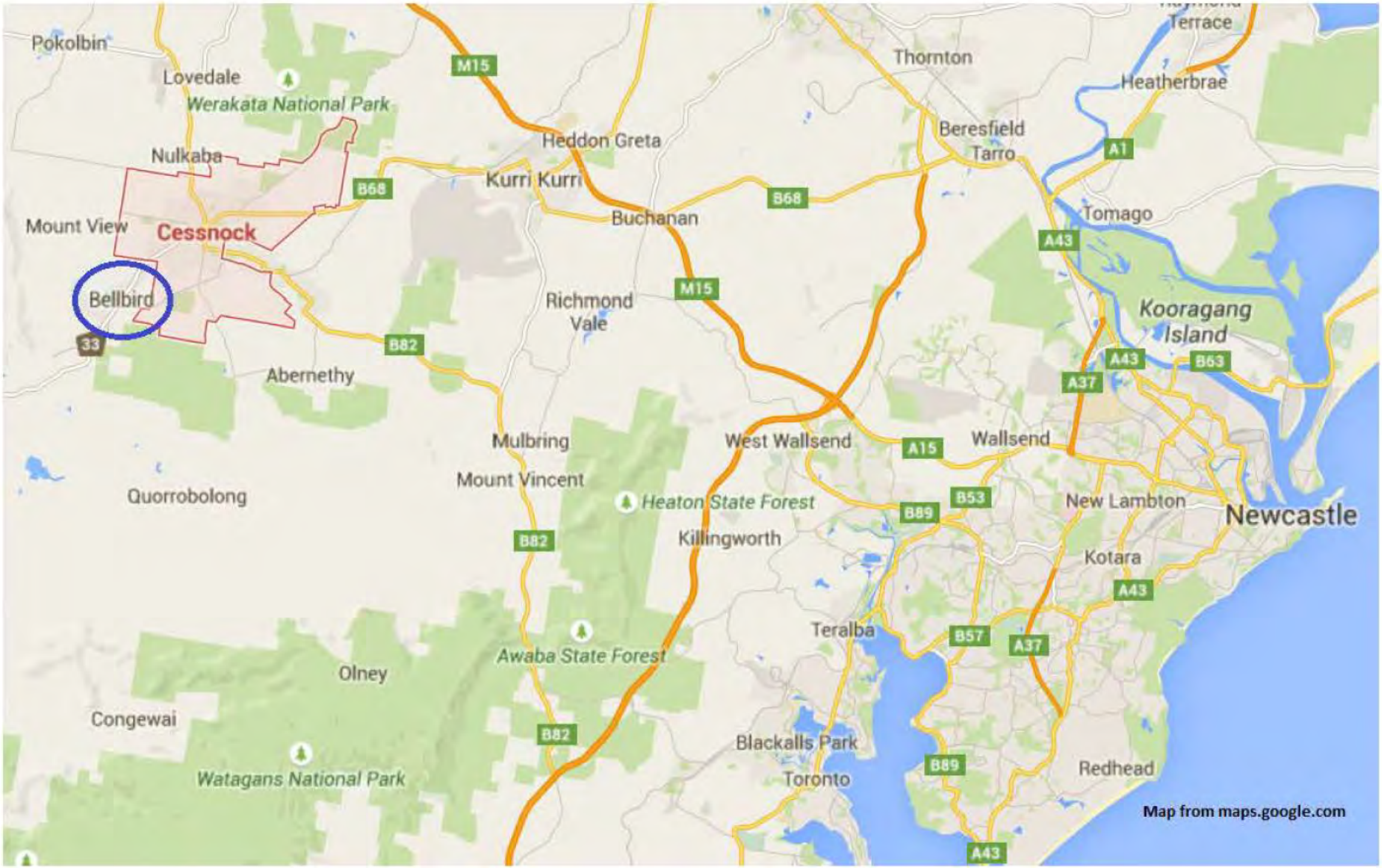
Bellbird Water

Appendix 3.2.5(a) Development Location


Pokolbin
Lovedale
Werakata National Park
Nulkaba
Mount View
Cessnock
Bellbird
33
B68
M15
Heddon Greta
Kurri Kurri
Buchanan
Richmond Vale
B82
Abernethy
Quorrobolong
Mulbring
Mount Vincent
Heaton State Forest
Killingworth
Awaba State Forest
Olney
Congewai
Watagans National Park
Thornton
Beresfield
Tarro
Terrace
Heatherbrae
A1
Tomago
A43
Kooragang Island
B63
A37
West Wallsend
A15
Wallsend
B53
B89
New Lambton
Newcastle
Kotara
Teralba
B57
Blackalls Park
Toronto
Redhead
Map from maps.google.com

Bellbird Water

Appendix 3.2.5(b) Development Masterplan and LWC Site

V S B Y

B B

S	B	S	
	9		9

A

A

A

A

A

A

A

A

WC

Da e 5 5 20 5

Rev A

D aw g No K00

S ae 0 50 100 150m
SCALE 1:3000 AT A0

BE BIRD
O A OU S

flow systems

Pressure System Solutions Pty Ltd
PLANNING, DESIGN & IMPLEMENTATION OF WATER & WASTEWATER SYSTEMS
Our Understanding and Experience Provides Certainty
PO Box 630 Jannali NSW 2226 T: +61 2 9584 1177
www.pssolutions.net.au F: +61 2 9584 1477

S 0 0 B

Appendix 3.2.5(c) Bellbird North Proposed Zoning Plan

Proposed LEP Zone Boundary

Cessnock City Council

3 of 4

B3
3.11 ha.

SP2
8077m²

R2
1.57 ha.

RE1
3765m²

LEP Legend

- R2 Low Density Residential
- B1 Neighbourhood Centre
- RE1 Public Recreation
- RU4 Rural Small Holdings
- SP2 Infrastructure
- Proposed Zone Boundary
- Bellbird North - Urban Release Area

0 100 200 300 400 500

Bar Scale 1: 10000 (A1), 1: 20000 (A3)

VER	DATE	COMMENT	DRAFTER
C	22/10/2014	AMEND PLANS	RC
D	29/10/2014	AMEND TITLE BLOCK	RC

PLAN PURPOSE: Proposed LEP Boundary

PROPERTY DESCRIPTION: Bellbird North Urban Release Area

COUNCIL: CESSNOCK

DWG REF: 239233U-PSK-005-D PM: MO

CLIENT:

JOHNSON PROPERTY GROUP

adw johnson

central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100

www.adwjohnson.com.au

URBAN PLANNING

• project management • civil engineering • infrastructure • superintendency • economic analysis • social impact • town planning • surveying • development feasibility • visualisation • urban planning

239233U-PSK-005-D

Plotted By: roberto Plot Date: 30/10/14 - 12:24 Cad File: N:\239233\239233U\dwg\239233U-PSK-002-2014-10-08-MO\239233U-PSK-005-D.dwg

"Copyright Notice" This plan and the information it contains are copyright and remain the property of ADW Johnson Pty Ltd. ADW Johnson Pty Ltd grants to the client named on this plan a license to use the information hereon for the purpose for which we were engaged to perform the work. Use of the plan and information it contains for any other purpose is not permitted unless prior written approval has been obtained from ADW Johnson Pty Ltd.

Bellbird Water

Appendix 3.2.5(d) Proposed Development Staging

V S B Y

B B

S	B	S	
	9		9

A

A

A

A

A

A

A

A

WC

Da e 5 5 20 5

Rev A

D aw g No K00

S ae 0 50 100 150m
SCALE 1:3000 AT A0

BE BIRD
O A OU S

flow systems

Pressure System Solutions Pty Ltd
PLANNING, DESIGN & IMPLEMENTATION OF WATER & WASTEWATER SYSTEMS
Our Understanding and Experience Provides Certainty
PO Box 630 Jannali NSW 2226 T: +61 2 9584 1177
www.pssolutions.net.au F: +61 2 9584 1477

S 0 0 B

Appendix 3.5.1(a) Gazettal of LEP Amendment for the Development

2011 No 38

New South Wales

Cessnock Local Environmental Plan 1989 (Amendment No 121)

under the

Environmental Planning and Assessment Act 1979

I, the Minister for Planning, make the following local environmental plan under the *Environmental Planning and Assessment Act 1979*. (NEW0000156/PC-1)

TONY KELLY, MLC
Minister for Planning

Cessnock Local Environmental Plan 1989 (Amendment No 121)

under the

Environmental Planning and Assessment Act 1979

1 Name of plan

This plan is *Cessnock Local Environmental Plan 1989 (Amendment No 121)*.

2 Land to which plan applies

This plan applies to the land shown edged heavy black on the map marked "Cessnock Local Environmental Plan 1989 (Amendment No 121)" deposited in the office of Cessnock City Council.

3 Amendment of Cessnock Local Environmental Plan 1989

(1) Clause 5 Definitions

Insert in appropriate order in the definition of ***the map*** in clause 5 (1):

Cessnock Local Environmental Plan 1989 (Amendment No 121)

(2) Clause 66 Public infrastructure in urban release areas

Insert in appropriate order in the definition of ***urban release area*** in clause 66 (8):

Cessnock Local Environmental Plan 1989 (Amendment No 121)

Appendix 3.5.1(b) Planning Proposal for the LWC Site Re-zoning

ADW JOHNSON PTY LIMITED
ABN 62 129 445 398

planning

working beyond expectations

Planning Proposal

Land:
North Bellbird
Part Lot 1 DP 597226
Part Lot 1 DP 327785
Lot 2 DP 597226

Applicant:
Johnson Property Group Pty Ltd

Date:
October 2014

adw johnson

project management • town planning • engineering • surveying
visualisation • economic analysis • social impact • urban planning

www.adwjohnson.com.au

Document Control

Issue No.	Date	Author	
		Name	Reviewed
A - Draft	14/10/2014	Kristy Sibanda	Craig Marler
B – Draft	22/10/2014	Kristy Sibanda	Craig Marler
C – Final	30/10/2014	Kristy Sibanda	Craig Marler

ADW Johnson Pty Limited
ABN 62 129 445 398

hunter region
7/335 hillsborough road
warners bay nsw 2282
ph. 02 4978 5100
fax. 02 4978 5199
email. hunter@adwjohnson.com.au

central coast
po box 3717
tuggerah nsw 2259
ph. 02 4305 4300
fax. 02 4305 4399
coast@adwjohnson.com.au

Table of Contents

DOCUMENT CONTROL 1

1.0 INTRODUCTION 1

1.1 SUMMARY OF PROPOSAL 3

1.2 URBAN RELEASE AREA PLANNING OBJECTIVES 4

2.0 SITE & LOCALITY 5

3.0 THE PROPOSAL 9

4.0 ENVIRONMENTAL CONTEXT 12

5.0 PLANNING CONTEXT 17

6.0 EXPLANATION OF PROVISIONS 20

7.0 JUSTIFICATION FOR THE PROVISIONS 21

7.1 NEED FOR THE PLANNING REQUEST 21

7.2 RELATIONSHIP TO STRATEGIC PLANNING FRAMEWORK 29

7.3 ENVIRONMENTAL, SOCIAL AND ECONOMIC IMPACT 33

7.4 STATE AND COMMONWEALTH INTERESTS 35

8.0 CONCLUSION 36

APPENDIX A 37

PLANS OF PROPOSED CLEP 2011 ZONE MAP AMENDMENTS 37

1.0 Introduction

The subject site, within which the proponent, Johnson Property Group (JPG), seeks a proposed amendment to the Cessnock Local Environmental Plan (CLEP) 2011, is described as Part Lot 1 DP 597226, Lot 2 DP 597226, and Part Lot 1 DP 327785, at North Bellbird.

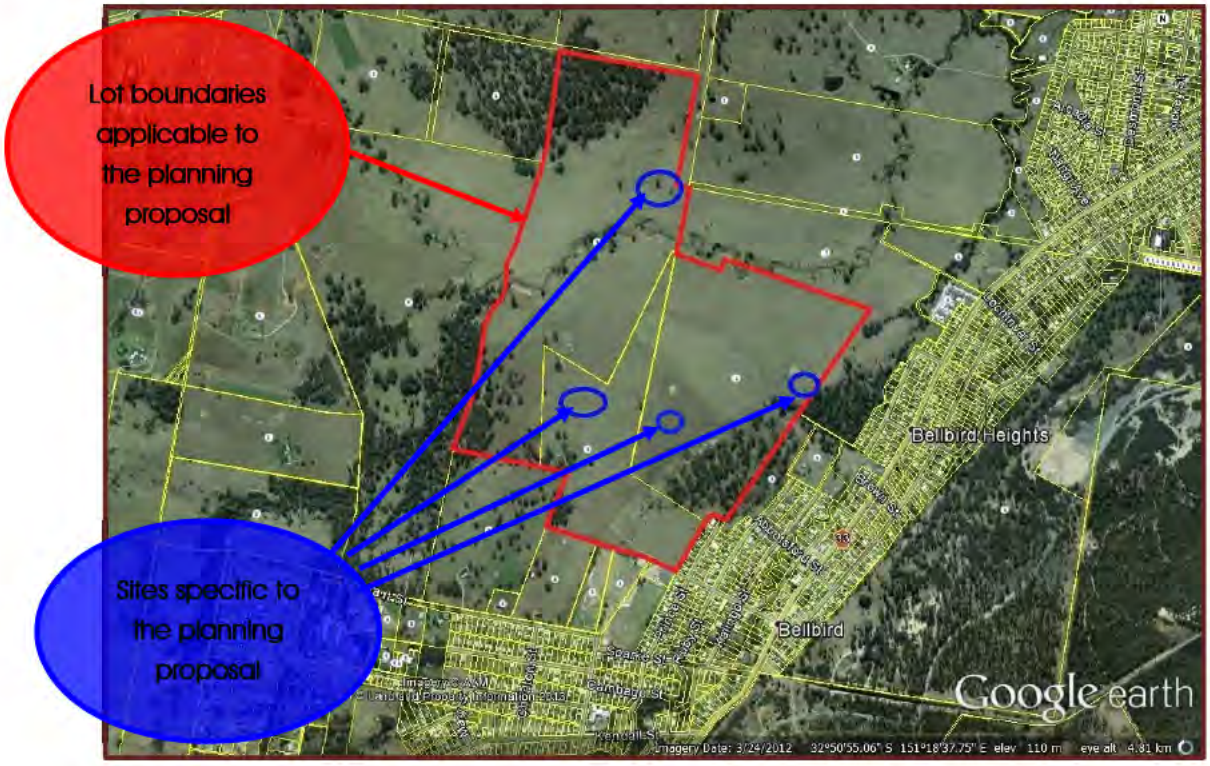


Figure 1: North Bellbird Site Location of Planning Proposal.

The North Bellbird site the subject of this Planning Proposal forms part of the North Bellbird Urban Release Area.

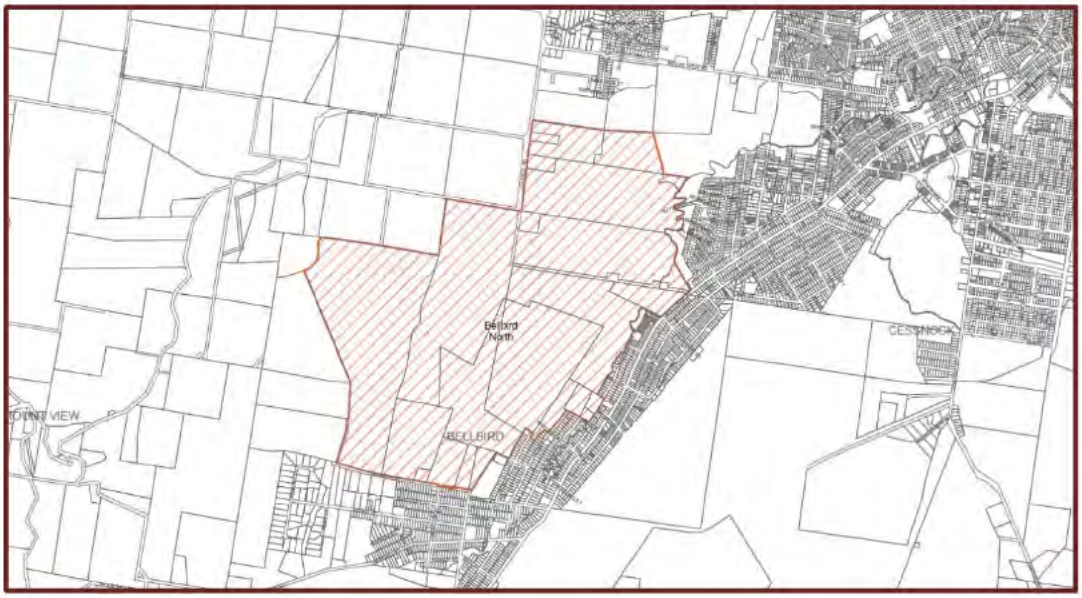


Figure 2: North Bellbird Urban Release Area.

From an initial application in 2006, the North Bellbird Urban Release area was rezoned in 2011 to a combination of residential, commercial and public open space zoned lands. The zonings are based on a masterplan dated 20.07.2006.

Land use zoning is now controlled by Cessnock LEP 2011, with the North Bellbird Urban Release Area including a combination of R2 Low Density Residential, B1 Neighbourhood Centre and RE1 Public Recreation zoned lands.

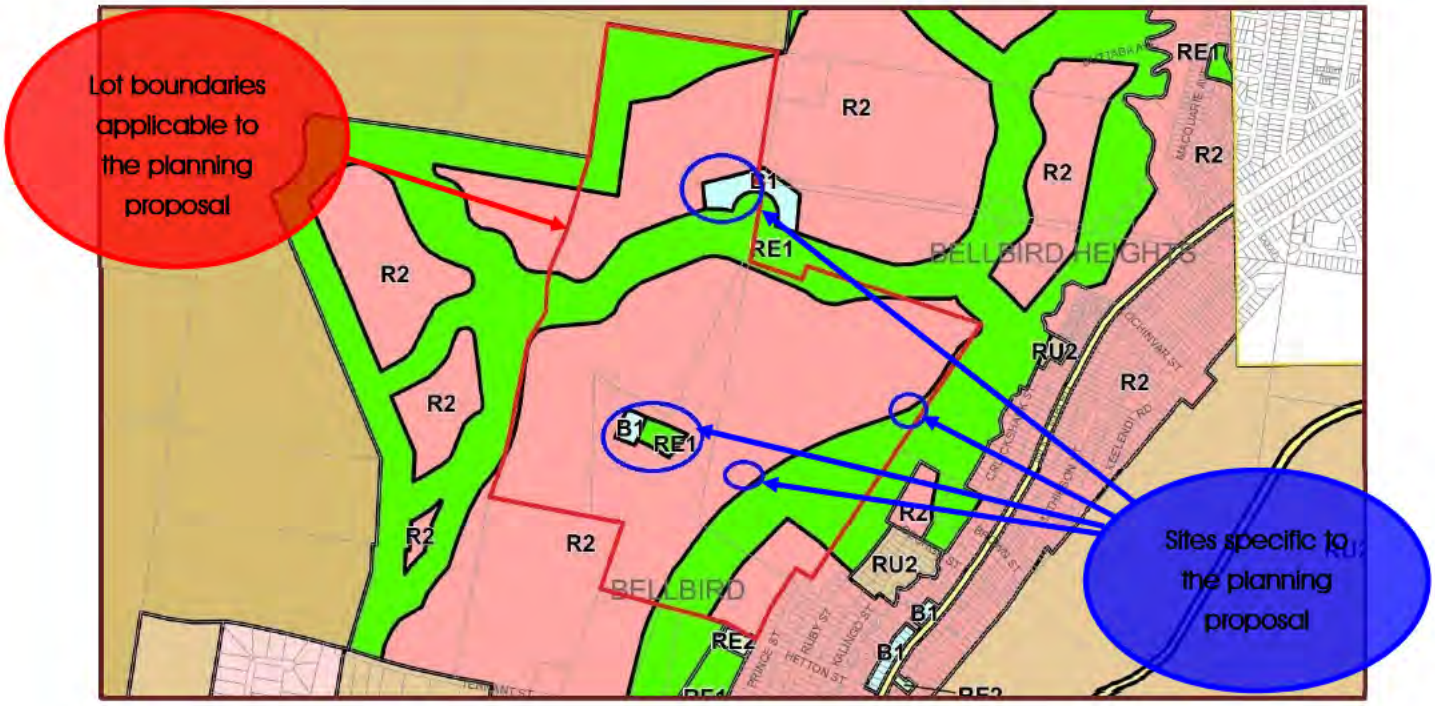


Figure 3: Zone Extract from CLEP 2011.

JPG successfully secured development consent for a sixty-two (62) lot staged subdivision in December 2013, for which they have recently secured construction certificate approvals (please refer to the blue outlined area in the figure below). Construction is expected to commence by the end of 2014.

JPG are currently investigating the most appropriate development strategy for the next stages of the proposed subdivision.

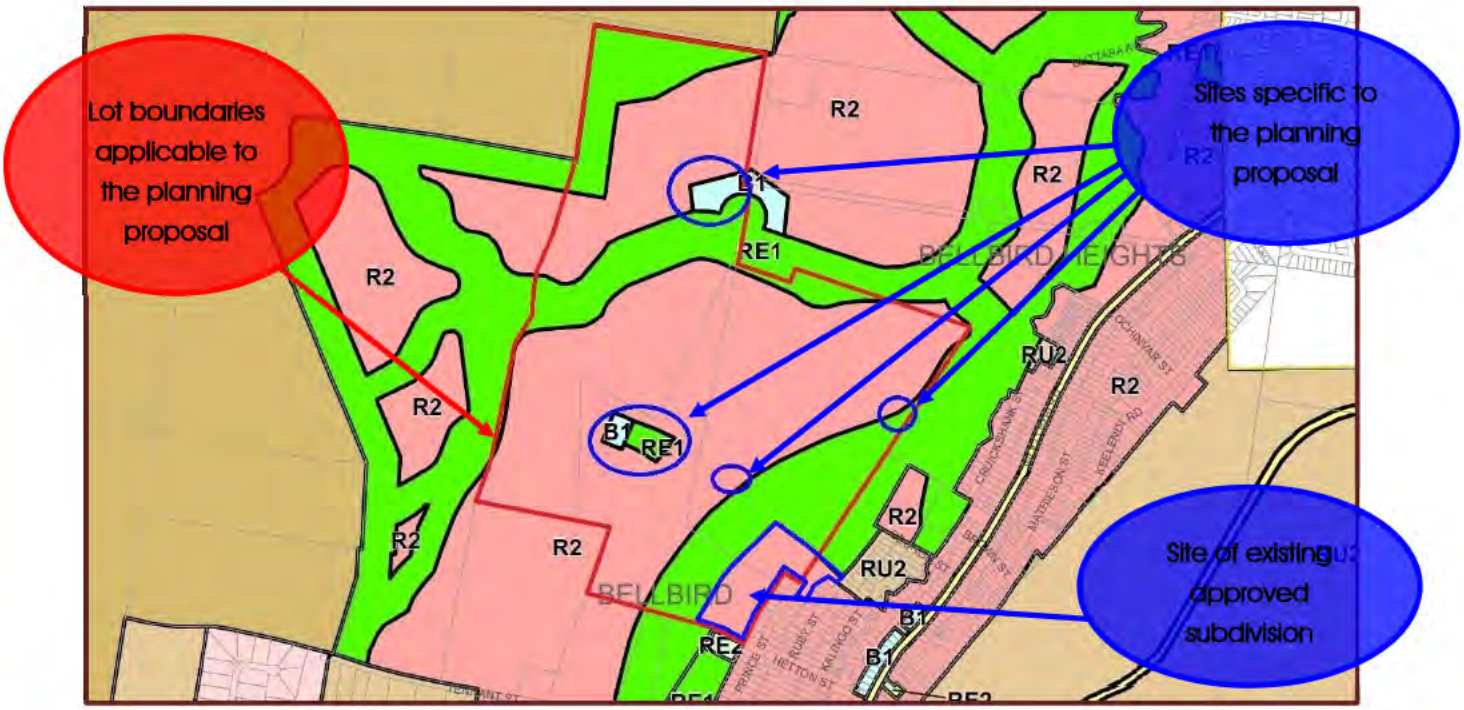


Figure 4: Zone extract from CCC LEP 2011 showing approved subdivision, lot boundaries applicable to the planning proposal, and sites specific to the planning proposal.

1.1 SUMMARY OF PROPOSAL

As part of progressing development of that part of the release area under JPG control, this planning proposal seeks a number of changes to the Cessnock LEP 2011 in order to facilitate and complement the proposed subdivision development, and future development.

In particular it has become necessary to provide for a wastewater recycling facility within an appropriate location to service the future residential lots to be released. In addition, it has been identified that commercially zoned land would be best consolidated on the site to provide for a more logical outcome and subdivision layout, as well as providing a commercial zone that will support a supermarket. Furthermore, it has been identified that the proposed centrally located park within the Masterplan would be best relocated to adjoin a larger corridor of RE1 zoned land within the site to also provide a more logical outcome and effective subdivision layout.

The proposed amendments therefore include the following:

- Zone change of 3538m^2 of RE1 Public Recreation land and 4539m^2 of R2 Low Density Residential Land to SP2 Infrastructure zone within Lot 1 DP 327785 (total of 8077m^2) to facilitate a proposed wastewater recycling facility;

- Zone boundary change of 1.47ha of B1 Neighbourhood Centre land, and 1.64ha of R2 Low Density Residential land to B3 Commercial Core zone (Lot 2 DP 597226) to consolidate commercial land on the site and accommodate a supermarket and other shop spaces with a Gross Lettable Area of approximately 4,175m^2, future expansion area of 2,025m^2, and car parking.

- Zone change of 5942m^2 of land from B1 Neighbourhood Centre to R2 Low Density Residential (Lot 1 DP 597226) resulting from consolidation of commercial land within the site, and so as not to compete with existing shops in Wollombi Road;

- Zone change of 9800m^2 of land from RE1 Public Recreation to R2 Low Density Residential (Lot 1 DP 597226), part of which is to be relocated (as per the following zone change); and

- Zone change of 3,765m^2 of land from R2 Low Density Residential to RE1 Public Recreation (Lot 1 DP 327785) to accommodate relocation of part of the RE1 zoned land currently on Lot 1 DP 597226.

Refer to **Figures 7** and **8** and **Appendix A** for a visual representation of the proposed amendments to the LEP zone boundaries.

1.2 URBAN RELEASE AREA PLANNING OBJECTIVES

The planning proposal, allowing for the proposed waste water recycling facility and rationalisation of commercially zoned land, will facilitate Council objectives for development of the North Bellbird Urban Release Area. The specific objectives for development of the Urban Release Area as contained in DCP 2010 are:

(a) To designate appropriate areas for development and conservation;

(b) To provide accessible neighbourhoods with an interconnected network of streets which provides safe, direct access to public transport;

(c) To facilitate appropriate mixed use development which is compatible with residential amenity, capable of adapting over time as the community changes, and which reflects community standards of health, safety and amenity;

(d) To provide a variety of lot sizes and housing types to cater for the diverse housing needs of the community at a density that can ultimately support the provision of local services;

(e) To provide for appropriate development of the land having regard to general flooding considerations and the need for specific development controls catering for development affected by the Probable Maximum Flood (PMF) event;

(f) To protect areas of significant vegetation and to enhance the habitat of threatened species, and promote biodiversity;

(g) To protect the water quality of receiving streams and to reduce land degradation; and

(h) To reduce the potential for land use conflict between the development arising as a result of the subdivision of the land and neighbouring viticultural and non-viticultural rural land uses by ensuring sympathetic location and design of new subdivisions.

These specific policy objectives provide the strategic context for the Planning Proposal.

2.0 Site & Locality

The site is located at North Bellbird, which is located approximately 4km southwest of the Cessnock CBD.

The following figures show the location of the site within the Bellbird area, and within the broader context of Cessnock.

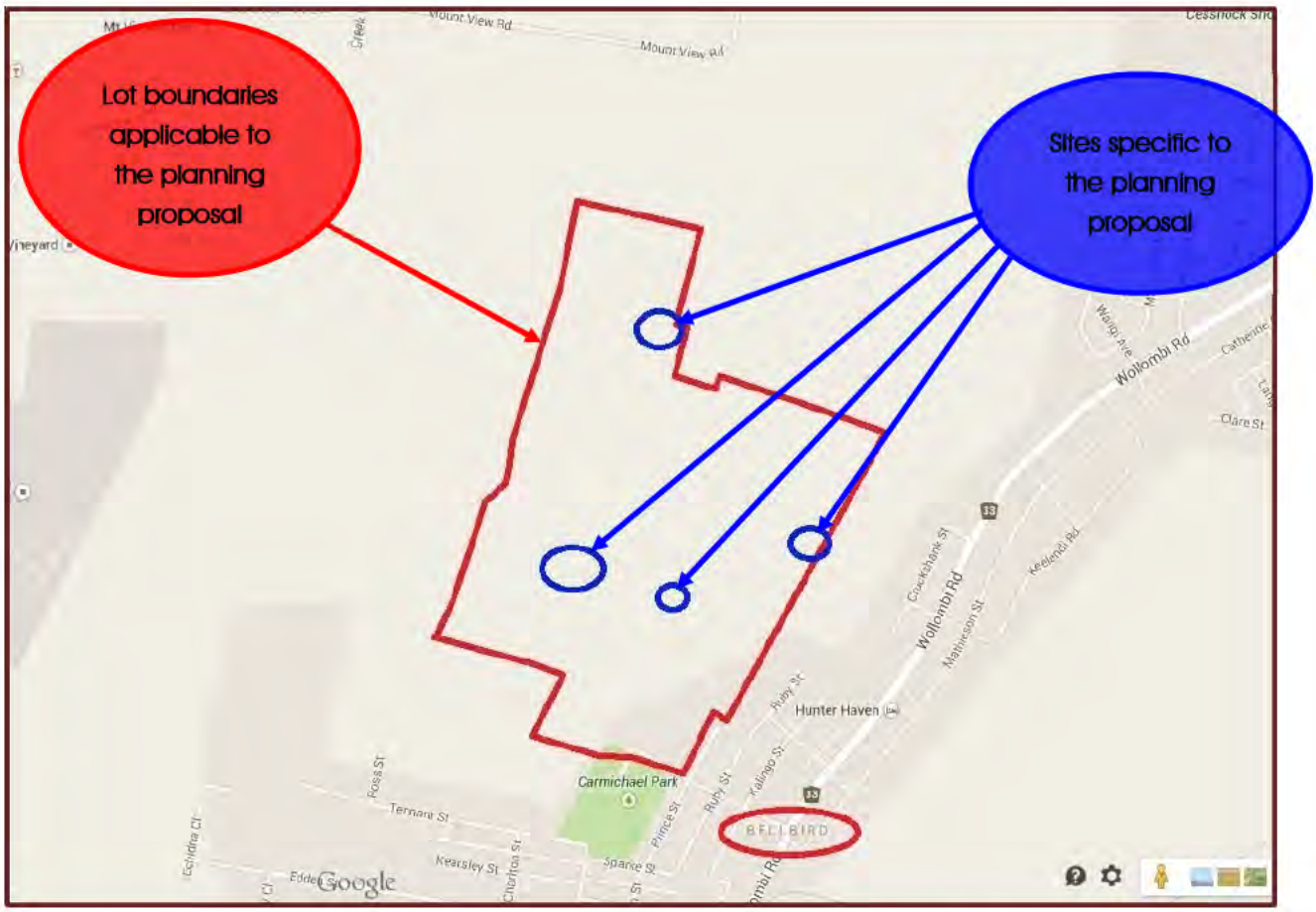


Figure 5: Approximate locality of the site within the Bellbird area.

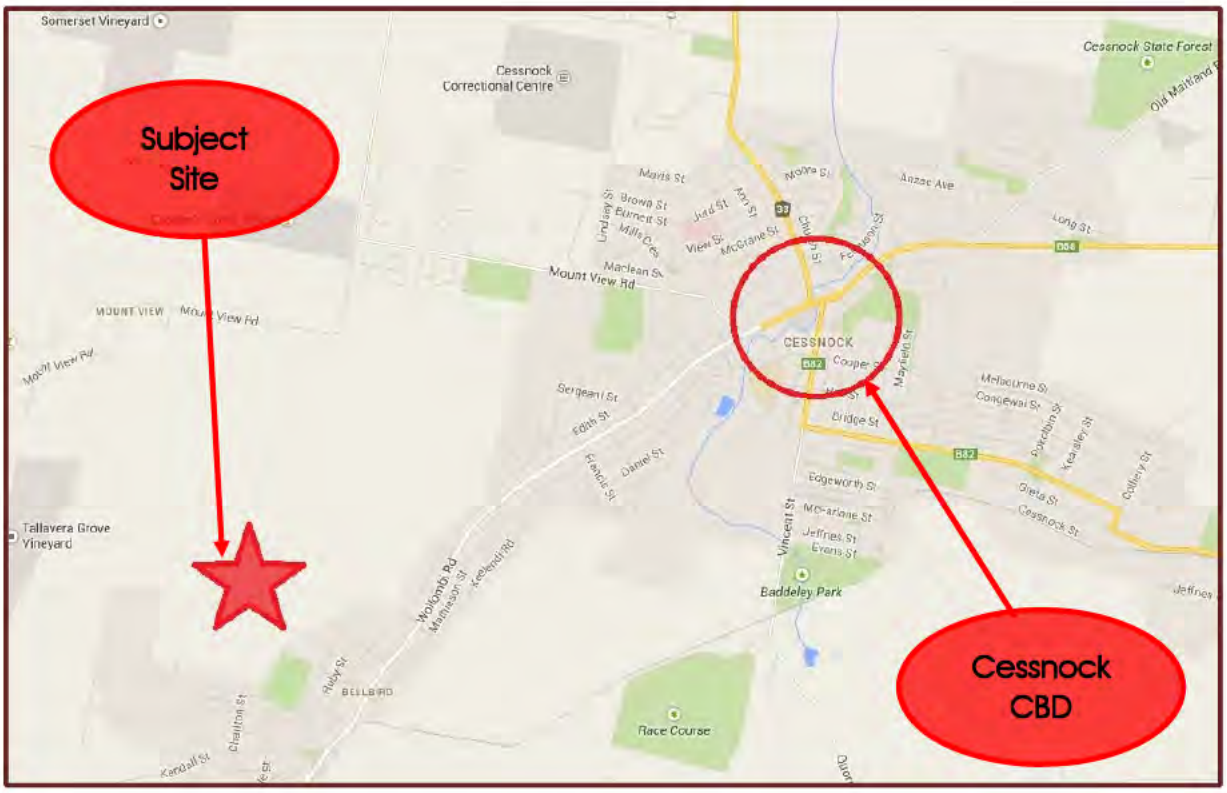
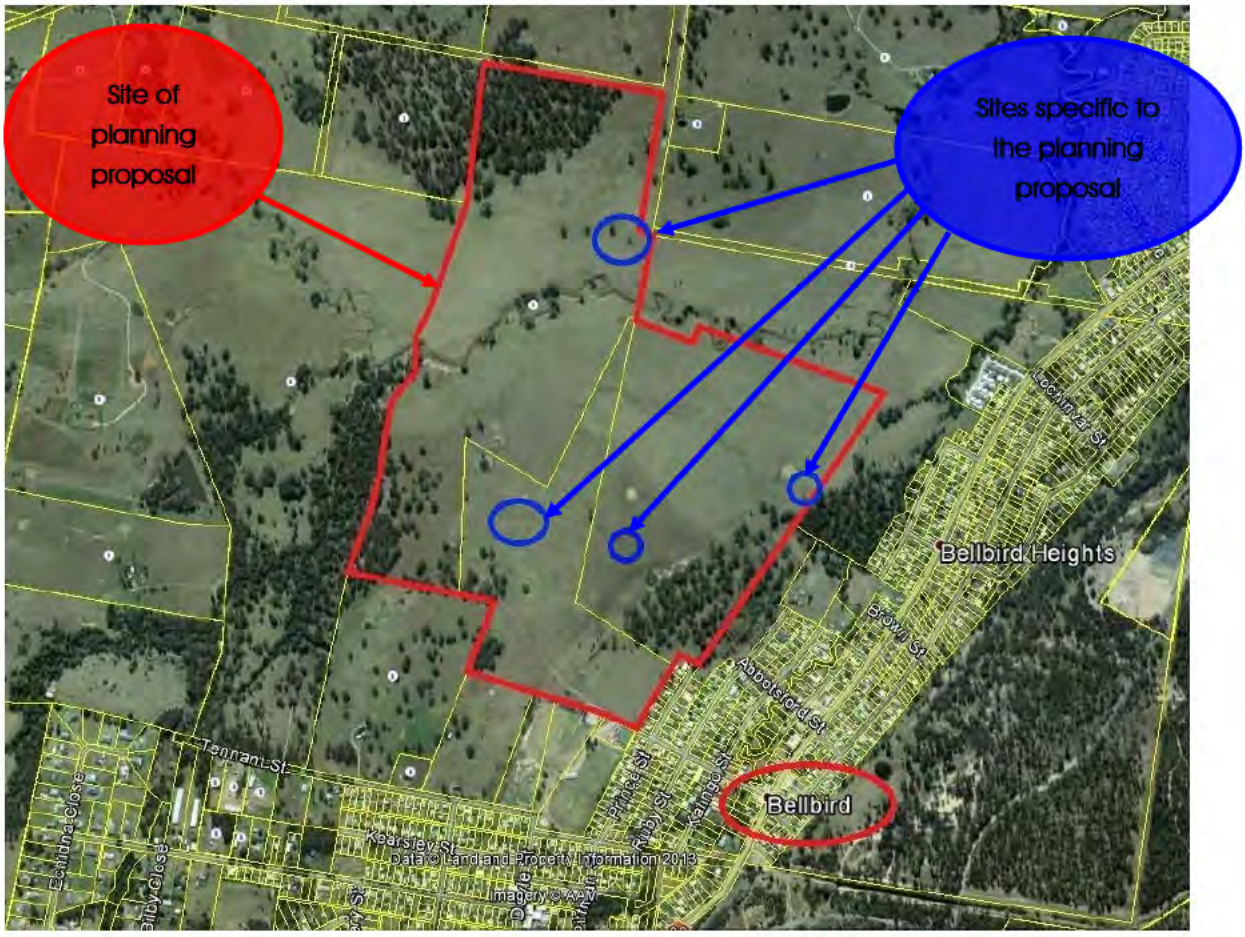
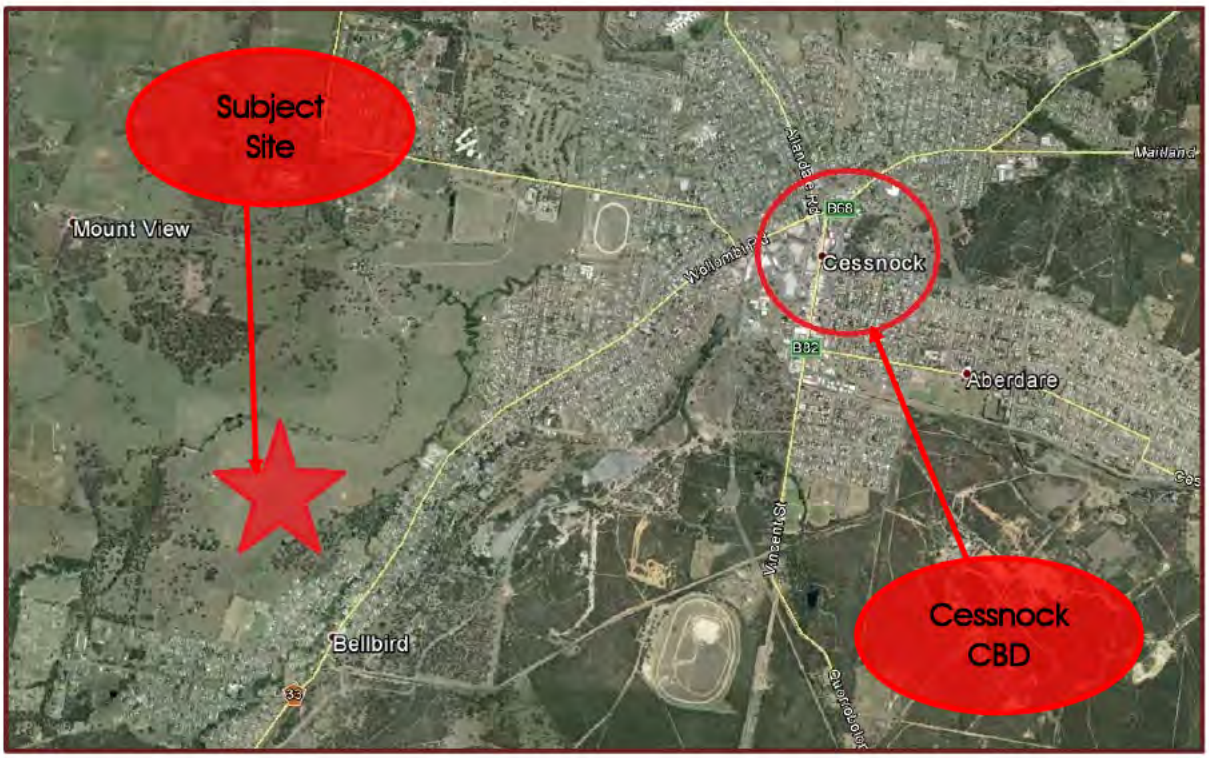


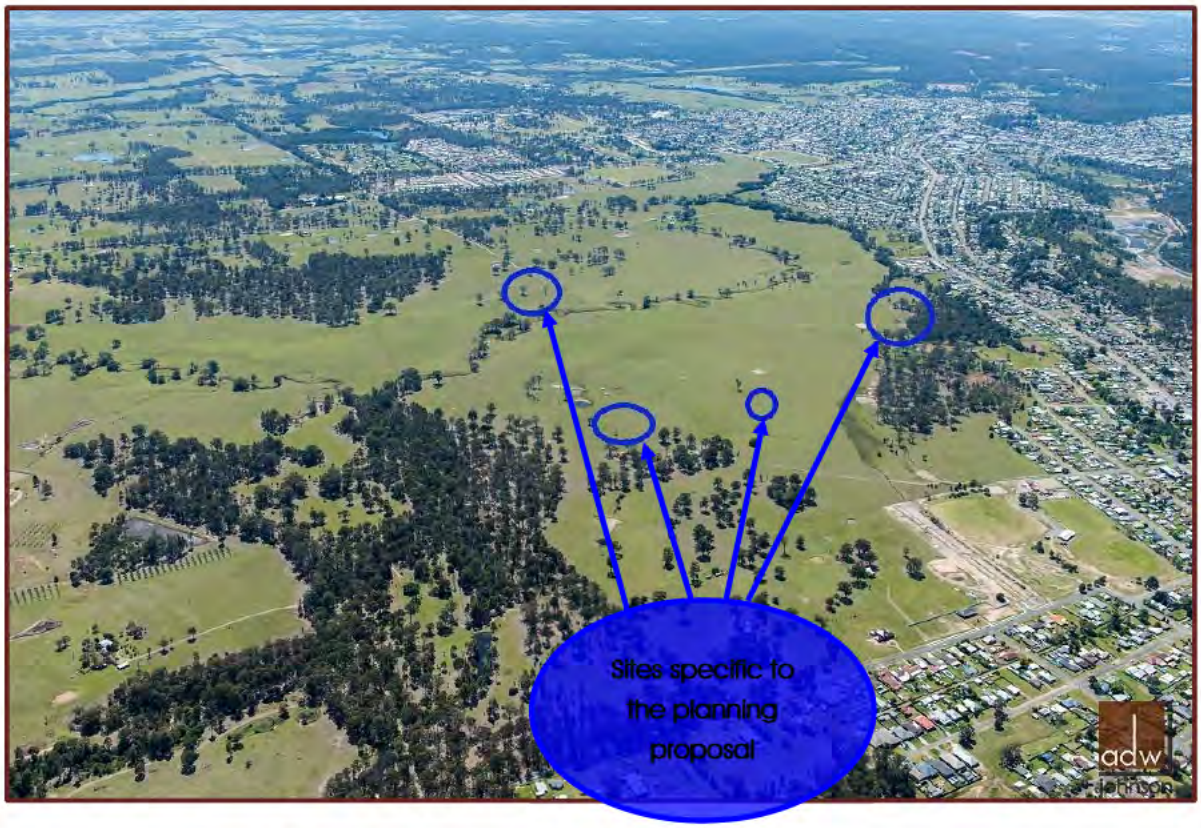
Figure 6: Approximate locality of the site within the broader Cessnock area.



Aerial Photo 1: Locality of the site within the Bellbird area.



Aerial Photo 2: Approximate locality of the site within the broader Cessnock area.



Aerial Photo 3: Aerial photo of subject site looking northeast.

The sites subject of this planning proposal comprises land within a number of parcels of land including:

- Part Lot 1 DP 597226;
- Lot 2 DP 597226; and
- Part Lot 1 DP 327785.

The above lots in their entirety have a total site area of 142.16ha.

The proposed land rezoning affects some 5.86ha of land within the site.

3.0 The Proposal

As part of progressing development of that part of the release area under JPG control, this planning proposal seeks a number of amendments to the Cessnock LEP 2011 in order to facilitate and complement the proposed subdivision, and future development.

Zone Change from RE1 Public Recreation and R2 Low Density Residential to SP2 Infrastructure (Lot 1 DP 327785)

As part of progressing the proposed subdivision development, the model for delivery of infrastructure (and in particular sewer infrastructure) has been investigated.

Subsequently, JPG seek an amendment to CLEP 2011 for a rezoning of approximately 3538m^2 of RE1 Public Recreation zoned land and 4539m^2 of R2 Low Density Residential zoned land along the eastern side of Lot 1 DP 327785, to an SP2 Infrastructure zone. Total area of land to be rezoned to SP2 is 8077m^2.

This zoning outcome is sought to facilitate an appropriate location for a wastewater recycling facility to service future JPG development, and reflects the approach made in other release areas in the Lower Hunter for sustainable local water utility outcomes.

JPG has engaged Flow Systems (a licenced entity) to provide the wastewater recycling facility and resultant water utility services to future residential subdivision development. For this purpose, Flow Systems has established a special purpose local water utility known as Bellbird Water. Bellbird Water will seek a network operator's licence under the NSW Water Industry Competition Act 2006 to construct, operate and maintain these services. Flow Systems will also apply to have its state-wide retail supplier's licence varied to allow the retailing of water services to the Bellbird North development.

Bellbird Water will harvest sewage from the development, treat it on site to a high quality in accordance with the Australian Guidelines for Water Recycling and return it to the development for non-potable uses such as toilet flushing, washing machine use and irrigation. The Bellbird Water recycling facility will be known as the Bellbird Local Water Centre (LWC). This is considered to be a significant benefit of the proposed facility compared with the standard sewer disposal system.

Whilst Hunter Water has indicated capacity to accept sewage collection via the proposed subdivision low pressure sewerage network on an interim basis (capacity is approximately 150 lots), Hunter Water's capacity has largely been exhausted by existing subdivision development. Consequently, the necessary upgrades required to access Hunter Water's low pressure sewerage network on a long-term and permanent basis for the proposed and future development of the area would be financially prohibitive to development. The construction of the wastewater recycling facility is considered to be a suitable and more sustainable option for the proposed and future development of the urban release area.

Bellbird Water will source drinking water from Hunter Water to distribute and retail to Bellbird North residents. The LWC site will also provide space for drinking water storage reservoirs.

Zone Change from B1 Neighbourhood Centre and R2 Low Density Residential to B3 Commercial Core (Lot 2 DP 597226)

JPG also seeks an amendment to CLEP 2011 for modification to the boundaries of that part of the B1 Neighbourhood Centre zoned land located on Lot 2 DP 597226, to provide an increased and more regular shaped area in response to market input. The planning proposal seeks an increase of commercial zoned land in the order of 1.64ha.

Further to this, JPG seeks an amendment to CLEP 2011 to rezone the B1 Neighbourhood Centre zoned land (1.47ha), and R2 Low Density Residential zoned land (1.64ha - resulting from the increased area of commercial land as described above) on Lot 2 DP 597226, to B3 Commercial Core to more appropriately accommodate a supermarket and other shop spaces with a Gross Lettable Area of approximately 4,175m^2, future expansion area of 2,025m^2, and car parking. Total area to be rezoned is 3.11ha.

The proposed and future subdivisions within the North Bellbird urban release area, and others in proximity to the area, will see a demand for a consolidated B3 Commercial Core Zone to service the area and surrounds.

Zone Change from B1 Neighbourhood Centre and RE1 Public Recreation to R2 Low Density Residential (Lot 1 DP 597226)

As part of the progression of the proposed subdivision and as a result of refinement of the layout since the initial Master plan of 2006, JPG also seek an amendment to CLEP 2011 to rezone a small portion of B1 zoned land (5942m^2) and a small portion of RE1 zoned land (9800m^2) on Lot 1 DP 597226 to R2 Low Density Residential. Total area to be rezoned is 1.57ha.

As a result of the proposed increase in the area of the existing B1 Neighbourhood Centre zoned land (proposed for B3 zoning) on Lot 2 DP 597226, the smaller portion of B1 zoned land on Lot 1 DP 597226 is considered unnecessary and inefficient in respect to the proposed neighbourhood design. Encouraging use of the existing shops along Wollombi Road, rather than competing against them, is considered to be a better outcome.

Similarly, the small portion of RE1 zoned land (park space) adjacent to the existing B1 zoned land centrally located on the site, is also considered to be ineffective and isolated in its current location, and is considered to be better placed adjacent to the larger RE1 corridor within the eastern section of the urban release area (proposed zoning to accommodate this is described below).

Zone Change from R2 Low Density Residential to RE1 Public Recreation (Lot 1 DP 327785)

In order to facilitate the relocation of part of the RE1 zoned land (park space) from Lot 1 DP 597226 to the existing RE1 corridor on Lot 1 DP 327785 as described above, a rezoning of a 3,765m^2 portion of R2 Low Density Residential land adjoining the existing RE1 corridor in the southeast of Lot 1 DP 327785 is proposed to be zoned RE1 Public Recreation. It is noted that approximately 1,235m^2 of existing RE1 zoned land within the corridor adjacent the 3,765m^2 portion of R2 zoned land proposed to be rezoned RE1, will combine with the land to be rezoned to accommodate at least a 5,000m^2 local park in accordance with Council's guidelines.

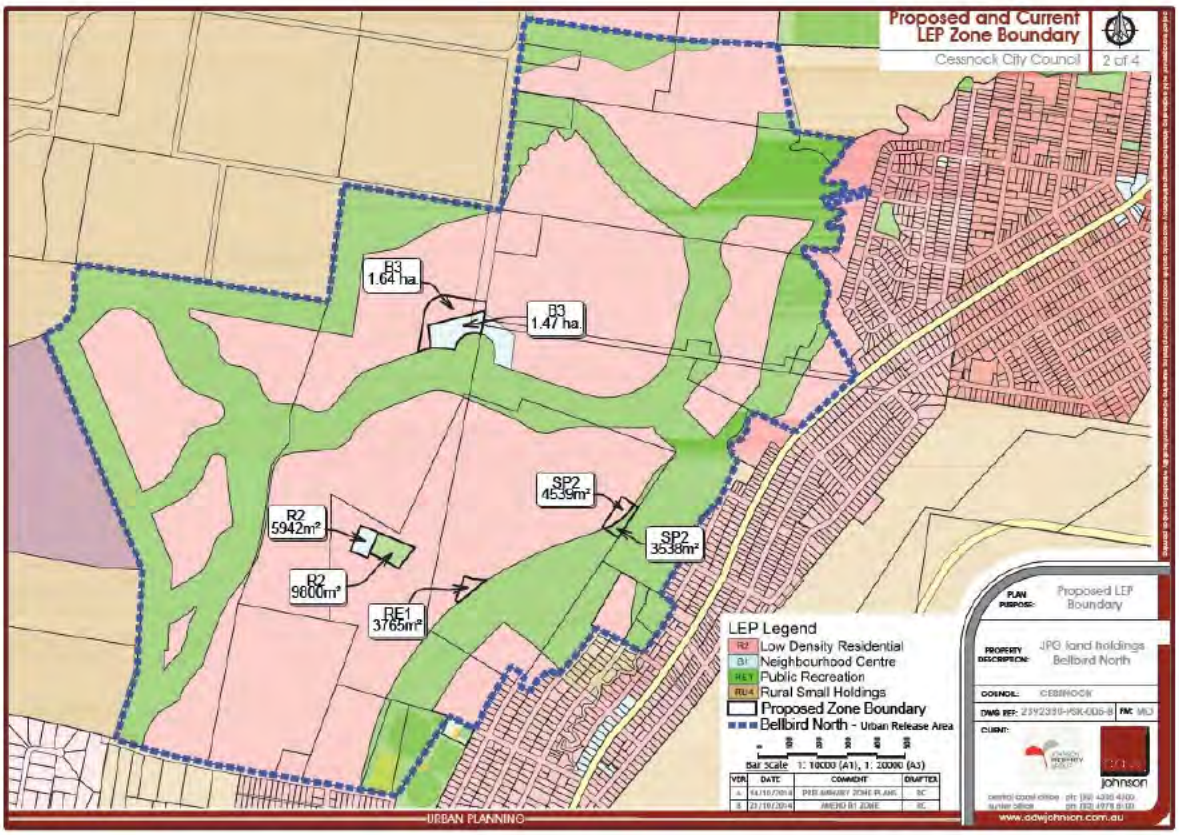


Figure 7: Current and proposed zone boundaries (larger plan attached at Appendix A).

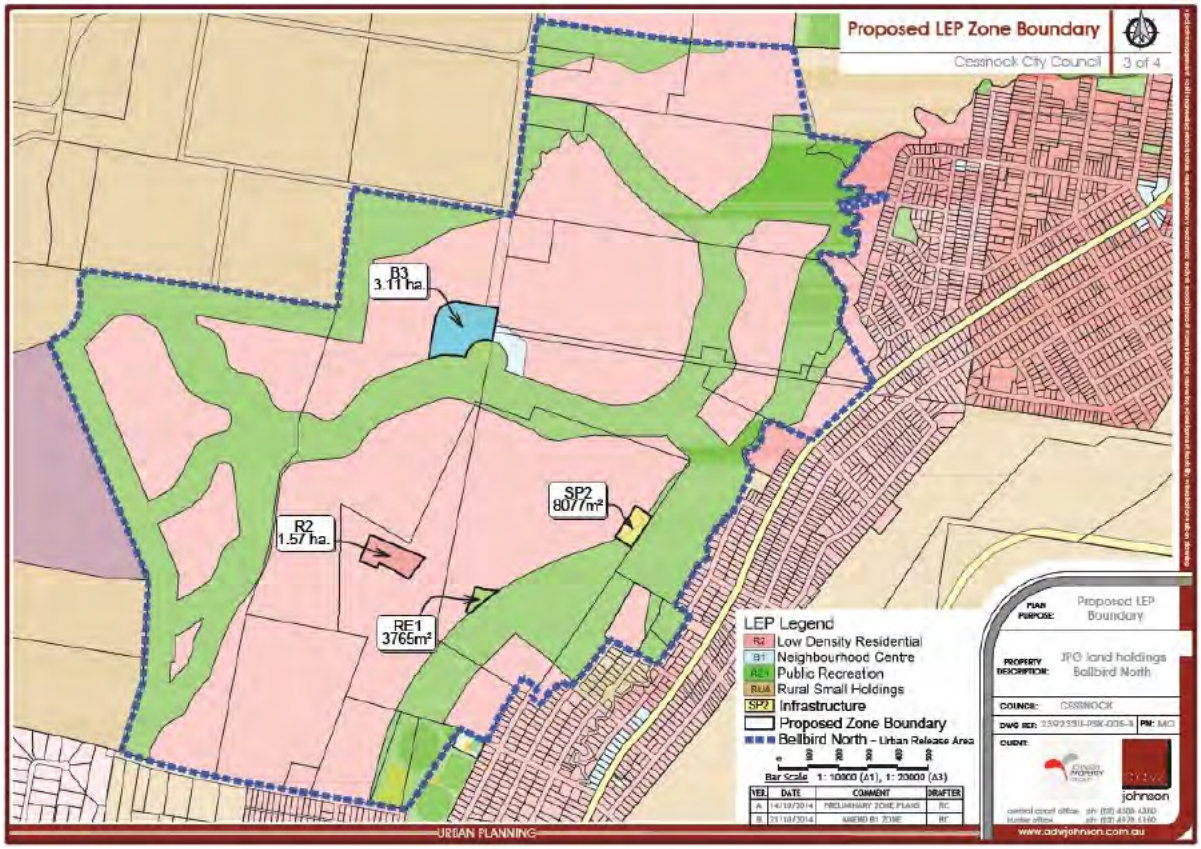


Figure 8: Proposed LEP zone boundaries (larger plan attached at Appendix A).

4.0 Environmental Context

The proposal seeks to facilitate the future development of a site containing residential, commercial and public recreation land uses.

Environmental land constraints identified on the site were addressed as part of the previous approved rezoning, and there are not considered to be any constraints over the site that would preclude the proposed LEP amendments, and future subdivision developments.

A desktop study of environmental constraints, inspection of the site, and previous studies undertaken reveal the following:

- The site is not located within a proclaimed Mine Subsidence District and is not subject to any building restrictions imposed by the Mine Subsidence Board;
- The site does not contain Acid Sulphate Soils;
- The site is not located within the NSW coastal zone;
- The subject site is not considered to contain contamination levels that would limit the development of the site; and
- The subject site is designated as bushfire prone land by Cessnock City Council.

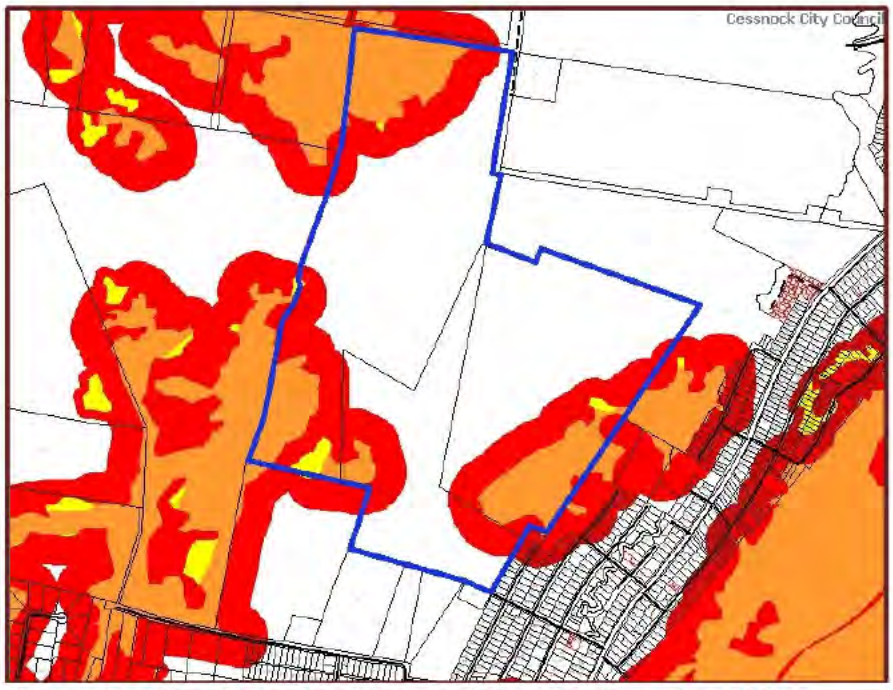


Figure 9: Extract from the Cessnock Bushfire Prone Land Map.

A Bushfire Planning Assessment was undertaken by HWR Pty Ltd as part of the previous rezoning in 2006.

The Bushfire Planning Assessment notes that a structure plan was developed for the North Bellbird Investigation Area which included a development footprint. This footprint was adopted as the basis for the bushfire planning assessment, and the analysis was based on the assumption that the existing mix of vegetation in areas not within the footprint would be maintained. The proposed LEP zone boundary plan attached at **Appendix A** generally remains consistent with the development footprint established by the initial structure plan.

The Bushfire Planning Assessment indicated that all areas of residential development adjoining vegetation requires a minimum building setback of 20m. This is increased with denser vegetation types and steeper slopes between the vegetation and the residential development.

The Bushfire Planning Assessment noted that a number of possible treatments could be employed to the design of APZs to meet these setback requirements. For example, it is likely that 20m setbacks could be catered for within a perimeter road reserve.

The Bushfire Planning Assessment also identified that specific building construction standards may be required for dwellings adjacent to remnant vegetation areas.

The Bushfire Planning Assessment stated that there are no matters with respect to bushfire risk to preclude development within the North Bellbird Investigation Area (now known as the North Bellbird Urban Release Area).

Similarly, the proposed LEP amendment is minor in nature, and is not considered to alter the above conclusions of the Bushfire Planning Assessment.

- The site is identified as being flood affected.

  A Flooding and Stormwater Assessment was undertaken by Parsons Brinckerhoff as part of the previous approved rezoning.

  The Flooding and Stormwater Assessment indicates that the majority of the study area drains in a north-easterly direction to the township of Cessnock.

  Hydraulic modelling of drainage lines crossing the site indicated that approximately 77ha (16%) of the proposed development site (North Bellbird Urban Release Area) is subject to inundation during the 100 year flood event.

  An extreme flood event such as the PMf will result in additional inundation over and above the 100 year ARI flood event. An emergency evacuation plan will need to be developed in consultation with Council and SES. An evacuation plan may also include locations elevated above the PMF level, where residents may safely congregate during an extreme flood event.

  Hydrologic modelling of existing and developed conditions suggests that there will be a negligible change in peak discharges for the 1, 5, 10, 20 and 100 year ARI storm events operating on the scale of the Bellbird Creek catchment to the outlet of the development site. Thus, it is unlikely that downstream flooding from events operating on a catchment scale, and producing the greatest flow rates, will be exacerbated as a result of developing the site.

Hydrologic modelling of existing and developed conditions suggests however that there will be an increase in existing peak discharges for the 1, 5, 10, 20 and 100 year ARI storm events operating on the local development catchment scale. It is recommended that detention storage be provided as part of future development to mitigate developed flows to existing conditions.

Future water quality solutions for the site should be analysed and designed in accordance with the recommendations of Australian Runoff Quality (Engineers Australia, 2006). Water quantity management structures should be designed in accordance with Cessnock City Council's drainage handbook.

More specifically, in regards to the location of the proposed Local Water Centre (wastewater recycling facility), it is proposed to be located in open space, adjacent to, but clear of, a small tributary that drains into Bellbird Creek. The tributary is ephemeral in nature and as such is typically dry except in response to rain events. It is proposed to locate the LWC above the 1% AEP Flood Level (or 1 in 100 year storm event), with 500mm freeboard. The proposed flood planning level is consistent with the requirements for residential development in *NSW Floodplain Development Manual* and *Cessnock City Council Engineering Specifications.*

Flood levels have been obtained from the "*Floodplain Risk Management and Stormwater Management Strategy – Patterson Britton 2007".* This report was undertaken to support the previously approved rezoning process, and defined the 1% AEP flood extents and the riparian corridor. Flows were calculated using an XP RAFTS hydrological model under post development conditions, and flood extents were modelled using HEC RAS, a 1-Dimensional model commonly used to model flood extents. At the proposed location of the water recycling facility the 1% AEP level was determined as approximately RL 88.5. Therefore, the minimum floor level of the LWC is to be set at RL 89. It should be noted that due to the topography at the recycling facility site, it is likely that the floor level will be set closer to RL 90.5 to allow for a level building pad, which will provide the recycling facility with flood immunity for storm events greater than the 1% AEP.

Generally the proposed rezoning is considered to be minor in nature, and will not alter the conclusions of the initial Flooding and Stormwater Assessment undertaken which indicate that flooding on the site will not preclude future residential development.

- The site is identified as containing some Endangered Ecological Communities and Threatened Species.

  Separate Flora and Fauna Assessments were undertaken by Anne Clements and Associates Pty Ltd and Andrews Neil Pty Ltd respectively, for the previous approved rezoning.

  The abovementioned flora and fauna assessments previously undertaken indicate that the sites specific to the proposed LEP amendments are not identified as containing any threatened species, nor any EECs, and as such, the proposed rezoning will not have an adverse impact on the management of flora and fauna on the site.

  A European Heritage Assessment was undertaken by Stedinger Associates as part of the previous rezoning. As a whole the site is considered to not have European historical, aesthetic,

social, or scientific heritage significance, however the site does contain 'the slaughterhouse' on Lot 1 DP 597226), which is considered to have moderate historical and aesthetic scientific significance at a local level.

It is noted that the European heritage item identified on the site, the Slaughterhouse, is not located within the specific sites of the planning proposal, and as such the proposed LEP amendments are considered to not have any impacts on this item, or management of the item.

- The subject site contains evidence of Aboriginal use and occupation, including Aboriginal stone artefact surface scatters and sub-surface deposits.

  An Aboriginal Heritage Assessment was undertaken by Archaeological and Heritage Management Solutions Pty Ltd for the previous approved rezoning.

  The report indicates that 21 open artefact scatters and four (4) isolated artefacts were identified during the archaeological field survey. The majority of sites were found across areas of exposed ground and soil profiles exposed on eroding creek banks. Across much of the study area, ground surfaces were covered by grass and vegetation which may have prevented effective detection of surface Aboriginal sites and biased the survey results in favour of creek margins where erosion has exposed the soils.

  It is likely that more sites and isolated objects exist on current ground surfaces below pasture grasses, and in sub-surface deposits throughout the study area. In general the assessment concludes that areas within 100 metres of creek line have a high potential for sub-surface deposits and areas outside these zones have a low to moderate potential. Test excavation would be required to accurately establish this pattern.

  The sites identified at North Bellbird are variously assessed as having moderate-high, low and low-nil archaeological significance at a local level. None of the sites are considered to have rarity at a regional or state level. Some of the sites have public significance values for their ability to demonstrate aspects of Aboriginal occupation and use of the landscape prior to dispossession. The Aboriginal cultural significance will be assessed by the local Aboriginal community.

  The report identifies Aboriginal heritage constraints and opportunities in regard to future development. It recommends an application to the Department of Environment & Conservation (DEC) for a Section 87 Preliminary Research Permit to undertake archaeological test excavation in advance of any future development. This should be done during pre-DA planning and prior to detailed development design. Test excavation would aim to determine the nature, extent and significance of Aboriginal sites and objects within the path of development. The results of excavation would be used to develop an Aboriginal heritage mitigation plan for future development which may include options such as conservation, salvage and/or consent to destroy Aboriginal sites.

  The assessment concludes that there are no Aboriginal heritage constraints on re-zoning of the subject land because Aboriginal sites, objects and cultural values within the subject land can be managed as part of any future Development Application process. In addition, the

specific sites of the planning proposal are not considered to contain any items or sites of Aboriginal heritage significance, and therefore the proposed rezoning is not considered to have any impacts from an Aboriginal heritage perspective.

5.0 Planning Context

State Planning Controls

There are no State Environmental Planning Policies applicable to this Planning Proposal.

Section 117 Ministerial Directions

Relevant Section 117 Ministerial Directions are addressed later in this document within *Table 2: Relevant Ministerial Directions.*

Regional Planning Controls

The Lower Hunter Regional Strategy applies to the Cessnock LGA. The primary purpose of the Lower Hunter Regional Strategy is to ensure that adequate land is available and appropriately located to accommodate in a sustainable manner the projected housing and employment needs of the Region's population over the next 25 years. The Bellbird urban release area is specifically identified within the Strategy to provide for an additional 4,000 dwellings. The Regional Strategy also aims to strengthen the viability of centres that support the role of Newcastle City Centre as the regional city.

The consistency of the Planning Proposal with the Lower Hunter Regional Strategy is addressed below within **Section 7** of this report.

Local Planning Controls

- **Cessnock Local Environmental Plan (CLEP) 2011**

The site contains a combination of R2 Low Density Residential, B1 Neighbourhood Centre and RE1 Public Recreation zoned lands.

Figure 10 below shows the current zoning of the subject site and surrounding land use zones under Cessnock LEP 2011.



Figure 10: Extract of the Cessnock LEP 2011 Zone Map.

- **Cessnock Development Control Plan (CDCP) 2010 – E.11 North Bellbird Precinct**

This Chapter of DCP 2010 adds detail to those planning provisions contained in Cessnock Local Environmental Plan. The plan provides detailed guidelines for the development of land within the area to which the plan applies for the purpose of land subdivision so as to facilitate the erection of dwelling houses or other buildings, including supporting infrastructure and community related uses. The plan also provides a basis upon which to implement stated objectives for the North Bellbird Precinct.

The consistency of the proposal with the E.11 Section of CDCP 2010 is addressed within **Section 8** of this report.

- **City Wide Settlement Strategy 2010**

The City Wide Settlement Strategy 2010 (CWSS) was adopted by Council on 15th September, 2010, and sets out the strategic directions to inform the preparation of the new LEP and implements a number of the outcomes and actions arising from the Lower Hunter Regional Strategy 2006.

The consistency of the proposal with the City Wide Settlement Strategy 2010 is addressed within **Section 7** of this report.

Meeting With Cessnock City Council

A meeting was held with Cessnock City Council on the 25th September, 2014, to discuss the proposed amendments to the CLEP 2011 to facilitate the future development of the site for residential, commercial and public recreation purposes.

Council were generally supportive of the proposed rezoning of RE1 Public Recreation zoned land, to SP2 Infrastructure on Lot 1 DP 327785 to accommodate an appropriate assessment and approvals pathway post zoning for private sewer infrastructure on the site.

Council were also supportive of the proposed zone boundary change of B1 Neighbourhood Centre zoned land and R2 Low Density Residential zoned land on Lot 2 DP 597226 to provide a slightly increased and more regular shaped commercial area in response to market input.

Council were also generally supportive of the proposed change from B1 Neighbourhood Centre zone to R2 Low Density Residential on Lot 1 DP 597226, as part of the refinement of the overall subdivision layout.

6.0 Explanation of Provisions

The Planning Proposal Request would result in the following amendments to Cessnock LEP 2011:

Amendment Applies to:	Explanation of Provision
Cessnock LEP 2011 and Land Zoning Map 006C	Rezone part of the land currently zoned RE1 Public Recreation and part of the land currently zoned R2 Low Density Residential on Lot 1 DP 327785 to SP2 Infrastructure.
Cessnock LEP 2011 and Land Zoning Map 006C	Rezone part of the land currently zoned R2 Low Density Residential and B1 Neighbourhood Centre on Lot 2 DP 597226 to B3 Commercial Core.
Cessnock LEP 2011 and Land Zoning Map 006C	Rezone the land currently zoned B1 Neighbourhood Centre and RE1 Public Recreation on Lot 1 DP 597226 to R2 Low Density Residential.
Cessnock LEP 2011 and Land Zoning Map 006C	Rezone part of the land currently zoned R2 Low Density Residential on Lot 1 DP 327785 to RE1 Public Recreation.

7.0 Justification for the Provisions

7.1 NEED FOR THE PLANNING REQUEST

1) Is the planning request a result of any strategic study or report?

Whilst the Planning Proposal is driven by the progression of the proposed, and future, subdivision of the site, the planning proposal is consistent with specific strategic goals for Cessnock and the region generally.

The Planning Proposal is not the result of a strategic study or report, however it will allow for the future residential development of the site consistent with a number of strategic plans including the Lower Hunter Regional Strategy (LHRS), the Cessnock DCP 2010 – E.11 North Bellbird Precinct, and the Cessnock City Wide Settlement Strategy 2010.

Ultimately, the proposed rezoning opens up the site for JPG to progress with development of land within an identified urban release area that would otherwise not be possible due to infrastructure constraints.

Lower Hunter Regional Strategy

The Lower Hunter Regional Strategy (LHRS) recognises that population growth in the Lower Hunter has been strong, averaging one per cent per annum (or approximately 4400 persons per year) in the period 1991-2001 and increasing more recently to more than 6200 people in 2004-05 (Australian Bureau of Statistics, Estimated Resident Population). The primary purpose of the Regional Strategy is to ensure that adequate land is available and appropriately located to sustainably accommodate the projected housing and employment needs of the Region's population over the next 25 years.

Some of the key elements of the Strategy are to provide for up to 115,000 new dwellings by 2031, ensuring the potential to accommodate both the changing housing demands of smaller households and reduced occupancy rates of the existing population, as well as meeting the housing demands for an additional 160,000 people, and enable the release of up to 69,000 new greenfield lots in a coordinated way with improved neighbourhood design and more efficient use of infrastructure.

The Strategy also aims to promote Newcastle as the regional city of the Lower Hunter, supported by a hierarchy of major regional centres at Charlestown, Cessnock, Maitland and Raymond Terrace, emerging major regional centres at Morisset and Glendale-Cardiff, as well as specialised centres and lower order centres.

The subject parcel of land is located approximately 4km south west of the major regional centre of Cessnock (see **Figure 11** below) within the North Bellbird urban release area.



Figure 11: Extract from the Lower Hunter Regional Strategy Map.

The Bellbird urban release area is specifically identified within the Strategy to provide for an additional 4,000 dwellings.

This Planning Proposal is consistent with, and supports the primary purpose of the Regional Strategy in seeking to facilitate appropriately located land to sustainably accommodate the projected housing needs of the Region (4000 additional dwellings in the Bellbird urban release area), and enabling the release of greenfield lots in a co-ordinated and well thought out manner, and that result from improvements in the proposed neighbourhood design and efficient use of infrastructure.

The provision of housing at North Bellbird (approximately 4km southwest of the Cessnock CBD) also supports Cessnock as a major regional centre, and therefore supports the hierarchy that promotes Newcastle as the Regional City of the Lower Hunter.

Cessnock Development Control Plan (DCP) 2010 – E.11 North Bellbird Precinct

The Cessnock DCP – E.11 North Bellbird Precinct provides detailed guidelines for the development of land within the area to which the plan applies for the purpose of land subdivision so as to facilitate the erection of dwelling houses or other buildings, including supporting infrastructure and community related uses.

The subject Planning Proposal seeks to facilitate the progression of a proposed subdivision of land contained within the North Bellbird Precinct, as per the objective of this section of DCP 2010.

Cessnock City Wide Settlement Strategy 2010

As previously noted, the City Wide Settlement Strategy 2010 (CWSS) was adopted by Council on 15th September, 2010, and sets out the strategic directions to inform the preparation of the new LEP and implements a number of the outcomes and actions arising from the Lower hunter Regional Strategy 2006.

The key challenge identified for the Cessnock LGA is to accommodate increased population growth as projected in the Lower Hunter Regional Strategy (2006) without significantly impacting on biodiversity and conservation values while, at the same time, protecting existing and potential resources that are largely contained within the rural areas.

For the Cessnock LGA, the LHRS projects that approximately 870 additional dwellings per year are required to be accommodated (790 additional dwellings per year in new release areas, and 80 dwellings per year to provide for changing housing needs within the existing population) over the next 25 years.

However, on average, only 229 separate dwelling houses have been constructed per year within the Cessnock LGA between 1995 and 2009.

The North Bellbird area is identified within the City Wide Settlement Strategy 2010 as being an urban release area expected to accommodate the projected housing needs of the LGA as identified within the LHRS.

The Planning Proposal will assist in facilitating the proposed, and future, residential subdivisions within the North Bellbird Urban Release Area to directly support the construction of the required 790 additional dwellings per year as indicated by the LHRS.

2) **Is the planning request the best means of achieving the objectives or intended outcomes, or is there a better way?**

The Planning Proposal request will facilitate the effective delivery of a proposed, and future, residential subdivision of land within the North Bellbird Urban Release Area, which is identified for residential development within Cessnock DCP 2010.

The Planning Proposal request seeks to ensure that the proposed subdivision delivers an improved, and more effective, neighbourhood design and efficient use of infrastructure. This is consistent with the aims of the Lower Hunter Regional Strategy in delivering much needed dwellings within the region in a co-ordinated and well thought out manner.

As part of the process of refining the proposed subdivision design, a number of alternative locations were considered for the proposed wastewater recycling facility. Five (5) options for the location of the Local Water Centre (wastewater recycling facility) were considered, as per Figure 12 below.

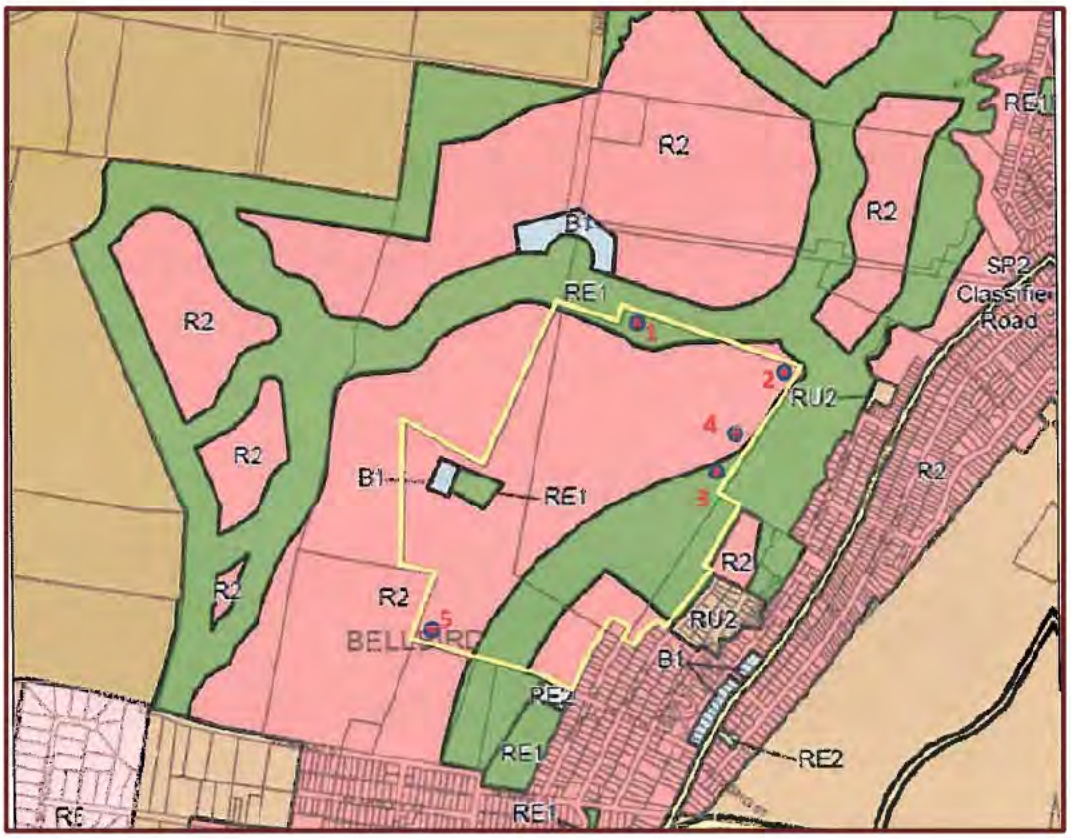


Figure 12: Local Water Centre site location options shown on existing CLEP 2011 zone map.

Site selection considered topography, ecological considerations, location relative to housing, loss of residential land and importantly the ability to provide an adjacent stormwater facility to draw additional top-up water from.

Option 3 was recommended as the best possible site for the proposed 8,000m^2 Local Water Centre for the following reasons:

- The site has minimal impact on residential yield;
- Is a significant distance from existing residents;
- Is adjacent to fewer proposed residents;
- Has few, if any, site development and environmental assessment concerns; and
- Can accommodate adjacent stormwater detention basins to provide an optional top up source of water in periods of high recycled water demand.

The specific site has been located and configured such that it is above the 1 in 100 year floor level, and away from the proposed stormwater culvert and overland flow path through the development.

More generally, the proposed wastewater recycling facility is considered to be a suitable and favourable option for inclusion in the proposed residential subdivision development, not only

due to the limited capacity of Hunter Water infrastructure, but also given the locality of the site. The future residents of the proposed subdivision will benefit significantly from an ample supply of sustainable recycled water given the hot climate of the Bellbird area.

In regards to the proposed amendments to existing commercial land on the site, the proposed removal of a small portion of B1 zoned land towards the centre of the site, and consolidation of commercial land into a larger B3 zoned area within the northern section of the site, will result in a more logical structure for the release area representation of more modern retail trenders.

The current Masterplan design fragments the commercially zoned land within the area effectively across three locations (please refer to **Figure 13** below).

With the already larger area of commercial land located in the northern part of the site, and the existing commercial zoned land along Wollombi Road, the smaller commercial land towards the centre of the site will not likely be economically sustainable and will compete with the other existing commercial and proposed commercial areas. Accordingly, a consolidation of the commercial land within the urban release area is considered to be a more logical use of commercial land.

At the same time it is an opportunity to improve the layout of the commercial area in the north side that is a more logical and developable area. The current zone reflects the 2006 masterplan which has a concept layout rather than with consideration to a developed outcome that takes amount of demand for commercial space (in 2014) and site constraints, Council may wish to also rationalise the commercial zoned land on the immediately adjoining lands in a similar manner.

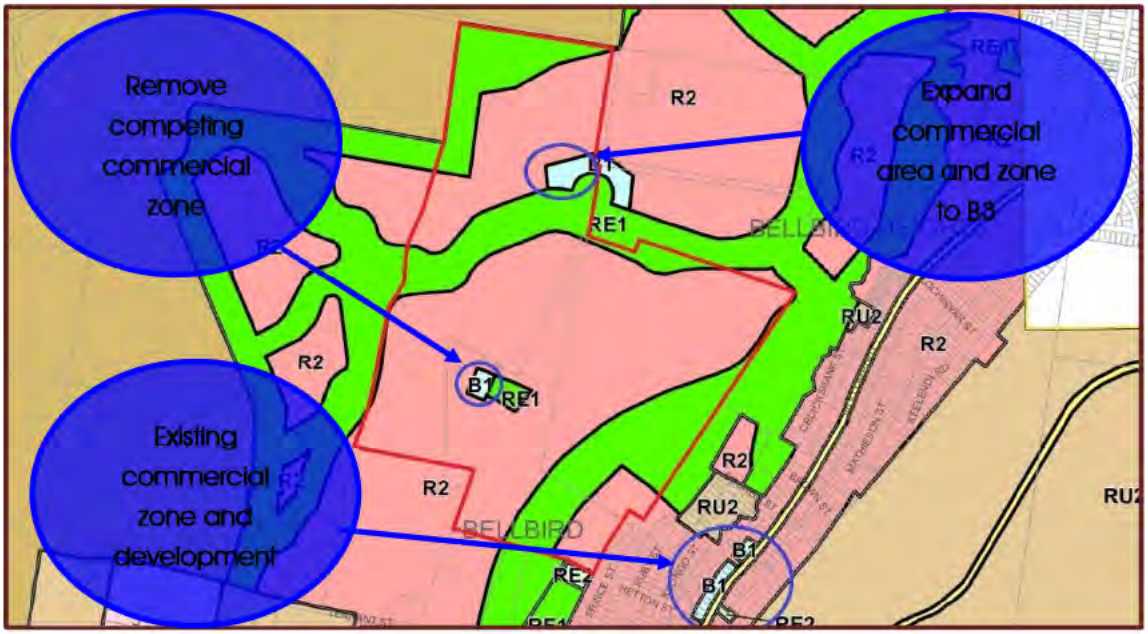


Figure 13: Commercially zoned sites within the CLEP 2011 zone map.

The Planning Proposal also seeks to rezone the larger area of commercial land in the north from B1 Neighbourhood Centre (and R2 Low Density Residential) to B3 Commercial Core.

Whilst 'shops' are a permissible land use within the B1 Neighbourhood Centre zone, the objectives of the B3 Commercial Core zone is considered more appropriate to accommodate a supermarket and other shop spaces with a Gross Lettable Area of approximately 4,175m^2, future expansion area of 2,025m^2, and car parking.

The B3 Commercial Core zoning will ensure the ongoing economic viability of the commercial land within the urban release area into the future.

The relocation of the RE1 zoned land currently centrally located within the site to be located adjacent to the existing RE1 corridor within the southeast of Lot 1 DP 327785 is considered to be a more appropriate outcome for the proposed park space within the subdivision. The relocation of the adjacent commercial land to the north would then result in an isolated small park land which would be inefficient in regards to the layout of the residential lots within the subdivision layout. Subsequently, it is considered more appropriate to relocate this park space to be adjacent to the existing RE1 corridor within the site.

3) Is there a net community benefit?

The Planning Proposal request will deliver a significant net community benefit, by enabling residential land to be released, and therefore increasing housing stock within the Lower Hunter Region, and more specifically within relatively close proximity to the major regional centre of Cessnock.

Furthermore, the proposed rezoning will facilitate the construction and operation of a wastewater recycling facility that will provide significant benefits to the future residents of the development through a sustainable supply of recycled water, which will be particularly beneficial given the hot climate of the Bellbird area.

The proposed rezoning will also result in a more logical urban release area structure for commercial zones, and an improved subdivision layout.

A net community benefit test, undertaken using the Department's Draft Centres Policy, is provided below:

Table 1: Net Community Benefit Test

Draft Centres Policy Criteria	Planning Request
Will the LEP be compatible with agreed State and regional strategic direction for development in the area (e.g. land release, strategic corridors, development within 800 metres of a transit node)?	Yes. The proposal will facilitate an increase in residential land and housing stock to support the growing population within the Lower Hunter.
Is the LEP located in a global / regional city, strategic centre or corridor nominated within the Metropolitan Strategy or other regional / subregional strategy?	The site is located close to the Cessnock major regional centre under the Lower Hunter Regional Strategy.
Is the LEP likely to create a precedent, or create or change the expectations of the landowner or other landholders?	The LEP will simply reflect an improved subdivision layout, and will still deliver residential, commercial and public recreation zoned lands, which will not change the expectations of the relevant landowners.
Have the cumulative effects of other spot rezoning proposals in the locality been considered? What was the outcome of these considerations?	There have been no previous spot rezonings within the locality, and as such there are not considered to be any cumulative effects within the locality.
Will the LEP facilitate a permanent employment generating activity or result in a loss of employment lands?	The proposed rezonings will maintain the provision of commercially zoned land within the urban release area, and will not result in loss of employment lands.
Will the LEP impact upon the supply of residential land and therefore housing supply and affordability?	The proposed amendments to the LEP will positively support the facilitation of increased residential land supply, and therefore increased housing supply and affordability.
Is the existing public infrastructure (roads, rail, utilities) capable of servicing the proposed site? Is public transport currently available or is there infrastructure capacity to support future public transport?	No significant changes to infrastructure will result other than improved wastewater arrangements.
Will the proposal result in changes to the car distances travelled by customers, employees, and suppliers? If so, what are the likely impacts in terms of greenhouse gas emissions, operating costs and road safety?	No.

Are there significant Government investments in infrastructure or services in the area whose patronage will be affected by the proposal? If so, what is the expected impact?	No, there are no known significant Government investments in infrastructure within the locality whose patronage could be affected by the proposal. The proposal complements Government investment residential land and housing supply for the benefit of the community.
Will the proposal impact on land that the Government has identified a need to protect (e.g. land with high biodiversity values) or have other environmental impacts? Is the land constrained by environmental factors such as flooding?	The proposed changes to commercial zones and removal of the central located commercial and public recreation land will not impact on protected areas, or be constrained by environmental factors. The proposed wastewater recycling facility, whilst located within land currently zoned RE1, will not impact on protected areas and will not be impacted by environmental factors.
Will the LEP be compatible / complementary with surrounding land uses? What is the impact on amenity in the location and wider community? Will the public domain improve?	It is considered that the proposed minor amendments will not impact on the amenity of the location.
Will the proposal increase choice and competition by increasing the number of retail and commercial premises operating in the area?	The proposal will increase availability and choice of retail and commercial premises within the area.
If a stand-alone proposal and not a centre, does the proposal have the potential to develop into a centre in the future?	The proposal will support the major regional centre of Cessnock, and will not detract from Cessnock as a major regional centre.
What are the public interest reasons for preparing the draft plan? What are the implications of not proceeding at that time?	Preparing the draft plan will facilitate an increase in much needed residential land and housing supply, and will ensure the best possible neighbourhood design and efficient delivery of infrastructure, including providing opportunity for recycling wastewater. Not proceeding with preparation of the draft plan would obstruct the provision of the proposed, and future, residential subdivision and housing supply.

7.2 RELATIONSHIP TO STRATEGIC PLANNING FRAMEWORK

4) Is the planning request consistent with the objectives and actions contained within the applicable regional or sub-regional strategy (including exhibited draft strategies)?

The Lower Hunter Regional Strategy (LHRS) recognises that population growth in the Lower Hunter has been strong, averaging one per cent per annum (or approximately 4400 persons per year) in the period 1991-2001 and increasing more recently to more than 6200 people in 2004-05 (Australian Bureau of Statistics, Estimated Resident Population). The primary purpose of the Regional Strategy is to ensure that adequate land is available and appropriately located to sustainably accommodate the projected housing and employment needs of the Region's population over the next 25 years.

Some of the key elements of the Strategy are to provide for up to 115,000 new dwellings by 2031, ensuring the potential to accommodate both the changing housing demands of smaller households and reduced occupancy rates of the existing population as well as meeting the housing demands for an additional 160,000 people, and enable the release of up to 69,000 new greenfield lots in a coordinated way with improved neighbourhood design and more efficient use of infrastructure.

The Strategy also aims to promote Newcastle as the regional city of the Lower Hunter, supported by a hierarchy of major regional centres at Charlestown, Cessnock, Maitland and Raymond Terrace, emerging major regional centres at Morisset and Glendale-Cardiff, as well as specialised centres and lower order centres.

The Planning Proposal request is consistent with the Lower Hunter Regional Strategy, particularly the requirement for additional housing supply.

The proposed rezoning of RE1 land to SP2 Infrastructure, will accommodate the construction and maintenance of a sustainable, efficient and effective wastewater recycling facility, which will support, and thereby, assist in facilitating the proposed and future subdivision and subsequent release of residential land for an increase in housing supply within the Lower Hunter region.

Furthermore, the proposed LEP amendments to the commercially zoned land create a consolidated, and more efficient commercial precinct, and the relocation of the existing park space, will support and facilitate a better subdivision design.

5) Is the planning request consistent with the local Council's Community Strategic Plan, or other local strategic plan?

Cessnock City Wide Settlement Strategy 2010

The Planning Proposal request is consistent with the Cessnock City Wide Settlement Strategy 2010.

As previously noted, the City Wide Settlement Strategy 2010 (CWSS) was adopted by Council on 15th September, 2010, and sets out the strategic directions to inform the preparation of the new LEP and implements a number of the outcomes and actions arising from the Lower Hunter Regional Strategy 2006.

The key challenge identified for the Cessnock LGA is to accommodate increased population growth as projected in the Lower Hunter Regional Strategy (2006) without significantly impacting on biodiversity and conservation values while, at the same time, protecting existing and potential resources that are largely contained within the rural areas.

For the Cessnock LGA, the LHRS projects that approximately 870 additional dwellings per year are required to be accommodated (790 additional dwellings per year in new release areas, and 80 dwellings per year to provide for changing housing needs within the existing population) over the next 25 years.

However, on average, only 229 separate dwelling houses have been constructed per year within the Cessnock LGA between 1995 and 2009.

The North Bellbird area is identified within the City Wide Settlement Strategy 2010 as being an urban release area expected to accommodate the projected housing needs of the LGA as identified within the LHRS.

The Planning Proposal will assist in facilitating the proposed, and future, residential subdivisions within the North Bellbird Urban Release Area to directly support the construction of the required 790 additional dwellings per year as indicated by the LHRS.

6) Is the planning request consistent with applicable State Environmental Planning Policies (SEPPs)?

It is considered that there are no State Environmental Planning Policies applicable to the Planning Proposal Request.

7) Is the planning request consistent with applicable Ministerial Directions (s.117 directions)?

The relevant Ministerial Directions are considered below:

Table 2: Relevant Ministerial Directions

Ministerial Direction	Relevance	Consistency / Comment
1.1 Business and Industrial Zones	This direction requires that a draft LEP contain provisions to retain the areas and locations of existing business and industrial zones.	**Consistent:** The proposal is consistent with this principle.
2.1 Environment Protection Zones	This direction requires that a draft LEP contain provisions to facilitate the protection of environmentally sensitive land.	**Consistent:** The proposed rezoning does not impact on environmentally sensitive land.
2.3 Heritage Conservation	This direction requires that a draft LEP provide provisions in order to conserve heritage items.	**Consistent:** The proposed LEP amendment is consistent with this principle.
2.4 Recreation Vehicle Areas	This direction restricts a draft LEP from enabling land to be developed for a recreation vehicle area.	**Consistent:** The draft LEP does not propose a recreation vehicle area, and is consistent with this direction.
3.1 Residential Zones	This direction requires a draft LEP to broaden the choice of building types and locations available in the housing market, make more efficient use of existing infrastructure and services, reduce the consumption of land for housing and associated urban development on the urban fringe and be of good design.	**Consistent:** The proposed LEP amendment is minor and does not alter the choice of housing provided for within the existing LEP.
3.2 Caravan Parks and Manufactured Home Estates	This direction requires a draft LEP to maintain provisions and land use zones that allow the establishment of Caravan Parks and Manufactured Home Estates.	**Consistent:** The draft LEP will not affect provisions relating to this direction, and will retain the provisions of the principal LEP in this regard.
3.3 Home Occupations	This direction requires that a draft LEP include provisions to ensure that Home Occupations are permissible without consent.	**Consistent:** The amendment will not affect provisions relating to this, and will retain the provisions of the principal LEP in this regard.
3.4 Integrating Land Use and Transport	This direction requires consistency with State policy in terms of positioning of urban land use zones.	**Consistent:** The proposed amendments will be consistent with this direction.

		The site is identified as being suitable for proposed residential development being identified as an urban release area under Cessnock DCP 2010. The area is within relatively close proximity to the Cessnock CBD, and the residential development will be serviced by the local public bus service.
4.3 Flood Prone Land	This direction applies where the draft LEP will affect provisions to flood prone land.	**Consistent:** The draft LEP will be consistent with this Ministerial Direction.
4.4 Planning for Bushfire Protection	This direction applied to land that has been identified as bushfire prone, and requires consultation with the NSW Rural Fire Service, as well as the establishment of Asset Protection Zones.	**Consistent:** The draft LEP will be consistent with this Ministerial Direction, and it is understood that consultation will be undertaken with the NSW Rural Fire Service.
5.1 Implementation of Regional Strategies	This direction requires a draft LEP to be consistent with the relevant State strategy that applies to the Local Government Area.	**Consistent:** The draft LEP will be consistent with the strategic direction set by the Lower Hunter Regional Strategy in increasing the supply of residential land and housing stock to support the increased population growth. The site is within relatively close proximity to the Cessnock major regional centre.
6.1 Approval and Referral Requirements	This direction prevents a draft LEP from requiring concurrence from, or referral to, the Minister or a public authority.	**Consistent:** The draft LEP will be consistent with this requirement.
6.2 Reserving Land for Public Purposes	This direction prevents a draft LEP from altering available land for public use.	**Consistent:** Adequate public land is available.
6.3 Site Specific Provisions	This direction requires that a draft LEP make use of existing land use zone categories and not introduce additional controls. The direction also requires the amendment does not impose any additional requirements to	**Consistent:** The draft LEP will be consistent with this requirement, seeking to rezone the subject land to existing zones (B3 Commercial Core, SP2 Infrastructure, and R2 Low Density Residential) already

	those already applying in the principal LEP.	applying in the Cessnock LEP 2011 that allows the proposed land uses without imposing any development standards or requirements in addition to those already contained in the zone.

7.3 ENVIRONMENTAL, SOCIAL AND ECONOMIC IMPACT

8) Is there any likelihood that critical habitat or threatened species, populations or ecological communities, or their habitats, will be adversely affected as a result of the proposal?

The proposed rezoning is of a minor nature, involving lands generally already zoned to promote urban purposes.

Flora and fauna has been addressed as part of the original rezoning and the areas proposed to be rezoned will not further impact on threatened species or EEC.

9) Are there any other likely environmental effects as a result of the planning request and how are they proposed to be managed?

The subject site is also identified as being bushfire prone land, however as discussed in **Section 4** of this report, appropriate measures will be implemented as part of any future subdivision. As such, there are deemed to be no matters with respect to bushfire risk that should preclude the proposed rezoning.

The subject site is identified as being flood affected, however as discussed in **Section 4** of this report, the results from the previous Flooding and Stormwater Assessment undertaken do not preclude future residential development on marginal flood areas so long as further detailed, and site specific, flood analysis is undertaken and appropriate engineering controls are implemented for the management of quality and quantity of local runoff.

The proposed Local Water Centre, it is proposed to be located in open space, adjacent to, but clear of, a small tributary that drains into Bellbird Creek. The tributary is ephemeral in nature and as such is typically dry except in response to rain events. It is proposed to locate the LWC above the 1% AEP Flood Level (or 1 in 100 year storm event), with 500mm freeboard. The proposed flood planning level is consistent with the requirements for residential development in *NSW Floodplain Development Manual* and *Cessnock City Council Engineering Specifications.*

Flood levels have been obtained from the "*Floodplain Risk Management and Stormwater Management Strategy – Patterson Britton 2007".* This report was undertaken to support the previously approved rezoning process, and defined the 1% AEP flood extents and the riparian corridor. Flows were calculated using an XP RAFTS hydrological model under post development conditions, and flood extents were modelled using HEC RAS, a 1-Dimensional

model commonly used to model flood extents. At the proposed location of the water recycling facility the 1% AEP level was determined as approximately RL 88.5. Therefore, the minimum floor level of the LWC is to be set at RL 89. It should be noted that due to the topography at the recycling facility site, it is likely that the floor level will be set closer to RL 90.5 to allow for a level building pad, which will provide the recycling facility with flood immunity for storm events greater than the 1% AEP.

Parts of the overall site contain both European and Aboriginal items of heritage significance. However, it is noted that the relevant items are not located within the specific areas proposed for rezoning, and as such the proposed LEP amendments will not impact on any measures already identified to manage the preservation of these items or information around these items. In any case, the recommendations from previous reports accompanying the previous rezoning will not be compromised.

10) How has the planning request adequately addressed any social and economic effects?

The proposal is expected to support and facilitate the release of much-needed residential land and housing supply for the community within land already identified for such development, as well as an increase in generation of employment resulting from the proposed associated commercial lands.

The proposed construction and operation of a wastewater recycling facility will provide significant benefits to the future residents of the development through a sustainable supply of recycled water, which will be particularly beneficial given the hot climate of the Bellbird area.

Removing the current fragmented approach to the provision of commercial land, and providing a consolidated commercial precinct will ensure the economic survival of the commercial areas.

The change in zoning of the commercial land in the north to a B3 Commercial Core zone will suitably accommodate the occupation of a supermarket within the commercial precinct, providing a higher level of amenity for the residents and reduced travel demand with associated benefits.

Whilst larger supermarket retailers are already well established within the Cessnock CBD, which is located approximately 4km to the northeast of the site, the establishment of a supermarket retailer within the North Bellbird commercial precinct is not considered to impact on the Cessnock CBD. The Cessnock CBD is identified as a major regional centre under the Lower Hunter Regional Strategy and as such not only services Cessnock and surrounding suburbs, but also services the wider LGA, as well as a high volume of tourists visiting the Hunter Valley area.

The small portion of RE1 zoned land, and associated park space, currently located adjacent to the B1 zoned land towards the centre of the site, will not be lost from the overall Masterplan, as it is simply proposed to be re-located adjacent the existing RE1 zoned land along the eastern side of the site.

7.4 STATE AND COMMONWEALTH INTERESTS

11) Is there adequate public infrastructure for the planning request?

The proposed minor LEP amendment does not significantly alter demand for public infrastructure. The proposed rezoning will, in part, provide for new infrastructure, that being a wastewater recycling facility.

8.0 Conclusion

The proposed minor amendments to the Cessnock LEP 2011 will deliver benefits by supporting and facilitating the release of much-needed residential land and housing supply within land already identified for development, as well as an increase in generation of employment resulting from the proposed associated commercial lands.

Commentary RE: the previous rezoning was based on a masterplan which did not respond in detail to topography nor current trends in residential and commercial development.

The Planning Proposal request seeks to ensure that the proposed, and future, subdivisions deliver an improved, and more effective, neighbourhood design and efficient infrastructure. This is consistent with the aims of the Lower Hunter Regional Strategy in delivering much needed dwellings within the region in a co-ordinated and well thought out manner that supports Cessnock as a major regional centre.

The proposed rezoning will facilitate the construction and operation of a wastewater recycling facility that will provide significant benefits to the future residents of the development through a sustainable supply of recycled water, which will be particularly beneficial given the hot climate of the Bellbird area. Various location options were considered for the wastewater recycling facility, however the proposed location and subsequent rezoning required is considered to be the best option based on the distance from existing residents, limited development and environmental constraints, negligible impact on RE1 land, the capacity for the location to accommodate stormwater detention basins to provide a top up source of water as required, and minimal loss of residential zoned land.

The proposed rezoning will also result in a more logical consolidation of commercial space, and as a result improve the prospects for economic survival of not only the proposed North Bellbird commercial precinct, but also the existing commercial premises along Wollombi Road.

The removal of the small portion of B1 zoned land and consolidation of this land in the northern commercial precinct, coupled with the re-location of the adjacent RE1 zoned land to adjoin the existing RE1 corridor within the site will ultimately result in an improved subdivision layout design.

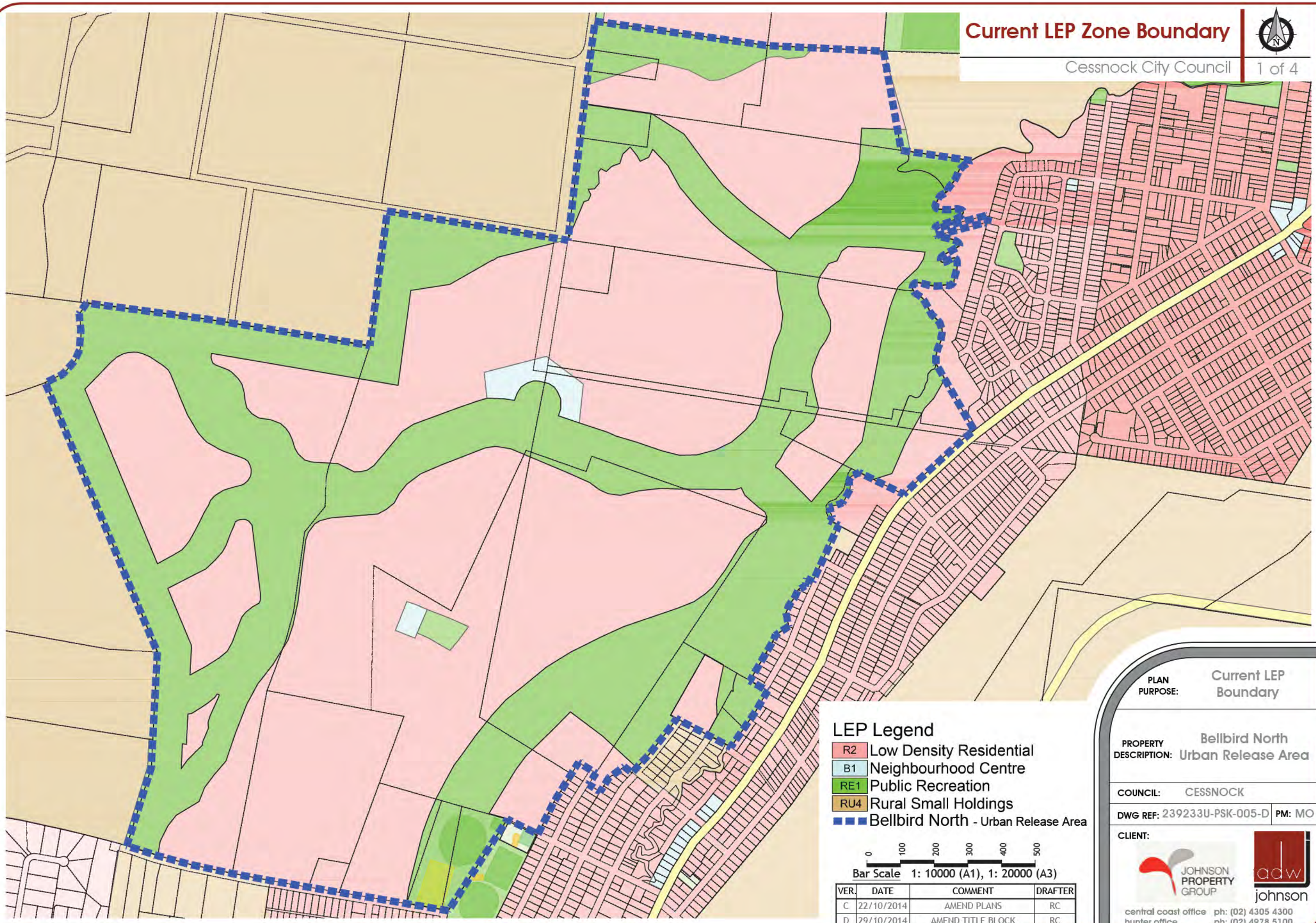
Appendix A

PLANS OF PROPOSED CLEP 2011 ZONE MAP AMENDMENTS

Current LEP Zone Boundary

Cessnock City Council

1 of 4



LEP Legend

- R2 Low Density Residential
- B1 Neighbourhood Centre
- RE1 Public Recreation
- RU4 Rural Small Holdings
- Bellbird North - Urban Release Area

0 100 200 300 400 500

Bar Scale 1: 10000 (A1), 1: 20000 (A3)

VER.	DATE	COMMENT	DRAFTER
C	22/10/2014	AMEND PLANS	RC
D	29/10/2014	AMEND TITLE BLOCK	RC

PLAN PURPOSE: Current LEP Boundary

PROPERTY DESCRIPTION: Bellbird North Urban Release Area

COUNCIL: CESSNOCK

DWG REF: 239233U-PSK-005-D | PM: MO

CLIENT:

JOHNSON PROPERTY GROUP

adw johnson
central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100
www.adwjohnson.com.au

URBAN PLANNING

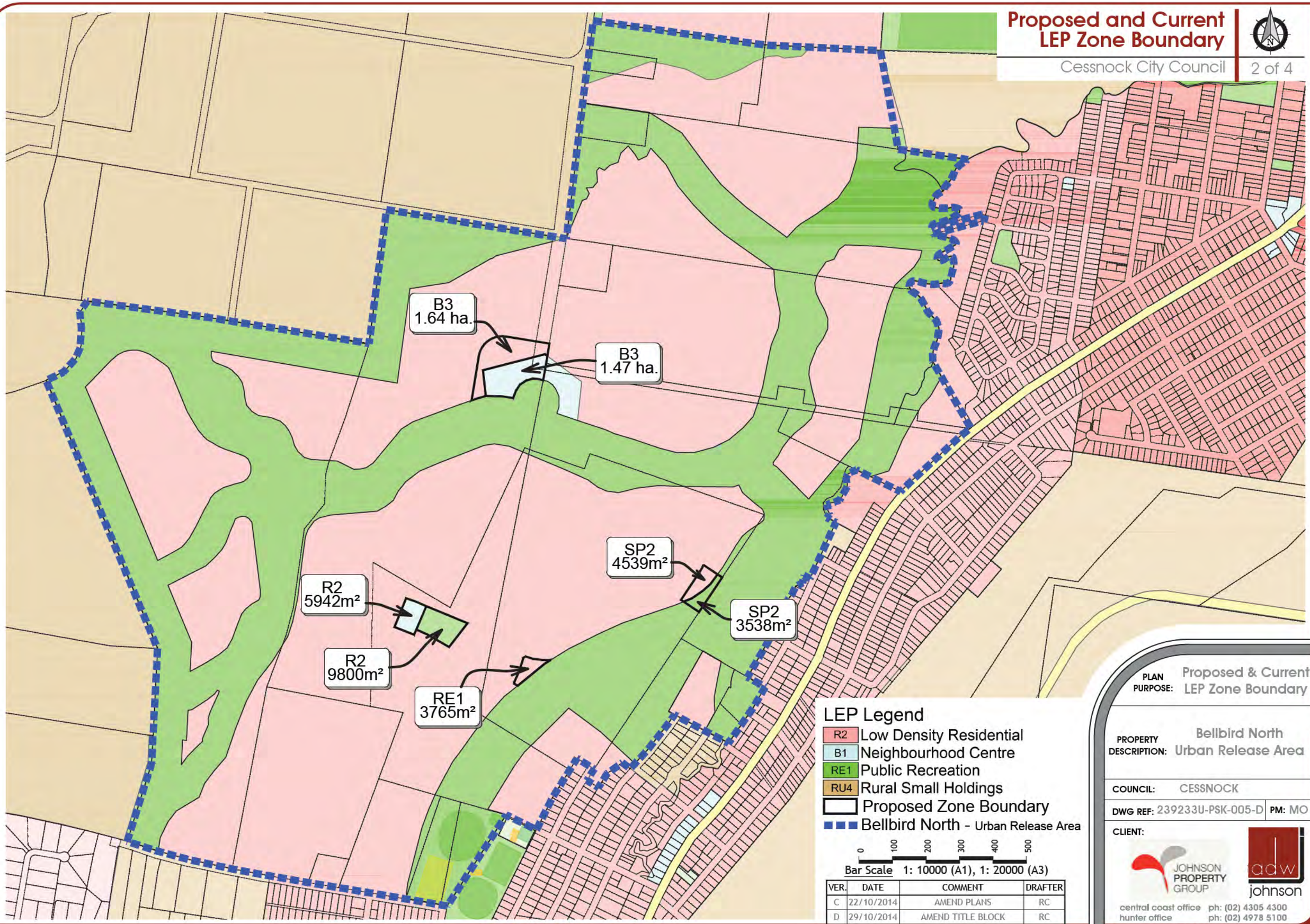
"Copyright Notice" This plan and the information it contains are copyright and remain the property of ADW Johnson Pty Ltd. ADW Johnson Pty Ltd grants to the client named on this plan a license to use the information hereon for the purpose for which we were engaged to perform the work. Use of the plan and information it contains for any other purpose is not permitted unless prior written approval has been obtained from ADW Johnson Pty Ltd.

239233U-PSK-005-D
Plotted By: roberto Plot Date: 30/10/14 - 12:23 Cad File: N:\239233\239233U\dwg\239233U-PSK-002-2014-10-08-MO239233U-PSK-005-D.dwg

• project management • civil engineering • infrastructure • superintendency • economic analysis • social impact • town planning • surveying • development feasibility • visualisation • urban planning

Proposed and Current LEP Zone Boundary

Cessnock City Council



LEP Legend

- R2 Low Density Residential
- B1 Neighbourhood Centre
- RE1 Public Recreation
- RU4 Rural Small Holdings
- Proposed Zone Boundary
- Bellbird North - Urban Release Area

Bar Scale 1: 10000 (A1), 1: 20000 (A3)

VER.	DATE	COMMENT	DRAFTER
C	22/10/2014	AMEND PLANS	RC
D	29/10/2014	AMEND TITLE BLOCK	RC

PLAN PURPOSE: Proposed & Current LEP Zone Boundary

PROPERTY DESCRIPTION: Bellbird North Urban Release Area

COUNCIL: CESSNOCK

DWG REF: 239233U-PSK-005-D | PM: MO

CLIENT:

JOHNSON PROPERTY GROUP

adw johnson

central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100

www.adwjohnson.com.au

URBAN PLANNING

"Copyright Notice" This plan and the information it contains are copyright and remain the property of ADW Johnson Pty Ltd. ADW Johnson Pty Ltd grants to the client named on this plan a license to use the information hereon for the purpose for which we were engaged to perform the work. Use of the plan and information it contains for any other purpose is not permitted unless prior written approval has been obtained from ADW Johnson Pty Ltd.

• project management • civil engineering • infrastructure • superintendency • economic analysis • social impact • town planning • surveying • development feasibility evaluation • urban planning

239233U-PSK-005-D

Plotted By: roberto Plot Date: 30/10/14 - 12:23 Cad File: N:\239233\239233U\dwg\239233U-PSK-002-2014-10-08-MO\239233U-PSK-005-D.dwg

Proposed LEP Zone Boundary

Cessnock City Council

3 of 4

B3
3.11 ha.

SP2
8077m²

R2
1.57 ha.

RE1
3765m²

LEP Legend

- R2 Low Density Residential
- B1 Neighbourhood Centre
- RE1 Public Recreation
- RU4 Rural Small Holdings
- SP2 Infrastructure
- Proposed Zone Boundary
- Bellbird North - Urban Release Area

0 100 200 300 400 500

Bar Scale 1: 10000 (A1), 1: 20000 (A3)

VER	DATE	COMMENT	DRAFTER
C	22/10/2014	AMEND PLANS	RC
D	29/10/2014	AMEND TITLE BLOCK	RC

PLAN PURPOSE: Proposed LEP Boundary

PROPERTY DESCRIPTION: Bellbird North Urban Release Area

COUNCIL: CESSNOCK

DWG REF: 239233U-PSK-005-D PM: MO

CLIENT:

JOHNSON PROPERTY GROUP

adw johnson

central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100

www.adwjohnson.com.au

URBAN PLANNING

• project management • civil engineering • infrastructure • superintendency • economic analysis • social impact • town planning • surveying • development feasibility • visualisation • urban planning

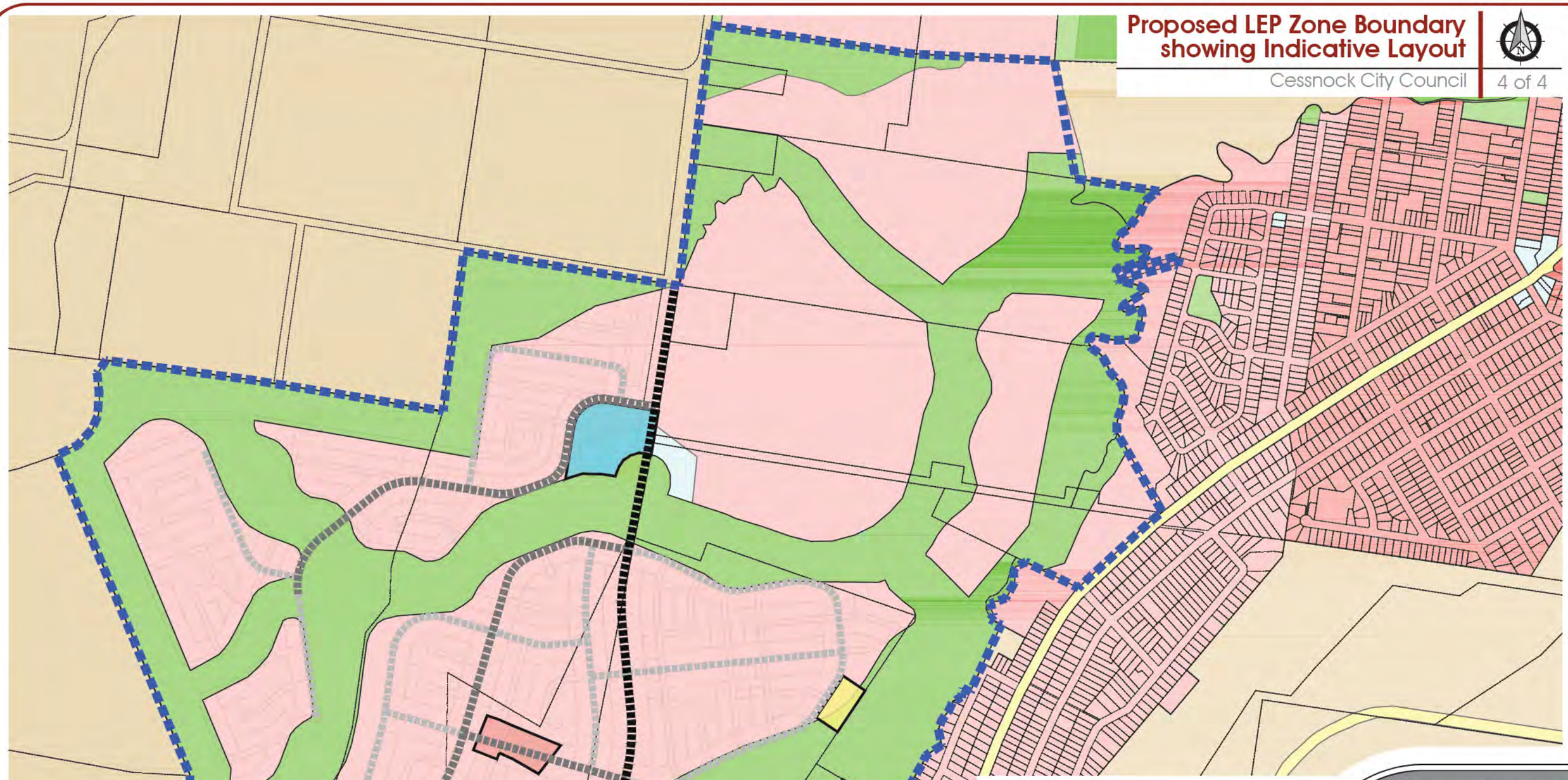
239233U-PSK-005-D

Plotted By: roberto Plot Date: 30/10/14 - 12:24 Cad File: N:\239233\239233U\dwg\239233U-PSK-002-2014-10-08-MO\239233U-PSK-005-D.dwg

"Copyright Notice" This plan and the information it contains are copyright and remain the property of ADW Johnson Pty Ltd. ADW Johnson Pty Ltd grants to the client named on this plan a license to use the information hereon for the purpose for which we were engaged to perform the work. Use of the plan and information it contains for any other purpose is not permitted unless prior written approval has been obtained from ADW Johnson Pty Ltd.

Proposed LEP Zone Boundary showing Indicative Layout

Cessnock City Council



LEP Legend

- R2 Low Density Residential
- B1 Neighbourhood Centre
- RE1 Public Recreation
- RU4 Rural Small Holdings
- Bellbird North - Urban Release Area
- Minor 15m Wide Road
- 18m Wide Road
- Major 20m Wide Road

Road Network Shown Indicative only

0 100 200 300 400 500

Bar Scale 1: 10000 (A1), 1: 20000 (A3)

VER.	DATE	COMMENT	DRAFTER
C	22/10/2014	AMEND PLANS	RC
D	29/10/2014	AMEND TITLE BLOCK	RC

PLAN PURPOSE: Proposed LEP Zone Boundary showing Indicative Layout

PROPERTY DESCRIPTION: Bellbird North Urban Release Area

COUNCIL: CESSNOCK

DWG REF: 239233U-PSK-005-D | PM: MO

CLIENT:

JOHNSON PROPERTY GROUP

adw johnson

central coast office ph: (02) 4305 4300
hunter office ph: (02) 4978 5100
www.adwjohnson.com.au

URBAN PLANNING

• project management • civil engineering • infrastructure • superintendency • economic analysis • social impact • town planning • surveying • development feasibility evaluation • urban planning

239233U-PSK-005-D

Plotted By: robertc Plot Date: 30/10/14 - 12:24 Cad File: N:\239233\239233U\dwg\239233U-PSK-002-2014-10-08-MO\239233U-PSK-005-D.dwg

"Copyright Notice" This plan and the information it contains are copyright and remain the property of ADW Johnson Pty Ltd. ADW Johnson Pty Ltd grants to the client named on this plan a license to use the information hereon for the purpose for which we were engaged to perform the work. Use of the plan and information it contains for any other purpose is not permitted unless prior written approval has been obtained from ADW Johnson Pty Ltd.

Bellbird Water

3.5.1(c) REF Executive Summary for the Reticulation Network

REF for Proposed Sewage, Recycled Water and Drinking Water Reticulation Systems

Bellbird North, New South Wales

Executive Summary Report

Prepared by:

RPS AUSTRALIA EAST PTY LTD

241 Denison Street
Broadmeadow NSW 2292
PO Box 428 Hamilton NSW 2303

Client Manager: Rob Dwyer
Report Number: 125544
Version / Date: Version 1 / July 2015

Prepared for the proponent:

FLOW SYSTEMS OPERATIONS PTY LTD, TRADING AS BELLBIRD WATER (A WHOLLY-OWNED SUBSIDIARY OF FLOW SYSTEMS PTY LTD)

Level 2, 1 Alfred Street
Sydney NSW, 2000

T: +61 2 8016 1021
E: dwharton@flowsystems.com.au

Executive Summary

The Proposal

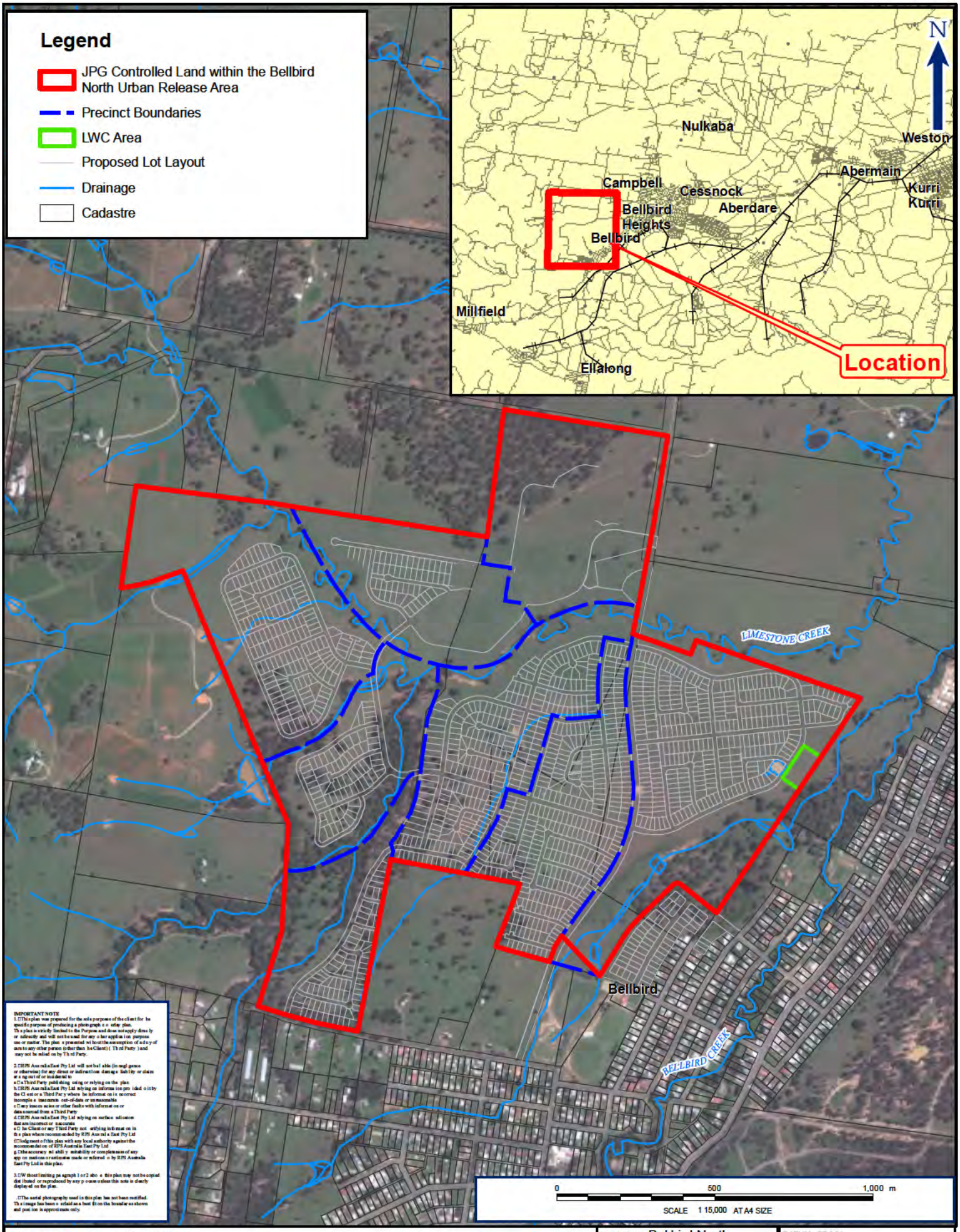
Flow Systems Operations Pty Ltd, trading as Bellbird Water (a wholly owned subsidiary of Flow Systems Pty Ltd herein referred to as Bellbird Water) is proposing to construct and operate a pressure sewage reticulation system, a recycled water reticulation system and a drinking water reticulation system (the proposal) at Bellbird. The proposal involves the installation and operation of a pressure sewage reticulation system, including the installation and operation of interim sewage servicing tanks (ISST) within the Bellbird North Urban Release Area. The proposal also includes the installation and operation of a recycled water reticulation system throughout the same area delivering high quality recycled water (for non-potable uses such as toilet flushing, washing machines, irrigation and car washing) back to the new residential areas. Finally the proposal also includes the installation and operation of a drinking water reticulation system. The three systems, under this proposal, will ultimately service around 1,600 dwellings and some ancillary facilities and areas. The sewage, recycled water and drinking water reticulation systems will be located on land controlled by Johnson Property Group Pty Ltd (JPG). The proposal will be operated and maintained by Bellbird Water in conjunction with the proposed Bellbird Local Water Centre (LWC) which will be located on part Lot 1 DP 327785, Bellbird.

A plan showing the location of the JPG controlled lands within the Bellbird North Urban Release Area and its proposed residential and street layout is shown in **Figure 1**. Concept master plans for the recycled water reticulation system and the drinking water reticulation system are contained in **Appendix 1**. Likewise **Appendix 1** contains a concept master plan for the sewage reticulation system and an indicative illustration of the interim sewage servicing tanks.

The installation of the sewer, recycled water and drinking water systems will occur simultaneously with the staged development of the Bellbird North Urban Release Area. New residential development requires the co-ordinated provision of sewage and water supply reticulation systems. The proposal and the development of the LWC (under separate approval) are seen as the best system for the Bellbird North Urban Release Area primarily due to its contribution to sustainability.

Statutory and planning framework

The Review of Environmental Factors (REF) has been prepared to provide the Independent Pricing and Regulatory Tribunal (IPART) and the NSW Minister for Lands and Water, with information to the fullest extent possible of all matters affecting, or likely to affect, the environment by the construction and operation of the reticulations systems. The proposal does not require development consent under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP& A Act) pursuant to *State Environmental Planning Policy (Infrastructure) 2007*. Therefore the proposal is the subject of environmental assessment under Part 5 of the EP&A Act. The proposal also requires environmental assessment pursuant to the environmental licensing principles of the *Water Industry Competition Act 2006* (WICA) and the *Water Industry Competition (General) Regulation 2008*. This document is an executive summary of the REF prepared for the environmental assessment.



IMPORTANT NOTE
1.This plan was prepared for the sole purpose of the client for be specific purpose of producing a photograph o o nday plan. Th s plan is strictly limited to the Purpose and does not apply direc ly or ndirectly and will not be used for any o her applica ion purpos ses or matter. This plan s presented wi hou the assumption of a d y of care to any other person (other than he Client) (Th rd Party) and may not be relied on by Th rd Party.

2.©RPS Aus ra lia East Pty Ltd will not be l able (in negl gence or otherwise) for any direct or indirect loss damage liab lity or claim ar s ng out of or incidental to
a.□a Third Party publishing using or relying on the plan
b.©RPS Aus ra lia East Pty Ltd relying on informa ion pro vided o it by the Cl ent or a Third Pa y where he informat on is incorrect incomple e inaccurate out-of-date or unreasonable
c.□any inaccu acies or other faults with informat on or data sourced from a Third Party
d.©RPS Aus ra lia East Pty Ltd relying on surface ndicators that are incorrect or inaccurate
e.□ he Client or any Third Party not relying in format on in th s plan where recommended by RPS Aus ra l a East Pty Ltd □lodgment o f this plan with any local authority against the recommend ation of RPS Australia East Pty Ltd
g.□the accuracy ad abil y suitability or completeness of any app ca tions or estimates made or referred o by RPS Australia East Pty Ltd in this plan.

3.□W thout limiting pa agraph 1 or 2 abo e this plan may not be copied dist ibuted or reproduced by any p rson unless this note is clearly displayed on the plan.

4.□The aerial photography used in this plan has not been rectified. Th s image has been o erlaid as a best fit on the boundaries shown and posi ion is approximate only.

Figure 1: Location Map

LOCATION: Bel bird North	DATUM: GDA94 PROJECTION: MGA Zone 56
JOB NO.: PR125544 PURPOSE: PLANNING Technician: Natalie.Wood Date: 2/07/2015	Data Sources: RPS flowsystems

CLIENT: Flowsystems

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4940 4200 F: 02 4961 6794 www.rpsgroup com au

RPS

Path: J:\JOBS\125k\125544 Bellbird\10 - Drafting\Arcgis Map Documents\Planning\125544 Figure 1 Location A A4 20150702.mxd

Environmental Impacts

The REF provides a detailed description of the potential environmental impacts associated with the proposal, during both construction and operation, and these include impacts associated with the:

- Removal of vegetation;
- Potential for the identification of Aboriginal and non-Aboriginal heritage;
- Potential for erosion;
- Potential for increase in noise;
- Air Quality and odour;
- Increase in traffic movements; and
- Potential for the generation of waste during the construction phase.

Noise Impacts

The Bellbird North Urban Release Area is is predominantly cleared rural land. Residential areas are currently located to east in the community of Bellbird. The main source of noise will be construction noise. Noise will be from machinery associated with earthworks. Due to the nature of the plant and equipment (relatively small scale) that will be used during construction the noise level during construction is unlikely to have an adverse impact on residential receivers.

Another source of noise emission will be from tanker trucks attached to the interim sewage servicing tanks on the LWC site. A Noise Impact Assessment of the interim sewage servicing tanks and the fully operational LWC has been carried out. When the interim sewage servicing tanks are at full capacity (noting it will take time to build up to this as houses are built and connect), there will be up to six tankers visiting the site per day for up to an hour each, and for 7 days per week and potentially sometimes at night. By the time residential development approaches to near the LWC site the interim sewage servicing tanks will have been decommissioned and the LWC commissioned.

Odour and Air Quality

An Odour Impact Assessment having due consideration for the NSW Environmental Protection Authority guidelines was carried out as part of the REF. The Assessment included modelling of the impact of the odour control unit associated with the interim sewage servicing tanks located on the LWC site.

The predicted odour concentrations for the odour control unit show that the 2 OU or 99th percentile threshold (the theoretical level at which odour becomes detectable but not necessarily distinguishable), is not predicted beyond the boundary of the LWC site. The Assessment also notes that the odour control unit vent stack emissions are likely to be conservative.

The predicted odour concentrations for the odour control unit associated with the interim sewage servicing tanks are shown in **Figure 2**. Note that the figure plots the 0.4 OU odour concentration contour which is much less than the 2 OU concentration contour.

Figure 2 Predicted 99th percentile odour concentration for ISST



Note: This figure plots the 0.4 OU odour concentration contour. The 1 OU or 99th percentile contour (the theoretical level at which odour becomes detectable but not necessarily distinguishable) is clearly not predicted beyond the boundary of the site.

Mitigation Measures

The REF provides a large number of mitigation measures that will avoid or reduce the potential impacts of the proposal. These mitigation measures have been designed to minimise and or mitigate, as far as practical, the potential impacts. All mitigation measures described in this REF will be incorporated into the site's CEMP and / or the Operational Environmental Management Plan (OEMP) / Licence Plans. The CEMP will be prepared prior to construction of the Bellbird LWC and the OEMP prior to the operation of the LWC and both are to be reviewed and approved by IPART prior to the commencement of relevant on-site works.

A summary of the mitigation measures (Construction and Operations) can be viewed in **Table 1** and **Table 2**. Common mitigation measures between key environmental issues have been amalgamated.

Table 1 Impact and Mitigation Measures to be Incorporated into the CEMP

Impact	Mitigation Measures
General	All contractors and machine operators will be inducted on the environmental sensitivities of the work site(s) and relevant safeguards.
Flora and fauna	The clearing extents are to be clearly demarcated with temporary fencing before commencement of works
	Materials, plant and equipment will not be stored within the drip-lines of any trees at the site.
	To prevent damage to vegetation outside the boundaries of access tracks, vehicles and machinery will be restricted to designated work areas.
	Where access tracks run alongside areas of natural bushland, protective fencing or paraweb fencing is to be installed along the boundaries of the track to prevent vehicles from inadvertently entering/damaging bushland.
	Degradation or disturbance to areas of water-side (riparian) vegetation will be avoided to the greatest possible extent. Any such areas will be clearly identified in the CEMP.
	Where excavated soil is to be used in site restoration, it will be excavated and stockpiled in sequential layers corresponding to the existing soil profile. Topsoil and leaf litter is to be removed first and windrowed in separate stockpiles of less than 1m in height on the upslope side of excavations. Soil layers will be replaced sequentially so that the soil profile is restored as closely as possible to its pre-work status.
	All temporary erosion and sediment control devices such as silt-stop fencing will be removed from the site at the completion of the works or when the site is stabilised.
Heritage	All relevant staff and contractors should be made aware of their statutory obligations for heritage under the *National Parks and Wildlife Act 1974* and the *Heritage Act 1977*, which may be implemented as a heritage induction.
	If unrecorded Aboriginal object/s are identified on the site during works, then all works in the immediate area must cease and the area should be cordoned off. OEH must be notified by ringing the Enviroline 131 555, so that the site can be adequately assessed and managed.
	In the unlikely event that skeletal remains are identified, work must cease immediately in the vicinity of the remains and the area must be cordoned off. The proponent must contact the local NSW Police who will make an initial assessment as to whether the remains are part of a crime scene or possible Aboriginal remains. If the remains are thought to be Aboriginal, OEH must be contacted by ringing the Enviroline 131 555. An OEH officer will determine if the remains are Aboriginal or not; and a management plan must be developed in consultation with the relevant Aboriginal stakeholders before works recommence.
	If, during the course of development works, suspected historic cultural heritage material is uncovered, work should cease in that area immediately. The OEH (Enviroline 131 555) should be notified, and works are only to recommence when an approved management strategy has been developed.

Impact	Mitigation Measures
Water quality management and stormwater	Sediment and nutrient controls will be implemented to reduce the impacts of stormwater, erosion and sedimentation on water quality. Specific erosion and sediment controls are to be contained within the site CEMP.
	All erosion and sediment control measures will be established before excavation and vegetation clearance begins. Control measures are to remain in place until all surfaces have been fully restored and stabilised.
	Sediment and erosion control devices will be inspected regularly, maintained to ensure effectiveness over the entire duration of the project, and cleaned out before 30% capacity is reached.
	Mulch bunds up slope of the proposed disturbance areas.
	Coir logs at 15m centres within the proposed road side swales.
	Sediment fences down slope of all disturbed areas and material stockpile areas.
	Disturbed areas will be stabilised by revegetation within 10 days after completion of construction.
	Site disturbance will be minimised by containing machinery access to site areas required for approved construction works.
	Erosion potential would be limited by managing runoff fetches and velocities, with measures such as contour drains, silt fences and level spreaders
	Sediment filters such as silt fences, coir logs, or turf strips will be located downstream of disturbed areas.
	The storage and handling of fuels and chemicals shall comply with Australian Standard AS1940.
	No chemicals, fuels, and/or waste will be stored or collected for disposal within or adjacent to drainage lines or unsealed surfaces.
	A 'spill kit' will be kept on site at all times for potential chemical or fuel spills.
	Refuelling, fuel decanting and vehicle maintenance work will take place in a designated sealed and bunded area.
	An Incident Management Plan (IMP) will be prepared as part of the CEMP and will include a contingency plan and emergency procedures for dealing with the potential spillage of fuel or other environmental incidents that may occur on the work site. The IMP should also contain procedures dealing with the unexpected onset of rainfall during the work period.
	Drainage systems will be checked at regular intervals and maintained to ensure they are operating at full capacity (e.g. clearance of debris from drainage lines).
Noise	All equipment used will comply with AS2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites.
	Work and deliveries will only occur during the following times: Monday to Friday: 7am to 6pm, Saturday: 8am to 3pm with deliveries 8am to 6pm. No construction work or deliveries will occur on Sundays or public holidays.
	Regular and effective maintenance of all equipment, including vehicles moving on and off the site, will be conducted.
	Plant and equipment which is used intermittently will either be shut down in the intervening periods between works or throttled down to a minimum.
	Any portable equipment with the potential to create high levels of noise (e.g. compressors, generators) will only be selected for use if it incorporates effective noise control. This equipment should be located, where practical, so that natural ground barriers are between it and the nearest potentially affected receivers.
Traffic and access	The Contractor will maintain a complaints register. Any complaints received will be responded to as soon as possible.
	A traffic control plan will be prepared and implemented in accordance with AS1742 and other relevant standards and by a suitably qualified person and will be submitted to Bellbird Water and the roads authority for approval prior to commencement of work on the site.

Impact	Mitigation Measures
Waste generation	All waste generated during the course of the works will be reused or removed from the work areas as soon as practicable and disposed of in accordance with the waste disposal safeguards.
	All vessels used for contaminated or hazardous waste should be sealed, labelled according to their contents, and stored within bunded areas until their removal from the work site.
	Any fuel, lubricant or hydraulic fluid spillages will be collected using absorbent material and the contaminated material disposed of at an EPA licensed waste depot.
	The work site will be left clean and free of debris and other rubbish at the end of works.
	All hazardous wastes on site will be removed and disposed in accordance with the state and national regulations and guidelines and best practice for the removal of these materials.
	The Contractor's recycling and reuse proposal will be detailed in the CEMP.
	Excess spoil material that cannot be reused on site will be utilised in the ongoing earthworks as part of the adjacent subdivision works.
	Green waste from vegetation clearing will be either chipped for reuse; retained for rehabilitation; or mulched and spread immediately after the trench has been covered to prevent encroachment by weed species and minimise erosion. NB: where mulched vegetation is to be used measures to prevent organic material entering the local waterway shall be installed.
	Off-cuts of piping and other construction material will be recycled where possible.
Amenity and public information	The Contractor will maintain a complaints register. Any complaints received will be responded to as soon as possible.
	Accurate public information signs will be displayed while work is in progress and maintained in presentable manner.

Table 2 Impact and Mitigation Measures to be incorporated into the OEMP

Impact	Mitigation Measures
General	An Infrastructure Operating Plan and a Water Quality Plan prepared in accordance with the *Australian Guideline for Water Recycling (2006*) and addressing the *Framework for Management of Recycled Water Quality and Use* is to be prepared prior to operation of the Bellbird LWC.
Land Capability	A Recycled Water Irrigation Management Plan, prepared in accordance with the *Australian Guideline for Water Recycling (2006*) is to be developed once further details of the irrigation of recycled water is established. The Recycled Water Management Plan is to detail the vegetation cover required, the maintenance of vegetated areas to be irrigated and details of irrigation preparation works for forested areas. The Recycled Water Management Plan will also detail soil improvement methods for the irrigated areas including the parameters for the use of gypsum.
Waste generation	During the operation of the LWC the disposal of sludge wastings, sludge cake and grit and screen debris will be carried out in accordance with the EPA *Environmental Guidelines: Use and Disposal of Biosolids Products (2000).*
	The management of waste, including its transport will comply with the POEO Act and POEO (Waste) Regulation.
	Waste materials will be separated, classified and managed in accordance with the *Waste Classification Guidelines Part 1: Classifying Waste* (DECCW 2009)
	All staff and contractors will be made aware of waste management procedures.
Risks and Hazards	Chemicals and potentially hazardous substances will be used and stored according to regulatory requirements including the *Work Health and Safety Act 2011* and *AS 3780 The storage and handling of corrosive substances.*
	Chemical, fuel and oil containers will be managed according to manufacturers' directions to avoid potential impacts to the environment or human health.
	Bellbird Water will ensure that in the unlikely event of a pollution incident all remedial actions are in accordance with the POEO Act. In accordance with Section 148 of the POEO Act pollution incidents causing or threatening material harm will be notified immediately with the EPA.

Impact	Mitigation Measures
	No chemicals, fuels, and/or waste will be stored or collected for disposal within or adjacent to drainage lines or unsealed surfaces.

Conclusion

The proposal will result in minimal adverse effects upon the environment. The proposal will be built in conjunction with the civil works associated with the approved subdivisions of the Bellbird North Urban Release Area. Following the assessment of potential environmental impacts, through the work of various specialists, the REF demonstrates that the proposal will result in no impact beyond relevant guidelines and legislation.

Various minor environmental impacts have been identified in the REF and these are generally temporary in nature. Specifically, it is unlikely that the proposal will have a significant impact on threatened species, populations and ecological communities listed pursuant to the *Threatened Species Conservation Act 1995* or impact on matters of National Environmental Significance pursuant to the *Environment Protection and Biodiversity Conservation Act 1999.* There are no long term adverse effects created by the construction of the proposal. The mitigation measures contained within the REF, which will be implemented, will avoid or reduce the potential impacts of the proposal.

In addition, the proposal is unlikely to present a significant risk of harm to the environment and approval of network operator's licence under the *Water Industry Competition Act 2006* and the *Water Industry Competition (General) Regulation 2008* would be in the public interest.

The proposal will provide a service essential for the development of the Bellbird North Urban Release Area which greatly benefits the community by ensuring supply of affordable housing for Cessnock. This construction will benefit the current and future community in providing ready access to sewage disposal, recycled water and drinking water schemes that make a significant contribution to sustainability.

Appendix 1

Concept Master Plans, LWC site plan and perspective illustration

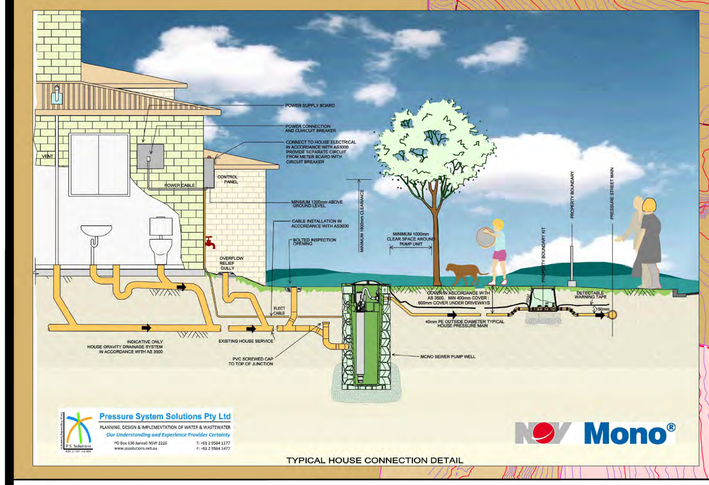
S S Y Y

S

Z1 B S

A V V

V S B Y



TYPICAL HOUSE CONNECTION DETAIL

Da e 5 5 20 5

Rev A

D aw g No K 0

S ae 0 50 100 150m
SCALE 1:3000 AT A0

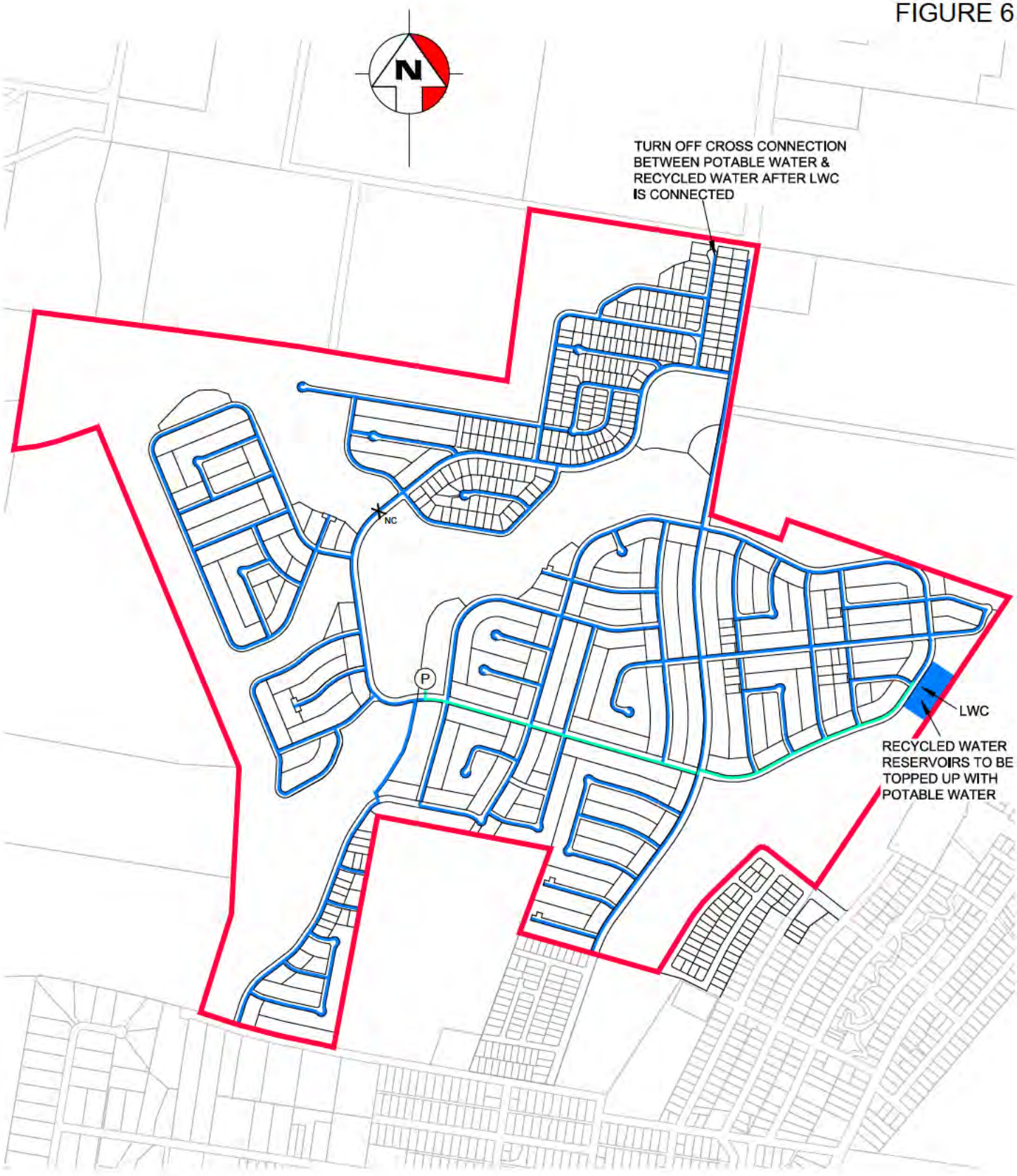
BE BIRD
RESSURE SEWERAGE S S EM
MAS ER AN

flow systems

Pressure System Solutions Pty Ltd
PLANNING, DESIGN & IMPLEMENTATION OF WATER & WASTEWATER SYSTEMS
Our Understanding and Experience Provides Certainty
PO Box 630 Jannali NSW 2226
www.pssolutions.net.au
T: +61 2 9584 1177
F: +61 2 9584 1477

S 0 0 B

FIGURE 6



LEGEND

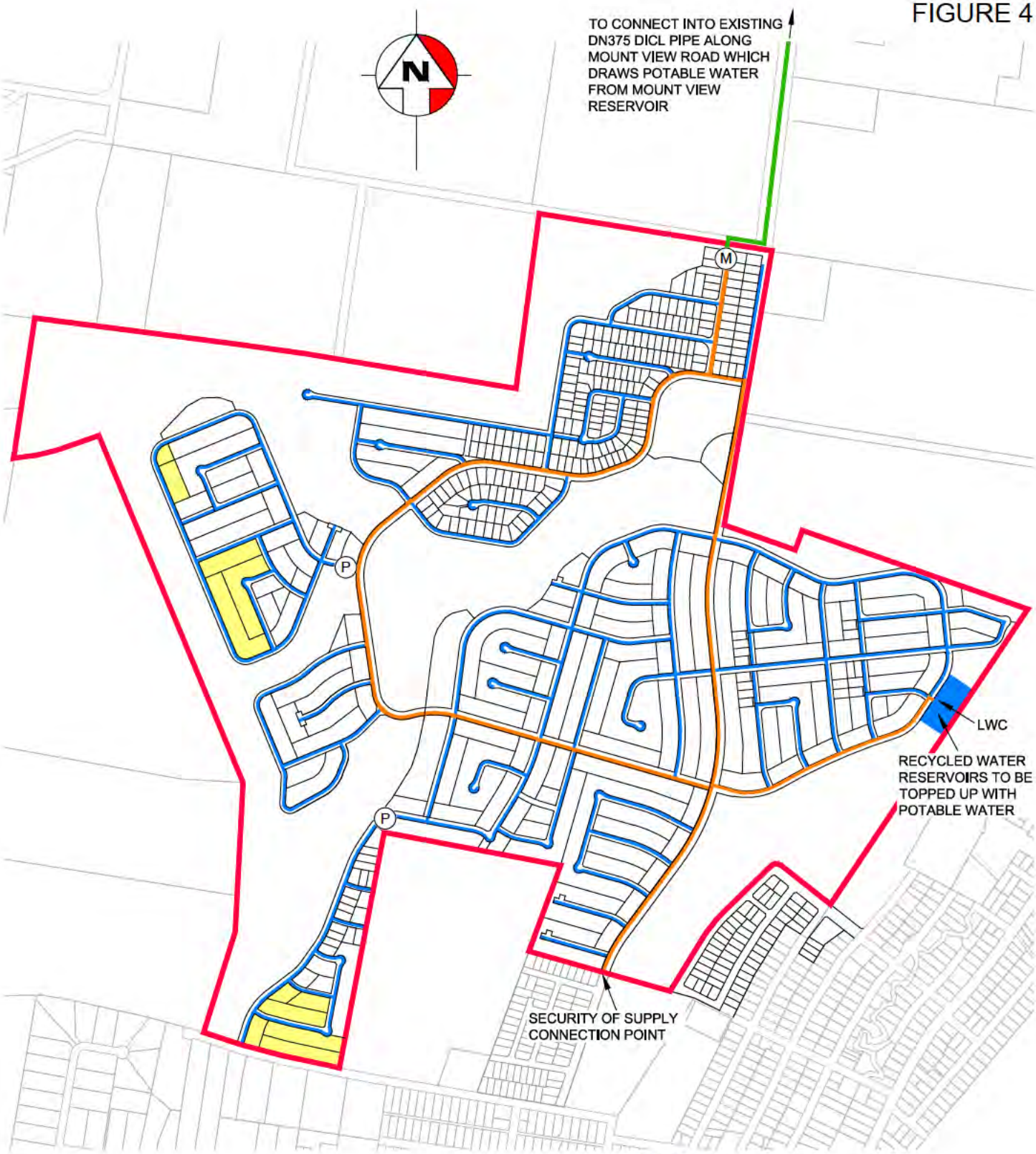
- DN100 PVC - M
- DN150 PVC - M
- (P) BOOSTER PUMP STATION
- NC NORMALLY CLOSED VALVE
- OPERATIONS BOUNDARY

WorleyParsons
resources & energy

NORTH BELLBIRD RECYCLED WATER MASTER PLAN ULTIMATE DEVELOPMENT

O:\301020\07966 - North Bellbird Development (Prop 07286)\12.0 Drawings\12.13 Water\CAD\MASTERPLAN-FIGURE 06.dwg 19/06/2015

FIGURE 4



LEGEND

- DN100 PVC - M
- DN200 PVC - M
- DN250 DICL
- (M) BULK WATER METER
- (P) BOOSTER PUMP STATION
- OPERATIONS BOUNDARY
- LOCAL LOW PRESSURE ZONE TO BE BOOSTED

WorleyParsons
resources & energy

NORTH BELLBIRD POTABLE WATER MASTER PLAN ULTIMATE DEVELOPMENT

O:\301020\07966 - North Bellbird Development (Prop 07286)\12.0 Drawings\12.13 Water\CAD\MASTERPLAN-FIGURE 04.dwg



Indicative Design for Interim Sewage Storage Tanks

PERMEATE PARTNERS
E : info@permeate.com.au | W : www.permeate.com.au
SYDNEY: (02) 368 6732 | MELBOURNE : (03) 8753 1317

COPYRIGHT
Th s document is and shall remain the property of Permeate Partners Pty Ltd. The document may only be used for the purpose for which t was commissioned in accordance with the terms of engagement for the commission. Unauthorised use of this document in any form is strictly prohibited. ©

NO.	DATE	DRAFTER	DESIGN	MGMT	DESCRIPTION
D	01 09/1	AJC	AJC	-	FOR INFORMATION

CLIENT

NAME:	FLOW SYSTEMS			TITLE:	PROCESS AND INSTRUMENTATION DIAGRAM INTERIM STORAGE TANKS
PROJECT:	HUNTLEE			SCALE NTS	PERMEATE PROJECT # C1 107 / PERMEATE DRAWING # C1 107 TANK LAYOUT 3D
Design	Date	Drafting	Date	SHEET A1	CLIENT PROJECT # - / CLIENT DRAWING # -

D:\Local Cloud\Shared\Internal\Production\Permeate Partners\.000003-Interim Storage Tanks Layout\Working Files\C1107 Tank Layout 3D.dwg

3.5.1(d) REF Executive Summary for the Water Recycling Facility

REF for the Bellbird Local Water Centre

North Bellbird

Executive Summary Report

Prepared by:

RPS AUSTRALIA EAST PTY LTD

241 Denison Street
Broadmeadow NSW 2292
PO Box 428 Hamilton NSW 2303

Prepared for the proponent:

BELLBIRD WATER (A WHOLLY OWNED SUBSIDIARY OF FLOW SYSTEMS PTY LTD)

Level 2, 1 Alfred Street
Sydney NSW, 2000

Executive Summary

The Proposal

Bellbird Water (a wholly owned subsidiary of Flow Systems) is proposing to construct and operate a water recycling facility at Bellbird North to facilitate residential development of the Bellbird North Urban Release Area. The proposal will be known as the Bellbird Local Water Centre (Bellbird LWC).

The Bellbird LWC will utilise sewage from the future residential area to produce high quality water. The sewage will be treated through a multi-stage process. The processes that the LWC will use will meet the strict *Australian Guidelines for Water Recycling 2006*. Wastewater is cleaned to the highest Australian standards, undergoing seven filtration and purification processes including Membrane Bioreactor and Ultraviolet treatment. The end product is recycled water plumbed into houses and public recreation areas (subject to separate Council approval) for non-potable uses such as toilet flushing, washing machines, irrigation and car washing, thus reducing potable water demand. The facility will be located on Part Lot 1 DP 32775 as illustrated in **Figure 1**. Lot 1 DP 32775 will be subdivided in the near future to accommodate the Bellbird LWC plant and facilities in a separate allotment. The facility is intended to operate 24 hours, 7 days per week, housed in a low-scale building within an open space setting. An architectural drawing of the proposal as it would appear once constructed is provided in **Figure 2.**

The alternatives to the proposed Bellbird LWC is to build a traditional local sewage treatment plant with potential discharge to the local waterway, or more expensively to pipe the sewage to an existing sewage treatment plant for treatment and disposal, which would also require an amplification/upgrade of the existing receiving treatment plant. Either alternative would be more expensive, take longer to implement, have greater potential environmental impacts, and fail to achieve sustainability initiatives for water re-use.

Statutory and planning framework

The Review of Environmental Factors (REF) for the Bellbird LWC has been prepared to provide the Independent Pricing and Regulatory Tribunal (IPART) and the NSW Minister for Lands and Water, with information to the fullest extent possible of all matters affecting, or likely to affect, the environment by the construction and operation of the Bellbird LWC. The proposal does not require development consent under Part 4 of the Environmental Planning and Assessment Act 1979 (EP& A Act) pursuant to *State Environmental Planning Policy (Infrastructure) 2007* and the imminent rezoning of the site to SP2 Sewerage System. Therefore the proposal is the subject of environmental assessment under Part 5 of the EP&A Act. This document is an executive summary of the REF prepared for the environmental assessment.

Environmental Impacts

The REF provides a detailed description of the potential environmental impacts associated with the proposal, during both construction and operation, and these include impacts associated with the:

- Application of recycled water around the Bellbird residential development;
- Removal of vegetation and habitat for fauna;
- Potential for the identification of Aboriginal objects;
- Increase in hardstand areas and associated runoff;
- Potential for increase in noise;
- Air Quality and odour;
- Potential for Bushfires;

- Increase in traffic movements;
- Potential for changes to visual character; and
- Potential for the generation of waste during the construction phase.

Noise Impacts

Operational noise associated with the equipment within the Bellbird LWC has been assessed against noise criteria set out in the NSW Environmental Protection Authority (EPA) NSW Industrial Noise Policy (INP). Noise monitoring to determine ambient noise was carried out as part of the specialist Noise Assessment contained within the REF and enabled the establishment of Project Specific Noise Criteria for daytime and night time operations. The noise monitoring and modelling used the $L_{Aeq,15min}$ criteria which is a common measure of environmental noise and road traffic noise. Criterion established were L_{Aeq} 43 dBA for day time and L_{Aeq} 37 dBA for night time. Under abnormal operating conditions involving the use of a back-up generator the INP allows for a positive adjustment of 5 dB to the criterion stated above.

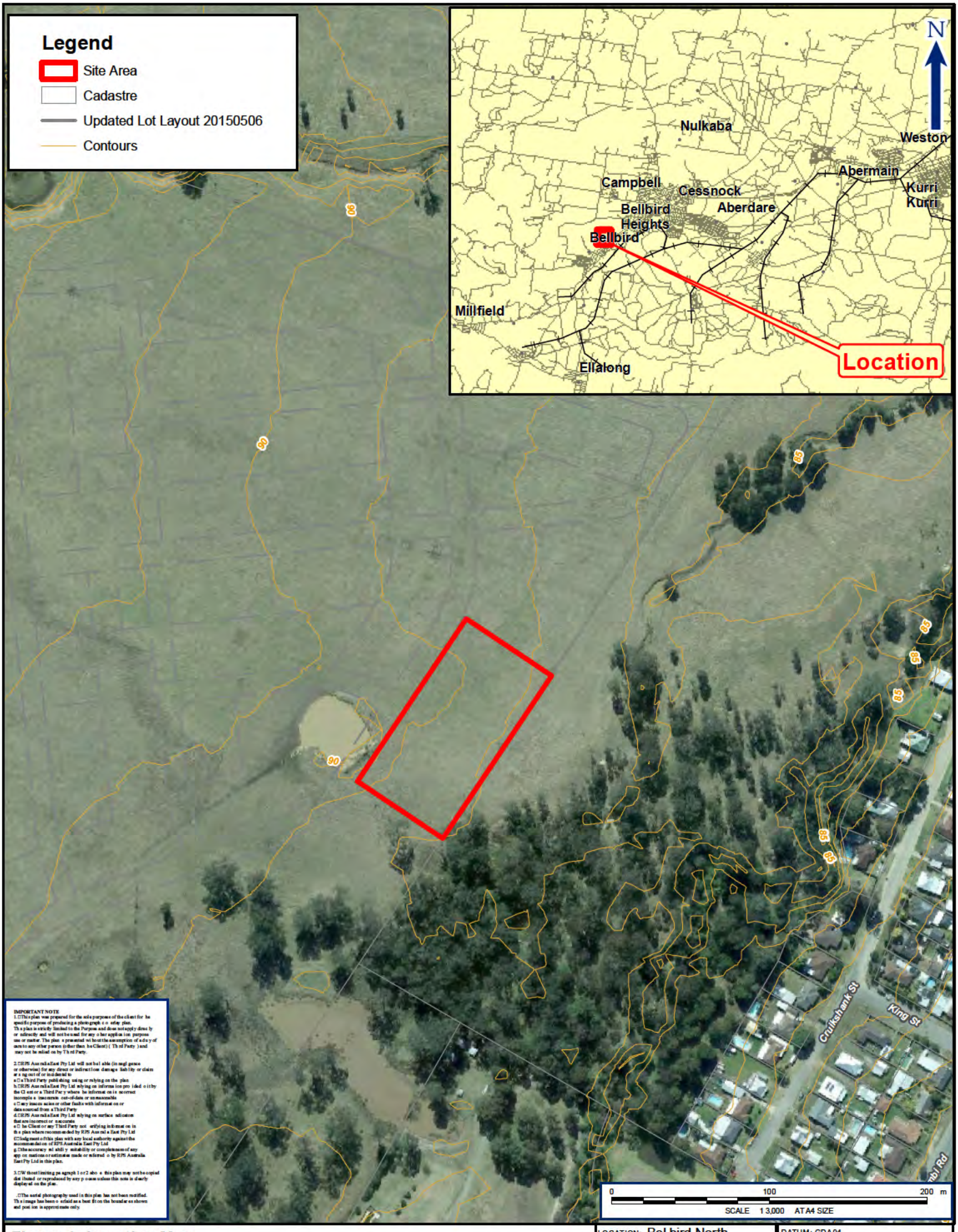
Predicted noise levels from the proposed blowers and compressors room, recycled water pumps and potable water pumps indicate compliance with all criteria on all occasions at the closest identified noise sensitive receptors provided that a number of minor modifications to the building construction / treatment are implemented. The results of the modelling of the typical operation of the Bellbird LWC with recommended mitigation measures in place are presented in graphical form as a contour map in **Figure 3**. The results of the modelling of the Bellbird LWC under abnormal operating conditions involving the use of a back-up generator but with recommended mitigation measures in place are presented in graphical form as a contour map in **Figure 4.** Predicted noise levels from the back-up generator comply with the adjusted acceptable daytime noise level on all occasions at the nearest existing and future residential receivers.

Specific acoustic treatment for the Bellbird LWC is contained within the mitigation measures which will be implemented during the Bellbird LWC's construction and operation.

Odour and Air Quality

An Odour Impact Assessment having due consideration for the NSW Environmental Protection Authority guidelines was carried out as part of the REF.

The predicted odour concentrations for the fully operational plant are provided in **Figure 5**. Results from the modelling used in the Odour Impact Assessment predicted odour concentrations from the proposed facility would comply with the most stringent assessment criterion at all sensitive receivers. The predicted odour concentrations show that the 1 OU or 99th percentile threshold (the theoretical level at which odour becomes detectable but not necessarily distinguishable), is not predicted beyond the boundary of the proposal site.



IMPORTANT NOTE

1. This plan was prepared for the sole purpose of the client for the specific purpose of producing a photograph of the plan. This plan is strictly limited to the Purpose and does not apply directly or indirectly and will not be used for any other application purpose use or matter. This plan is presented without the assumption of a duty of care to any other person (other than the Client) (Third Party) and may not be relied on by Third Party.

2. RPS Australia East Pty Ltd will not be liable (in negligence or otherwise) for any direct or indirect loss damage liability or claim arising out of or incidental to
a. a Third Party publishing using or relying on the plan
b. RPS Australia East Pty Ltd relying on information provided by the Client or a Third Party where the information is incorrect incomplete inaccurate out-of-date or unreasonable
c. any inaccuracies or other faults with information or data sourced from a Third Party
d. RPS Australia East Pty Ltd relying on surface indications that are incorrect or inaccurate
e. the Client or any Third Party not verifying information in this plan where recommended by RPS Australia East Pty Ltd
f. lodgement of this plan with any local authority against the recommendation of RPS Australia East Pty Ltd
g. the accuracy reliability or completeness of any app raisals or estimates made or referred to by RPS Australia East Pty Ltd in this plan.

3. Without limiting paragraph 1 or 2 above this plan may not be copied distributed or reproduced by any person unless this note is clearly displayed on the plan.

4. The aerial photography used in this plan has not been rectified. This image has been orientated as best fit on the boundaries shown and position is approximate only.

Figure 1: Location Map

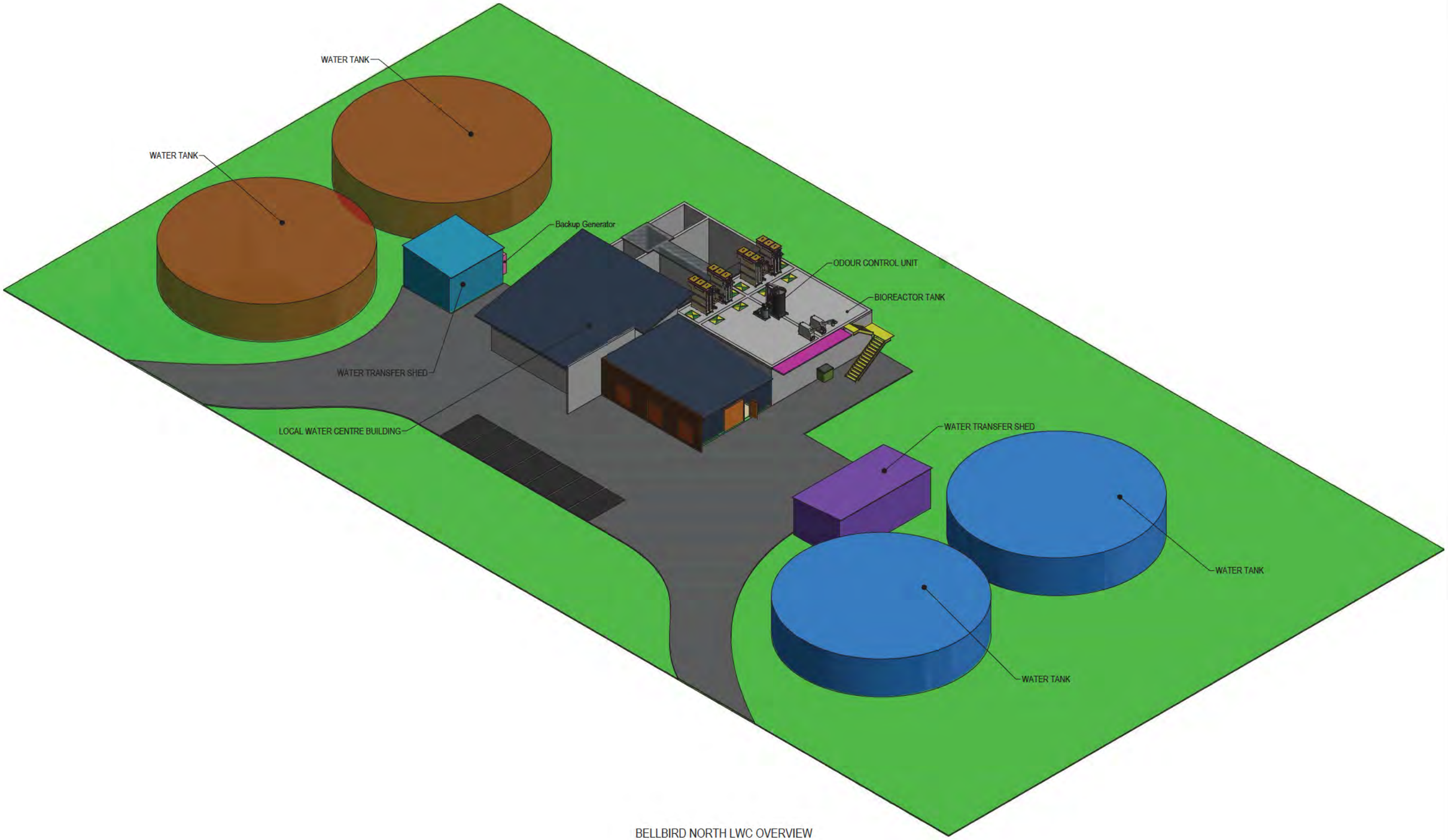
LOCATION: Bellbird North	DATUM: GDA94 PROJECTION: MGA Zone 56
JOB NO.: PR125173-1 PURPOSE: PLANNING Technician: Natalie.Wood Date: 1/07/2015	Data Sources: RPS flowsystems OEH

CLIENT: Flowsystems

RPS AUSTRALIA EAST PTY LTD (ABN 44 140 292 762)
241 DENISON STREET BROADMEADOW PO BOX 428 HAMILTON NSW 2303
T: 02 4940 4200 F: 02 4961 6794 www.rpsgroup.com.au

RPS

Path: J:\JOBS\125k\125173 Bellbird North\10 - Drafting\Arcgis Map Documents\Planning\125173-1 Figure 1 Location A4 20150701.mxd



BELLBIRD NORTH LWC OVERVIEW

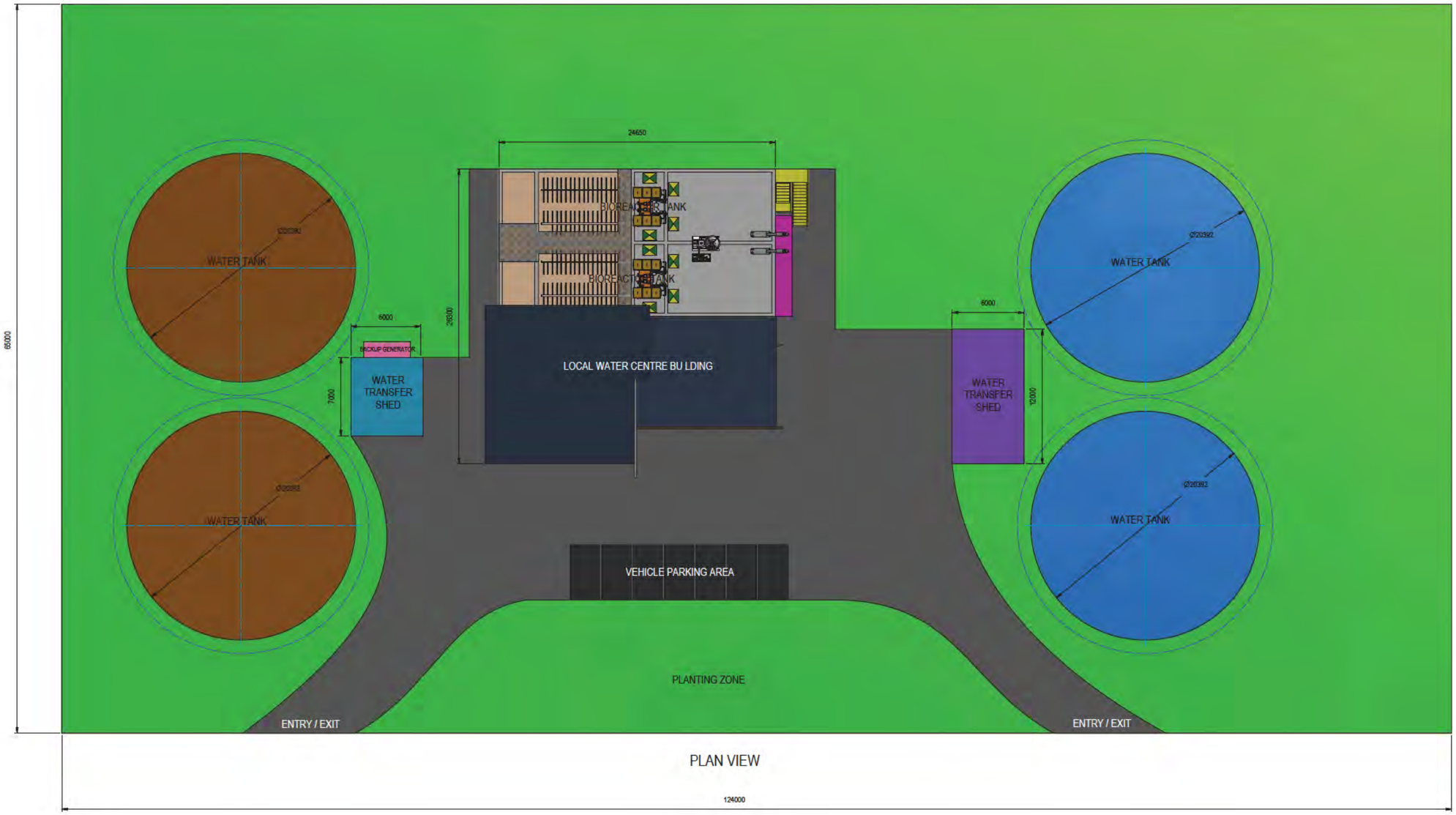
DATE	REV	AMENDMENT	BY	CHKD	DATE	REV	AMENDMENT	BY	CHKD
14.05.15	0	CONCEPT DESIGN	JA	GM					

Figure 2.1

Bellbird Water

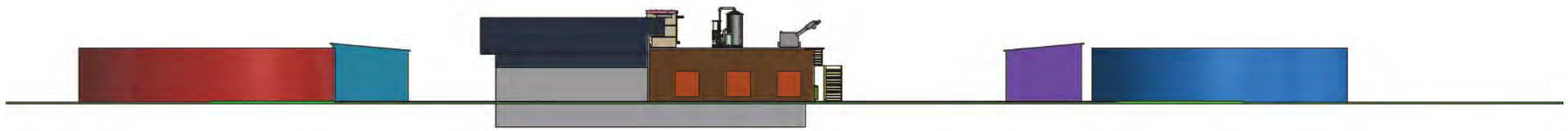
WJP SOLUTIONS
proven · safe · reliable water
T: 03 9854 0900 F: 03 9819 7979
E: info@wjpsolutions.com.au W: www.wjpsolutions.com.au

PROJECT:	BELLBIRD LOCAL WATER CENTRE
CLIENT:	
DESCRIPTION:	BELLBIRD NORTH LOCAL WATER CENTRE OVERV EW
DATE: 13/05/2015	DRAWN: Jonathan Arulappen
SCALE:	CHECKED: GM
SHEET SIZE: A1	APPROVED: GM
TYPE OF PROJECTION:	DWG/PRT NO.: 9267 - 1
	PROJECT NO.: 9267
	REVISION NO.: 0 SHEET NO.: 1



PLAN VIEW

124000



FRONT VIEW

14.05.15	0	CONCEPT DESIGN	JA	GM						
DATE	REV	AMENDMENT	BY	CHKD	DATE	REV	AMENDMENT	BY	CHKD	

Figure 2.2

Bellbird Water

WJP SOLUTIONS
proven · safe · reliable water
T: 03 9854 0900 F: 03 9819 7979
E: info@wjpsolutions.com.au W: www.wjpsolutions.com.au

PROJECT: BELLBIRD LOCAL WATER CENTRE

CLIENT:

DESCRIPTION: BELLBIRD NORTH LOCAL WATER CENTRE PLAN & FRONT VIEW

DATE: 13/05/2015
SCALE:
SHEET SIZE: A1
TYPE OF PROJECTION:

DRAWN: Jonathan Arulappen
CHECKED: GM
APPROVED: GM
DWG/PRT NO.: 9267 - 2
PROJECT NO.: 9267
REVISION NO.: 0
SHEET NO.: 2

Figure 3 Noise Modelling - Normal Operation with recommended mitigation measures

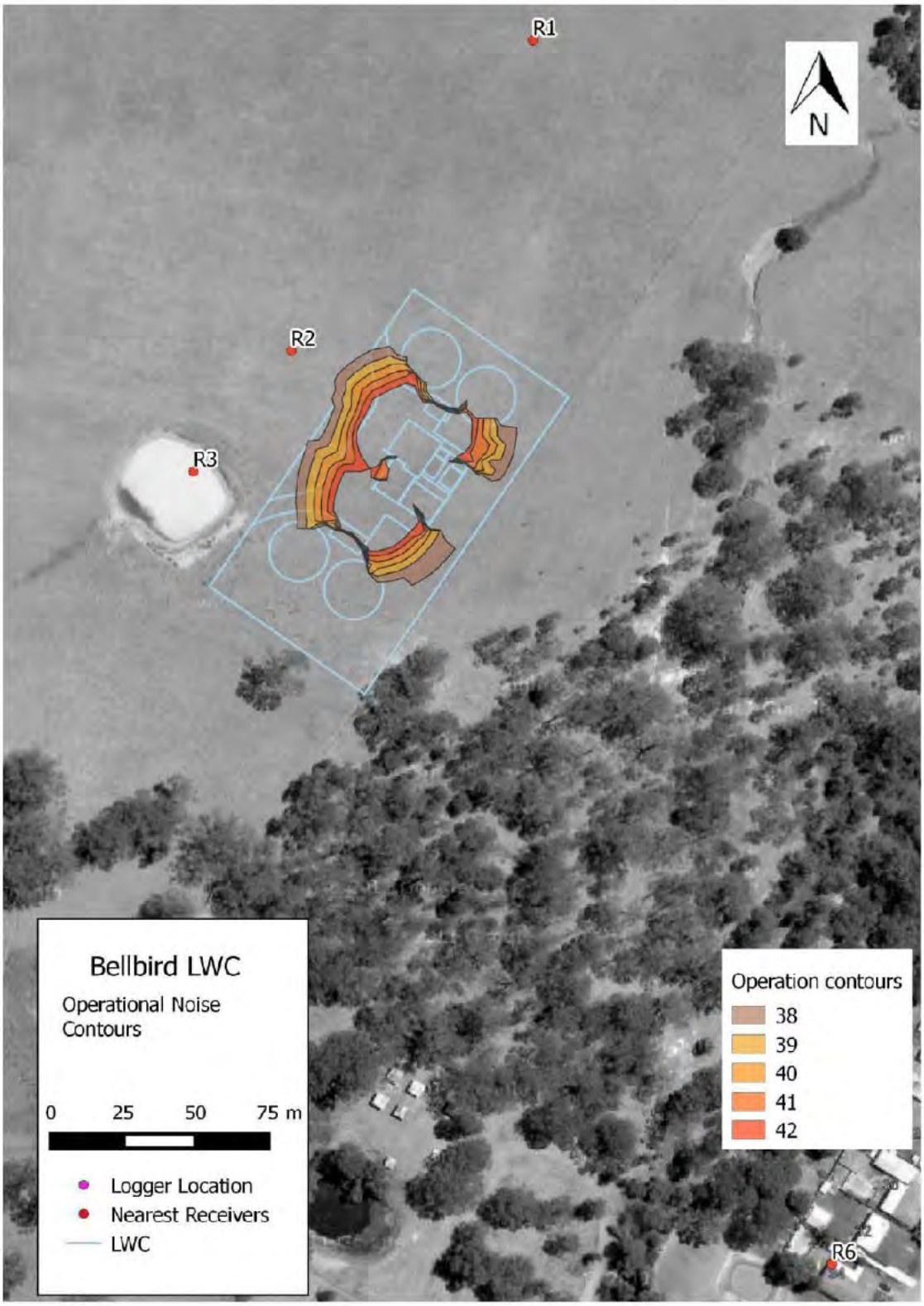


Figure 4 Noise Modelling – Abnormal Operation with back-up generator with recommended mitigation measures

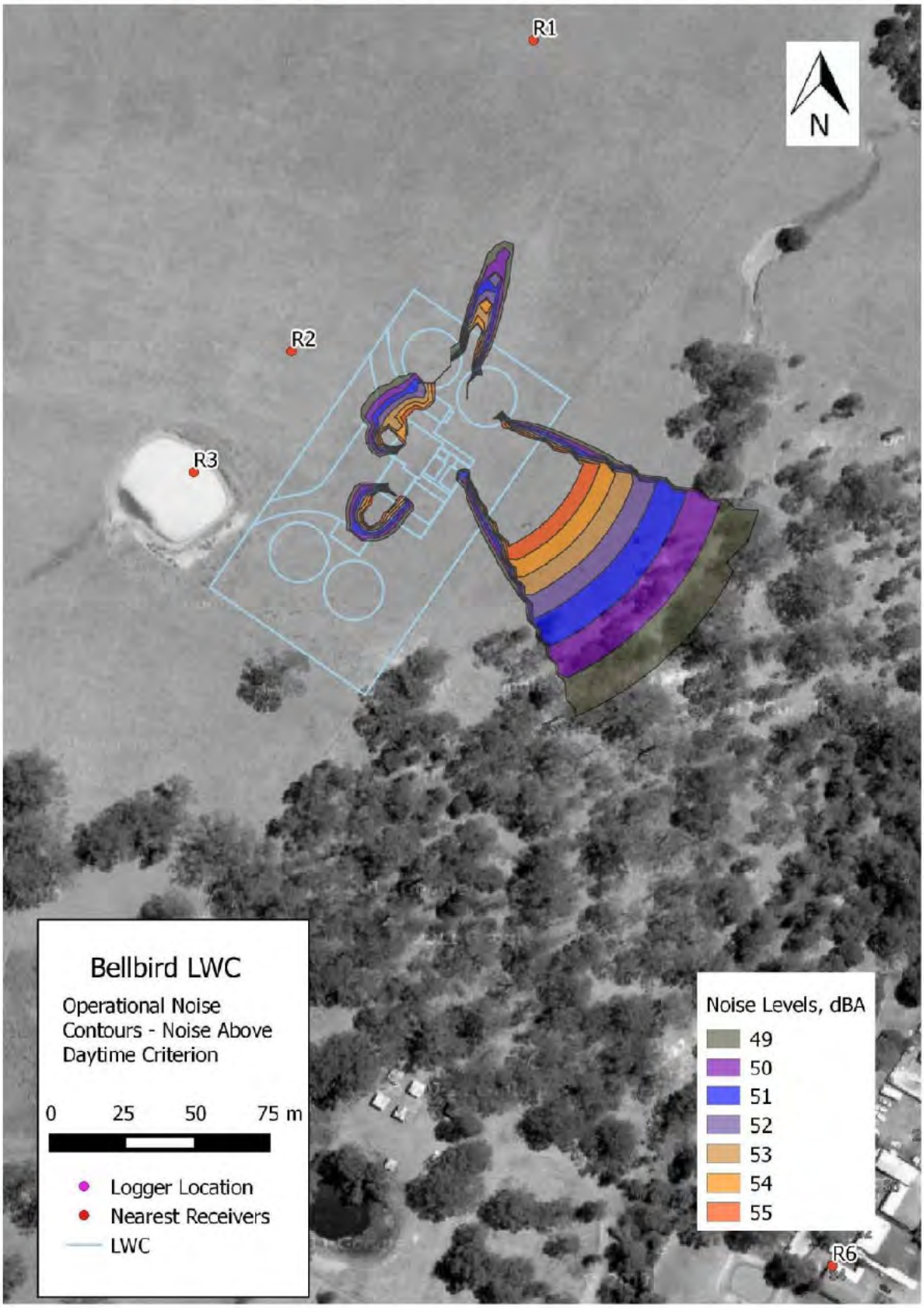


Figure 5 Odour Modelling - Predicted 99th percentile odour concentration (OU) when the Bellbird LWC is fully operational



Mitigation Measures

The REF provides a large number of mitigation measures that will avoid or reduce the potential impacts of the proposal. These mitigation measures have been designed to minimise and or mitigate, as far as practical, the potential impacts. All mitigation measures described in this REF will be incorporated into the site's CEMP and / or the Operational Environmental Management Plan (OEMP) / Licence Plans. The CEMP will be prepared prior to construction of the Bellbird LWC and the OEMP prior to the operation of the LWC and both are to be reviewed and approved by IPART prior to the commencement of relevant on-site works.

A summary of the mitigation measures (Construction and Operations) can be viewed in **Table 1** and **Table 2**. Common mitigation measures between key environmental issues have been amalgamated.

Table 1 Impact and Mitigation Measures to be incorporated into the CEMP

Impact	Mitigation Measures
General	All contractors and machine operators will be inducted on the environmental sensitivities of the work site(s) and relevant safeguards.
Erosion and Sediment Control	Sediment and nutrient controls will be implemented to reduce the impacts of stormwater, erosion and sedimentation on water quality. Specific erosion and sediment controls are to be contained within the site CEMP.
	All erosion and sediment control measures will be established before excavation and vegetation clearance begins. Control measures are to remain in place until all surfaces have been fully restored and stabilised.
	Sandbags will be placed at the entry points to any culverts and stormwater channels to prevent sediment entering the stormwater system.
	Any spoil storage areas or temporary stockpiles will have appropriate erosion control devices installed to control runoff and prevent sedimentation.
	Sediment control devices (e.g. silt fences, straw bales wrapped in geotextile etc will be installed parallel with the contours of the site and immediately down slope of any areas where the natural ground surface has been disturbed.
	Any spoil storage areas or stockpiles will have appropriate erosion control devices installed to control runoff and prevent sedimentation.
	Sediment and erosion control devices will be inspected regularly, maintained to ensure effectiveness over the entire duration of the project, and cleaned out before 30% capacity is reached.
	Disturbed areas will be stabilised by revegetation within 10 days after completion of construction.
	The natural landform of the site will be restored as closely as possible to the pre-works condition.
Flora and Fauna	The clearing extents are to be clearly demarcated with temporary fencing before commencement of works.
	Materials/ equipment lay-down areas will be shown in the CEMP.
	To prevent damage to vegetation outside the boundaries of access tracks, vehicles and machinery will be restricted to designated access tracks.
	All temporary erosion and sediment control devices such as silt-stop fencing will be removed from the site at the completion of the works or when the site is stabilised.
	Where excavated soil is to be used in site restoration, it will be excavated and stockpiled in sequential layers corresponding to the existing soil profile. Topsoil and leaf litter is to be removed first and windrowed in separate stockpiles of less than 1m in height on the upslope side of excavations. Soil layers will be replaced sequentially so that the soil profile is restored as closely as possible to its pre-work status.
Heritage (Aboriginal and non-Aboriginal)	A No Go Zone demarcated by high visibility fencing must be erected around the isolated find located on the eastern boundary of the site before commencement of works and remain in place for the duration of works.
	All relevant Flow Systems staff and contractors should be made aware of their statutory obligations for heritage under the *National Parks and Wildlife Act* 1974 and the *Heritage Act* 1977, which may

Impact	Mitigation Measures
	be implemented as a heritage induction.
	The Aboriginal Due Diligence Assessment (**Appendix 5** of this REF) must be kept by Flow Systems so that it can be presented, if needed, as a defence from prosecution under Section 86(2) of the *National Parks and Wildlife Act 1974*.
	If unrecorded Aboriginal object/s are identified in the Project Area during works, then all works in the immediate area must cease and the area should be cordoned off. OEH must be notified by ringing the Enviroline 131 555 so that the site can be adequately assessed and managed.
	In the unlikely event that skeletal remains are identified, work must cease immediately in the vicinity of the remains and the area must be cordoned off. The proponent must contact the local NSW Police who will make an initial assessment as to whether the remains are part of a crime scene or possible Aboriginal remains. If the remains are thought to be Aboriginal, OEH must be contacted by ringing the Enviroline 131 555. An OEH officer will determine if the remains are Aboriginal or not; and a management plan must be developed in consultation with the relevant Aboriginal stakeholders before works recommence.
	If, during the course of development works, suspected historic cultural heritage material is uncovered, work should cease in that area immediately. The Heritage Branch, Office of Environment & Heritage (Enviroline 131 555) should be notified and works only recommence when an approved management strategy has been developed.
Stormwater and water quality	Mulch bunds up slope of the proposed disturbance areas.
	Hay Bales at 15m centres within the proposed road side swales.
	Sediment fences down slope of all disturbed areas and material stockpile areas.
	Disturbed areas will be stabilised by revegetation within 10 days after completion of construction.
	Site disturbance will be minimised by containing machinery access to site areas required for approved construction works.
	Erosion potential would be limited by managing runoff fetches and velocities, with measures such as contour drains, silt fences and level spreaders
	Sediment filters such as silt fences, straw bales, or turf strips will be located downstream of disturbed areas.
	No chemicals, fuels, and/or waste will be stored or collected for disposal within or adjacent to drainage lines or unsealed surfaces.
	A 'spill kit' will be kept on site at all times for potential chemical or fuel spills.
	Refuelling, fuel decanting and vehicle maintenance work will take place in a designated sealed and bunded area.
	An Incident Management Plan (IMP) will be prepared as part of the CEMP and will include a contingency plan and emergency procedures for dealing with the potential spillage of fuel or other environmental incidents that may occur on the work site. The IMP should also contain procedures dealing with the unexpected onset of rainfall during the work period.
	Drainage systems will be checked at regular intervals and maintained to ensure they are operating at full capacity (e.g. clearance of debris from drainage lines).
Noise	Additional lining of colorbond on the internal face of the plant room with appropriate air gap to accommodate 50mm thick polyester insulation of density 14kg/m3
	All equipment used will comply with *AS2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites*.
	Work and deliveries will only occur during the following times: Monday to Friday 7am to 6pm, Saturday 8am to 3pm. No construction work or deliveries will occur on Sundays or public holidays.
	Regular and effective maintenance of all equipment, including vehicles moving on and off the site, will be conducted.
	Plant and equipment which is used intermittently will either be shut down in the intervening periods between works or throttled down to a minimum.
	Any portable equipment with the potential to create high levels of noise (e.g. compressors, generators) will only be selected for use if it incorporates effective noise control. This equipment

Impact	Mitigation Measures
	should be located, where practical, so that natural ground barriers are between it and the nearest potentially affected receivers.
Odour and Air Quality	All vehicles and machinery will be fitted with approved exhaust systems to maintain exhaust emissions within accepted standards.
	Machinery and vehicles will not be left running or idling when not in use for long periods.
	Odour or air pollutant emission complaints will be dealt with promptly and the source will be eliminated wherever practicable
	All loads of excavated material, soil, fill and other erodible matter that are transported to or from the work site will be kept covered at all times during transportation and will remain covered until they are unloaded either for use at the work site, reuse or disposal at a OEH licensed waste disposal facility.
	All work sites, general work areas and stockpiles will be closely monitored for dust generation and watered down (with clean water) or covered (via seeding or tarpaulins) in the event of dry and/or windy conditions.
	Rehabilitation of disturbed surfaces would be undertaken within 10 days of completion of construction on site.
Bushfire	Bushfire buffers in the form of a Managed Fuel Zone are recommended to the east, southeast and south of the Study Area between the hazard/s and proposed development.
	Future buildings within the site should have due regard to the specific considerations given in the BCA, which makes specific reference to the Australian Standard (AS3959 – 2009) construction of buildings in bushfire prone areas.
	Where fitted, the openable parts of windows and any vents or unprotected openings shall be screened with mesh with a maximum aperture of 2mm, made of non-combustible material.
	Consideration should be given to landscaping and fuel loads on site to decrease potential fire hazards on site.
	Internal road networks should consider the requirements for road construction detailed within section 4.1.3 of PBP 2006.
	All stored water tanks should be fitted with a suitable connection – 65mm Storz outlet with a Gate or Ball valve.
	An Emergency Management Plan is to be prepared to identify the nearest bushfire hazards and preferred refuges and evacuation routes.
Traffic and access	Bellbird Water will maintain a complaints register. Any complaints received will be responded to as soon as possible.
	As part of the CEMP a traffic control plan will be prepared by a suitably qualified person.
Visual character	On completion of the works, all vehicles, construction equipment, materials, and refuse relating to the works will be removed from the work site(s) and any adjacent affected areas.
	Work sites will be restored as close to their original condition as possible following the completion of the proposed works.
Waste generation	All waste generated during the course of the works will be reused or removed from the work areas as soon as practicable and disposed of in accordance with the waste disposal safeguards.
	All vessels used for contaminated or hazardous waste should be sealed, labelled according to their contents, and stored within bunded areas until their removal from the work site.
	Any fuel, lubricant or hydraulic fluid spillages will be collected using absorbent material and the contaminated material disposed of at an EPA licensed waste depot.
	The work site will be left clean and free of weeds, debris and other rubbish at the end of works.
	All hazardous wastes on site will be removed and disposed in accordance with the state and national regulations and guidelines and best practice for the removal of these materials.
	The Contractor's recycling and reuse proposal will be detailed in the CEMP.
	Excess spoil material that cannot be reused on site will be utilised in the ongoing earthworks as part of the adjacent subdivision works.

Impact	Mitigation Measures
	Green waste from vegetation clearing will be chipped for reuse; retained for rehabilitation; or mulched and spread immediately after the trench has been covered to prevent encroachment by weed species and minimise erosion. NB: where mulched vegetation is to be used measures to prevent organic material entering the local waterway shall be installed.
	Off-cuts of piping and other construction material will be recycled where possible.
Risks and Hazards	Chemicals and potentially hazardous substances will be used and stored according to regulatory requirements including the *Work Health and Safety Act 2011* and *Australian Standard 1940*.
	Chemical, fuel and oil containers will be managed according to manufacturers' directions to avoid potential impacts to the environment or human health.
	Bellbird Water will ensure that in the unlikely event of a pollution incident all remedial actions are in accordance with the POEO Act. In accordance with Section 148 of the POEO Act pollution incidents causing or threatening material harm will be notified immediately with the EPA.
	No chemicals, fuels, and/or waste will be stored or collected for disposal within or adjacent to drainage lines or unsealed surfaces.
	A 'spill kit' will be kept on site at all times for potential chemical or fuel spills.
	Signage and buffer zones will be employed at recycled water reuse areas as appropriate to the relevant end use.
Amenity and public information	Accurate public information signs will be displayed while work is in progress and maintained in presentable manner.

Table 2 Impact and Mitigation Measures to be incorporated into the OEMP

Impact	Mitigation Measures
General	An Infrastructure Operating Plan and a Water Quality Plan prepared in accordance with the *Australian Guideline for Water Recycling (2006*) and addressing the *Framework for Management of Recycled Water Quality and Use* are to be prepared prior to operation of the Bellbird LWC.
Land Capability	A Recycled Water Irrigation Management Plan, prepared in accordance with the *Australian Guideline for Water Recycling (2006*) is to be developed once further details of the irrigation of recycled water is established. The Recycled Water Management Plan is to detail the vegetation cover required, the maintenance of vegetated areas to be irrigated and details of irrigation preparation works for forested areas. The Recycled Water Management Plan will also detail soil improvement methods for the irrigated areas including the parameters for the use of gypsum.
Waste generation	During the operation of the LWC the disposal of sludge wastings, sludge cake and grit and screen debris will be carried out in accordance with the EPA *Environmental Guidelines: Use and Disposal of Biosolids Products (2000).*
	The management of waste, including its transport will comply with the POEO Act and POEO (Waste) Regulation.
	Waste materials will be separated, classified and managed in accordance with the *Waste Classification Guidelines Part 1: Classifying Waste* (DECCW 2009)
	All staff and contractors will be made aware of waste management procedures.
Risks and Hazards	Chemicals and potentially hazardous substances will be used and stored according to regulatory requirements including the *Work Health and Safety Act 2011* and *AS 3780 The storage and handling of corrosive substances.* Chemical, fuel and oil containers will be managed according to manufacturers' directions to avoid potential impacts to the environment or human health.
	Bellbird Water will ensure that in the unlikely event of a pollution incident all remedial actions are in accordance with the POEO Act. In accordance with Section 148 of the POEO Act pollution incidents causing or threatening material harm will be notified immediately with the EPA.
	No chemicals, fuels, and/or waste will be stored or collected for disposal within or adjacent to drainage lines or unsealed surfaces.
	A 'spill kit' will be kept on site at all times for potential chemical or fuel spills.

Conclusion

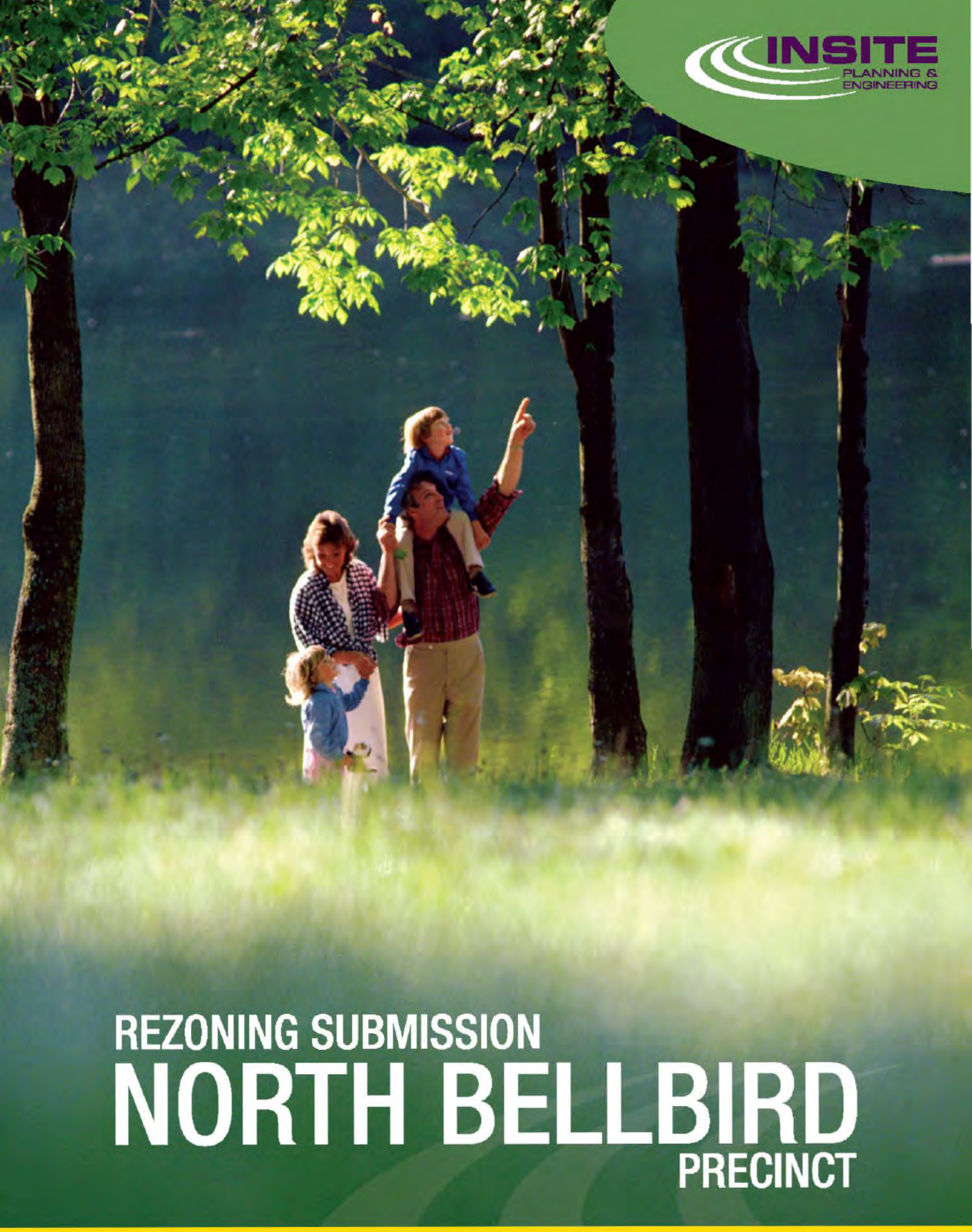
Construction of the Bellbird LWC will allow the provision of reticulated sewer services to the Bellbird North Urban Release Area. Following the assessment of potential environmental impacts through the work of various specialists the REF demonstrates that the proposal will result in no impact beyond relevant guidelines and legislation.

Various minor environmental impacts have been identified in this REF and these are generally temporary in nature. Specifically, it is unlikely that the proposal will have a significant impact on threatened species, populations and ecological communities listed pursuant to the Threatened Species Conservation Act, 1995 or impact on matters of National Environmental Significance pursuant to the Environmental Protection and Biodiversity Conservation Act, 1999. There are no long term adverse effects created by the construction or operation of the proposal. The mitigation measures contained within the REF, which will be implemented, will avoid or reduce the potential impacts of the proposal.

The proposal will provide a service essential for the development of the Bellbird North Urban Release Area which greatly benefits the community by ensuring supply of affordable housing for the Cessnock area and makes a significant contribution to sustainability through the provision of recycled water back to the new residential areas.

Bellbird Water

Appendix 3.5.1(f) Development Planning Proposal



INSITE PLANNING & ENGINEERING

REZONING SUBMISSION
NORTH BELLBIRD PRECINCT

Johnson Property Group
Creating living communities





Confidentiality Statement

All information, concepts, ideas, strategies, commercial data and all other information whatsoever contained within this document as well as any and all ideas and concepts described during the presentation are provided on a commercial in confidence basis and remain the intellectual property and Copyright of Insite Planning, Johnson Property Group and affiliated entities.

This document has been registered with our solicitors along with a copy of all previous materials.

CONTENTS

Executive Summary 1
1.0 Introduction 6
1.1 The Site And Location Context 6
1.2 Site History 8
1.3 Community Profile 11
1.4 Methodology 12
1.5 Strategic Framework 13
1.6 Rezoning Process 15
2.0 Opportunities And Constraints Analysis 18
2.1 Ecological Environment 18
2.1.1 Flora Opportunities And Constraints 18
2.1.2 Fauna Opportunities And Constraints 20
2.2 Bushfire 21
2.3 Viticultural Assessment 22
2.4 Indigenous Archaeology 25
2.5 Flood, Drainage And Water Quality 27
2.6 European Heritage 28
2.7 Visual Impact 30
2.8 Servicing 31
2.8.1 Reticulated Water Supply 31
2.8.2 Sewerage 31
2.8.3 Electricity Supply 31
2.8.4 Natural Gas Supply 33
2.8.5 Telecommunications Systems 33
2.9 Community Profile 33
2.9.1 Community Facilities And Services 34
2.9.2 Open Space And Regional Facilities 34
2.9.3 Potential Social Infrastructure Needs 35
2.10 Economic Impact 37
2.11 Traffic Impact Assessment 39
2.11.1 Access Opportunities 39
2.11.2 External Road Network 40
2.11.3 Public Transport 40
2.11.4 Pedestrian & Cycle Networks 41
2.12 Geotechnical Opportunities And Constraints 41
2.13 Composite Constraints And Opportunities Plan 42
3.0 Proposed Structure Plan 44
3.1 Residential Precincts 44
3.2 Open Space 45
3.3 Town Centre 46
3.4 Road Hierarchy 46
3.5 Cycle And Footpath Network 46
3.6 Development Yield 47
3.7 Summary 48
4.0 Assessment Of The North Bellbird Structure Plan 50
4.1 Ecological Environment 50
4.2 Bushfire Hazard 51
4.3 Viticultural Assessment 52
4.4 Aboriginal Archaeology 52
4.5 European Heritage 52
4.6 Visual Impact 55
4.7 Servicing 57
4.8 Community Infrastructure 57
4.9 Economic Infrastructure 58
4.10 Flooding And Stormwater Management 59
4.10.1 Flooding 59
4.10.2 Stormwater 62
4.11 Access And Traffic 62
4.12 Geotechnical Considerations 62
5.0. Justification For Development 64
6.0 Strategic And Statutory Planning Context 68
6.1 Environmental Protection & Biodiversity Conservation Act 1999 69
6.2 Nsw Legislation 69
6.2.1 Environmental Planning And Assessment Act 1979 69
6.2.2 Rivers And Foreshores Improvement Act 1948 70
6.2.3 Protection Of The Environment Operations Act 1997 70
6.2.4 Roads Act 1993 71
6.2.5 Threatened Species Conservation Act 1995 71
6.2.6 Rural Fires And Environmental Assessment Legislation Amendment Act 2002 72
6.2.7 Native Vegetation Act 2003 72
6.2.8 Contaminated Land Management Act 1997 72
6.3 Environmental Planning Instruments 73
6.3.1 Applicable State Environmental Planning Policies 73
6.3.2 Hunter Regional Environmental Plan 1989 74
6.4 Draft Environmental Planning Instruments 75
6.4.1 Draft State Environmental Planning Policy No. 66: Integrating Land Use And Transport (Sepp 66) 75
6.5 Section 117 Directions 75
6.6 Cessnock Lep, 1989 77
6.7 Strategic Plans And Policies 77
6.7.1 "Shaping Our Cities" 77
6.7.2 Draft Lower Hunter Regional Strategy 78
6.7.3 Cessnock City Wide Settlement Strategy 78
7.0 Suitability Of The Proposed Zonings And Planning Mechanisms 84
7.1 Assessment Of Potential Zones 86
7.1.1 R1 General Residential 86
7.1.2 B4 Mixed Use 87
7.1.3 E2 Environmental Conservation 88
7.1.4 E4 Environmental Living 89
7.1.5 Re1 – Public Recreation 89
7.1.6 Sp2 – Infrastructure 89
7.2 Proposed Zoning Structure And Planning Mechanisms 90
7.3 Proposed Development Control Measures 92
8. Conclusion 94



EXECUTIVE SUMMARY

This Planning Report accompanies a submission seeking Council and Department of Planning support to prepare a draft Local Environmental Plan to rezone the *North Bellbird Investigation Area*. This area has been identified in both the Cessnock City Wide Settlement Strategy and the draft Lower Hunter Regional Strategy with the proposed rezoning allowing for a mix of urban development and conservation outcomes. This submission has been made by the *Johnson Property Group Pty Limited*.

LOCATION

The North Bellbird Investigation Area is located on the immediate western fringe of the township of Cessnock and to the immediate north of the township of Bellbird. This area is within the Cessnock Local Government Area which lies to the west of Newcastle in the lower Hunter Valley. It comprises **496 hectares** of undulating rural land which has been utilised for a range of agricultural pursuits since European settlement. Archaeological findings also suggest that sections of the site have historically been used by indigenous peoples prior to settlement.

PLANNING CONTEXT

The **Cessnock City Settlement Strategy** was adopted by Cessnock City Council in December 2003 and later endorsed by the then Department of Infrastructure Planning and Natural Resources, now the Department of Planning. This strategy document provides a plan for the future urban settlement of the Cessnock LGA with the North Bellbird Investigation Area identified as the largest potential urban release area within the City.

The draft Lower Hunter Regional Strategy has also identified this investigation area as a new release area for the creation of in excess of 2,000 lots. The draft Lower Hunter Regional Strategy has aimed to provide a blue print for the future of the lower Hunter within a twenty five year horizon. Again the North Bellbird Investigation area was identified as one of the seven largest urban release areas in the Hunter. In this context it is a regionally significant site providing land for future urban growth.

This proposal to rezone the North Bellbird investigation lands for future urban development is therefore consistent with both Cessnock City Councils Citywide Settlement Strategy and the draft Lower Hunter Regional Strategy.

This proposal to rezone the North Bellbird investigation lands for future urban development is therefore consistent with both Cessnock City Councils Citywide Settlement Strategy and the draft Lower Hunter Regional Strategy.

ENVIRONMENTAL INVESTIGATIONS

The rezoning submission combines a suite of environmental studies that have been prepared over the past 15 months. These studies have been investigating the suitability of the site to absorb urban development. The consulting team undertaking these investigations is as follows: –

- **Town Planning, Urban Design and Project Management:** – Insite Planning and Engineering;
- **Urban Design:** – Andrews Neil;
- **Visual Impact Assessment:** – Andrews Neil;
- **Flora and Fauna:** – Andrews Neil, Anne Clements & Associates and Andrew Smith;
- **Bushfire Threat:** – HWR Ecological;
- **Flooding and Stormwater Management:** – Parsons Brinckerhoff;
- **Surveying:** – SurDevel;
- **Traffic Impact Assessment:** – Parsons Brinckerhoff;
- **Geotechnical:** – Network Geotechnics;
- **Servicing:** – Insite Planning and Engineering;
- **Social and Community:** – Elton Consulting;
- **Economic:** – Castlecrest Consulting; and
- **Viticultural:** – Allynbrook Consulting.
- **European Heritage:** - Stedinger Associates
- **Aboriginal Heritage Assessment:** – Archaeological & Heritage Management Solutions Pty Ltd.

The majority of the North Bellbird Investigation area is suitable for rezoning for urban purposes.

The primary constraints to urban development in the North Bellbird Investigation Area that were identified include: –

- Flood Affected land, in particular along the eastern flank of the Investigation Area (Bellbird Creek);
- The ecological value of Flora and Fauna Habitat especially in the south western section of the site along Limestone Creek;
- Indigenous Archaeology, again in the south western section of the site along Limestone Creek;
- Viticultural capability of the soils to support vineyard; and
- Visual impact on the surrounding vineyard district.

The primary opportunities benefiting the North Bellbird Investigation Area include:-

- The ability to utilise available infrastructure;
- The opportunity for positive environmental outcomes, including the revegetation of riparian corridors and in particular Limestone Creek;
- The creation of a new commercial / retail centre;
- The opportunity to provide a higher level of social infrastructure to service the needs of the future North Bellbird Community as well as the existing Cessnock, Bellbird and Mount View Communities;
- The rationalisation of existing social and recreational facilities to better serve the needs of the community; and
- The eventual upgrade of road infrastructure external to the site, in particular sections of Wollombi Road.

THE NORTH BELLBIRD STRUCTURE PLAN

The Structure Plan has evolved through a planning process that aims to create desirable neighbourhoods, sensitively designed around open space and within short distances of transport and community services. It aims to provide a new community where people can bring up their families, enjoy their lives, while at the same time satisfying the modern demands of today's economy.

The development context for the North Bellbird Investigation Area represents a unique opportunity to develop a benchmark urban development as a seamless extension to the existing settlements of Cessnock and Bellbird. The development will aim to establish a new community within traditional neighbourhood design principles. It will be a highly liveable place; a place that will encourage healthy living through physical activity such as walking, bicycle use and community interaction.

The formulation of the North Bellbird Structure Plan has been based on an extensive opportunities and constraints analysis and urban design process, with the vision to create a sustainable urban environment.

The planning process we have adopted has seen the creation of a structure plan which will have the capacity to sustain a mix of land uses and respond to conservation needs including: –

- a range of housing choice from integrated housing and mixed use developments through to larger lifestyle lots;





- a commercial and retail precinct including mixed use development capable of serving the needs of the existing and future community without compromising existing trade in the Cessnock CBD;
- social and community infrastructure such as schools, community and recreational facilities including open space;
- infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails;
- conservation of quality remnant vegetation; and
- rehabilitation of degraded riparian corridors to provide habitat linkages.

The formulation of the North Bellbird Structure Plan has been based on an extensive opportunities and constraints analysis and urban design process, with the vision to create a sustainable urban environment.



CONCLUSION AND RECOMMENDATION

The result of the detailed environmental investigations is that the majority of the North Bellbird Investigation area is suitable for rezoning for urban purposes. These investigations have also concluded that it is appropriate to retain the existing Rural Vineyards zoning on the western side of the investigation area. Conservation outcomes have also been reflected in the North Bellbird Structure Plan as has been the proposed urban form of this new community.

Specifically the proposed LEP amendment is sought to enable the rezoning of certain land from 1(a) – Rural and 1(v) – Rural (Vineyards) to a range of new residential, conservation, mixed use, open space and infrastructure zones that have been nominated in the "model LEP" by the Department of Planning.

The rationale for the amendment of the Cessnock Local Environmental Plan, 1989 to facilitate urban development within the North Bellbird Precinct lies in:

- The Investigation Area's identification and standing within strategic planning documents of regional and local significance, namely the draft Lower Hunter Regional Strategy and the Cessnock Citywide Settlement Strategy; and
- A demand for land zoned appropriately for residential purposes on a local and regional level;
- A short term supply shortage of residential allotments in the Cessnock locality and throughout the region;
- The opportunity to rezone land for urban purposes which will provide a development which is capable of meeting all relevant sustainability criteria set down in the draft Lower Hunter Regional Strategy;
- The opportunity to create an urban environment which will not impinge on or detract from the scenic and visual qualities of the Vineyards District while still maintaining appropriate residential densities; and
- The opportunity to create an urban environment which will result in positive environmental outcomes including the retention and ongoing management of flora and fauna habitat; the rehabilitation of riparian corridors and the cessation of unsustainable agricultural practices which have contributed to environmental degradation (erosion, weed infestation etc.), particularly in riparian corridors.



1.0



1.0 INTRODUCTION

The North Bellbird Investigation Area forms part of an identified urban release area located in a region which is set to undergo unprecedented social, economic and demographic change over the next 25 – 30 years. The Lower Hunter Region and Newcastle is evolving into a self sustaining urban region with strong ties to metropolitan Sydney, as well as establishing its own unique identity and direction in terms of lifestyle, employment generators and links to natural resources.

Development pressure in this region from both government and market forces continues to grow. As affordable and constraint free land in the Sydney Basin dries up, the future strategic direction and management of land within the Lower Hunter and Newcastle takes on state wide significance.

The North Bellbird Investigation Area is a significant parcel (496ha) of relatively constraint free land which presents an opportunity to capitalise on strong locational benefits to create an urban environment based on sound economic and ecological principles. Such opportunities comfortably sit in the context of ongoing development of the Lower Hunter Region.

This report seeks to amend the Cessnock LEP to allow for the development of the North Bellbird Investigation Area for a range of urban purposes. A structure plan, based on the outcomes and recommendations of a comprehensive opportunities and constraints analysis, has been developed. The North Bellbird Structure Plan is capable of providing a mix of residential lifestyles, opportunities for commercial and retail development, high levels of accessibility to services, a range of recreational opportunities, and where appropriate the conservation of environmentally sensitive and valuable habitat.

It is anticipated that this structure plan will be supported by the relevant stakeholders and its implementation will result in the most appropriate development form within the 'flagship' urban release area of the Cessnock LGA. Through appropriate staging, this release area will accommodate the housing needs of the Cessnock community and lower Hunter region over a 10 – 20 year period.

An analysis of the strategic context which underpins the identification of the North Bellbird Investigation Area reveals its significance at a state and regional level. This Precinct stands as the only significant "new release area" identified in the **draft Lower Hunter Regional Strategy** in the Cessnock Locality. It is thus essential to the supply of urban land for residential housing, a primary objective of the aforementioned strategy and is likely to yield between 3,500 and 5,000 dwellings accommodating between 9,100 and 13,000 new residents.

1.1 THE SITE AND LOCATION CONTEXT

The North Bellbird Investigation Area is located on the western fringe of Cessnock in the Cessnock Local Government Area. From a regional perspective the investigation area lies inland from Newcastle in the lower Hunter Valley, approximately 160 km north of Sydney. **Figure 1.1** illustrates the location of this site from a regional perspective while **Figure 1.2** shows the site in relation to the surrounding communities of Bellbird and Cessnock.

As evident in **Figure 1.3**, which is an aerial photo of the site, the precinct is typically open grass land with pockets of remnant vegetation in the south east, south west and north western corners. The land typically falls away from the south west (130m) to the north east (83m) and is split into two principle catchments. An elevated broad ridge in the southern half of the site splits Limestone Creek, which transects the precinct from south west to north east, and Bellbird Creek which follows the eastern precinct boundary.

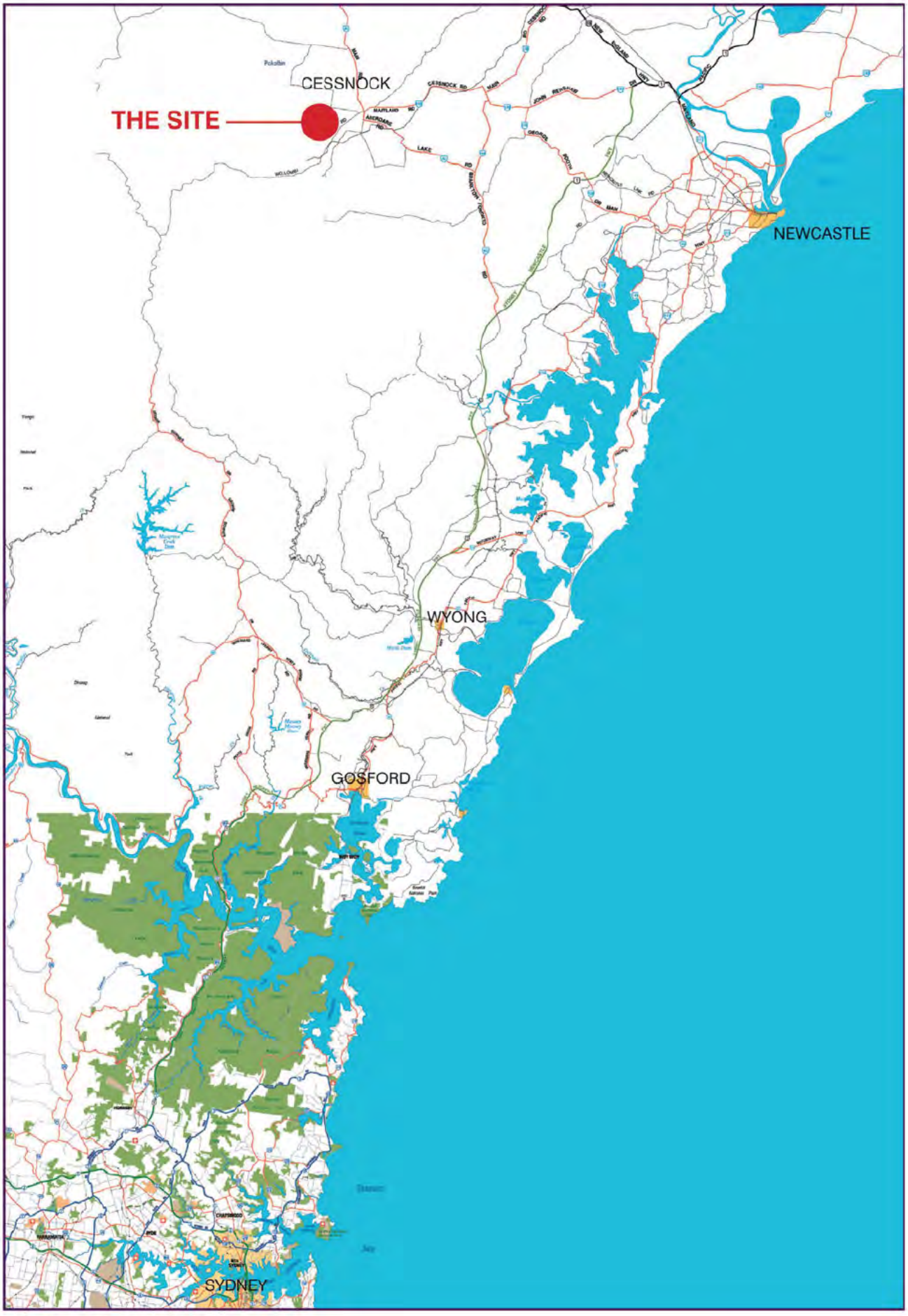


Figure 1.1: *Regional Location Plan*

The Investigation Area forms part of the Black Creek Catchment. Land along the north eastern boundary is flood affected in parts. The land relief is predominantly between 0 and 5 degrees. Creek embankments are, in sections, steeper, up to 15 degrees.

The subject land has an area of 496 hectares and is described as:

LOT NO.	D.P.	AREAS BY DP
PT 1	66183	(20.33) **PT-9.785**
2	66183	16.43
1	167004	1.4
1	196460	30.12
1	196997	6.726
1	327580	6.665
1	327785	47.84
1	328497	2.464
1	328498	4.191
1	329071	2
1	349452	1.897
261	524058	2.681
1	597226	28.35
2	597226	65.97
3	597226	93.71
2	624793	0.5561
3	624793	3.551
10	806584	19.4
11	806584	0.8237
PT51	807540	(1.486) **PT-1.162**
52	807540	0.6239
3	810827	11.45
10	815485	2
11	815485	41.76
PT13	880374	(41.54) **PT-11.15**
141	986905	1.2
1	1011544	34.97
2	1011544	2.397
210	1012346	2
211	1012346	40.73
212	1053307	2.52
	Total Area:	**– 496.5**

Figure 1.4 shows an aerial photograph of the site with topographical detail. These figures demonstrate the proximity of the North Bellbird Investigation Area to Bellbird and Cessnock. They also show that there is the opportunity for any urban development of this investigation area to be undertaken as an extension to these current settlements.

To the west and south west, the land rises to the foothills of the visually significant Brokenback Range which is an identifiable landform within the lower Hunter Valley. These foothills consists of a rural setting with cleared managed farmland interspersed with vineyards, pockets of remnant vegetation and rural style homesteads and associated outbuildings. The topography and landuse over allotments that form the western edge of the North Bellbird Investigation Area are identifiable with this landscape. Due to the regional significance of the Brokenback Range it is critical that its integrity is not compromised by development within this investigation area. As will be discussed throughout this report, the treatment of this western edge stands as a critical feature of the North Bellbird Structure Plan.

The remainder of the North Bellbird Investigation Area to the east also has a rural character as identified in the following list of activities / improvements undertaken within: –

- Agriculture, primarily cattle grazing, with some wine grape and olive production to the west;
- Rural residential size holdings;
- Storage of plant, equipment and material stockpiles in relation to earth moving operations;
- Recreational activities at the Bellbird Bowling Club and Carmichael Park.

Improvements and structures within the North Bellbird Investigation Area include:

- Dwelling houses of various age and condition;
- Rural sheds;
- Stockyards;
- Fencing;
- Access tracks;
- Farm dams;
- The Bellbird Bowling Club

1.2 SITE HISTORY

Prior to European settlement, archaeological findings indicate that land within the North Bellbird Investigation Area was used for hunting and gathering by local indigenous groups. There is evidence of occupation concentrated along creek banks and riparian corridors, particularly in the south west of the North Bellbird Investigation Area.



Figure 1.3: *Aerial Image*

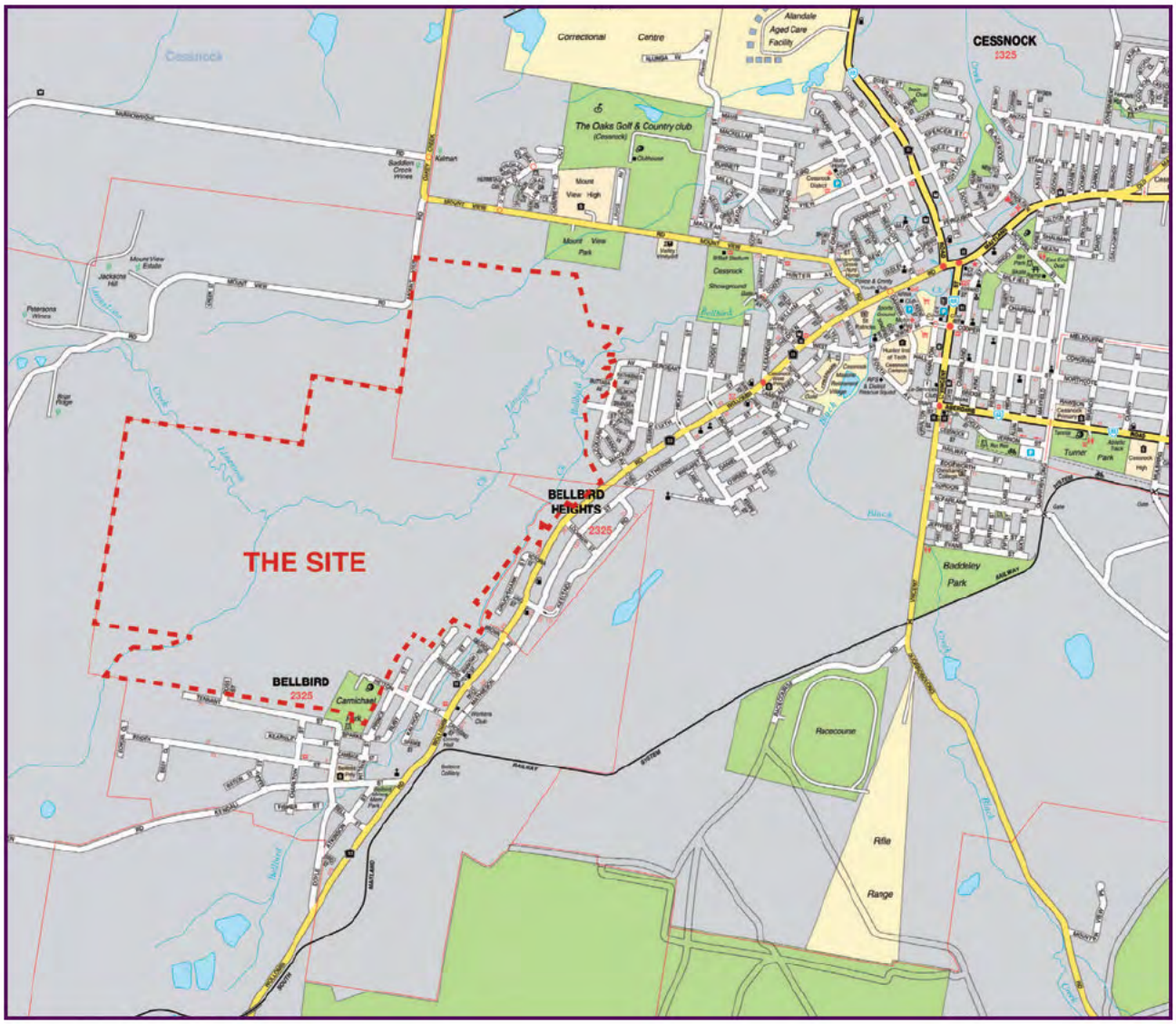


Figure 1.2: *Local Context Plan*

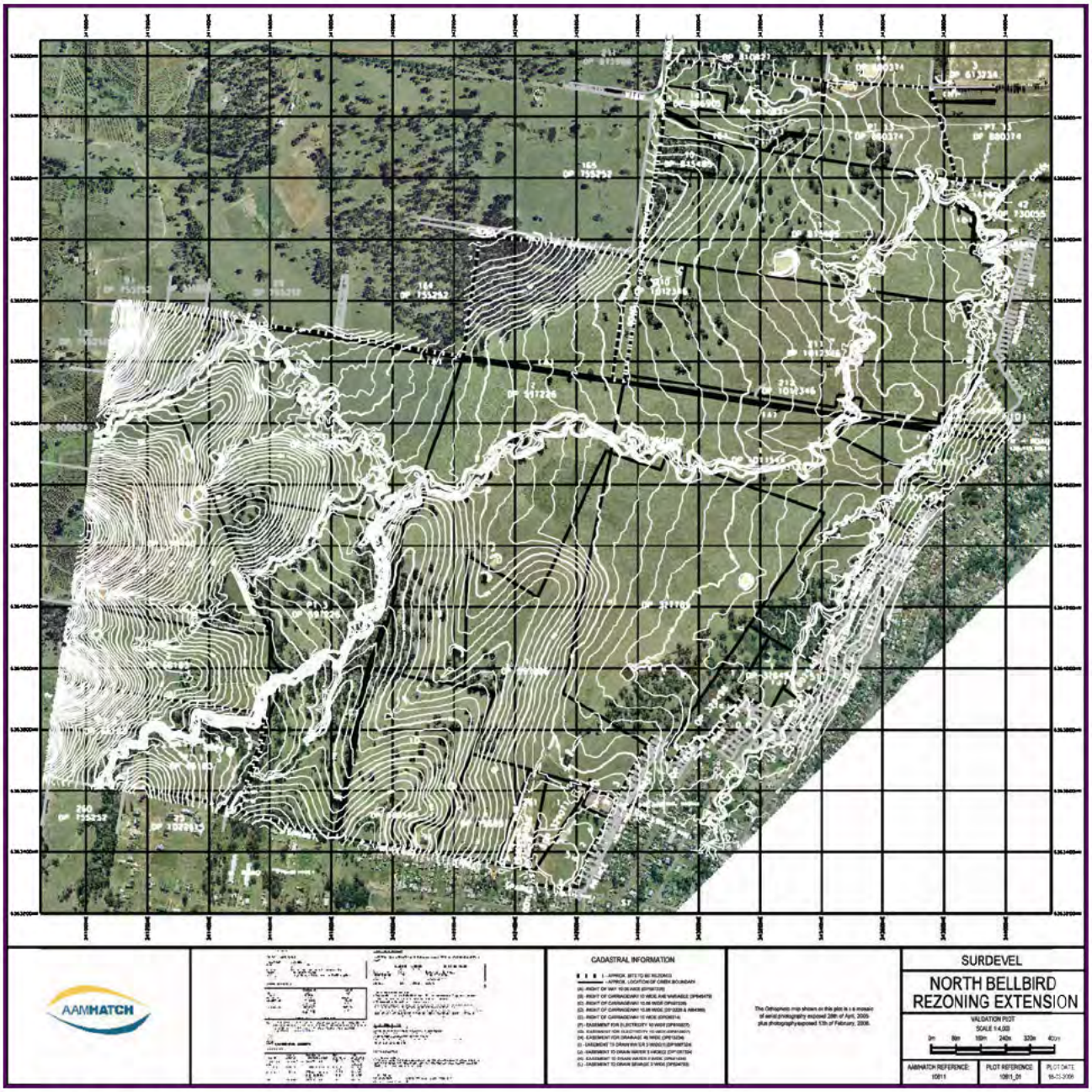


Figure 1.4: *Aerial with topography*

The principle use of the investigation area since European Settlement has been agriculture. In early years the land was grazed and cultivated for crops such as wheat, tobacco and other mixed crops including vines for wine production. In more recent times cropping has given way to cattle grazing, with only one remaining commercial vineyard located on Lot 1, DP 196460.

Agriculture, namely cattle grazing, is the predominant land use within the North Bellbird Investigation Area. The relatively small size of the existing land holdings and in general terms a lack of suitable soils restrict agricultural practices to light cattle grazing with marginal levels of productivity. Landowners have advised that these farming activities pay the land rates, help with the general upkeep of the land, and are essentially a part time activity; they do not present as a reliable source of income.

Other activities of note within the North Bellbird Investigation Area include the O'Neil's' Wine Bar and Saloon, which moved location over the course of time and is now operating as a restaurant; the establishment of Mitchell Bros Earthmoving in the North Eastern quarter of the site; and the establishment of Carmichael Park and Bellbird Bowling Club in the South Eastern corner.

There is no record of any subterraneous mining activities occurring within the Investigation Area.



1.3 COMMUNITY PROFILE

Any development of the North Bellbird Investigation Area will occur as a continuation of the existing urban settings of Cessnock and Bellbird, as well as the Mount View rural community to the west. It is therefore relevant at this stage to profile the existing communities so as to understand the community context of the investigation area. This will ensure that the likely needs and social impacts are recognised and addressed in the master planning process so as to ensure the successful integration of any future urban expansion.

The Elton Consulting Social Impact Assessment provides detailed community profiles of the existing communities. While the population of the Cessnock LGA is generally similar to that of NSW, it also differs in some important ways:

- It has a slightly higher proportion of children and older people 70+, and a slightly lower proportion of young people and young adults;
- It has a slightly higher proportion of one parent family households, and low proportion of group households;
- It is relatively culturally homogenous and has low proportions of both indigenous people and people from non English speaking backgrounds;
- It has relatively lower proportions of residents in the higher household income brackets, significantly lower average weekly household income, and higher rates of unemployment;
- It has lower proportions of people with university qualifications and employed in professional and managerial occupations, and higher rates with no qualifications working in lower skilled occupations;
- It has very high rates of home ownership and slightly higher rates of vehicle ownership; and
- A very high proportion of its housing stock is separate houses, with very low proportions of medium density dwelling types.

This process identified the location and nature of the significant physical constraints which affect the land, and has allowed for the formulation of suitable recommendations to facilitate the master planning process.

1.4 METHODOLOGY

While the planning investigations summarised in this report have been prepared on behalf of the landowners of the North Bellbird Investigation Area, they have been undertaken in full consultation with both Cessnock City Council and the Department of Planning. Following discussions with Council and in order to ensure that an appropriate planning process was adopted, the following staged process was used as the methodology for the planning investigations:

1. **Stage 1** – Identifying site opportunities and constraints. This involved the engagement of a number of specialist consultants.
2. **Stage 2** – Development of a draft Structure Plan.
3. **Stage 3** – Consultants then undertook an impact assessment of the proposed Structure Plan so as to ensure that it complimented the opportunities and constraints analysis undertaken in stage 1.
4. **Stage 4** – Preparation of a Planning Report to accompany the rezoning submission.

The range of technical studies that have been undertaken in stage one were aimed at identifying site specific constraints and opportunities as well as to investigate the implications of urban development within the North Bellbird Investigation Area. This process identified the location and nature of the significant physical constraints which affect the land, and has allowed for the formulation of suitable recommendations to facilitate the master planning process.

The following specialist consultants were engaged in disciplines relevant to their expertise as part of the opportunities and constraints / masterplanning exercise:



DISCIPLINE / STUDY	CONSULTANT
Site Survey	Surdevel
Indigenous Heritage	AHMS Pty Ltd
European Heritage	Stedinger and Associates Heritage and Archaeology
Ecology	Andrews Neil, Anne Clements and Associates and Andrew Smith
Geotechnical	Network Geotechnics
Flooding and Stormwater	Parsons Brinckerhoff
Traffic Impact Assessment	Parsons Brinckerhoff
Bushfire Risk Assessment	HWR Ecology
Viticultural Assessment	Allynbrook Pty Ltd
Visual Impact Assessment	Andrews Neil
Urban Design	Andrews Neil and Insite Planning and Engineering
Servicing	Insite Planning and Engineering
Social Impact Assessment	Elton Consulting
Economic Impact Assessment	Castlecrest Consulting
Town Planning and Project Management	Insite Planning and Engineering

The nature and implications of these constraints and how they have been addressed in the master planning process (stage 2) will be discussed at length in subsequent sections of this report.

Constant dialogue with Council and representatives of the Department of Planning has been occurring through out these investigations to ensure that the relevant planning issues relating to the North Bellbird Investigation Area are addressed. This process has extended to the submission of preliminary reports to both authorities for review and comment. Appendix 1 contains the formal advice from the relevant authorities with regard to this process and includes the relevant Council reports.

The aim of this process has been to ensure consistency in terms of expectations and outcomes between Council, the Department, and the landowners of the North Bellbird Investigation Area, particularly in terms of statutory requirements. This matter will be further discussed in Chapter 7 of this report.

1.5 STRATEGIC FRAMEWORK

The **Cessnock Citywide Settlement Strategy** (Cessnock CWSS), adopted by Cessnock City Council in December 2003 and subsequently endorsed by the Department of Planning, identified an area of some 322 hectares of land north of Bellbird and west of Cessnock as being suitable for possible urban development (subject to detail investigations). This area has been identified in the Cessnock CWSS as the "North Bellbird Precinct" (see **Figure 1.5**) and is referred to as the North Bellbird Investigation area in this report.

The North Bellbird Investigation area is significant as it is the primary urban release area within the Cessnock Local Government Area.

The North Bellbird Investigation Area has also been identified in the **draft Lower Hunter Regional Strategy** as a major new release area, one of seven identified within the Hunter region. Typically a major new release area is defined as having in excess of 2,000 dwellings which signifies the importance of the North Bellbird Investigation Area at a regional level.

Following consultation with Council and the Department of Planning the original Investigation Area has been extend to the west so that now some 496 hectares is covered. This extension has occurred in two stages.

Constant dialogue with Council and representatives of the Department of Planning has been occurring through out these investigations to ensure that the relevant planning issues relating to the North Bellbird Investigation Area are addressed.

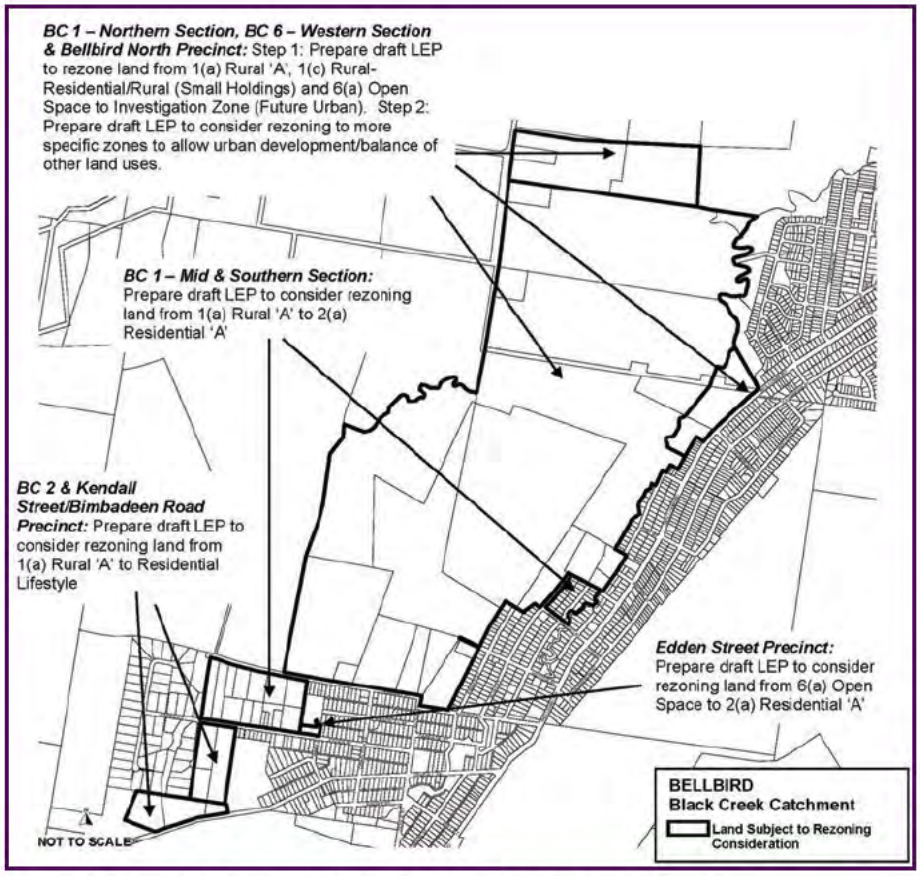
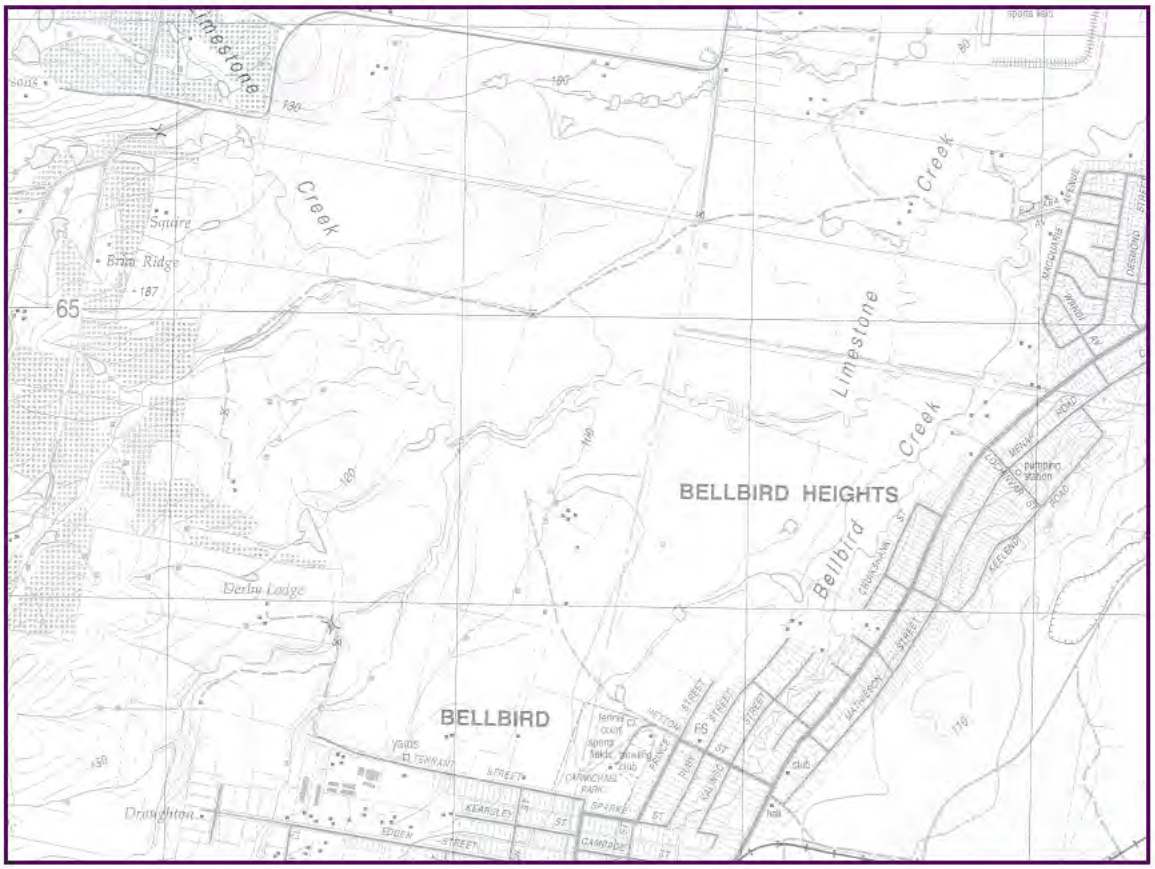


Figure 1.5: City Wide Settlement Strategy - North Bellbird Investigation Area

Figure 1.6: City Wide Settlement Strategy - Additional Investigation Areas



The CWSS excluded any area that was zoned Rural 1"v" (Vineyards). However initial planning investigations identified land on the western and north western edge of the original identified investigation area as potentially suitable for urban development despite the fact that it had a 'vineyards' zoning. This was due to the fact that mapping Council had undertaken previously showed the land as containing soils not suitable for viticultural production and the fact that the land was not under commercial vineyards in any case. Consequently a submission was made to Cessnock City Council to extend the investigation area to include the following land:

Part of Lot 3 DP 597226 Tennant Street

- (Southern) Part of Lot 1 DP 66183 Tennant Street
- (Northern) Part of Lot 2 DP 597226 Tennant Street (the southern part of this lot was already in the Bellbird North Precinct).

This additional area is illustrated in **Figure 1.6**. The inclusion of this additional land into the North Bellbird investigation area was supported by Council in December 2004 and subsequently by the Department of Planning. This was subject to investigation being undertaken into the viticultural capability of the land and a visual impact analysis.

The investigation area was again extended following the stage 1 opportunities and constraints analysis. This followed ecological constraints being found along the Limestone Creek riparian zone in the south western section of the investigation area which was impacting on the potential densities, the identification of land that again appeared to be suitable for urban development, and representations made by landowners on the western edge of the investigation area. In a report to Cessnock City Council on February 15 2006 it was reported that:

> *"The Johnson Property Group has written to Council requesting extension of the precinct to ensure lot yields anticipated by them, the City Wide Settlement Strategy and the draft Lower Hunter Regional Strategy can be achieved while protecting important vegetation, including creek lines and corridors identified in DCP 28 – Vineyards District.*
>
> *The Johnson Property Group has held discussions with private land owners on the edge of the current precinct, with a view to including their land in further investigations. This has resulted in a written request from one of the owners for their land also to be included. The result is the proposed addition of the remainder of Lot 3 DP 597226, all of Lot 2 DP 66183 and all of Lot 1 DP 196460."*

Council and the Department of Planning subsequently supported the addition of this land (**Figure 1.6**) into the investigation area.

1.6 REZONING PROCESS

Cessnock City Council at its meeting on September 21, 2005 resolved to commence the rezoning process when it resolved as follows:

1. *Pursuant to Section 54 of the Environmental Planning and Assessment Act 1979, Council resolve to prepare a draft local environmental plan to allow future urban development of the Bellbird North Precinct, as identified in the Cessnock City Wide Settlement Strategy Stage 1, including those areas added by Council resolution of 8 December 2004 and subsequently agreed to by the Department of Planning.*
2. *Council seek specifications from the Director-General of the Department of Planning as to the form, content and preparation of a Local Environmental Study over the land to which the draft local environmental plan will apply.*

The Department of Planning responded on February 17 2006 supporting this resolution of Council. A copy of that advice is provided in **Appendix 1** with their primary requirements summarised as follows:

- *Traffic and transport analysis including an examination of the existing road network and capabilities for increased demands, a traffic management strategy, provision of cycleways and pedestrian movements, interconnection with existing development, access to public transport and reduced reliance on car oriented transport.*
- *Infrastructure Assessment identifying availability of services such as water, sewer, gas, electricity and communications, liaison with service providers and staging in accordance with infrastructure capacity.*
- *Social impact assessment which incorporates an understanding of the existing and future needs for community facilities, the provision of aged care, child care, education, health services and other community facilities, recreation, sporting facilities and open space as well as retail opportunities.*
- *Incorporation of best practice urban design principles including minimising development footprints and identifying appropriate development.*
- *Consideration of the regional planning context including State and regional policies, Section 117 Directions, the Hunter Regional Environmental Plan and the draft Lower Hunter Regional Strategy.*

- *Consideration of the local planning context including the Cessnock City Wide Settlement Strategy, Council's Section 94 Contribution Plans and other relevant Council policies*
- *Incorporation of Sustainability Principles such as Improved environmental outcomes, promotion of energy efficiency and solar access, use of public transport with reduced reliance upon cars, interconnection existing communities, the orderly staging of the development and incorporation of precautionary principles.*
- *Assessment of the suitability and capability of the land for urban development.*
- *Assessment of population projections, demographic trends, and land supply and demand.*
- *Consideration of the Council's sequencing program for the staged and coordinated release of residential land across the LGA.*
- *Overall strong justification for the proposed urban development when all of the above environmental, social and economic issues are considered in combination.*
- *The evaluation methodology for analysing the data collected by the environmental study and the subsequent determination of a recommended suitability map should be well defined and discussed in detail. The evaluation process should aim to provide the framework against which competing demands for different parts of the site are measured. The methodology should outline key objectives and relevant assessment criteria and how they have been used to define and measure the capacity of the site to accommodate the full range of different land uses and opportunities.*

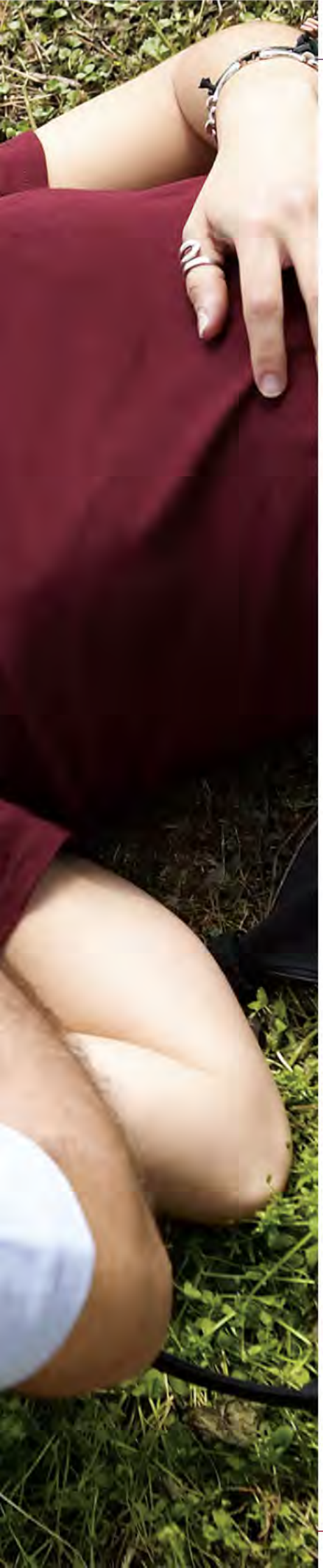
The investigation summarised in this report has been prepared to address the issues raised by the Department of Planning and Council, the environmental and the social impacts of development of the investigation area, so that the rezoning process now may proceed to a consultation phase with government authorities and the community.








2.0



2.0 OPPORTUNITIES AND CONSTRAINTS ANALYSIS

The opportunities and constraints analysis is a reflection of existing physical, social and economic environment and condition of North Bellbird and how it relates to land / activities external to the precinct as identified in the specialist consultant's reports. This process resulted in the creation of a *Composite Opportunities and Constraints Plan* (Figure 2.1) which provides the basis for the creation of the draft North Bellbird Structure Plan.

2.1 ECOLOGICAL ENVIRONMENT

Andrews Neil and Anne Clements & Associates, in conjunction with Dr Andrew Smith, have undertaken a comprehensive Ecological Assessment of the North Bellbird Investigation Area. This has included a desk top analysis, field survey work over three seasons and a targeted species survey, with the intent of identifying ecological opportunities and constraints to assist in the formulation of the North Bellbird Structure Plan. Ecological considerations have been addressed through the preparation of separate 'Flora' and 'Fauna' studies with the objective being to respond to the different conservation requirements of specific plant and animal species as well as endangered ecological communities.

2.1.1 FLORA OPPORTUNITIES AND CONSTRAINTS

The Anne Clements & Associates Report (2006) is based on a review of previous studies affecting the Investigation Area and a current (2006) survey of the site. A total of 296 species were recorded (216 native and 74 exotic). The outcome of the survey saw the Investigation Area broken into ten (10) identifiable vegetation assemblages (detailed in **Figure 2.2**): –

- Cleared grazing paddocks without remnant trees;
- Grazing paddocks with remnant trees;
- Forested vegetation along and adjoining Bellbird Creek;
- Vegetation of Limestone Creek in the central areas of the site;
- Forest Vegetation in the south adjoining Limestone Creek;
- Forest vegetation in the south of the site on the slopes of Limestone Creek;
- Forest vegetation in the north of the site;
- Low lying drainage depressions along Bellbird Creek;
- Agricultural Dams; and
- Olive Groves and Vines.

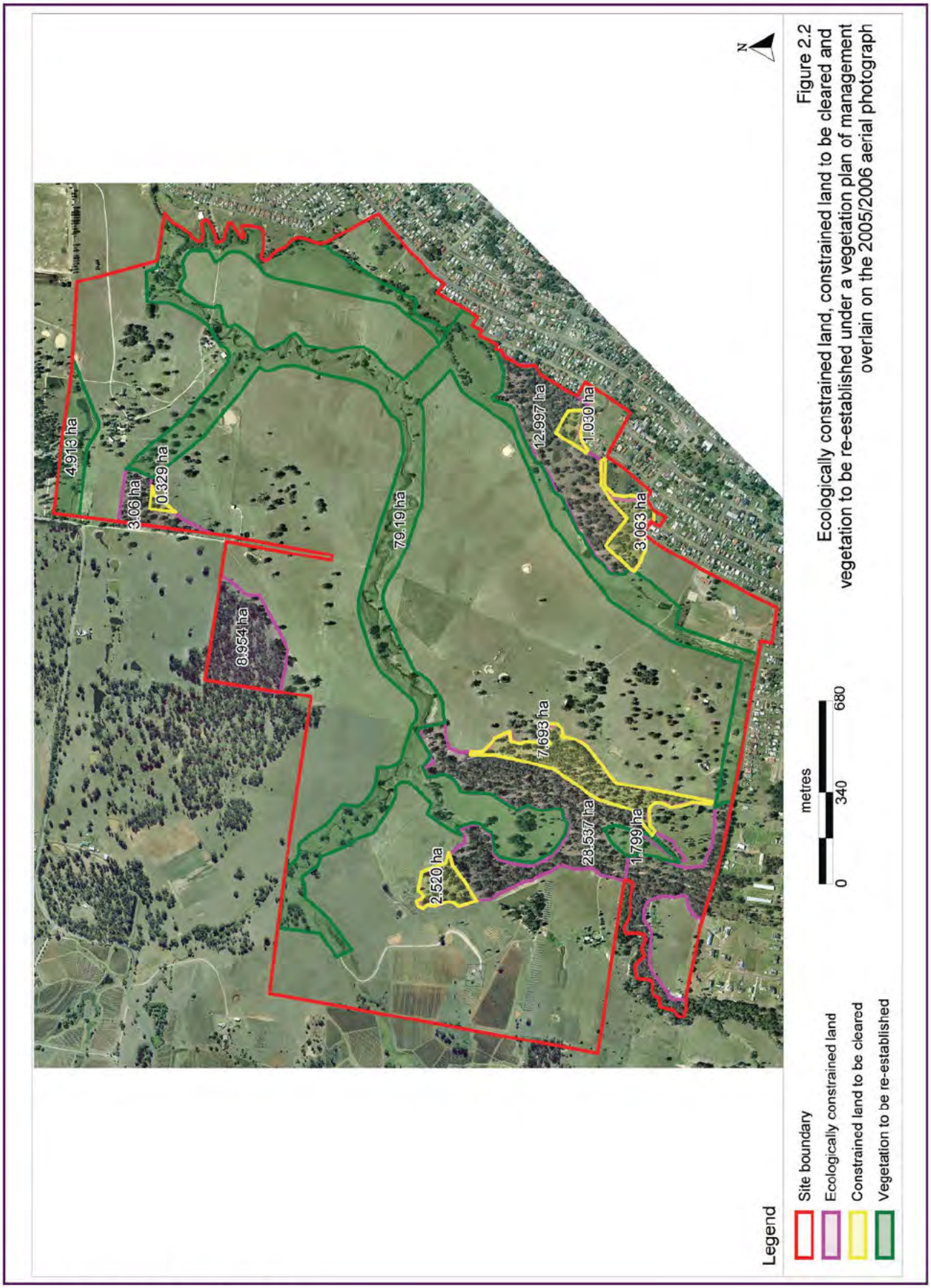


Figure 2.2: *Vegetation Assemblages*

The findings and conclusions regarding Flora in the North Bellbird Investigation Area are as follows: –

- *A total of 290 species (216 native and 74 exotic) were recorded in 26 quadrats (20m x 20m in size) and 17 Spot location;*
- *No nationally listed species of conservation significance (EP & BC Act) were recorded;*
- *One State listed species Prostanthera cineolifera (Singleton Mint Bush), of conservation significance (TSC Act) was recorded in the steep sided valley in the south of the site;*
- *No nationally listed endangered ecological communities (on the schedules of the Environment Protection and Biodiversity Conservation Act 1999 (EP & BC Act) were recorded;*
- *Two State listed endangered ecological communities (on schedule of the NSW Threatened Species Conservation Act 1995 (TSC Act) were recorded, namely:*
  - *Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregion; and*
  - *Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion*
- *Eight noxious weeds (NSW Agriculture Noxious Weeds List) were recorded on the Site.*

The recommendations based on the above findings are as follows: –

- *The vegetation with more than 30% tree canopy cover be retained and enhanced, especially vegetation of the steep sided valley in the south of the Site. The steep side valley in the south of the Site was the recorded habitat of Prostanthera cineolifera;*
- *Local native vegetation be retained and enhanced in the riparian corridors on the Site. Much of the vegetation within the riparian corridors require reestablishment using plant material collected on Site or nearby;*
- *A vegetation plan of management is required.*

The findings and recommendations of the Anne Clements & Associates report can be clearly identified in the composite opportunities and constraints plan (**Figure 2.1**) and allows for the North Bellbird Structure Plan to respond appropriately to these requirements.

2.1.2 FAUNA OPPORTUNITIES AND CONSTRAINTS

Field Investigations for fauna revealed a total of 22 mammal species, 86 bird species, 10 frog species and 6 reptile species. Of this list the following species are considered to be vulnerable under the TSC Act and / or the EPBC Act: –

- East Coast Freetail bat (*Mormopterus norfolkensis*)
- Eastern Bent wing bat (*Miniopterus schreibersii oceanensis*)
- Greater Broad – noses bat (*Scoteanax rueppellii*)
- Grey – headed Flying Fox (*Pteropus poliocephalus*)
- Grey Crowned Babbler (*Pomatostomus temporalis*)
- Large footed Myotis (*Myotis adversus*)
- Speckled Warbler (*Pyrrholaemus sagittata*)
- Squirrel Glider (*Petaurus norfolcensis*)
- Yellow bellied Sheathtail bat (*Saccolaimus flaviventris*)

The location of the identified species is detailed in **Figure 2.3.** The key recommendations here are to ensure that adequate habitat for each of the above species is retained and that where necessary appropriate linkages are established to provide connectivity with larger tracts of vegetation external to the Investigation Area. The opportunities and constraints analysis plan identifies the location of species sitings as well as incorporating habitat areas and corridors throughout the investigation area.



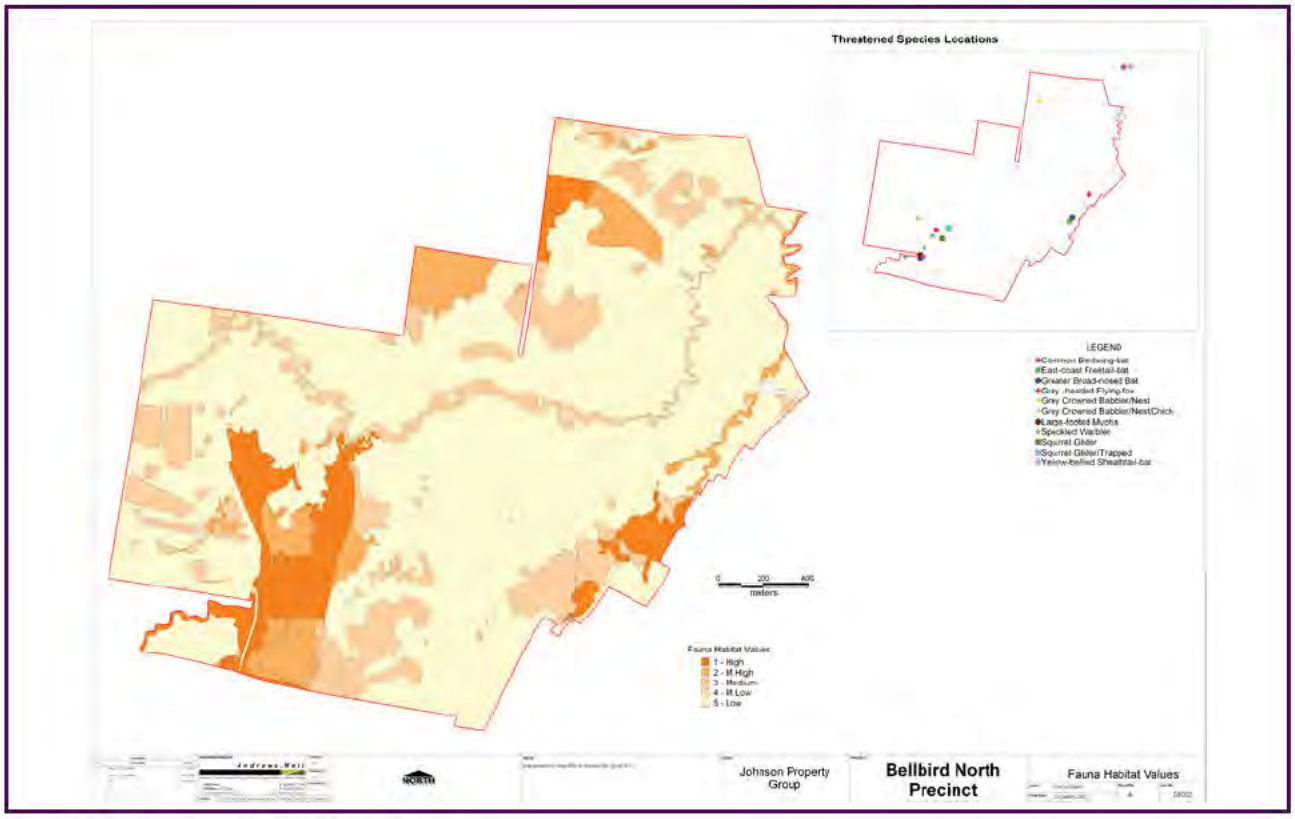


Figure 2.3: *Threatened Species Fauna Locations*

2.2 BUSHFIRE

The *Bushfire Threat Assessment Report* (BTA Report) prepared by HWR Ecology establishes that the North Bellbird Investigation Area is, in part, Bushfire Prone Land. It has been prepared having regard for the Rural Fires Act, 1997. Environmental Planning & Assessment Act 1979 and Planning for Bushfire Protection – 2001. The report provides an assessment of the bushfire protection measures required for the draft Structure Plan to guard against the assessed potential impacts of bushfires.

Bushfire hazards are defined by HWR Ecology as: –

> *A bushfire hazard is regarded as anything which may result in a fire or increase the severity of a fire and result in the death or damage to life or property. Remnant patches of vegetation occur within the investigation area and are considered to be potential bushfire hazards. Remnant vegetation mainly occurs in riparian corridors and as scattered pasture trees. Maintained (ie slashed or grazed) woodland and open forest remnants greater than 1 hectare also occur within the investigation area and adjacent properties.*

The vegetation assessment of the North Bellbird Investigation Area and surrounds was able to remove some vegetation from being categorised as a bushfire hazard. Those areas consisted of the following: –

- Bushland areas of less than 1 hectare and more than 100 metres from a high hazard area;
- Strips of vegetation less than 20 metres wide (eg road or river corridor); and
- Vegetation not mapped as bushfire prone (managed or otherwise).

The Bushfire Threat Assessment Report then classifies vegetation based on Rural Fire Service requirements as follows: –

- Tree height;
- Canopy cover; and
- Habitat descriptions (ie dry sclerophyll forest, open woodland, woodland, grassland etc.)

This classification is then combined with a slope assessment to produce the bushfire constraints map with indicative asset protection zones as demonstrated in **Figure 2.4**.

It is important to note that the assessment is based on the **current (2006) vegetation composition** which is likely to change as a result of internal and external factors. Such changes are likely to affect the nature and location of the defined Bushfire Hazards. Such factors include the removal of vegetation within the North Bellbird Investigation Area in association with urban development, the revegetation of certain areas, in particular riparian zones, the maintenance of the prescribed APZ's, the management of vegetation as part of a Property Management Plan or other practices such as viticulture and any clearing external to the Investigation Area.

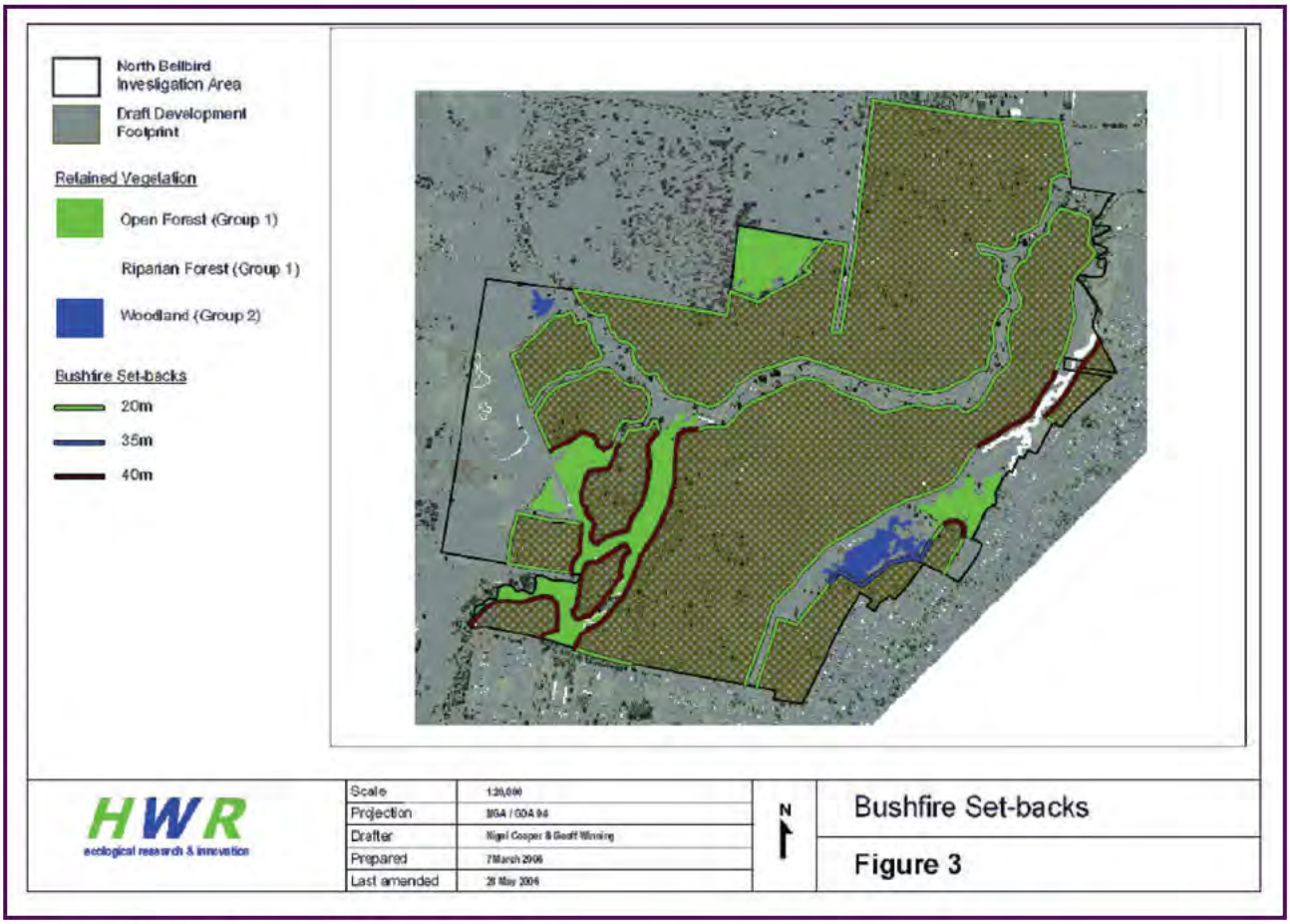


Figure 2.4: *Bushfires Constraints Map*

On this basis it is considered that Bushfire APZ's will require continual refinement at the subdivision stage of various precincts. It is anticipated that matters such as methods of ingress and egress will be refined as well as the exact nature and size of changes to the APZ's.

On this basis the bushfire threat to development will be revisited at the subdivision / development stage to ensure compliance with the *Rural Fires Act, 1997* and *Planning for Bushfire Protection Guidelines, 2001*. For the purpose of the proposed rezoning it can be established that the **overall threat is low and that the setback requirements are not prohibitive to urban development**. This categorisation will clearly not compromise the overall viability of the subsequent staging, subdivision and development of the North Bellbird Precinct.

2.3 VITICULTURAL ASSESSMENT

The western third of the North Bellbird Investigation Area is currently located in the 1(v) Vineyards Zone under the Cessnock LEP, 1989. In accordance with Council and the Department of Planning's directive for allowing the inclusion of this land into the investigation area, a Soil Survey has been undertaken by *Allynbrook Pty Ltd*. The purpose of this Soil Survey is to ascertain whether this land contained prime viticultural soils and thus the potential to be utilised for wine grape production. It is essential that the location of these soils be defined and that the western 'edge' of urban development reflect the capability of this land.

For the purpose of the proposed rezoning it can be established that the overall bushfire threat is low and that the setback requirements are not prohibitive to urban development.

In summary it is concluded that urban development within the North Bellbird Investigation Area can occur without any impact on prime viticultural soils.

It is essential that the location of these soils be defined and that the western 'edge' of urban development reflect the capability of this land.

As part of recognizing this capability it is critical that urban development is appropriately set back from existing vines and prime viticultural soils to ensure that the opportunity to utilise these soils for wine grape production remains. On this basis, the study was only undertaken over land currently zoned 1(v) Vineyards District, including: –

- Lot 3, DP 597226
- Lot 2, DP 597226
- Lot 1, DP 661832
- Lot 1, DP 196460; and
- Lot 2, DP 66183

Soil sampling of 1(v) lands was followed by an analysis of the soil profile in terms of:

- Depth of horizon
- Texture
- pH
- Soil Colour
- Presence of Mottling
- Pedality (structure)
- Topsoil Depth
- Potential root zone depth
- Readily available water holding capacity (RAW) in the root zone.

The results of the Allynbrook soil analysis are most appropriately illustrated in the attached Viticultural Soils Analysis Plan (**Figure 2.5**). This plan clearly shows the extent of prime viticultural soils. These 'prime' areas, as described in the Allynbrook report, are as follows:

Lot 3, DP 59226

"On the western side of the creek and running up to Lot 1, DP 196460 … has better soils, especially the alluvial deposits adjacent to the creek. Here, potential rootzones extend 60cm to 100cm. The soil profiles on the ridge are also quite good. Potential rootzone depths range from 55cm to 70cm. These soils tend to be reasonably well structured, although most are acidic.

Lot 1, DP 196460

…The better soils occur higher up the slopes in the higher vineyard blocks. The soil profiles here consist of quite deep clay loam topsoils overlying well structured red clays …These soils in the higher areas are prime viticultural soils and the vineyard blocks planted in these soils do produce high quality fruit.

Lot 2, DP66183

…The soils are of low to moderate productivity. None of the test sites in the steeper western areas included the rich clay loam topsoils or red basalt clays.

The remainder of the 1(v) – Vineyards land is described as having low productivity due to a variety of reasons (shallow acidic soils, poorly mottled clay subsoils etc.).

This summary largely reflects the findings of NSW Department of Agriculture's broad scale 1993 study which classifies the land as class '4 – unsuitable soils' in the Viticultural Soil Groups.

The land is also classified as being Class '4' land under the NSW Agriculture Suitability Classification. Class '4' land is described as *"being suitable for grazing, but not for cultivation. Agriculture is based on native pastures or improved pastures using minimum tillage techniques"* and in this regard is not considered to be prime crop or pasture land such as Class 1, or 2 lands.

This report, when combined with the Viticultural Soils Analysis Plan, addresses a key element in defining the location of the western edge of urban development within the North Bellbird Investigation Area. The implications of these findings will be addressed in an analysis of the North Bellbird Structure Plan.

In summary it is concluded that **urban development within the North Bellbird Investigation Area can occur without any impact on prime viticultural soils (as detailed in Figure 2.5) providing the western edge is avoided**. In this respect the concerns of Council, the Department of Planning and the community on this matter are considered to be satisfactorily addressed.

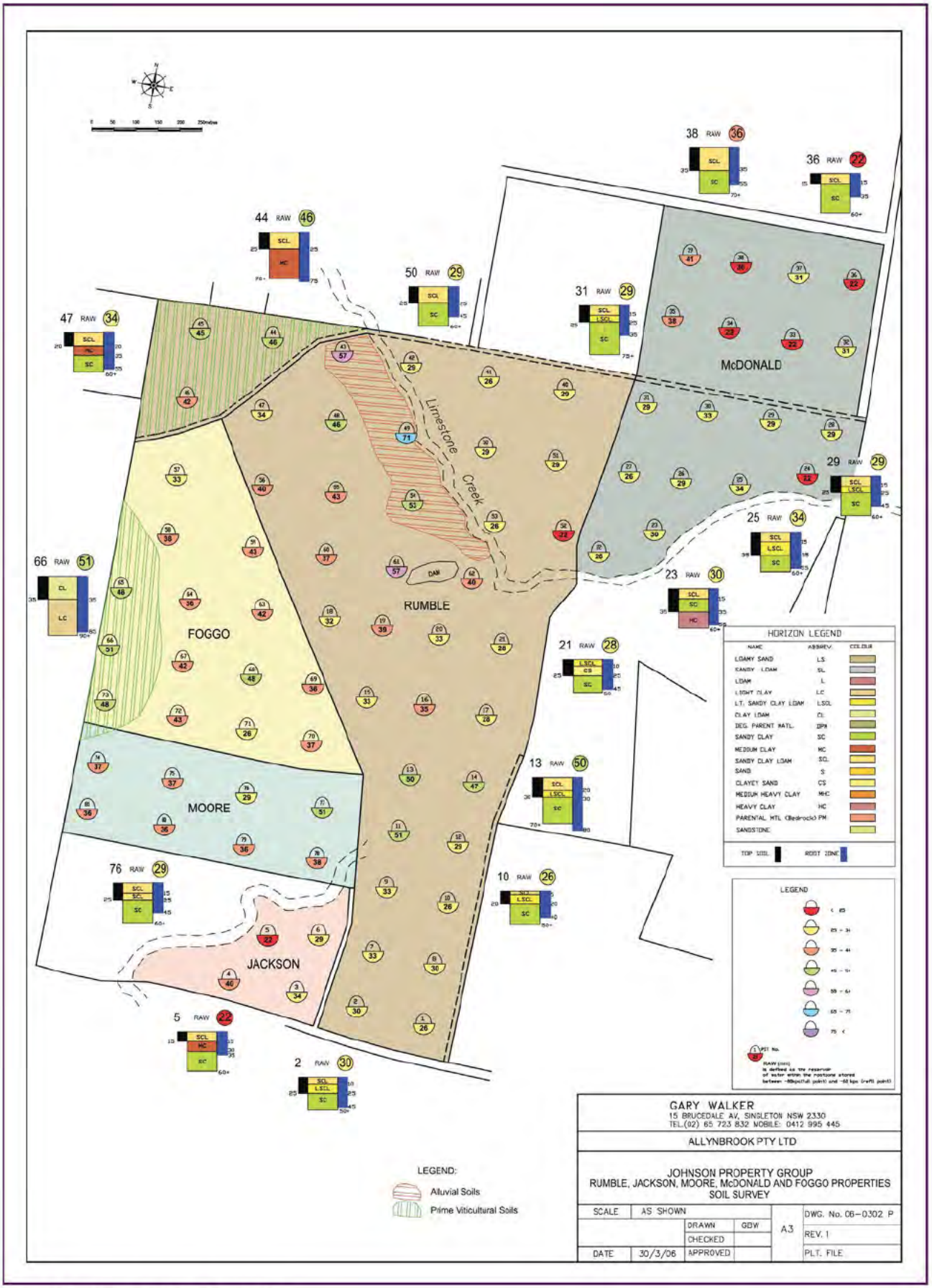


Figure 2.5: *Viticultural Soils Analysis Plan*

2.4 INDIGENOUS ARCHAEOLOGY

Archaeological and Heritage Management Solutions (AHMS) Pty Ltd were commissioned to undertake a Aboriginal Heritage Assessment to identify potential constraints to development, investigate management options and determine the cultural and archaeological significance of the North Bellbird Investigation Area to indigenous peoples.

The purpose of the study was to establish the indigenous archaeological and heritage significance of the North Bellbird Investigation Area and assess potential constraints on future development.

The primary objective of the research is to allow for the results of the assessment to be incorporated into the North Bellbird Structure Plan and to provide direction relating to management options at the subdivision and detailed design stages.

CONSULTATION

Consultation was undertaken in accordance with the procedures set out in the Department of Environment and Conservation's *Interim Community Consultation Requirements for Applicants 2005*. The following indigenous groups sought inclusion in the investigative and consultative process and were engaged in the field survey process:

- Tom Franks and Danny Franks of *Yarrawalk*;
- Mark Hickey and Robert Lester of *Wonnarua Nation Aboriginal Corporation*;
- Ann-Marie Hickey of *Barkuma Community Centre*;
- Margaret and John Matthews of *ANTEC*; and
- Alfred Whaledom, Phillip Hall and Joby Patterson of *Mindaribba Local Aboriginal Land Council*.

At the time of lodgement the AHMS report had been forwarded to these groups for comment. The outcome of this process will be addressed alongside the community consultation process undertaken in accordance with Section 62 of the Environmental Planning and Assessment Act, 1979.

FINDINGS

The report observes that:

- Twenty One (21) open artefact scatters and four isolated artefacts (**Figure 2.6**) were identified during the archaeological field survey. The majority of sites were found across areas of exposed ground and soil profiles exposed on eroding creek banks. Across much of the study area, ground surfaces were covered by grass and vegetation. This prevented effective detection of surface Aboriginal sites. Most sites were discovered within the **creek margins** where erosion has exposed the soils.
- It is likely that more sites and isolated objects exist on current ground surfaces below pasture grasses, and in sub-surface deposits and areas outside these zones have a low to moderate potential. Test excavation would be required to accurately establish this pattern. This testing process is most appropriately undertaken in conjunction with development applications should rezoning proceed.

Based on the results of the survey the following conclusions are made in the AHMS report: –

- Areas of remnant A horizon topsoil adjacent to creeklines have a high potential to contain Aboriginal archaeological deposits, **particularly near the confluence of Limestone Creek and two tributaries in the south western portion of the study area**. The creek junction may have been an important resource zone and an important local focus for Aboriginal occupation and use in the past.
- Stone artefacts were consistently found on exposures of lower remnant A2 horizon soils at the interface with B horizon clay. No artefacts or other stone materials were seen on exposures of upper A1 horizon topsoil. This indicates that stone materials, including Aboriginal artefacts, have deflated through the soil profile. It also suggests that there is little vertical integrity of archaeological deposits within the duplex soils.
- The broad variety of stone raw materials, percentage of cortex and proportion of primary reduction material observed at the sites on Limestone Creek indicate local sourcing of river pebbles.

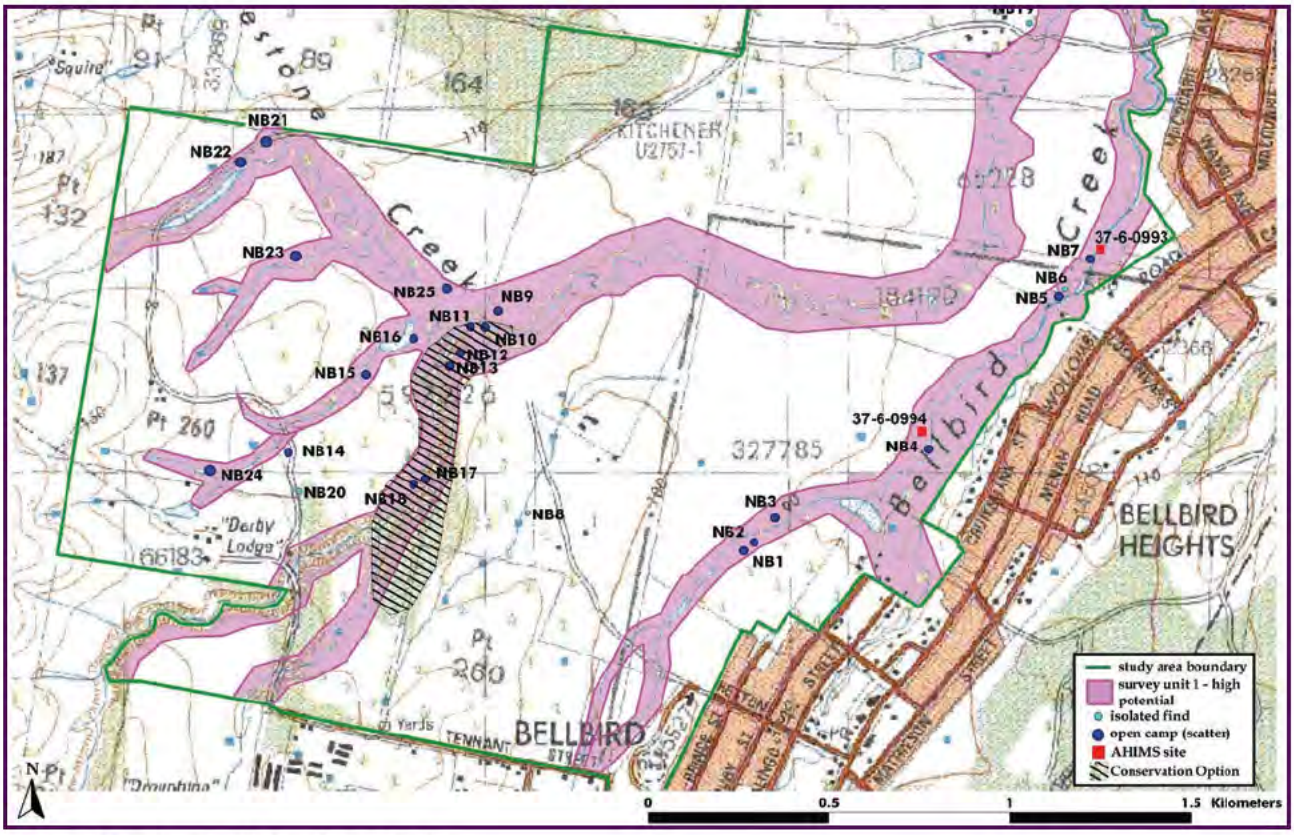


Figure 2.6: *Indigenous Archaeological Findings*

The sites identified at North Bellbird are variously assessed as having moderate – high, low and low – nil archaeological significance at a local level. **None of the sites are considered to have rarity at a regional or state level**. Some of the sites have public significance values for their ability to demonstrate aspects of Aboriginal occupation and use of the landscape prior to settlement.

The AHMS report identifies Aboriginal heritage constraints and opportunities in regard to future development. It is recommended an application be submitted to the *Department of Environment and Conservation* for a Section 87 – Preliminary Research Permit to undertake archaeological test excavation in advance of any future development. **This should be done during the DA planning and prior to detailed development design**. Test excavation would aim to determine the nature, extent and significance of Aboriginal sites and objects within the path of development. The results of the excavation would be used to develop an Aboriginal heritage management plan for future development which may include:-

- Conservation options;
- Salvage options; and / or
- Consent to destroy options

Appropriate permits will be obtained prior to the undertaking of any earthworks within the Investigation Area.

MANAGEMENT OPTIONS

In view of the findings of the field survey the AHMS report makes the following recommendations:

- A Section 87 Application to undertake a systematic programme of landform based archaeological test excavation. This should be undertaken during pre DA planning and prior to detailed development design;
- A 100 metre management zone either side of Limestone Creek and tributaries is established as an area where Section 90 permits are most likely to be required for any work within this zone.
- Salvage of site NB10 prior to development works under the terms of a Section 87 or Section 90 permit. AHMS describe Site NB10 as being subject to active erosion and in a highly fragile condition. Activities such as changes in hydrology, increased erosion from nearby developments and increased human traffic will further disturb the site. It is for these reasons that AHMS recommend the salvage of this site prior to development.

The AHMS identifies additional investigations, particularly in relation to excavation and management options will be required during the development stage, the report highlights the areas of highest significance. However the nature of the evidence of indigenous occupation is not seen as prohibiting development, rather requiring further investigation with elements of conservation and salvage closer to the development stages of the site.

The report has concluded that there are no issues related to aboriginal archaeology that would otherwise preclude urban development of the site. What will be required will be the conservation of areas around the confluences of Limestone Creek in the south western section of the site and further investigations within 100 metres of the watercourses through the remainder of the site.

In summary it can be safely concluded that **urban development within the North Bellbird Investigation Area can occur with only minimal impact or disturbance on objects and artefacts of significance**.

There are no issues related to aboriginal archaeology that would otherwise preclude urban development of the site. What will be required will be the conservation of areas around the confluences of Limestone Creek.



2.5 FLOOD, DRAINAGE AND WATER QUALITY

The Parsons Brinckerhoff *Flooding and Stormwater report* assesses the current level of flood affectation, provides a development footprint based on the extent of flooding based on water levels for the 1, 5, 10, 20, and 100 year ARI and probable maximum flood (PMF) events, and examines stormwater management and detention.

The North Bellbird Investigation Area forms part of the Bellbird and Limestone Creek catchments. Limestone Creek traverses the investigation area from south west to north east, and Bellbird Creek flows in a northerly direction along the eastern flank of the Investigation Area. The confluence area of the two creeks is in the north eastern quarter and discharges into Black Creek.

Flooding is identified as a primary constraint to residential development. **Figure 2.7** details the extent of flood affectation during the 5, 10, 20 and 100 year ARI and the PMF event. As can be seen, much of the flooding identified within the site occurs "in bank" along Limestone Creek, with some minor out of bank flooding occurring along Bellbird Creek.

In terms of defining the constraint free land for the purposes of residential development, the Parsons Brinckerhoff report recommends that all finished floor levels for residential dwellings be situated a minimum of 500mm above the estimated 100 year flood level. For other building classifications it is recommended that the finished floor level be determined in consultation with Council and in accordance with the NSW Floodplain Management Guidelines.

The report notes that opportunities exist to undertake further investigations that may allow for some regrading and earthworks to occur on the marginal flood liable land, which will create no adverse flood impacts and can therefore satisfactorily increase the developable area within the North Bellbird Investigation Area. This is considered an opportunity which will be further explored at the detailed design stage.

Despite the need to undertake further investigations to refine the development footprint over marginally flood affected land, it can be said that **flood events will not preclude urban development within the North Bellbird Investigation Area**.

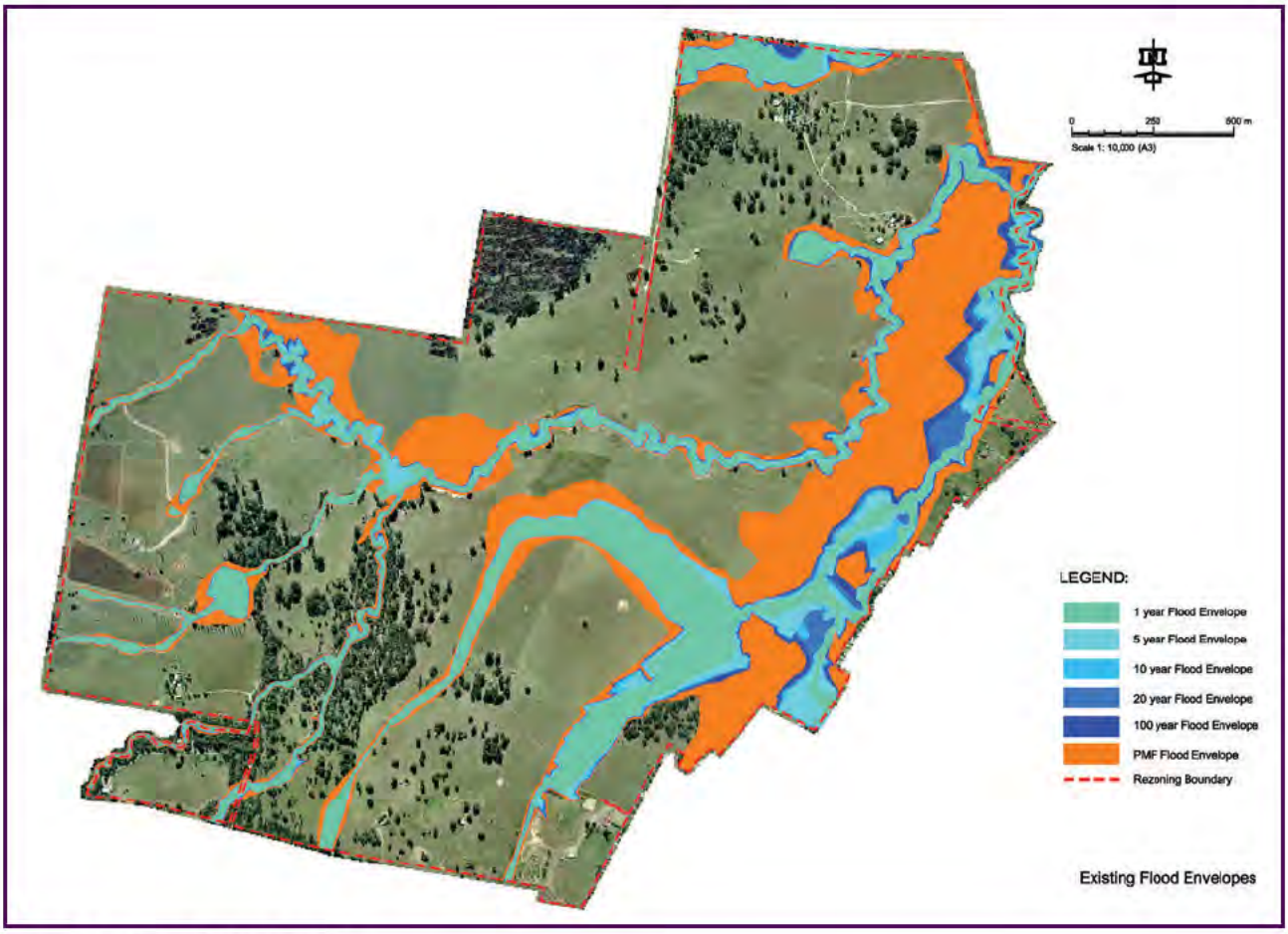


Figure 2.7: *Flood Affected Area Plan*

2.6 EUROPEAN HERITAGE

Stedinger & Associates were commissioned to undertake the European Heritage Impact Assessment over the North Bellbird Investigation Area. The report has been prepared in accordance with the NSW Heritage Manual and is consistent with the principles of the ICOMOS Burra Charter.

As expressed in the *Stedinger & Associates* European Heritage Impact Assessment, the North Bellbird Investigation Area is not considered to have European heritage significance and the site is *unlikely* to contain relics that provide information on the settlement and development of the locality. There are, however some items / structures which warrant further consideration either through recognition within the North Bellbird Structure Plan, or addressed as part of the subsequent subdivision / development. As extracted from the European Heritage Assessment these include: –

- A small slaughter house operated out of Lot 1, DP 597226 (refer **Figure 2.8**);
- The site / relics of the 'Red House' is reportedly located within the North Bellbird Precinct. A local bushranger (Patrick Bruin) was brought here fatally wounded in 1843. The building was deserted in the 1880's and its sub surface remains may lie on Lot 1, DP 349452. While field work did not reveal any evidence, relics may be discovered during the construction phase.
- A cottage on Mount View Road (Lot 141, DP 986905) was found to be aesthetically significant and is associated with the historic growth of Bellbird due to mining.

the North Bellbird Investigation Area is not considered to have European heritage significance and the site is unlikely to contain relics that provide information on the settlement and development of the locality.

The North Bellbird Structure Plan reflects or is capable of reflecting these requirements. This can be seen in the establishment of a pocket park to allow for the retention of the slaughterhouse and its curtilage and the retention of the cottage on Lot 141, DP 986905. It is expected that any relics, including that of the 'Red House' will not be uncovered until such time as bulk earthworks are undertaken. It is anticipated that any development consent issued for such works will contain appropriate conditions to ensure that all relics are dealt with in accordance with the Heritage Act.

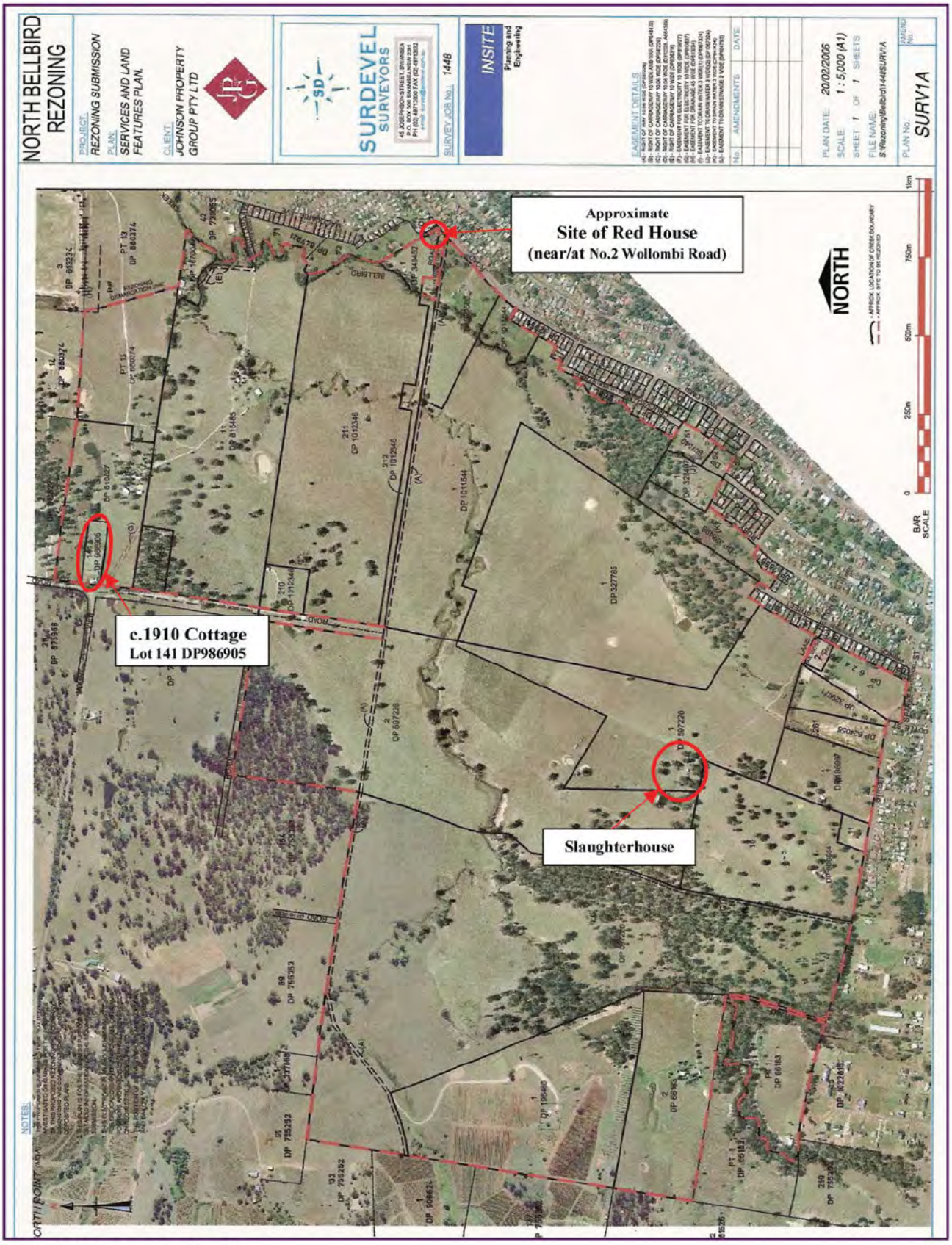


Figure 2.8: European Heritage Plan



2.7 VISUAL IMPACT

The Visual Impact Assessment was prepared specifically to address the likely impact of urban development within land that is currently zoned 1(v) – Vineyards under the Cessnock LEP, in particular addressing the 'western' edge of the investigation area. The assessment also considers the remainder of the precinct and in this regard has had substantial input into the North Bellbird Structure Plan.

The Visual Impact Assessment determines the location and assesses the significance of the visually prominent features both internal and external to the site. The Assessment then considers the investigation area in terms of scenic quality and absorption capacity which is aimed at directing the urban form based on the overall visual impact. This is combined with a series of development principles which will assist in increasing the absorption capacity and reducing the visual impact of urban development within the North Bellbird Investigation Area on external areas, particularly significant views and vistas to the west of the precinct and views towards the features such as the Broken back range / Pokolbin Hills. The development principles are summarised as follows: –

- *Identification of a transition zone within which development should increase in density from west to east.*
- *Development of Riparian Zones which may incorporate passive recreational uses such as cycle ways and picnic facilities.*
- *Revegetation of riparian zones will also provide visual relief to the urban form and provide connectivity between existing vegetation stands in the south west areas of the site and tracts of vegetation external to North Bellbird.*
- *Consider linking with the existing street network within Bellbird. Connectivity with the surrounding, established residential areas will provide greater integration both physically and visually.*
- *Retain visually prominent stands of vegetation.*
- *Use key site features as key points within the development, for example, the southern ridgeline is suitable for a north south road.*
- *Open space areas for passive and active recreation should be located along significant edges to maintain existing open space or to further enhance the transition between the western and eastern portion of the site.*

There is no finding or recommendation contained in the Andrews Neil Visual Impact Assessment which would preclude urban development in the North Bellbird Investigation Area. However the form of development will need to be controlled through the Structure Plan so that the future urban development of the investigation area does not impact on the scenic qualities of adjoining rural areas.

2.8 SERVICING

The servicing and infrastructure assessment, prepared by Insite Planning and Engineering has been undertaken with the primary aim of establishing the availability of services and to highlight any significant impediments to servicing this investigation area. It is anticipated that this report will be utilised as a basis for establishing the most appropriate staging for the North Bellbird Investigation Area.

Specifically this report comments on the location, capacity, serviceability and all significant issues relating to the provision of:

- Reticulated Water Supply;
- Sewerage System;
- Electricity Supply;
- Natural Gas Supply;
- Telecommunications systems; and
- Roads and Drainage Infrastructure.

The following is a summary of the findings in relation to each of the above services:

2.8.1 RETICULATED WATER SUPPLY

With reticulated water being available adjacent to the site in both Bellbird and Cessnock there is no real impediment to the supply of water to the proposed development. The Infrastructure and servicing report concludes in noting that there is no real impediment to the supply of reticulated water to the development provided that a suitable servicing strategy is developed.

HWC has advised that typically upgrading works take between 5 and 7 years to complete from the initial planning stages therefore the commissioning of a servicing strategy should commence as soon as a lot yield and structure plan has been adopted.

Preliminary discussions have also been held with HWC to investigate the opportunities to reticulate the North Bellbird area with recycled water.

2.8.2 SEWERAGE

HWC is the service provider for wastewater (sewerage) services to the Cessnock LGA. There is no real impediment to the provision of sewerage services to the precinct. It does, however appear that timing for upgrading works stands as the biggest hindrance to development with upgrading works to take between 5 and 7 years to complete from the initial planning stages. As with the water strategy, the Insite Planning and Engineering report recommends the commissioning of a servicing strategy as soon as a master plan has been adopted.

2.8.3 ELECTRICITY SUPPLY

Energy Australia are the service provider responsible for the provision of electricity to the Cessnock LGA and the North Bellbird Investigation Area. The advice of Energy Australia has been sought and it has been ascertained that services are available in the vicinity of the North Bellbird Precinct and that supply can be provided in accordance with Energy Australia's current ES8 – Capital Contributions Guidelines – July 2002.

With existing electricity infrastructure being adjacent to the development site and advice from Energy Australia that the network has the capacity to service the development it is concluded that there are no impediments to the supply of electricity to the North Bellbird Investigation Area. Some augmentation of the 11,000 volt supply to the site will be required at some stage depending on the staging of the development.

In this respect then it seems that early stages of the development should be located adjacent to existing residential areas in Bellbird (see **Figure 2.9**) with further discussions with Energy Australia recommended once a structure plan and/or staging plan for the development has been adopted.

The report concludes that there appears to be no impediment to the supply of electricity to the proposed development.



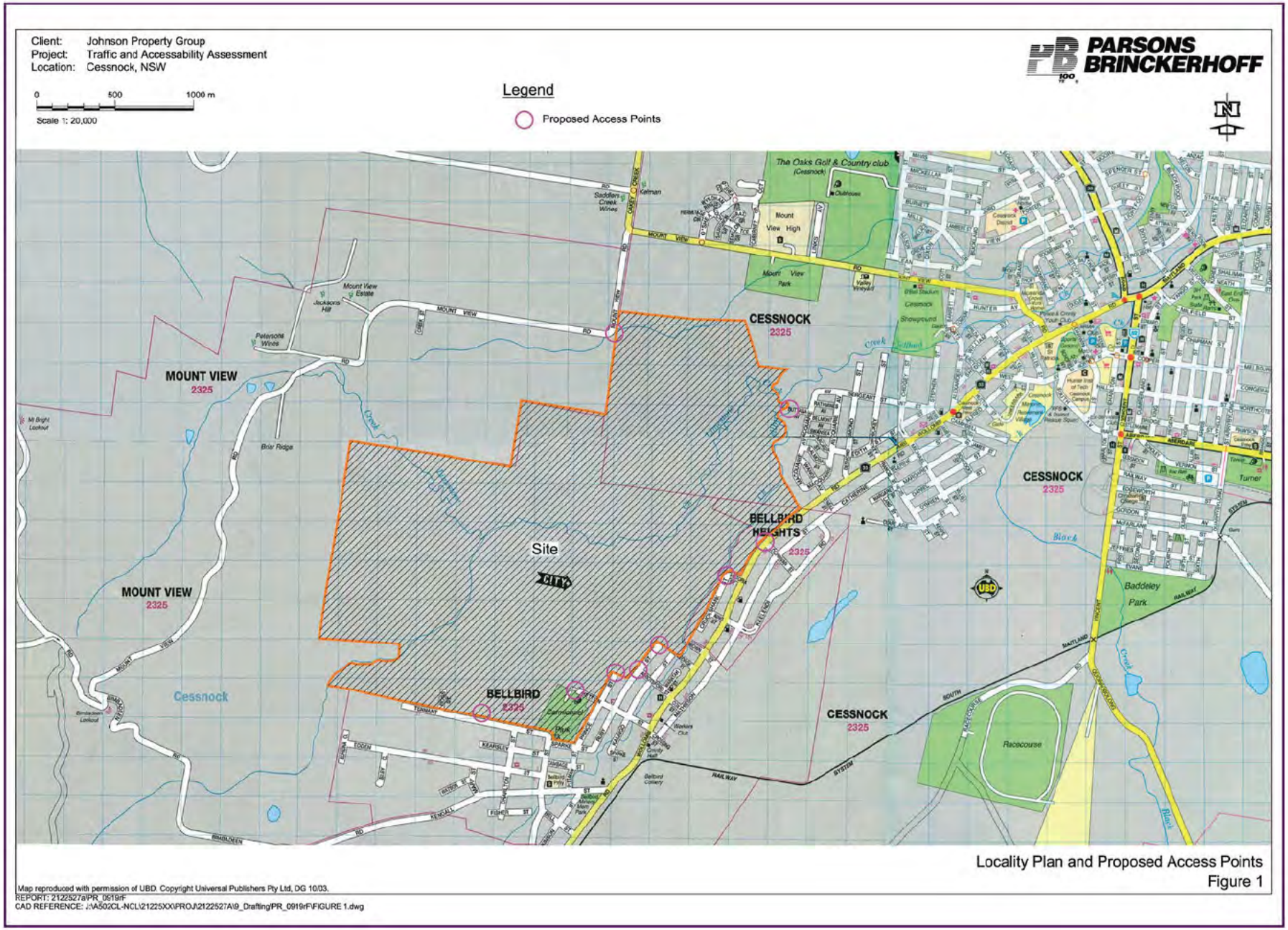


Figure 2.9: Investigation Area Access Plan

2.8.4 NATURAL GAS SUPPLY

Agility (AGL) are the service provider responsible for the provision of natural gas services to North Bellbird. Whilst natural gas is not considered an essential service, it is becoming a economic fuel source for heating and cooking, can achieve higher energy efficiency ratings and thus its inclusion is desirable in terms of attracting a wider spectrum of the market to the site.

Based on the proximity of the site to existing natural gas services and the likely demand for such services generated by a 5,000 lot subdivision it is reasonable to conclude that the North Bellbird Investigation Area can be serviced with natural gas.

The report suggests that there will be no impediment to the provision of gas to the site and that it is likely that this will take place due to the anticipated demand for the service.

The report suggests that there will be no impediment to the provision of gas to the site and that it is likely that this will take place due to the anticipated demand for the service.

2.8.5 TELECOMMUNICATIONS SYSTEMS

Telstra Country Wide is the service provider responsible for providing telecommunication services in the Cessnock City Local Government Area. As such Telstra Country Wide is the appropriate authority to seek advice on the availability and feasibility of providing telecommunication services to the North Bellbird Investigation Area.

Existing telecommunications services are located in the residential areas surrounding the development in Bellbird and Cessnock.

As Telstra are bound by law to provide telecommunications services to new development the issue of existing capacity is of limited relevance.

Infrastructure will be progressively upgraded to meet the demand created by the North Bellbird Investigation Area. Thus it can be assumed that there is sufficient capacity in the existing infrastructure to accommodate the development.

Due to the close proximity of the site to the existing telecommunications services located in Bellbird and Cessnock, the North Bellbird Investigation Area will be comfortably serviced with telecommunications services.

Telstra being bound by law to provide telecommunication services to new developments can provide a telecommunications service to the North Bellbird Investigation Area.

The report concludes that there appears to be no impediment to the supply of electricity or telecommunications to the proposed development.

2.9 COMMUNITY PROFILE

The *Community Profile*, prepared by Elton Consulting forms the first stage of a Social Impact Assessment which will be finalised as part of the community consultation process for the Investigation Area At this stage no community consultation has been undertaken and the focus has been to assist in the formulation of the North Bellbird Structure Plan. In this regard the purpose of the report is to: –

- Describe the social context of the North Bellbird Investigation Area;
- Identify the opportunities and constraints associated with the site from a community planning perspective; and
- Identify community planning issues that will need to be addressed in the Structure Plan.

For the purposes of creating the North Bellbird Structure Plan the last two findings listed are most relevant and are derived from the analysis of the demographic profiling and existing social / recreational infrastructure.

The principle outcomes relating to the likely social needs evolving as a result of ongoing development in the North Bellbird Investigation Area are as follows.



2.9.1 COMMUNITY FACILITIES AND SERVICES

The key findings in relation to the provision of community facilities and services for the North Bellbird Investigation Area are summarised as follows:

- There is potential for local primary schools in Bellbird and West Cessnock to meet some of the needs generated by the proposed development, particularly in the early years. However existing spare capacity will not be sufficient to absorb all of the population growth anticipated, and an additional primary school is likely to be required.
- While the site is adjacent to an existing high school at Mount View, this school has already reached its capacity and will have little ability to absorb significant demand from the new development. Cessnock High School does, however, have some spare capacity;
- There is little or no capacity in local childcare centres or preschools. This situation will need to be reviewed closer to the time of development.
- There is very little spare capacity in existing community centres. In particular, the Bellbird Hall and new Multi Purpose Community Centre will not be able to absorb demand generated by the proposed development.
- Currently within Cessnock, there is a high unmet demand for self care accommodation for older people. Provision of housing designed and located to meet the needs of older people within the development may contribute to the alleviation of this situation.
- There is very little spare capacity in health, welfare and support services, which are already stretched within the limits of their existing resourcing. The projected population growth from the proposed development will be significant and will lead to an increase in demand for these types of services.
- Services in the area for young people are already inadequate and the development may further contribute to this situation.
- The adequacy of existing emergency services will need to be reviewed later in the planning process once development yields and road layouts have been determined.

It is clear that final composition of the likely needs in relation to community facilities will be refined as a result of the community / stakeholder consultation. However for the purposes of the North Bellbird Structure Planning exercise and establishing the likely needs of the future community it is felt that the above findings present an accurate representation of the needs of the future North Bellbird Community.

2.9.2 OPEN SPACE AND REGIONAL FACILITIES

The Elton Consulting report describes the current supply of recreational facilities in the LGA as being based on traditional field sports which appear to be well catered for. The report does however describe there being a lack of indoor facilities as well as expressing a need for a wider range of recreational pursuits. The success of the indoor Kurri Kurri Aquatic Centre highlights the need for more indoor recreational facilities.

At a subregional level there appears to be a need for a multipurpose indoor sports venue in the Cessnock LGA. This presents as a key opportunity within the North Bellbird Investigation Area and can be tied in with the likely educational needs of the future North Bellbird Community.

In relation to outdoor recreational space, there is a good mix of opportunities for active and passive recreational pursuits in a range of spaces. Cessnock LGA has a hierarchy of open space capable of serving the community at a subregional and local level. Council is currently in the process of rationalising local open space, with funds from the sale of land being directed towards the improvement of the retained spaces.





2.9.3 POTENTIAL SOCIAL INFRASTRUCTURE NEEDS

While a comprehensive assessment of the future social and community needs of the North Bellbird population will need to be undertaken, the Elton report makes some preliminary assertions based on the existing services in Cessnock and likely population scenarios within North Bellbird. It is noted that: –

> *"Facilities and services built to meet the needs of a population of about 22,000 cannot be expected to satisfy the needs of 32 – 36,000 people without some considerable augmentation and additional facilities and services being provided … While Cessnock Council is in the process of redeveloping a number of its community and recreational facilities, the planning on which such a redevelopment has been based has not taken account of population growth associated with all the urban investigation areas identified in the Cessnock City – Wide Settlement Strategy."*

On this basis any additional infrastructure currently planned or provided by Council will not be sufficient to meet the anticipated demands of the North Bellbird Precinct. In terms of local facilities the likely demand generated by the North Bellbird Precinct is detailed in **Table 3**.

The Elton report encourages the clustering of facilities to improve accessibility and create a focal point for the community. Clustering may also involve co – location of facilities to improve efficiency of land use and integrated service delivery.

In relation to regional services and facilities the population projections for the North Bellbird Precinct may not necessarily require the provision of regional facilities within the Precinct but may require the following: –

- Augmenting facilities and services located outside of the site that serve the population of the Cessnock area as a whole; and
- Identifying district level services that might be appropriately located within the North Bellbird site to serve the wider area such as a private high school and the location of a regional recreational facility.

There are opportunities to locate such services within the North Bellbird Precinct or address the provision of such matters through an appropriate developer contributions plan.

Clustering may also involve co – location of facilities to improve efficiency of land use and integrated service delivery.

Table 3: Social and Community Services and Infrastructure

SERVICE	NUMBER REQUIRED	COMMON STANDARD	LAND REQUIREMENTS	LOCATIONAL REQUIREMENTS	COMMENTS
Public primary school	1 – 2 Could provide 1 large school or 2 smaller schools	One per 1500 – 2000 new dwellings	Approx 3 ha per school	Distributor or collector road Majority of students within 1.6km Adjacent to community playing fields if possible Encourage joint use of land Close to village centre, Potential for clustering – child care, community centre	Assumes up to half of the demand will be met by spare capacity in existing schools.
Multipurpose Community Centre	1 large centre for lower range, 1 large and 1 smaller centre for upper range	1 per 7-10000 people	2500m^2	Close to neighbourhood shops Co-location potential with Primary School, Childcare Centre, Family and Children's Services	Will be influenced by Council proposals for existing Bellbird Community Hall
Childcare Services	At least 1; others may be provided by private sector subject to market demand	1 place per 20 children 0-4 years. Usually equates to a 60 place centre for a population of 7-10000 people, but will depend on anticipated age profile	2500m^2	Central convenient location, neighbourhood hub Co-location potential with primary school, community centre	
Local parks and playgrounds	To be determined	Quality, not quantity, is important. Also need to provide a range of play and recreation opportunities to meet diverse needs	To be determined	Walking distance from most dwellings, Co-locate with community facilities, creek corridors, conservation areas	Even though Council is consolidating existing open space, will still be a need for some local provision within the development.
Local retail and commercial services eg local convenience shops, medical centre	To be determined		To be determined	Neighbourhood hub	
Public domain areas for informal meeting and gathering	To achieve urban design and social sustainability objectives		Areas for plazas, civic squares, cultural events such as markets	Neighbourhood hub	



2.10 ECONOMIC IMPACT

The Castlecrest Economic Impact Assessment focuses on the likely non – residential land requirements for the North Bellbird Precinct in the context of the existing and future supply of such land based on the findings of Stages 1 and 2 of the Citywide Settlement Strategy and the most likely population scenarios for the North Bellbird Precinct. Stage 2 of the Strategy is of particular interest as it focuses on determining the needs of non – residential land uses (retail, commercial and industrial) on a subregional basis.

This report analysis the likely future economic impact and needs of the North Bellbird Precinct in terms of: –

- *Context;*
- *Demographic Profile;*
- *Retail demand estimates factoring population and household growth, retail expenditure and consequential retail and commercial floor space demand;*
- *Assessment of land requirement and scope for additional retailing based on the North Bellbird Area and taking into account the role and function of the existing commercial centres growth.*
- *Employment…*

While again it must be observed that the exact composition of retail and commercial land within the North Bellbird Precinct will be refined following community / stakeholder consultation, this report provides an assessment of the likely needs based on the current and future supply of such land and the likely future population of the North Bellbird Precinct. The principle findings of this report are as follows:

- Whilst in recent times Cessnock has experienced uplift in population and dwelling growth, the change has not been strong in comparison to other areas within the Lower Hunter. However, there has been a raft of rezoning and development proposals which have the capacity to increase both the residential and non-residential development outcomes within the Cessnock LGA;
- In planning for new residential areas there is a capacity and a propensity to include non-residential land holdings consistent with the approach and doctrine outlined in Draft SEPP 66. The proposed development at Bellbird North has an extensive capacity and depending on dwelling yield outcomes could support a population of up to 13,000 people in up to 5,000 dwellings when fully developed. This yield alone is sufficient to support the development of a neighbourhood shopping centre comprising a supermarket and a range of specialty shops;

- Owing to the proximity of extensive sub-regional retail and commercial facilities at the Cessnock CBD, the demand for retail facilities within the Bellbird North area will support only a local/convenience provision. The forecast population within Bellbird and Bellbird North will have the capacity to support additional floorspace in the range of **4,800 to 6,860 square metres**;
- This will in turn generate the need to allocate between **1.20 and 2.29 hectares** of land sufficient to accommodate non-residential development to meet the demand of the Bellbird North and immediate trade area once the estate is fully developed;
- In order to reinforce the objectives and characteristics of Draft SEPP 66 the land allocation should occur close to existing or proposed transport routes within the local precinct. The land areas should also be provided in one parcel and not be disaggregated;
- If other future development nearby warrants further community and retail facilities, they should be at least 1 kilometre from the existing and planned Bellbird North provision and target limited local/convenience capacity only. The floor space should **be limited to 1,000 square metres on land of approximately 3,000 square metres**;
- Future commercial and retail land provision should focus locations related to main road and transport routes. This will facilitate the capacity to support integrated local transport service within the local area as the areas grow and develop.









2.11 TRAFFIC IMPACT ASSESSMENT

The Parsons Brinckerhoff Traffic Impact Assessment focuses on providing an overview of the current and likely traffic implications for the North Bellbird Precinct and provides recommendations relating to accessibility.

The report focuses upon: –

- Assessment of existing local traffic and investigations of access requirements;
- Determine public transport requirements;
- Investigate options for access to the existing road network;
- Assessment of sight distances, access requirements and available space;
- Assessment of local traffic and determination existing loadings in the area; and
- Collation of any existing RTA and Council data on traffic in the area.
- Pedestrian and cycleway… see requirements for LES

The intent here is to provide input for the structure planning process. Once this has been drafted, issues relating to internal configuration requirements can be provided to establish a road hierarchy and network configuration within the North Bellbird Precinct. Similarly modelling and any associated traffic impact assessment on the external road network will be done at a later stage.

2.11.1 ACCESS OPPORTUNITIES

The focus of the traffic report has been directed at constraints and opportunities relating to vehicular, pedestrian, cycle and public transport access considerations to the North Bellbird Precinct. In terms of vehicular access, opportunities exist as follows: –

> *"The obvious access points to the eastern part of the site are via extension of the existing local streets of Victoria, Ruby, Abbotsford, Prince and Hetton Streets by creating "T" intersections along Wollombi Road … Practical access points are also available at the extension of Buttaba Avenue in the north east of the site and via an existing … easement off Mount View Road in the north of the site"*

The suitability of the above access points are made based on field measurements assessed against Austroads Part 5 "Intersection at Grade" requirements to determine the opportunities and constraints relating to each road / prospective intersection. These are summarised as follows: –

- **Wollombi Road**: – There are opportunities to provide direct access into the North Bellbird Precinct from Wollombi Road at Bellbird Heights to the north of Lochinvar Street (see **Figure 2.10**). There is ample room for a 'T' or 4 – way intersection with good site lines. To access developable land a new crossing over low lying land and Bellbird Creek is required. This section of Wollombi Road is in poor condition and will require upgrade. Such upgrades are likely to be funded in part by the developer.
- **Victoria, Abbotsford and Hetton Streets**: – Access to the site can be provided via extension of these local streets. It is likely that utilisation of these streets will involve some upgrades due to deterioration. There are opportunities to widen Victoria Street if necessary. Timber bridges upon Abbotsford Street and Hetton Street are likely to require upgrading, especially if utilised as a major access to the site. Access points with Wollombi Road are described as being acceptable to the Austroads criteria.
- **Tennant Street**: – Tennant Street is described as being straight with a gentle gradient which is suitable to provide adequate sight distance for access points. Traffic volumes are low and it is recommended for further consideration for the provision of access into the North Bellbird Precinct.
- **Buttaba Avenue**: – The extension of Buttaba Avenue will provide access to the Precinct via Macquarie Street, Wangi Street to Wollombi Road. Access involving more than three turns at intersections to access the main road network is undesirable. In this regard this access point is not recommended as a major link to the development.
- **Mount View Road**: – Recent upgrades along the length of Mount View Road to the east of the likely North Bellbird access point are of a high standard. This includes the Wollombi Road / Mount View Road intersection. Depending on traffic volumes as a result of development within the North Bellbird Precinct additional upgrades may be required.
- **Ruby Street**: – Access to a small section of the investigation area at Bellbird is also via an extension to Ruby Street.



2.11.2 EXTERNAL ROAD NETWORK

If the investigation area is developed in the future for urban purposes, it will have the potential to generate significant traffic which would feed onto the adjoining road network. The primary roads that will be affected are Wollombi Road and Mount View Road.

Sections of Wollombi Road between the investigation area and Cessnock are currently in poor condition and in need of upgrading now; in particular the section from Bellbird through to Cessnock West.

It is also likely that the Mount View Road/ Wollombi Road intersection would also require upgrading if development of the area proceeds.

2.11.3 PUBLIC TRANSPORT

The local service provider, Rover Coaches, services Bellbird via Wollombi Road. This route includes Hetton, Prince, and Doyle Streets and on this basis presents a logical opportunity to extend this service into the North Bellbird Precinct.

The Parsons Brinckerhoff report makes specific recommendations to facilitate the provision of this service: –

- *Understand the 'desire lines' for users, which will assist planning where the bus destinations should be;*
- *Cater for different user types, shopping, night life, longer and shorter trips to larger centres;*
- *Look at providing a youth bus service and tailor it to specific events, eg concerts, after school activities, movies etc.*
- *Have bus services aligned with stages of development;*
- *Look at demographics of the area to understand what the people want.*

2.11.4 PEDESTRIAN & CYCLE NETWORKS

The Parsons Brinckerhoff report outlines opportunities that exist to integrate the pedestrian and cycle network with the public transport routes and provide pedestrian / cycle links throughout the site, along linear parklands/open space.

2.12 GEOTECHNICAL OPPORTUNITIES AND CONSTRAINTS

Network Geotechnics have undertaken a geotechnical and contamination site assessment over the North Bellbird Investigation Area. The intent of this report is to identify specific constraints to urban development, establish the geotechnical suitability of the Investigation Area for Urban Development, and advise on the suitability of constrained or contaminated land to be remediated or treated to enable urban development to proceed. Specifically the assessment targeted the following areas: –

- Geotechnical aspects affecting the suitability of land for subdivision, in particular slope instability;
- Preliminary site contamination assessment including a title search and examination of aerial photographs, sampling and testing in accordance with NSW EPA Guidelines;
- Preliminary appraisal of soil salinity; and
- Preliminary assessment of acid sulphate potential of site soils, particularly in low lying areas.

The primary findings of this report with regard to opportunities and constraints to urban development are as follows.

Aerial Photographs between 1954 and 2004 were viewed to consider any previous activities which may have led to any contamination within the Investigation Area. This assessment indicates that: –

> *"Based on the information and the site history contained in land titles it may be assessed that there are no indications of recent on site activities which could lead to site contamination. Although the site may have been previously been used as a grazing area similar to the present land use, there were dams, sheds, dwellings and a previous slaughter house present which could have a potential for site contamination"*

Following the desktop analysis fieldwork was undertaken throughout the investigation area, with test-pits logged and sampled by the consultants. Samples were subsequently analysed for contamination, salinity, and acid sulphate soils.

The findings of such analysis are summarised as follows: –

- **Slope Analysis**: – Slope stability is not considered to be a major concern within the site. Local areas with slope exceeding 12.5 % would require construction to be carried out in accordance with *good hillside engineering practices* as outlined by Australian Geomechanics. Such areas were only identified in the south west corner of the Investigation Area.
- **Stormwater**: – Disposal of stormwater may be carried out by conventional means. Excess stormwater runoff generated by urban development work may be directed to detention basins. Sizing of detention basins may be based on an absorption rate of 30mm/d from preliminary assessment.



- **Salinity**: – While there are no salinity maps available for the Investigation Area (DNR), anecdotal evidence indicates an exposed saline profile to the south west of the site. Soils close to creeks may be moderately saline. Such soils may generate salts when disturbed which may cause problems in road pavements, brickwork and concrete in buildings / structures. Further investigation should be carried out to delineate areas of possible moderate or high salinity. As a rule of thumb, areas within 50m to 100m of creek lines underlain by shale / siltstone may contain saline soils.
- **Contamination Issues**: – Testing did not reveal site contamination levels that would limit the development of the Investigation Area. One sample contained marginally higher metal concentrations, which may be due to the chemical composition of natural soils. Further testing is recommended to assess any contamination potential of surface water in the vicinity of this sample at the DA stage. A water sample (Sample Dam 12) contained a localised contamination of Total Petroleum Hydrocarbons and should be subject to further investigation during the DA process. A 'phase 1' contamination site assessment for any development involving the demolition of existing structures, such as farm houses, kennels, the slaughter house should be undertaken at the DA stage.
- **Acid Sulphate Assessment**: – Fourteen samples were taken in close proximity to water courses revealed only negative results. The report outlines that acid sulphate soils are generally found in low lying marine deposits. Soils within the Investigation Area are derived from the weathering of sandstone / siltstone and transportation from adjacent hills. Results suggested that site soils would not generate acid on exposure. On this basis **it is considered unlikely that Acid Sulphate Soils are present** in the Investigation Area.
- **Mine Subsidence**: – Investigations with the Mine Subsidence Board (Singleton) indicates that the site is not within a proclaimed mine subsidence district and is not subject to any building restrictions.

It can be concluded that the geotechnical investigations **have not revealed any environmental or geotechnical constraint** that would restrict urban development of the investigation area.

It can be concluded that the geotechnical investigations have not revealed any environmental or geotechnical constraint that would restrict urban development of the investigation area.

2.13 COMPOSITE CONSTRAINTS AND OPPORTUNITIES PLAN

The specialist reports summarised in this section have identified the following primary constraints which are identified in the Composite Constraints and Opportunities Plan:

- Flora and Fauna – resulting in the identification of specific stands of remnant vegetation to preserve the integrity of these communities and identified threatened species;
- Bushfire Threat – resulting in the identification of asset protection zones based on the current vegetation composition;
- Viticultural Soils – resulting in the identification of prime viticultural soils within the 1(v) Vineyards District Zone;
- Flooding – the identification of flood affected land, in particular, on the eastern flank of the Investigation Area and in the confluence areas of Bellbird and Limestone Creeks;
- Aboriginal Archaeology – the identification of a 27 artefacts within the investigation area, as well as identifying a management area for further investigations.

The primary opportunities identified were as follows:

- The ability to utilise available infrastructure;
- The opportunity for positive environmental outcomes, including the revegetation of riparian corridors and in particular Limestone Creek;
- The creation of a new commercial / retail centre;
- The opportunity to provide a higher level of social infrastructure to service the needs of the future North Bellbird Community as well as the existing Cessnock, Bellbird and Mount View Communities;
- The rationalisation of existing social and recreational facilities to better serve the needs of the community; and
- The eventual upgrade of road infrastructure external to the site, in particular sections of Wollombi Road.

The Opportunities and Constraints Plan, which details the above, has been used as the basis in the formulation of the North Bellbird Structure Plan, which will be introduced and described in Chapters 3 and 4 of this submission.


3.0



3.0 PROPOSED STRUCTURE PLAN

The urban design vision for the North Bellbird Investigation area has sought to create a liveable community with people in mind and not just the car. Endless sprawling suburbs, isolated from centres of activity, without a heart or an identity, damage the very fabric of communities and make urban environments unsustainable. North Bellbird will seek to reject this form.

The built form is planned to promote a sense of community and identity. All dwellings are within short walking distances of transport and other services. Pedestrians are not ignored. The streets will accommodate cars and parking but will be designed to make walking more convenient – and therefore preferable – rather than driving.

Neighbourhoods are designed to include many of the services and facilities that enable residents to stay within the community, avoiding the extensive travel that can create divisions in family life.

The proposed Structure Plan (**Figure 3.1**) will create a resilient, vibrant and desirable community, not just a housing estate. The focus will be on the new residents and how they go about their daily lives. It will create a place where they can bring up their families in safety and in an environmentally friendly atmosphere.

The built form is planned to promote a sense of community and identity.

The capability of this site for urban development has been demonstrated through a detailed environmental constraints and opportunities analysis and complemented by an assessment of the social and economic needs of the future community. This process has paved the way for a framework to guide the future development options of the site. This framework will come in the form of the structure plan, a site specific development control plan and supporting design guidelines which will be prepared in consultation with Council and the community. These documents will be prepared in response to the environmental constraints and opportunities and the anticipated needs of the future residents.

In this respect it is anticipated that the urban form can be described as follows:

3.1 RESIDENTIAL PRECINCTS

The opportunities and constraints analysis sets aside for residential development. The structure plan identifies residential precincts based on a defined road hierarchy to provide diversity in housing stock and an urban form responsive to the site opportunities and constraints.

Lots will progress from shop-top housing to Integrated Housing Allotments (200 – 300 m²) and onto conventional residential land (450m² to 800m²) and larger lifestyle lots (up to 2,000m²). The anticipated lot sizes in each precinct has been established with full consideration given to constraints affecting the land such as bushfire, remnant vegetation, and natural watercourses, as well as recognising opportunities to increase densities around areas of higher amenity to take advantage of views, topography, prevailing breezes, accessibility to open space and existing community and recreational facilities. The structure plan also provides an element of transition between the residential precincts which will have the desired effect of perceived continuity throughout the site.



Figure 3.1: *North Bellbird Structure Plan*

AMENITY

A DCP should be prepared to encourage constructive residential design which should seek to avoid generating a formula for repetitive designs across the precincts. Lower fencing heights should be encouraged so as to provide an attractive transition between the private and public domain.

FUNCTION

The Structure Plan encourages housing that will interact with the public domain. It should also place an emphasis on building layout and orientation, and opportunities for casual streetscape surveillance.

In the higher density precincts large windows, wrap-around verandas on corner lots and second floor balconies addressing the street are encouraged to allow for better surveillance and activation. Where developers incorporate such features the building line setback requirements can become more flexible. This will allow for better, more attentive and functional design in higher density areas.

As the lot sizes increase the setbacks should progressively increase to establish a sense of space and to allow for the retention of vegetation, higher levels of visual and acoustic privacy and the like.

3.2 OPEN SPACE

Open Space will broken up into three distinct spaces being:

- Riparian vegetation corridors following Bellbird and Limestone Creeks;
- Active sporting fields in association with the proposed school: and
- Various parks and pocket parks that will be scattered throughout the area.

The objective is to create a range of passive and active recreation areas that support the future sense of community of the North Bellbird Investigation Area.

BELLBIRD AND LIMESTONE CREEKS RIPARIAN ZONES

These areas will act as corridors that will support a variety of recreational needs, through-connecting cycleways, regenerated bushland areas and aesthetic benefits to the new community.

The anticipated lot sizes in each precinct have been established with full consideration given to constraints affecting the land.

3.3 TOWN CENTRE

Of particular note is the proposed Town Centre Precinct as illustrated on the Structure Plan. Positioned in the centre of the new community, the Centre will provide commercial and retail facilities for the future local community. It is not intended that the Bellbird North Town Centre will compete with the core retail area of the Cessnock CBD, however it will act as an important district business area. In this regard it will be of a sufficient area to provide for the future retail and commercial needs of the Bellbird North community.



3.4 ROAD HIERARCHY

The road hierarchy will be defined by an entry boulevard from Wollombi Road through Abbotsford Street and into North Bellbird and will be complemented by central landscaping. The road network has been designed to provide visual links between the entry boulevard, the various pocket parks, the Town Centre, and the riparian corridors as well as defining the residential precincts. This will maximise the visual qualities of remnant and regenerated vegetation as well as complementing the landscaped boulevards and secondary access ways.

The road hierarchy has been developed to accommodate a bus service which will provide a high level of connectivity to Bellbird and Cessnock and reduce dependency on private motor vehicles. It will also facilitate connectivity with the adjacent urban environments of Cessnock and Bellbird.



3.5 CYCLE AND FOOTPATH NETWORK

The North Bellbird Structure Plan has been formulated to encourage residents to cycle or walk for journeys within the Precinct. All residential areas will be serviced by footpaths and will have shared or dedicated cycleways in close proximity. It is anticipated that this will provide a more convenient alternative for residents other than driving to the open space areas within the site or the town centre. While vehicular parking spaces will be provided at these locations, it is considered that the high levels of accessibility provided for non motorised modes will encourage more residents to walk or ride.

This has positive influence of better visual surveillance throughout the precinct. Pathways and cycle ways will be complemented by lighting (where appropriate) and softened by landscaping.





3.6 DEVELOPMENT YIELD

The benchmark set for greenfields urban development generally stands at a gross ratio of between 12 and 15 dwellings per hectare. In the case of the North Bellbird Investigation Area, the Structure Plan has been prepared with the intent of achieving this ratio.

The North Bellbird Investigation Area contains a percentage of land which is constrained from urban development, principally the flood affected land and watercourses and some of the existing vegetated areas with good quality habitat. The riparian zones have been retained in the Structure Plan as Open Space and in accordance with the ecological recommendations. Other constraints to development which would otherwise affect the overall lot yield have been carefully incorporated into the structure plan so as to not significantly impact on the development density.

The following methodology describes the process for calculating the gross development ratio for the North Bellbird Investigation Area:

The table below clearly demonstrates that the North Bellbird Investigation Area is capable of achieving a residential development yield of between 12 and 15 dwellings per hectare. Measures taken in the urban design and constraints analysis process to ensure that this ratio can be achieved include:

- Detailed attention to the interface between development land and flood affected land, to ensure efficient use of the valuable land resource. Generally resulting in the retention of flood liable land with some rationalisation along flood zone edges
- Incorporating drainage paths into the road network;
- Allowing for larger allotments in treed areas to ensure that vegetation is retained where appropriate while still allowing the land to be viable for residential development;
- Incorporating defined integrated housing precincts into the Structure Plan; and
- Where possible, anticipated Bushfire Asset Protection Zones have been incorporated into the road network.

The benchmark of 12 to 15 dwellings per hectare is seen as an important constraint in ensuring that land use is optimised, thereby reducing sprawl. By focusing on providing neighbourhoods with high level public amenity densities of 12 to 15 dwellings are readily achievable.

LAND USE	AREA (HA)	RATIO (PER HA)
Proposed Open Space	145	(20.33) **PT-9.785**
Total Developable Area	**289 / 3731**	**13 dwellings / ha**
Total Area		



The road network has been designed to provide visual links between the entry boulevard, the various pocket parks, the Town Centre, and the riparian corridors as well as defining the residential precincts.

3.7 SUMMARY

The North Bellbird Investigation Area will be an urban village which is liveable, functional, and with heterogeneous elements to ensure that it is an interesting and enjoyable place to live. The proposed structure plan will ensure that future urban form responds to the natural constraints and opportunities of the site which not only provides a better living environment, but assists in minimising the ecological footprint of the development.

The Structure Plan is at a stage now following environmental investigations to be discussed with the community. From that stage it will be further refined into a more detailed Development Control Plan. The drafting of a site specific Development Control Plan will also become an import planning tool in guiding future development within the investigation area so that sustainable and traditional neighbourhood design principles are achieved.




4.0



4.0 ASSESSMENT OF THE NORTH BELLBIRD STRUCTURE PLAN

During the preparation of the North Bellbird Structure Plan discussed in the previous chapter, a series of workshops were held with the relevant consultants to ensure that the North Bellbird Structure Plan would appropriately respond to the opportunities and constraints identified in the Stage 1 reports. The following chapter discusses how the North Bellbird Structure Plan responds to the opportunities and constraints analysis and the recommendations contained in each specialist report.

4.1 ECOLOGICAL ENVIRONMENT

It is considered that the North Bellbird Structure Plan when considered conjunction with the draft North Bellbird Zoning Plan appropriately addresses the ecological considerations in rezoning the Investigation. This is evident in the fact that 154 hectares of land is to be covered by an 'environmental' zone as contained in the *Standard LEP 2006 Order*.

Specifically the North Bellbird Structure Plan responds to the Flora and Fauna Reports detailed in the Anne Clements and Associates Report (Flora) and the Andrews Neil (with Dr Andrew Smith) (Fauna) Reports as follows: –

- Land in the south west has been retained and will only be subject to limited development. In particular where Singleton Mint Bush Habitat has been identified, land will be zoned to 'E2' – Environmental Conservation which will also be supported by a **vegetation plan of management**.
- Creek corridors and riparian zones **will be retained** allowing for rehabilitation and providing corridors to link retained habitat within the Investigation Area to external habitat areas to the north (Golf course), North West (Vineyards District), and South (upper reaches of Limestone Creek through to remnant vegetation in the Austar Coal Lands).
- The provision of **specific habitat corridors** to ensure the preservation of squirrel glider and babbler communities. These can be seen in **Figure 4.1** and are found in: –
    - Southern Boundary, abutting Tennant Street;
    - Linking Limestone and Bellbird Creek in the North East;
    - Traversing the north western boundary adjoining the Vineyards District;
    - Providing connectivity between the Limestone / Bellbird Creek confluence and the Vineyards District.
- The incorporation of **larger private allotments** on the fringe of environmentally sensitive areas to provide substantial buffer and separation from urban development.
- The creation of a '**Transition Zone**' running across the western third of the Investigation Area which will not only provide visual relief between urban and rural landscapes, but will provide a large percentage of the investigation area which will be covered by zoning with environmental objectives.

The incorporation of these environmental features into the North Bellbird Structure Plan ensures that the recommendations and requirements of the Flora and Fauna Investigations are implemented. This will be supported by the incorporation of appropriate zones 'on top' of the structure plan. The zoning mechanisms will be discussed in Chapter 7 of this submission.

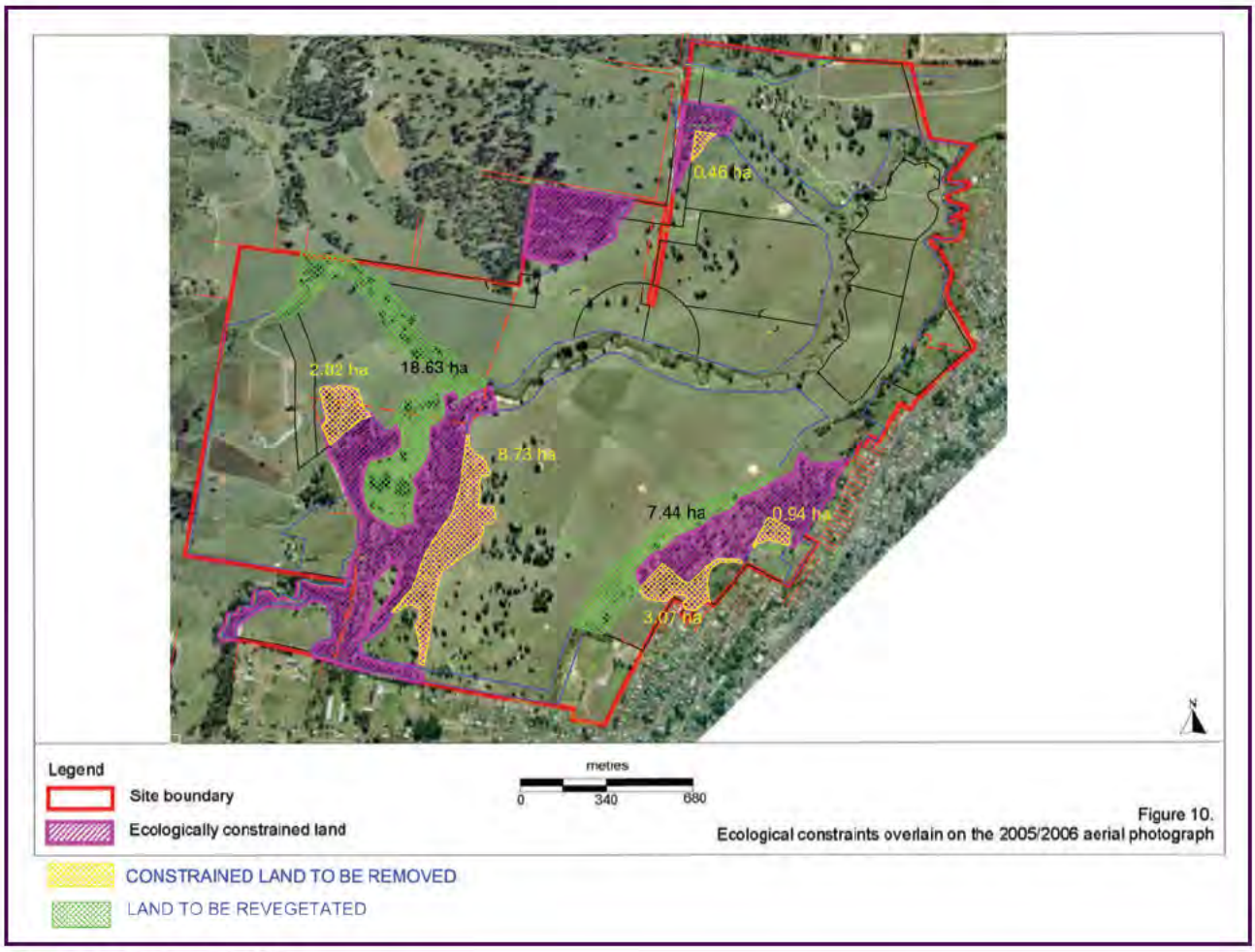


Figure 10.
Ecological constraints overlain on the 2005/2006 aerial photograph

Figure 4.1: *Ecology Offset Plan*

4.2 BUSHFIRE HAZARD

The North Bellbird Structure Plan is clearly capable of addressing the requirements of the *Planning for Bushfire Protection Guidelines*. The North Bellbird Structure Plan will result in the retention and re-establishment of vegetation corridors which are classified as a bushfire hazard under *Planning for Bushfire Protection Guidelines*. This is particularly evident in the south west section of the precinct where it is anticipated that the interconnected canopy will be largely retained and will remain a potential hazard. Pockets of vegetation retained in the west and north west have an element of connectivity with tracts of vegetation external to the site and will also pose a potential risk. Such areas have been appropriately addressed through the provision of larger allotments which will allow for the establishment of appropriate asset protection zones.

The North Bellbird Structure Plan is clearly capable of addressing the requirements of the Planning for Bushfire Protection Guidelines.

Given the scale of the North Bellbird Investigation Area there may still be the requirement for some dwellings to be constructed in accordance with Australian Standard 3959 – Construction in Bushfire Prone Areas, however it is anticipated that the application of this standard will be most appropriately dealt with at the subdivision stage where building envelopes, precise APZ's and Levels of Construction in accordance with *Planning for Bushfire Protection Guidelines* can be most accurately detailed.

The proposed road network is capable of meeting the *Planning for Bushfire Protection Guidelines*. The collector road network ensures that there is always an alternate exit point which will ensure that in the event of a bushfire the affected resident will be capable of evacuation to a safe, hazard free location. It is also anticipated that the road network will be capable of accommodating the needs and requirements of all Rural Fire Service Tankers.

Evidence of this can be seen in the location of 'perimeter' roads on the fringe of retained vegetation. The benefits here are two fold. Firstly the perimeter roads can be utilised as APZ's. Furthermore, the location of the perimeter roads will ensure that the NSW RFS has suitable access to the fringe of remnant vegetation which will improve the ability of the RFS to protect life and prevent damage to assets.

The entire North Bellbird Investigation Area is to be provided with a reticulated water service. This will ensure that water for fire fighting purposes is available.

The incorporation of these environmental features into the North Bellbird Structure Plan ensures that the recommendations and requirements of the Flora and Fauna Investigations are implemented.

4.3 VITICULTURAL ASSESSMENT

The North Bellbird Structure Plan responds appropriately to the Viticultural Soils Assessment which identifies the location of Prime Viticultural Soils on land currently located in the 1(v) – Vineyards Zone. This is clearly evident in the treatment of the western rural / urban 'fringe' within the proposed Structure Plan. **Figure 4.2** extracted from the Allynbrook Viticultural Soils Assessment details the location of *Prime Viticultural Soils* and any land utilised for wine grape production within the North Bellbird Investigation Area.

With the intent of ensuring that the land described in **Figure 4.2** remains capable of being utilised for viticultural purposes, urban development has been restricted from this land and set back a minimum of 150 metres to ensure that conflict between land uses as a result of practices such as spraying is avoided.

In this regard the North Bellbird Structure Plan will not result in the loss of any prime viticultural land or create potential for land use conflict.

The North Bellbird Structure Plan also proposes significant revegetation of the western 'urban edge' within the precinct which will further re-enforce the buffer zone between prime viticultural land and urban development. The benefits here are two fold. Not only does the revegetation further reduce the ability for spray drift to impact on urban areas, but the revegetation will evolve into a substantial visual screen which recognizes the need to retain the current rural amenity to successfully pursue any tourist related development associated with wine grape production in this area.

In this regard the North Bellbird Structure Plan will not result in the loss of any prime viticultural land or create potential for land use conflict.

4.4 ABORIGINAL ARCHAEOLOGY

The North Bellbird Structure Plan is clearly consistent with the recommendations of the AHMS Aboriginal Heritage Assessment. This is evident in the proposed retention of all riparian corridors and creek margins throughout the investigation area which have been found to have the highest potential for aboriginal archaeology deposits. Particular attention has been given to the Limestone Creek confluence area which is identified as a potentially important resource zone and local focus for past Aboriginal use and occupation.

Retention of the Limestone Creek confluence area ensures that all management options remain available, including the conservation of these areas.

While the AHMS report makes reference to the 100 metre zone adjacent to watercourses as being the area likely to have the highest level of archaeological significance, it does not infer that development should not or cannot occur within this area. This setback is more appropriately described as a *management zone* for addressing areas that are more likely to have a higher level of archaeological significance. Section 8.3 of the AHMS report discusses the management of aboriginal heritage within the North Bellbird Investigation Area including the 100 metre 'management zone'. In this regard it is felt that the North Bellbird Structure Plan appropriately addresses the requirements and recommendations of the AHMS report. The need to undertake further investigations within this "management zone" can be reflected in the DCP provisions that will ultimately apply to the investigation area.

4.5 EUROPEAN HERITAGE

As detailed in *Chapter 2* of this report, issues pertaining to European Heritage do not pose a significant constraint to development nor do any items present a high level of significance. The specific recommendations raised in the Stedinger & Associates report have been addressed by the North Bellbird Structure Plan as follows: –

- *Ruins and potential subsurface remains exist at the Slaughter House site shown in* **Figure 4.3** *(Lot 2, DP 597226).*

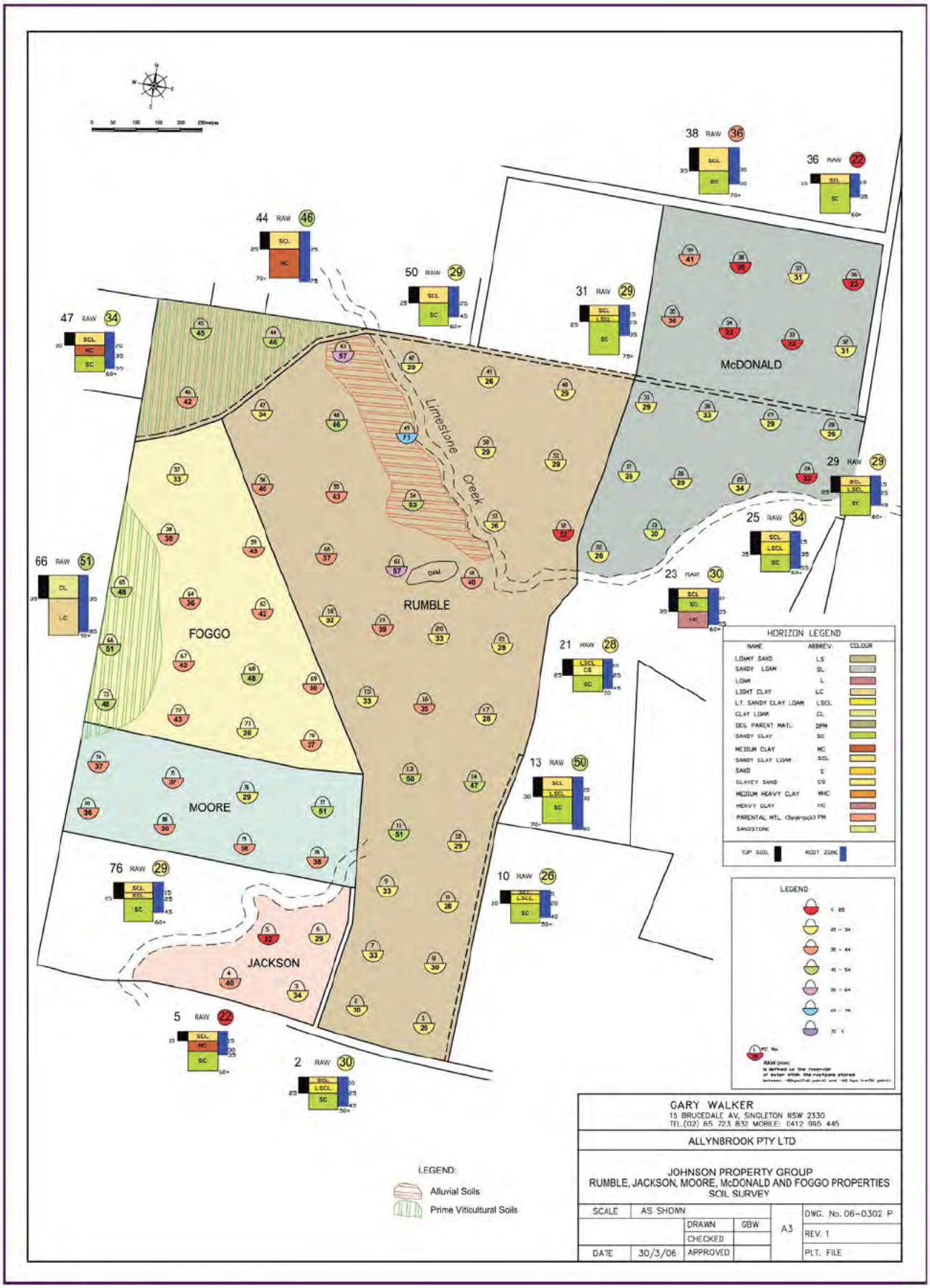


Figure 4.2: *Viticultural Soils Analysis Plan*

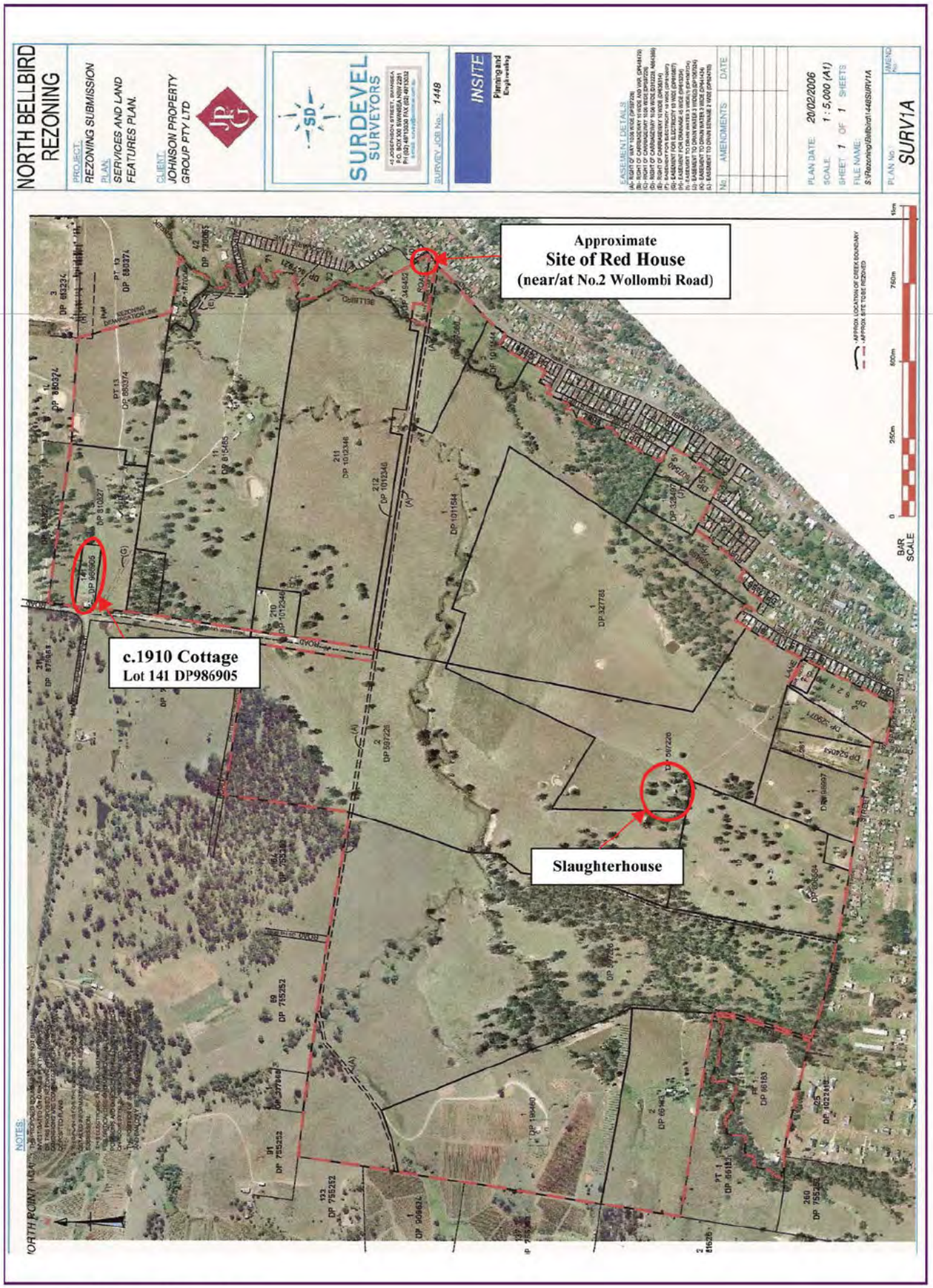


Figure 4.3: European Heritage Plan

Comment: – The North Bellbird Structure Plan identifies the Slaughterhouse and its curtilage as a pocket park. While it is anticipated that some excavation works and potentially the removal of some structures may be required due to an advanced state of dilapidation, it is the intention to make record of the use and publicly identify this (ie notice board). It is anticipated that this will ensure a continued understanding and knowledge of this activity within the future North Bellbird Community. The prominent location (ridgeline) of the Slaughterhouse structures further encourages the use of this location as open space and will assist in the recognition of the previous occupation of the site. This should be reflected in the DCP applying to the investigation area.

- *Remains of the Red House.*

  Comment: – As the location of the *Red House* remains an unknown, it is difficult to address in the structure plan. It is anticipated that identification of any relics during construction activity on site will result in this item being addressed under the provisions of the NSW Heritage Act, 1977.

- *Future development along the north half of Cruikshank Street (Lot 1, DP 1011544), on the east side of Lot 1, DP 349452 and in Carmichael Park.*

  Comment: – As is evident within the North Bellbird Structure Plan the above areas will only be subject to limited development. The Structure Plan shows that the elevated parts of Carmichael Park will be retained for recreational purposes. Land within the vicinity of the northern half of Cruickshank Street is subject to environmental constraints and is unlikely to contain any urban development.

- The cottage on Mt View Road (Lot 141, DP 986905).

  Comment: – The North Bellbird Structure Plan makes provision for the retention of the c. 1910 cottage. The cottage is located in the north western corner of the Precinct. The Structure Plan encourages larger allotments (2000m²) in this locality to allow for a transition zone and a visual buffer between the Vineyards District on the western side of Mount View road and conventional lot housing on the eastern side of the 'buffer' allotments. It is anticipated that a 2000m² allotment will accommodate this dwelling house and curtilage to ensure that its heritage significance is retained. Such detail will be provided at the subdivision and design stage.

4.6 VISUAL IMPACT

The Andrews Neil Visual Impact assessment provides a number of directives / principles aimed at addressing the western urban fringe to ensure that there is an appropriate transition between urban and rural landscapes and to retain the visual and scenic qualities of the Vineyards District to the west. The development principles identified in the Visual Impact Assessment have been incorporated into the North Bellbird Structure Plan as follows: –

- *Identification of a transition zone within which development should increase in density from west to east.*

  Comment: – This transition is clearly evident in the North Bellbird Structure Plan. In describing the Precinct from west to east there is a clear transition from rural (1V) to urban (2c) and an increase in density to match these changes. The lots in the western part of the site will be retained as 'viticultural' holdings which will allow the continuation of wine grape production in this area. The retention of vines and the current rural character will set an attractive 'back drop' to the precinct when viewed from urban areas to the east.

  The transition zone between rural and urban is clearly evident. The transition zone is typified by larger allotments and where possible is defined or bounded by a natural constraint such as a water course or existing remnant vegetation. This will distinguish the rural and urban landscapes without the creation of a 'hard edge' (colourbond fencing backing onto rural paddocks). This transition zone is particularly evident in the north west, where the Precinct is in

The North Bellbird Structure Plan will result in the creation of an urban setting which appropriately responds to its existing environment and addresses the scenic quality and visual significance of the Vineyards District to the west.

The 100 metre zone adjacent to watercourses as being the area likely to have the highest level of archaeological significance, it does not infer that development should not or cannot occur within this area. This setback is more appropriately described as a management zone.

close proximity to Mount View. While there is no environmental constraint that would preclude smaller allotments in this location they have been specifically provided to ensure that a buffer is provided between the urban and viticultural landscapes.

It is anticipated that the larger allotments in the transition zone will result in a reduction in built form and an increase in vegetation in undeveloped parts of these allotments. This will reinforce the creation of a transition zone and buffer in the North Bellbird Investigation Area.

- *Revegetation of riparian zones will also provide visual relief to the urban form and provide connectivity between existing vegetation stands in the south west areas of the site and tracts of vegetation external to North Bellbird.*

  Comment: – As with the creation of transitional allotments within the North Bellbird Precinct the revegetation of riparian zones will assist in creating a buffer between urban and rural areas as well as breaking up the built form of urban areas and creating a soft edge between the existing urban area of West Cessnock and the North Bellbird Investigation Area along the Bellbird creek margins.

- *Consider linking with the existing street network within Bellbird. Connectivity with the surrounding, established residential areas will provide greater integration both physically and visually.*

  Comment: – This recommendation has been adopted in the creation of the North Bellbird Structure Plan. The key entry points from Bellbird (Abbotsford Street) and West Cessnock (Buttaba Avenue) will be seen as extensions of the existing network. It is anticipated that this will allow for a better integration of new urban development within the North Bellbird Investigation Area with the existing housing stock and setting of West Cessnock and Bellbird. Both of these access points run along an east west axis which, when driving into the site, will draw attention to the Brokenback Ranges backdrop.

- *Retain visually prominent stands of vegetation.*

  Comment: – As is the case with riparian corridors, the retention of the existing vegetation stands will assist in breaking up the built form of the urban environment as well as allowing for a transition between rural and urban landscapes. Provides high level of residential amenity

- *Open space areas for passive and active recreation should be located along significant edges to maintain existing open space or to further enhance the transition between the western and eastern portion of the site.*

  Comment – Revegetated riparian zones and remnant vegetation stands of high ecological value will typically be used for passive recreational purposes. The riparian zones extend across the site from the south west to the north east and provide an ideal opportunity for a cycle way / walkway. This not only provides interconnectivity within the North Bellbird Precinct but reinforces the re-establishment of these areas and assists in the transition between rural and urban development.

The North Bellbird Structure Plan will result in the creation of an urban setting which appropriately responds to its existing environment and addresses the scenic quality and visual significance of the Vineyards District to the west. The establishment of the transitional allotments as part of a transition zone throughout the site ensures that the established viticultural landscape is not eroded through a harsh urban edge.

The North Bellbird Structure Plan will result in the creation of an urban setting which appropriately responds to its existing environment and addresses the scenic quality and visual significance of the Vineyards District to the west.

4.7 SERVICING

The North Bellbird Structure Plan is capable of accommodating the servicing requirements of the future community, with upgrading of existing infrastructure undertaken throughout the life of the project.

While no formal staging plan has been prepared at this point in time, it is envisaged that the specific servicing requirements for each provider will be established as part of this ongoing process.

The logical progression of development is likely to enable development to utilise, where possible, existing infrastructure. As development extends throughout the Investigation Area, it is anticipated that any upgrades will be funded through an appropriate developer agreements / contributions with the relevant service provider.

4.8 COMMUNITY INFRASTRUCTURE

The North Bellbird Structure Plan is capable of meeting the likely future social infrastructure needs of the North Bellbird Community. As detailed in the Elton Consulting report, the scale of the North Bellbird Investigation Area is such that a number of social services and facilities will need to be provided within the precinct on top of those already available in the Cessnock LGA.

At this stage it is critical that the Structure Plan responds appropriately to incorporate the likely areas that may be needed to allow for the provision of such facilities. As detailed in *Section 2.8* of this report and in the Elton report, one of the key opportunities in relation to a greenfields rezoning such as North Bellbird is the ability to co-locate facilities.

The Elton Report runs a series of population scenarios which gives an indication of what services will need to be provided within the North Bellbird Precinct. The opportunities and constraints analysis reveals that the North Bellbird Precinct is likely to yield between 3,500 and 5,000 dwellings and on a basis of accommodating 2.6 persons per dwelling the North Bellbird Precinct will house between 9,100 and 13,000 residents. On this basis the North Bellbird Structure Plan is capable of accommodating the following facilities and services: –

LOCAL FACILITIES AND SERVICE			
FACILITY / SERVICE	**TRIGGER**	**AREA REQUIRED**	**PROVIDED IN STRUCTURE PLAN**
Public Primary School	1,500 – 2,000 dwgs	Approx 3ha	Yes – 1
Multi Purpose Centre	1 / 7- 10,000 people	2,500m^2	yes
Child Care Service	60 places / 7 – 10,000 people	2,500m^2	not explicitly but able to be accommodated within the plan at numerous locations
Local Parks			yes
Public domain areas			yes
High school	4,500 – 6,000 dwellings	6 hectares	yes
Upgrade of recreational facilities			yes



While it is marginal as to whether a high school is required, it is evident that the capacity of the existing high schools suggests that it needs to be provided. As detailed in the opportunities and constraints analysis, facilities should be clustered where possible and appropriate. The North Bellbird Structure Plan allocates over **7 hectares**, in a central location, which is capable of being utilised as a combined primary / high school site which can also incorporate child care, community and recreational facilities. The co – location of facilities and services here has the positive attribute of creating a community 'hub', will save on vehicle trips / movements when compared to a more fragmented provision of services, and is close enough to the existing Cessnock urban area for existing residents to benefit from the facilities. In this respect it is felt that the North Bellbird Structure Plan appropriately accommodates the necessary social and community facilities and services to provide for the future population of the Precinct.

The Structure Plan also accommodates a series of four local parks which represent an opportunity for 'micro – communities' to integrate. These are strategically positioned at intersections and present an opportunity to assist in creating community.

It is clear that the North Bellbird Structure Plan addresses the likely needs of the community and will result in the creation of a vibrant and functional urban setting. In this regard it is considered that the Structure Plan will be well received by the community.

4.9 ECONOMIC INFRASTRUCTURE

The North Bellbird Structure Plan appropriately responds to the findings and recommendations of the Castlecrest Economic Impact Statement. It ensures that there are appropriate opportunities for retailing and commercial activities without identifying land superfluous to the needs of the North Bellbird Community, or land that will detract or fragment the commercial and retailing centre of Cessnock.

In considering the likely area that will be required to provide such a centre the Castlecrest report considers the current and future scenarios for the existing commercial and retail centres, in particular Cessnock and Bellbird as well as the likely demand estimates for the North Bellbird Community. On this basis the report is able to allocate the anticipated floor space demand for the North Bellbird Precinct.

This has been provided for in the Structure Plan by providing a town centre which will provide sufficient land area to allow the establishment of a small town centre in line with the recommendations of the Castlecrest report.

4.10 FLOODING AND STORMWATER MANAGEMENT

The North Bellbird Structure Plan addresses the opportunities and constraints presented by Flooding and Stormwater as follows: –

4.10.1 FLOODING

The opportunities and constraints analysis identifies flooding as a significant constraint to urban development within the North Bellbird Investigation Area. This is evident in the Parsons Brinckerhoff report which identifies 77ha of the site as being subject to inundation during the 100 year flood event.





The Structure Plan clearly demonstrates flooding as a constraint to development which can be appropriately addressed and will not preclude urban development within the North Bellbird Investigation Area.

The Structure Planning process addresses this constraint through applying the 100 year flood event as the basis for defining the developable area within the North Bellbird Investigation Area, consistent with flood planning guidelines but also including land which can be developed through consideration of filling and engineered drainage lines where appropriate. The impact of such works on other land within the catchment is considered as part of this process and through the application of a holistic approach ensures that the development yield is optimised with regard to flood affected land.

This is particularly evident in the Bellbird and Lavender Creek Catchments where an engineered drainage line is proposed (see **Figure 4.4**) to accommodate overland flow paths. The confluence area of Limestone Creek and Bellbird Creek presents a substantial area which is inundated by the 100 year flood event by flood 'breakouts' from Limestone Creek. Where appropriate, and supported by further site specific analysis, such areas may be subject to regrading and filling to form a flood free envelope. Other areas in the northern part of this confluence will be utilised for recreational purposes, primarily sports fields associated with the future school / community facilities site. It is anticipated that there will be minimal filling / regrading in the provision of the community facilities thus minimising the impact on flood liable land.

Outside of these areas the water courses will generally accommodate flood waters 'in bank', where flooding is not seen as a major constraint in the 'upper' parts of these catchments. In this regard the structure plan will accommodate urban development within close proximity to the riparian corridors associated with these water courses.

The Structure Plan clearly demonstrates flooding as a constraint to development which can be appropriately addressed and will not preclude urban development within the North Bellbird Investigation Area.

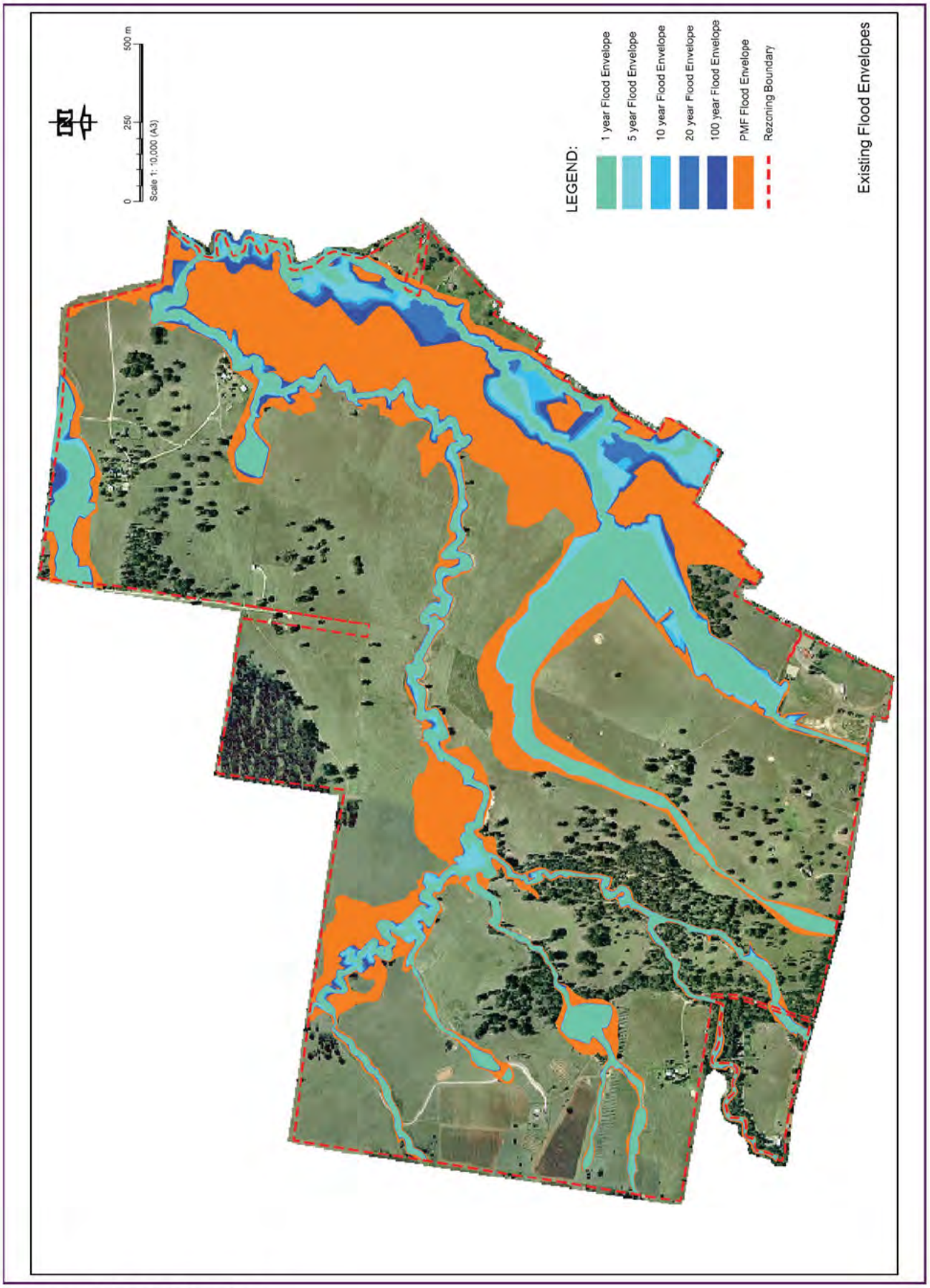


Figure 4.4: *North Bellbird Flood Plan*

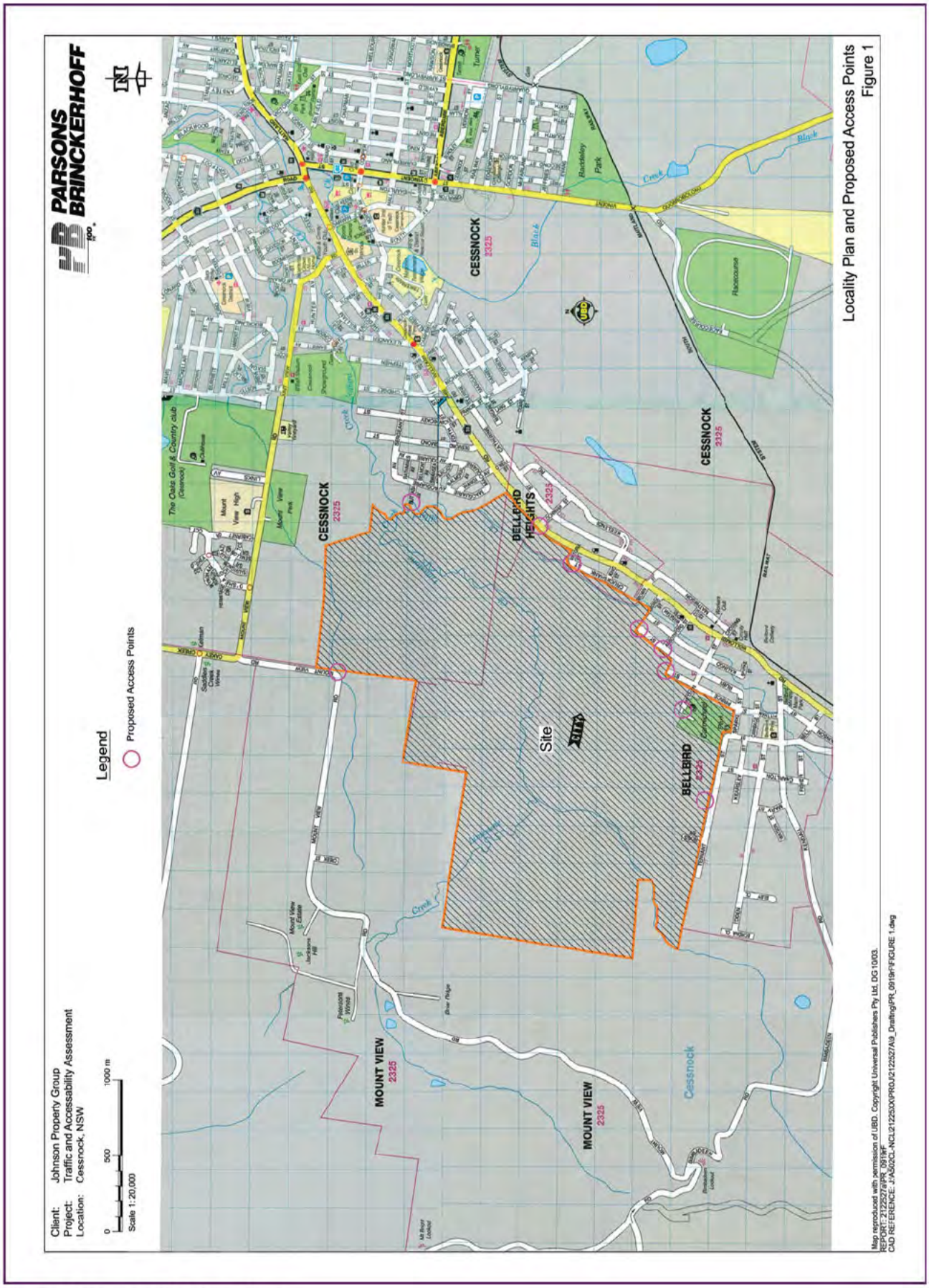


Figure 4.5: *North Bellbird Access Plan*

4.10.2 STORMWATER

The North Bellbird Structure Plan is capable of addressing the requirements of the Parsons Brinckerhoff Stormwater Management Strategy which is based on a Water Sensitive Urban Design Approach, aiming to address water quality and quantity management throughout the North Bellbird Investigation Area.

The North Bellbird Structure Plan is capable of incorporating a suite of stormwater management devices which are the primary method aimed at addressing stormwater constraints relating to the North Bellbird Precinct.

Runoff volumes, flow rates and pollutant loads from the proposed development will be managed through a combination of at – source and end – of – pipe controls in line with the current best practice WSUD principles and includes: –

- Stormwater harvesting for reducing runoff volumes (including BASIX requirements);
- Porous pavements;
- Grassed swales and buffer strips;
- Bio-retention structures;
- Gross pollutant traps;
- Constructed wetlands;
- Detention storage; and
- Water quality control ponds.

While the design and implementation of the majority of the above will occur at the detailed design and subdivision stage, the North Bellbird Structure Plan will allow for suitably located detention basins and water quality control ponds. All basins / ponds, bar one, will be located off line to allow for the most efficient attenuation of stormwater flows. Where possible existing farm dams will be augmented into Water Quality Control Ponds.

On this basis it is established that the North Bellbird Structure Plan is clearly capable of incorporating a number of devices which will ensure the appropriate management of stormwater flows within the North Bellbird Investigation Area.

4.11 ACCESS AND TRAFFIC

The North Bellbird Structure Plan appropriately responds to the opportunities and constraints set down in the Parsons Brinckerhoff Traffic and Accessibility Assessment.

The North Bellbird Structure Plan incorporates major access points as detailed in **Figure 4.5**-

- Abbotsford Street
- Mount View Road;
- Tennant Street (1 major);
- Wollombi Road (T intersection)

The major access points have been selected based on capability to link in with the existing road network, accommodate an internal road hierarchy and take advantage of local scenic qualities to create distinct entry points.

Minor Access points into the Precinct are provided at: –

- Hetton Street;
- Tennant Street (3 minor);
- Buttaba Avenue; and
- Ruby Street.

In this regard the North Bellbird Structure Plan reflects the requirements and recommendations with regard to vehicle accessibility into the site. It is anticipated that the major access points will allow for the optimum integration of the existing Bellbird bus route into the precinct.

4.12 GEOTECHNICAL CONSIDERATIONS

The Geotechnical Opportunities and Constraints analysis shows that the North Bellbird Investigation Area is largely free from constraints and that those examples identified are isolated and do not require extensive remediation. Similarly soil conditions are generally identified as being suitable for urban development.

In this regard the North Bellbird Structure Plan is considered to appropriately respond to the recommendations of the consultant report. While the report does identify isolated examples of constrained land, as detailed in the North Bellbird Opportunities and Constraints Plan, it is envisaged that such land will be remediated at the subdivision and detailed design phase of the project. This will not impose any significant cost to the construction of dwellings within the Investigation Area.

The Network Geotechnical Assessment identifies land having a slope of greater than 12.5% as having some limitations. The Surdevel Slope Analysis suggests that such land is limited within the North Bellbird Investigation Area and is largely limited to creek embankments and riparian zones. As detailed in the Structure Plan, urban development will be limited within these areas to servicing infrastructure only. It is anticipated that such activities will be subject to assessment and conditions of consent to ensure appropriate construction methodologies are adopted in these circumstances.

It is concluded that the geotechnical conditions of the North Bellbird Investigation Area are considered suitable for urban development, and that the North Bellbird Structure Plan appropriately responds to the constraints identified during the Investigations.


5.0



5.0. JUSTIFICATION FOR DEVELOPMENT

This rezoning proposal is made in response to the inclusion of the North Bellbird Investigation Area into the Cessnock City Council Citywide Settlement Strategy and the draft Lower Hunter Regional Strategy. It presents an opportunity to create a masterplanned urban environment which will offer a range of housing choices, a high level of accessibility to employment, resources and infrastructure.

The development of the Hunter Economic Zone (HEZ), the construction of the F3 extension from Seahampton to Branxton, and the revitalisation of the Austar Coal Mine (Pelton) will be major factors that will drive significant economic development through the Lower Hunter, in particular the Cessnock LGA. In this regard the North Bellbird Investigation Area is ideally situated to capitalise on this evolving landscape.

The North Bellbird Structure Plan shows the basis for the creation of a community where residents will have the opportunity to take advantage of high levels of accessibility to employment and resources, ample open space which can be utilised for a range of passive and active pursuits. The scale of the North Bellbird Investigation Area presents an opportunity to preserve and rehabilitate natural habitat while providing a range of housing stock to cater for a full spectrum of the demographic profile while efficiently integrating into the existing Cessnock and Bellbird communities.

This report gives a clear indication that the future urban form of the North Bellbird Investigation Area sits comfortably within the Council's expectations set down in the CWSS, the Department of Planning's objectives on a regional scale contained in the Draft Lower Hunter Regional Strategy. The extentsion of Cessnock and Bellbird into the North Bellbid Investigation are will also provide beneficial social services and infrastructure for the new residents of North Bellbird and the established communities at Cessnock, Bellbird and Mount View.

The Structure Plan demonstrates that while the community will have close ties with the existing communities, the resultant urban form will stand unique to the existing urban setting and respond to the surrounding environmental characteristics of the locality.

The Structure Plan has evolved out of a synthesis of a comprehensive constraints and opportunities analysis which will provide the building blocks for a development control plan. This document will guide the built form within the North Bellbird Investigation Area. It is anticipated that the Structure Plan will evolve into a detailed Masterplan following a community consultation process that will provide a strong level of certainty for both the landowners and the relevant consent authorities as development proceeds.

As detailed elsewhere, North Bellbird is likely to yield between 3,500 and 5,000 dwellings at a ratio of 2.6 residents per dwelling. This suggests the Investigation Area will accommodate between 9,100 and 12,000 residents within a developable footprint of approximately 330 hectares. In this regard it is clear that residential development within the North Bellbird Investigation Area is capable of achieving the Department of Planning's desired densities of between 12 and 15 dwellings per hectare for greenfields release areas (Draft SEPP 66 – Integration of Transport and Landuse).

Chapters 2 to 4 of this report have also shown that the investigation area is relatively constraint free. Consequently the expansion of the existing settlements into this area can occur with minimal impact on the environment. The proposed structure plan should actually achieve a net environmental benefit. In this regard while some vegetation may be lost, it will be more than compensated for through the establishment of corridors linking remaining pockets of remnant vegetation and re-establishing the riparian corridor along Limestone Creek.

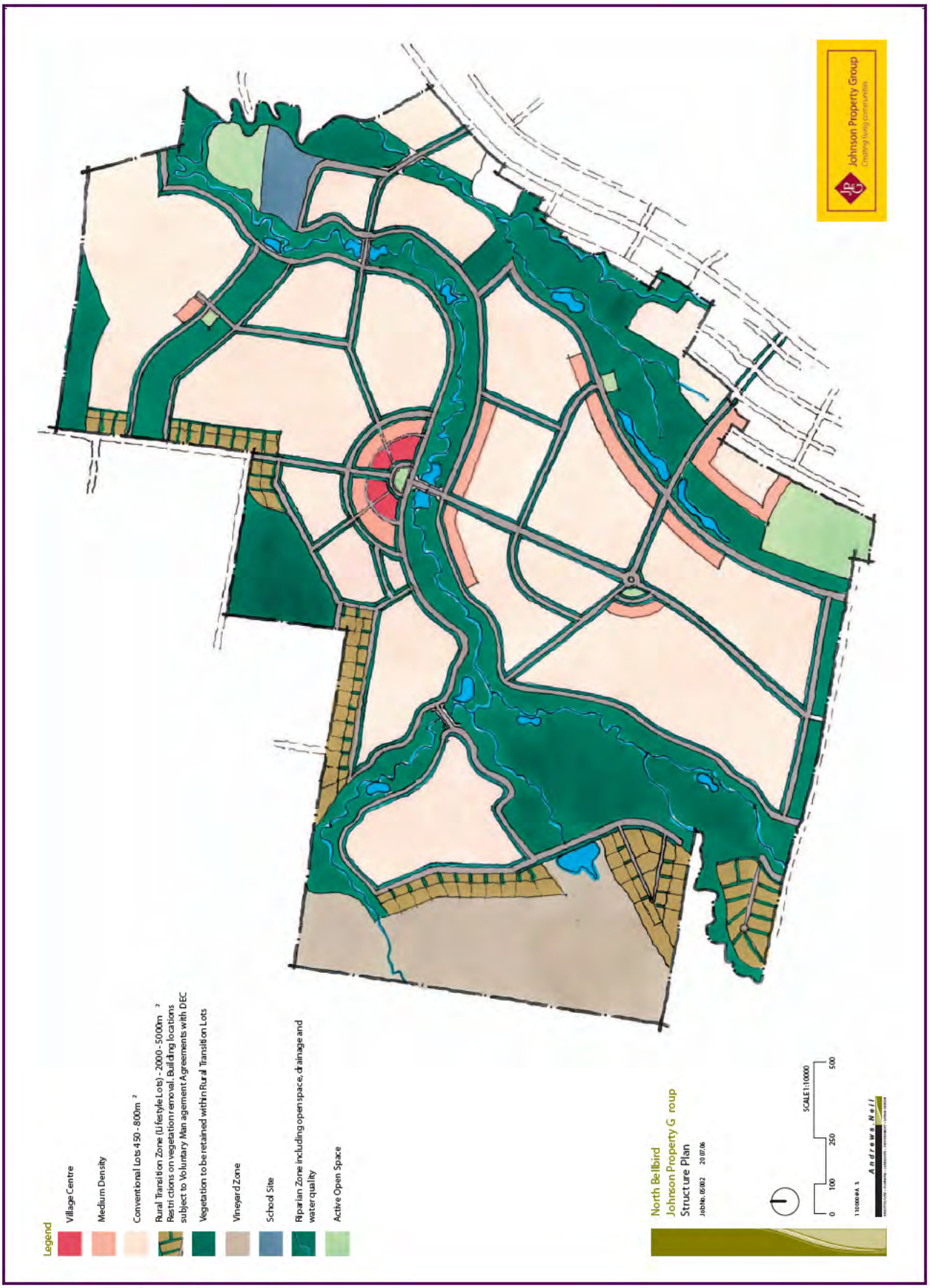
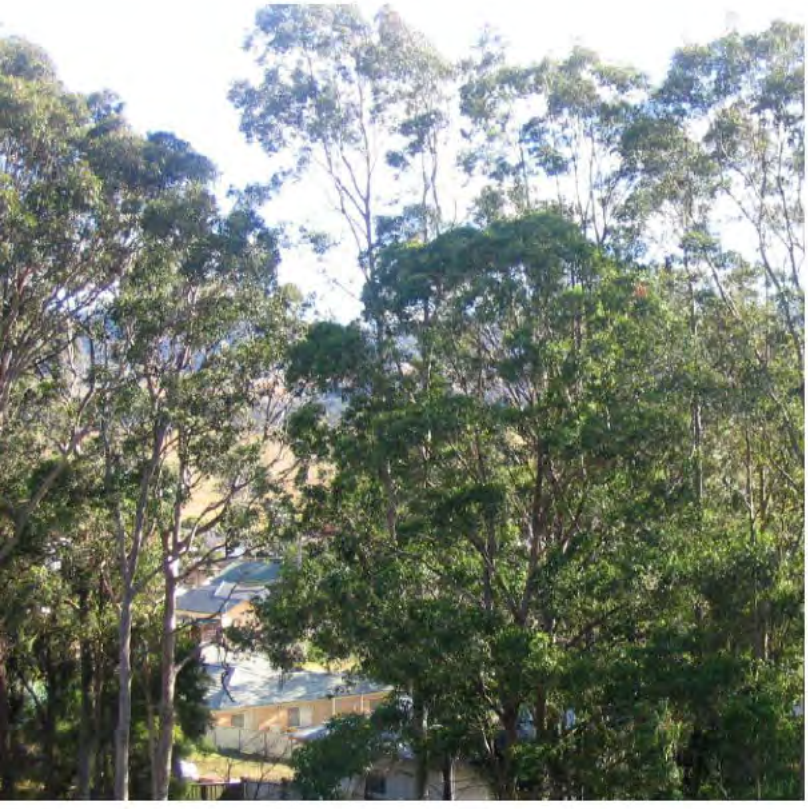


Figure 5.1: *North Bellbird Structure Plan*








6.0



6.0 STRATEGIC AND STATUTORY PLANNING CONTEXT

This section provides an overview of the planning framework relevant to this rezoning submission, including; state and commonwealth legislation and environmental planning instruments. A list of the relevant policies are listed below followed by a brief overview of each statutory requirement and policy and their implications for the proposed rezoning of the site and in particular in terms of subsequent development.

COMMONWEALTH LEGISLATION

- Environmental Protection and Biodiversity Conservation Act 1999

NSW LEGISLATION

- Environmental Planning and Assessment Act 1979
- Rivers and Foreshores Improvement Act 1948
- Water Management Act 2000
- Protection of the Environment Operations Act 1997 (No. 156)
- Roads Act 1993
- Threatened Species Conservation Act 1995
- Rural Fires and Environmental Assessment Legislation Amendment Act 2002
- Native Vegetation Act 2003
- Contaminated Land Management Act 1997

ENVIRONMENTAL PLANNING INSTRUMENTS

- State Environmental Planning Policies
- Hunter Regional Environmental Plan 1989
- Cessnock Local Environmental Plan 1989

DRAFT ENVIRONMENTAL PLANNING INSTRUMENTS

- Draft SEPP 66: Integrating Land Use and Transport

POLICIES

State

- Shaping Our Cities (1998) – The planning strategy for the Greater Metropolitan Region of Sydney, Newcastle, Wollongong and the Central Coast.
- Draft Hunter Regional Strategy (2005)

Local

- Cessnock City Wide Settlement Strategy

6.1 ENVIRONMENTAL PROTECTION & BIODIVERSITY CONSERVATION ACT 1999

The Environmental Protection and Biodiversity Conservation Act 1999 provides a national framework for environment protection. It focus's on matters of national environmental significance which include:

- World heritage properties
- National heritage places (from 1 January 2004)
- Ramsar wetlands of international significance
- Listed threatened species and ecological communities
- Listed migratory species
- Commonwealth marine area
- Nuclear actions (including uranium mining).

Only those listed threatened species, ecological communities and migratory species found on the investigation area are relevant. The Act aims to protect and manage the environment (especially matters of national environmental significance), conserve biodiversity, and promote ecologically sustainable development.

The EPBC Act requires the approval of the Department of Environment and Heritage for any 'action' (defined to include a 'project' or 'development') that would generate significant impact on a matter of national environmental significance (which can be determined by reference to the EPBC Act Administrative Guidelines on Significance, July 2001) referral of the application to the Commonwealth Environment Minister (Department of Heritage) is required.

IMPLICATIONS

- Prior to any development on the land (i.e. an 'action') an assessment should be undertaken by the applicant in accordance with the EPBC Act Administrative Guidelines on Significance to determine whether an action has, will have, or is likely to have a significant impact on a matter of national environmental significance.
- In the preparation of the Structure Plan consideration has been given to matters of national significance and a mock eight part test (based on the Structure Plan) by Dr Anne Clements and Dr Andrew Smith have determined that the development is not likely to have an adverse impact on threatened or endangered species or a significant impact.

It is therefore unlikely that a future development application stage (post the rezoning of the land) will trigger the need for a Species Impact Statement or a referral to the Commonwealth Environment Minister under the EPBC provisions.

6.2 NSW LEGISLATION

6.2.1 ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

Cessnock City Council at its meeting of September 15 2005 resolved to prepare a draft LEP under Section 54 of the EP&A Act. This proposal, including all accompanying documents, supports the Council resolution.

Once the Council has resolved to prepare the LEP will be considered by the newly created LEP Review Panel. This panel has been established by the Department of Planning to review notifications from councils under section 54(4) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The panel may also reconvene at later stages of the LEP preparation process, e.g. to review a draft plan at section 68(4) stage to ensure that it is consistent with any advice previously given at section 54 stage.

In relation to the LEP Review Panel the Department of Planning has released Circular PS 06-005 which states in part:

> *The panel will consider whether section 65 and section 69 functions are to be delegated to councils and what conditions should apply to the exercise of that delegation. Consideration of the delegation of functions will be assessed on a case-by-case basis. Options may include:*
>
> - *no delegation*
> - *delegation subject to conditions, or*
> - *full delegation.*
>
> *After considering all the information presented to it, the council will be provided with writtennotification of the panels' deliberations and whether the proposed LEP can proceed under a 'Written Authorisation to Exercise Delegation' issued by the Director-General (including specification of the conditions on which the delegation can be exercised).*
>
> *The panel will also consider and make recommendations on whether a council should be directed pursuant to section 74(2)(b) of the EP&A Act to prepare and have regard to an environmental study prior to preparing its draft LEP, any specifications under section 57(2) of the Act as to the form, content and preparation of the study and/or any other general issues to be considered when preparing the draft LEP.*

Councils will need to obtain the Department's advice before proceeding with further stages of the LEP-preparation process.

The next stage in the process is the exhibition of the draft LEP. Section 65 of the EP& A Act requires that a certificate be obtained from the Director-General Planning prior to this public exhibition process. The Section 65 Certificate will only be issued once the Director is satisfied that Council has consulted with all relevant government agencies in relation to the proposal and the LEP Review Panel requirements satisfied.

Once the draft LEP or rezoning has been exhibited the process is as follows:

- Council shall consider all public submissions and this may involve the establishment of a 'public hearing' (S.68);
- If the Council resolves to proceed with the making of the draft LEP, it shall then submit the plan to the Director General (S.68);
- The Director General shall then prepare a report to the Minister (S.69);

After considering the Director-General's report made under section 69, the EP&A Act allows the Minister to either:

(a) make a local environmental plan:

(i) in accordance with the draft local environmental plan as submitted by the council, or

(ii) in accordance with that draft plan with such alterations as the Minister thinks fit relating to any matter which in the opinion of the Minister is of significance for State or regional environmental planning,

(b) decide not to proceed with the draft local environmental plan.

It is clear in the above assessment that urban development within the North Bellbird Investigation Area will be consistent with the provisions and application of all relevant State Environmental Planning Policies (SEPP's).

6.2.2 RIVERS AND FORESHORES IMPROVEMENT ACT 1948

The Rivers and Foreshores Improvement Act (RFI Act) applies when obtaining approval for works within the 'protected land' of a waterbody or waterways. The RFI Act is administered by the Department of Natural Resources (DNR). Under Section 22A of the RFI Act 'protected land' refers to land that is the bank, shore or bed of protected waters, or land that is not more than 40 metres from the top of the bank or shore of a river or lake.

This legislation will have implications in respect of development in the vicinity of Bellbird and Limestone Creeks as well as various other watercourses located on the North Bellbird Investigation area.

Under section 23A a Part 3A permit is required if a person proposes to

a) make an excavation on, in or under protected land, or

b) remove material from protected land, or

c) do anything which obstructs, or detrimentally affects, the flow of protected waters or which is likely to do so.

6.2.3 PROTECTION OF THE ENVIRONMENT OPERATIONS ACT 1997

The Protection of the Environment Operations Act (POEO Act) enables the government to set out explicit protection of the environment policies (PEPs) and adopt more innovative approaches to reducing pollution.

The Environmental Protection Authority (EPA), which is part of the Department of Environment and Conservation (DEC) is the statutory authority for issuing licences to carry out scheduled activities specified in Schedule 1 of the POEO Act.

In most cases, local councils are the regulatory authorities for non scheduled activities, except activities undertaken by a public authority, which the EPA will regulate, or where a public authority has been declared the regulatory authority. The Act provides for the issuing of Environment Protection Licenses. These authorise the carrying out of scheduled activities and control the carrying out of non-scheduled activities.

Some of the factors to be considered when deciding if a licence is to be granted include (see section 45 of the POEO Act):

- any PEPs;
- the objectives of the EPA in section 6 of the *Protection of the Environment Administration Act 1991*, including ecologically sustainable development principles which have been redefined;



- the impact on the environment of any pollution likely to be caused by an activity or work;
- any relevant environmental impact statement or other statement of environmental effects received under the *Environmental Planning and Assessment Act 1979*.

There are no Scheduled activities of relevance to the North Bellbird Investigation area.

6.2.4 ROADS ACT 1993

Under Section 138 of the *Roads Act 1993*, any of the following activities are considered to be 'integrated development' and may require the approval of the relevant roads authority (as defined by section 7 Roads Act 1993).

(a) erect a structure or carry out a work in, on or over a public road, or

(b) dig up or disturb the surface of a public road, or

(c) remove or interfere with a structure, work or tree on a public road, or

(d) pump water into a public road from any land adjoining the road, or

(e) connect a road (whether public or private) to a classified road

Development is not integrated development in respect of the consent required under section 138 of the Roads Act 1993 if in order for the development to be carried out it requires the development consent of a council and the approval of the same council.

6.2.5 THREATENED SPECIES CONSERVATION ACT 1995

The Threatened Species Conservation Act (TSC Act) aims to conserve threatened species, populations and ecological communities of fauna and flora. Specific aims of the TSC Act include the conservation of diversity and promotion of ESD and ensuring that impacts on threatened species are properly assessed.

The TSC Act lists those species, populations and ecological communities currently deemed to be threatened within NSW, and sets the framework within which species, populations and ecological communities can be eligible for listing. Where significant impacts on threatened species, populations and ecological communities, or their habitat, may occur as a result of a development proposal, the Act identifies the need for a Species Impact Statement to be prepared.

The TSC Act amends Section 5A ('seven part test') of the EP&A Act. This Section aims to improve the standards of consideration and protection afforded to threatened species, populations and communities and their habitats in the planning process. A Species Impact Assessment would identify the impact of a proposed development and test for the significance of any effects identified. The consent authority will consider these impacts under Section 79C of the EP&A Act when assessing future development applications for the site.

The potential adverse impact on a species of state significance is determined by the preparation of a new seven part test based on the details or a particular Development Application.

As this submission does not seek consent for clearing of native vegetation, the requirements of the NV Act will be addressed as part of future development applications.

This submission is for a rezoning not development however an seven part test has been prepared in order to test if likely future development applications would result in an adverse impact. The seven part tests by Dr Anne Clements and by Dr Andrew Smith have determined that the development is not likely to have a significant impact on threatened or endangered species and therefore a Species Impact Statement should not be required for future development applications.

6.2.6 RURAL FIRES AND ENVIRONMENTAL ASSESSMENT LEGISLATION AMENDMENT ACT 2002

The *Rural Fires and Environmental Assessment Legislation Amendment Act 2002* took effect on 1 August 2002. It amends the EP&A Act to provide a system for planning for bushfire protection.

Cessnock City Council is required to designate bushfire prone land and indicate such areas on bushfire prone land maps. The site is identified on Council's map as bushfire prone land (refer to HWR Bushfire report). Section 79BA of the EP & A Act requires development on bushfire prone land to comply with the requirements of *Planning for Bushfire Protection 2001*, which is described later in this report. Council may consult the NSW Rural Fire Service in assessing applications for development within bushfire prone areas.

Certain types of proposals are considered 'integrated development' under Section 91 of the EP&A Act, including:

- subdivision of bushfire prone land that could be lawfully used for residential or rural residential purposes; and,
- development of bushfire prone land for a special fire protection purpose, as identified under the Rural Fires Act.

Land at North Bellbird is mapped as bushfire prone land by Cessnock City Council. Future development applications must be assessed as to whether it complies with the requirements of *Planning for Bushfire Protection 2001*.

6.2.7 NATIVE VEGETATION ACT 2003

The Native Vegetation Act (NV Act) aims to promote the management of native vegetation, protect native vegetation of high conservation value, and prevent broad scale clearing unless it improves or maintains environmental outcomes. Under Section 6 of the NV Act, 'native vegetation' includes trees, understorey plants, groundcover and plants occurring in a wetland if they comprise species of vegetation that existed in the State before European settlement.

Under Section 12 of the NV Act native vegetation must not be cleared except in accordance with:

a) *a development consent granted in accordance with this Act, or*

b) *a property vegetation plan.*

The Minister is the consent authority, in accordance with the EP&A Act, for any clearing of native vegetation that requires development consent under the NV Act.

The NV Act does not apply to certain types of development that are authorised under a number of Acts, such as the *Plantations and Reafforestation Act 1999* and the *Water Management Act 2000*.

As this submission does not seek consent for clearing of native vegetation, the requirements of the NV Act will be addressed as part of future development applications.

Much of the vegetation at North Bellbird is native. However any clearing of this vegetation will be done under a development application for subdivision activities.

6.2.8 CONTAMINATED LAND MANAGEMENT ACT 1997

The Contaminated Land Management Act (CLM Act) regulates contaminated sites that pose a 'significant risk' of harm to human health or the environment. The Network Geotechnics report has not identified any potentially contaminated sites at North Bellbird.

6.3 ENVIRONMENTAL PLANNING INSTRUMENTS

6.3.1 APPLICABLE STATE ENVIRONMENTAL PLANNING POLICIES

The State Environmental Planning Policies applicable to the rezoning of the North Bellbird Investigation Area are as follows:

SEPP / DRAFT SEPP	APPLICATION TO REZONING OF NORTH BELLBIRD INVESTIGATION AREA
SEPP 4 Exempt and Complying	This SEPP may apply, or be utilised in relation to minor works during the development stage.
SEPP Senior's Living	Seniors Living Developments will be permitted in land zoned for urban purposes subject to Council's development consent and full compliance with the provisions of the SEPP.
SEPP 6 – No. of Storeys in a Building	The provisions of this SEPP will be considered in the preparation of any DCP governing residential development affecting the Investigation Area.
SEPP 9 – Group Homes	As expressed in Clause 5 of SEPP 9 Group Homes will be permitted with Councils Development Consent in the North Bellbird Investigation Area.
SEPP 11 – Traffic Generating Dev.	It is anticipated that the subdivision of the North Bellbird Investigation Area will trigger SEPP 11. It is anticipated that the proposed upgrades to the local road network will be consistent with the requirements of SEPP 11
SEPP 44 – Koala Habitat	The site has been considered under the provisions of SEPP 44 by Clements and Associates Ecology who conclude in advising that the site does not constitute 'Potential Koala Habitat' as defined in SEPP 44. No Koalas were observed during any stage of field work. The development of the North Bellbird Investigation Area will pose no threat to Koala Habitat and is thus consistent with the intent of the instrument.
SEPP 55 – Remediation of Land	During the subdivision, development and construction stages, contaminated lands will be remediated in accordance with SEPP 55. Preliminary Investigations undertaken by Network Geotechnics have been undertaken and described in this report. These investigations will provide the basis for more specific detailed studies which will make specific recommendations for the remediation of land
SEPP 60 – Exempt and Complying	This SEPP may apply, or be utilised in relation to minor works during the development stage.
SEPP 65 – Design Quality of Residential Flat Buildings	The proposed DCP should permit buildings up to 9 metres, which indicates that three storey residential flat buildings are a possibility during the construction phase of the North Bellbird Investigation Area. It is anticipated that any future DCP will contain provision to advise prospective developers of this trigger
Draft SEPP 66 – Integration of Transport & Landuse	In the preparation of the North Bellbird Structure Plan consideration has been given to the aims, strategy and guiding provisions of Draft SEPP 66, in particular Clause 8(e) which requires the inclusion of provisions for an urban form and structure that encourages walking, cycling and public transport; and minimum densities that will achieve viable public transport services. Draft SEPP 66 also refers to the need to achieve a minimum density of 15 dwellings per hectare. As demonstrated in this submission, the North Bellbird Structure Plan is capable of achieving this ratio. Clause 12 of the Draft SEPP requires consideration of the transport implications of the development. Such consideration is given with appropriate recommendations in the Parsons Brinckerhoff traffic assessment.

It is clear in the above assessment that urban development within the North Bellbird Investigation Area will be consistent with the provisions and application of all relevant State Environmental Planning Policies (SEPP's). It should, however, be acknowledged that some of these SEPP's will be revisited to ensure consistency and compliance at the detailed design, construction and subdivision stages.

6.3.2 HUNTER REGIONAL ENVIRONMENTAL PLAN 1989

A number of issues relating to the rezoning and development of land are driven by State and Regional imperatives for the Hunter Region. These imperatives are presently drawn from the **Hunter Regional Environmental Plan, 1989 (HREP)**. Those that relate specifically to the issues raised in this planning submission are provided below in support of the proposal.

The general aims of this plan include:

(a) to promote the balanced development of the region, the improvement of its urban and rural environments and the orderly and economic development and optimum use of its land and other resources, consistent with conservation of natural and man made features and so as to meet the needs and aspirations of the community,

(b) to co-ordinate activities related to development in the region so there is optimum social and economic benefit to the community, and

Comment: – The proposed rezoning and subsequent development of the North Bellbird Precinct is considered to be consistent with the general aims of the Hunter REP, 1989. This can be seen through the consideration of the structure plan in the context of the relevant provisions of the Hunter REP as follows: –

Part 2 – Social Development – Division 1 – Housing

The Hunter REP, 1989 requires that a draft local environmental plan which provides land for residential developments should only be prepared when the appropriate government authorities are satisfied that adequate and affordable health and other community facilities and services can be provided. Where necessary, a draft plan should make provision for the establishment of those facilities to meet the needs of the residents.

Comment: – The supply of community facilities needs to be monitored and suitable timing and sequential roll out considered.

This has seen the dedication of appropriate land within the North Bellbird Precinct and the nomination of services likely to be required.

Population growth can be accommodated to a threshold where the supply of these services becomes viable. The likely community services and facilities required to service the North Bellbird Precinct have been identified in the Elton Community Impact Assessment. This report identifies needs based on the current and anticipated requirements of the existing community and factors in the requirements generated out of the additional population contained within the North Bellbird Precinct.

This has seen the dedication of appropriate land within the North Bellbird Precinct and the nomination of services likely to be required. Where services are available, the unused capacity will be utilised to reduce any waste of limited public resources while new facilities are being planned.

PART 4 – LAND USE AND SETTLEMENT

Rural Land

The HREP requires that the prime agricultural rural land be retained, changing agricultural practices be provided for and rural small holdings be allowed on land that is suitable.

Comment: – An agricultural assessment in the form the Allynbrook Viticultural Assessment has been undertaken over the North Bellbird Precinct. This report details the specific location of the prime agricultural / viticultural land within the North Bellbird Precinct.

The Master Planning exercise to date has integrated the retention of the identified prime viticultural land with the objectives of the HREP taken into consideration. This can be seen in the North Bellbird Structure Plan which retains **all of the prime viticultural soils** as well as allowing for the establishment of larger allotments on the fringe of the prime viticultural land to minimise conflict between land uses. In this regard it is seen that rezoning of the North Bellbird Precinct appropriately considers the directions issued in the Hunter REP, 1989.

The Master Planning exercise to date has integrated the retention of the identified prime viticultural land.

Urban Land

The objective of the HREP with regard to urban land is to provide for sufficient urban land to meet anticipated growth in an orderly and efficient manner.

> **Comment**: – The North Bellbird Precinct seeks to provide up to 5,000 residential dwellings ranging from medium density/ integrated housing and mixed use housing through to conventional residential lots and larger lifestyle opportunities (2,000m²). It is anticipated that this will be achieved at a density between 12 and 15 dwellings per hectare which the Department of Planning considers to be an efficient use of urban land and will limit underutilised land and 'sprawl'.

It is anticipated that this will be achieved at a density between 12 and 15 dwellings per hectare which the Department of Planning considers to be an efficient use of urban land and will limit underutilised land and 'sprawl'.

It is anticipated that the staging of the North Bellbird Precinct will somewhat be determined by demand on a regional scale and that the sequential staging of residential land will ensure serviceability and prevent unnecessary delays in releasing land. In this regard it is considered that the North Bellbird Investigation Area will play a significant role at a regional level in accommodating the housing needs of the Lower Hunter and in this regard is considered to be consistent with the aims of the Hunter Regional Environmental Plan.

6.4 DRAFT ENVIRONMENTAL PLANNING INSTRUMENTS

6.4.1 DRAFT STATE ENVIRONMENTAL PLANNING POLICY NO. 66: INTEGRATING LAND USE AND TRANSPORT (SEPP 66)

This draft SEPP aims to better integrate land use and transport planning at the local level, by putting in place provisions to guide:

- the preparation of draft local environmental plans
- the adoption of development control plans and master plans
- the consideration of development applications.

In relation to new residential development, the draft SEPP 66 states:

1) *In preparing an environmental planning instrument that will allow residential development on land that is not being used for residential purposes, and before approving a development control plan, master plan or precinct plan relating to such a plan, the person who prepares or approves the instrument or plan should include provisions that:*

   (a) *ensure an average gross residential density of development within the neighbourhood of at least 15 dwellings per hectare, and support the achievement of viable public transport thresholds, and*

   (b) *that development of the land will result in building forms and subdivision designs and layouts that encourage and are supportive of walking, cycling and the use of public transport.*

2) *Despite subclause (1), the Minister may make a local environmental plan, with provisions that will allow an average gross residential density of development, within the neighbourhood of less than 15 dwellings per hectare, if the council for the area concerned can justify a lower density by reasons that specifically address any departure from the planning objectives of this Policy.*

It is desirable that any proposed residential development adhere to the state government's target minimum density of 15 dwellings per hectare for new residential release areas.

This submission is accompanied by a traffic and transport report which assesses the impact of the proposed uses on the surrounding street network and includes recommendations for new roads and new public transport routes.

To encourage use of alternative modes of transport to the car, building forms and subdivision designs and layouts must encourage walking, cycling and the use of public transport, and bus services must be introduced early in the development process. The Structure Plan is conductive to these objectives. There will be consultation with transport operators (ie. Rover Motors Bus Company) as a precursor to future development applications for subdivision.

6.5 SECTION 117 DIRECTIONS

The following table comprises a list of the revised Section 117 Directions which came into force on 30 September 2005. The table outlines the Directions relevant to the rezoning proposal and how the proposed amendment adheres to the Minister's Direction:

GENERAL DIRECTIONS	APPLICABLE	COMMENTS
D No. 1:	Yes	The Network Geotechnics Assessment does not identify any ASS or PASS within the Investigation Area. The likelihood of finding such soils at during the design and construction phase is low. The Network Geotechnics report has considered the relevant Acid Sulphate Soils Risk Map.
D No. 2	Yes	The draft LEP instrument does not contain provisions requiring concurrence, consultation or referral of a Minister or public authority as described in section 4 of the EP & A Act.
D No. 3	No	There are no business zones proposed in the North Bellbird Investigation Area.
D No. 4	No	
D No. 5	Yes	It is anticipated that this rezoning will be referred to the DPI for consideration, however the subject Area does not contain any regionally significant reserves of coal and / or other minerals. On this basis the mining and / or winning of mineral resources will be prohibited within land zoned for urban purposes.
D No. 6	No	
D No. 7	No	
D No 8	Yes	Ensure that planning controls do not prevent community use of schools. Educational establishments will not be prohibited by the LEP amendment. Educational establishments will be located within the Investigation Area as identified in the North Bellbird Structure Plan.
D No. 9	Yes	Conservation and Management of Environmental and Indigenous Heritage. Items of heritage significance including those protected under the National Parks and Wildlife Act will be subject to appropriate identification and management in accordance with the findings and recommendations of the Stedinger European Heritage Assessment and the AHMS Aboriginal Archaeological Assessment.
D No.10-12	No	
D No.13 – 14	No	
D No.15 Flood Liable Land	Yes	Flood Prone Land: – Full consideration has been given to the level of flood affectation. It is demonstrated in the Parsons Brinckerhoff Flooding and Stormwater Assessment that the application of the North Bellbird Structure Plan will ensure that development is not undertaken in floodway areas, flood liable land will not impact on downstream catchments (pending appropriate engineering solutions), will not result in significant increase in flood impacts upon other land, nor permit development to be carried out without development consent, except as specified in the direction.
D No. 16	No	
D No.17 Integrating Land use Transport	Yes	The master planning process has captured these matters for consideration and these are reflected in the North Bellbird Structure Plan. The Investigation Area will be capable of successful integration with employment and services through the provision of cycle ways, walkways and a road network which is capable of accommodating a bus service and thus reducing levels of car dependency. Furthermore the co-location of community facilities within the Investigation Area and the proximity of such facilities to retail / commercial land (the village area) will reduce vehicle movements.
D No.18 Manufactured Home Estates and Caravan Parks	Yes	The possibility of a caravan park or manufactured home estate has been considered and opportunities will be identified if appropriate and will not be prohibited in the urban areas.
D No.19 Planning for Bushfire Protection	Yes	A Bushfire Threat Assessment has been prepared and accompanies the rezoning report and identifies the requirements of this legislation for the development of this Precinct
D No.20 Recreational Vehicle areas	Yes	Recreational vehicles will be prohibited from the environmentally sensitive areas retained within this precinct
D No.21 Residential Zones	Yes	The matters raised in this Direction are captured in the planning report and proposed rezoning for the land. The site can be serviced and represents a logical extension to the existing Cessnock Urban area.
D22 Rural zones	Yes	Productive agricultural land has been retained in a rural zone (1(v) with appropriate buffers to minimise landuse conflict.
D23 – 24	No	
D No.25: Site Specific rezoning	Yes	The application of the 2(c) Zone over identified urban areas within North Bellbird will ensure flexibility relating to the range of uses permissible. It can be said the 2(c) Zone is ideal for achieving the requirements of this direction.
D26 Special Area zones and recreation zones	Yes	Zones for specific community purposes and recreation will be determined at the end of the DA process.

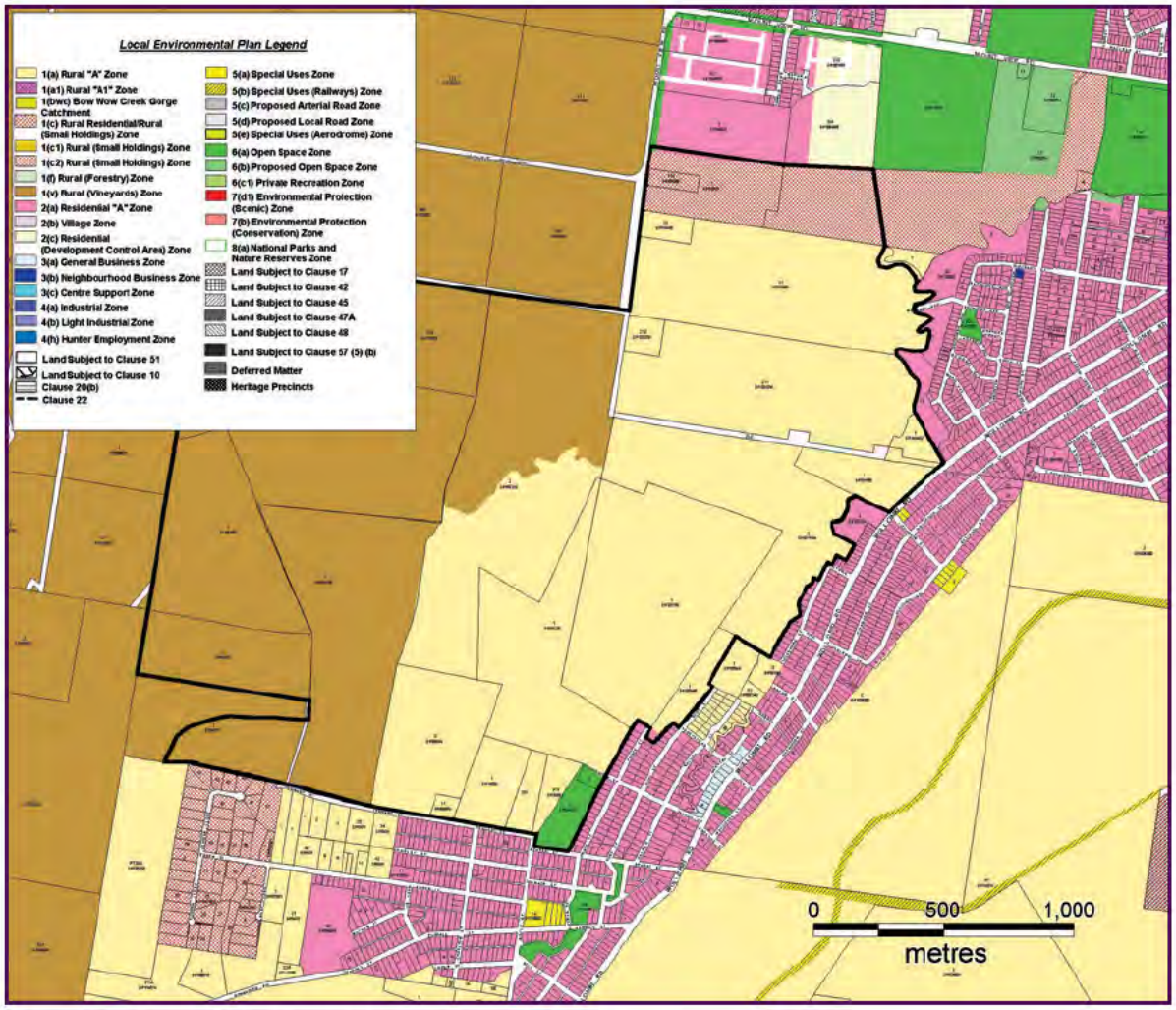


Figure 6.1: *Current Zoning Composition*

6.6 CESSNOCK LEP, 1989

The Cessnock Local Environmental Plan, 1989 details the land use zoning provisions, including general restrictions on development and special provisions for development in the Cessnock LGA. The Cessnock LEP 1989 was gazetted on November 3, 1989.

The zoning composition of the North Bellbird Investigation Area, under the Cessnock LEP, 1989 is as follows:

- Zone No. 1(a) – Rural "A" Zone
- Zone No. 1(v) – Rural (Vineyards) Zone

Figure 6.1 details the current zoning composition of the Investigation Area. Under both of the current zones applying to the land, urban development, such as that detailed in the Structure Plan, is prohibited. Consequently any proposal for urban development will require the Cessnock LEP to be amended to permit such uses.

6.7 STRATEGIC PLANS AND POLICIES

6.7.1 "SHAPING OUR CITIES"

Shaping Our Cities is a planning strategy for the Greater Metropolitan Region of Sydney, Newcastle, Wollongong and the Central Coast. The strategy sets out a direction for future growth in NSW, and promotes ecologically sustainable development. It sets out ways to enhance air quality, waterways, biodiversity etc.. It also lists a number of urban design principles that development in urban areas are required to adhere to.

Government will give priority to initiatives that result in open space enhancement, especially in areas with recreation or conservation needs, and initiatives that result in the regeneration and maintenance of existing urban bushland areas especially to protect or establish threatened species and habitats.

The Structure Plan adheres to the general principles set out in this planning strategy, in particular the urban design principles.

6.7.2 DRAFT LOWER HUNTER REGIONAL STRATEGY

The draft Lower Hunter Regional Strategy identifies the North Bellbird area as a new release area with over 2,000 dwellings. North Bellbird is considered the priority location for the investigation of a major urban development in the Cessnock LGA. The north Bellbird site is one of seven such sites identified in the lower Hunter. Although primary land use is for residential development, the site will also contain a mix of local open space, employment opportunities and community facilities.

As is evident in the following table, urban development within the Investigation Area will be on the whole consistent with the sustainability criteria contained in the draft Lower Hunter Regional Strategy. It is imperative that this quality be recognised in considering the proposed rezoning in the context of this Strategy.

6.7.3 CESSNOCK CITY WIDE SETTLEMENT STRATEGY

The Cessnock Citywide Settlement Strategy, which has been endorsed by the Department of Planning, was adopted by Cessnock City Council on December 10, 2003. This strategy document seeks to identify sufficient land to meet demand for closer settlement growth over the next 10 years. While not included in the Draft Citywide Settlement Strategy, the North Bellbird Precinct was included in the final document following the realisation by Council that initial growth projections were low and hence proposed land supply was unlikely to meet future demand.

The final recommendation for the North Bellbird Precinct as specified in the Citywide Settlement Strategy is as follows:

> *"Prepare Draft LEP to consider rezoning to mixed residential densities, rationalisation of open space and environmental features. Extensive LES, specialist studies and master planning will be required to justify rezoning. Prepare concurrent Draft DCP and Draft s94 Contributions Plan to accompany Draft LEP."*

The rezoning process is consistent with the Citywide Settlement Strategy recommendation. In consultation with Cessnock City Council and the Department of Planning it was initially established that an "Extensive LES" would not be required. However, the department has since revised its position on this matter and it is understood that they will now require the rezoning application to go through an LES process. In this regard the Department and Council have agreed that the environmental studies being undertaken as part of this rezoning application can be used in the LES documentation provided they are reviewed by Council and adopted by them.

The CWSS Stage stands as the primary mechanism to allow for the consideration of the North Bellbird Precinct for urban development. The objectives and recommendations of the CWSS Stage 1 are aimed at addressing projected dwelling demand for a 10 – 15 year period.

A structure planning exercise has formed part of the process which has culminated in the preparation of a functional and responsive plan. This will need to be developed into a Masterplan following a community consultation process. A Development Control Plan and Design Guidelines will also need to be prepared as well as a developer contribution plan or Developer Agreement.

The process undertaken to date, which is described in the body of this report, demonstrates that the development and planning for the North Bellbird Investigation Area is consistent with the intent of the Cessnock Citywide Settlement Strategy. This can be further quantified in considering the area in the context of the *Growth Management Principles (GMP)* contained within the Strategy. The GMP are defined and adopted in the Strategy as 'benchmark' or 'best practice' objectives for strategic planning at a local government level:



THRESHOLD SUSTAINABILITY CRITERIA	MEASURABLE EXPLANATION OF CRITERIA	NORTH BELLBIRD PRECINCT
1. Infrastructure Provision Mechanisms in place to ensure utilities, transport, open space and communication are provided in a timely and efficient way	• Development is consistent with any regional strategy, subregional strategy, and State Infrastructure Strategy. • The provision of infrastructure (utilities, transport, open space, and communications) is costed and economically feasible based on Government methodology for determining infrastructure development contributions. • Preparedness to enter into development agreement.	• The North Bellbird Precinct is identified as the only new release area with over 2,000 dwellings in Cessnock Council area; The CWSS also identifies the Precinct for investigation for future urban development. • On this basis the North Bellbird Investigation Area should be considered in the preparation of any future regional infrastructure strategies. • This precinct forms a natural extension to the urban areas of Cessnock with services located to the edge of the Investigation Area. The development is capable of meeting the cost of connection to infrastructure and augmentation throughout as stages are developed. • Infrastructure provision has been costed and is economically viable to service the land.

2. Access
Accessible transport options for efficient and sustainable travel between homes, jobs, services and recreation to be existing or provided
	• Accessibility of the area by public transport and/or appropriate road access in terms of:
	  • Location/Land Use – to existing networks and related activity centres.
	  • Network – the area's potential to be serviced by economically efficient transport services.
	  • Catchment – the area's ability to contain, or form part of the larger urban area which contains adequate transport services. Capacity for land use/transport patterns to make a positive contribution to achievement of travel and vehicle use goals.
	• No net negative impact on performance of existing subregional road, bus, rail, ferry and freight network.
		• Public transport is available across the Cessnock LGA with limited transport between Cessnock and Maitland, Newcastle, Singleton.
		• The location and the ability to provide public transport to the future residents of North Bellbird ensures consistency with the provisions of Draft SEPP 66.
		• Job opportunities close by include HEZ, mines, which initially will be accessed by private transport, however continued employment generating development within HEZ coupled with residential development within North Bellbird is likely to result in the establishment of a bus route between the two.
		• In this regard Additional population could support improved transport service for this area.
		• Satisfactory public transport has not been established in this area. Private buses and community transport attempt to fill this void. This development will provide no net impact on existing regional roads as these have to be used to access a full range of services and facilities. The additional population within North Bellbird will undoubtedly result in an increase in service provision to existing areas of Cessnock, Bellbird and Bellbird Heights, which will benefit these established communities.

3. Housing Diversity Provide a range of housing choices to ensure a broad population can be housed	• Contributes to the geographic market spread of housing supply, including any government targets established for aged, disabled or affordable housing.	• The Bellbird Investigation Area will provide housing diversity that will add to the variety of housing stock to cater more appropriately for various life stages and family sizes in the Cessnock area. This precinct will provide the opportunity to develop new housing stock in the area that is not currently provided. • The Structure Plan incorporates medium density and mixed use precincts which will result in diversity in housing choice. • Similarly the rezoning of the land will create an opportunity for the development of Seniors Living housing / accommodation within North Bellbird.
4. Employment Lands Provide regional/local employment opportunities to support the Lower Hunter's expanding role in the wider regional and NSW economies	• Maintain or improve the existing level of subregional employment • selfcontainment. • Meets subregional employment projections. • Employmentrelated land is provided in appropriately zoned areas.	• The size of the proposed development provides the opportunity to include some commercial development within the precinct to cater for the needs of the expanding community. This will provide some employment for existing residents. Employment lands have been identified at HEZ and additional employment lands are proposed around Cessnock. Cessnock Council has prepared an Industrial Strategy for Cessnock that identifies employment areas.

5. Avoidance of Risk
Land use conflicts, and risk to human health and life, avoided
	• No residential development within 1:100 floodplain.
	• Avoidance of physically constrained land, e.g.
	  • high slope
	  • highly erodible.
	• Avoidance of land use conflicts with adjacent existing or future land use as planned under relevant subregional or regional strategy.
	• Where relevant available safe evacuation route (flood and bushfire).
		• The site has minimal environmental constraints.
		• Flood affected land will generally not be subject to urban development, however where opportunities arise to develop marginally flood affected land where proven appropriate through detailed, site specific site analysis which demonstrates the suitability of this land.
		• The land is generally flat rising slightly at the edges to form the foothills of the Brokenback Ranges. Development will not be undertaken upon protected lands or land affected by highly erodable soils. The Network Geotechnics assessment suggests that such conditions are only experienced within riparian corridors and will generally not be subject to urban development.
		• The precinct development is designed to blend into the surrounding area and the sloping edges of the precinct will be utilised for vineyard planting. The potential for conflict with the adjoining Vineyards have been considered and designed into the Structure Plan as is evident through the incorporation of the transition zone.
		• Bushfire threat is low and access from the site is well formed and water is available on site. This risk is mitigated through the incorporation of fire trails and appropriate APZ's into the North Bellbird Structure Plan.

THRESHOLD SUSTAINABILITY CRITERIA	MEASURABLE EXPLANATION OF CRITERIA	NORTH BELLBIRD PRECINCT

6. Natural Resources
Natural resource limits are not exceeded/ environmental footprint minimised
	• Demand for water within infrastructure capacity to supply water and does not place unacceptable pressure on environmental flows.
	• Demonstrates most efficient/ suitable use of land
	  • Avoids identified significant agricultural land.
	  • Avoids productive resource lands – extractive industries, coal, gas and other mining, and quarrying.
	• Demand for energy does not place unacceptable pressure on infrastructure capacity to supply energy requires demonstration of efficient and sustainable supply solution.
		• The Investigation Area is relatively unconstrained;
		  • Significant or prime agricultural land shall not developed for urban purposes;
		  • Resources will not be sterilised or impacted on by the development;
		• The precinct development will be designed with consideration for sustainability and to reduce the use of natural resources by the future development. It is anticipated that the future housing stock will incorporate best practice energy efficiency features in accordance with the Council's / Department of Planning's requirements.
		• Water Sensitive Urban Design will be utilised to reduce impact on water resources and the environment in this area while allowing for appropriate environmental flows.

7. Environmental Protection Protect and enhance biodiversity, air quality, heritage, and waterway health	• Consistent with government approved Regional Conservation Plan (if available). • Maintains or improves areas of regionally significant terrestrial and aquatic biodiversity (as mapped and agreed by DEC). This includes regionally significant vegetation communities; critical habitat; threatened species; populations; ecological communities and their habitats. • Maintain or improve existing environmental condition for air quality. • Maintain or improve existing environmental condition for water quality • Consistent with community water quality objectives for recreational water use and river health (DEC and CMA) • Consistent with catchment and stormwater management planning (CMA and council). • Protects areas of Aboriginal cultural heritage value (as agreed by DEC).	• Revegetation of identified riparian and priority corridors; • The site qualities have been identified and areas of high environmental value have been retained as vegetated pockets. Corridors are proposed to link these areas. • The vegetation along existing waters courses will be enhanced. This will increase bank stabilisation; • The ecological values of the area will be enhanced; • Stormwater management will maintain water quality and environmental flows; • Aboriginal artefacts have been identified across the site. These artefacts will be managed in accordance with DEC guidelines. • Water quality will not be impacted on as a detailed storm water management strategy has been prepared to address this issue.

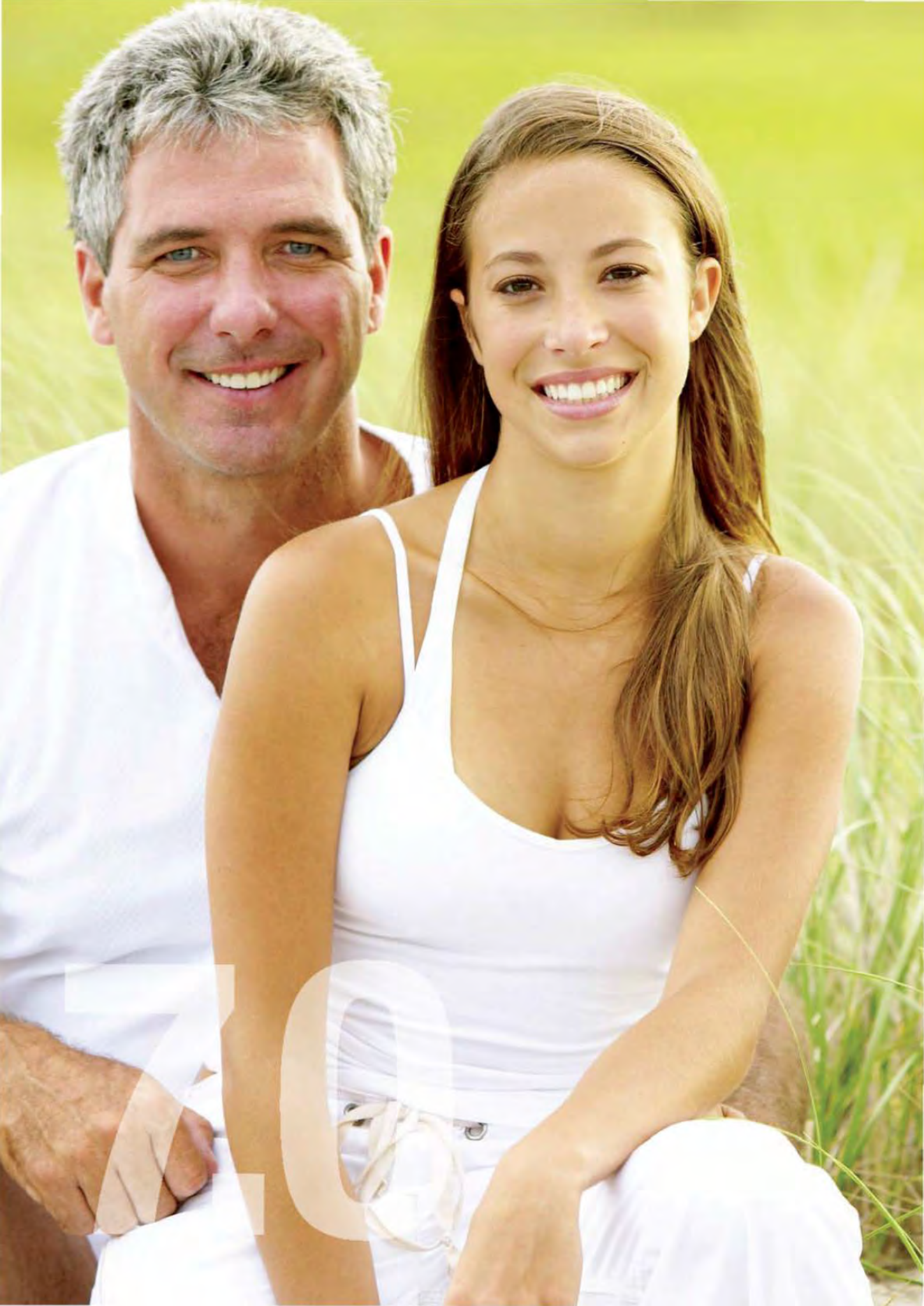
8. Quality and Equity in Services
Quality health, education, legal, recreational, cultural and community development and other government services are accessible
	• Available and accessible services
	  • Do adequate services exist
	  • Are they at capacity or is some capacity available
	  • Has Government planned and budgeted for further service provision
		• A Social Impact Assessment has been undertaken that identifies the existing community facilities, the available capacity of these facilities and the demand that will be generated by residents of the new precinct. Required facilities and services have been planned for and are indicated on the Structure Plan.

GROWTH MANAGEMENT PRINCIPLES		
PRINCIPLE	**CWSS COMMENT**	**NORTH BELLBIRD PRECINCT COMMENT**
Threshold to Growth	Manage supply of rural and rural-residential lots in conjunction with urban development within identified carrying capacity of catchments (based on physical, servicing and social criteria) and based on analysis of genuine demand.	The North Bellbird Investigation Area stands as the major urban release area within the Cessnock locality. Issues related to carrying capacity in terms of the catchment were considered when the site was nominated by Council as a major release area.
Natural Environment	Ensure settlement growth protects & where possible enhances natural features & ecological values of the catchments.	The rezoning of the North Bellbird Investigation Area will facilitate the regeneration of existing riparian zones.
Diversity of Lifestyle	Provide a range of sustainable options for rural living as a limited alternative to urban living.	The rezoning of the North Bellbird Investigation Area incorporates 'lifestyle' sized allotments on the fringe which will act as a buffer to the adjoining rural areas as well as allowing the establishment of vegetation corridors around the site linking existing habitats both internal and external to the site.
Character and Identity	Design rural and residential settlements which retain and enhance the rural character of local areas and do not lead to a blurring of distinction between urban settlement and the surrounding hinterland.	As described above, the rezoning of urban precincts will reduce the demand for small lot rural residential estates (2000 m^2+). The North Bellbird Investigation Area will be developed as a distinct urban village and will not result in any blurring between urban and rural settings and it will occur as a seamless extension to the existing settlements.
Land use suitability and compatibility	Identify preferred areas physically suitable for urban, rural residential, and rural settlement which are compatible with surrounding land uses…	A detailed opportunities and constraints analysis as been undertaken to define areas of the investigation area which are suitable for urban development. The investigation area is seen as a continuation of existing urban development and thus compatible with this use.
Efficient Servicing and Self – reliance	Encourage growth of villages, rural residential estates and rural settlements only when they are located and designed to minimise the economic, social and environmental costs of providing and maintaining services.	As the rezoning of the North Bellbird Investigation Area will eventuate in an increase in supply of fully serviced allotments with high levels of accessibility there should be less pressure or demand for the unorderly and inefficient development of un-serviced villages, rural – residential estates and rural settlements.
Integrated Settlement	Integrate rural settlement, rural residential settlement and urban settlement in a distinct hierarchy within the catchment, by focusing new settlement on preferred areas and adopting a cluster approach to rural and rural residential settlement.	The North Bellbird Investigation Area sits within the Cluster methodology adopted by Cessnock Council and is an identified precinct for residential development in the adopted Strategy.

GROWTH MANAGEMENT PRINCIPLES		
PRINCIPLE	**CWSS COMMENT**	**NORTH BELLBIRD PRECINCT COMMENT**
Enhancing existing rural development	Adapt existing rural residential and rural settlements where possible to improve their form and liveability.	Through increasing the supply of residential allotments in the LGA this will decrease pressures for rural residential development.
Quality of Life	Encourage urban, rural residential and rural settlement design which promotes quality loving throughout the various stages of life.	The North Bellbird Investigation Area seeks to provide a range of lots which will result in diversity housing stock, thus catering for a broad demographic profile. This, when tied in with the recreational opportunities available will see the area provide quality living over the various stages of life.
Awareness and responsible action	Educate people and foster community involvement in sustainable settlement growth. Promote the themes for new rural residential and rural settlement to create a focus for rural residents and achieve greater cooperation in land management issues.	The North Bellbird Investigation Area will define a new benchmark in living in the Cessnock LGA as well as providing opportunities for community involvement in the regeneration and management of the riparian corridors. Such opportunities encourage involvement and will result in a community which has respect and a sense of ownership for its surrounds.

It is intended that land within this zone will form the 'town centre' of North Bellbird and allow for a range of retail and commercial opportunities combined with community activities.





7.0 SUITABILITY OF THE PROPOSED ZONINGS AND PLANNING MECHANISMS

This section describes the proposed rezoning of the North Bellbird Investigation Area. The proposed rezoning is supported by detailed consultant studies and a Structure Plan that identifies opportunities for conservation and future urban development and provides a sound basis for the rezoning.

The adoption of the North Bellbird Structure Plan over the Investigation Area is seen as a **seamless extension** to the urban areas of Cessnock and Bellbird. Future residents will benefit from high levels of accessibility to employment, education, recreational facilities and other services making the location ideal for residential as the primary land use. The master planning exercise undertaken reveals that there is an opportunity to improve the environmental quality of degraded riparian corridors and establish linkages with ecological communities external to the investigation area.

It is considered that the potential of the North Bellbird Investigation Area is best realised through amending the Cessnock LEP, 1989 with the adoption of the current 'best practice' zoning mechanisms derived from the *Standard Instrument (Local Environmental Plans) Order 2006*, adopted by the Minister for Planning on March 30, 2006. The application of appropriate zones contained in the Standard Instrument will ensure that the landscapes and urban environments defined in the opportunities and constraints analysis and the North Bellbird Structure Plan will materialise over the life span of the development.

By April 2008, Council will be required, under statutory obligation, to adopt a new LEP which includes the mandatory provisions of the Standard Instrument and applies to all land contained in the Cessnock LGA. While the insertion of the zones from the Standard LEP into the CLEP, 1989 will result in additional zones being created, the instrument, as drafted, will be amended to ensure that there will be no conflict between any of the current or new provisions relating to development within the Investigation Area. Once Council adopts the Standard LEP Zones and format in 2008, the North Bellbird Investigation Area will seamlessly fall into the new instrument.

It is considered that zones contained in the Standard Instrument will provide more direction and certainty than any attempt to use the current zones in the Cessnock LEP, 1989. Council and the Department of Planning have been consulted in this process and have advised of the suitability of this approach. The written advice of Cessnock City Council and the Department of Planning is contained in **Appendix 1**.

The implementation of the North Bellbird Zoning Plan (**Figure 7.1**) will provide an appropriate mechanism for the realisation of a mixture of residential development, retail and commercial opportunities, educational facilities, open space, and areas environmental conservation and management. The zoning plan will also allow for the retention of prime viticultural soils.

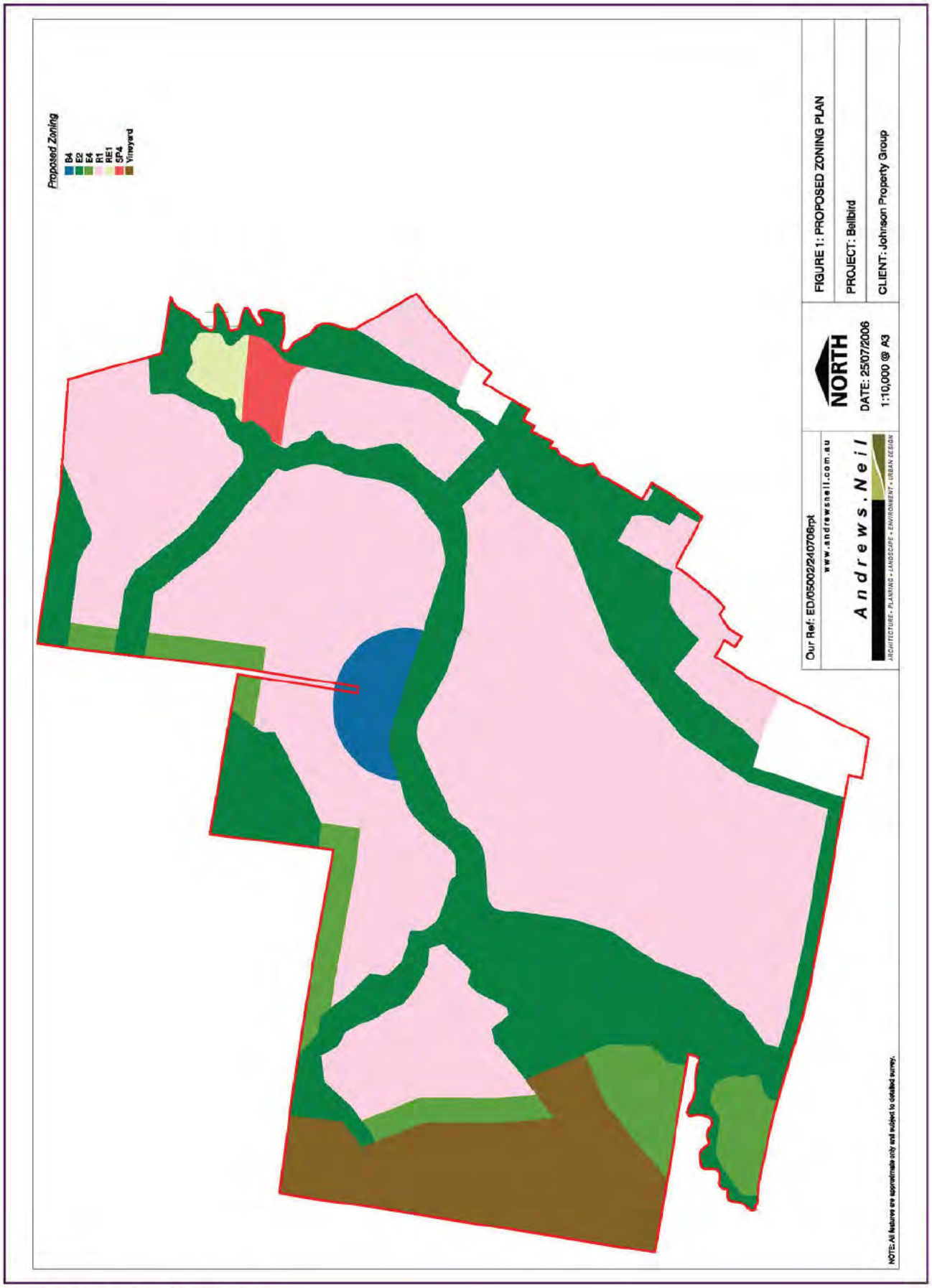


Figure 7.1: *North Bellbird Zoning Plan*

7.1 ASSESSMENT OF POTENTIAL ZONES

The proposed LEP amendment seeks to insert the following zones into the Cessnock LEP1989 as a mechanism of governing future development in the North Bellbird Investigation Area: –

- R1 – General Residential
- R2 – Low Density Residential
- B4 – Mixed Use
- E2 – Environmental Conservation
- E4 – Environmental Living
- RE1 – Public Recreation
- SP4 – Infrastructure

It is considered that the objectives of the above zones and the intent of the zones as prescribed by the Department of Planning (PN 06 – 002) most appropriately reflect the intent of the proposed structure plan. The suitability of the above zones has been determined through an assessment of the opportunities and constraints analysis which has established the capability of land for urban development. An assessment of the proposed zones against other likely zones is described as follows: –

7.1.1 R1 GENERAL RESIDENTIAL

The *R1 General Residential* zone will take up approximately 249 hectares of the Investigation Area and is considered to be the principal zone for residential development.

This zone will apply to land that is generally **constraint free**, easily serviced and with high levels of accessibility to transport, infrastructure, education, open space, and commercial and retail opportunities within the Investigation Area. This is consistent with the Department of Planning's intent for this zone which is described in *Practice Note 06 – 002* as follows: –

> *"This zone is generally intended to provide for a variety of residential housing types and densities, including dwelling houses, multi – dwelling housing, residential flat buildings, boarding houses and seniors housing. The zone also provides for additional uses that provide facilities or services to residents, including neighbourhood shops and child care centres"*

The objectives of the zone as prescribed in the Standard LEP Template 2006 are as follows:-

- *To provide for the housing needs of the community.*
- *To provide for a variety of housing types and densities.*
- *To enable other land uses that provide facilities or services to meet the day to day needs of residents.*

It is considered that this zone is the most appropriate zone to address the future housing needs of the North Bellbird Community. It clearly has elements of flexibility and can accommodate a range of housing types without placing a particular emphasis on any particular housing type. In this regard, it is envisaged that the implementation of the R1 General Residential Zone as the *primary* residential zone for North Bellbird will facilitate the creation of a heterogeneous community. It is also considered that the application of the R1 Zone will achieve the density requirements for the Investigation Area. This can be seen in the application of the *Lot Size Plan* which stipulates a range of allotment sizes for the R1 Zone.

Other Zones that were considered for the area to be covered by the R1 Zone are: –

- **Zone R2** – Low Density Residential Zone;

  It is considered that the adoption of this zone would not result in the optimum use of largely constraint free land in the investigation area, and would largely 'lock in' detached dwelling houses as the only form of housing. It is considered that the use of this zone over the majority of constraint free land would be an under utilisation of this resource, reduce the ability to construct other housing forms, and would ultimately result in difficulties in achieving desired housing yields.

It is intended that land within this zone will form the 'town centre' of North Bellbird and allow for a range of retail and commercial opportunities combined with diverse housing styles and community activities.







7.1.2 B4 MIXED USE

The B4 Mixed Use Zone is proposed over 8 hectares of the North Bellbird Investigation Area. It is intended that land within this zone will form the 'town centre' of North Bellbird and allow for a range of retail and commercial opportunities combined with community activities. It is anticipated that medium density housing will typify the housing stock in this zone. The central location of this zone within the investigation area makes it ideal for such activities.

It is intended that land within this zone will form the 'town centre' of North Bellbird and allow for a range of retail and commercial opportunities combined with community activities.

The use of the 'Mixed Use' zone will also reflect the position of the North Bellbird 'town centre' within the Cessnock commercial centres hierarchy. The opportunities and constraints analysis indicates that this land is free from physical and environmental constraints.

The intent of the Department of Planning is as follows: –

> *"This zone is generally intended for use where a wide range of land uses are to be encouraged, including retail, employment, residential, community and other uses"*

The objectives of this zone are as follows: –

- *To provide a mixture of compatible land uses;*
- *To integrate suitable business, office, residential, retail and other development in accessible locations so as to maximise public transport patronage and encourage walking and cycling.*

The anticipated development form for the 'town centre' area, as detailed in the North Bellbird Structure Plan is consistent with the objectives of the B4 mixed use zone. It is felt that the use of this zone will encourage the desired mix without attracting activities which would see this centre compete with the Cessnock CBD.

The mixed use zone will also encourage medium density housing in close proximity to retailing and commercial activities.

Other zones which warranted consideration, but discounted included: –

- **B2 Local Centre**

  While the objectives B2 Local Centre zone will encourage development capable of accommodating the commercial and retailing needs of the Investigation Area, it is considered that the mix provided by the B4 zone more conducive to creating a sense

of place and community in the town centre, rather the B2 zone, which may result in a separation of complementary land uses.

- **B3 Commercial Core**

  It is felt that the adoption of a commercial core zone is likely to encourage retailing and commercial development of a scale which would compete with the existing Cessnock CBD. As detailed in the Castlecrest Economic Impact Assessment the population of the Investigation Area is unlikely to generate the demand needed to support a major retailing or commercial centre.

7.1.3 E2 ENVIRONMENTAL CONSERVATION

The opportunities and constraints analysis reveals the need to conserve land to protect identified endangered ecological communities and threatened flora and fauna species. It is imperative that such land is covered by a zone which includes objectives that will enable the protection and rehabilitation of such environments. The E2 Zone is proposed over 139 hectares of land identified as having ecological value.

It is considered that the adoption of the E2 Zone will ensure the fulfilment of the recommendations of the Andrews Neil Fauna and Anne Clements and Associates Flora Reports. The Department of Planning's intent for this zone, as prescribed is Practice Note 06-002 is as follows: –

> *"This zone is generally intended to be applied to land that has environmental or scenic values or hazard risk, but where a limited range of development including dwelling houses and other uses could be permitted. This zone might also be suitable as a transition between areas of high conservation value and other land uses such as rural or residential."*

The objectives of the zone are as follows: –

- *To protect, manage and restore areas of high ecological, scientific, cultural or aesthetic values.*
- *To prevent development that could destroy, damage or otherwise have an adverse effect on those values.*

It is considered that such zone objectives tied in with the implementation of appropriate management plans will ensure that any land covered by this zone will retain or improve its environmental integrity in perpetuity regardless of its ownership status.

It is considered appropriate that land zoned E2 Environmental Conservation be dedicated to Council / public ownership to ensure such land is preserved for the benefit of the public / Cessnock Community. Development in the E2 zone is to be limited to activities associated with the management, preservation and rehabilitation of land within this zone and other activities associated with the provision of servicing and infrastructure. While dwelling houses are permitted with consent in the E2 Zone, the proposed minimum lot size (refer to minimum lot size plan), and the anticipated ownership status of land within this zone will effectively inhibit any residential / urban development. Land within the E2 Zone will also be subject to a vegetation management plan which will place further restrictions on development within this zone.

Other zones that were considered appropriate for the land to be zoned E3 Environmental Management include: –

- **E3 Environmental Management Zone**

  It is considered that the E3 Environmental Management Zone would not provide enough certainty to enable the environmental conservation required for these areas.

- **RE1 Public Recreation Zone**

  While it is considered that the environmental conservation requirements for land to be zoned E2, could also be achieved under the RE1 Zone, it is felt that the zone objectives of the E2 Zone are better suited to the intent of preserving and rehabilitating the vegetation communities within this area.



7.1.4 E4 ENVIRONMENTAL LIVING

As detailed in the opportunities and constraints analysis and the North Bellbird Structure Plan, one of the key ecological outcomes is the opportunity to establish or re – establish strategic vegetation / habitat corridors throughout the investigation area. The primary object for this is to allow for the migration of fauna throughout the investigation area and provide linkages with external tracts of remnant vegetation. The opportunities and constraints analysis suggest that the corridors will typically be a width of 50 metres, and on this basis can be suitably contained in the rear of larger allotments, particularly on the fringe of the proposed urban areas. It is also envisaged that the establishment of such corridors will assist in mitigating the visual impact of urban development by creating a buffer between rural and urban landscapes.

The E4 Environmental Living Zone has an area of 15 hectares. The Department of Planning's intent for the E4 Environmental Living Zone is described in Practice Note 06 – 002 as follows: –

> *"This zone is generally intended for land with special environmental or scenic values where residential development could be accommodated"*

The objectives of the E4 Environmental Living Zone contained in the Standard LEP Template are as follows: –

- *To provide for low-impact residential development in areas with special ecological, scientific or aesthetic values.*
- *To ensure that residential development does not have an adverse effect on those values.*

It is considered that the anticipated housing / development density in the E4 Zone, as reflected in the North Bellbird Structure Plan and the North Bellbird Lot Size Plan will ensure that development is capable of meeting the above objectives. On this basis development in the E4 Zone will be of a nature that will ensure that recommendations relating to Flora and Fauna are capable of being met.

Other zones that were considered for this land include: –

- **R5 Large Lot Residential**

  The R5 Large Lot Residential Zone was discounted as its objectives do not incorporate reference to environmental protection as required to ensure certainty regarding the establishment of habitat corridors.

- **RU6 Transition**

  The R6 Transition Zone was discounted as its objectives do not incorporate reference to environmental protection as required to ensure certainty regarding the establishment of habitat corridors.

7.1.5 RE1 – PUBLIC RECREATION

The North Bellbird Structure Plan proposes the establishment of a number of 'pocket parks' as well as the establishment of sporting ovals located adjacent to the proposed North Bellbird school precinct. It is considered that the RE 1 Public Recreation zone is the most appropriate zone for land proposed to be used for public recreation purposes.

The Department of Planning's practice note PN 06-002 explains the intention of this zone as follows:

> *"This zone is generally intended for a wide range of public recreation areas and activities, including local and regional open space. Councils may generally permit typical public recreation uses in this zone. A range of land uses compatible with the recreation use of the land should be permitted."*

The objectives of this zone are as follows:

- *To enable land to be used for public open space or recreational purposes.*
- *To provide a range of recreational settings and activities and compatible land uses.*
- *To protect and enhance the natural environment for recreational purposes.*

There are no other zoning options contained within the Model LEP Template.

7.1.6 SP2 – INFRASTRUCTURE

The Social Impact Assessment undertaken by Elton Consulting has concluded that land be set aside in the North Bellbird precinct for appropriate schooling facilities. The only suitable zone identified in the LEP Template is the SP2 – Infrastructure Zone. Practice note PN 06-002 explains the intention of this zone as follows:

> *"This zone is generally intended to cover a wide range of physical and human infrastructure uses such as transport (e.g. roads and railways), utility undertakings and works, community uses, educational establishments (e.g. schools) and hospitals. This zone would be used for some facilities where previously a special uses zone may have been used."*

The objectives of this zone are as follows:

- To provide for infrastructure and related uses.
- To prevent development that is not compatible with or that may detract from the provision of infrastructure.

7.2 PROPOSED ZONING STRUCTURE AND PLANNING MECHANISMS

Figure 7.1 to this report contains the proposed zoning plan for the North Bellbird Investigation Area. As detailed in this figure the proposed rezoning is as follows:-

- Zone 1(a) – Rural Zone and 1(v) – Rural (Vineyards District) to:
  - R1 – General Residential
  - R2 – Low Density Residential
  - B4 – Mixed Use
  - E2 – Environmental Management
  - E4 – Environmental Living
  - RE1 – Public Recreation
- Retention of the remaining land on the western flank of the investigation area as Zone 1(v) – Rural (Vineyards District).

Gazettal of the above rezoning is the first mechanism required to facilitate the development of the North Bellbird Investigation Area. Environmental investigations undertaken to date indicate the suitability of the area for its intended purpose. Following the completion of the consultation process it is anticipated that a Development Control Plan will be formulated (in consultation with Council and the community), which will subsequently be adopted to act as a mechanism to guide development from bulk earthworks through to the built form.

It is anticipated that the endorsement and adoption of the North Bellbird Structure Plan, (**Figure 7.2**), with an associated Development Control Plan and Developer Contributions Plan or Developer Agreement (which are to be prepared following stakeholder consultation) and the application of the proposed zoning structure will allow for certainty in regard to all land uses within the North Bellbird Investigation Area.

The remainder of land not intended to be used for urban purposes is currently zoned 1(v) – Rural (Vineyards) and will retain its current zoning.









Figure 7.2: *North Bellbird Structure Plan*



7.3 PROPOSED DEVELOPMENT CONTROL MEASURES

A detailed level of strategic planning has been involved in the development of the Structure Plan and whilst statutory development control is proposed via Council's DCP, it is proposed to ensure that development outcomes are consistent with the Structure Plan given that it provides a sound basis for the rezoning.

It is therefore proposed to prepare a Development Control Plan (DCP) for the North Bellbird Investigation area which is likely to be inserted into the City wide DCP. It is envisaged that the DCP would provide additional controls specific to the North Bellbird Investigation area, including but not limited to:

- housing type, density and location;
- provision and location of community facilities;
- a landscape strategy;
- connection with adjoining land;
- water management provisions; and
- conservation management provisions.

It is proposed that the DCP will be prepared by the Johnson Property Group in consultation with Cessnock City Council concurrent with Council's consideration of the draft LEP in order to give both parties confidence in the final outcome for the site. It is envisaged that the DCP will be available for Council adoption concurrent to gazettal of the LEP amendment such that Development Applications for initial stages can be lodged.

A detailed level of strategic planning has been involved in the development of the Structure Plan




8.0

8. CONCLUSION

This Planning Report supports the application to amend the Cessnock LEP 1989 so as to enable urban development of the North Bellbird investigation area. The future development of this area will occur as a seamless extension of the existing settlements of Bellbird and Cessnock. This has been detailed on the proposed North Bellbird Structure Plan which provides a framework for the creation of a new urban village based on the principles of 'Traditional Neighbourhood Design'.

This report, and supporting specialist studies, has sought to comprehensively addressed the opportunities and potential constraints to urban development in the North Bellbird Investigation Area. It has highlighted the opportunities and constraints, in particular the primary constraints of flooding, aboriginal archaeology, and ecology, and detailed how such constraints can be appropriately managed.

Similarly direction is provided in relation to opportunities such as: –

- Positive environmental outcomes, in particular the revegetation of riparian corridors;
- The ability to utilise available infrastructure;
- The creation of a new town centre;
- The opportunity to provide a higher level of social infrastructure to service the needs of the future North Bellbird Community and the existing Cessnock LGA;
- The rationalisation of social and recreational facilities to better serve the community; and
- Upgrades to the local road network.

It is felt that the adoption of the North Bellbird Structure Plan and the rezoning of land to facilitate urban development is the highest and best use for this land and will result in significant benefit to the Cessnock LGA.



This report demonstrates that the Structure Plan prepared for North Bellbird Investigation Area is, in the context of the draft Lower Hunter Regional Plan, the Cessnock CWSS, applicable SEPP's, the Hunter REP, 1989 and all relevant Section 117 directions, appropriate and on the whole compliant.

This report provides clear direction in terms of how these opportunities will be incorporated into the planning and development of North Bellbird, in particular what steps need to be undertaken from hereon.

This report demonstrates that the Structure Plan prepared for North Bellbird Investigation Area is, in the context of the draft Lower Hunter Regional Plan, the Cessnock CWSS, any applicable SEPP's, the Hunter REP, 1989 and all relevant Section 117 directions, appropriate and on the whole compliant.

In particular, this report demonstrates the consistency of the North Bellbird Structure Plan, and associated studies with the sustainability criteria contained in both the draft Lower Hunter Regional Strategy and the Cessnock CWSS.

An amendment to the Cessnock LEP, 1989 is sought to enable the rezoning of the North Bellbird Investigation Area from 1(a) – Rural and Rural 1(v) – Rural (Vineyards) to a range of zones described in the Standard LEP Template as well as the retention of Rural 1(v) – Rural (Vineyards) zoned land on the western edge of the investigation area as described in Chapter 7 of this report. It is anticipated that such an amendment combined with the adoption by Council of the North Bellbird Structure Plan and supporting Development Control Plan, which will be prepared following the community consultation process, will allow for the orderly staging and subsequent subdivision and development of the North Bellbird Investigation Area.

It is felt that the adoption of the North Bellbird Structure Plan and the rezoning of land to facilitate urban development is the highest and best use for this land and will result in significant benefit to the Cessnock LGA. Not only will increase housing choice and allow the town of Cessnock to grow into a major regional centre, it will do so and at the same time achieve a more sustainable and liveable community.



INSITE
PLANNING &
ENGINEERING

Johnson Property Group
Creating living communities

Monday, 31 July 2006

General Manager
Cessnock City Council
PO Box 152
Cessnock NSW 2325

Attention: Mr. Neil Selmon

Dear Sir,

Re: Proposed Rezoning
Citywide Settlement Strategy - Bellbird North Precinct

We refer to the attached Rezoning Application submission and supporting documentation.

We hereby submit an application for the proposed rezoning of the land referenced in the attached map.

We look forward to your consideration of this matter. Should you have any queries or require any additional information, please do not hesitate to contact the undersigned.

Yours sincerely,
Johnson Property Group Pty Limited

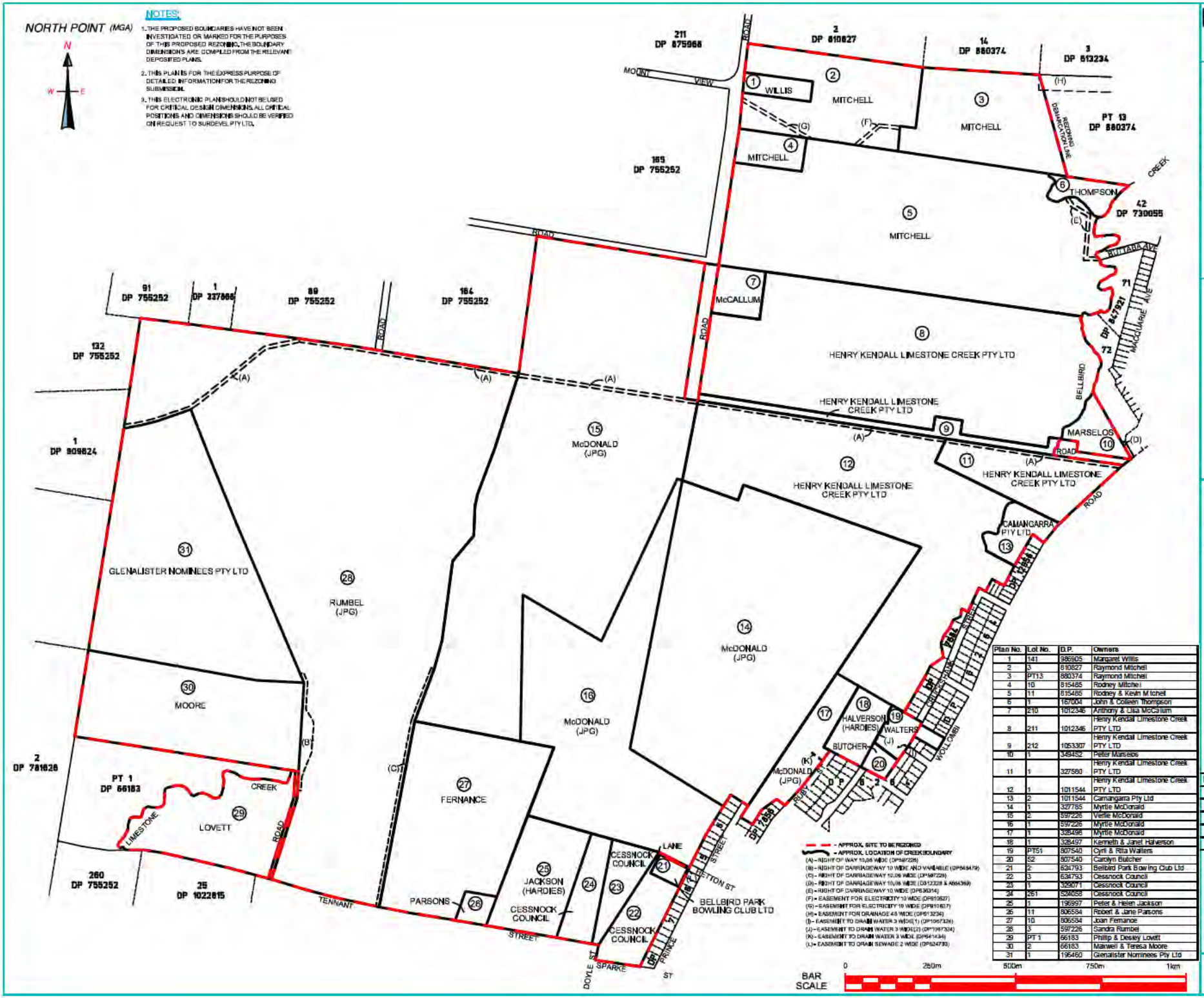
Keith Johnson
Managing Director

268 Old Northern Road
Castle Hill NSW 2154
PO Box 1196
NSW 1765

Creating Living Communities

www.jpg.net.au

Telephone (02) 9899 1888
Facsimile (02) 9899 8100
A.B.N. 58 102 465 814



Plan No.	Lot No.	D.P.	Owners
1	141	986905	Margaret Willis
2	3	810827	Raymond Mitchell
3	PT13	880374	Raymond Mitchell
4	16	815485	Rodney Mitchell
5	11	815485	Rodney & Kevin Mitchell
6	1	167004	John & Colleen Thompson
7	210	1012346	Anthony & Lisa McCallum
8	211	1012346	Henry Kendall Limestone Creek PTY LTD
9	212	1053307	Henry Kendall Limestone Creek PTY LTD
10	1	348452	Peter Marselos
11	1	327560	Henry Kendall Limestone Creek PTY LTD
12	1	1011544	Henry Kendall Limestone Creek PTY LTD
13	2	1011544	Camangarra Pty Ltd
14	1	327785	Myrtle McDonald
15	2	597226	Verlie McDonald
16	1	597226	Myrtle McDonald
17	1	328496	Myrtle McDonald
18	1	328497	Kenneth & Janet Halverson
19	PT51	907540	Cyril & Rita Walters
20	52	907540	Carolyn Butcher
21	2	624793	Bellbird Park Bowling Club Ltd
22	3	624793	Cessnock Council
23	1	329071	Cessnock Council
24	261	524058	Cessnock Council
25	1	196997	Peter & Helen Jackson
26	11	806584	Robert & Jane Parsons
27	10	806584	Joan Fernance
28	3	597226	Sandra Rumbel
29	PT 1	66183	Phillip & Desley Lovett
30	2	66183	Maxwell & Teresa Moore
31	1	196460	Glenalister Nominees Pty Ltd

NORTH BELLBIRD REZONING

PROJECT:
REZONING SUBMISSION

PLAN:
OWNERSHIP & LOT DESCRIPTIONS INCLUDED IN REZONING

CLIENT:
JOHNSON PROPERTY GROUP PTY LTD

SURDEVEL SURVEYORS
45 JOSEPHSON STREET, SWANSEA
P.O. BOX 300 SWANSEA NSW 2281
PH (02) 49713030 FAX (02) 49713032

SURVEY JOB No.: 1448

INSITE
Planning and Engineering

No.	AMENDMENTS	DATE

PLAN DATE: 13/02/2006
SCALE: 1 : 5,000 (A1)
SHEET 1 OF 1 SHEETS
FILE NAME:
S:\Rezoning\Bellbird\1448OWNERS

PLAN No.: SURV6
AMEND No.:

NSW GOVERNMENT
Department of Planning

Contact: Garry Forster
Phone: 4929 9849
Fax: 4929 5509

Our ref: N99/72
Your ref: Bellbird North LEP & LES

Mr B Mortomore
General Manager
Cessnock City Council
PO Box 152
CESSNOCK NSW 2325

CESSNOCK CITY COUNCIL
24 FEB 2006
RECEIVED

Dear Mr Mortomore

DRAFT CESSNOCK LEP 1989 - AMENDMENT NO. 121
NORTH BELLBIRD PRECINCT

I refer to the Council's letter of 15th November 2005 and subsequent discussions with the Council's planner concerning the preparation of an environmental study for the above draft plan.

This letter is to confirm my previous advice that the Department supports the Council's decision to prepare an environmental study for this proposal.

I note that the proponent has already prepared a number of background documents relating to the rezoning and future development of the site which the Council proposes to incorporate into its environmental study. As previously advised, the Department agrees to the use of this material provided the Council carries out an independent review of the documents to determine their suitability for incorporation into the environmental study.

In the absence of a Council study brief for the environmental study I advise that, in addition to all of the relevant planning, environmental, social and economic considerations, the environmental study is to include:

- *Traffic and transport analysis including an examination of the existing road network and its capabilities for increased demands, a traffic management strategy, provision of cycleways and pedestrian movements, interconnection with existing development, access to public transport and reduced reliance on car oriented transport.*
- *Infrastructure Assessment identifying availability of services such as water, sewer, gas, electricity and communications, liaison with service providers and staging in accordance with infrastructure capacity.*

- *Social impact assessment which incorporates an understanding of the existing and future needs for community facilities, the provision of aged care, child care, education, health services and other community facilities, recreation, sporting facilities and open space as well as retail opportunities.*
- *Incorporation of best practice urban design principles including minimising development footprints and identifying appropriate development.*
- *Consideration of the regional planning context including State and regional policies, Section 117 Directions, the Hunter Regional Environmental Plan and the draft Lower Hunter Regional Strategy.*
- *Consideration of the local planning context including the Cessnock City Wide Settlement Strategy, Council's Section 94 Contribution Plans and other relevant Council policies.*
- *Incorporation of Sustainability Principles such as improved environmental outcomes, promotion of energy efficiency and solar access, use of public transport with reduced reliance upon cars, interconnection with existing communities, the orderly staging of the development and incorporation of precautionary principles.*
- *Assessment of the suitability and capability of the land for urban development.*
- *Assessment of population projections, demographic trends, and land supply and demand.*
- *Consideration of the Council's sequencing program for the staged and coordinated release of residential land across the LGA.*
- *Overall strong justification for the proposed urban development when all of the above environmental, social and economic issues are considered in combination.*
- *Consideration of other matters that Council wishes to be addressed in the study plus those raised by government agencies during consultation.*

The evaluation methodology for analysing the data collected by the environmental study and the subsequent determination of a recommended suitability map should be well defined and discussed in detail. The evaluation process should aim to provide the framework against which competing demands for different parts of the site are measured. The methodology should outline key objectives and relevant assessment criteria and how they have been used to define and measure the capacity of the site to accommodate the full range of different land uses and opportunities.

If you wish to discuss any aspect of this matter please contact Mr Garry Forster on telephone 49299849.

Yours sincerely

17·2·06

for Jeff Hunt
Team Leader–Local Planning
Hunter Region

elton consulting
ABN 56 003 853 101
PO Box 1488
Bondi Junction NSW 2022
Level 6 332-42 Oxford Street
T 61 2 9387 2600 F 61 2 9387 2557
E consulting@elton.com.au

Community Impact Assessment
for
North Bellbird Investigation Area

Final Stage 1 Report

Prepared for:
Insite Planning & Engineering Services
on behalf of the Johnson Property Group

by
Elton Consulting in association with
Tangent Leisure Consultants

May 2006

Contents

Executive Summary

1. Introduction
- 1.1 Scope of this Report 1
- 1.2 Development Context 2
- 1.3 The North Bellbird Investigation Area 3

2. The Policy Context
- 2.1 State Government and Regional Planning Policies 5
- 2.2 Council Planning Policies 7
- 2.3 Summary of Policy Implications 13

3. Profile of Population and Housing in the Surrounding Area
- 3.1 Population Size 14
- 3.2 Age Profile 15
- 3.3 Families and Households 16
- 3.4 Cultural and Linguistic Diversity 16
- 3.5 Income 17
- 3.6 Employment 18
- 3.7 Education 20
- 3.8 Computer Use 21
- 3.9 Housing 21
- 3.10 Car Ownership 23
- 3.11 Conclusion 23

4. Existing Community Facilities and Services
- 4.1 Community Centres 25
- 4.2 Children's Services 26
- 4.3 Education 28
- 4.4 Health Services 30
- 4.5 Welfare and Support Services 31
- 4.6 Services for Older People 31
- 4.7 Services for Young People 32
- 4.8 Libraries and Cultural Facilities 33
- 4.9 Emergency Services 33
- 4.10 Places of Worship 34
- 4.11 Summary 34

5. Existing Open Space and Recreation Facilities
- 5.1 Context of the Site 35
- 5.2 Environmentally Significant Open Space 35
- 5.3 Council's Approach to Open Space Provision 36
- 5.4 Current Levels of Provision 37
- 5.5 Analysis 37
- 5.6 Areas for Discussion 38

6. Potential Social Infrastructure Needs
- 6.1 Potential Development and Population Scenarios 39
- 6.2 Local Neighbourhood Facilities 40
- 6.3 District and Regional Services and Facilities 43
- 6.4 Principles for the Provision of Community Facilities and Open Space 44

7. Potential Social Impact Issues
- 7.1 Changes in population size and profile 47
- 7.2 Changes in character and identity of the area 48
- 7.3 Changes to amenity of the area 49
- 7.4 Changes in access to services and facilities 49
- 7.5 The social sustainability of the development 50

8. Summary of Site Opportunities and Constraints 52

References 55

Executive Summary

This report presents findings of the first stage of a Community Impact Assessment for the North Bellbird Investigation Area, located on the western perimeter of the town of Cessnock. The report has been prepared for Insite Planning and Engineering Services, on behalf of the Johnson Property Group, to assist the project team in the further planning of the site. It describes the social context of the site and identifies issues, opportunities and constraints to development from a community planning perspective.

The report contains 8 chapters. Chapter 1 outlines the scope and purpose of the study, and describes the North Bellbird Investigation Area and the development context. The Area, comprising 496 hectares, has been assessed with respect to its capacity to sustain a mix of development and conservation including: -

- a mix of residential environments provided through sequential staging,
- a commercial and retail precinct including mixed use development capable of serving the needs of the North Bellbird community;
- social and community infrastructure including schools, community and recreational facilities and open space;
- infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails;
- conservation of quality remnant vegetation; and;
- rehabilitation of degraded riparian corridors to provide habitat linkages.

Chapter 2 reviews the key state, regional and local government planning policies that have implications for the development. These include targets, objectives and guidelines associated with the Metropolitan Strategy, the Draft Lower Hunter Regional Strategy, and Council objectives articulated in its Strategic Plan, ESD Strategy and City Wide Settlement Strategy. It also outlines Council objectives and strategies relating to social infrastructure, open space and community building, contained within its Social and Community Plan, Draft Outdoor Recreation and Open Space Plan, and Section 94 Contributions Plan. The planning policies together provide consistent direction and a framework of social objectives to guide the further planning of the site.

Chapter 3 examines the characteristics of the population in the areas surrounding the site, as the basis for assessing how the proposed development may impact upon it. The profile of the Bellbird/West Cessnock area is fairly similar to that of Cessnock as a whole, although it has a higher proportion of older people and more rental housing. This profile differs from the NSW average in terms of having lower socio-economic status, on a number of indicators. By contrast, the Mount View area adjoining the site to the north has a much higher socio-economic status, consistent with the state average. Mount View is also characterised by a higher proportion of families with children, a higher proportion of young people, and lower proportion of older people.

Chapter 4 examines the existing community facilities and services in the area around the site, in terms of their capacity to absorb demand that would be generated by the future North Bellbird community. There is potential for local primary schools to meet some of the needs arising from the development, but existing capacity will not be sufficient to absorb all of the growth. The adjacent Mount View High School has already reached capacity and, as things stand, will not be available to service the site. Other types of services and facilities are also generally already operating at capacity. This points to a need for a variety of new facilities and services to meet the needs of the new population, and for augmentation or upgrading of some existing facilities and services.

Chapter 5 examines existing open space and recreation facilities. Cessnock Council has commenced a process of rationalising its parks, with a focus on quality, rather than quantity, of open space, and of upgrading its major recreation facilities. The North Bellbird project will need to work in with this process. There will, however, be a need to provide for the local open space and recreation needs of the future population within the development.

Chapter 6 outlines indicative needs for social infrastructure and open space, based upon a population forecast range of 9 - 13,000 people (3,500 – 5,000 dwellings). A full assessment of the needs of the North Bellbird population for social infrastructure is dependent on formulation of development options and population projections and will be provided in the Stage 2 report, along with a strategy for delivery. Cessnock Council is currently in the process of planning for the upgrading or development of a number of major facilities for the existing Cessnock population, and the planning of new facilities for the North Bellbird project will need to have regard to these proposals and occur in close consultation with Council.

Chapter 7 identifies some potential social impact issues, based on outcomes of previous community consultations and discussions with Council staff. The full assessment of social impacts will rely on consultations with the communities and organisations likely to be most affected by the development, to take place in the second stage of the study.

Chapter 8 presents a brief summary of the opportunities and constraints associated with development of the site from a community planning perspective. The site presents opportunities for development which can benefit the wider community and enhance the vitality of Cessnock. Potential constraints are associated with the existing community's acceptance of a development of the proposed scale and density, and the impacts this might have on the character, identity amenity and cohesion of existing settlements. Appropriate responses and strategies to address any issues of community concern will be developed through consultation with the Cessnock community in subsequent stages of the planning process.

In summary the Stage 1 Community Impact Assessment has identified no matter which would preclude urban development within the North Bellbird Investigation Area, or which cannot be addressed at the detailed design phase.

1. Introduction

1.1 Scope of this Report

This report presents preliminary findings of the Community Impact Assessment for the North Bellbird Investigation Area, within Cessnock Local Government Area. The report has been prepared for Insite Planning and Engineering Services, on behalf of the Johnson Property Group, to assist the project team in the further development of the planning proposal for the site. In particular, the purpose of the report is to:

- Describe the social context of the North Bellbird Investigation Area,
- Identify the opportunities and constraints associated with the site from a community planning perspective, and
- Identify community planning issues that will need to be addressed in the masterplan, draft DCP and Section 94 process for the site.

The report presents findings of the first stage of what will be a comprehensive two stage Community Impact Assessment that will, when completed:

- examine the social impacts of the proposed development within the context of the broader community and relationships with adjacent communities, and

- prepare a plan for the proposed new community, detailing how it will meet the needs of the future population in terms of social infrastructure, open space and recreation facilities.

The Community Impact Assessment report will be one of a number of specialist technical studies to support and inform the rezoning application, masterplan, draft DCP and draft Section 94 Plan for the development when they are submitted to the consent authority.

The scope of this Stage 1 report includes:

- Review of relevant background reports, plans and policies which may have implications for the development,

- Description and analysis of the social context of the proposed development, in terms of the characteristics of the population of surrounding areas, using Council data and 2001 ABS Census material;

- Assessment of existing social infrastructure, open space and recreation opportunities in the surrounding area and their capacity to meet the needs of the future population, based upon Council directories and consultation with Council staff and local service providers;

- An outline of potential needs of the future population for social infrastructure,

- A preliminary scoping of potential social impact issues, and identification of the opportunities and constraints of the site.

The study has been undertaken by Elton Consulting in association with Tangent Leisure Consultants, who have had responsibility for the open space and recreation components of the study.

1.2 Development Context

Cessnock is a sub-region of the Hunter Valley with a current population estimated to be in the order of 45,000 people (A.B.S. Census 2001), and with an area of 1950 square kilometres. The majority of the population of the City is located in a thin urban belt between Cessnock and Kurri Kurri with the remainder located in outlying rural areas.

The Hunter Valley wine-growing area in Cessnock LGA is Australia's oldest wine region and one of the most famous, with around 4,500 acres under vine. Both wine production and tourism are expanding industries. Wine-related tourism has also created opportunities for other attractions such as the historic Marthaville Arts and Crafts Centre, Wollombi Village, the Richmond Main Mining Museum and the Richmond Vale Railway. The Hunter Employment Zone (HEZ) proposal near Kurri Kurri is expected to attract new industries to the area. In addition to providing more employment for existing residents it will attract new employees and their families to the area.

The Cessnock Local Government Area is characterised by a variety of geographic features, which include large areas of state forest, national parks and world heritage areas, grazing land and areas for viticulture.

In 2004 Cessnock City Council released the Cessnock City Wide Settlement Strategy as a major component of its response to sustainability issues. The Strategy aims to redirect future population growth away from the current dispersed pattern and into a more compact, sustainable settlement hierarchy. This recognises the finite nature of land available for closer settlement growth and the need to develop it wisely, along with the need to provide for a range of lifestyle opportunities throughout the LGA. The Strategy sets out principles for future settlement growth and establishes a settlement hierarchy that seeks to support urban growth through development of higher density clustered settlement patterns. In particular, it seeks to maximise development opportunities in areas closer to existing settlements, and to increase the supply of land for closer settlement growth to meet demand over the next decade or more. To this end, it identifies a number of sites or precincts within catchment areas that are suitable for investigation for future urban development in a more compact form.

One such precinct is the North Bellbird Investigation Area, which lies within the Black Creek catchment. Within this catchment, there are recognised shortfalls in the supply of land currently available for village growth, with recommendations that further sites will need to be rezoned for higher density residential uses to meet projected dwelling demand.

1.3 The North Bellbird Investigation Area

The North Bellbird Investigation Area has an area of 496 ha and is situated to the north and west of the existing settlement of Bellbird, on the south west fringes of the town of Cessnock. Consistent with the recommendations of the Cessnock City Wide Settlement Strategy, the site has been assessed with respect to its capacity to sustain a mix of development and conservation, including:

- a mix of residential environments provided through sequential staging,
- a commercial and retail precinct including mixed use development capable of serving the needs of the North Bellbird community;
- social and community infrastructure including schools, community and recreational facilities, and open space;
- infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails;
- conservation of quality remnant vegetation; and;
- rehabilitation of degraded riparian corridors to provide habitat linkages.

The North Bellbird Investigation Area is properly described as:

Lot / DP	Lot / DP	Lot / DP	Lot / DP	Lot / DP
141 / 986905	210 / 1012346	2 / 1011544	52 / 807540	11 / 806584
3 / 810827	211 / 1012346	1 / 327785	2 / 624793	10 / 806584
PT13 / 880374	212 / 1053307	2 / 597226	3 / 624793	3 / 597226
10 / 815485	1 / 349452	1 / 597226	1 / 329071	PT 1 / 66183
11 / 815485	1 / 327580	1 / 328498	261 / 524058	2 / 66183
1 / 167004	1 / 1011544	PT 51 / 807540	1 / 196997	1 / 196460

Approximately 322 hectares of the site are suitable for development, with an anticipated lot yield of approximately 3,500 – 5,000 lots, spanning a 15-20 year development timeframe. The development is intended to complement the adjoining neighbourhoods of Bellbird, Bellbird Heights and Cessnock and the adjacent rural community of Mount View.

The North Bellbird Investigation Area is made up of undulating creek flats and is currently used for rural purposes. It is traversed by a series of creeks that include Limestone Creek and Bellbird Creek. Bellbird Creek runs along the eastern boundary of the site and separates the site in part from the older residential areas of Bellbird Heights and West Cessnock to the east. The northern boundary of the site is adjacent to a retention basin which is used for sport and is opposite a high school and new residential estate, Vineyard Grove. The western boundaries of the site are bounded by predominantly rural lots, in reasonably close proximity to the vineyards

district. To the south, the site is bounded by larger rural-residential and residential lots that are part of the village of Bellbird.

2. The Policy Context

This chapter reviews the key state, regional and local policies and planning documents that have implications for community planning for the proposed North Bellbird development. These include:

- City of Cities: The Metropolitan Strategy;
- Draft Lower Hunter Regional Strategy 2006-2031;
- Cessnock City Council's Strategic Plan 2004-2009;
- Cessnock City Council's Ecologically Sustainable Development (ESD) Strategy;
- Council's City Wide Settlement Strategy (CWSS);
- Cessnock Social and Community Plan 2004-2009;
- Council's Social Impact Assessment Procedure and Guidelines;
- Council's Draft Outdoor Recreation and Open Space Plan, March 2005;
- Council's Section 94 Contributions Plan.

2.1 State Government and Regional Planning Policies

2.1.1 Metropolitan Strategy: City of Cities – A Plan for Sydney's Future

The recently released Metropolitan Strategy is a strategic document that will guide major decisions and plans by State and local government and inform private sector investment to respond to the growth and change that will occur in the Greater Metropolitan Region (GMR) over the next 30 years. The GMR stretches from Kiama in the south to Port Stephens in the north. Key regions identified within the Metro Strategy include: Sydney, the Central Coast, the Lower Hunter and the Illawarra. Cessnock is located within the Lower Hunter Regional Strategy. The Metropolitan Strategy will consider the relationships between these regions. Separate but complementary Regional Strategies are currently being prepared for the Lower Hunter, Central Coast and Illawarra regions, and the Sydney to Canberra corridor. These regional strategies will set directions for managing growth and change in the regions and will complement the directions for Sydney.

The strategy has identified five aims to achieve a more sustainable city. These are:

- Enhance Liveability;
- Strengthen Economic Competitiveness;
- Ensure Fairness;
- Protect the Environment; and
- Improve Governance.

The Metropolitan Strategy is made up of seven subject areas, or strategies. These include:

- Economy and Employment;
- Centres and Corridors;
- Housing;
- Transport;
- Environment and Resources;
- Parks and Public Spaces; and

- Implementation and Governance.

Social considerations in the Sustainability Criteria released for new land release areas as part of the Metro Strategy include:

- Provision of quality places to live and play. This includes provision of parks, community facilities, quality urban spaces, easy accessibility for walking and cycling in local areas. Design codes to encourage *Liveable Neighbourhoods* will be introduced;
- Provision of a range of housing choices to ensure a broad population can be housed and which can be adapted over time;
- Provision of access to employment opportunities;
- Provision of sustainable accessibility between homes, jobs, services and recreation, including public transport provision;
- Equitable provision of quality health, education, security, community development and other government services.

2.1.2 Draft Lower Hunter Regional Strategy 2006-2031

The Draft Lower Hunter Regional Strategy applies to the five local government areas of Newcastle, Lake Macquarie, Port Stephens, Maitland and Cessnock. The Strategy aims to ensure that adequate land is available and appropriately located to sustainably accommodate the projected housing, employment and environmental needs of the region's population over the next 25 years. It presents a broad land use planning framework which identifies urban centres and lands for future residential and employment growth, to ensure that future population growth is supported by essential human services and associated infrastructure. The Strategy is based on forecasts that there will be a 25% increase in the region's population over the next 25 years, along with 50,000 new jobs.

The strategy aims to ensure:

- the future for the Lower Hunter Region is sustainable, affordable, prosperous and liveable;
- a hierarchy of centres is created to produce more compact urban forms, reducing urban spread and facilitating revitalisation of urban centres;
- greater housing mix will provide for changing demographics and facilitate greater choice, affordability and social diversity;
- greenfield land is released in a co-ordinated way with improved neighbourhood design and more efficient use of infrastructure;
- neighbourhood planning will incorporate mixed use, diversity of housing choice and pedestrian-friendly spaces.

The Strategy identifies Cessnock as one of six major mixed use regional centres to have greater population density in and around them, thereby becoming more vibrant. It also identifies Bellbird as one of seven major urban release areas of more than 2000 dwellings. The Strategy sets out the planning process through which development of new release areas may occur, to ensure co-ordination and consistency with the Regional Strategy.

2.2 Council Planning Policies

2.2.1 Council's Strategic Plan

Cessnock City Council's current Strategic Plan *Our People, Our Place, Our Future* – provides a framework for identifying the social objectives for the proposed development. The primary vision and long term goals for the Strategy were identified through extensive community consultation and in line with Council's Ecologically Sustainable Development Strategy. The long term vision identified within the strategy for the Cessnock LGA sees a city full of "safe, healthy [environs] where residents can enjoy a high quality of life." Within this vision, the element of "Lifestyle" encompasses local shopping, employment close to home, accessibility and closer links with the environment while "Security" has been considered in its broadest sense, that is, it includes a focus on comfort, confidence and a future for residents and their families. The final Strategic Plan identifies 5 key goals:

1. To promote and provide quality services and facilities which focus on the needs of the community.
2. To protect, enhance and promote our natural, developed and cultural environment.
3. To actively foster the creation of employment and sustainable development opportunities acceptable to community and environmental standards.
4. To be a professionally managed and customer focused organisation which provides leadership through partnerships with the community.
5. To identify needs, share information and provide opportunities for active participation and community consultation.

A summary of key social objectives identified under these goals that will need to be considered in the planning of the proposed development includes:

Facilities, services and accessibility

- Continue to promote the use of public transport by providing more bus shelters and transport facilities;
- Create a new Civic Precinct within the Cessnock City as part of a broader specific use precinct program. The precinct is expected to include a multi-purpose centre, the relocated Cessnock branch library, a youth facility, a central park and outdoor sporting facilities.
- Ensure the health of the community is a high priority.

- Ensure that social and community planning within the Cessnock LGA identifies the needs of the diverse groups within the new and existing community.
- Ensure the provision, maintenance and management of community infrastructure including community halls and centres, community based pre-schools and childcare centres;
- Ensure support and development of community services and activities through partnerships with a range of government and non-government service providers.
- Ensure advances in technology are used to improve work practices and provision of services to the community.

Development, Cultural Environment

- Protect and enhance the cultural, natural and built aspects of the environment.
- Develop strategic plans for each community to ensure that residential areas are supported and enhanced by active commercial, community and cultural facilities.
- Encourage new cultural activities in order to improve the diversity of cultural facilities and services accessible to the community.
- Preserve the unique cultural identity and heritage of Cessnock City, particularly in consideration of developments.
- Protect Aboriginal and European heritage.

Community Consultation

- Encourage community involvement in planning and project implementation where appropriate.
- Conduct issue specific surveys and /or hold public meetings/forums on issues of interest to the community.

2.2.2 Council's Ecologically Sustainable Development Strategy (ESD)

In August 2003, Council resolved to adopt an Ecologically Sustainable Development (ESD) Strategy for use within Council' administration and operations. The strategy provides formal recognition of Council's commitment to applying ESD.

The broad objectives of the ESD Strategy include:

- Recognising and addressing the needs of everyone, including future generations;
- Careful use of natural resources;
- Protection of the Environment;
- Being cautious in activities which may harm the environment; and,
- An economic system that achieves the above objectives while supporting development.

2.2.3 Cessnock City Council's City Wide Settlement Strategy (CWSS Stage 1)

Stage 1 of the City Wide Settlement Strategy (CWSS Stage 1) was adopted by Council in 2003 and endorsed by DIPNR in 2004. The CWSS Stage 1 has a focus on rural, residential and tourism development. It sets future direction for population growth throughout the Cessnock LGA for the next 10 years, 'captures' land for closer residential settlement beyond the 10 year timeframe, provides the basis for a new planning policy for rural tourism and the foundation for a sustainable planning policy which balances growth with the natural, scenic and cultural assets of the LGA. The CWSS Stage 1 builds on the broader aims and objectives of Council's Strategic Plan and ESD Strategy, providing an ESD framework for future land use planning within the Cessnock LGA by:

- Redirecting future settlement growth into a more compact, sustainable settlement hierarchy that recognises:
  - The infinite nature of land available to the LGA for closer settlement growth and the need to develop it wisely.
  - The need to provide for a range of lifestyle opportunities throughout the LGA.
- Introducing provisions to foster more sustainable living, whilst conserving the significant environmental, resource and scenic assets of the LGA.

As mentioned in Chapter 1, CWSS (Stage 1) identifies a number of catchment areas suitable for future urban development, with North Bellbird located within the Black Creek Catchment. This catchment also includes the area surrounding the proposed development, as well as the outlying areas of Aberdare, the village of Nulkaba and Kitchener, the rural area of Polkolbin, Keinbah, Lovedale and parts of north Rothbury and the Vineyards District. The CWSS Stage 1 notes that "the LGA has sufficient zoned land, in overall terms, to meet demand for closer settlement growth for the next 10 years" although it notes that there is a short fall of sufficiently zoned land for village growth and a glut of land for rural-residential growth within the Black Creek Catchment.

To develop a more compact and sustainable settlement pattern in the future, the CWSS Stage 1 utilises a settlement hierarchy and clustering planning (i.e. reduced urban-residential sprawl and centralisation of community services). The settlement hierarchy and clustering planning principles maximize development opportunities in areas closer to existing urban settlements to reduce rural-residential sprawl. The strategy utilises a ring/radii based concept to cluster residential development about existing settlement, with the centre of each ring/radius being either a primary or secondary school. The proposed North Bellbird development falls within three rings centered on Mt View High School, West Cessnock Primary School and Bellbird Primary School. Given that these three schools are in existing residential zones, land within the proposed North Bellbird development within 5 kilometres of the Mt View High School and 2 kilometres of the two primary schools is delineated as an opportunity for residential 2a urban growth.

The CWSS Stage 1 identifies the following series of social constraints associated with the current dispersed settlement growth patterns within the Cessnock LGA that will be reduced through the implementation of the CWSS:

- Currently a large number of schools are dispersed throughout the Cessnock LGA. The clustered (radial) development about schools adopted in the CWSS ensures future residents have appropriate access to school facilities from the residential core and residential fringe layers in the settlement hierarchy. The settlement strategy limits school bus travel distances and subsidies.
- The CWSS limits access problems to and duplication of community services that are caused by the existing dispersed settlement patterns.
- Clustered (radial) residential development within the CWSS is consistent with the Council's need to rationalize open space provision within the LGA (currently the LGA has excessive open space provision within existing settlement areas) and to upgrade facilities.
- Current housing is occupying commercial land within service centres – village and town centres – that could be better used for commercial purposes.

The CWSS Stage 1 identifies the following community vision and values for the Black Creek Catchment:

- A strong desire to maintain rural character and amenity of the catchment;
- Development should be ecologically sustainable;
- A desire to keep catchment free of industrial development;
- Productive agricultural land to be preserved;
- Vineyard development should be sufficiently separated from urban settlement;
- Buffers and corridors should be placed between different types of land uses;
- A desire to see an increase in the provision and standard of public infrastructure and provision of parks, playground areas for community and tourist use; and
- A desire to increase the availability of public transport.

The CWSS (Stage 2) examines the LGA's future commercial/industrial needs. It is intended that both Stages 1 and 2 of the CWSS will inform the content of a new planning instrument for the Cessnock LGA. The current planning instrument for the LGA is the Cessnock LEP 1989.

2.2.4 Social and Community Plan 2004-2009

Cessnock City Council has recently prepared a Social and Community Plan to guide the future planning and development of services that contribute to the health and wellbeing of residents, as well as the provision of support, facilitation and co-ordination of established services and networks of importance to the community. The plan was developed in consultation with communities within specific environs of the LGA. Key social and community concerns raised by the local community focus group from the Bellbird/West Cessnock area, immediately to the

east and south of the new development that could be addressed through the new development include the need to:

- Create local business opportunities to increase employment;
- Increase apprenticeship and traineeship opportunities;
- Introduce different cultural activities to the area;
- Provide opportunities to help bridge the gap between the "haves" and "have-nots";
- Increase youth opportunities (i.e. co-op to develop resources for youth).

Key social and community concerns raised by the local community focus group from the Millfield/Mt View area immediately to the north of the new development include:

- Uncertainty about future land-use and concerns that the village feel and lifestyle will be lost;
- Littering and vandalism of parks and streetscapes;
- Need for more festivals and cultural facilities;
- Lack of transport to and from educational institutions, with the area isolated from public transport; and
- Property owners of Mt View fell that they are "out of site and out of mind" in regard to Council services.

What follows is a list of key community issues identified within the Social Plan for the entire Cessnock LGA that are of relevance to the proposed North Bellbird development and a brief outline of Council"s proposed response, where appropriate:

- Extensive waiting lists for childcare for children aged 0-3 and lack of flexible care options. In response, Council intends to: relocate and expand the Cessnock Multi-Purpose Children's Centre and fund additional places for after hours respite services provided by Samaritans Family Day Care Scheme.
- Lack of transitional links for children/ young people in years 6 to 7. In response to this issue, Council intends to improve appropriateness of vacation acre for children over 9 years of age.
- Lack of accessible, affordable and flexible transport services for youth and women.
- Lack of affordable and culturally appropriate entertainment for young people, aboriginal specific entertainment and diverse cultural events and celebrations.
- Limited access to services re drug and alcohol use, mental health and sexual health for young people.
- Lack of accommodation for young people, affordable housing for older people and emergency and crisis housing for both men and women.
- Reduced access to employment, education and training for women due to limited childcare options, and young people due to transport access.
- A need to make public spaces safer. In response to this issue, Council intends to involve young people in the design of public space, and utilise CPTED in new developments.
- Lack of female GPs and need to improve outreach services for women.
- Lack of culturally appropriate medical and outreach services for Aboriginal and Torres Strait Islanders.

- A need to enhance existing disability services, and services to people with HIV and AIDS.

Key strategies contained within the Social Plan include:

- New community facilities within Cessnock LGA are to correlate with service outreach demands identified in the Social and Community Plan;
- A Civic Precinct will be created in Cessnock which includes provision of key community facilities including a new multi-purpose community centre and quality open/public space;
- All land use planning processes are to include a formal Social Impact Assessment;
- The needs of people with disabilities are to be considered, in line with Council's Access DCP.

2.2.5 Draft Outdoor Recreation and Open Space Plan

Council has recently prepared a draft 2004 Recreation and Open Space Plan to replace its existing 1996 Plan. The objectives of the draft plan are to:

- Examine the existing supply and effectiveness of reaction facilities and open space throughout the LGA;
- Identify and assess existing and future community needs for all recreation facilities and open space settings throughout the LGA;
- To emphasise the dynamic nature of planning in the recreation are; and,
- Provide the basis for community to determine the direction of recreation and open space development.

2.2.6 Council's Social Impact Assessment Procedure and Guidelines

Social Impact Assessment Procedure and Guidelines May 2003 requires a Social Impact Assessment (SIA) to be carried out for "large scale residential developments" like that proposed for North Bellbird. The SIA for the proposed development at North Bellbird is required because it has the potential to:

- Change the characteristics of the general population;
- Impact on existing housing stock;
- Cause additional utilisation of community infrastructure (i.e. community halls, childcare facilities, sporting and recreation);
- Require additional support services;
- Impact on community identity;
- Impact on cultural identity.

The SIA Guidelines set out the elements of a social impact assessment required by Council, as follows:

- *Description of the Development* – detailed understanding of the housing mix, anticipated population/ customers; construction timeframe and phases; and community facilities and services provision.

- *Social Impact Assessment* – preparation in accordance with Council's Social Impact Assessment Checklist and Section 79 (1b) of the EPAA. Key areas of analysis within this section include: population; community structure, character, values and beliefs; health and safety; social cohesion; income levels, cost of living, employment; housing; accessibility; sense of place and community; interaction between development and the community; and impact on existing services.
- *Conclusions on Social Impacts*
- *Addressing Issues and Monitoring Social Impacts.*

2.2.7 Section 94 Contribution Plans

Cessnock City Council adopted a Section 94 Contributions Plans for residential areas in 2003 – *Cessnock Section 94 Contribution Plan: Residential Development*. The plan identifies contributions required from development to accommodate natural population growth to 2011. Council has advised that the large scale of the proposed residential development at North Bellbird is beyond the expected residential development identified in its *Section 94 Contribution Plan,* and will require the preparation of a separate Section 94 plan that relates specifically to the site. Whilst not directly applicable to the proposed development, the *Cessnock Section 94 Contribution Plan* provides a series of formulas and contribution rates that can be used to inform the planning agreement that will be prepared for the site. In terms of social infrastructure, contributions are currently being levied for:

- Both district and local open space, including land acquisition and embellishments
- Community facilities and upgrading of community halls
- Library facilities
- Bushfire fighting facilities

2.3 Summary of Policy Implications

The planning policies reviewed within this chapter together provide consistent direction and a framework of social objectives to guide the further planning of the site. Council policies and strategies require the following studies and plans to be carried out for the new development:

- a development specific Social Impact Assessment (ie Stages 1 and 2 of the Community Impact Assessment),
- a development specific Section 94 Contribution Plan, and
- a Strategic Plan for the new community (which may equate to the Structure Plan).

In addition, the various plans and polices have implications for:

- The nature and character of development required to achieve sustainability objectives and Council's urban development objectives;
- The facilities, services and open space areas to be provided within the development, and those requiring enhancement in the wider district.

3. Profile of Population and Housing in the Surrounding Area

The characteristics of the population in and around the North Bellbird site have been examined and compared with those of Cessnock LGA and NSW as a whole to:

- Assist in identifying potential impacts of future development on the existing population in adjoining areas; and
- Assist in developing population projections, based on who is already being attracted to live in the area.

ABS 2001 and 1996 Census Community profiles have been used as the basis for analyzing population and dwelling data for each of four areas – NSW Statistical Division, Cessnock LGA, Bellbird / West Cessnock and Mt View , as follows:

- Bellbird/West Cessnock includes Cessnock West, Bellbird Heights and Bellbird and equates to six ABS 2001 collector districts: 1131301, 1131304, 1131305, 1131507, 1131508, 131509;
- Mt View includes Vineyard Grove and part Cessnock West and equates to one ABS 2001 collector district: 1131303;
- Cessnock LGA equates to ABS 2001 LGA 11720 Statistical Division;
- NSW equates to ABS 2001 1 Statistical Division.

3.1 Population size

The population of each of the four areas in 2001 is shown in Table 1.

Table 1: Population Size

	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
2001	5,719	890	45,204	6,371,745
1996	Not available	Not Available	44,362	6,038,696
1991	Not available	Not available	43,854	

This table shows that Cessnock LGA as a whole has undergone below average growth between 1996 and 2001 of only 1.8%, compared to NSW which experienced a growth rate of 5.5% for the same period. Whilst the growth rate in Cessnock was below average for the census period 1996-2001, it was 50% greater than the rate in the previous census period 1991-1996.

- Whilst there is no comparative data for population growth within the Bellbird/West Cessnock area and Mount View area for 1991-2001, Council has provided the following overviews: Population growth within Bellbird/West Cessnock has been steady, while population growth within the Mt View area has been significant due to the development of the new Vineyard Grove Estate.

Cessnock LGA is currently estimated to contain about 48,661 people and is planned to grow to 50,239 by 2011. This does not take account of a number of large developments foreshadowed by the CWSS.

3.2 Age profile

The age profile of each area is shown in Table 2 below. Key findings are:

- In comparison with the NSW average, Cessnock LGA has a higher proportion of children under 14 years, a lower proportion of adolescents and young adults, an average proportion of adults aged 35-69 and a higher proportion of people aged 70+;
- Bellbird/ West Cessnock has a higher proportion of people aged 60+ in comparison with Mt View, the rest of the Cessnock LGA and NSW. It also has a high proportion of young children 0-4 years, although its proportion of young adults is only marginally higher than that of Cessnock LGA.
- Mt View has a significantly lower proportion of older people (aged 70+) in comparison with Bellbird, the rest of Cessnock LGA and NSW. It has a correspondingly higher proportion of pre-school aged children, adolescents and young adults under 24 years.
- Both Bellbird/West Cessnock and Cessnock LGA have a median age above the state average of 35 years, while the median age in Mount View is below the state average at 33 years.

Table 2: Age structure by proportion of the population 2001 (Excludes visitors)

Age	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
	%	%	%	%
0-4	7.9	8.3	7.1	6.7
5-9	7.7	6.9	7.9	7.2
10-14	7.8	9.2	7.7	7.1
15-24	13.3	14.2	12.9	13.4
25-34	13.2	13.8	13.0	14.5
35-49	21.5	22.6	21.9	22.1
50-59	9.0	12.6	12.1	11.7
60-69	8.6	8.6	7.7	7.9
70+	11.0	3.8	9.7	9.4
Total	100	100	100	100
Median age	36.4	33	36.3	35

While 1996 data for Mount View and Bellbird/West Cessnock is not available, it is worth noting that for Cessnock LGA as a whole between 1996 and 2001:

- The median age rose from 34 years to 36.3 years,
- The proportion of children aged 0-4 years fell from 11.6% of the population to 7.1%,
- The proportion of people aged 65+ rose from 12.7% of the population to 13.4%.

In other words, the population of Cessnock is an ageing one.

3.3 Families and households

Table 3 shows the proportion of different types of households and families in each area. Key findings are:

- The Cessnock LGA profile is reasonably similar to that of NSW as a whole, with comparative proportions of couple with children and couple without children households. However Cessnock has a slightly higher proportion of single parent families and much lower proportion of group households.
- Mount View has a particularly high proportion of family households comprising couples with children, in comparison with Bellbird/West Cessnock and Cessnock LGA, and a corresponding lower proportion of couples without children, group households and lone person households.
- Bellbird/West Cessnock is characterized by a high proportion of households comprising one parent families and groups, but is otherwise consistent with the Cessnock LGA and NSW profiles.

Table 3: Household type 2001

	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
	%	%	%	%
Couple with Children	52.9	63.1	54.1	54.5
Couple without Children	19.5	17.9	19.6	20.1
One Parent Families	16.5	12.4	14.4	11.9
Other Family household	1.9	0.0	1.0	1.1
Lone person household	9.1	5.7	9.2	9.0
Group household	2.9	0.9	1.7	3.4
Total	100	100	100	100

3.4 Cultural and Linguistic Diversity

The proportion of the population of each area born overseas and speaking a language other than English at home is shown in Table 4 below.

Table 4 Place of Birth and Language Spoken at Home

	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
Born in non English speaking country	2.0	2.0	2.2	14.4
Born in English-speaking country	3.6	4.0	4.1	8.8
Total overseas born	5.6	6.0	6.3	23.2
Australian born	86.7	87.4	87.2	69.9
Speaks English only	91.9	93.2	92.2	75.0
Speaks language other than English at home	1.4	2.3	1.6	18.8

Cessnock LGA and the two smaller areas have a reasonably consistent profile in relation to cultural and linguistic diversity. This profile differs significantly from that of NSW as a whole, in terms of its very low proportions of people of non English speaking background and those speaking a language other than English at home.

Further analysis of this data shows that the:

- Main non English speaking countries from which residents of Cessnock as a whole have come are Germany, China, Netherlands, Poland and Philippines.

- Numbers of residents of Aboriginal or Torres Strait Islander background living in Cessnock LGA are very low. In 2001, there were 661 people (1.5% of the population) who identified in this way.

3.5 Income

Table 5 below shows that compared with NSW as a whole, Cessnock LGA has a lower proportion of high income households and a higher proportion at the lower income end of the spectrum. More than half of all Cessnock LGA households have an income lower than the average for the NSW Statistical District.

The table also shows that Mount View has a markedly greater concentration of high income households than the rest of Cessnock LGA, with a significantly higher proportion of people in each of the three highest income brackets and lower proportion in each of the three lowest income brackets. This reflects the relative exclusivity of the area and its attractiveness to more affluent households. The proportions of Mount View household incomes across all brackets are generally closer to those for the NSW Statistical District than for Cessnock LGA. There is, however, a higher proportion of the Mount View population (32.7%) in the upper two income categories than the NSW average (28.1%), although proportions in the lowest two categories are much the same (at around 33%).

The Bellbird/ West Cessnock profile is relatively close to that of the Cessnock LGA, although marginally more affluent. This means that there are quite significant differences in the income profiles of Mount View and Bellbird/West Cessnock, despite their physical proximity. In Mount

View 33.9% of the population has household incomes in the lowest two income brackets, compared with 50.8% in Bellbird/West Cessnock. Correspondingly, Mount View has 32.7% of its population in the two highest income brackets, compared with 16.3% for Bellbird/West Cessnock.

The differences among areas are clearly apparent when the median weekly household income is considered. While Mount View has an average weekly household income the same as that of NSW as a whole, both Cessnock LGA and Bellbird/West Cessnock have average household weekly incomes two brackets below those of Mount View and NSW as a whole.

Table 5: Weekly household income by total households 2001

Income	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
	%	%	%	%
$0-$399	21.3	15.3	30.1	13.7
$400-$699	29.5	18.6	22.5	19.9
$700-$999	13.7	10.2	13.9	15.4
$1,000-$ 1,499	16.2	19.5	15.2	20.2
$1,500-$1,999	10.3	15.3	8.1	14.2
$2,000 or more	6.0	17.4	5.2	13.9
All incomes not stated	3.0	3.9	5.0	2.7
Total	100.0	100.0	100.0	100.0
Median weekly household income	$600-699	$800-999	$600-699	$800-999

3.6 Employment

Mount View has a significantly higher proportion of its population in the labour force, employed, and employed both full and part-time, than the NSW average. Unemployment rates in 2001 were correspondingly significantly lower than the NSW average.

In contrast the Cessnock LGA and Bellbird/West Cessnock areas have a significantly higher unemployment rate than the NSW average. Also of note are the relatively lower rates of participation in the labour force in Cessnock LGA and Bellbird/West Cessnock. This is in part related to the higher than average proportions of older people above the standard retirement age.

Table 6: Employment status 2001

Status	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
	%	%	%	%
Employed:				
Full-time	57.1	61.2	54.6	61.0
Part-time	28.5	31.4	30.6	29.0
Not stated	2.9	3.1	3.4	2.9
Total	*88.5*	*95.7*	*88.6*	*92.9*
Unemployed	11.5	4.3	11.4	7.1
Total labour force	100	100	100	100
Total in labour force	48.9	62.7	52.0	59.3
Total not in labour force	43.6	34.9	42.6	36.0
Not Stated	7.5	2.4	5.4	4.7

*calculated as a percentage of the total labour force.

Table 7 below outlines the occupational profile of the workforce. Compared with NSW as a whole, Cessnock LGA and the two small areas have a much lower proportion of managers/administrators and professionals and higher proportion of "blue collar" workers - tradespersons, production and transport workers, and labours.

Also of note is the much higher proportion of managers/administrators, professionals, and clerical and sales workers (ie "white collar" occupations) living in the Mount View area in comparison with Bellbird/West Cessnock. Corresponding to this is a lower proportion of "blue collar" workers in Mount View than in Bellbird/West Cessnock.

Table 7: Occupation 2001

	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
	%	%	%	%
Managers and Administrators	3.2	5.7	5.0	9.5
Professionals	9.7	10.0	10.4	19.1
Associate Professionals	10.0	10.8	10.0	11.6
Tradespersons and Related Workers	17.5	12.0	17.0	11.9
Clerical, Sales and Service Workers	30.5	36.1	28.5	30.0
Production and Transport Workers	15.1	13.6	14.8	7.9
Labourers and Related Workers	13.0	10.3	13.1	8.0
Inadequately described / Not stated	1.0	1.5	1.7	2.0
Total	100.0	100.0	100.0	100

Table 8 shows that compared with NSW as a whole, Cessnock LGA and both the small areas have a significantly:

- Higher proportion of their population employed in agriculture, forestry, fishing and mining which is expected, given Cessnock's rural location and proximity to the Hunter Valley coal fields and vineyards.
- Lower proportion of their population employed in finance, insurance and business services, public administration and communication services.

Compared with Bellbird/West Cessnock, the Mount View area has: a higher proportion of people engaged in wholesale/retail trade and within the areas of education, health and community services; and lower proportion engaged in the transport and utilities industries.

Table 8: Industry Type

	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
	%	%	%	%
Agriculture, forestry, fishing, mining	13.2	11.7	10.8	3.9
Manufacturing	11.2	10.7	15.6	11.5
Electricity, gas, water	1.1	0.0	0.6	0.7
Construction	5.8	4.2	6.6	6.9
Wholesale/retail trade	30.6	37.7	29.0	24.9
Transport and storage	4.4	0.8	3.5	4.6
Communication services	0.8	0.8	0.9	2.0
Finance, insurance, business services	7.5	8.3	7.8	17.0
Public admin and defence	2.4	2.3	2.4	3.8
Education, health, community services	14.7	19.3	14.8	16.4
Recreation, personal services	5.4	4.2	5.4	6.0
Not classifiable, not stated	2.9	0.0	2.6	2.3
Total	100	100	100	100

3.7 Education

Cessnock LGA and the two small areas differ from the NSW average in terms of having a significantly lower proportion of people with university qualifications and higher proportion with vocational certificates or no qualifications. This trend is also reflected in current university enrolment rates detailed in Table 10.

Consistent with the higher socio-economic status of residents in Mount View, Mount View has a higher proportion who have attained all levels of educational qualifications in comparison with both Bellbird/West Cessnock and Cessnock as a whole.

Table 9: Level of education 2001

	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
	%	%	%	%
Bachelor or higher Degree	3.6	6.1	4.4	13.6
Advanced Diploma and Diploma	3.3	4.9	3.4	6.2
Vocational Certificate	18.7	22.7	19.0	16.4
No qualifications	59.2	55.3	59.2	51.5
Not stated	15.2	11.0	14.0	12.3
Total	100.0	100	100.0	100

Cessnock LGA and the two smaller areas have a lower proportion of their students attending non-government high schools, in comparison with the rest of NSW. This is consistent with their relatively lower socio-economic profiles, but also reflects the lack of non-government high school options within Cessnock.

Consistent with its age profile and high proportion of young children and adolescents outlined above, Mount View has a relatively high proportion of its population attending pre-school, primary school and secondary school, compared with Bellbird/West Cessnock.

Table 10: Type of educational institution attended

	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
	%	%	%	%
Pre-school	1.5	1.9	1.6	1.5
Primary school	7.6	8.9	10.1	9.2
Secondary –government	5.0	7.4	5.4	4.4
Secondary - independent	1.0	1.8	1.3	2.5
Secondary total	6.0	9.2	6.7	6.9
TAFE	3.1	2.5	*3.2*	3.2
University	1.1	1.6	1.4	3.7
Other	0.5	0.7	0.5	0.9
Not attending	71.1	71.0	69.8	69.2
Not stated	3.1	4.2	6.7	5.4
Total	100	100	100	100

3.8 Computer Use

Computer use in Cessnock LGA and the two smaller areas was significantly below that of NSW as a whole in 2001. By contrast, usage of computers generally and the internet in particular was higher in Mount View than in Bellbird/West Cessnock and the Cessnock LGA as a whole.

Table 11: Computer Use

	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
	%	%	%	%
Total computer users	28.7	38.7	31.9	41.2
Total non computer users	70.1	58.2	62.5	54.4
Not stated	5.5	3.1	5.6	4.3
Uses internet	21.1	28.5	22.8	36.1
Do not use internet	72.8	68.6	70.7	58.1
Not stated	6.0	2.6	0.3	4.9

3.9 Housing

In terms of housing type, Cessnock LGA and both small areas are characterised by an overwhelming predominance of separate houses, compared to NSW as a whole. Medium density forms of housing (both town houses and apartments) make up only a very small proportion of the housing stock. Associated with this, and the higher proportion of children, adolescent and couple family household in Mount View, the average household size in Mount View is higher than NSW or Cessnock LGA as a whole.

Table 12: Housing type as a proportion of all dwellings 2001

	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
	%	%	%	%
Separate House	85.1	90.3	85.2	64.1
Semi-detached/ terrace house	3.8	1.5	1.4	8.5
Flat/Unit/Apartment	4.0	0.9	2.5	16.2
Other (Caravans, cabins, etc)	0.9	0.0	1.1	1.5
Not stated	1.4	0.0	0.9	0.8
Total	95.2	92.7	91.1	91.1
Mean household size	2.57	2.90	2.60	2.60

Table 13 indicates that a high proportion of dwellings in Cessnock LGA and the two smaller areas are owned or being purchased, in comparison with the NSW average. The proportion of housing stock available for rental is below the NSW average. Bellbird/West Cessnock has a lower level of home ownership and correspondingly higher proportion of rental housing than Mount View or the overall Cessnock LGA.

Table 13: Housing tenure as a proportion of all private dwellings 2001

	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
	%	%	%	%
Fully owned or being purchased	67.1	75.1	73.1	64.4
Rented	23.7	18.1	19.0	27.5
Other	1.9	1.9	2.9	2.8
Not stated	7.3	4.9	4.9	5.3
Total	100	100	100	100

3.10 Car ownership

Associated with its location in the rural hinterland of the Lower Hunter Valley, its high proportion of rural and semi-rural lands and limited availability of public transport, rates of car ownership are slightly higher in Cessnock LGA when compared with NSW as a whole.

When comparing the two smaller areas, the proportions of households owning no vehicle or only one vehicle are considerably less in Mount View, while the proportions owning two, three or more vehicles are significantly higher.

Table 14: Car ownership

	Bellbird-Cessnock (West)	Mount View	Cessnock LGA	NSW
	%	%	%	%
No vehicle	11.9	3.9	10.1	12.0
1 vehicle	40.9	32.3	38.9	39.8
2 vehicles	28.5	45.5	31.9	30.1
3 or more vehicles	10.2	12.6	12.7	10.8
Not stated	8.5	5.7	6.4	7.3
total	100	100	100	100

3.11 Conclusion

While the population of the Cessnock LGA is similar to that of NSW as a whole in many ways, it also differs in some important ways:

- It has a slightly higher proportion of children and of older people 70+, and a slightly lower proportion of young people and young adults;
- It has a slightly higher proportion of one parent family households, and low proportion of group households;
- It is relatively culturally homogeneous and has low proportions of both indigenous people and people from non English speaking backgrounds;
- It has relatively lower proportions of residents in the higher household income brackets, significantly lower average weekly household income, and higher rates of unemployment;

- It has lower proportions of people with university qualifications and employed in professional and managerial occupations, and higher rates with no qualifications working in lower skilled occupations;
- It has very high rates of home ownership and slightly higher rates of vehicle ownership;
- A very high proportion of its housing stock is separate houses, with very low proportions of medium density dwelling types.

The population living immediately adjacent to the North Bellbird site has been analysed to identify particular characteristics that may be important from the perspective of social integration between the new and existing populations. This analysis has shown that both Bellbird/West Cessnock and Mount View differ from the Cessnock profile in some important ways, and differ from each other quite significantly.

The Bellbird/West Cessnock population is characterised by the following features when compared with Cessnock LGA as a whole:

- Its higher proportion of older people aged 60+;
- Its lower proportion of people with tertiary qualifications;
- Its slightly higher rates of household income, lower labour force participation, and lower proportion of managers /administrators and professionals;
- Its lower use of computers and the internet;
- Its higher proportion of rental accommodation.

On most dimensions, however, the Bellbird/West Cessnock population is reasonably similar to the profile of Cessnock LGA.

In contrast, the Mount View population differs from that of Cessnock LGA and Bellbird/West Cessnock in a number of significant ways. These include:

- Its very high proportion of couple families with children and young people, and much lower proportion of older people 70+;
- Its significantly higher levels of average household income, and proportions of the population in the higher income brackets,
- Its higher proportion of people with tertiary qualifications and in “white collar” occupations;
- Its higher rates of labour force participation and lower rates of unemployment;
- Its higher rates of private school attendance;
- Its higher use of computers and the internet.
- Its higher rates of home ownership/purchase;
- Its higher rates of multiple vehicle ownership.

4. Existing Community Facilities and Services

Existing community facilities and human services in the area surrounding the North Bellbird site have been identified and examined to assess:

- Their availability and accessibility for the incoming population;
- Their suitability; and
- Their capacity to absorb demand that may be generated by the future community of the North Bellbird site.

Some types of facilities and services have a local catchment, while others are provided on a district or regional level. Accordingly, the study area selected for this assessment has varied according to the type of service or facility. The focus for local level services has been the areas immediately surrounding the sites, and further afield within the town of Cessnock, while district level services have included all of Cessnock LGA, and regional services have considered the wider Lower Hunter Region.

An overview of issues associated with each type of service or facility is provided below.

4.1 Community Centres

Community Centres provide space for a variety of local community activities, for community meetings, for sessional and outreach services, and for private functions such as birthday parties. They also provide a focal point for community development initiatives.

Cessnock City Council is currently in the process of developing and upgrading its community halls into Neighbourhood Community Centres and selling off those which are not adaptable to this purpose. The Council intends using these community centres for local outreach services and as a facility for local resident groups, whilst centralising regional community services within the new Cessnock Civic Precinct. It should be noted that these Neighbourhood Community Centres are merely spaces for community activities and so are generally not staffed unless activities are taking place.

The closest community halls to the site are in Bellbird and Cessnock West. As a Neighbourhood Community Centre the Bellbird Community Hall is being heavily utilised on a weekly basis by a variety of outreach services, indoor recreation activities, playgroups, lifestyle groups, dance classes, and social gatherings. Cessnock Council recently sold the Cessnock West Hall because of its inadequate facilities and limited adaptability. Neighbourhood Centre services that would have been provided out of the Cessnock West Hall are currently been provided from the Indoor Basket Ball Stadium to the north of the site. The Bellbird Hall and Indoor Basket Ball Stadium are available for use by community groups on a commercial basis. The Bellbird Hall is already operating at capacity and will have no ability to meet the needs of the new North bellbird population. Over time Council is seeking to replace the Bellbird Hall with a purpose built community centre on a larger, more appropriate site within adjoining new development.

Cessnock City Council is currently planning a new Multi-Purpose Community Centre for the Cessnock area 2km to the east of the site within the proposed Cessnock Civic Precinct. This Centre will address a diverse range of community needs within one multi faceted building. The key components will be: a divisible auditorium capable of holding approximately five hundred (500) people; a specific performing arts centre with a 120 seat theatre; café; community meeting rooms; a Senior Citizens Centre that will be fully accessible and aim to address the needs of the senior citizen community on a daily basis. The new multi-purpose community centre will replace several existing community facilities within the Cessnock area which are currently heavily used by both the existing Cessnock community and the wider community as district level resources, such as the Cessnock Pensioners Association facility on North Avenue. The new facility will also be home to the Cessnock City Council's Community Development Office.

The Samaritans currently operate a Community Centre in Cessnock which provides a range of services, programs and support to the community as well as information, referral and advocacy, office and meeting space. The venue is heavily utilised by a variety of community groups and outreach services such as Jobs Placement Employment and Training (JPET, Australian Hearing, Financial Counselling Service, Hunter Community Legal Service, Emergency Relief, Cancer Support Group, a Community Aid Panel, Family Adolescent Counsellor, and Mental Health Support.

It should be noted that most of the public schools are also used significantly as venues for community activities.

A key issue with regard to community centres is the need for sustainable maintenance and management arrangements. Currently the community facilities are managed directly by Cessnock Council.

4.2 Children's services

Services for children available in the Cessnock area include:

- Long daycare for children aged 0-5 years;
- Pre-school for children aged 3-5 years;
- Occasional care for children aged 0-5 years;
- Before and after school care for primary school children; and
- Vacation care for primary school children.

Currently there is only one childcare centre within Cessnock which offers long daycare, the Multi-purpose Child Care Centre located in Dudley Street. This centre currently provides 45 long day care places and a further 40 pre-school places. The centre is running at full capacity or close to full capacity, has an extensive waiting list for 0-3 years, and is currently looking to add an additional 5 places for 0-3 years. Priority within this facility is given to children of working/studying parents (a significant component of the parents are single teenage mothers). A DA has been submitted to relocate this facility to a new site within the civic precinct.

A new 72 place long day care facility is currently proposed, to be operated as a private centre by ABC Learning, and will be located on Quarrybylong Street, Cessnock. This centre is

intended to address the high unmet demand for long daycare within Cessnock, but it is not clear whether it will also have any capacity to meet demand likely to be generated by the North Bellbird development.

Long daycare for children 0-4 years is also provided through the Family Day Care scheme provided by the Samaritans. The Samaritans currently have 35 carers that provide services from their own home and 3 travelling carers. These carers provide services to working/studying parents as well as respite care and emergency care. Of the 35 home based carers, 3 are located in Bellbird and 14 are located in Cessnock. No carers operate from homes in the new Vineyard Grove Estate area to the north of the site. Each of these carers can look after up to seven children. Several of the carers within the Cessnock and Bellbird area are currently operating below capacity.

There are a further four facilities in the Cessnock area that provide pre-school services for the 3-5 age cohort, and all except one have been operating at full capacity for some time.

Occasional care within the area surrounding the site is provided at the Cessnock Occasional Care Centre which provides 29 places and has been operating at full capacity for some time.

A number of playgroups providing informal activities for young children and their parents operate from community centres across the LGA. The two closest playgroups meet at 2 Hetton Street and 14 Kearsley Street, Bellbird.

Before and after school care and vacation care services for the 5-12 year age cohort within the Cessnock area are provided by the Cessnock Multipurpose Children's facility. The facility provides 40 before school care places and 60 after school care places. These services are currently under utilised, with 17 free before school places and 25 free after school places available. The facility provides 90 vacation care places in two facilities within Cessnock. These facilities met full capacity for several days during 2004, but generally average free capacity of 15-17 places.

The provision of childcare services is summarized in Table 15 below.

Table 15: Current Childcare Services in Cessnock Area

Venue	Suburb	Provider type	Full Day care places (DC)	Pre – school places (PS)	Before /after School Care Places (BSC)	Vacation Care Places (VC)	Capacity 2005-2006
Cessnock Multi-purpose Children's Centre (CMPCC)	Cessnock	Multi-purpose facility	45	40	100	45	No spare capacity for 0-5's and long waiting lists Some spare capacity for out of school care
Samaritans Family Day Care Daycare	Cessnock	35 at home Carers (0-5yrs)	Approx 175 places				Some spare capacity has been identified.
Proposed ABC Facility	Cessnock	Long daycare	72				
Bellbird Pre-School	Bellbird	Pres-school		20			Full
Aberdare Pre-school	Aberdare	Pre-school		35			free capacity 2-3 places
Natural Step Pre-school	West Cessnock	Pres-school		29			Full
Nalkaba Pre-school	Nulkaba	Pre-school		29			Full
Cessnock High School (outreach for CMPCC)	Aberdare	Vacational care				45	VC free capacity generally 15-17 places, capacity only met on 2 days during 2004.
Cessnock occasional Care (part for CMPCC)	Cessnock	Occasional care facility	29				Full Provides 8 places for 0-2yrs and 10 places for 2-3 places

4.3 Education

In terms of public schools, the closest primary schools to the site are at Bellbird and West Cessnock. The Bellbird Primary School is operating with demountable accommodation (6 classrooms) due to a small number of permanent class rooms (7). The small size of the site limits any further expansion. Since the mid 1990s enrolment at Bellbird has been declining and based on current population growth for the area, the Department of Education and Training (DET) expects this decline to continue, dropping to an enrolment of about 240 students by 2010. Based on previous peak enrolment rates reached in 1995, Bellbird Primary School has the capacity to absorb about 140 additional students. The enrolment at West Cessnock Primary School is currently 401; DET expects this enrolment to decrease to 360 by 2010. Based on the previous peak enrolment rate in 1990, the school has the capacity to absorb at least 214 additional students. In other words, both the local primary schools have some spare capacity which could be used by the North Bellbird development.

In the wider area, Cessnock East Primary School and Cessnock Primary School both have spare capacity and a declining or stagnant enrolment pattern. Based on previous peak enrolment rates and current enrolment trends, these primary schools have the capacity to absorb approximately 200 additional students. When this is added to the current spare capacity in Bellbird and West Cessnock primary schools outlined above, it appears that local primary schools have capacity to absorb over 550 new enrolments (refer Table 16 below).

The extent to which this spare capacity might be sufficient to meet the needs generated by North Bellbird will need to be examined in the Stage 2 Community Impact Assessment, when a full social infrastructure strategy will be prepared. In particular, this issue will require preparation of population estimates for all age cohorts, which can only occur once dwelling yield, mix and target market projections have been confirmed. However, given the proposed scale of the North Bellbird development, it is likely that existing schools will be unable to absorb all future demand, and that at least one new primary school will also be required. The existence of spare capacity in surrounding primary schools will influence the timing of provision of any new school, for children in the early years of settlement will be able to attend existing schools until sufficient numbers build up to justify a new school within the development.

For high schools, the site is within the catchment area of two existing high schools – Mount View High School immediately to the north of the site and Cessnock High School approximately 3km to the east in Aberdare. Mount View High School is reasonably new and its enrolment has grown steadily to reach a peak of 1046 students in 2005. It is currently operating at full capacity and already has additional demountable teaching space. DET expects enrolments at Mount View High to remain continuously above 1000 until early next decade, based on existing population demand. Whilst Mount View High currently has no spare capacity, its site area is large and potentially could provide some room for expansion. However, a school of about 1,000 students is already considered to be a large one, and there are limits to growth. Cessnock High School's current enrolment is below 650 students and has experienced a gradual decline in enrolments since the early 1990s. Based on these current enrolment trends and existing teaching space, there is currently spare capacity of about 350 places. The site will not permit any further expansion.

A strategy to meet the high school needs generated by the development will need to be developed in conjunction with DET. There may be scope to change the zoning catchment areas of the high schools, to divert more students to Cessnock High in order to make space at Mount View for those living at North Bellbird. Provision of a new high school will also need to be considered. This will depend on the final development and population projections for the site.

For Catholic schools, the closest primary schools are St Patrick's in Cessnock and Holy Spirit Infants School 14km to the north in Abermain. Both these schools are considered to have reached their maximum capacity and will be unable to absorb a large number of additional students. No Catholic High School is located in the LGA, with students predominately travelling to either the Maitland or Newcastle areas. The Newcastle-Maitland Dioceses is currently exploring the possibility of providing a new high school on a piece of land already owned by the Dioceses at the intersection of Blackhill Road and John Renshaw Drive which is approximately 25km north-east from Cessnock. It is proposed that this site will begin as a High School with the later addition of a primary school. However, this site is considered too far away to address any substantial demand generated at North Bellbird.

Table 16: Schools

School Name	Level	Permanent Rooms	Perm. Student Accommodation	Temp. Rooms	Peak Enrolment 1990-2005	2005 Enrolment	2010 Enrolment Projection	Additional Capacity
Bellbird Public School	Primary	7	180	6	378	288	240	138
Cessnock East Public School	Primary	10	260		308	188		120
Cessnock Public School	Primary	19	490		459	406		84
Cessnock West Public School	Primary	19	490		574	401	360	214
Cessnock High School	Secondary	52	1000		784	641		359
Mount View High School	Secondary	44	800	4	1046	1046	1000	Full
St Patrick's Catholic Primary	Primary		349			349		Full

The closest tertiary education facility to the site is the Cessnock campus of the Hunter Institute of Technology (TAFE) which is located 1km to the north of the site and provides a range of adult and career training opportunities. Other key tertiary facilities within the surrounding region are provided at the Kurri Kurri Campus of the Hunter Institute of Technology (TAFE) and the Callaghan campus of the University of Newcastle. Community education is available through the Workers Education Association (WEA) which runs classes from the Kurri Kurri Community Centre.

4.4 Health Services

Public health services within Cessnock LGA are provided by Cessnock District Hospital, Maitland Hospital and the Cessnock/Kurri Kurri Community Health Service. Cessnock District Hospital is a 68 bed acute facility. Services include general medicine, general surgery, orthopaedics, urology, gynaecology, obstetrics and a 24-hour emergency department. It also provides a range of allied health services including physiotherapy, social work, dietetics, speech pathology and occupational therapy. The Cessnock area is also serviced by Maitland Hospital, which is a referral facility for the Upper and Lower Hunter Regions and is located 35 minutes from the John Hunter Hospital which is the principal referral hospital for the region. A comprehensive range of services is provided at Maitland Hospital including medical and rehabilitation, surgical and day surgery, and maternity and child services.

The Cessnock/Kurri Kurri Community Health Service provides a wide range of services located in both Cessnock and Kurri Kurri. Its Cessnock centre provides information about health related services and groups in the local area; counselling services; nursing assessment and home nursing; early childhood services; palliative care service; child health screening and immunization; support for families and individuals in times of stress; integrated services with local medical practitioners and hospitals; health education promotion and programs; runs special clinics on autometry, continence, womens' health, diabetes, genetics; and community development programs. All these services are heavily utilized and would have no capacity to meet the additional needs of the North Bellbird population under current resourcing arrangements. The capacity of this facility is more a function of staffing levels, rather than the

building itself, and these can be increased as population growth occurs, subject to additional recurrent funding from the NSW Government.

Community mental health services are provided by the Hunter Valley Mental Heath Team which is based at Maitland Hospital.

Approximately 8 private medical practices are located in Cessnock. The Cessnock Social and Community Plan notes that there is a particular lack of female GPs within the Cessnock LGA.

Within its 2004-2009 Social Plan, Council identifies a series of key shortfalls in the current provision of health services within the Cessnock LGA including: lack of public transport access to regional health services outside the Cessnock LGA, youth access to services re drug and alcohol usage, mental health and sexual health, and lack of medical facilities that are culturally appropriate to aboriginal people.

4.5 Welfare and Support Services

Branches of Lifeline, Samaritan Emergency Relief, St Vincent de Paul and the Salvation Army are located in the Cessnock Town Centre, providing emergency assistance, financial assistance and support to people in crisis. There is also the Cessnock Family Support Service, the Department of Community Services Community Service Centre, a CentreLink Office, disability support and accommodation services, marriage and family counselling services, and a range of other groups that provide families and individuals with support around issues such as domestic violence, diabetes, chronic fatigue, addiction, ageing and acrophobia. These services are all operating at capacity and will require additional funding for staff and programs if they are to meet the needs of the new population of North Bellbird.

Cessnock East contains a social housing estate of 140 dwellings. Another 200 social housing dwellings are scattered throughout Cessnock, with concentrations in North Bellbird and Cessnock West. Given the high concentration of social housing within Cessnock, the Department of Housing plays a significant welfare support role within the city.

4.6 Services for Older People

A number of aged care services to support older people living at home and their carers are provided in Cessnock LGA, with particular concentrations in Cessnock, Abermain and Kurri Kurri. Key services include the home modification and support service provided by the Aged Care Assessment Team operating out off the Kurri Kurri District Hospital, Lower Hunter Dementia Options Service operating out of offices in Kurri Kurri, aged health services provided by the Cessnock Community Health Services from its facilities in the grounds of Cessnock District Hospital, respite care at the Kaludah Day Centre in Abermain, home carer services provided by the Coalfields Neighbour Care and the Hunter Valley unit of the Home Care Service of NSW. Within the Cessnock area Meals on Wheels operates out of Cessnock District Hospital. District level services funded under the Home and Community Care Program are based at Newcastle and serve the entire Hunter region. All these services are currently heavily used and struggling to meet existing demand within the limits imposed by government funding levels. A particular shortage of facilities for respite care has been identified. There is currently

a lack of transport services to access aged care services both within and outside the LGA. Additional resources will need to be made available for aged care services to meet the needs of the new North Bellbird community, if that community is to contain significant numbers of older people.

Currently there is a high demand for self care accommodation for older people in the Cessnock area. This demand is currently being met in part by several existing accommodation complexes. These facilities primarily provide self-care accommodation. Residential aged care (nursing home and hostel places) is provided by North Coalfields Community Care Association (at the Jacaranda Grove Hostel, Mountain View Lodge Hostel, and Abernethy Nursing Home), Calvery Retirement Community Cessnock, Cessnock Masonic Retirement Village, and Cessnock House. Cessnock House is a nursing home for women only. The scale of demand for retirement housing will require further careful investigation if consideration is to be given to providing aged housing within the North Bellbird development.

Social and recreational activities for older people are provided at some of the neighbourhood community centres, including the Cessnock Pensioners Association facility on North Avenue. This centre will be absorbed into the soon to be completed new Senior Citizens Centre that will be part of the new multi-purpose community centre within the Civic Precinct.

4.7 Services for Young People

The Cessnock Youth Development Project operates out of offices in Kurri Kurri. The service aims to develop and support services available to young people in the Cessnock Local Government Area. Within Cessnock the Youth Development Program provides outreach services 4 days a week from the Cessnock Youth Centre & Outreach Service (CYCOS). CYCOS provides a range of education, vocational, social and recreational activities and programs for young people within the Cessnock area. The CYCOS is currently located within the Indoor Basketball Hall immediately to the north of the North Bellbird site.

Given the low school retention rates and high youth unemployment levels within Cessnock, both the Links to Learning and the Samaritan JPET program run programs to provide training and further education to early school leavers aged 15-24 years, and support and assistance to young people to overcome barriers to employment and training. However access to these services, as with the TAFE College, are limited by transport.

Youth experiencing difficulty within the Cessnock area have access to two counselling services – Samaritans Family Liaison Worker and an Adolescent and Family Psychologist. The St. Alban Youth Accommodation Service also provides a 24hr supervised accommodation service for young people that are homeless or at risk of being homeless.

Further facilities for young people include:

- The Cessnock PCYC, which provides a range of both indoor and outdoor sporting and recreational activities for young people.
- A Scout Hall and Guide Hall;
- The RSL also provides a Cadet program.
- There are a couple of youth groups run by churches in the Cessnock area.

Further recreational opportunities for young people are outlined in Chapter 5.

Specialist services for young people (health, accommodation, legal aid, employment, training, counselling) are also available in both Maitland and Newcastle. However access to these services is limited by poor public transport.

4.8 Libraries and Cultural Facilities

Cessnock Council's library service operates from three services points at Cessnock, Kurri Kurri and from a Mobile Library. Council is currently exploring the re-location of the Cessnock Branch Library to the proposed Civic Precinct. Library catalogues are available online at both the Cessnock and Kurri Kurri branch providing internet access to the public. Council's Section 94 Contributions Plan makes provision for contributions from all new development towards the provision of library services to ensure they keep pace with population growth. In additional to Council's library service, a research library and archive facility which collects documentation on the settlement and coal mining history of the LGA was established in the grounds of the Kurri Kurri High School in 1995.

The Cessnock LGA contains three regional museums: the Endeavour Museum at Wollombi, Greta Tidy Towns Museum at Greta, and the Sir Edgeworth David Memorial Museum in the ground of Kurri Kurri High School. These museums focus on the regions mining and settlement history.

Cultural facilities for community festivals and events, and the performing and visual arts are limited within Cessnock. The Council is seeking to rectify this in part through the construction of the new Performing Arts Centre within the Civic Precinct. Currently Council's halls and community centres, school halls and church halls are used for a variety of cultural activities. Other facilities operated by private providers in Cessnock that cater to cultural events include the Wine Interpretative Centre and the historic Marthaville Arts and Crafts Centre.

Other entertainment facilities include a cinema within Cessnock and a number of pubs and restaurants. Given the limited entertainment facilities for young people within Cessnock, Council is currently exploring the possibility of developing a bowling centre and indoor rock climbing facility.

4.9 Emergency Services

The closest police station to the site is located in Cessnock and an ambulance station is located in Cessnock West. Currently responsibility for providing fire services in North Bellbird is split between the NSW Fire Brigades, stationed at both Bellbird and Cessnock, and the NSW Rural Fire Service, based in Cessnock. Responsibility for the undeveloped parts of the area will rest with the Rural Fire Service.

For all emergency services, the critical factor in servicing an area is the time required to respond to a call, a function of travel distance and road layout, rather than population or dwelling numbers. The subject sites are within reasonable range of all the existing emergency

service bases, using Wollombi Road and Mount View Road. Further input from the emergency services will be required once the access points and internal road layouts for the development have been determined, at masterplan / DCP stage.

4.10 Places of Worship

The closest churches are located in Bellbird (with one church organisation) and Cessnock (with 6 organisations). These churches would welcome new members.

4.11 Summary

In summary, this assessment has shown:

- There is potential for local primary schools in Bellbird and West Cessnock to meet some of the needs generated by the proposed development, particularly in the early years. However, existing spare capacity will not be sufficient to absorb all of the population growth anticipated, and an additional primary school is likely to be required. While the site is adjacent to an existing high school at Mount View, this school has already reached its capacity and will have little ability to absorb significant demand from the new development. Cessnock High School does, however, have some spare capacity.
- There is little or no capacity in local childcare centres or pre-schools. This situation will need to be reviewed closer to the time of development, given the proposed establishment of an additional centre within the Civic Precinct.
- There is very little spare capacity in existing community centres. In particular, the Bellbird Hall and new Multi Purpose Community Centre will not be able to absorb demand generated by the proposed development.
- Currently within Cessnock, there is a high unmet demand for self care accommodation for older people. Provision of housing designed and located to meet the needs of older people within the development may contribute to the alleviation of this situation.
- There is very little spare capacity in health, welfare and support services, which are already stretched within the limits of their existing resourcing. The projected population growth from the proposed development will be significant and will lead to an increase in demand for these types of services.
- Services in the area for young people are already inadequate and the development may further contribute to this situation.
- Cultural facilities and opportunities are also quite limited in the area and the development may further contribute to this situation.
- The adequacy of existing emergency services will need to be reviewed later in the planning process once development yields and road layouts have been determined.

An outline of the services and facilities that will potentially need to be provided within the North Bellbird development to meet the needs of the future population is provided in Chapter 6.

5. Existing Open Space and Recreation Facilities

This chapter provides background information on the current provision of recreation and open space in Cessnock and outlines issues which may influence the provision and management of open space for the proposed North Bellbird site. In 2005, Council formulated a Recreation and Open Space Plan which addresses recreation and open space objectives listed in the Vision Plan "*Our People, Our Place, Our Future*". This plan has been used to inform the recreation planning process for the North Bellbird site.

5.1 Context of the site

The Cessnock Local Government Area is characterised by a variety of geographic features which include large areas of state forest, national parks and world heritage areas, grazing land and areas for viticulture. These natural resources provide a wide range of opportunities for passive recreation activities such as walking, tramping, mountain biking, and fishing.

The North Bellbird site reinforces the rural landscape of Cessnock. The northern boundary of the site is adjacent to a retention basin which is used for sport and is opposite a high school and new residential estate, whilst to the west and south of the site the landscape is predominantly rural. A park and sporting facilities are also located at the southern perimeter of the site. Open space and the natural environment is fundamental to maintaining the character of the region.

Cessnock contains a series of independent residential areas and villages which are enhanced by the development of open space which:

- Provides appropriate separation, containment and linkage of urban development;
- Preserves cultural landscape elements by the retention of view corridors and adequate buffers;
- Establishes sustainable populations of native flora and fauna; and
- Provides appropriate recreation and leisure opportunities for the community.

5.2 Environmentally significant open space

The subject site may contain environmentally significant open space which is defined as: 'land which exhibits distinctive scenic appeal or natural and cultural heritage qualities'. These areas may include hills, ridgelines, floodplains, watercourses and remnant native vegetation. Acknowledging the significance of the open space on the site, it is important to retain adequate curtilage to ensure the integrity of items are preserved and enhanced. The principle of retaining the open space around these properties for their distinctive scenic appeal is an important design consideration for the site.

The ecological study being undertaken in conjunction with this report will determine if there are any conservation zones with high, medium and low areas of ecological significance. The

design of open space areas should allow for the provision of movement and vegetation linkages or corridors to connect habitat areas and significant features to allow for the movement of flora and fauna. Consequently, recreation opportunities may need to be sensitive in particular areas and access controlled or restricted to preserve sensitive areas. Conversely the provision of passive recreation opportunities may be used to reinforce and preserve the integrity of the open space areas.

5.3 Council's approach to open space provision

Cessnock Council's Draft Recreation and Open Space Plan has been used to inform the recreation and open space provision for the North Bellbird site. Council provides open space to separate and accentuate the character of semi rural areas, as outlined above, and to fulfill both passive and active recreational needs.

Passive Recreation provision includes open space providing opportunity for the pursuit of informal leisure activities such as walking, cycling, children's play and social gatherings. The function of *active open space* is to provide opportunities for structured or formal recreation and sport, and include areas designated for playing fields, courts, pitches and other sporting facilities.

Within Cessnock LGA, Council provides open space and recreation facilities at both sub-regional and local levels. *Subregional o*pen space includes areas catering for structured recreation. 'Sub-regional facilities include those that are large in area and have the capacity to cater year round for large numbers of participants in a wide variety of activities within the one site'[1] For example, Peace Park at Weston contains a number of recreational facilities and associated infrastructure such as carparks, public toilets, picnic areas, walking trails and a children's playground. Turner Park and Baddley Park (Cessnock) and Birralee Ovals (Kurri Kurri) service the existing demand for competitive sport (in particular, soccer, rugby and athletics). These large parks incorporate playing fields, amenities, floodlights and irrigation systems.

Council recognises the need for development of sub-regional sporting facilities at Carmichael Park (which is adjacent to the North Bellbird Site at the south east corner) to meet the sporting needs of the outer lying villages such as Ellalong, Paxton and Millfield, as well as the Bellbird and West Cessnock areas.

Council also has a policy of developing *sub-regional playgrounds* in order to centralise facilities and plans to have sub-regional playgrounds in each major catchment of the LGA. Local playgrounds are located in smaller towns and villages.

Local open space areas provide informal park settings, including the following base facilities: grassed areas for walking, casual games, seating and shade and playground equipment. Local open spacer areas are generally within walking distance of their catchment population. Cessnock LGA has a high number of small pocket parks developed historically as memorial parks. Recently Council has undertaken a process of rationalisation of local parks and has

[1] Draft Outdoor Recreation and Open Space Plan Cessnock Council (May 2005)

offered excess open space for sale. The profit from these sales will be directed towards improving community and recreation assets.

Recreation and open space opportunities are predominantly provided on publicly owned land. However some facilities are provided by private business interests, such as golf courses, horse riding facilities, and lawn bowls.

5.4 Current levels of provision of recreation and open space

The Cessnock Local Government Area currently has a high availability of open space. This is due to its rural nature and past Council practices. Council does not plan open space on the basis of a standard rate of provision per 1000 people, but rather on the basis of need, with a focus on quality rather than quantity of space. Table 17 identifies the range of sub-regional and local level facilities available to Cessnock residents.

Table 17 Current Supply of Sport and Recreation Facilities for Cessnock Residents

Existing Sub regional Level Facilities		Existing Local Level Facilities	
1.	Baddeley Park- Sports ground and new grandstand for 1,400 people with floodlights for community events and sport	10.	Carmichael Park- bike park, cricket oval and clubhouse, amenities, basic playground
2.	Turner Park – Tennis complex, bowling green and clubhouse and oval with grandstand	11.	Cessnock PCYC
3.	Mt Vernon Netball Centre with lights	12.	Cessnock Outdoor Pool
4.	Kurri Kurri Indoor Aquatic Centre 25m pool and leisure pool opened 2002	13.	Mt View Basin- 2 ovals and Neath Target Archers
5.	Peace Park, picnic areas, walking trails and a children's playground carparks, public toilets	14.	Oaks Golf Course- Cessnock
6.	Birralee Ovals (Kurri Kurri)	15.	Ken James Tennis Complex (Kurri Kurri)
7.	Cessnock Basketball Association Stadium- in need of upgrade	16.	Branxton Golf Course
8.	Cessnock Showground	17.	Kurri Kurri Golf Course
9.	Miller Park Branxton		

Source: Based on desktop review of Council webpage, Council's Recreation and Open Space Plan (2005) and site visit

5.5 Analysis

The current supply of recreation facilities in Cessnock is largely based on traditional field sports, which appear to be quite well catered for. As illustrated by the mix of facilities outlined above, Cessnock Council provides subregional standard netball, tennis, and rugby/soccer facilities. However, indoor recreation opportunities are limited, and indoor sports such as basketball, volleyball, gymnastics, badminton, table tennis at representative or club level are not catered for. The only indoor centre is the basketball centre which requires upgrading. The large number of small community halls throughout the district accommodates junior indoor activities such as gymnastics, martial arts and dance. The success of the new aquatic centre in Kurri Kurri highlights the need for more indoor recreation facilities. This was acknowledged in discussions with Council officers and is addressed in Council's draft Recreation Plan 2005.

There is an under provision in the range of recreation opportunities for young people in the area.

At a subregional level there appears to be a need for a multipurpose indoor sports venue to accommodate spectator events and community events.

5.6 Areas for Discussion

Cessnock Council has already commenced a process of rationalisation of its pocket parks and community centres that are surplus to current and projected requirements. Council is planning to upgrade the quality of the existing parks and facilities to make them more usable, rather than focusing on acquiring more open space. In particular, Council is in the process of developing proposals to upgrade Cessnock outdoor pool and the basketball centre. It is not envisaged that the existing outdoor pool and indoor centre will be able to accommodate the demand from the projected North Bellbird population. The redevelopment potential for the existing Cessnock outdoor pool is constrained by its location. The availability of land at the basketball centre site provides an opportunity to consolidate the two facilities at the same site, which is opposite the high school and adjacent to an area of urban growth. The proposed residential development on the North Bellbird site (adjacent to the basketball centre) may provide the impetus for this multipurpose facility which could include other community facilities.

6. Potential Social Infrastructure Needs of the North Bellbird Population

A comprehensive assessment of the needs of the future North Bellbird population for social infrastructure and a strategy for the delivery of social infrastructure will be provided in the second stage of this study, once development yields, development layouts, densities, access routes, population projections and staging programs have been formulated.

At this stage, potential needs are outlined in order to identify possible land requirements for social infrastructure that should be taken into account in preliminary masterplanning and assessment of development yields. These needs will be refined as planning for the site proceeds.

6.1 Potential development and population scenarios

The development capacity of the site and development options are being investigated in the various Stage 1 studies. Different parts of the Investigation Area will be suited to different housing densities, and it is likely that a range of lot sizes and dwelling types will be provided, ranging from medium density through to rural residential development. At this stage, it has been suggested that the Investigation Area might be developed to contain between about 3,500 and 5,000 dwellings. Based on the 2001 average household occupancy rate for Cessnock LGA of 2.6 persons per dwelling, this would result in population numbers as follows:

3,500 dwellings:	9,100 people
4,000 dwellings:	10,400 people
4,500 dwellings:	11,700 people
5,000 dwellings:	13,000 people

In other words, the population of the North Bellbird development, at completion, is likely to lie somewhere between 9,000 people and 13,000 people. Compared with the existing population of Cessnock (town) and its immediate environs of about 22,000 people, it is clear that such population growth will be very significant. Facilities and services built to meet the needs of a population of about 22,000 people cannot be expected to satisfy the needs of 31-35,000 people without some considerable augmentation and additional facilities and services being provided.

Of particular importance in determining needs for social infrastructure will be the extent to which North Bellbird is developed as family housing, attracting a fairly young population with a high proportion of children, or as a mixed development with a higher proportion of people without children, including both younger and older people in couple or single person households. The age, household and socio-economic characteristics of this population will depend on dwelling type, size, price and target market, and are yet to be determined. Accordingly it can only be assumed at this stage that the North Bellbird population will have a range of fairly generic needs and characteristics, roughly similar to the population already living in the district.

The staging of the development and growth in population numbers will also be important in the planning of social infrastructure. At this stage, it is anticipated that the development would be staged over a 15-20 year span, at a rate of about 200 dwellings (520 people) per annum. The implications of staging for the timetable for delivery of social infrastructure will be set out in the social infrastructure strategy in the Stage 2 report.

While Cessnock Council is in the process of redeveloping a number of its community and recreation facilities, the planning on which such redevelopment has been based has not taken account of population growth associated with all the urban investigation areas identified in the Cessnock City-Wide Settlement Strategy. Accordingly it is likely that the new facilities being provided or proposed by Council will not be built with sufficient capacity to satisfy the North Bellbird population (of the scale suggested above), in addition to the existing Cessnock population. Council staff have indicated a need for a separate planning agreement / Section 94 Contributions Plan for North Bellbird, once development options have been prepared.

As indicated from the assessment of existing facilities and services in Chapters 4 and 5 above, social infrastructure may be considered in two broad categories:

- local level facilities that are provided on a neighbourhood basis, which meet day to day needs and which ideally are accessible by walking, and
- district or regional level facilities, serving a larger catchment area and more specialist needs, and to which people are prepared to travel larger distances.

6.2 Local neighbourhood facilities

The North Bellbird development will need to contain its own local neighbourhood facilities to meet the day to day needs of the new population. Based on our assessment of existing facilities and services in adjoining areas and the size of the population likely to live in North Bellbird, there is likely to be a need for the following baseline facilities to be provided within the development. This list is indicative only, as a starting point for masterplanning, and has not yet been the subject of any detailed consultation with Council and other agencies. This will occur in Stage 2 of the Community Impact Assessment. It will also need to be reviewed in the light of the urban design and community building objectives determined for the proposed development.

It should also be noted that at this stage the projected dwelling yield of 3,500 to 5,000 dwellings is very broad, and social infrastructure requirements will vary considerably depending on whether the upper or lower ranges are achieved.

Table 18: Potential local neighbourhood services and facilities

Service	Number required	Common Standard	Land Requirements	Locational Requirements	Comments
Public primary school	1 – 2 Could provide 1 large school or 2 smaller schools	One per 1500 – 2000 new dwellings	Approx 3 ha per school	Distributor or collector road; Majority of students within 1.6km; Adjacent to community playing fields if possible; a slope not greater than 1:10; site must be above the 1:100 year flood level and be well drained; site should have a substantially regular shape; site should be free of possible restrictions such as power easements, contamination and environmental constraints.	Assumes up to half of the demand could be met by spare capacity in existing schools. Potential for clustering with child care, community centre, close to village centre; Encourage joint use of land
Multipurpose Community Centre	1 large centre for lower range, 1 large and 1 smaller centre for upper range	1 per 7-10000 people	2500 sq m	Part of community hub with neighbourhood shops; Co-location potential with primary school, childcare centre, family and children's services	Will be influenced by Council proposals for existing Bellbird Community Hall
Childcare Services	At least 1; others may be provided by private sector subject to market demand	1 place per 20 children 0-4 years. Usually equates to a 60 place centre for a population of 7-10000 people, but will depend on anticipated age profile	2500 sq m	Central convenient location, neighbourhood hub Co-location potential with primary school, community centre	Currently 70-80% of childcare centres are provided by private sector operators
Local medical and allied health services (GP's, dentist etc)	Subject to market demand		Commercial suites in neighbourhood hub	Commercial centre, neighbourhood hub	

Local parks and playgrounds	To be determined	Quality, not quantity, is important. Also need to provide a range of play and recreation opportunities to meet diverse needs	To be determined	Walking distance from most dwellings, Co-locate with community facilities, creek corridors, conservation areas	Even though Council is consolidating existing open space, there will still be a need for some local provision within the development.
Local Sporting facilities	To be determined		Land for playing fields, multi-use ball courts		While a variety of sub-regional facilities exist, these will need to be upgraded and more local facilities provided to meet need generated by the additional population.
Local retail and commercial services eg local convenience shops,	To be determined		To be determined	Neighbourhood hub	
Public domain areas for informal meeting and gathering	To achieve urban design and social sustainability objectives		Areas for plazas, civic squares, cultural events such as markets	Neighbourhood hub	
Post and telecommunication services, including telecommunications infrastructure	To be determined				

The timing of required delivery of facilities will be considered in the Stage 2 report. Considerations will include the staging sequence of development (eg whether development starts at the Bellbird end of the site or the Mount View end) and the extent to which the new population can use existing facilities in adjoining areas (eg primary schools) until the thresholds have built up to warrant new facilities. In particular, the timing of provision of new schools will depend on detailed assessment of enrolment trends in adjacent schools closer to the time of development. It will also depend on whether the school is to be provided through private financing partnership arrangements, as is now the case with most new government primary schools. Generally the Department of Education and Training would aim to have a new school in place once there were about 150-200 students ready to be enrolled.

A population of the size envisaged for North Bellbird may also require land to be set aside for places of worship, which are often missing from new release areas. Places of worship can contribute significantly to community identity and activity. They can also provide an important

base for community development, youth and welfare support activities in new communities, in addition to their spiritual functions.

Issues associated with the planning of churches include:

- They should be located close to other types of community facilities to create synergies and help provide a focal point for the community;
- Places of worship need to be readily accessible and visible, and located so as not to impact on adjoining residential areas;
- Given the limited utilisation of such facilities across the week, it is important that opportunities for shared or joint use be explored with other types of facilities, in the interests of making the most efficient use of land resources. This includes shared provision of parking and meeting / activity space.

6.3 District and Regional Services and Facilities

Meeting the needs of the future North Bellbird population for district and regional level facilities and services, which have a catchment population larger than that envisaged for the site alone, will involve a combination of:

1. Augmenting facilities and services located outside of the site that serve the population of the Cessnock area as a whole. For instance, facilities for consideration may include those to be located in the proposed Civic Precinct, spaces for performing and visual arts, the proposed new aquatic centre and indoor recreation facility, and the library. The ways in which such facilities might be augmented will require close consultation with Cessnock Council. Community services provided by government and non-government agencies, including health, welfare and support services for families, young people and older people, will also need to be expanded. This will require additional recurrent funding from government agencies for extra staff and programs, which in turn may generate a requirement for expanded accommodation for such services. This will require close consultation with service providers and government agencies, such as the Area Health Centre, Department of Community Services and Department of Ageing, Disability and Home Care.

2. Identifying district level services that might be appropriately located within the North Bellbird site to serve the wider area. The suitability of the site for district level facilities will depend on a number of factors, including its accessibility, public transport and recreation opportunities associated with creek corridors and conservation areas. The expanded population of Cessnock town and environs, at up to 35,000 people, may support a variety of new leisure, recreation and entertainment facilities that would not be viable with the current population of about 22,000 people. Sites for such city-wide facilities will need to be identified, and the North Bellbird precinct may offer such opportunities. The site appears to offer potential to locate recreation facilities particularly suited to the needs of older children and young people to address the current deficit, such as an upgraded BMX/skateboard facility to replace that which currently exists in the south-east corner of the site. Locations for upgraded aquatic and indoor recreation facilities for Cessnock need also to be selected, and the North Bellbird Precinct may be appropriate, particularly sites around its periphery that would also be very accessible to the existing population of the area.

In addition, there may be a need to locate a new high school within the precinct, given that Mount View High is already at capacity and will remain so for the foreseeable future. DET guidelines suggest a high school is required for 4,500 – 6,000 new dwellings, and under higher density scenarios North Bellbird would fall within this range. Alternatively, it may be appropriate to provide a site for a private high school, given the lack of such options within Cessnock currently, and the fact that a population of 31-35,000 people could support a private high school in the town. This may be influenced by the socio-economic profile of the future North Bellbird population. These issues will be considered in the second stage of the study. A (government) high school requires a site of approximately 6 hectares, and at this stage it is suggested that such a requirement be factored into the land use considerations, in case a new high school is required.

6.4 Principles for the Provision of Community Facilities and Open Space

Development of North Bellbird will need to have regard to the following principles for the provision of sustainable social infrastructure:

- Timely provision to ensure the needs of the new population can be met from the early stages of settlement;
- Making efficient use of limited resources such as land, for instance through shared facilities and multiple use arrangements;
- Clustering facilities to promote synergy, safety, security and focal points for the community;
- Placing facilities in convenient central locations which contribute to the vibrancy of the development and are accessible by public transport;
- Ensuring flexibility in the design and use of facilities, so they can respond and adapt as needs change;
- Promoting innovation and creativity in the way agencies come together to deliver services;
- Promoting integrated service delivery among related agencies;
- Providing environmentally and economically sustainable buildings;
- Developing sustainable funding, ownership, governance, management and maintenance arrangements;
- Promoting equitable access for all sections of the population, through the distribution, design and management of facilities.

In the planning of new community facilities for the development, the following general principles regarding the location of community facilities should be considered:

- Facilities should be central to their catchment population and easily accessible by the majority of their users;
- Facilities should be located to enhance a sense of community, vibrancy and local identity, and to help create a focal point or hub for the community. They should be located in places where people already have cause to congregate, rather than on

stand alone sites, for reasons of safety, accessibility and convenience. Shopping centres and schools are recognised as the key destinations where people tend to congregate within a neighbourhood. Location within or adjacent to commercial centres also adds to the activity level and critical mass needed to create a vibrant mix of activities and lively centre.

- Where appropriate, they should be clustered together or co-located on a single site to provide opportunities for shared and efficient use of resources (management, parking, meeting rooms, amenities, play equipment) and for convenience, visibility and capacity for a "one stop shop". Clustering will also create synergies that promote better utilisation of services.
- Consideration needs to be given to locations which provide a high level of safety and security, particularly at nights and weekends. This is most usually associated with high levels of activity and casual surveillance, as well as lighting and proximity to public transport.
- For some types of facilities such as community centres, locations adjacent to open space are desirable to allow for larger outdoor community events and spill-over activities.
- Facilities should be accessible by public transport, and located to maximize access for pedestrians and cyclists.
- Facilities should have safe and adequate parking provision, to reduce impacts on adjacent residential areas.

In terms of principles for the provision of open space, the following need to be considered in the design of open space areas:

- There needs to be a focus on providing areas of quality open space which are functional and well located for a variety of recreation purposes, not leftover spaces and bushland conservation corridors that are difficult to use for recreation purposes;
- Larger district level parks (5-10 ha) should be located within 2 km of all dwellings, located near public transport routes or be easily accessible to cars, pedestrians and public transport;
- Local open space (minimum 0.2-0.3 ha) should be within 4-500 metres walking distance of all dwellings. Pocket parks of less than this size are not functional as recreation areas and present maintenance challenges;
- Where possible, a range of recreation opportunities should be provided on the one site by clustering facilities to minimise travelling and satisfy the demands of families with children of different ages and interests (eg playgrounds for very young and older children in the one park);
- Open space and other public civic space needs to accommodate the needs of young people for unstructured space to gather for social interaction and entertainment, as well as meeting safety, surveillance and crime prevention objectives;

- Dual use agreements should permit community use of school facilities such as playing fields;
- Rather than providing single playing fields and courts, clustering of facilities is preferred, to achieve economies of scale (eg amenity blocks) and to make the facilities appealing for local competitions, where multiple games are played at once;
- Active recreation areas should be provided above the 1:100 year flood zone where possible to ensure they are available year round for sporting competitions;
- Urban design must consider the characteristics and needs of the potential user / community to understand how spaces and places can relate to activities and movement patterns and develop social value for residents. Access and equity are important considerations.

7. Potential Social Impact Issues

The identification of social impact issues needs to await consultation with the communities who are likely to be most affected by the development, those surrounding the site, as well with agency stakeholders. Such consultation will occur in the next phase of the planning process following synthesis of the Stage 1 reports.

In the interim, the following potential issues have been identified, based upon previous local consultations and studies, discussions with Council staff and our site visits. The list of matters Council requires to be addressed in a social impact assessment (as outlined in Section 2.2.6 above) has also been considered. The nature and extent of impacts likely in relation to each of these issues will need to be examined once details of the proposed development become available.

7.1 Changes in the population size and profile of the area, and in community structure and cohesion

As outlined in the previous chapter, the new population arising from the development is potentially very large in relation to the existing population of Cessnock / Bellbird, increasing the population of the area by up to more than 50%. The ways in which this new population will impact on the composition of the Cessnock population, in terms of its similarities and differences, will depend on the target market and profile of the new population, yet to be determined. It will depend particularly on whether the new North Bellbird residents are newcomers to the Cessnock area and to the Hunter Valley, or whether they are "locals" relocating and trading up. It will also depend on the rate of population growth, and extent to which newcomers can be gradually absorbed or arrive in large influxes.

Similarities and differences in the demographic characteristics of the new and existing populations may be associated with similarities and differences with regard to people's values, priorities and lifestyle choices. Perceptions and stereotypes of "newcomers" and whether they share outlooks and lifestyles with the existing populations can impact on acceptance of the new population and levels of social cohesion and social integration in an area. It may take some effort for a community which is not accustomed to change to absorb "outsiders" and be open to change. If the new population differs in significant attributes and values from the existing population, or is perceived to have access to advantages and opportunities not available to the existing community, then social cohesion may be challenged.

As discussed in Chapter 3, the populations of the areas immediatey adjacent to the site in Mount View and Bellbird/West Cessnock differ in some significant ways from each other, especially with regard to age and household profile and socio-economic characteristics. At this stage, we would assume that the new North Bellbird population is likely to have greater similarities to the Mount View population, given the likely cost of new housing. To facilitate social, as well as physical integration, particularly with the more disadvantaged Bellbird/West Cessnock population, it will be important that opportunities are created for the new and existing populations to come together and mix. This can be achieved through the provision of facilities and services that will be used by both populations (shops, schools, parks etc) and by equitable distribution of and access to facilities (for instance, not all the new facilities need be located

within the new development). There will also be a need for community development programs and activities that bring the two populations together to encourage inclusiveness, facilitate interaction and break down stereotypes that could act as barriers to integration, and to welcome the newcomers. Details of the proposed community development program will be provided in the Stage 2 report. In addition, the proposed community consultation strategy, by engaging surrounding residents with the planning of the development, will also facilitate social integration. Other opportunities to enhance social integration and avoid or ameliorate risks associated with social division and relative inequality will need to be explored in the second stage of this study.

7.2 Changes the character and identity of the area

As mentioned previously, development of the Cessnock CWSS involved a series of public workshops in which participants collectively formulated a vision for their catchment and articulated the characteristics and values of their area that they would wish to retain. Issues identified within the Black Creek catchment included:

- A desire to maintain the existing character and amenity of the area, the identity of villages and the quality of life of village communities;
- A need to retain separation between towns and villages rather than create contiguous development; and
- A need for buffers and corridors around different types of land uses to minimise conflict.

These issues will need to be addressed in the design of the proposed development. It will be important that the new development, given its large scale, does not overwhelm the character of adjacent settlement, particularly Bellbird and the semi-rural settlement of Mount View, thereby threatening existing residents' sense of place and community.

Further considerations may include:

- Impacts of new housing stock and different building types and forms in the locality. As outlined in Chapter 3, the existing communities are characterized by an overwhelming predominance of detached housing on traditional lots. The potential introduction of higher densities and different dwelling forms (such as small lot/attached housing) to achieve government urban design outcomes may be controversial, in terms of impacts on the existing character of the area, and may challenge levels of community acceptance of change. At the same time, the benefits of more diverse housing forms will need to be identified, in terms of providing greater housing choice and providing for markets not currently catered for with traditional detached dwellings, particularly older people, single person households and those wanting more affordable housing options.

- The importance of public access through the development, to ensure it is not segregated or exclusive of existing residents, in keeping with local practice;

- The importance of connectivity and integration with the existing road pattern and open space network to facilitate ready access by new and existing residents;

- The evolving cultural life of the community, and its incorporation into the mainstream community life of Cessnock. As mentioned above, there will be a need for community and cultural development initiatives that foster integration with the wider area as well as build the life and identity of the new community.

- Cumulative impacts arising from other developments in the area, and the capacity of the existing community to cope with change and growth occurring on multiple fronts. For instance, it is understood that sites identified in the Cessnock CWSS for potential urban development in East Cessnock are also proposed for early development. Planning of the social infrastructure for North Bellbird and transport and traffic arrangements will need to have regard to cumulative population growth arising from other sites.

7.3. Changes to the amenity of the area

Impacts on the immediate neighbours of the development and the surrounding communities will need to be examined following community consultation. At this stage, issues are likely to include:

- the visual impacts of the development and loss of rural scenic landscape outlook. This may be a particular concern for existing residents who have chosen a rural or rural residential lifestyle in the area and who would not want to look out on continuous "suburban" development;
- impacts on local traffic and potential for congestion on local roads and key access intersections;
- potential for improved connectivity and access between Bellbird and Mount View through the site;
- privacy impacts for any adjoining properties;
- potential impacts on community safety and personal security, including road and traffic safety and neighbourhood design that encourages public surveillance and an active street life; and
- impacts during the construction phase – noise, dust, traffic etc.

7.4 Changes in access to services and facilities in the area

It will be important to ensure that the significant increase in the population of Cessnock/Bellbird arising from the development does not disadvantage the existing community with regard to the access to services and facilities it currently enjoys. As discussed in the previous chapters, the development will give rise to a need for a variety of new facilities, services and areas of open space, and to the augmentation or improvement of existing facilities and services. It will be important not only that additional physical facilities are provided, but also that additional recurrent funds are available to enhance services and activities and allow them to keep pace with population growth (eg community health and welfare services).

In addition to meeting the needs generated by the new population, there are opportunities for the development to create significant community benefit through:

- Enabling public access to the new facilities, services and open space areas that will be created within the development;
- Locating some of the new facilities within or adjacent to existing areas, and not only within the new Precinct,
- Contributing to the upgrading or expansion of social infrastructure in the wider area, particularly for city-wide facilities such as a new aquatic centre;
- Making viable the provision of new types of facilities and services, which require higher population thresholds than currently exist around Cessnock, through increasing the size of the population. This particularly includes recreation, leisure and entertainment opportunities, as well as retail and commercial services, but may also include a private high school and specialist health facilities.
- Associated with this, there is potential for the development to result in significant improvement to public transport services in the area, through higher population concentrations that would support enhanced transport services.

It should be noted that a desire for an increase in the provision and standard of public infrastructure and availability of public transport was one of the key issues arising from the CWSS consultations in the Black Creek catchment conducted by Cessnock Council in 2004. Opportunities to satisfy this desire will be explored in the second stage of this study, especially as a means of off-setting any negative impacts that might be perceived from the development.

7.5 The social sustainability of the development

Creating new communities which are sustainable is a key objective in both the State Government and Cessnock City Council policies outlined in Chapter 2. For North Bellbird to become a community which is socially sustainable, the following key issues will need consideration in its planning:

1. Adoption of a planning approach that integrates social planning components with physical, environmental and economic planning, to ensure comprehensive sustainability principles are addressed;
2. Achieving housing and lifestyle choice and population diversity, to create social mix and a balanced community. This will require development to incorporate a range of lot sizes and dwelling forms and styles, appropriate for different sub-markets and price points in response to identified housing demand in the region;
3. Creating a pleasant and safe environment which promotes a sense of security, health, well-being and quality of life, and an active, lively neighbourhood. Urban design should also promote accessibility, connectivity and opportunities for social interaction, through a public domain which provides spaces for informal gathering and meeting;
4. Provision of a range of facilities, services and programs that meet the learning, social, cultural, health and recreational needs of the community and are responsive to future change;

5. Convenient and equitable access to jobs, shops, public transport, schools and facilities in the wider region;
6. Creating an identity and image that promotes civic pride and celebrates the community's unique sense of place, and providing opportunities for cultural expression;
7. Respect, interpretation and celebration of the site's natural and cultural heritage;
8. Integration with surrounding communities and the wider region, both physically and socially, in ways that enhance social cohesion, inclusiveness and relative equity;
9. Providing opportunities for all age groups and sections of the population to become involved in the life of the community, to develop community networks and connections with other residents and to create a sense of belonging;
10. Providing opportunities to participate in the on-going planning and development of the community and to develop stewardship over its resources.

Strategies to achieve these social sustainability objectives will be developed in association with other members of the consultant team and presented in the Stage 2 report of the Community Impact Assessment.

8. Conclusion: Summary of Site Opportunities and Constraints

Summarising from the previous chapters, key opportunities associated with the North Bellbird site include:

- The opportunity to implement the principles and objectives of the City Wide Settlement Strategy and Draft Lower Hunter Regional Strategy to provide higher density sustainable settlements which will provide housing opportunities for future population growth. Such growth will promote the vitality and vibrancy of Cessnock and make efficient use of existing investment in social infrastructure, for instance by making use of the spare capacity which currently exists in local primary schools.

- The opportunity to create a socially sustainable new community that showcases principles for liveable neighbourhoods, as contained in the State Government's Metropolitan Strategy and Lower Hunter Regional Strategy,

- The opportunity to increase housing diversity within Cessnock and to provide greater housing choice, especially for segments of the population not previously catered for. In particular, there is an opportunity to address the needs of an ageing population and to provide housing especially suited to the needs of older people and the growing numbers of single person households;

- The opportunity to increase the population of the area and provide a critical mass which will enhance the viability of new services and facilities, including retail and commercial services, and public transport, thereby benefiting the whole population of Cessnock. The increased population will also enhance business and employment opportunities in the area;

- The opportunity to provide quality new social infrastructure which not only responds to the needs of the new population but which can also benefit the existing population, especially the more disadvantaged areas of Bellbird and West Cessnock;

- The opportunity to enhance recreation, leisure and entertainment opportunities in Cessnock, especially for young people. In particular, there is potential for development of indoor recreation and aquatic facilities around the existing basketball stadium just to the north of the site, and for enhanced sporting facilities in the open space areas to the south of the site. Population growth will also help to finance improvements to recreation facilities such as a new aquatic centre;

- The opportunity to make use of the creek corridors and flood-prone land within the site to create parks and playgrounds, and walking and cycling trails, which are publicly accessible. In this way the development will provide access to resources that until now have not been available for public use;

- The opportunity to enhance connectivity between Bellbird to the south of the site and Mount View to the north, by creating new links through the site;

- Opportunities to promote integration between existing and new development and enhance social cohesion through both masterplanning and community building initiatives.

At this stage in the planning process, potential constraints and risks include:

- Existing social infrastructure within Cessnock has been provided to serve a population of about 22,000 people and will not have capacity to meet the demands of an additional 9-13,000 people without additional facilities and services and/or upgrading of existing facilities and services. This will require capital funding for land and buildings (Section 94 contributions and regional infrastructure levies), recurrent funding for services and programs (developer contributions, State and Commonwealth funding programs) and on-going funding streams for the management and maintenance of resources.

- Many of the existing facilities within Cessnock are old and of low quality, and are not able to meet the needs of the current population, let alone additional growth. Cessnock Council has proposals for the redevelopment or upgrading of a number of key facilities within the town, including development of a Civic Precinct where a new multi-purpose community centre, childcare centre and recreation facilities will be built. Plans for the redevelopment of indoor recreation and aquatic facilities are also being developed. However planning for these facilities to date has not taken account of potential population growth arising from the North Bellbird investigation area. The needs of the future North Bellbird population need to be included in this planning so that facilities are not built that will be inadequate to meet the future needs of the whole area. If the new North Bellbird population is to integrate socially with the existing Cessnock/Bellbird population, it will be important that some higher threshold facilities are developed for the whole population, not separate facilities just for North Bellbird.

- It is understood that other sites identified around Cessnock in the CWSS for urban development are also now being planned (eg East Bellbird). The cumulative impacts and requirements of all proposed development for social infrastructure need to be considered together. In particular, there is a risk that spare capacity in facilities (such as schools) identified now may be taken up by other development, before the North Bellbird population arrives.

- There may be limits to community acceptance of higher density development within the site. At this stage, community attitudes towards the development are untested. Potential issues may include concern about loss of rural landscape outlook, impacts on rural residential lifestyle, traffic impacts, and impacts on the character and identity of existing villages, particularly the separate identity of Bellbird, which could be "swamped" by the new development. It is noted that the need to retain separation between existing and new settlements, rather than create contiguous suburban development, has been identified in previous community consultations. At the same

time, there are opportunities to respond to the desires of the existing community for retention of the character and identity of existing settlements, through urban design solutions.

- Population growth of the scale envisaged will be very significant, relative to the existing population of the Cessnock area, and has the potential to change the composition of the Cessnock population considerably. Maintaining social cohesion and acceptance of newcomers will be influenced by the characteristics of the new population and rates of change. In particular, the new population may be quite different to the adjoining West Cessnock and Bellbird populations, in terms of age, household composition and socio-economic indicators. On the other hand, it may have many similar characteristics to the adjoining Mount View population. There will be a need to manage the integration of new and existing populations in ways that minimise the social divide and maximise inclusiveness and wider community benefit.

In conclusion, the Stage 1 Community Impact Assessment has reviewed the social context of the site and has identified no matter which would preclude urban development within the North Bellbird Investigation Area, or which cannot be addressed at the detailed design phase.

The study has identified a range of matters to be considered in the Stage 2 Community Impact Assessment, which will be prepared at the masterplan / DCP phase of the planning process. The second stage of the Assessment will also satisfy Council's requirement for a detailed social impact assessment of the proposed development. This will include a description of the proposed housing mix and anticipated population, and a detailed strategy for the delivery of community facilities, services and open space. Cessnock Council is currently in the process of planning for the upgrading or development of a number of major facilities for the existing Cessnock population, and the planning of new facilities for the North Bellbird project will need to have regard to these proposals and occur in close consultation with Council. Importantly, the second stage of the assessment will also involve examination of social impacts based upon consultation with the Cessnock community, when appropriate responses and strategies to address any issues of community concern will be developed.

References

ABS *Census of Population and Housing Data* 2001 and 1996

ABS *Social Trends Data* 1999

ABS *Social Trends Data* 2003

Shaping our Cities, DIPNR

SEPP 66, Integrating Land Use and Transport, DIPNR

City of Cities: A Plan for Sydney's Future – NSW Government Metropolitan Strategy 2005

Draft Lower Hunter Regional Strategy, Department of Planning 2006

Strategic Plan 2004-2009, Cessnock City Council

Ecologically Sustainable Development (ESD) Strategy, Cessnock City Council

City Wide Settlement Strategy (CWSS), Cessnock City Council

Cessnock Social and Community Plan 2004-2009, Cessnock City Council

Social Impact Assessment Procedure and Guidelines, Cessnock City Council

Draft Outdoor Recreation and Open Space Plan, March 2005, Cessnock City Council

Various *Section 94 Contributions Plans*

ECONOMIC DEMAND AND IMPACT ASSESSMENT

North Bellbird Investigation Area

For

Insite Planning & Engineering
on behalf of the
Johnson Property Group.

May 2006

Castlecrest Consultants

PO Box 185
The Junction 2291
Ph 4940 8802
Fax 4940 8807
b.hawes@sherwoodbaycrest.com.au

Contents

1 Introduction 1
2 Background 3
3 Methodology 4
4. Context 6
4.1 Introduction 6
4.2 Location Context 6
4.3 Retail Context 6
4.4 Planning Context 9
4.5 Proposed and Mooted Development 9
5. Demographic Profile and Analysis 12
5.1 Introduction 12
5.2 Definition of Trade Area 12
5.3 Demographic Analysis 14
5.3.1 Population 14
5.3.2 Age Profile 14
5.3.3 Household Density 14
5.3.4 Mobility 16
5.3.5 Household Income 16
5.3.6 Household Structure 17
5.3.7 Occupation 17
5.3.8 Summary 17
6 Retail Demand Estimates 18
6.1 Introduction 18
6.2 Population Growth and Potential 18
6.3 Retail Expenditure Estimates 20
6.4 Available Retail Spending 21
7 Conclusions and Recommendations 27

Tables

Table 1 Retail Centres - Cessnock Trade Area 8
Table 2: Selected Demographic Characteristics, Primary Trade Area 15
Table 3: Selected Demographics, Cessnock Retail Trade Area, 2001 16
Table 4: Building Approvals - Dwellings - Cessnock SD 2000 – 2004 19
Table 5: Estimated Population and Dwelling Yield, Bellbird North 20
Table 6: Estimates of Average Annual Household Expenditure 22
Table 7: Estimated Total Annual Household Expenditure, Bellbird North. 22
Table 8: Estimated Trade Capacity and Capture, Bellbird North ($2004) 23
Table 9: Allocation of Trade, Bellbird North 24
Table 10: Retail Floor space Demand, Bellbird North 25
Table 11: Retail/Commercial Land Requirements, Bellbird North 25

Figures

Figure 1: Subject Land 2
Figure 2: The Trade Area 13

Executive Summary

1 Introduction

The report has been prepared for Insite Planning and Engineering on behalf of the Johnson Property Group.

This report investigates, analyses and recommends the likely non-residential land requirements to provide for a predominantly residential development on 496 hectares of land in North Bellbird.

This report, along with a suite of other documents have assessed the North Bellbird Investigation Area with respects to its capacity to sustain a mix of development and conversation including: -

- A mix of residential environments provided through sequential staging,
- A commercial and retail precinct including missed use development capable of serving the needs of the North Bellbird Community;
- Social and community infrastructure including schools, community and recreational facilities including open space;
- Infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails;
- Conservation of quality remnant vegetation; and;
- Rehabilitation of degraded riparian corridors to provide habitat linkages.

2 Background

The North Bellbird precinct is identified in the Citywide Settlement Strategy, Stage 1 (CWSS 1) report as an area capable of providing future residential development and other land uses subject to investigation.

The Citywide Settlement Strategy Stage 2 (CWSS 2) report focuses on non-residential land use in determining the needs of the subregion for retail, commercial and industrial land use into the future. This report considers the economic impact of land use options in the context of these reports.

3 Methodology

The report will include a number of sections and will examine the following:

- Context: Provides an overview of location, planning and retail and commercial profile of the Cessnock sub-region and the subject land.
- Demographic profile: analysis of the characteristics of the population incorporating forecasts of population and household growth.
- Retail demand estimates: factoring population and household (dwelling) growth, retail expenditure and consequential retail and commercial floor space demand.
- Assessment of land requirement and scope for additional retailing based on the Bellbird North area and taking into account the role and function of the existing commercial centres and market growth.

4 Context

4.1 Introduction

The Cessnock LGA includes a number of retail and commercial centres that currently service the population within the subregion.

New residential development not in the immediate proximity of these centres has the capacity to support additional non-residential development to service the convenience and local needs of the respective community.

4.2 Location Context

The proposed Bellbird North release area is in relative close proximity to existing development and the township of Cessnock. The overall site has access to Mt View Road, one of the major feeder roads to and from Cessnock. The land is currently substantially used for rural and agricultural purposes pursuant to the current zoning of rural 1(a) and rural 1(v) – Vineyards District.

4.3 Retail Context

The CWSS 2 report estimated that there was 38,000 to 42,000 square metres of retail floor space within Cessnock City Centre. Existing retail development is fulfilling the majority of needs for the community but the report recognised that a significant amount of leakage is occurring to other centres in Maitland, Lake Macquarie and Newcastle.

Relatively high vacancy rates persist in both Cessnock and Kurri Kurri. To some extent these reflect a weakness in the local commercial market as well as sections of the retail market similar to other centres of this nature across the Hunter Region.

The CWSS 2 report recognises that the Cessnock LGA needed to provide the opportunity to accommodate emerging retail formats. It is envisaged that where these are concerned with comparative goods, household durables, bulky goods and the like, they will be provided close to the CBD's and within the existing centres of Cessnock and Kurri.

4.4 Planning Context

The CWSS 1 report identifies Bellbird North as an investigation area for the release area for future residential growth.

4.5 Proposed and Mooted Developments

Within the Cessnock LGA there area a range of proposals that will increase the potential supply for residential and retail development within the LGA. If all projects proceed the context of the Cessnock CBD in terms of its retial provision will change significantly. The residential developments have an enormous capacity to increase the population within the subregion. Non-residential developments including the HEZ and Austar coal mine will provide significant employment opportunity and further underwrite the strength on retail and commercial capacity in Cessnock.

5 Demographic Profile Analysis

5.1 Introduction

The demographic characteristics of the existing Bellbird district and the proposed Bellbird North release area will have a bearing on capability and capacity of population to support the provision of non-residential development.

5.2 Definition of Trade Area

The primary trade area (PTA) and secondary trade area (STA) have been defined for the purposes of the analysis. The PTA includes the townships of Cessnock, Kurri, Rothbury, Wollombi and south to the Wattagan forest. The STA is confined to an area of between 10-30 kilometre radius from Cessnock CBD.

5.3 Demographic Analysis

The increase in population within both the PTA and STA is reflective of the trend within the Hunter statistical district (SD). The defined areas are within proximity of the coastal margin and growth within the STA has displayed stronger characteristics. The area has a capacity to sustain and perhaps experience an increase on current population growth rates into the future.

The trend of decreasing household density and aging nature of the catchment population is reflective of trends across NSW and Australia. This factor will have a direct impact on the capacity of the trade area to generate retail expenditure. The increasing proportion of lone parent and lone person households in comparison to the relative decline of families with children and other family groups within the trade area is also of note. This is likely to be offset by strong growth within the STA, although this will have a less direct influence and impact on the retail spending habits within Bellbird North and the township of Cessnock.

6 Retail Demand Estimates

6.1 Introduction

The CWSS 2 report concluded and recommended that *"no additional land be rezoned for commercial purposes across the LGA, with the exception of any specific land identified to accommodating emerging retail formats that compliment and support the existing commercial hierarchy."* However, the Bellbird North release area did not rate a mention within this CWSS 2 report.

We believe there is sufficient justification for this area to contemplate inclusion of a retail and commercial precinct based on the potential size and population generated from the project

6.2 Population Growth and Potential

The development capability of the Bellbird North precinct is reflective of a dwelling yield per hectare and rate of population growth forecast for the area.

The draft Lower Hunter Regional Strategy suggests a greenfield yield of around 12 dwellings per hectare within the Lower Hunter. This rate has been adopted for the medium scenario.

An average dwelling density of 2.6 persons per household, slightly less than the 2.8 persons recorded in the trading area in 2001, has been adopted for calculating household growth. The potential population and dwelling outcomes are based on the draft Urban Structure plana re as follows:

ESTIMATED POPULATION AND DWELLING YIELD, BELLBIRD NORTH

Gross Land Area		Land Available for Development	
496 ha		322 ha	
Dwelling and Population Yield			
Scenario	**Dwellings**	**Average Density**	**Additional Persons**
High	5,000	2.6	13,000
Low	3,500	2.6	9,100

Source: Development Concept Plan, Andrews Neil, Feb 2006; Castlecrest estimates

6.3 Retail Expenditure Estimates

Retail expenditure estimates have been prepared on the basis of forecast dwelling yields for the Bellbird North precinct, reconciled to estimates of expenditure sourced from the 1998/99 ABS Household Expenditure Survey and other retail industry statistics.

6.4 Available Retail Spending

It is not intended that retail or commercial facilities within the context of Bellbird North's precinct would provide a full regimen of food and non-food items. The population would continue to be drawn to Cessnock to fulfil most of the comparative goods and non-food shopping particularly for bulky goods, household durable and major items.

The capacity for households in terms of generating local convenience spending is estimated at $15,088 per household ($ 2004). This compares with $16,925 for NSW.

The Bellbird North project is estimated to have a retail spending capacity in the range of between $52.81 million and $75.44 million per annum ($2005).

Assuming leakage from the area and additional capture from surrounding suburbs, the net sales capture at Bellbird North retail precinct would range between $30.57 million and $43.58 million per annum once the area is fully developed.

Having allocated this expenditure to respective supermarket and specialty shop components in both food and non-food categories the retail floorspace demand is summarised as follows:

RETAIL FLOOR SPACE DEMAND, BELLBIRD NORTH

Category		$/sqm per annum	Area in Square Metres	
			Low	High
Food	- Supermarket	$8,000	2,160	3,100
	- Specialty	$6,000	910	1,300
Non-food		$4,500	1,730	2,460
Sub-total			**4,800**	**6,860**
Less Bellbird (existing)			1,690	1690
Total			**3,110**	**5,170**

Source: Castlecrest estimates

The floorspace estimates will generate a land demand based on the yield of between 30% and 40% of land area. Consequential allocation at these respective figures is as follows:

RETAIL/COMMERCIAL LAND REQUIREMENTS, BELLBIRD NORTH

Yield	Area in hectares	
	Low	High
30%	1.60	2.29
40%	1.20	1.72

Source: Castlecrest estimates

This provision is exclusive of small pocket developments within potential new sub-divisions beyond the Bellbird North precinct. If planned and included, these should generally consist of land area up to 3,000 square metres and not within 1 kilometre of a major centre. Furthermore, the facilities should, where possible, be located closer to main transport arterials and not in the midst of low density residential development.

7 Recommendations and Conclusions

Whilst in recent times Cessnock has experienced uplift in population and dwelling growth, the change has not been strong in comparison to other areas within the Lower Hunter. However, the raft of rezoning and development proposals mooted, have the capacity to increase both the residential and non-residential development outcomes within the Cessnock LGA.

Significant locally based economic drivers including the Hunter Economic Zone and the recently announced Austar coal mine have the capacity not only to provide local employment opportunities to support further population growth, but diversify the industry and employment base. This is a vital consideration in an area that lost primary and secondary industry representation through the 1980's and 1990's despite the growth in the wine industry and tourism and tertiary sector growth.

In planning for new residential areas there is a capacity and a propensity to include non-residential land holdings consistent with the approach and doctrine outlined in Draft SEPP 66. The proposed development at Bellbird North has an extensive capacity and depending on dwelling yield outcomes could support a population of up to 13,000 people in 5,000 dwellings when fully developed. This yield is sufficient to support the development of a neighbourhood shopping centre comprising a supermarket and a range of specialty shops.

Owing to the proximity of extensive sub-regional retail and commercial facilities at the Cessnock CBD, the demand and need to provide extensive non-food and comparative retail facilities within the Bellbird North area is mitigated. The forecast population within Bellbird and Bellbird North will have the capacity to support additional floorspace in the range of 4,800 to 6,860 square metres.

This will in turn generate the need to allocate between 1.2 and 2.3 hectares of land sufficient to accommodate non-residential development to meet the demand of the Bellbird North and immediate trade area once the estate is fully developed.

Future commercial and retail land provision should focus locations related to main road and transport routes. This will facilitate the capacity to support integrated local transport service within the local area as the areas grow and develop.

DISCLAIMER

This assessment is based on information researched by Castlecrest Consultants. Whilst the information is believed to be accurate the assessment or any information is not warranted or guaranteed and no responsibility or liability for any information, opinion or commentary contained herein, or for any consequences of its use will be accepted by Castlecrest Consultants or by any person involved in the preparation of this reassessment and report.

ECONOMIC DEMAND AND IMPACT ASSESSMENT

Proposed Rezoning – Bellbird North

1 Introduction

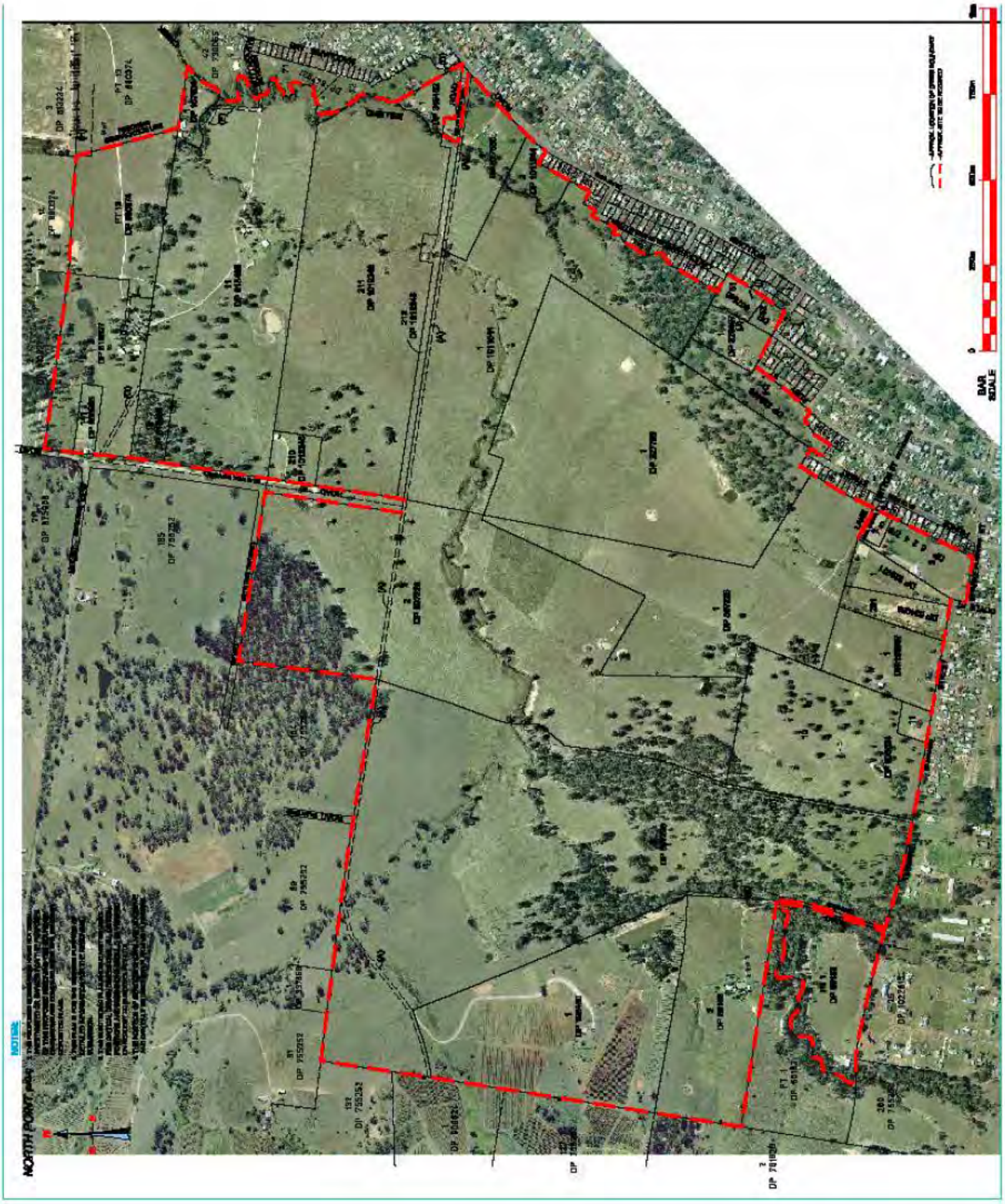
This report has been prepared for Insite Planning and Engineering on behalf of the Johnson Property Group Pty Limited (JPG). The report will investigate, analyse and recommend the likely non-residential land requirements to facilitate the provision of commercial, retail and support services arising from demand generated by potential new residential development consequential to the rezoning of lands in Bellbird North within the Cessnock City Council Local Government Area (Cessnock LGA).

The investigation area comprises land parcels of approximately 496 hectares amidst lands identified in the Cessnock City Wide Settlement Strategy for potential rezoning to mixed residential densities along with open space and environmental features. The land subject to rezoning is depicted in Figure 1.

This report, along with a suite of other documents have assessed the North Bellbird Investigation Area with respects to its capacity to sustain a mix of development and conversation including: -

- A mix of residential environments provided through sequential staging,
- A commercial and retail precinct including missed use development capable of serving the needs of the North Bellbird Community;
- Social and community infrastructure including schools, community and recreational facilities including open space;
- Infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails;
- Conservation of quality remnant vegetation; and;
- Rehabilitation of degraded riparian corridors to provide habitat linkages.

Figure 1: Subject Land



2 Background

During 2003, the Cessnock City Council adopted Stage 1 of the Citywide Settlement Strategy (CWSS 1)

The strategy sets future direction for population growth in the Cessnock LGA and identifies a range of opportunities to investigate providing potential for residential settlement and other land uses. A significant proportion of the land subject to this assessment was identified for potential rezoning to residential within the strategy.

In 2005 the Cessnock Council adopted the Citywide Settlement Strategy Stage 2 report[1] (CWSS 2) that concerned itself with non-residential and particularly retail and industrial lands provision within the LGA.

The Stage 2 Strategy used the CWSS 1 report findings as the building blocks to contemplate and project the provision for employment lands within the Cessnock LGA. It scoped both the existing retail and industrial land provision and the identification of new areas for industrial development.

Both Strategy documents recognise the nexus between population and household growth leading to demand for retail, commercial and industrial services. Existing and new communities have the capacity to support respective provisions of commercial and retail facilities within particular localities.

This economic study is intended to scope the retail and commercial opportunity potentially deriving from future population and household growth for the Bellbird North rezoning area. It will also examine the capacity and capability for existing and proposed new development areas to accommodate both supply and demand arising from the change.

[1] City Wide Settlement Strategy Stage 2 – Commercial/Industrial Land Study, Parsons Brinkerhoff November 2004.

3 Methodology

The report will include a number of sections which will examine the following:

- Context: Provides an overview of location, planning and retail and commercial profile of the Cessnock sub-region and the subject land.
- Demographic profile: analysis of the characteristics of the population incorporating forecasts of population and household growth.
- Retail demand estimates: factoring population and household (dwelling) growth, retail expenditure and consequential retail and commercial floor space demand.
- Assessment of land requirement and scope for additional retailing based on the Bellbird North area and taking into account the role and function of the existing commercial centres and market growth.

In compiling the research and analysis Castlecrest have regard to the following:

1. Review of existing reports and documents relating to retail and commercial structure for Cessnock.
2. Field survey of the trade area with specific reference to retail and commercial provision.
3. Review of existing retail provision in Cessnock and its trade area.
4. Definition of the trade area population and analysis of the demographic characteristics and retail spending pattern in the trade and catchment area.
5. Reference to other documentation and reports concerned with the application for the subject rezoning.

The primary documents sourced in collating the report have comprised and include the following:

a) 1996 and 2001 Census information compiled by the Australian Bureau of statistics (ABS).

b) The ABS Household Expenditure Survey, 2003/04 (HES).

c) The NSW/ACT Shopping Centre Directory 2005, Property Council of Australia (PCA 2005).

d) Cessnock City Wide Settlement Strategy, Stage 1 Report 2002 (CWSS 1).

e) Cessnock City Wide Settlement Strategy, Stage 2, Commercial/Industrial Land Study, Parsons Brinckerhoff/Hill PDA, November 2004 (CWSS 2)

f) Cessnock CBD Planning Study, GHD April 2002 (CBD Study)

g) Retail Industry Statistics, Commodity Sales and Floor Space Analysis, ABS, 1998/99

h) Building Statistics for LGA produced by the ABS.

i) Community Impact Assessment , North Bellbird Rezoning, Elton Consultancy March 2006.

Market information has been compiled from the outcome of fieldwork investigations as well as discussions with local contacts and the applicant.

The statistical, demographic and data input for the study is generated from the various ABS publications as well as consultant estimates. The Census and HES data provide the framework to generate the retail capacity of the defined trade area. This is reconciled to estimates of the actual provision and estimated trading performance of existing facilities within the catchment to allow an assessment of the capability of the area to support additional retail facilities and permit estimates of the economic impact of the provision of those facilities.

In providing the assessment, the following assumptions apply:

1. The economic circumstances through the forecast period remain stable.

2. Characteristics and assumptions in relation to population growth are realised through the forecast period.

3. The project will proceed in a format in line with the current proposal and achieve forecast development timing.

4. Context

4.1 Introduction

There already exists within the Cessnock LGA a number of retail centres which not only provide for the existing population but have the potential to service the areas including Bellbird North.

Over the last 10 years the potential for growth and development in the Cessnock area has increased in focus. A significant volume of development based on Wine Country tourism has provided a focus for the Cessnock sub-region.

The range of recent planning strategies have to some extent defined opportunity for the market and a range of proposals across all sectors of the property market are being mooted or proposed in the sub-region.

The recent real estate boom across the Lower Hunter fuelled both supply and demand. Areas like Cessnock provided relatively good value while maintaining accessibility and proximity to developed commercial facilities and employment opportunities. Potential new residential development has the capacity to not only support existing businesses but draw new commercial activity to the area. The extent of this capacity is linked to the timing of growth and matters relating to these issues will be examined later in the report.

4.2 Location Context

The North Bellbird investigation area is in relative close proximity to the existing township of Cessnock, the overall site has access to Mt View Road, one of the major feeder roads to and from Cessnock. The land is currently substantially used for rural and agricultural purposes pursuant to the current zoning of Rural 1(a) and rural 1(v) – Vineyards District.

The proximity to Mt View Road means the site is highly accessible and relatively prominent.

4.3 Retail Context

The Cessnock LEP 1989 does not contain a formal hierarchy of retail or commercial centres. Furthermore, there are no Development Control Plans which are specific to retail or commercial development or a hierarchy in the LGA.

The CWSS 2 report recognised that there was commercial hierarchy operating within the Cessnock LGA. The report estimated that the Cessnock City Centre comprised "*38,000 – 42,000 square meters of retail floor space. Cessnock City Centre is the*

largest commercial centre in Cessnock LGA and performs a role of a small sub-regional centre." The report suggested that nearby centres as Green Hills (East Maitland), the Maitland CBD and more distant centres such as Charlestown Square still have an influence on the shopping habits of the Cessnock LGA population.

Within the lower tier of the retail and commercial provision, the report identified Kurri Kurri as a "*neighbourhood centre providing mostly convenience goods and services for day to day shopping with limited opportunity for weekly shopping needs."*

The report also recognised roles played by centres at Branxton and Singleton as well as other local centres. These centres have a variable influence and significance in terms of retail trade for the Cessnock area owing to their smaller size and distance from the populated areas around Cessnock.

Table 1 presents summary information in relation to the major retail centres in the vicinity of the Cessnock trade area.

Table 1 clearly demonstrates the dominance of Cessnock in terms of floor area (47,080 sqm) and retail store provision in the local area. Vincent Street is a traditional shopping precinct based on strip commercial and retail development. It also comprises node developments namely Cessnock Plaza, Cessnock Marketplace, Cessnock City Centre, the Big W centre and an Aldi store within reasonable and close proximity to each other and Vincent Street.

The CWSS Stage 2 report identified that around 20 or 12% of premises in the Vincent Street precinct were food related. A further 68 or 40% were service related and 60 or 35% are nominated as general retail. It also nominated a 10% vacancy rate. Our fieldwork identified 40 vacancies totalling approximately 3,745 square metres or 8.6% of floor area. This is not inconsistent with the CWSS Stage 2 report given the variation as a result of take up or vacating of relatively small premises in the context of the total vacancy.

The CWSS Stage 2 report recognised there was a high vacancy rate at Kurri Kurri. This clearly persists today. The same situation applies for the smaller village commercial centres along with a level of underutilisation of existing space or lack of intensity in general retail provision. Cessnock and to a limited extent Kurri Kurri, are complimented by a component of first floor development which, by and large, seems predominantly underutilised or vacant. Commercial service activity tends to occupy ground-floor space in Cessnock.

TABLE 1 RETAIL CENTRES - CESSNOCK TRADE AREA

Centre	Retail Floor Space (sqm GLA)	Major Tenants	No of Specialties
Neighbourhood			
Cessnock City Centre	8,500	Target Coles Supermarket	10
Cessnock Marketplace	4,142	IGA Supermarket	17
Cessnock Plaza	6,145	Woolworths	20
Big W	6,545 (1)	Big W	3
Aldi	1,200	Aldi Supermarket	0
Kingsway Plaza	3,088	IGA Supermarket	10
Kurri Kurri Plaza	2,100	Bi Lo	4
Other			
Cessnock	20,500	-	170
Abermain	1,900	-	9
Bellbird	1,690	-	9
Branxton	2,690	-	24
Kurri Kurri	12,442	-	71
Weston	2,090	-	21

Source: NSW Shopping Centre Directory, Property Council of Australia, 2005; Castlecrest fieldwork and estimating, 2005.
Notes (1): Includes 1,918 sqm for bulky goods.

The development of the nodal centres within Cessnock has also changed the retail dynamics over the last 20 years. In the early 80's, Cessnock boasted a Grace Bros Country store and relatively strong representation of national traders. After the Grace Bros. outlet closed, Cessnock did not have a discount department store outlet until 2001 with the development of the Cessnock City Centre. Not withstanding this, the intensification of the Vincent Street strip centre was slowly diluted as Cessnock Plaza, Cessnock Marketplace and Cessnock City Centre and more recently the Big W centre were developed as destination centres in their own right, particularly for weekly grocery shopping and lower order comparative retail needs.

The CWSS 2 report noted *"that there is currently little demand for additional commercial floor space in Cessnock CBD, Kurri Kurri and smaller surrounding centres."* The report further surmised that should there be *"a substantial development of additional floor space beyond (Cessnock City Centre) it is likely that the vacancy*

rate would increase." It also noted that owing to the high vacancy rate in Kurri Kurri, there appeared to be sufficient capacity for retail expansion within the existing centre until 2011. We believe there are contextual circumstances that should qualify these observations.

Importantly, the CWSS 2 report pre-dated and did not to any significant extent assimilate the Big W Centre development. To a large extent, this centre will have mopped up spare retail spending capacity and is likely to have reduced the extent of escape expenditure particularly in non-food categories. The CWSS Stage 2 report had estimated the gross escape expenditure to be approximately $97.05 million in 2005 without accounting for the Big W centre.

The CWSS 2 report did however highlight that *"the (Cessnock) LGA needs to provide opportunity to accommodate emerging retail formats."* However, it is unlikely the Bellbird North Site will offer this opportunity in a manner consistent with the outcomes of the CWSS Stage 2 Strategy and the principals of draft SEPP 66 without creating a negative impact on existing centres in Cessnock and Kurri Kurri.

4.4 Planning Context

The CWSS 1 report, 2002 developed a set of urban settlement strategies which include the identification of Bellbird North as a release area for future residential growth. The CWSS 1 report also highlighted the indifferent potential for future growth as a consequence of a range of constraints impacting on land potentially earmarked for urban expansion.

The CWSS 1 also set out a vision for the future character of the LGA recognising the predominantly rural nature of the area currently but also recognising future development needs. The examination of matters relating to the Bellbird North release area, to a significant extent, fulfils the objectives and strategies of the CWSS 1 Strategy.

4.5 Proposed and Mooted Development

Within the Cessnock LGA there are currently a number of prominent proposals that will potentially provide competitive circumstances to components of the project which is the subject of this report but also play a role as new economic drivers for the region with a capability to support employment to complement the potential for population growth in the area. These include the following:

1. *Proposed rezoning for a Homemaker Centre, Maitland Road Cessnock:* This development on Maitland Road is northeast of the City Centre. We

understand that is intended to provide bulky goods outlets of around 12,800 square meters along with car parking and a recreational facility.

2. *Proposed rezoning for a mixed use development, Vincent Street Cessnock:* The development proposes the subdivision of a large land parcel for bulky goods (8.85 hectares) business transition (3.23 hectares) office/restaurant (0.65 hectares) along with light industrial, open space, residential and service industry. The development has an enormous capacity to provide low intensity retail and commercial floor space with the bulky goods area alone, having the potential to provide in the order of 30,000 square meters of floor space.

3. *Proposed rezoning for a Bulky Goods and Factory Outlet Development, Maitland Road Cessnock:* the development proposes the provision of 2,676 square metres of bulky goods and 9,357 of a Factory Outlet Centre, along with carparking and some fast food premises.

4. *Richmond Vale Village:* Press reports have indicated that a development comprising large urban release area along with support facilities was being planned for Richmond Vale. However, significant ecological and infrastructure delivery issues have delayed further work on the proposal. Whilst the potential exists for the development to include retail and commercial facilities, both Kurri Kurri and Cessnock and more importantly the growth of residential development in the location would provide additional retail support within the trade area.

5. *Cliftleigh/Heddan Greta*: This area of predominantly residential release will provide for over 1,500 lots. We understand a rezoning application is being progressed with the potential for the land to be released sometime in 2007.

6. *Sweet Water Estate, Branxton:* We understand this proposal would include residential, support retail and commercial facilities. Like the Richmond Vale project, the development would appear to have a capacity to increase the intensity of trade support within the catchment area. Details relating to the commercial and retail areas are being formulated. The project is not identified in either the CWSS 1 or the Draft Lower Hunter Regional Strategy and therefore is considered a medium or long term prospect at best.

7. *HEZ, Kurri Kurri:* The HEZ development is intended to provide for large scale industrial projects. However, re-subdivision and reclassification of land to permit smaller more intensive industrial uses are being considered for approval and release. The development could then provide for urban services or new forms of retail outlets. Not withstanding this, the HEZ has a significant employment generative capacity, which will benefit other local businesses.

8. Recent announcements have indicated Austar will seek approval to recommence mining at the Austar coalmine near Bellbird. The mine will potentially provide 270 jobs over a 20 year period. This will represent a substantial boost to the local economy and underwrite the performance of retail and commercial activity in the area.

9. Within the western section of the Maitland LGA and close to Cessnock there are a number of active small and large scale proposals. Of most significance is the 3,000 lot release area near Gilliston Heights which is currently subject to investigation by Maitland City Council. Pending application and approval, the supply of this land to the market could occur in early 2007.

The extent of mooted and proposed developments shows there is enormous expansive interest and potential for both residential and commercial/retail development in and around Cessnock. The approval and provision of the respective sub-divisions commercial, retail and industrial developments along with and community facilities would change significantly the context of the Cessnock CBD in its commercial and retail provision.

It is unlikely all these projects will proceed and that the market will be capable of absorbing the extent of these developments concurrently. The significant supply of residential land in greenfield subdivision would significantly test the historical take up rate of dwellings. Furthermore, the potential range of commercial and retail developments will add in excess of 50,000 square metres of retail space within the Cessnock LGA exclusive of any additional areas within the Bellbird North, Richmond Vale, Sweet Water, Cliftleigh or Gilliston Heights localities.

Whilst these issues will be examined more closely in the report it seems at face value the provision of additional facilities of a non-residential nature should be concurrent with and complimentary to local development.

5. Demographic Profile and Analysis

5.1 Introduction

The purpose of this section of the report is to define and analyse the characteristics of the Cessnock trade area in proximity to the proposed Bellbird North release area. These factors will have a bearing on the capability and capacity of the existing population to support the provision, both existing and proposed non-residential development within the sub-region.

5.2 Definition of Trade Area

For the purposes of this analysis we have defined a trade area consisting of a primary trade area (PTA) and a secondary trade area (STA) shown in Figure 2.

The PTA is relatively confined to the built up areas around Cessnock and towards Kurri Kurri. The STA is more expansive however and draws in many sparsely populated regional and rural areas, particularly to the north west of the Cessnock Township.

We note that whilst both the Cessnock CBD Planning Study[2] and the CWSS St2 study provide analysis for trade area demand, both assume capture based on the extent of the entire Cessnock LGA. Our definition of a trade area shows distinctive characteristics compared to the LGA. In terms of retail analysis, trade areas tend to be aligned to distance and geographical characteristics and also acknowledge the proximity of competitive centres. In this type of analysis, it is not uncommon for the trade areas to overlap across centres as well as LGA boundaries.

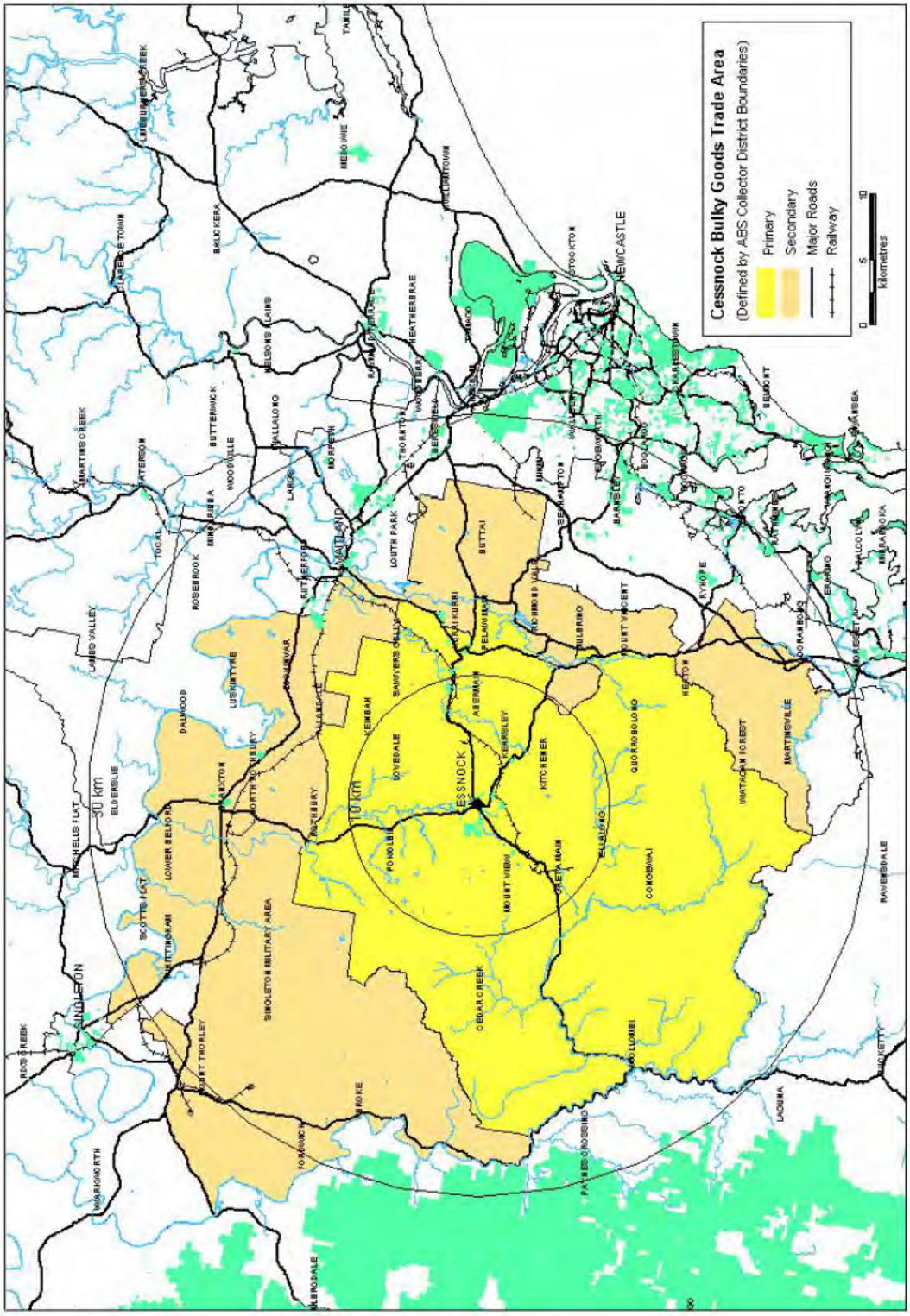
The PTA includes the townships of Cessnock, eastwards to Kurri, northwards to Rothbury, westwards to Wollombi and southwards to the Wattagan Forest. The STA is confined to between the 10 and 30 kilometre radius from Cessnock. It extends to Martinsville in the south, Stockrington in the east, Dalwood and Gosforth to the north and Fordwich and Bulga to the west.

It is important to note that the extent of the trade area, particularly to the south and west, concerns sparsely populated and large censor collector districts (CCD's). These extend the trade area to a significant extent but actually pick up very sparsely populated regions and do not distort the statistics to any significant extent.

We believe the capability of the development to service local convenience needs will have a localised trade area drawing significantly and predominantly from the PTA.

[2] Cessnock CBD Planning Study report, GHD, April 2002

Figure 2: Cessnock Retail Trade Area



5.3 Demographic Analysis

For the purposes of developing a demographic profile for the respective trade areas, we have compared the 1996 and 2001 Census information for the trade area based on the CCD's making up those areas. The information will form part of the building blocks for determining demand estimates to be discussed in the next section of the report.

Table 2 outlines the characteristics for the primary trade area. Table 3 distinguishes in summary form the characteristics for both the PTA and STA.

The statistics for the respective trade areas are compared to the Hunter Statistical District in 2001 (Hunter SD) to provide a comparison to an area that combines both similar and contracting characteristics to the identified trade area.

5.3.1 Population

There was an increase in population within the PTA of 617 persons in the period 1996 to 2001. This represented a growth of 1.6% or approximately 0.4% per annum. This was roughly comparable to the growth experienced in the Cessnock LGA over the same period. By contrast the STA experienced significantly stronger growth of 4% or just under 1.7% per annum. The growth rates compare favorably to the Hunter SD and we are forecasting the positive growth trend to continue in the future.

5.3.2 Age Profile

The PTA shows a remarkable correlation to the age structure experienced in the Hunter SD. This is characterised by decreasing growth in the younger age groups (up to 45 years) and an increase in relativity of the 45 years and over. This is reflective of the statistics in NSW and across Australia, displaying an aging of the population in relative terms.

Similar results are noted for the STA, noting however the relative difference for those over 65.

5.3.3 Household Density

The growth in the number of occupied dwellings is outstripping the population growth in relative terms. This characteristic is not unique and reflective of trends elsewhere in NSW showing a decrease in the average household size in the period 1996 to 2001. The household growth is reflected in Council's approval statistics and the decline in household density is forecast to continue in the future. This change is reflective of a decrease in fertility rates and the aging of the population.

TABLE 2: SELECTED DEMOGRAPHIC CHARACTERISTICS, PRIMARY TRADE AREA.

Characteristic	1996		2001		Change 96 - 01		Hunter SD (2001)	
	No.	%	No.	%	No.	%	No.	%
Population	38,392		39,009		617	1.6%	563,587	2.5%
Total Dwellings	15,058		15,420		362	2.4%	241,620	
Occupied Dwellings	13,743	91.3%	14,223	92.2%	480	3.5%	217,310	89%
Avg Household Size	2.8		2.7		-	-2.1%	2.6	
Age Structure								
0-14	8,884	23.1%	8,591	22.0%	-293	-3.3%	118,004	21.0%
15-24	5,376	14.0%	5,074	13.0%	-302	-5.6%	73,003	13.0%
25-44	11,240	29.3%	10,704	27.4%	-536	-4.7%	153,866	27.4%
45-64	7,744	20.2%	8,995	23.1%	1,251	16.2%	131,994	23.5%
65+	5,081	13.2%	5,520	14.2%	439	8.6%	84,655	15.1%
O/S Visitors	67		125		58		2,065	
Median Age			36				37	
Mobility *(Vehicles per household)*								
0 Vehicles	1,720	12.5%	1,535	10.8%	-185	-107%	24,177	11.1%
1	5,909	42.9%	5,642	39.6%	-267	-4.5%	89,569	41.2%
2	4,102	29.8%	4,421	31.1%	319	7.8%	68,154	31.4%
3 or more	1,389	10.1%	1,759	12.4%	370	26.6%	23,131	10.6%
Not stated	661	4.8%	874	6.1%	213	32.2%	12,279	5.7%
Household Income								
Neg/Nil	79	0.6%	57	0.4%	-22	-27.8%	1,060	0.5%
$1-$299	3,453	25.2%	2,227	16.2%	-1,266	-35.5%	30,457	14.5%
$300-$499	2,410	17.6%	3,040	22.1%	630	26.1%	42,039	20.0%
$500-$999	3,518	25.7%	3,423	24.9%	-95	-2.7%	53,409	25.4%
$1,000-$1,499	1,760	12.8%	1,892	13.7%	132	7.5%	31,513	14.9%
$1,500 or more	1,010	7.4%	1,692	11.8%	619	61.3%	28,961	13.7%
Partial/Not Stated	1,485	10.8%	1,504	10.9%	19	1.3%	22,959	10.9%
Household Structure *(by households)*								
Lone parent	1,648	12.2%	1,976	14.1%	328	19.9%	25,448	12.4%
Family – no children	3,147	23.2%	3,445	24.7%	298	9.5%	57,756	28.2%
Family – with children	5,089	37.6%	4,744	34.0%	-345	-6.8%	67,917	33.1%
Other Family/Group	629	4.7%	481	3.3%	-148	-23.5%	2,175	1.1%
Lone person	3,033	22.4%	3,320	23.8%	287	9.5%	51,850	25.3%
Occupation								
Managers & Administrators	551	4.1%	664	4.9%	113	20.5%		6.7%
Professionals	1,300	9.8%	1,396	10.3%	96	7.4%		16.0%
Associate Professionals	1,195	9.0%	1,384	10.2%	189	15.8%		10.7%
Trade and related	2,449	18.4%	2,257	16.6%	-192	-7.8%		14.8%
Adv. Clerical and Service	410	3.1%	368	2.7%	-42	-10.2%		3.5%
Intermediate Clerical, Sales and Service	1,871	14.1%	2,035	15.0%	164	8.8%		15.9%
Intermediate Production and Transport	2,388	17.9%	1,963	14.4%	-425	-17.8%		9.8%
Elementary Clerical, Sales and Service	1,273	9.6%	1,542	11.3%	269	21.1%		10.7%
Labourer and Related	1,594	12.0%	1,734	12.7%	140	8.8%		9.5%
Not/inadequately Stated	285	2.1%	264	2.0%	-21	-12.1%		0.8%

Source: ABS 1996 and 2001 Census

TABLE 3: SELECTED DEMOGRAPHICS, CESSNOCK RETAIL TRADE AREA, 2001

Characteristic	Trade Area			Hunter SD
	Primary	Secondary	Total	
Population and dwellings				
Population 1996	38,392	11,236	49,628	540,490
2001	39,009	11,684	50,693	563,586
% Change 1996 – 2001	1.6%	4.0%	2.2%	2.5%
Occupied dwellings	14,223	3,890	18,113	217,310
Average household size	2.7	3.0	2.8	2.6
Age Structure				
% Younger than 14	22.0%	23.2%	22.3%	21.0%
% Older than 65	14.2%	9.1%	13.0%	15.1%
Car Ownership				
% 0 Car household	10.8%	5.3%	9.6%	11.1%
% 1 Car Household	39.6%	32.0%	38.0%	41.2%
% 2 plus cars household	43.5%	58.4%	52.4%	42.0%
Household Income (Avg. Weekly)				
% Below $300 per week	16.6%	10.6%	15.3%	15.0%
% Above $300 per week	72.5%	76.0%	73.4%	74.1%
Household Structure				
% Lone Parent	14.1%	11.4%	13.5%	12.4%
% Lone Person	23.8%	17.5%	22.4%	25.3%
%Couple with Children	34.0%	42.1%	35.7%	33.1%
% Couple with no Children	24.7%	26.6%	25.1%	28.2%
Occupation				
%White collar	54.3%	54.1%	54.2%	65.1%
%Blue collar	43.7%	44.2%	44.0%	34.1%

Source: ABS 1996 and 2001 Census

5.3.4 Mobility

The vehicle ownership characteristics within the PTA align closely with the Hunter SD. This is not as consistent in the STA, likely to reflect the characteristics of more remote townships that display a skew towards two or more vehicles per household. The vehicle ownership statistics highlight the population's ability to travel within and beyond the trade area to satisfy not only retail shopping needs but also travel to work and other social demands.

5.3.5 Household Income

The characteristic within the PTA is reflective of some skew to the lower income (compared to the Hunter SD). The characteristics for the STA display a skew towards a higher income earning capacity reflective of populations closer to Singleton, Maitland and west Lake Macquarie. This assists to underpin retail spending habits

which tend to improve in higher income areas based on the ABS household expenditure survey.

5.3.6 Household Structure

The significant growth in lone parent, families with no children and lone person households is consistent with trends across NSW and Australia. The relative decrease of families with children impacts the retail spending characteristics. Families with children tend to spend a higher proportion of disposable income on retail goods, particularly food. Groupings in family formation years also underpin future population growth and robust spending habits.

5.3.7 Occupation

There has been a marked change in the PTA for the occupation characteristics between 1996 and 2001. Growth in managers and administrators, associate professionals and elementary clerical, sales and service has been offset by falls in trade related, intermediate production and transport and advance clerical service. Despite these declines, the relative representation of these groups remain stronger or not inconsistent with those for the Hunter SD. However, there appears to be a skew towards lower skilled and lower paid occupations, which is reflective of the household income characteristics in the PTA noted earlier.

Within the STA the characteristics are broadly similar to the PTA but different to the Hunter SD. That is, a relatively lower proportion of white collar occupations and a stronger relative representation of blue collar occupations within the STA.

5.3.8 Summary

The increase in population within both the PTA and STA is reflective of the trend within the Hunter SD. The defined areas are within proximity of the coastal margin and growth within the STA has displayed stronger characteristics. We believe the area has a capacity to sustain and perhaps experience an increase on current population growth rates into the future.

The trend of decreasing household density and aging nature of the catchment population is reflective of trends across NSW and Australia. This factor will have a direct impact on the capacity of the trade area to generate retail expenditure. The increasing proportion of lone parent and lone person households in comparison to the strong relative decline of families with children and other family groups within the trade area is also of note. This is likely to be offset by strong growth within the STA, although this will have a less direct influence and impact on the retail spending habits within Bellbird North and the township of Cessnock.

6 Retail Demand Estimates

6.1 Introduction

This section of the report will examine the projected demand generated by the Bellbird North project to support retail facilities. The assessment will include projection of the population growth, household growth and levels of retail expenditure capacity into the future.

The analysis will be principally confined to the impact or effect of the proposed Bellbird North project. It is clear from the conclusions from the CWSS 2 report that the focus of future retail and commercial growth in Cessnock should be the Vincent Street precinct. This includes non-food components such as bulky goods retailing and new retail formats such as factory outlet retailing.

The CWSS 2 concluded and recommended that *"no additional land be rezoned for commercial purposes across the LGA, with the exception of any specific land identified to accommodate emerging retail outlet formats that compliment and support the existing commercial hierarchy. In this instance, only land within, or in the immediate vicinity of the commercial precinct of Cessnock (Vincent Street) should be considered for rezoning."* The report recommended the existing zoned 3(a) general business land on Wollombi Road at Bellbird be rezoned to 3(b) neighbourhood business to better reflect the role in the commercial hierarchy.

In view of the extent of the mooted and proposed development outlined in section 4.5 we concur with the findings of the CWSS 2 strategy. It is unlikely that in the short term the Cessnock trade area will support the extent of the facilities being proposed. Assuming some of the non-food projects will proceed, it is probable that retail floorspace focused on food based needs as a direct response to population growth will be justified into the future.

Whilst the Bellbird North release area does not rate mention within the CWSS 2 strategy, we believe that there is sufficient justification for this area to contemplate inclusion of a retail and commercial precinct based on the potential population that could be achieved in this locality. This will be discussed in the next section of the report.

6.2 Population Growth and Potential

Notwithstanding an annual average growth between 1996 and 2001 in the defined STA of 1.7% per annum, we have noted that the Cessnock area has grown by approximately 0.4% per annum in the period 1996-2001. Whilst the CWSS 1 report initially contemplated the future annual growth of between 2% and 3% per annum the

projections were qualified to the extent that the 2001 Census data revealed that Cessnock LGA had in fact grown at a slower rate than projected within the strategy. The qualification noted that the existing land supplies for future urban component based on high growth rate estimates (three times the LGA's actual growth rate based on the 1996 to 2000 Census figures) would sustain more than 20 years residential land supply.

For the purposed of our report, the LGA population growth assumptions have some bearing on the rate of development and yield for the Bellbird North project. Annual growth within the trade area and Cessnock LGA could be assumed to continue at approximately 0.5% per annum for the foreseeable future. Dwelling growth is likely to occur at a much faster rate as was witnessed between 1996 and 2001. Furthermore, within the Cessnock district there are likely to be high, medium and low growth areas. In other words greenfield subdivisions are likely to produce both higher yields in absolute and relative terms for population and dwelling growth compared to areas targeting and experiencing urban consolidation.

Table 4 depicts the new dwelling approvals in the Cessnock statistical district for the period 1999 to 2005.

TABLE 4: BUILDING APPROVALS - DWELLINGS - CESSNOCK SD 2000 – 2004

Category	Year						
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**
Houses	162	213	269	345	293	254	**1,536**
Other Dwellings	21	21	31	71	67	61	**252**
Total	**183**	**234**	**300**	**416**	**360**	**315**	**1,788**

Source Building Approvals NSW and ACT, ABS Cat No. 8731.1

The statistics indicate the new dwelling approvals peaked in 2003. The total approvals for the period 2003 to 2005 increased 52% compared with the previous three years. Not withstanding this, the figures show that uptake through new dwelling approvals are unlikely to exceed 500 dwellings per annum in the short term. The 2005 figures reflect decline as a consequence of the cooling in the property market since its peak in late 2004.

The Bellbird North project is likely to be one of a number of areas that will contribute to the supply of new dwellings. The capacity of the land can be estimated in terms of population and dwelling yield based on the draft urban structure.

The average density of 2.6 persons per household is slightly less than the 2.8 persons recorded in the trade area in 2001. The decrease is reflective of general demographic trends in Australia. It is possible the density could continue to decline across the LGA however, we believe the 2.6 figure will be within the range and is reflective of stronger averages generally recorded in new development areas which often attract families and younger person households. It is also consistent with the figure used by Elton Consultancy in the Community Impact Assessment.

Insite Planning & Engineering in conjunction with Andrews Niel have developed an urban structure plan for the North Bellbird investigation area. From this, notional population an dwelling yields have been extracted and summarised in Table 5.

TABLE 5: ESTIMATED POPULATION AND DWELLING YIELD, BELLBIRD NORTH

Gross Land Area		Land Available for Development	
496 ha		322 ha	
Dwelling and Population Yield			
Scenario	**Dwellings**	**Average Density**	**Additional Persons**
High	5,000	2.6	13,000
Low	3,500	2.6	9,100

Source: Development Concept Plan, Andrews Neil, Feb 2006; Castlecrest estimates

In consideration of the dwelling approval statistics in Table 4 and the potential yield for Bellbird North depicted in Table 5 the project is likely to take considerable time to be fully absorbed to the market. As a large project located close to the existing Cessnock Township, the Bellbird North project has the potential to capture a considerable proportion of the new dwelling market. At an absorption rate of 200 dwellings per annum, the population increase will amount to approximately 520 residents per annum. The project period could extend for 20 years depending on market conditions.

6.3 Retail Expenditure Estimates

In view of the potential dwelling and population yield from North Bellbird it is desirable for the area to provide for local and convenience based shopping needs. In the context of draft SEPP 66, it is desirable for communities to be connected to and in proximity of facilities that provide basic facilities and a community focus point. It is also intended that these areas be located so as to reduce car dependency and provide critical mass to facilitate public transport provision into the future.

It is possible to project a floorspace and land requirement for the potential retail and community centre based on the population, household expenditure and retail capacity and capture.

The estimates will be prepared in reference to the following:

- The estimates for population and dwelling yield for Bellbird North depicted in Table 5.
- The 2003/04 ABS Household Expenditure Survey.
- The ABS retail industry statistics (cat No. 8622.0 and 8624.0)

The forecast estimates will reflect a relatively "closed" economy in terms of the Bellbird North project. That is, the retail analysis will not attempt to assess and assimilate full trade area impact having regard for such issues as transport systems, competition and development in other areas. The forecast estimates will not factor tourism not withstanding the significance of tourism trade in the Cessnock district.

6.4 Available Retail Spending

Based on the components on the goods likely to be available for neighbourhood, convenience or local shopping needs we have extracted expenditure estimates from the HES 2003/04. In broad terms coverage for food and non-food items are as follows:

Food

- Grocery Shopping
- Meals and out and fast food.
- Alcoholic beverages

Non-food

- Tobacco
- Clothing and footwear
- Household furnishings (selected)
- Household services (selected)
- Medical care and health (selected)
- Recreation (selected)
- Personal care
- Miscellaneous goods and services (selected)

The complete regimen of these items has not been drawn down within the categories noted as "selected". The average household expenditure estimates for the categories compared to the average for NSW are depicted in Table 6.

TABLE 6: ESTIMATES OF AVERAGE ANNUAL HOUSEHOLD EXPENDITURE

Category	Cessnock	NSW
Food	$8,680	%9,718
Non-Food	$6,408	$7,207
Total	**$15,088**	**$16,925**

Source: HES 2003/04 ABS; Castlecrest estimates

The estimates for average household expenditure within Cessnock are lower than for NSW which is reflective of the household structure and income characteristics based on the Census data. The total average household expenditure within the selected categories of $15,088 compares with the figure of approximately $16,355 derived from the CWSS 2 report. The CWSS 2 figure was more inclusive of items such as household furniture and non-durable categories particularly. These categories include items found typically in bulky goods and large white goods applications which are not likely to be relevant for retail development in the Bellbird North instance.

Using the expenditure estimates and the projected dwelling numbers attributed to the Bellbird North area (Table 5) we can estimate the generative retail expenditure capability based on the low, medium and high outcome. This assessment is depicted in Table 7.

TABLE 7: ESTIMATED TOTAL ANNUAL HOUSEHOLD EXPENDITURE, BELLBIRD NORTH.

Category	$ per household per annum ($2004)	Population/Dwelling Scenario and consequent expenditure ($ million per annum)	
		Low	High
Food	$8,680	$30.38	$43.40
Non-Food	$6,408	$22.43	$32.04
Total	**$18,088**	**$52.81**	**$75.44**

Source: Household Expenditure Survey, 1998/99, ABS; Castlecrest Estimates

Based on the extent of the Bellbird North project the estimated retail spending in the relevant categories ranges between $52.81 million and $75.44 million depending on the yield outcome of the development. This estimate is in constant dollar terms

($2004) and has not been escalated for inflation through the life of the development. The estimates in Table 7 do not include significant representation of the Household Expenditure Survey regimen items and therefore allow a natural escape of significant expenditure capacity to existing and proposed developments elsewhere in the Cessnock area.

The actual capacity for proposed retail and commercial development at Bellbird North to capture trade will depend on a range of factors. This will include the actual location of the centre, the size of the development and the range of traders which ultimately establish.

Notwithstanding this, it is possible to estimate a market share and thus a nominal value capture for a potential retail development in the Bellbird North development. The estimates based on the low and high scenario is depicted in Table 8. The table includes allowances for capture from the Bellbird North as well as trade from the immediate surrounding area which is estimated to represent 20% of food trade and 10% of non-food trade. Both estimates are considered conservative in the circumstances.

TABLE 8: ESTIMATED TRADE CAPACITY AND CAPTURE, BELLBIRD NORTH ($2004)

Category A: Bellbird North B: Nearby areas		Trade Area Capture %	Scenario ($ million per annum)	
			Low	High
Food.	A:	60%	$18.28	$26.04
	B:	20%	$3.65	$5.21
Sub-total			**$21.93**	**$31.25**
Non-Food	A:	35%	$7.85	$11.21
	B:	10%	$0.79	$1.12
Sub-total			**$8.64**	**$12.33**
Total			**$30.57**	**$43.58**

Source: Castlecrest Estimates

The estimated trade capacity and retail sales capture at Bellbird North ranges from $30.75 to $43.58 million once the estate is fully developed.

The actual floorspace demand consequential to the trade capture can be extrapolated by applying floor space sales averages to the estimates for the trade. In order to allocate the respective sales, assumptions are made as to the distribution of trade between supermarket and specialty traders. Typically the food trade will for the

most part will be captured by a supermarket whilst non-food trade, by a range of specialty traders.

Modelling the likely centre in the local or neighbourhood scale, food and convenience non-food traders will predominate. Consequently, table 8 assumes trade capture of less than 50% of the total food and non-food trade available from all households in the North Bellbird investigation area. Assuming a centre is planned and built, it is likely to consist of a supermarket and a range of specialty shops. The centre will have a superior capacity to capture food rather than non-food trade in these circumstances. The allocation of trade, assuming a neighbourhood centre is planned, is depicted in Table 9.

Table 9 examines the expenditure breakdown by distinguishing "supermarket" and "specialty" trade for the purposes of the subsequent floorspace analysis. The capture rates relate to industry standards for neighbourhood style centres.

TABLE 9: ALLOCATION OF TRADE, BELLBIRD NORTH

Category		Sales $million per annum	
		Low	High
Food - Supermarket	75%	$16.45	$23.44
- Specialty	25%	$5.48	$7.81
Non Food - Supermarket	10%	$0.86	$1.23
- Specialty	90%	$7.78	$11.08
Total		**$30.57**	**$43.56**

Source: Castlecrest estimates

The allocation suggests the supermarket will have a capacity range of between approximately $17.31 million per annum (low) to $24.67 million (high). Specialty traders will range between $13.26 million (low) and $18.89 million (high). In constructing an assessment for retail floorspace demand we have assumed that the "average" supermarket will trade at $8,000 per square metre, retail food specialties at $6,000 per square metre and non-food specialty traders at $4,500 per square metre.

Based on the trade capture depicted in Table 9 the projection of net retail floor space demand for the respective low and high scenarios are depicted in Table 10. These estimates assume constant yields and no escalation per square metre over time. An allowance for current floor space in Bellbird is included as it is within the trade area assumed in capture in Table 8.

TABLE 10: RETAIL FLOOR SPACE DEMAND, BELLBIRD NORTH

Category		$/sqm per annum	Area in Square Metres	
			Low	High
Food	- Supermarket	$8,000	2,160	3,100
	- Specialty	$6,000	910	1,300
Non-food		$4,500	1,730	2,460
Sub-total			**4,800**	**6,860**
Less Bellbird (existing)			1,690	1690
Total			**3,110**	**5,170**

Source: Castlecrest estimates

The range of floorspace requirement after fully accounting for existing floorspace in Bellbird is between 3,110 square metres and 5,170 square metres. This will generate a land requirement to permit the development for the extent of non-residential land use.

Based on historical averages and assuming that there are limited constraints in development, floorspace yield will generally range between 30% to 40% of land area. In other words, having allowed for carparking, landscaping, goods delivery, common areas and the like, the gross floor area ranges between 30-40% of the total land available.

Using this allocation, Table 11 depicts the areas in hectares required to service the retail floorspace demand indicated in Table 10. we have excluded the existing space at Bellbird to provide an overall gross figure for the defined catchment.

TABLE 11: RETAIL/COMMERCIAL LAND REQUIREMENTS, BELLBIRD NORTH

Yield	Area in hectares	
	Low	High
30%	1.60	2.29
40%	1.20	1.72

Source: Castlecrest estimates

Subject to the ultimate estate population and household density and the floor area yield, the land area requirement to service the estimated retail trade will range between 1.20 hectares and 2.30 hectares inclusive of the current provision in Bellbird of approximately 0.5 hectares.

The allocation is based on limited regimen items from the Household Expenditure Survey and does not include a full range of non-food items such as bulky goods and urban services trade.

The aspect of timing is important to consider in the assessment. In the short to medium term, the retail land areas should be identified but are unlikely to be developed. It is possible development could be staged. In any event, our assessment assumes the retail nearby to the proposed Bellbird North release area is likely to satisfy demand in the early years of the project.

In the longer term, the take up and development of land within Bellbird North provision will be limited to food businesses (supermarket, fresh produce, take away, liquor) and lower order non-food operations (personal care, clothing, commercial premises). The continued aggregation of higher order centres elsewhere in the Cessnock trade area will progress and account for higher order non-food shopping including bulky goods, recreational services and household durables. The assessment provides for local convenience facilities so as not to compromise the viability of main centres.

Depending on prospects for other developments close to the Bellbird North estate there may be arguments to supply additional retail land allocations of up to 3,000 square metres to provide for small local facilities in proximity to new communities. We would not advocate the provision of such centres within a 1 kilometre radius of other major centres not withstanding the planning paradigms of “ped-shedding” to a 400 metre radius.

Additional local facilities will not be viable if their relative proximity brings them closer to larger centres. Placement should pick up main road and transport routes and not be restricted to pockets in the midst of low density residential areas. History shows the less exposed locations away from transport routes, unless there is substantial population density along with an efficient, reliable and regular public transport service, will not remain viable and survive in the longer term.

The population growth possible in the longer term may have the capacity to support a public transport service and non-residential planning should account for this at the time.

7 Conclusions and Recommendations

Whilst in recent times Cessnock has experienced uplift in population and dwelling growth, the change has not been strong in comparison to other areas within the Lower Hunter. However, there has been a raft of rezoning and development proposals which have the capacity to increase both the residential and non-residential development outcomes within the Cessnock LGA.

Significant locally based economic drivers including the Hunter Economic Zone and the recently announced Austar coal mine have the capacity not only to provide local employment opportunities to support further population growth, but diversify the industry and employment base. This is a vital consideration in an area which lost primary and secondary industry representation through the 1980's and 1990's despite the growth in the wine industry and tourism and tertiary sector growth.

In planning for new residential areas there is a capacity and a propensity to include non-residential land holdings consistent with the approach and doctrine outlined in Draft SEPP 66.

The proposed development at Bellbird North has an extensive capacity and depending on dwelling yield outcomes could support a population of up to 13,000 people in 5,000 dwellings when fully developed. This yield alone is sufficient to support the development of a neighbourhood shopping centre comprising a supermarket and a range of specialty shops.

Owing to the proximity of extensive sub-regional retail and commercial facilities at the Cessnock CBD, the demand for retail facilities within the Bellbird North area will support only a local/convenience provision. The forecast population within Bellbird and Bellbird North will have the capacity to support additional floorspace in the range of 4,800 to 6,860 square metres.

This will in turn generate the need to allocate between 1.2 and 2.3 hectares of land sufficient to accommodate non-residential development to meet the demand of the Bellbird North and immediate trade area once the estate is fully developed.

In order to reinforce the objectives and characteristics of Draft SEPP 66 we believe the land allocation should occur close to existing or proposed transport routes within the local precinct. The land areas should also be provided in one parcel and not be disaggregated.

If other future development nearby warrants further community and retail facilities, we believe they should be at least 1 kilometre from the existing and planned Bellbird North provision and target limited local/convenience capacity only. The floorspace

should be limited to 1,000 square metres on land of approximately 3,000 square metres.

Future commercial and retail land provision should focus locations related to main road and transport routes. This will facilitate the capacity to support integrated local transport service within the local area as the areas grow and develop.

DISCLAIMER

This assessment is based on information researched by Castlecrest Consultants. Whilst the information is believed to be accurate the assessment or any information is not warranted or guaranteed and no responsibility or liability for any information, opinion or commentary contained herein, or for any consequences of its use will be accepted by Castlecrest Consultants or by any person involved in the preparation of this reassessment and report.



Visual Impact Assessment

for the North Bellbird Investigation Area

June, 2006

The report has been prepared for:

Insite Planning and Engineering Services

Suite 1, Level 1, 102 104 Vincent Street, Cessnock

PO Box 93 Cessnock NSW 2325

T 4991 4793 F 4990 7551 www.insiteplan.com.au

North Bellbird Investigation Area, Cessnock

Andrews.Neil

Job Title: VIA Bellbird A3.indd Job No.: 05002

File Locations: T:\05\05002 Insite Planning, Bellbird\Img\01 presentation\Visual Impact Assessment\VIA Bellbird A3.indd

Quality Control Plan

ISSUE	DATE	DESCRIPTION	CHECKED BY
A	03.02.06	Work in Progress Document	MW/JW
B	10.02.06	Draft Report	IA/MW
C	21.02.06	Amendments as per client request	JW
D	23.03.06	Changes to Visual Impact Rating and Development Principles Diagram	
E	25.05.06	Changes	JW
F	30.05.06	Minor text changes and new Viewshed Analysis and masterplan	JW
G	07.06.06	Minor text changes	GO

Please initial page to proceed with above changes or for approval with no additions.

Signature/s: ..... Dated: .....

This document, including the information and intellectual property contained is the property of Andrews.Neil and is subject to copyright. The document must not be reproduced or adapted in whole or in part in any form without the written permission of the copyright owner









Contents

Executive Summary 1

1.0 Introduction 2

2.0 Methodology 3

3.0 Site Context 4

4.0 Visually Prominent Features 5

- 4.1 Landscape Character Zones 9

5.0 Visual Impact Rating 10

- 5.1 Scenic Quality 10
- 5.2 Visual Absorption Capacity 10

6.0 Development Principles 11

7.0 Viewshed Analysis & Point to Point Visibility 12

8.0 Conclusion 18

Appendix A - Masterplan 19

Executive Summary

This report has been prepared for Insite Planning and Engineering on behalf of Johnson Property Group. The North Bellbird Investigation Area includes is 496ha in total and includes;

LOT NUMBER	D.P
141	986905
3	810827
PT13	880374
10	815485
11	815485
1	167004
210	1012346
211	1012346
212	1053307
1	349452
1	327580
1	1011544
2	1011544
1	327785
2	597226
1	597226
1	328498
1	328497
PT51	807540
52	807540
2	624793
3	624793
1	329071
261	524058
1	196997
11	806584
10	806584
3	597226
PT1	66183
2	66183
1	196460

The area has been assessed with respect to its capacity to sustain a mix of development and conservation including;

- A mix of residential environments provided through sequential staging,
- A commercial and retail precinct including mixed use development capable of serving the needs of the North Bellbird community,
- Social and community infrastructure including schools, community and recreational facilities including open space,
- Infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages all reticulated service infrastructure and fire trails,
- Conservation of quality remnant vegetation,
- Rehabilitation of degraded riparian corridors to provide habitat linkages.

The Visual Impact Assessment was prepared to identify any significant views, viewpoints or landscape features which should be retained or enhanced through the Masterplanning process. The site and surrounds were inspected by vehicle and supported through desk tops reviews of aerial photography and topographic information. A GIS program was used to confirm findings of Point to point Visibility and viewsheds.

Significant landscape features and views were identified prior to preparation of the Masterplan and as a result the key findings have generally been addressed by the plan, Appendix A. The most significant visual component of the proposal is that the western edge adjoins the highly scenic “Vineyards District” and that there are a number of outstanding regional views available from the Vineyards District across the cleared central portion of the Investigation Area.

The Visual Analysis and Assessment Report recommends that development density is increased from west to east allowing for a transition between the rural vineyards district and the suburban areas of Bellbird in the east. The report also recommends the retention of existing vegetation stands and the revegetation of riparian corridors to “visually fragment” the proposal when viewed from the elevated areas of the vineyards district. These key recommendations are reflected in the Masterplan and other recommendations such as street tree planting, building and material finishes can be dealt with at the detailed design stage.



Fig 1 - Site Location

1.0 Introduction

Andrews.Neil has been engaged by Insite Planning to prepare a Visual Impact Assessment for the site known as The North Bellbird Investigation Area. The report has been requested to identify potential visual impacts on the adjoining Vineyards District as identified in Cessnock City Council (CCC), DCP 28 and the adjoining residential area of Bellbird.

The Visual Impact Assessment along with other specialist reports will assist in the development of an Urban Design Masterplan for the proposed rezoning of the site. The Masterplanning process will consider the Principles proposed in this report to minimise potential visual impacts. The rezoning of the site is intended to allow for mixed use development which will take into account the advice from various other specialist reports such as ecological, archaeological, engineering, planning, bushfire, geotechnical and economic.

The North Bellbird Investigation Area has been assessed with respect to its capacity to sustain a mix of development and conservation including:

- A mix of residential environments provided through sequential staging,
- A commercial and retail precinct including mixed use development capable of serving the needs of the North Bellbird community,
- Social and community infrastructure including schools, community and recreational facilities including open space,
- Infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails,
- Conservation of quality remnant vegetation, and,
- Rehabilitation of degraded riparian corridors to provide habitat linkages.



Fig 2 - Survey Plan

2.0 Methodology

- Desktop study including review of aerial photography, topographic survey and relevant literature including CCC DCP 28.
- Describe the site in its regional Context and how it relates to the adjoining urban and rural developments.
- Describe the Visually Prominent site features.
- Determine key viewpoints to the site using Vertical Mapper (MapInfo) GIS software.
- Key Viewpoints are those from significant public space such as roads, parks, lookouts and tourist destinations.
- Site survey (2 days) to confirm key viewpoints as determined by Vertical Mapper and investigates the impact on views from vegetation and built form in these locations.
- Describe and analyse the views to the site.
- Discuss the significance of the site in relation to its context.
- Discuss the Absorption Capacity of the site.
- Discuss the features and views that should be retained or enhanced during the Masterplanning process.

Following completion of the initial site investigations and analysis the Draft Masterplan will be reviewed to determine likely impacts upon the visually significant areas identified during the site assessment. (refer to Appendix A - Masterplan)

- Review Masterplan (Andrews.Neil May 2006).
- Provide Principles for development to minimise potential visual impacts.

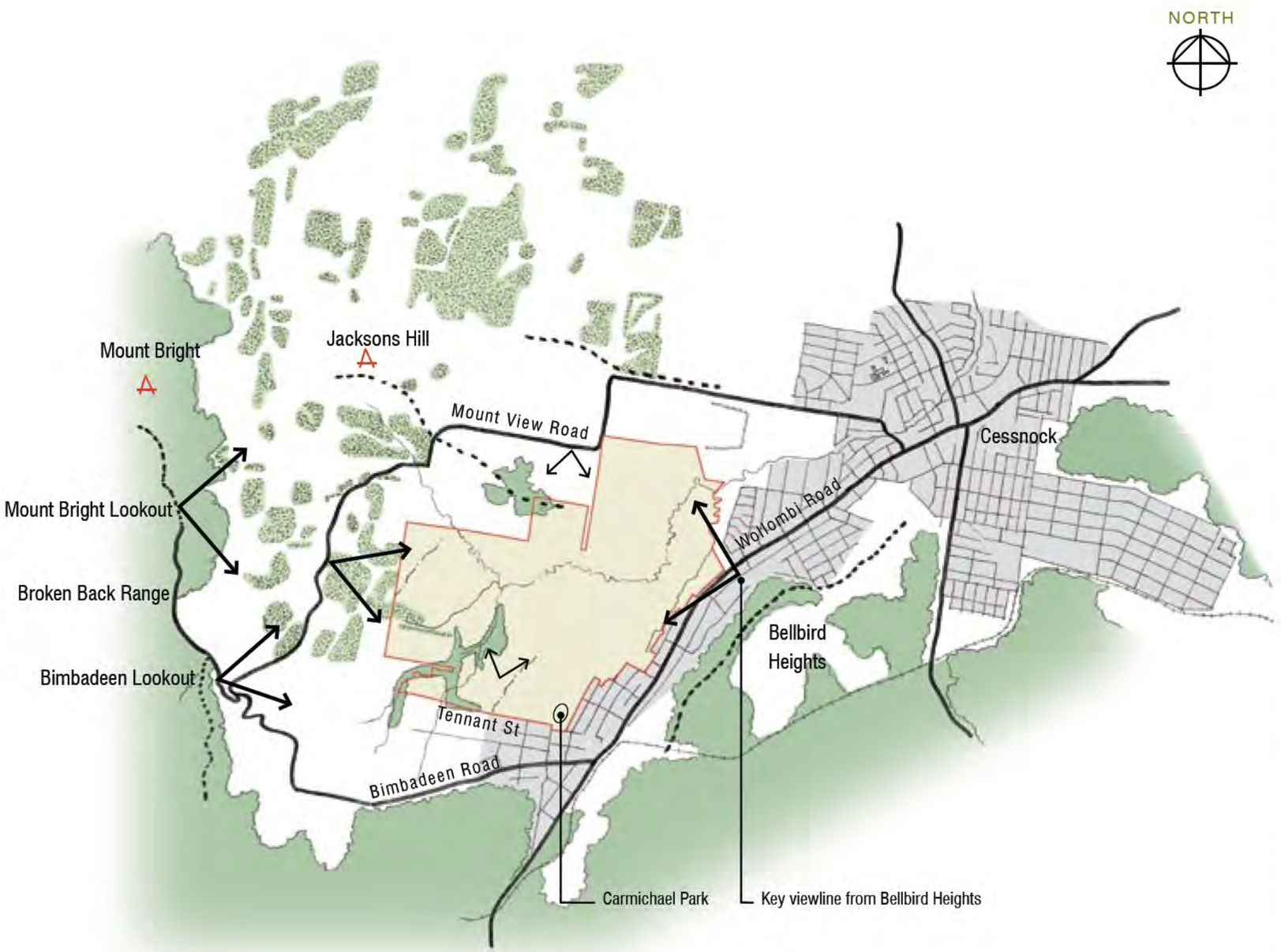
3.0 Site Context

The proposed development area is located in a valley between the Broken Back Range and Bellbird Heights residential area, west of the Cessnock CBD. The dominant feature of the site is the centrally cleared zone that has been grazed over time leaving the site mostly devoid of vegetation. Pockets of vegetation occur towards the site periphery and sporadically along creeklines. Isolated cottages occur across the site however they are insignificant when considering the site as a whole, refer to Context Plan.

The site is physically bounded by Tennant Street to the south, Bellbird residential area to the east, the vineyards district to the west and Mount View Road to the north. The site lies to the west of the established township of Cessnock and is situated between the Vineyards District and the urban area of Bellbird. The eastern boundary and part of the southern boundary are adjoined by existing urban development whilst the western and northern boundaries are adjoined by rural areas consisting of bushland, vineyards and grazing land.

The western most parts of the site are identified as being within the Vineyards District (DCP 28) and include established vines, bushland, riparian zones/corridors and open space areas. These areas are considered visually significant as they are a part of the vineyards district which is a major NSW tourist destination.

The visual catchment of the site can be defined as the Broken Back Range to the west and Bellbird Heights to the east. Views to the north and south are limited by vegetation and topography. Views to the site are also available from elevated locations such as Mount View Road, Broken Back Range and Bellbird Heights.



LEGEND

- Elevated views across the site
- Local views into the site
- Limits to visual catchment of the site
- Vineyards/ Olive Groves
- Bushland
- Existing urban development
- High point

Fig 3 - Site Context Map

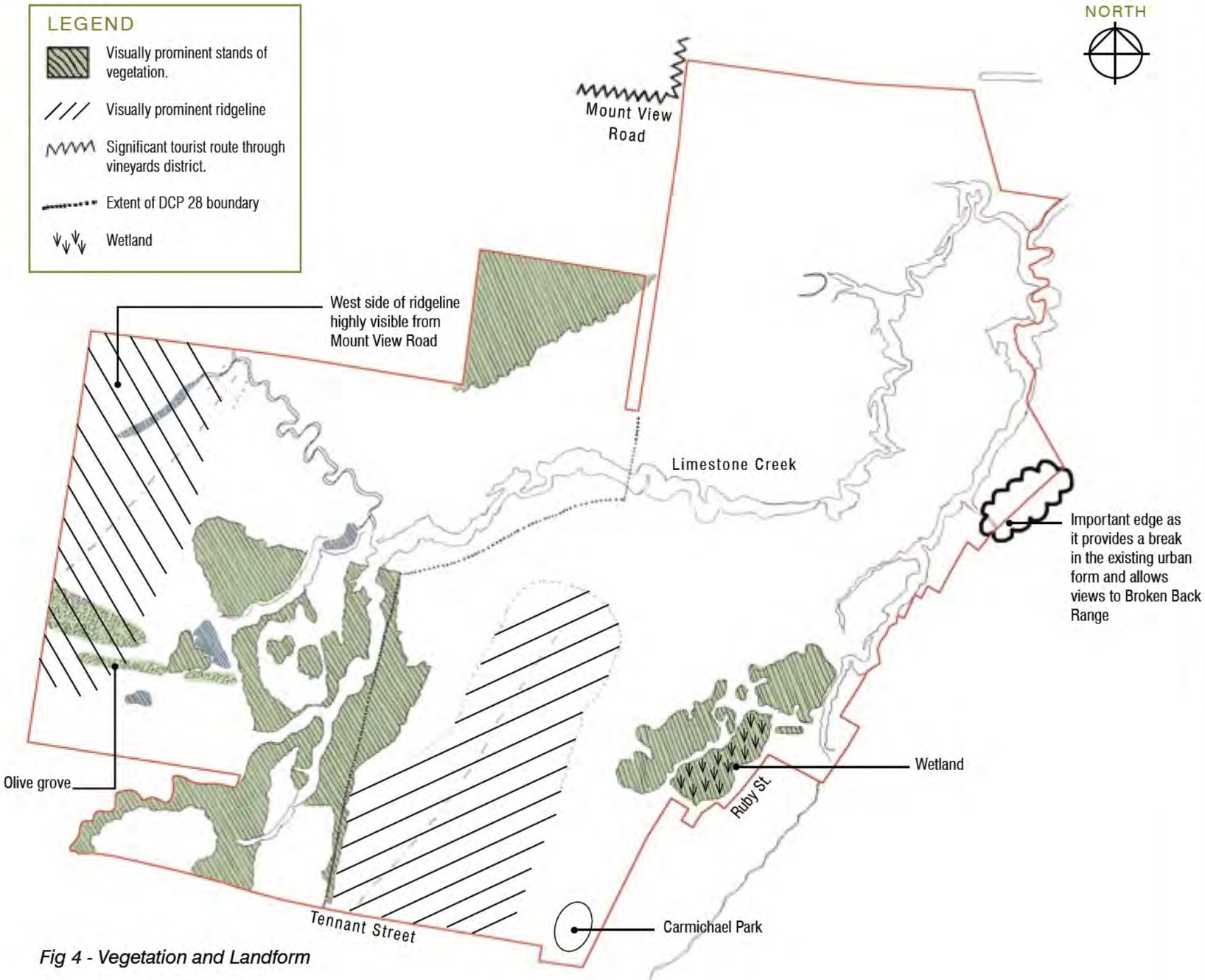


Fig 4 - Vegetation and Landform

4.0 Visually Prominent Site Features

Views to the site are available from two generalised locations; 1. Edge views, 2. Regional views. Edge views can be described as those views which are available from adjacent to the site boundary from roads, parks, lookouts and key tourist destinations.

Regional views are views to the site from surrounding ridgelines, roads on tourist routes, lookouts, vineyards and resorts.

Visually significant site features are also those physical features such as vegetation and landform that dominate or determine the site character, refer to Visually Prominent Site Features.

Regional Views

• Broken Back Range

Expansive views across the site are available from designated Lookouts such as Bimbadeen and Mount Bright where it is possible to view the whole site. From these vantage points the Bellbird Heights ridgeline is clearly visible as the eastern most limit of the visual catchment for the site and although Tomalpin is visible in the distance it is not possible to see the site from that point.

From Mount Bright Road which is located along the Broken Back Range ridgeline many of the potential views are obscured by vegetation and it is necessary to walk to the edge of the escarpment to gain a view across the site. Given that the Great North walk crosses the Broken Back Range ridgeline all views available from the elevated position are considered significant. (refer to Photo 1 on Page 7)

Issues for development:

Development of the site will be visible from this highly scenic, elevated position. Although the township of Cessnock is visible it is mitigated by the following points;

- Setback to the vineyards district with rural lands providing a buffer.
- Established street and garden canopy trees.
- Low rise development.

Development for the proposed site should look to implementing similar principles, with the addition of;

- Low key and low density within the vineyards region.
- Using vegetation corridors to 'visually fragment' development.

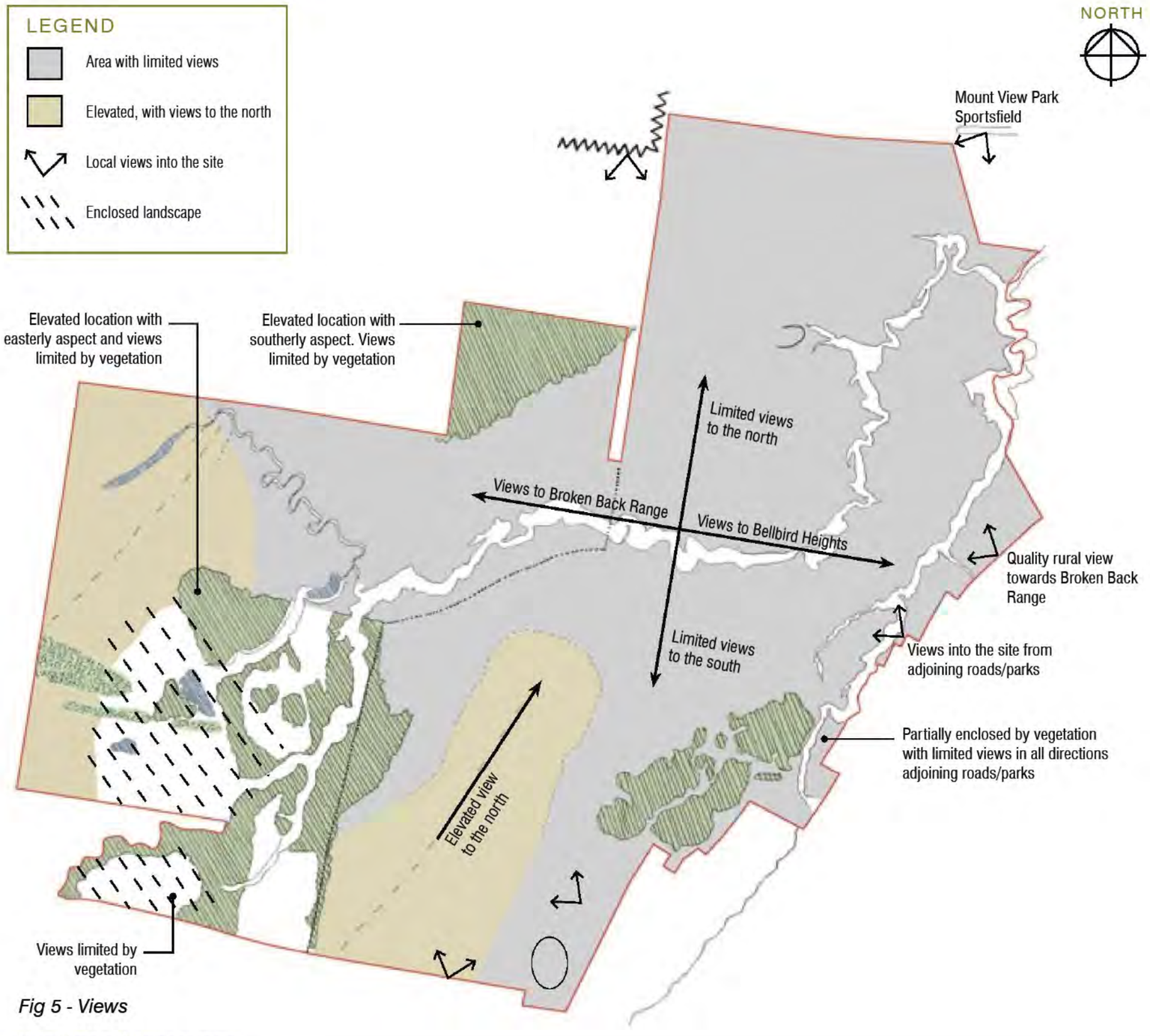


Fig 5 - Views

4.0 Visually Prominent Site Features

- Bimbadeen Road

Bimbadeen Road intersects with Mount View Road to the south west of the study site. The elevated position of this intersection gives views to the northern cleared area of the site with an intermediate ridge obscuring views of the south eastern part of the site. Cessnock township is visible in the distance and the rural lands provide a pleasant buffer to the developed township area. The eastern end of Bimbadeen Road is characterised by grazing lands and native vegetation generally obscures views north towards the site. A glimpse of vines adjacent to Derby Lodge is possible from the Eastern end of Bimbadeen Road however it is not a significant view as it is mostly screened by vegetation on an adjoining lot. (refer to Photo 2 on Page 7)

Issues for development:

The western end of Bimbadeen Road offers the most likely views over the site, however, the western most ridgeline extending north through the site generally obscures views.

In addition, the road topography is not conducive to stopping and taking in the view as it is steep, narrow and winding.

- Mount View Road

Views to the north western part of the site are available from Mount View Road which is a major tourist route through the vineyards district. Views from Mount View Road are considered visually significant as a requirement of CCC DP 28 is to retain the scenic qualities of the vineyards district.

The elevated areas of Mount View Road have scenic views to the east and west. Views to the east overlook the study site and with a number of vineyards being located in this area, retention of the rural outlook is important to the overall experience of visiting a major wine producing region.

Although Bellbird and Cessnock are visible in the middleground they have a vegetated backdrop and a setback to the urban edge which is characterised by the cleared grazing land of the study site. The rural buffer provides visual relief to the more densely developed areas. (refer to Photo 3 on Page 7)

Issues for development:

Sensitive development control will be required along the interface with Mount View Road to ensure that the scenic qualities of the Vineyards District are not adversely affected, refer to Principles Plan.

The western edge of the site is the most critical to retaining the scenic qualities of the Vineyards District. Low key, low density development with generous space between development sites for open space and vegetation should be considered.



Photo 1 - Broken Back Range



Photo 2 - Bimbadeen Road (West end) looking north. Demonstrates that the ridge in the right hand side of the photo obscures views to the eastern side of the site



Photo 3 - Mount View Road - Looking east



Photo 4 - Bellbird Heights - Looking west. Demonstrates the rural buffer between the Vineyards District and urban areas



Photo 5 - View from Tomalpin



Photo 6 - Derby Lodge - Looking north east. Demonstrates that vegetation limits views of the eastern side of the Investigation Area

4.0 Visually Prominent Site Features

• Bellbird Heights

Various parts of the site are visible from the street network within Bellbird Heights. Residences in streets such as Keelendi Road enjoy a rural outlook with views across to Mount Bright. Given that the site lies in the valley floor below Mount Bright and the Broken Back Range any future development is unlikely to inhibit views to these key landmarks. (refer to Photo 4)

Issues for development:

The most significant visual feature from the residential area and from Wollombi Road is the Broken Back ridgeline.

Although there is also a pleasant outlook across a rural landscape towards the west, it is the ridge that has the highest scenic qualities and is of regional significance.

Future development should attempt to maintain opportunities for viewing the ridgeline which may be achieved by;

- Providing at least one significant east/west road.
- Carefully designing riparian corridors.
- Controlling building height in key view line areas.

• Jacksons Hill

Jacksons Hill is easily identifiable from the surrounding areas and is located west of the project site. Jacksons Hill is mostly devoid of vegetation and a key visual landmark within the region. Views to the site from Jacksons Hill are obstructed by the low, vegetated ridge in the North West corner of the study site.

Issues for development:

This landscape feature is regionally significant as its characteristic 'bald' top is easily identifiable.

Views to or from Jacksons Hill are unlikely to have a significant impact.

• Tomalpin

Tomalpin is a unique landform rising above Werakata National Park and has a number of walking trails which are difficult to access by 2WD vehicle. The west facing hillside is well vegetated and unobstructed views are difficult to obtain. From this vantage point Mount Bright and the Broken Back Range are clearly visible however the valley floor below is insignificant. Tomalpin is approximately 10.5km east of the site and is not considered a significant viewpoint given the distance to the site, access difficulties and vegetation cover. (refer to Photo 5)

Issues for development:

No issues envisaged due to distance and topography.

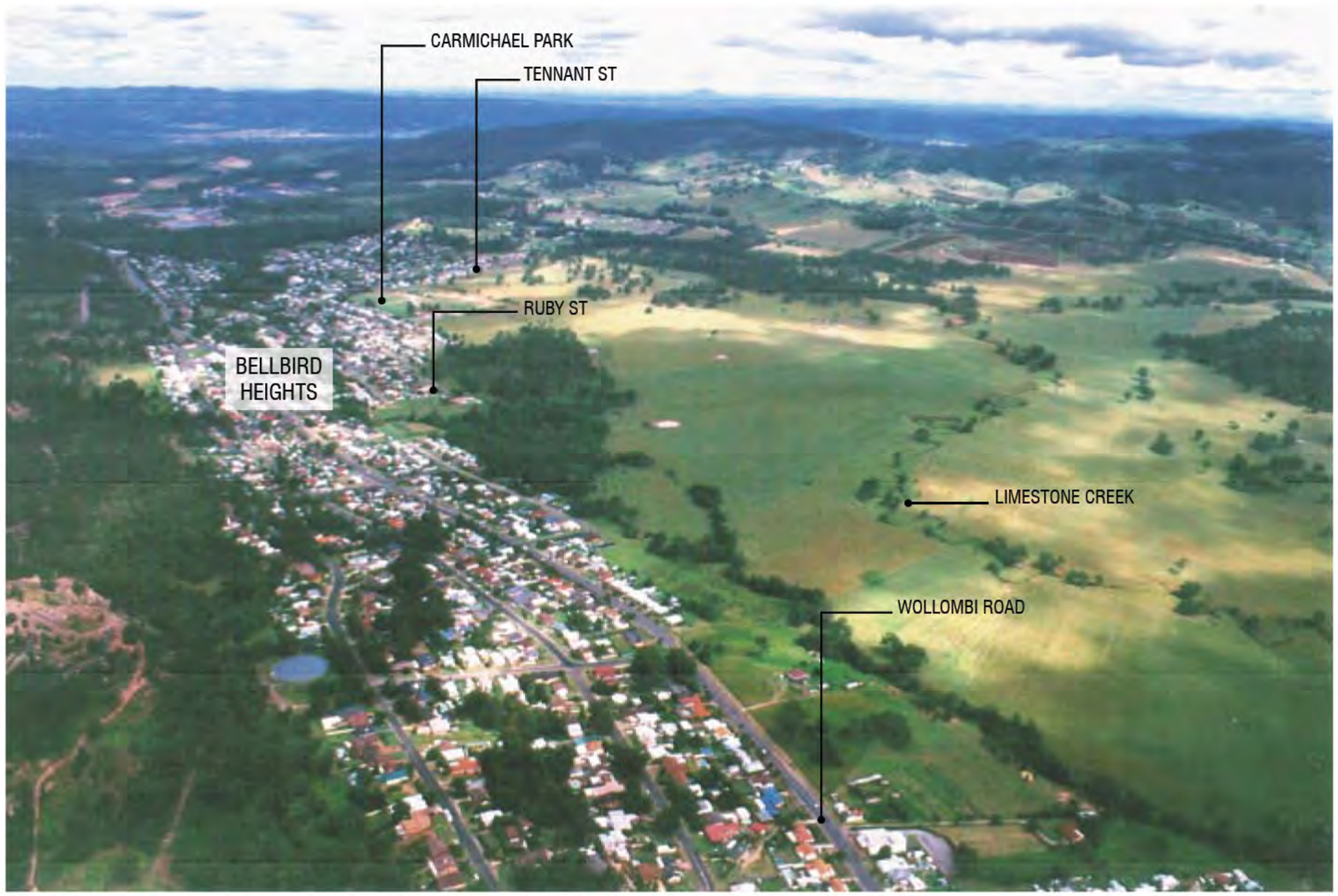


Photo 7 - Aerial View showing visually prominent Edge Features

4.0 Visually Prominent Site Features

Edge Views

Views from adjoining areas are not expansive, however in a number of cases significant visual features are located close to the perimeter of the site and the detail of these elements contributes to the quality of the adjoining streetscape.

• Tennant Street

Views into the site are available along Tennant Street from which the most expansive edge views of the site occur. From this generally elevated position views extend to the northern boundary across the centrally cleared grazing land, west to the Broken Back range and East to Bellbird Heights. Views to the south are limited by nearby residential development.

A low ridgeline extending northwards from Tennant Street will provide a good opportunity to retain elevated views across the site and may provide an identifiable landmark within the development area.

Issues for development:

An opportunity exists to retain the elevated views to the north by possibly locating a north/south oriented road along the ridge. This will have the added benefit of providing 'filtered' views from the Mount View Road area through the incorporation of street trees.

• Bellbird Residential Area

Numerous views into the site area available from Bellbird such as from Wollombi Road, Hetton Street, Ruby Street and Cruikshank Street. A small area of wetland and associated canopy tree vegetation occurs adjacent to Ruby Street and provides a scenic outlook and point of interest. Connection with the existing street pattern is possible from Ruby Street and significant visual features such as the small wetland may be utilised and enhanced to provide a natural entry feature into the site.

Where the site adjoins Wollombi Road it provides visual relief from the urban development and allows views through to the Broken Back Range. This point is a key location along Wollombi Road as it provides a physical connection between the rural lands and the urban area of Bellbird. This point also creates an opportunity to connect with the existing street network in Bellbird and make use of the drainage line along the eastern boundary as a natural entry feature to the site.

Issues for development:

Consider providing connectivity to the existing road network to allow physical and visual integration between existing and 'new' development areas.

Reinforcement of the existing riparian zone with the inclusion of cycleways and public facilities would retain some separation and scenic outlook that the residential area already enjoys.

• Mount View Park Sportsfield

Views into the northern section of the site are available from the spectator mound and extend to the central areas of the site. This viewpoint is not considered significant as Mount View Road is already developed with residential, accommodation and sporting facilities and any adjoining development with appropriate interface is not likely to have a significant visual impact.

Issues for development:

No visual impact issues are envisaged although access should be encouraged for vehicles, cyclists and pedestrians. The sportsfield will contribute to visual buffering of 'new' development.

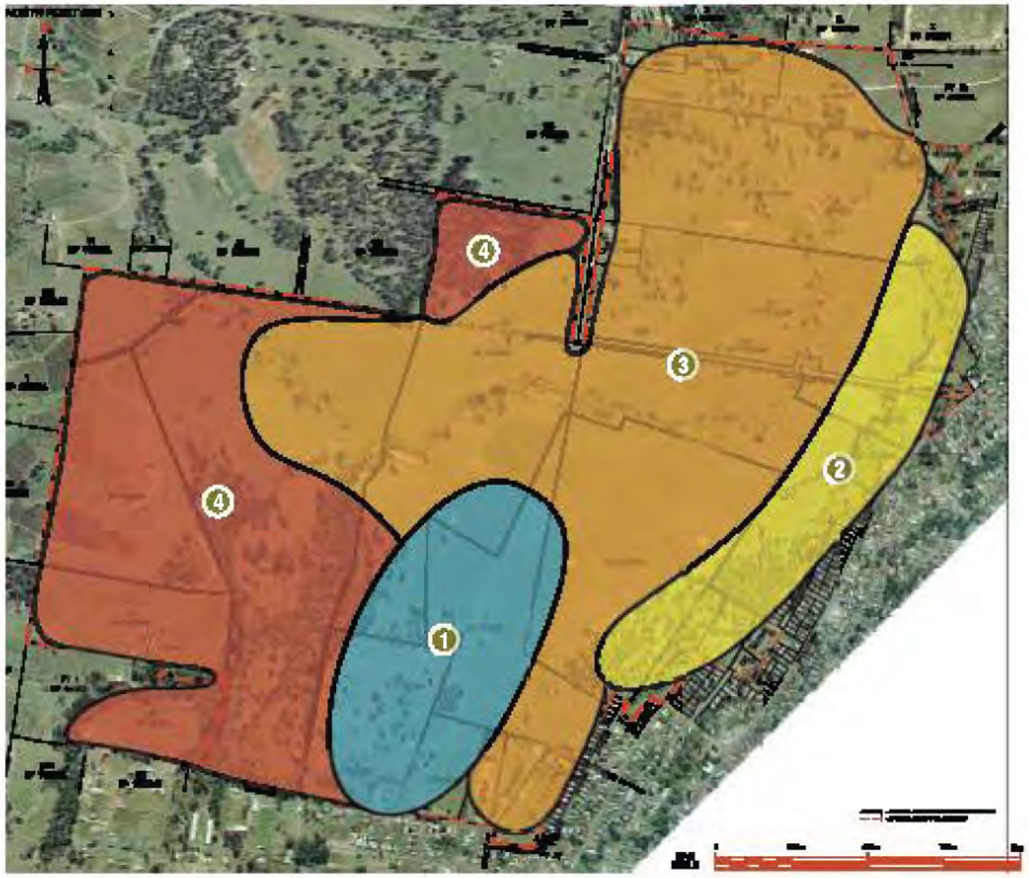


Fig 6 - Landscape Character Zones



Photo 8 - Broken Back Range



Photo 9 - Eastern Edge



Photo 10 - Cleared Central Portion (aerial view)



Photo 11 - Western Edge - View from Mount View Road

4.0 Visually Prominent Site Features

4.1 Landscape Character Zones

The site has a number of distinct landscape character zones as described below and illustrated on the Visually Prominent Site Features Plan;

Ridgeline

A cleared, low ridgeline occurs at the southern end of the site and extends in a northerly direction providing good views to the east, west and north over the site. The ridgeline is visually prominent with the generally flat to undulating topography of the site.

With respect to future development within this zone it would be appropriate to consider the following;

- Residential lots - particularly on the eastern side of the ridge.
- Possibly rural residential on the western side of the ridge for vegetation retention and to provide a 'softer' edge to the existing vegetation to the west.
- A north side oriented road is also appropriate on top of the ridge to capture views to the north and allow the street trees reduce impact of development to the east.

Eastern Edge

The eastern edge is generally flat an is characterised by a mix of residential development, drainage depressions, scattered vegetation and open views to the west across the site to Mount Bright and the Broken Back Range.

With respect to future development within this zone it would be appropriate to consider;

- Residential lots in conjunction with retention of existing vegetation.

Cleared Central Portion

The central area of the site is cleared and has some scattered vegetation associated with Limestone Creek that dissects the site. The lack of creekline vegetation allows the central part of the site to be perceived as one continuous zone.

With respect to future development within this zone it would be appropriate to consider;

- Mixed use development.
- Revegetation of the riparian corridor.

Western Edge

The western edge has two slightly elevated areas with native vegetation including the north western corner and the south western corner. These stands of vegetation offer some screening of the site from Mount View Road. The western edge is informal and not as clearly defined as the east due to the lack of an urban edge. This area falls under the requirements of DCP 28 and therefore is dominated by rural activities such as grazing and small scale tourist accommodations.

With respect to future development within this zone it would be appropriate to consider;

- Open space
- Rural residential
- Revegetation of riparian zone
- Vineyards



Fig 7 - Scenic Quality Map



Fig 9 - Visual Impact Rating



Fig 8 - Visual Absorption Capacity

Visual Impact Rating		Scenic Quality		
		Low	Moderate	High
Visual Absorption Capacity	Low	Moderate	High	High
	Moderate	Low	Moderate	High
	High	Low	Low	Moderate

5.0 Visual Impact Rating

The visual impact rating is determined by comparing the Scenic Quality with the Visual Absorption Capacity. This cross referencing ensures that the viewers emotional response to scenic quality is considered with the respect to the capacity for change. In this case, the capacity for change has been valued with consideration to the requirements of DCP 28 and the impacts on the amenity to existing residents.

The ratings shown in the Table below are described as;

High

Developments within this rating are likely to have a significant visual impact upon the scenic quality of the Vineyards District and existing residents. The impacts are considered regional and should be considered at the Masterplanning Stage.

Moderate

Developments within this rating will have a visual impact upon on a limited area at a local scale and may be mitigated during the Detail Design Stage.

Low

Developments within this rating will not have significant visual impact.

5.1 Scenic Quality

For the purpose of the project scenic quality has been qualified into 3 Categories;

- High: Areas within vineyards district or with visually prominent features of landform, land cover, waterform or built elements. These may include escarpments, elevated ridgelines, visually significant stands of vegetation, geological formations, rivers, parks, buildings, city skyline or streetscape. Views from an elevated position are also usually of high scenic value.
- Moderate: Areas with landform or built features which tend to be common throughout the region and are not outstanding in visual quality.
- Low: Areas with features of minimal diversity or variety.

The site includes areas of native vegetation, vineyards and creeklines but more importantly provide an open space buffer between the vineyards district and urban areas of Bellbird and Cessnock.

5.2 Visual Absorption Capacity

Absorption Capacity can be described as the amount of change a site (or parts of), can accommodate without adversely affecting the desired character. The absorption capacity may vary across a site depending on likely visual impacts from development in relation to the site an its broader context. For the purpose of this study, qualitative criteria listed below have been used to assess the visual absorption capacity.

- High: Existing landscape and built environment able to absorb development with no or minimal obstruction to significant views.
- Moderate: Existing landscape able to absorb some development with moderate obstruction to significant views.
- Low: Existing landscape unable to absorb development without a high degree of obstruction to significant views.

The site has been modified by grazing and rural practices over the past. It is adjoined by urban areas to the east and areas of High Scenic Quality to the west. Areas closer to the western edge are within the Vineyard District Zone and have a lower ability to absorb change than areas to the east.

LEGEND

- Connect with existing street pattern where possible and provide street trees to provide 'visual relief' through the site.
- Ridge top road with street tree planting to provide screening to the east and to define the ridgeline.
- Visually prominent vegetation to be retained where possible.
- Removal of existing vegetation unlikely to have significant visual impact.
- Reinstate riparian vegetation to provide 'visual relief definition of water course.
- Riparian buffer to provide separation and Character Zones within the site.



Significant Edge

- Incorporate landscape buffers.
- Increased setbacks to provide visual relief.
- Maintain frontage to roads where appropriate.
- Provide variation in built form to reduce visual impact.



Transition Zone

- Increase density from west to east.
- Retain existing vegetation where possible.
- Restrict fencing to 'open style' rural.
- Informal road design.
- Limited street lighting.



Cycleway

- Possible cycleway connection through open space areas to provide visual and physical link to adjoining residential areas.

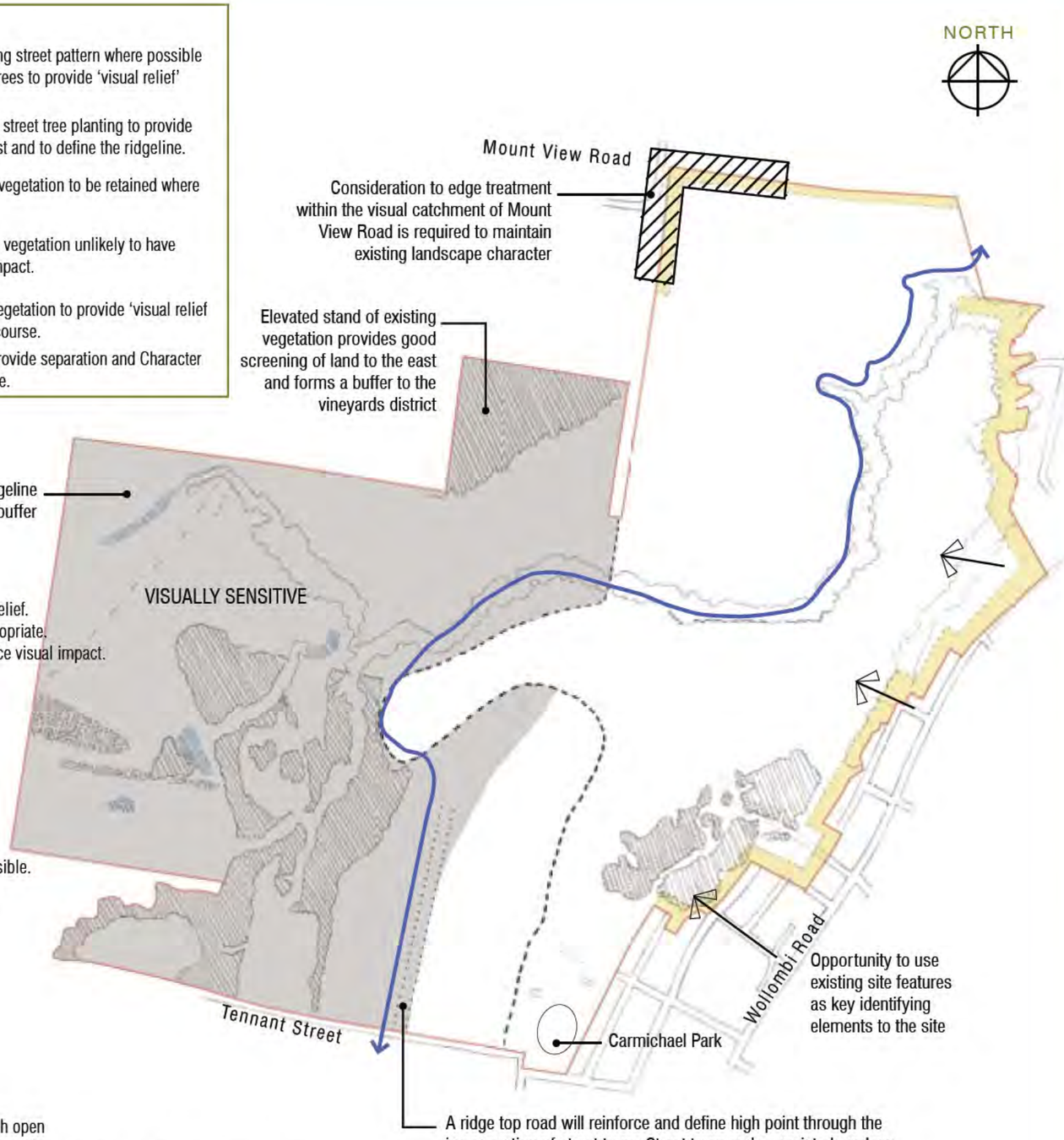


Fig 10 - Development Principles

6.0 Development Principles

A Principles Plan has been prepared to demonstrate the following;

(i) Visually significant areas of the site,

(ii) How they may be developed and,

(iii) Opportunities for enhancing existing site features to incorporate them as key development features.

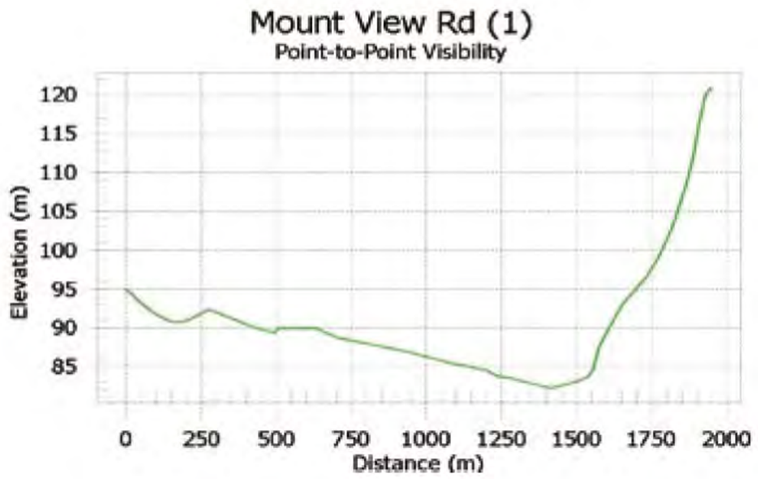
The Principles include;

- Identification of a Transition Zone within which development should increase in density from west to east. This will soften the edge between the rural foothills of the Broken Back Range and the proposed development.
- Identification of a Significant Edge Zone within which the built form should be integrated with landscaped setbacks, landscaped buffers and streetscapes to address the interface between urban areas and open space areas.
- Development of Riparian Zones which may incorporate passive recreational uses such as cycle ways and picnic facilities. Riparian Zones will also play a role in identifying precincts within the development, for example, Limestone Creek divides the site into a northern and southern precinct which helps to establish future character zones. Riparian zones will also provide visual relief to the urban form and provide connectivity with existing vegetation stands in the south west areas of the site.
- The existing Riparian Zone is essentially devoid of vegetation, therefore the benefits of revegetation will be both environmental and visually.
- Consider linking with the existing street network within Bellbird. Connectivity with the surrounding, established residential areas will provide greater integration both physically and visually.
- Retain visually prominent stands of vegetation. Vegetation provides visual relief, screening, shade and amenity.
- Open space areas for passive and active recreation should be located along significant edges to maintain existing open spaces or to further enhance the transition between the western and eastern portions of the site. Consideration to relocating Carmichael Park to the central areas of the site which will free up the south east corner for urban development and provide a greater visual buffer through the central portion of the site.

These strategies would further reduce the likely impacts on the Vineyards District.



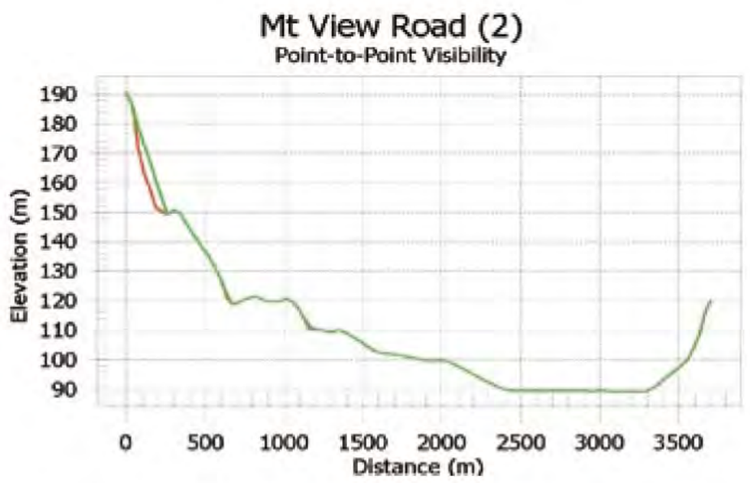
Map 1 - Mount View Road 1 (refer to photo 11 page 9)
This point on Mount View Road is lower lying compared to the majority of Mount View Road. The view from this point is limited by topography which rises on both sides of the viewpoint.



Cross Section 1 -
Vertical Exaggeration = 25.66



Map 2 - Mount View Road 2



Cross Section 2 -
Vertical Exaggeration = 18.67

7.0 Viewshed Analysis & Point to Point Visibility

Viewshed Analysis maps were prepared with Vertical Mapper which creates viewsheds. A viewshed is a sight map which is used to make inferences about the relationships of intervisibility between an origin point and other locations within a landscape. The viewshed analyses have been created by obtaining the heights of cells within a numeric grid (created from elevation data) in order to determine whether or not the cells are visible from a specified origin location. An additional value has been added to the origin location to account for the human eye above the ground (in this case, 1.5 metres).

The result of each of these calculations is either a positive solution meaning that the cell is visible from the origin location (represented by the colour Blue), or a negative solution meaning that the cell is not visible from the origin location (represented by the colour grey).

The software does not accommodate vegetation or built form unless these values are manually inserted. The comments below the maps discusses the impact of vegetation and built form.

Cross sections are a graphical representation between locations on the earth's surface to illustrate how the elevation changes over distance. The horizontal axis represents distance, and the vertical axis represents the elevation along a specified line.

When graphing distances relative to heights on a graph, it is necessary to report the 'Vertical Exaggeration' of the cross-section. Vertical exaggeration is used to show how much the vertical scale has been exaggerated by to show the details of changes in elevation, creating a readable cross section. For example, a vertical exaggeration of 20 means that the vertical scale is 20 times more exaggerated than the horizontal scale in order to show the required detail of the landscape. Without vertical exaggeration, the profile of the cross section may be so shallow that only the highest peaks stand out.

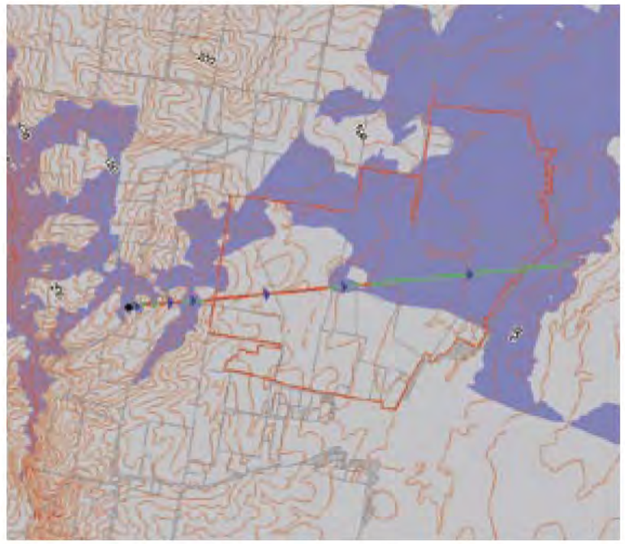
A line-of-sight calculation between the locations is also provided where the relative elevation (indicated by the Black line) represents the surface topography along the line of sight, and the relative viewable elevation (indicated by the Yellow line) represents the line of visibility from the origin location (at 1.5 metres above ground level). Where the two lines are coincident, that section of topography is visible from the origin point. Where the two lines are separated, the landscape is not visible from the origin location.

LEGEND

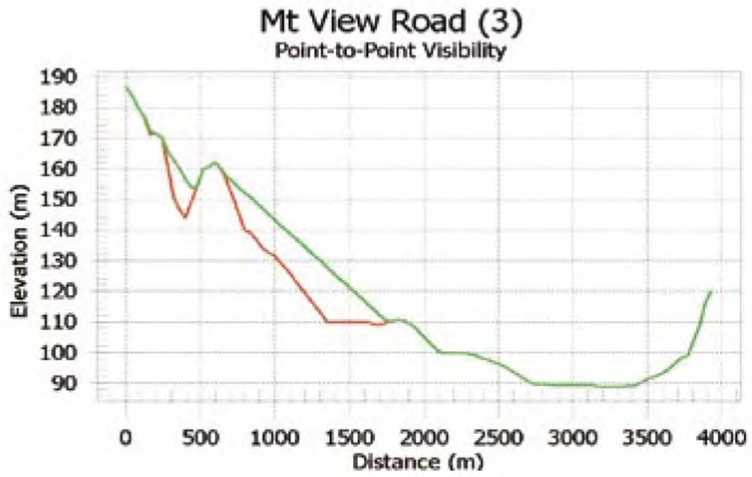
Point to Point Visibility
- Visible
- Not Visible

Viewshed Analysis
- Visible
- Not Visible
- Viewpoint
- Site Location
- Direction of Visibility

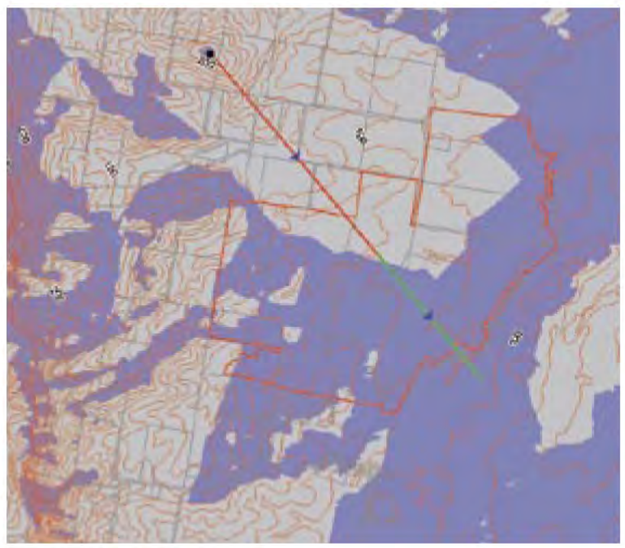
NORTH



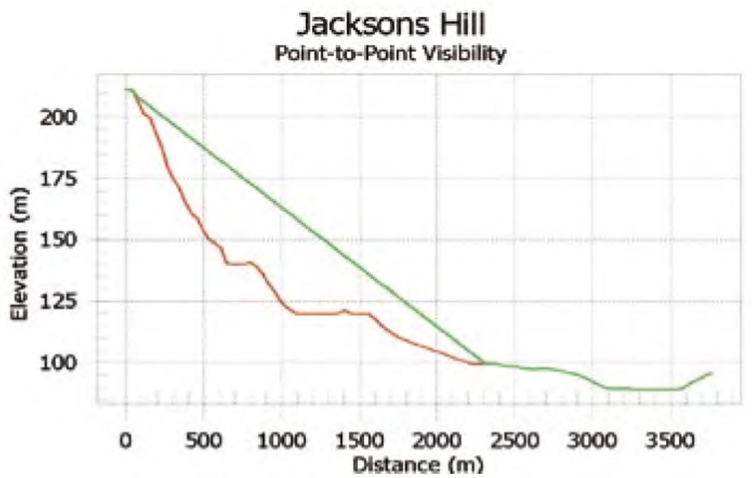
Map 3 - Mount View Road 3 (refer to photo 3 on page 7)
This view is open and expansive across the site. The ridge in the foreground with vineyards inhibits views to the southern portion of the site.



Cross Section 3 -
Vertical Exaggeration = 20.41



Map 4 - Jacksons Hill
The view from Jacksons Hill is less significant than Mount View Road as access.



Cross Section 4 -
Vertical Exaggeration = 15.79

LEGEND

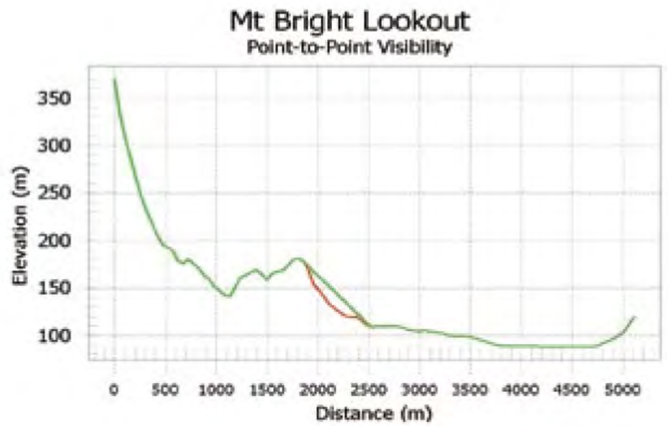
Point to Point Visibility
- Visible
- Not Visible

Viewshed Analysis
- Visible
- Not Visible
- Viewpoint
- Site Location
- Direction of Visibility

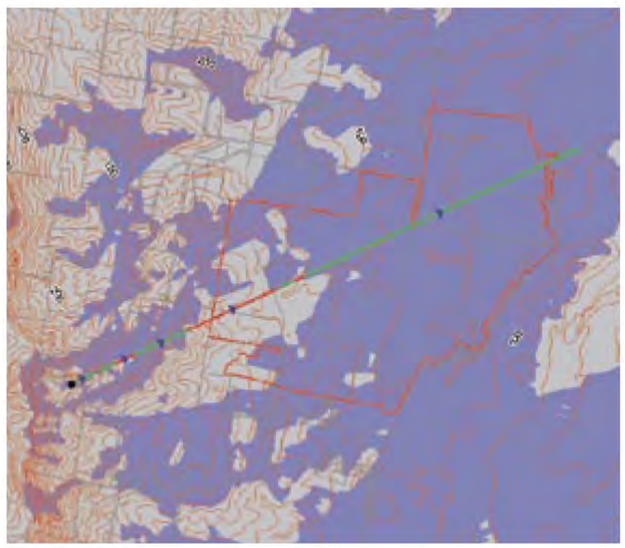
NORTH



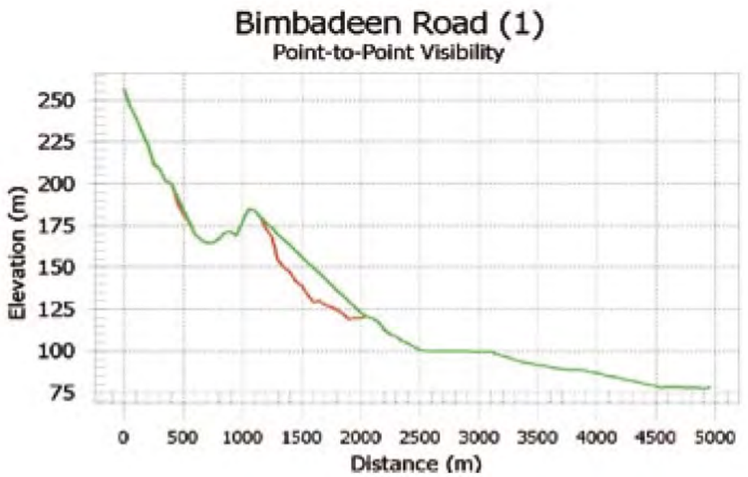
Map 5 - Mount Bright
The view from the lookout is expansive and uninhibited by vegetation. However, views from the ridgeline in general are screened by vegetation.



Cross Section 5 -
Vertical Exaggeration = 9.39



Map 6 - Bimbadeen Road 1 (refer to photo 2 page 7)
The view from Bimbadeen Road is expansive although the low ridge to the south west of the site obscures part of the view.



Cross Section 6 -
Vertical Exaggeration = 14.04

LEGEND

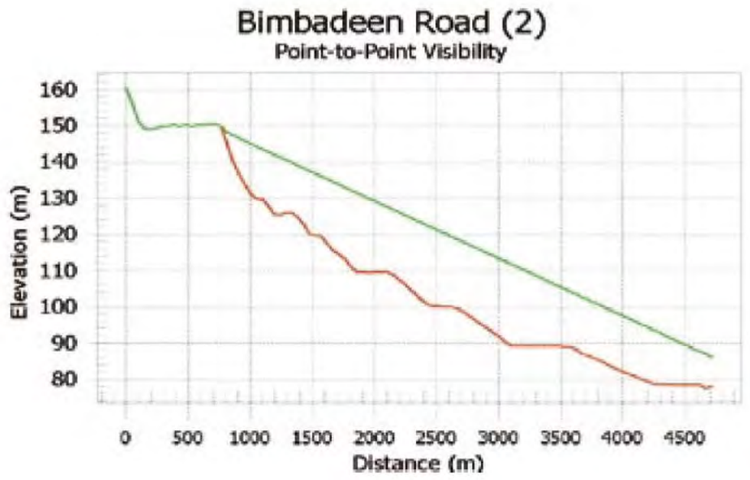
Point to Point Visibility
- Visible
- Not Visible

Viewshed Analysis
- Visible
- Not Visible
- Viewpoint
- Site Location
- Direction of Visibility

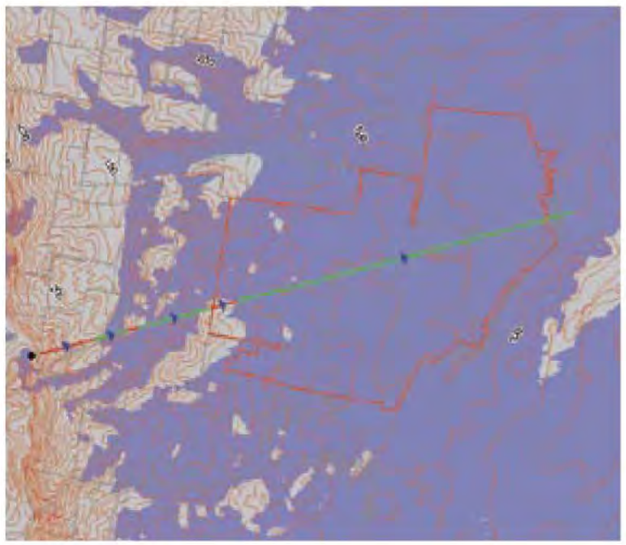
NORTH



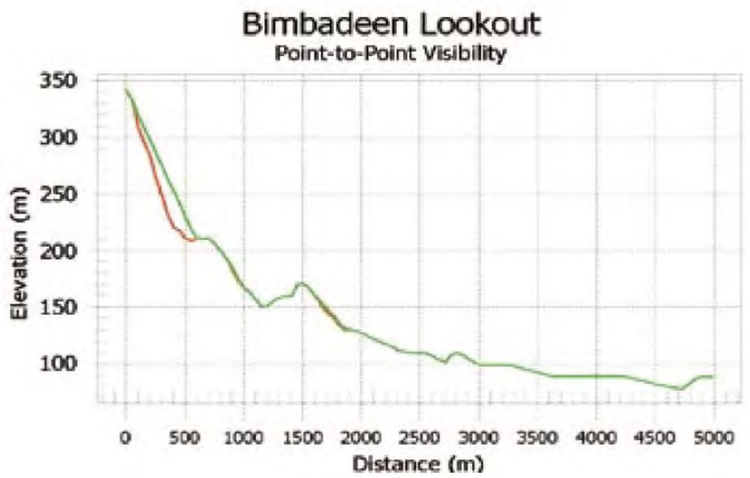
Map 7 - Bimbadeen Road 2



Cross Section 7 -
Vertical Exaggeration = 29.32



Map 8 - Bimbadeen Lookout



Cross Section 8 -
Vertical Exaggeration = 9.58

LEGEND

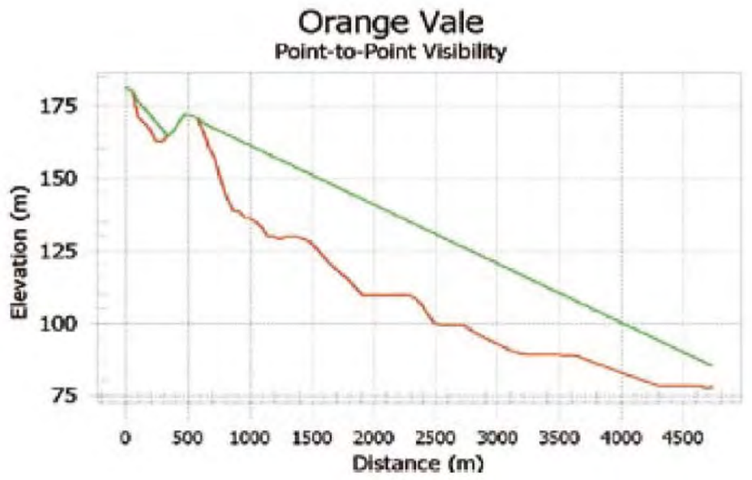
Point to Point Visibility
- Visible
- Not Visible

Viewshed Analysis
- Visible
- Not Visible
- Viewpoint
- Site Location
- Direction of Visibility

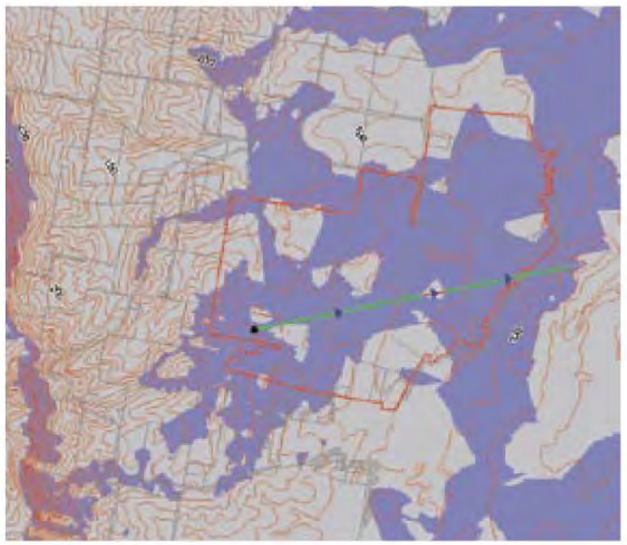
NORTH



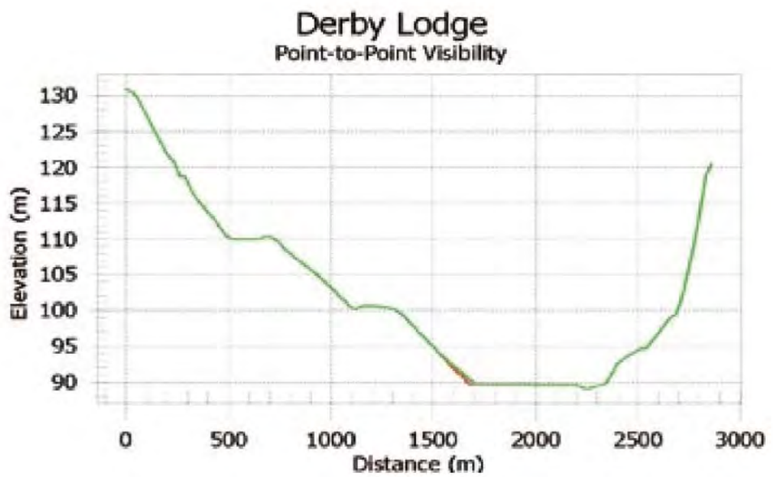
Map 9 - Orange Vale



Cross Section 9 -
Vertical Exaggeration = 23.33



Map 10 - Derby Lodge



Cross Section 10 -
Vertical Exaggeration = 35.00

LEGEND

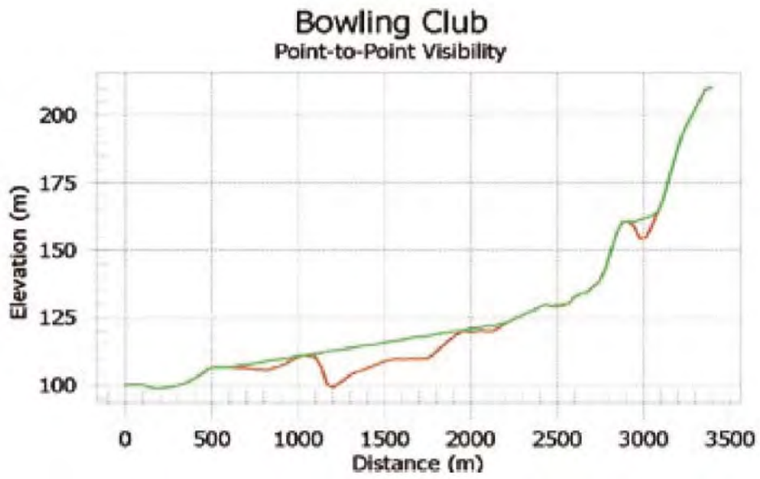
Point to Point Visibility
- Visible
- Not Visible

Viewshed Analysis
- Visible
- Not Visible
- Viewpoint
- Site Location
- Direction of Visibility

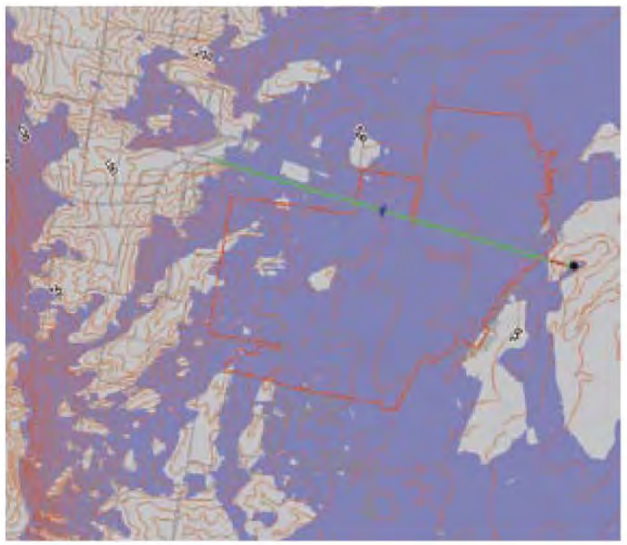
NORTH



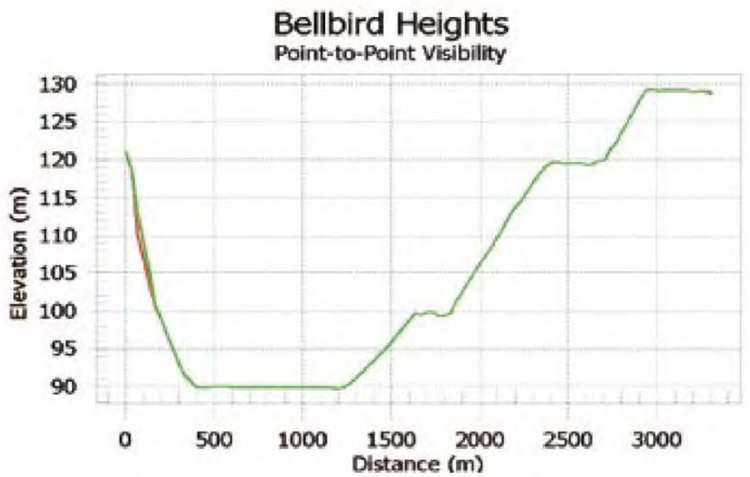
Map 11 - Bowling Club



Cross Section 11 -
Vertical Exaggeration = 15.61



Map 12 - Bellbird Heights



Cross Section 12 -
Vertical Exaggeration = 42.69

LEGEND

Point to Point Visibility
- Visible
- Not Visible

Viewshed Analysis
- Visible
- Not Visible
- Viewpoint
- Site Location
- Direction of Visibility

NORTH

8.0 Conclusion

The North Bellbird Investigation Area is ideally located for a mixed use development given its proximity to the existing urban areas of Bellbird and Cessnock. The proximity of the study area to the scenic Vineyards District provides an opportunity to introduce low key developments that consider the existing landscape character such as rural residential lots, vineyards and tourist amenities or open space and recreation facilities.

This treatment will provide a transition between the Vineyards District and more developed areas.

From the Visual Assessment and Analysis it is evident that the western side of the site should be treated as a transition to the more developed eastern edge as a means to complementing the scenic qualities of the vineyards district rather than competing with it. Development within the western side of the Investigation Area has a High Visual Impact Rating and should consider the following;

- Retain existing vegetation to buffer and "visually fragment" development.
- Developments such as open space and recreation, rural lifestyle lots (2000m^2), vineyards and low key tourist accommodations such as cabins.
- Informal roads that use swales in lieu of kerb and gutter, rural style fencing or wind breaks and native canopy trees within road reserves.

In addition to this established gardens and streetscapes will contribute to a general "greening" of the development area over time. The Masterplan, contained in Appendix A. The townships of Cessnock and Bellbird have a setback to Mount View Road vineyards region, of approximately 4km, which reduces the visual impact of these urban centres.

The revegetation of the Limestone Creek corridor will provide visual relief to any development occurring on the eastern side of the corridor. The Limestone Creek corridor provides a good point of difference between the lower key development recommended for the western side of the study area and the eastern side. The setback from the Vineyards District to the more developed areas will therefore be closer to 2km which will assist in reducing the visual impact.

The Investigation Area fills the gap between these existing townships and the Vineyards District. Development within the western, most scenic, side should be dealt with in a manner that complements rather than competes with the Vineyards District. The site is partially within the visual catchment of the Vineyards District and has a number of visually significant stands of vegetation which can be appropriately managed into a development plan as illustrated by the Masterplan, Appendix A.



Appendix A

Masterplan

North Bellbird Investigation Area, Cessnock



HARDIE HOLDINGS

HENRY KENDALL GROUP

Andrews.Neil

19 - 21 WATT STREET
P.O.BOX 1476 GOSFORD NSW 2250
TELEPHONE: 02 43 24 3633
FACSIMILE: 02 43 24 3771
EMAIL: anap@andrewsneil.com.au

PROJECT

NORTH BELLBIRD INVESTIGATION AREA

LOCATION

NORTH BELLBIRD

CLIENT

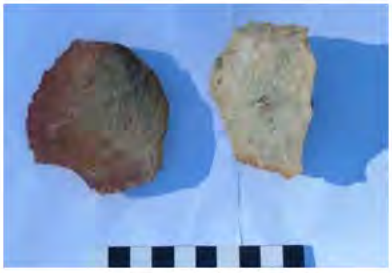
NORTH BELLBIRD CONSORTIUM
JOHNSON PROPERTY GROUP Pty Ltd
HARDIE HOLDINGS
HENRY KENDALL GROUP

DRAWING TITLE

DRAFT STRUCTURE PLAN

DATE FEBRUARY 2006	DRAWN BY AG	PROJECT No 0502	STAGE REZONING
SCALE 1:5000@A1	CHECK BY VL	DRAWING No D03	REVISION C
PLOT DATE 28/02/06			

© This drawing and the design shown hereon is the property of Andrews Neil Pty Ltd and shall not be copied or reproduced in part or in whole in any form without the written permission of Andrews Neil Pty Ltd and shall be used only by the client of Andrews Neil Pty Ltd for the project for which it was provided.



NORTH BELLBIRD INVESTIGATION AREA, NSW

ABORIGINAL HERITAGE ASSESSMENT

FOR

PROPOSED REZONING & MASTERPLANNING FOR URBAN DEVELOPMENT



PHOTOGRAPH OF LIMESTONE CREEK - LOOKING SOUTH-WEST ACROSS THE STUDY AREA.

By Jim Wheeler & Fiona Leslie

AHMS

ARCHAEOLOGICAL & HERITAGE MANAGEMENT SOLUTIONS PTY LTD

349 Annandale St
Annandale
NSW 2038

ACN 088 058 388 ABN 45 088 058 388

on behalf of

Johnson Property Group & North Bellbird Land Owners

JULY 2006

Contents

EXECUTIVE SUMMARY 4

1.0 INTRODUCTION **7**

1.1 PREAMBLE 7
1.2 SITE IDENTIFICATION 7
1.3 REASON FOR THE CURRENT STUDY 9
1.4 STATUTORY CONTROLS 10
1.5 THE PROPOSAL 12
1.6 PROJECT SCOPE AND OBJECTIVES 13
1.7 REPORT OUTLINE 15
1.8 AUTHORSHIP 16
1.9 ACKNOWLEDGEMENTS 16

2.0 ENVIRONMENTAL CONTEXT **17**

2.1 BACKGROUND 17
2.2 LANDSCAPE 17
2.3 GEOLOGY 19
2.4 SOILS 19
2.5 VEGETATION 20

3.0 ARCHAEOLOGICAL CONTEXT **21**

3.1 REGIONAL ARCHAEOLOGICAL CONTEXT 21
3.2 AHIMS SEARCH RESULTS 24
3.3 LOCAL ARCHAEOLOGICAL CONTEXT 24
3.4 PREDICTIVE MODELLING 28

4.0 SURVEY RESULTS **30**

4.1 SURVEY DETAILS 30
4.2 SURVEY METHODOLOGY 30
4.3 SURVEY COVERAGE 31
4.4 RESULTS OF THE SITE SURVEY 33
4.5 ARCHAEOLOGICAL POTENTIAL 44

5.0 ABORIGINAL COMMUNITY CONSULTATION **48**

5.1 DEVELOPMENT OF CONSULTATION 48
5.2 OUTCOMES OF CONSULTATION 50

6.0 SIGNIFICANCE ASSESSMENT **52**

6.1 BASIS FOR SIGNIFICANCE ASSESSMENT 52
6.2 ABORIGINAL CULTURAL SIGNIFICANCE 52
6.3 PUBLIC SIGNIFICANCE 53
6.4 SCIENTIFIC SIGNIFICANCE 53

7.0 ABORIGINAL HERITAGE MANAGEMENT **56**

7.1 PREAMBLE 56
7.2 RE-ZONING & FUTURE DEVELOPMENT 56
7.3 OPPORTUNITIES & CONSTRAINTS 57

8.0 RECOMMENDATIONS **60**

8.1 BASIS FOR RECOMMENDATIONS 60
8.2 ABORIGINAL CONSULTATION 60
8.3 ARCHAEOLOGICAL MANAGEMENT 61

REFERENCES.....64

APPENDICES

Appendix 1 – *Aboriginal Community Correspondence*

Appendix 2 – *Site Records*

Appendix 3 – *Survey Recording Form*

Appendix 4 – *Notification advertisement in the Cessnock Advertiser*

EXECUTIVE SUMMARY

Insite Planning and Engineering on behalf of *Johnson Property Group* (JPG) and the land owners of the North Bellbird Investigation Area engaged *Archaeological and Heritage Management Solutions* (AHMS) *Pty Ltd* to undertake an Aboriginal heritage assessment in support of an application for re-zoning and preparation of an accompanying master-plan for urban development of land at North Bellbird, in the Hunter Valley, NSW.

The purpose of the study was to determine the archaeological and Aboriginal heritage significance of the study area and assess potential constraints on future development. Specific aims of the study were to:

- assess the potential composition, extent and significance of Aboriginal sites and objects within the study area;
- identify potential Aboriginal heritage constraints on future development;
- consult with the local Aboriginal community to assess the cultural significance of the study area. DEC's *Interim Community Consultation Requirements for Applicants* was implemented for this purpose; and
- provide management options that ensure future development complies with the requirements of State and Federal heritage legislation.

The results of the Aboriginal heritage assessment presented in this report will be incorporated into Master Planning and into an evaluation of development constraints and opportunities.

Twenty-one open artefact scatters and four isolated artefacts were identified during the archaeological field survey. The majority of sites were found across areas of exposed ground and soil profiles exposed on eroding creek banks. Across much of the study area, ground surfaces were covered by grass and vegetation. This prevented effective detection of surface Aboriginal sites and biased the survey results in favour of creek margins where erosion has exposed the soils. As a result, the survey was largely ineffective in establishing the real nature and extent of the local archaeological resource.

It is likely that more sites and isolated objects exist on current ground surfaces below pasture grasses, and in sub-surface deposits throughout the study area. In general the assessment concludes that areas within 100 metres of creekline have a high potential for sub-surface deposits and areas outside these zones have a low to moderate potential. Test excavation would be required to accurately establish this pattern.

Drawing on the results of the survey, the following general conclusions are made regarding the archaeology of North Bellbird:

- Areas of remnant A horizon topsoil adjacent to creeklines have a high potential to contain Aboriginal archaeological deposits, particularly near the confluence of Limestone Creek and two tributaries in the south-western portion of the study area. The creek junction may have been an important resource zone and an important local focus for Aboriginal occupation and use in the past.

- Stone artefacts were consistently found on exposures of lower remnant A2 horizon soils at the interface with B horizon clay. No artefacts or other stone materials were seen on exposures of upper A1 horizon topsoil. This indicates that stone materials, including Aboriginal artefacts, have deflated through the soil profile. It also suggests that there is little vertical integrity of archaeological deposits within the duplex soils.

- The broad variety of stone raw materials, percentage of cortex and proportion of primary reduction material observed at the sites on Limestone Creek indicate local sourcing of river pebbles and cobbles and the presence of an "on-source" reduction industry.

The sites identified at North Bellbird are variously assessed as having moderate-high, low and low-nil archaeological significance at a local level. None of the sites are considered to have rarity at a regional or state level. Some of the sites have public significance values for their ability to demonstrate aspects of Aboriginal occupation and use of the landscape prior to dispossession. The Aboriginal cultural significance will be assessed by the local Aboriginal community.

The report identifies Aboriginal heritage constraints and opportunities in regard to future development. It recommends an application to the *Department of Environment & Conservation (DEC)* for a *Section 87 Preliminary Research Permit* to undertake archaeological test excavation in advance of any future development. **This should be done during pre-DA planning and prior to detailed development design.** Test excavation would aim to determine the nature, extent and significance of Aboriginal sites and objects within the path of development. The results of excavation would be used to develop an Aboriginal heritage mitigation plan for future development which may include options such as conservation, salvage and/or consent to destroy Aboriginal sites.

The assessment concludes that there are no Aboriginal heritage constraints on re-zoning of the subject land because Aboriginal sites, objects and cultural values within the subject land can be managed as part of any future Development Application processes.

1.0 INTRODUCTION

1.1 PREAMBLE

Insite Planning and Engineering on behalf of *Johnson Property Group* (JPG) and the land owners of the North Bellbird Investigation Area engaged *Archaeological and Heritage Management Solutions* (AHMS) *Pty Ltd* to undertake an Aboriginal heritage assessment in support of an application for re-zoning and preparation of an accompanying master-plan for urban development over land at North Bellbird.

This report presents the results of the assessment. Attachments to this report include *Aboriginal Community Correspondence* received during the consultation process, *Site Record* sheets for Aboriginal sites identified during archaeological survey and a copy of the *Survey Recording Form*. The general location of the study area is shown on Figure 1.1.

1.2 SITE IDENTIFICATION

The subject land at North Bellbird (hereafter referred to as the "study area"), is situated to the west and north-west of the suburbs of Bellbird and Bellbird Heights, south of the city of Cessnock in the Hunter Valley, NSW. The study area is located between Tennant Street Bellbird to the south, Bellbird Creek to the east and Mount View Road to the north. The total area is approximately 496 hectares (ha) comprising property allotments described in Table 1.1 overleaf.

One land holdings within the study area is currently the subject of a separate development proposal. It is a small holding on the eastern fringe of the study area (Lot 2 DP 1011544), currently the subject of a rezoning application. This holding may ultimately be excluded from the North Bellbird subject land; however they have been assessed for the purposes of the current study and preliminary constraints and opportunities planning.

The study area is currently zoned Rural 1(a) and Rural 1(v). It includes agricultural land used primarily for beef cattle breeding, agistment, cultivation and viticulture.

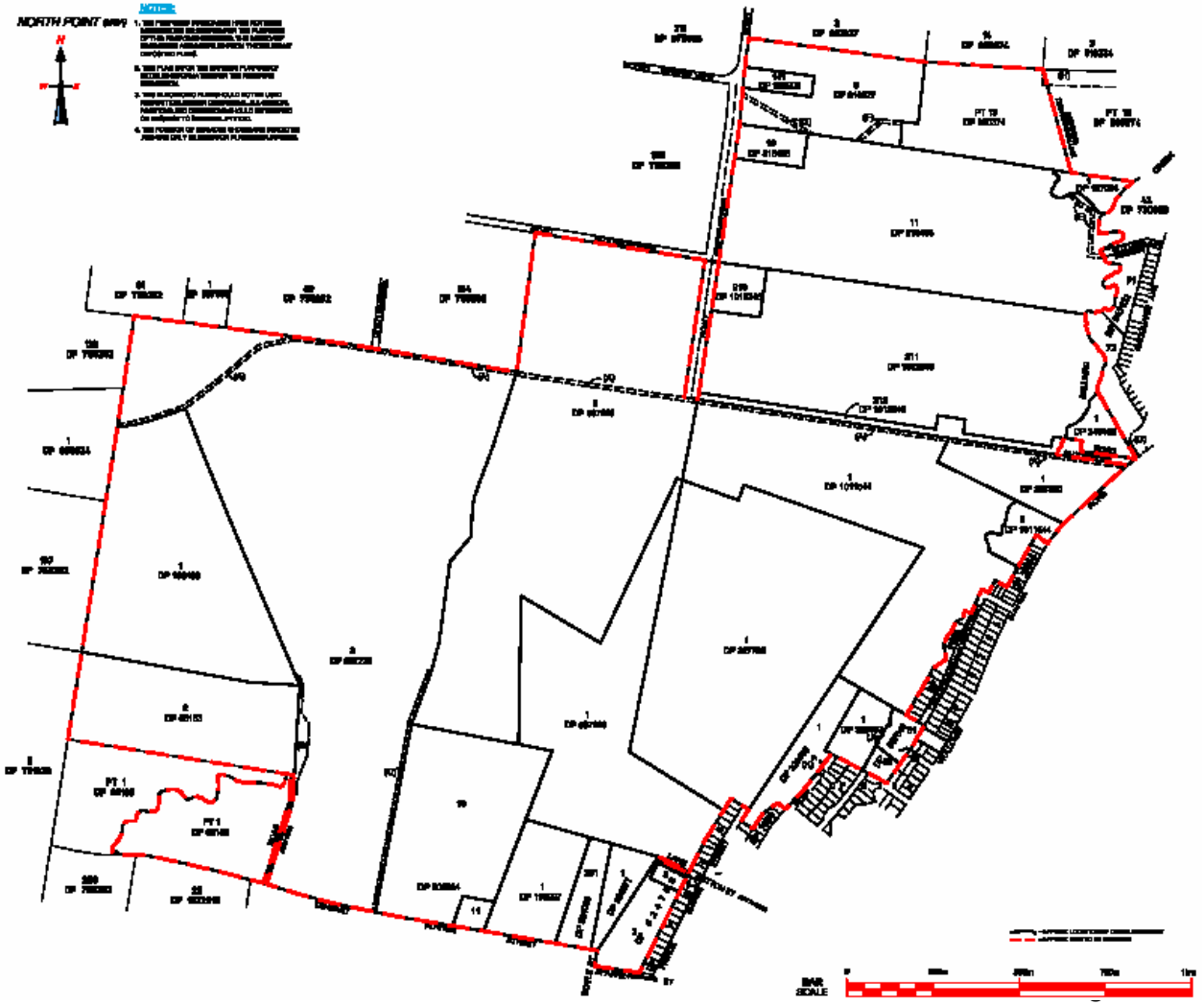


Figure 1.1 – Location Plan (study area is outlined in red).

Table 1.1 – Lot Descriptions

Lot / DP	Lot / DP	Lot / DP	Lot / DP	Lot / DP
141 / 986905	210 / 1012346	2 / 1011544	52 / 807540	11 / 806584
3 / 810827	211 / 1012346	1 / 327785	2 / 624793	10 / 806584
PT13 / 880374	212 / 1053307	2 / 597226	3 / 624793	3 / 597226
10 / 815485	1 / 349452	1 / 597226	1 / 329071	PT 1 / 66183
11 / 815485	1 / 327580	1 / 328498	261 / 524058	2 / 66183
1 / 167004	1 / 1011544	PT 51 / 807540	1 / 196997	1 / 196460

1.3 REASON FOR THE CURRENT STUDY

The assessment was prepared in support of a re-zoning submission to assist Cessnock City Council with preparation of a draft LEP for the subject land. The subject land is identified in the Cessnock Citywide settlement. The proposal is to re-zone the subject land for future mixed urban development. In support of their re-zoning submission, JPG on behalf of North Bellbird land owners are preparing a Master Plan and draft Development Control Plan (DCP). The results of the Aboriginal heritage assessment presented in this report will be incorporated into Master Planning and into an evaluation of development constraints and opportunities.

The assessment was prepared in accordance with provisions of the *Environmental Planning and Assessment Act 1979* which requires that a consent authority is to take into consideration the likely impacts of rezoning and development on Aboriginal heritage values, including impact on Aboriginal objects, sites and places. This objective is achieved by:

1. Undertaking an Aboriginal archaeological survey and assessment of the development area in accordance with *National Parks & Wildlife Service* (NPWS) *Guidelines for Archaeological Survey and Reporting (1997)*; and

2. Assessing the re-zoning, and potential future development arising from the re-zoning's impact upon Aboriginal heritage values.

The archaeological assessment is also necessary to ensure that any future development will not disturb, destroy, deface or desecrate Aboriginal objects without the consent of the Director-General of DEC, as required by Section 90 of the *National Parks & Wildlife Act 1974*. Accordingly, this report identifies

potential Aboriginal heritage constraints on future development and provides options for heritage management during the pre-DA planning process. This approach will allow for the consideration of a range of options for managing Aboriginal heritage prior to detailed development design.

1.4 STATUTORY CONTROLS

1.4.1 Statutory Protection

The *National Parks & Wildlife Act (1974)* and the *Environmental Planning and Assessment Act (1979)* provide the statutory tools for Aboriginal cultural heritage management in New South Wales. The *Aboriginal and Torres Strait Islander Heritage Protection Act (1984)* also provides protection for Aboriginal heritage at a Federal level.

The implications of these statutes for future development are outlined below.

1.4.2 National Parks & Wildlife Act 1974 (Amended 2001)

The provisions of the *NP & W Act (1974)* provide blanket protection for Aboriginal objects (material evidence of indigenous occupation) and Aboriginal places (areas of cultural significance to the Aboriginal community). The following sections are particularly pertinent:

- Section 91 states that anyone who discovers an Aboriginal object is obliged to report the discovery to the Department of Environment & Conservation (DEC).

- Section 90 states that it is an offence to destroy, deface, damage or desecrate, or cause or permit the destruction, defacement, damage or desecration of, an Aboriginal object or Aboriginal place.

- Section 86 and 87 state that it is an offence to collect or disturb objects or excavate, or in any way disturb land for the purpose of discovering objects without a permit authorised by the Director-General DEC.

- Section 84 makes provision for protection of 'Aboriginal Places' or locations of special significance to Aboriginal culture.

In practical terms, the provisions of the Act require an archaeological assessment of any land where there is potential that Aboriginal sites or objects may be impacted by development. Aboriginal archaeological assessments are governed by the *NPWS Guidelines for Archaeological Survey and Reporting (1997)*. These guidelines require consultation with Aboriginal communities and

relevant representative bodies such as Local Aboriginal Land Council's (LALCs) and Traditional Owner groups. This includes Aboriginal community participation in all archaeological survey and excavation work and consideration of the Aboriginal cultural significance of sites and places.

In accordance with *Section 90* of the *NPW Act 1974*, all Aboriginal objects are protected and cannot be destroyed or disturbed without a *Section 90 Heritage Impact Permit* from DEC. Protection is provided irrespective of both the level of significance of the objects and issues of land tenure.

In December 2004 DEC released new *Interim Community Consultation Requirements for Applicants* that require a series of formal Aboriginal community consultation and notification procedures for sites that require applications under *Section 87* or *Section 90* of the NP & W Act 1974. In summary, the following procedures are required:

1. Notification and Registration of Interests: The consultant must actively seek to identify stakeholder groups by:

   (a) providing written notification to Local Aboriginal Land Council(s), Registrar of Aboriginal Owners, Native Title Services, Local Council(s), and DEC; and
   (b) placing an advertisement in the local print media.

   The closing date for registration of interest must allow at least 10 working days for groups to respond.

2. Preparation of the Assessment Methodology: The consultant must present and/or provide Registered Stakeholders with a proposed methodology for the assessment / testing methodology. The stakeholders must be allowed at least 21 days to review and provide feedback to the consultant.

3. Drafting, Review and Finalisation of the Assessment Report: Following completion of the survey a draft Aboriginal Heritage Impact Assessment (AHIA) report on the cultural and archaeological significance of the study area should be made available to all Registered Stakeholders and the Local Aboriginal Land Council for comment. After considering comments received, the consultant must then finalise the report and submit to DEC for consideration with their application.

1.4.3 Environmental Planning & Assessment Act 1979

The *EP & A Act 1979* requires that environmental and heritage impacts are considered by consent authorities prior to granting development approvals. Under *Part IV* of the Act, specific approval from state agencies may be required in certain circumstances. This mechanism is known as an 'integrated development application' or IDA.

The DEC is an approval body in the IDA process when a development will impact on an Aboriginal object or place, and thereby require a *S.90 Heritage Impact Permit* from DEC to allow the destruction or disturbance of a registered site. In this situation, consent must be granted by DEC prior to a development being approved.

1.4.4 Federal Legislation

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* was enacted at a Federal level to preserve and protect areas (particularly sacred sites) and objects of particular significance to Aboriginal Australians from damage or desecration. Steps necessary for the protection of a threatened place are outlined in a gazetted *Ministerial Declaration (Sections 9 and 10).* This can include the prevention of development.

As well as providing protection to areas, it can also protect objects by *Declaration*, in particular Aboriginal skeletal remains (Section 12). Although this is a Federal Act, it can be invoked on a State level if the State is unwilling or unable to provide protection for such sites or objects.

1.5 THE PROPOSAL

The study area has been identified in the *Cessnock City Wide Settlement Strategy* (CWSS) for re-zoning to mixed residential densities, rationalisation of open space and environmental features. The strategy has been formally adopted by DIPNR and Council. Pursuant with the CWSS, JPG are preparing a re-zoning submission to Council.

It is envisaged that future urban development of the study area will include:

- a mix of residential environments provided through sequential staging,
- a commercial and retail precinct including mixed use development capable of serving the needs of the North Bellbird community;

- social and community infrastructure including schools, community and recreational facilities including open space;
- infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails;
- conservation of quality remnant vegetation; and
- rehabilitation of degraded riparian corridors to provide habitat linkages.

Detailed development design would be undertaken following re-zoning, during the pre-DA planning phase. The results of the Aboriginal heritage assessment, together with other environmental studies, will be considered by JPG in the pre-DA planning process.

1.6 PROJECT SCOPE AND OBJECTIVES

The objective of the study was to undertake an Aboriginal archaeological and heritage assessment of the re-zoning area in partnership with the local Aboriginal community to:

- Determine the archaeological and cultural heritage significance of the study area; and
- Assess the potential constraints on future development.

Specific aims of the study were as follows:

- assess the potential composition, extent and significance of Aboriginal sites and objects within the study area;
- identify potential Aboriginal heritage constraints on future development;
- consult with the local Aboriginal community to assess the cultural significance of the study area. DEC's *Interim Community Consultation Requirements for Applicants* was implemented for this purpose; and
- provide management options that ensure future development complies with the requirements of State and Federal heritage legislation.

The assessment was undertaken in accordance with the:

- legislative requirements of the *NSW National Parks and Wildlife Act, 1974*;
- procedures for Aboriginal heritage assessments and management outlined in the Aboriginal Cultural Heritage Standards and Guidelines Kit *(National Parks and Wildlife Service, 1997)*; and
- Australia ICOMOS 'Burra' Charter for the conservation of culturally significant places and associated guidelines regarding significance assessment, conservation policy and processes.

The assessment required completion of the following tasks:

1.6.1 Aboriginal Community Consultation

Consultation with the local Aboriginal community using procedures set out in DEC's *Interim Community Consultation Requirements for Applicants*. The following procedures were undertaken:

- Notification and Registration of Interests: stakeholder groups were identified by:

  (a) providing written notification to Mindaribba Local Aboriginal Land Council, Registrar of Aboriginal Owners, Native Title Services, Cessnock City Council and DEC; and
  (b) placing an advertisment in the *Cessnock Advertiser* (27/4/05 edition). A copy of the advertisment is included in Appendix 4.

  Registration of interest allowed for 10 working days for groups to respond. Groups that registered their interest included the *Mindaribba Local Aboriginal Land Council*, *Yarrawalk*, *Wonnarua Nation Aboriginal Corporation*, *Barkuma Community Centre* and *Combined Council Hunter Valley Aboriginal Corporation*.

- Preparation of the Assessment Methodology: The assessment and survey methodology was provided to the registered organisations for their review. Responses from the organisations were received within the 21 day prescribed period. At the same time, offers to provide archaeological survey assistance were received from the registered organisations.

- Drafting, Review and Finalisation of the Assessment Report: Following completion of the draft Aboriginal Heritage Assessment, copies were made available to all Registered Stakeholders for comment. Comments received from the groups regarding the assessment results, recommendations and proposal for test excavation were considered during finalisation of this report.

1.6.2 Research

- Search the DEC *Aboriginal Heritage Information Management System* (AHIMS) in order to determine the type and distribution of Aboriginal sites that have been recorded in the Bellbird area;
- Review previous archaeological investigations and studies carried out within the subject land and more generally across the Cessnock area; and

- Prepare a predictive model of the "archaeological potential" of the study area, including prediction of the potential for unrecorded Aboriginal sites to occur within the development area.

1.6.3 Field Survey

- Undertake a systematic sample of landforms within the study area, focusing on landforms of high potential for Aboriginal sites and objects, and areas of ground exposure that have potential to reveal Aboriginal objects;
- Record any Aboriginal objects or sites within the study area;
- Identify any locations within the study area that have archaeological potential based on the results of field survey, predictive modelling and previous investigations in the area; and
- Determine the degree to which previous land-use and landscape modification has disturbed original soils, and assess its implications for preservation of archaeological deposits.

1.6.4 Reporting

- Prepare a report to inform the making of a new draft LEP, presenting the results of the assessment and Aboriginal community consultation, in accordance with the requirements of the *NSW NPWS Aboriginal Cultural Heritage Standards & Guidelines Kit (1997)*;
- Identify Aboriginal heritage constraints on future development; and
- Recommend options for management of Aboriginal objects and sites the future development process, in accordance with the requirements of the *National Parks & Wildlife Act 1974*.

1.7 REPORT OUTLINE

This remainder of the report presents the following:

- Description of the environmental context of the study area (Section 2.0).
- Review of the local and regional Aboriginal archaeological context, including predictions regarding types of Aboriginal archaeological evidence that may be present in the study area (Section 3.0).
- Description of the archaeological field survey results (Section 4.0).
- Results of Aboriginal community consultation (Section 5.0).
- Assessment of the *heritage significance* of the site (Section 6.0).
- Identification of Aboriginal heritage constraints and opportunities in regard to future development (Section 7.0).
- Management recommendations (Section 8.0).

1.8 AUTHORSHIP

This report was written by Jim Wheeler. It includes contributions by Fiona Leslie (field survey, site recording, GIS mapping) and Adam Patterson (assistance with preparation of report). The report was reviewed by Fiona Leslie.

1.9 ACKNOWLEDGEMENTS

The author acknowledges the assistance provided by Mr Paul Hedge of *Johnson Property Group* and Steven Leathley of *Insite Planning Pty Ltd.* We would also like to acknowledge the assistance and valuable input provided by the following representatives of local Aboriginal organisations:

- Scott Franks, Tom Franks and Danny Franks of *Yarrawalk*;
- Mark Hickey and Robert Lester of *Wonnarua Nation Aboriginal Corporation*;
- Ann-Marie Hickey of *Barkuma Community Centre*;
- Margaret and John Matthews of *ANTEC*; and
- Rick Griffiths, Alfred Whaledom, Phillip Hall, Joby Patten and Maria Griffiths of *Mindaribba Local Aboriginal Land Council.*

2.0 ENVIRONMENTAL CONTEXT

2.1 BACKGROUND

Archaeological assessment reports include information about the environmental context of study areas because of the important role environmental characteristics played in influencing the types of archaeological sites in any given area. Physical environments influenced both the type and availability of natural resources and the types of cultural activities that were carried out in the past. As a result, this also influenced the types of archaeological sites that may be found.

A determination of the former environmental context is essential to develop accurate models of cultural activity, site distribution patterns and the archaeological potential of any given area. The environmental setting of North Bellbird is discussed below.

2.2 LANDSCAPE

2.2.1 Soil Landscapes

The study area is situated within the Central Lowlands of the Hunter Valley. Most of the subject land is located within the 'Branxton' soil landscape, although the western margin corresponding with upper hill slope terrain falls within the 'Pokolbin' soil landscape. These soil landscapes are described below.

The Branxton soil landscape is characterised by undulating low hills and rises and many small creek flats [1]. Slope gradients are 3 to 5 per cent and elevation throughout the landscape ranges from 50 to 80 metres. Common features of the landscape include flat crests, long and gently incised sideslopes and creek flood plain. The Branxton landscape is susceptible to tunnel and gully erosion, especially in areas that have been disturbed by vegetation clearance and on the lower slopes where the dominant yellow Soloths are highly dispersable. The landscape has frequent drainage lines, spaced at between 400 and 1,500 metre intervals.

[1] Kovac & Lawrie 1991

The 'Pokolbin' yellow podzolic soil landscape is characterised by undulating and rolling low hills[2]. Slope gradients are 2 to 13 per cent and elevation throughout the landscape ranges from 100 to 240 metres. Common features of the landscape include flat crests and long, gently incised side-slopes. The Pokolbin landscape is susceptible to minor-moderate sheet erosion on slopes, especially in areas that have been disturbed by vegetation clearance. The landscape has frequent drainage lines that run to the east and north east at 200 – 800 metre intervals.

2.2.2 Local Landscape Characteristics

The landscape of the study area comprises slopes of undulating low hills and creek flats. It is dissected by two principal creeks. Bellbird Creek is a permanent 4th order stream running south to north across the eastern margin of the study area. Limestone Creek is a semi-permanent 3rd order stream crossing the study area from west to east and then turning sharply to the north to join Bellbird Creek at the north-eastern corner of the study area. Limestone Creek is joined by three 2nd order tributaries on the western margin of the study area.

The creek margins have been severely gullied during flood episodes. The gullying is more extreme on the western portions of Limestone Creek and the northern portion of Bellbird Creek, where stream gradients are steeper, exacerbating erosion and down-cut. Much of the gullying present would have occurred after European settlement, when vegetation clearance caused massive sheet erosion and scouring of drainage lines where root systems that previously held creek banks together had been removed. The effects of vegetation clearance resulted in a loss of original surface topsoils washed downstream during flood and gullying of drainage lines described above. These processes have formed the current configuration of creeks in the study area.

2.2.3 Landform Patterns and Elements

The study area is dominated by simple slopes with gentle gradients (1% - 10%) sloping south-west to north-east. Using the system described by Speight in the landform section of the *Australian Soil and Land Survey Field handbook*[3], landform patterns within the study area include *plain* and *undulating low hills*. Landform elements identified include *maximal upper slope*, *waning mid slopes*, *waning lower slopes*, *flats* and *open depressions* (ie. creeks)[4]

[2] Kovac & Lawrie 1991
[3] Speight 1990
[4] ibid

2.3 GEOLOGY

The geology of the study area comprises lithic sandstone, siltstone, mudstone, shale, limestone, tuff, lava conglomerate and coal of the Permian Lochinvar Formation. The Lochinvar Formation includes the "Greta Top" coal seam, which was mined near the study area during the early-mid 20th century as part of the *Hetton-Bellbird Colliery* operation. Rock outcropping is rare, and is only found exposed in deeply cut sections of drainage lines. During the survey, sandstone bedrock was observed at the base of exposed creek bed at a ford crossing Bellbird Creek on the eastern margin of the study area. On the western margin, weathered shale bedrock (C horizon sub-soil) was exposed in a drainage ditch adjacent to a dam. Bedrock is overlain by hard dark reddish clays, up to 4 metres thick.

Alluvial deposits present on creek channel terraces and in the stream bed include cobbles and pebbles of various sizes carried in by fluvial processes. The cobbles and pebbles provided a source of flake-able stone for Aboriginal stone tool manufacture. Because the material was carried downstream by water, the cobbles and pebbles include a wide variety of stone types suitable for percussion and/or bipolar flaking techniques.

2.4 SOILS

The depth of the A horizon topsoil across the Branxton and Pokolbin Landscapes ranges between 10 and 25 centimetres, with deeper soil profiles for alluvial and siliceous soils on the creek margins. The duplex soil profile on hill crests, mid slopes and lower slopes comprises sandy loams overlying a sharp transition to medium clays. Parent rock comprises sandstone, mudstone, siltstone, shale, tuff, coal, conglomerate and limestone.

Insite Heritage undertook archaeological and geomorphological test excavation within part of the study area comprising the lower reaches of Limestone Creek and adjacent paddocks[5]. The project was undertaken by archaeologists Angela Bessant and Norma Richardson, and geomorphologist Phillip Hughes, in support of a development proposal by the *Henry Kendall Group*. A total of 6 pits were excavated across a 200 metre transect to assess sub-surface archaeological potential through an examination of the nature, depth and integrity of topsoils. The excavations found sandy clay B-horizon soils near current ground levels, with only a thin veneer of sandy topsoil overlying the clay (between 0 and 100 mm thick). The authors interpret the plain soils as probably alluvial in origin, the sandy clays being deposited by a much larger Bellbird Creek fluvial system during the Pleistocene period.

[5] Insite Heritage 2005

2.5 VEGETATION

Original vegetation was cleared from most of the site during the historic period. Some remnant trees survive across the study, either as "shade trees" in the middle of farm paddocks or on the margins of Bellbird Creek and Limestone Creek. Some of these trees may be of sufficient age to have scars associated with Aboriginal removal of bark for making products such as shields, canoes or containers. Such trees are known as "scarred trees".

Re-growth communities are found on the western margins of the study area comprising some remnant trees, re-growth trees, understorey shrubs and ground covers. The remainder of the study area is cleared land comprising paddocks. Across the paddocks, understorey has been completely cleared and ground cover now comprises pasture grass. A flora assessment commissioned by *Insite Planning* for the re-zoning application includes a detailed description of vegetation communities and species.

3.0 ARCHAEOLOGICAL CONTEXT

3.1 REGIONAL ARCHAEOLOGICAL CONTEXT

For the purposes of determining settlement and site location patterns, archaeologists examine regional and local trends in the distribution of known sites in relation to environment and topography. This provides evidence about economic and social systems in the past and also assists archaeologists in predicting likely site types and locations in any given area.

The study area falls within the Hunter Valley region. As a result of the extensive development in the Hunter Valley in the form of mining, quarrying, viticulture and housing, the archaeology of the Hunter region has been well documented through development impact assessments. In the last thirty years over 2,000 sites have been recorded, building up a significant database on the archaeology of the Hunter Valley.

3.1.1 Hunter Valley Site Patterns

There is general consistency in the types and distribution of archaeological sites throughout the Hunter Valley. The distribution, density and size of sites is largely dependent on environmental context. For instance, middens are found in close proximity to marine, estuarine and less often, freshwater bodies. Rock shelters are only found in areas of exposed sandstone escarpment and grinding grooves are found in areas of exposed flat beds of sandstone.

In a study of known sites in the Hunter region, Hughes[6] concluded that:

- sites would be found across the entire Hunter Valley;
- several site types exist, the most common being open artefact scatters;
- artefact scatters are most likely to occur on creek banks, especially at creek junctions, with low frequencies found over 100 metres from creeks and on hillslopes and crests;
- sites will generally reduce in size as associated watercourses decrease in catchment size; and
- most archaeological evidence dates to the mid to late Holocene; and technological analysis of stone artefacts may assist in relatively dating sites that cannot be directly dated.

[6] Hughes 1984

Investigations carried out since Hughes' study have tended to confirm the patterns described above. Environmental and topographic context is an important determinant of the size and nature of sites. The most commonly reported pattern in the lower Hunter is the frequency of open artefact scatters found near watercourses. Surveys in the Hunter Valley indicate a high density of open artefact scatters along the Hunter River and associated drainage networks. As a result of cyclical flooding, notably the 1949 and 1955 floods, archaeological material is often buried by more recent alluvial and colluvial deposits. This means that archaeological material is often found in areas of sub-surface exposure, such as those caused by erosion.

It has been argued that the concentration of sites along watercourses is a result of sample bias[7] or increased exposure and visibility due to erosion in these areas. Despite the evidence of survey bias, Barber[8] showed that the pattern was real rather than just a function of bias or increased exposure of artefact-bearing deposits along creeklines. Barber excavated a representative sample of all landforms adjacent to Bettys Creek and found 62% of sites were along creeklines even though these areas represented only 22% of the survey area.

3.1.2 Dating of Hunter Valley Sites

Hunter Valley duplex soils are classified into two divisions consisting of an upper A-horizon and an underlying B-horizon. The majority of archaeological deposits are found in the A-horizon with artefact assemblages commonly reflecting the Holocene aged 'Small Tool Tradition'.

In an analysis of Hunter Valley stone artefacts, Hiscock[9] argued that open site assemblages in the region are generally no older than 5,000 years BP. However, evidence of earlier Pleistocene occupation has been found at Glennies Creek, north of Singleton. Radiocarbon-dated charcoal and geomorphological evidence suggests that artefacts found in the B-horizon were deposited between 10,000 and 13,000 years BP[10]. In the lower Hunter, occupation has been dated to as early as 17,376 years before present at Moffats Swamp[11].

The vast majority of dated sites are less than 5,000 years old. It has been argued that this is a result of increased populations and 'intensification', during this period. The prevalence of sites dating to the last 5000 years may also be a result of the last significant rise in sea level, approximately 6000 years ago. The sea

[7] Kuskie and Kamminga 2000
[8] Barber 1993
[9] Hiscock 1986, pp. 40-50
[10] Koettig 1986a and 1986b
[11] Baker 1994

level rise would have submerged many of the older sites along the coastal fringe and forced Aboriginal groups westward to the current coastline.

3.1.3 Stone Artefacts

Aboriginal stone artefacts are an important source of archaeological information because stone is preserved for long periods of time whereas organic materials such as bone, shell, wood and plant fibres decay. Stone artefacts provide valuable information about technology, economy, cultural change through time and settlement patterning. Stone has also been used for 'relative' dating of sites where direct methods such as Carbon dating cannot be applied. Based on direct dating of excavated sequences, an Eastern Regional Sequence has been developed and refined over the last 50 years. The Eastern Regional Sequence phases are as follows:

- Capertian – is distinguished by large uniface pebble tools, core tools, horsehoof cores, scrapers and hammerstones. Backed artefacts occasionally present. Generally dates to before 5,000 years before present (BP).

- Early Bondaian – Aspects of the Capertian assemblage continue, but backed artefacts and ground-edged artefacts increase. Artefacts during this period were predominantly made from fine-grained silicious stone such as silcrete and tuff. Generally dated from 5,000 BP to 2,800 BP.

- Middle Bondaian – Characterised by backed artefacts, particularly Bondi Points and ground-edged artefacts. Artefacts made from silicious materials, however quartz becomes more frequent. Generally dated from 2,800 BP to 1,600 BP.

- Late Bondaian – characterised by bipolar technology, eloueras, ground-edged artefacts, bone and shell artefacts. Bondi points are virtually absent and artefacts are predominantly made from Quartz. Generally dated from 1,600 BP to contact.

In an overview of Hunter Valley lithic assemblages Baker[12] has observed that artefacts are generally made from indurated mudstone and silcrete, with Nobby's Tuff common in the coastal zone. Baker also notes that high quality raw materials at Hunter River gravel point bars generally result in abundant flaking debris on the sides of watercourses with a stream order of two or

[12] Baker 1992, pp. 7-9

higher. Such locations were important sources of raw material for stone artefact manufacture.

In a technological analysis of the Hunter Valley "small tool tradition", Moore describes the following items: primary cobble blanks, large primary flake blanks struck during on-source reduction of large cores, secondary flake blanks for use and reduction as blade cores, blade cores, flake blanks for backing, unused microliths, flake tools and composite tools made from microliths[13]. The items described above form the series of reduction steps (from source to finished product) used to produce microliths (also known as 'backed artefacts'). Comparing microlith use-wear and breakage patterns with experimental studies of microlith breakage patterns, Moore concludes that Hunter Valley microliths may have been used in composite tools; hafted in series on timber to produce a cutting/processing implement (ie. a knife).

3.2 AHIMS SEARCH RESULTS

A search of the DEC Aboriginal Heritage Information Management System (AHIMS) for a six kilometre area surrounding the study area was undertaken to identify previously recorded sites in and around North Bellbird. A total of 9 open camp sites / isolated finds (ie. stone artefact scatter sites) have been recorded within the search area.

The predominance of stone artefact scatters reflects the local geology and distribution of resources. For example, rock engravings, axe grinding grooves and rock shelters are only found in areas of outcropping bedrock. Because the study area does not have outcropping bedrock, these site types will not be present.

3.3 LOCAL ARCHAEOLOGICAL CONTEXT

A limited number of archaeological studies have been undertaken in the Cessnock area over the past 15 years. The majority of investigations in the area have been development impact assessments. Of particular note are two excavations recently undertaken by *Insite Heritage* and *Stedinger & Associates* which have important findings about the nature of the archaeological resource in the local area. This section provides a review of these recent excavations, followed by a general summary of archaeological assessment work in the Cessnock area as a means of determining site types and site distribution in the local area, and the nature of the archaeological resource.

[13] Moore 2000

3.3.1 Lot 101, Mt View Road, Cessnock - 2004

Stedinger & Associates undertook a programme of test excavation immediately to the north of the current study area at Lot 1, Mt View Road. The final report on excavations is still in preparation; however *Stedinger & Associates* kindly provided draft copies of their geomorphology[14] and stone artefacts[15] reports for our literature review.

Four grader scrapes were excavated, followed by an open-area excavation 25 metres by 25 metres in dimension. Although no surface sites were identified across this area, a total of 3,777 whole and broken flaked artefacts were recovered during the excavation (with a minimum number calculation of 2,686). The soil profile revealed during excavation was a classic duplex or texture contrast soil profile common throughout the Central Lowlands of the Hunter Valley. Artefacts were recovered from an A horizon topsoil unit comprising relatively well sorted sediment about 150 mm to 250 mm thick with a silty fine sand texture. The topsoil contained very little clay and very little gravel. The A horizon overlay a hard, weathered, slightly mottled clayey sandy B horizon. The contact between the two horizons was sharp and undulated slightly in places.

The assemblage comprised 87.4 % un-retouched flakes, 7 % retouched flakes, 2.4 % cores and 3.1 % flaked pieces. Three pebble hammerstones were also identified. Raw material types included fine grained silcrete (83.5 %), fine-grained silicious (7.7 %), coarse-grained grey silcrete (4.7%) and smaller quantities of quartzite, chert, volcanic stone and petrified wood. Flake to core ratios were generally high, particularly for silcrete (41.5 flakes per core). High rates of artefact breakage were also observed, with 48.2 % of flakes being broken. The evidence for heating was very low and not a major cause of artefact breakage. Finally, there was a low incidence of cortex, suggesting minimal on-site primary reduction of pebbles and cobbles. The small size of artefacts and absence of cortex suggests stone source not nearby (ie. this is primarily an "off-source" site).

3.3.2 Henry Kendall Retirement Village – Limestone Creek

Insite Heritage undertook archaeological survey, assessment and test excavation of a parcel of land within the current study area between 2002 and 2004[16]. The

[14] Hughes 2004
[15] Untitled draft prepared by Norma Richardson for Stedinger Assoc.
[16] Lot 1 DP1011544, Lot 1 DP 327580, Lot 211 DP 1012346 & Lot 212 DP 1012346

investigations were in support of a DA proposal for a retirement village development.[17]

In 2002, *Insite Heritage* undertook an archaeological survey of the Henry Kendall Retirement Village study area. Two artefact scatter sites were identified on the western side of Bellbird Creek (AHIMS # 37-6-0994; 37-6-0993) and potential archaeological deposits (PADs) were identified on the north side of Limestone Creek. The assessment report was accompanied by an Application under Section 87 of the National Parks & Wildlife Act for test excavation of the PADs adjacent to Limestone Creek. The results of excavation are described below.

In mid 2004 *Insite Heritage* undertook test excavation of sandy deposits identified as PAD in three locations on the north side of Limestone Creek. The investigation area was located on the lower reaches and on the north side of Limestone Creek. A total of 20 square metres were excavated.

Phillip Hughes reported on the soils encountered during the excavation and interpreted the geomorphology of the study area. Hughes describes the sand comprising the PAD as very similar in texture, weathering and compaction to the sand forming the Holocene terraces of Limestone Creek. The sand is distinguished from the hard, weathered clayey sediments into which the creek is cut and which form the plain to the west of the creek (which are presumed to be of Pleistocene age). The Pleistocene clays are encountered on the surface of the plain, overlain by a thin A-horizon topsoil that has been regularly ploughed in the past.

Hughes interprets the sands as overbank flood deposits, probably of Holocene age. The feature is described as a small sandy levee bank (approx 200 – 250 mm high) typical of those commonly found along the banks of larger creeks and rivers in the Hunter Valley. The status of the sand levee as an archaeological deposit was confirmed by testing, during which a range of stone artefacts described below were recovered. Deposits encountered within Sample Area 3 included gravels comprising river pebbles and cobbles that were probably deposited during floods. The pebbles and cobbles were an obvious on-site raw material source for stone artefact manufacture.

Hughes' report concludes that although the sand levee contains archaeological deposits, the Pleistocene clay profile that forms the remainder of the plain probably has no archaeological potential. Hughes argues that if artefacts were

[17] Insite Heritage 2005; Norma Richardson 2005

present within these soils *"(a) they would be completely disturbed, and (b) some would be visible on the present surface"*. As the archaeological survey did not locate any artefacts on the plain, Hughes concludes, that on balance, there is no potential for the sediments underlying the plain to contain stone artefacts.

Richardson's analysis of stone artefacts reports a total of 166 flaked artefacts recovered from the three sample areas[18]. The majority were flakes made from silcrete. Richardson also reports that two glass artefacts and one ceramic fragment with negative scars (core) were also recovered. There was a high incidence of artefact breakage; 31% of flakes and 42% of retouched flakes were broken. A comparison with other assemblages from the region indicated whole flakes were slightly shorter and less elongated. Richardson also observed that the small number of cores combined with the generally small size of the flakes suggests that raw material sources may not be in the immediate vicinity[19].

The highest densities of flaked artefacts were found in the four pits closest to Limestone Creek. The higher density pits also contained the widest range of artefact types and raw materials. Despite this sample size effect, Richardson concluded that there are no major differences between the assemblages from each of the three sample areas, apart from the density of the artefacts. Artefacts were distributed through the vertical horizon of excavated sediments.

3.3.3 Archaeological Investigations on Black Creek

A number of surveys and assessments have been undertaken to the north of the study area in similar landscape and geomorphic settings. Archaeological survey work along Black Creek has shown that there is a consistently high potential for artefact scatter sites adjacent to watercourses and back swamps. ERM[20] identified a scatter of 26 stone artefacts along a 220 metre strip that runs either side of a watercourse along the Allandale Road reserve margin. Kuskie[21] found 19 sites (isolated finds and artefact scatters) in disturbed contexts such as grader scrapes and erosion exposures in close proximity to watercourses. Burramoko Archaeological Services[22] found 22 open artefact scatters in a 237 hectare area adjacent to Black Creek. Artefact types included chert, mudstone, siltstone and silicified sandstone. Approximately 60 per cent of artefact scatters were found in locations exhibiting deep disturbance and in contexts below the present ground surface. The landform containing the highest frequency of recorded sites was the middle terrace or low slopes adjacent to Black Creek.

[18] Including 19 retouched flakes and 6 backed artefacts
[19] Although Hughes identified river cobbles and pebbles within the sand levee
[20] ERM 1997
[21] Kuskie 1996
[22] Burramoko Archaeological Services 1998

3.4 PREDICTIVE MODELLING

3.4.1 Site Types

Based upon information compiled within the *NPWS AHIMS*, and background archaeological data reviewed above, the types of sites that may be expected to occur within the boundaries of the subject land are described below.

Open Artefact Scatter

Occur almost anywhere that Aborigines travelled in the past. The cultural activity represented by these sites may be associated with hunting or gathering activities, domestic camps, or the manufacture and maintenance of stone tools. The density of artefacts present in these scatters can vary dramatically and may relate to either transient or short stay camps, or base camps of long term and/or repeated occupation. These types of sites are commonly referred to as '*open campsites*'.

Isolated Find

Occur anywhere in the landscape and may represent the random loss, deliberate discard or abandonment of artefacts, or the remains of dispersed artefact scatters.

Scarred / Carved Tree

Aboriginal people used trees in many ways and in many environments. Bark was removed from trees to make artefacts, vessels, shelters and medicines. Bark was removed both as sheets, for shaped artefacts such as canoes, and fibre for twine. In the case of carved trees; tree trunks were carved with shapes and patterns that had mythological symbolism. Carved trees are specifically associated with Bora grounds (initiation ceremony sites). Carved trees are very rare and important sites. Scarred and Carved trees are found within areas of old growth remnant vegetation.

3.4.2 Site Predictions

The topography and distribution of natural resources within the study area indicates a potential for the site types described above. In particular, the North Bellbird study area has a potential for:

- Open artefact scatter sites across all landforms within the study area where original A-horizon topsoils are present. The frequency, density and complexity of stone artefact scatters will increase with proximity to Limestone Creek and Bellbird Creek. The integrity of stone artefact deposits will depend on the degree of disturbance of original topsoils caused by erosion and farming activities;

- Scarred or carved trees within areas of remnant vegetation containing old growth trees (within vegetation communities that include remnant trees on the western margin of the study area); and
- Isolated finds anywhere across the landscape.

Previous excavations at the Lot 101 Mt View Road site indicate a potential for high densities of stone artefacts below current ground surfaces in areas where no surface evidence is present. This highlights the limitations of surface survey in determining the nature and distribution of archaeological material across the local landscape. It also suggests that landform-based test excavation should be undertaken to accurately determine the nature, extent and significance of the local archaeological resource.

More generally, previous excavations and surveys in the Cessnock area indicate that stone artefact scatters are larger and more frequent in close proximity to water sources. Natural drainage lines within the study area, such as Bellbird Creek and Limestone Creek, would have provided a source of fresh water. The availability of fresh water in combination with terrestrial resources would have facilitated Aboriginal occupation and associated social and economic activities within the study area.

Although analysis of artefact assemblages from the Mt View Road site and the Henry Kendall Retirement Village site suggest minimal on-site primary reduction and local sourcing of stone material, the discovery of river cobbles and pebbles within the sand levee investigated at the Henry Kendall site indicates local stone sources were available. It is highly likely that sources of flakable stone pebbles and cobbles are present within alluvial deposits adjacent to Limestone and Bellbird Creeks. Such locations may have been raw material sources and there is potential that primary reduction sites adjacent to such sources may be present.

4.0 SURVEY RESULTS

4.1 SURVEY DETAILS

The survey was carried out in two stages. The majority of the study area was investigated in June 2005 by archaeologists Jim Wheeler and Fiona Leslie of AHMS Pty Ltd in partnership with representatives of the local Aboriginal community. Survey of additional land[23] included in the study area was undertaken in March 2006 by Jim Wheeler in partnership with representatives of the local Aboriginal community. The survey sampled all landforms present within the study area.

The objectives of the survey were to identify any Aboriginal sites, objects or potential archaeological deposits (PAD's). The investigation also assessed the extent to which past land-uses may have affected the natural soil profiles. This information was used to assess the depth and potential integrity (intactness) of natural soil profiles across the study area and the likely impact of future development.

4.2 SURVEY METHODOLOGY

The first procedure in developing a survey methodology was to divide the study area into its various topographic landform elements using the system described by Speight in the landform section of the *Australian Soil and Land Survey Field handbook*[24]. Each landform element was given a separate survey unit number. A series of **landform survey transects** (ie. survey walking routes) were placed over the study area to provide for adequate coverage of each survey unit (landform element). The landform coverage was "weighted" to provide for thorough coverage of drainage lines and creek banks; areas where Hunter Valley site patterning indicate the highest density of artefact scatter sites will be found. Creek margins also have a higher level of ground exposure resulting from creek bank erosion, therefore increasing effective survey visibility.

A second series of survey transects were designed following an analysis of topographic maps and aerial photographs of the study area. Tracks, unsealed roads and areas of ground exposure (ie. erosion scours) were identified. These areas were targeted with the second series of survey transects referred to as **track/road transects**. The purpose of these transects was to inspect known areas

[23] Lot 1 DP196460, Lot 3 DP597226 & Lot 2 DP66183.
[24] Speight 1990

of ground surface visibility within the study area. Stone artefact scatters may be detected in areas where soils are exposed and visible, whereas stone artefacts will not be detected in areas where soils are covered by grass or vegetation.

Each survey transect was traversed on foot, with the aim of locating and examining any areas of ground surface visibility. Areas of erosion and ground exposure were examined for archaeological evidence such as stone artefacts, charcoal and shell. Ground surfaces and cuttings were also examined to determine the degree of soil disturbance, erosion and potential for archaeological deposits below current ground. Old growth trees were examined for evidence of scarring or carving. Each survey team included one archaeologist and two Aboriginal community survey assistants.

During the survey, detailed field notes were made and photographs taken to document landscape configuration, soil profiles, soil disturbance, ground visibility and vegetation types. Aboriginal sites found during the survey were recorded in detail using the survey record sheet shown in Appendix 3.

4.3 SURVEY COVERAGE

Effective coverage is calculated by multiplying the % ground exposure (or visibility for detecting artefacts) by the % survey coverage (or actual area surveyed). The calculation of effective coverage shows the effectiveness of the surface survey in detecting surface archaeological sites and accordingly, how much weight ought to be put on the results.

As discussed above, the study area was divided into 5 survey units based on landform elements (refer to Figure 4.1 for location of survey units). The units were as follows:

Survey Unit 1) - Open Depression (drainage lines);
Survey Unit 2) - Mid-slopes;
Survey Unit 3) – Lower-slopes;
Survey Unit 4) – Flats; and
Survey Unit 5) – Upper-slopes;

Table 5.1 displays the survey coverage data. The data indicates that, with the exception of Survey Unit 1 (where soils were exposed through erosion on drainage lines and gullies), the survey was generally ineffective in detecting surface sites. As described in the following sections, grasses and vegetation covering ground surfaces in Units 2, 3, 4 and 5 reduced effective coverage across these landforms.

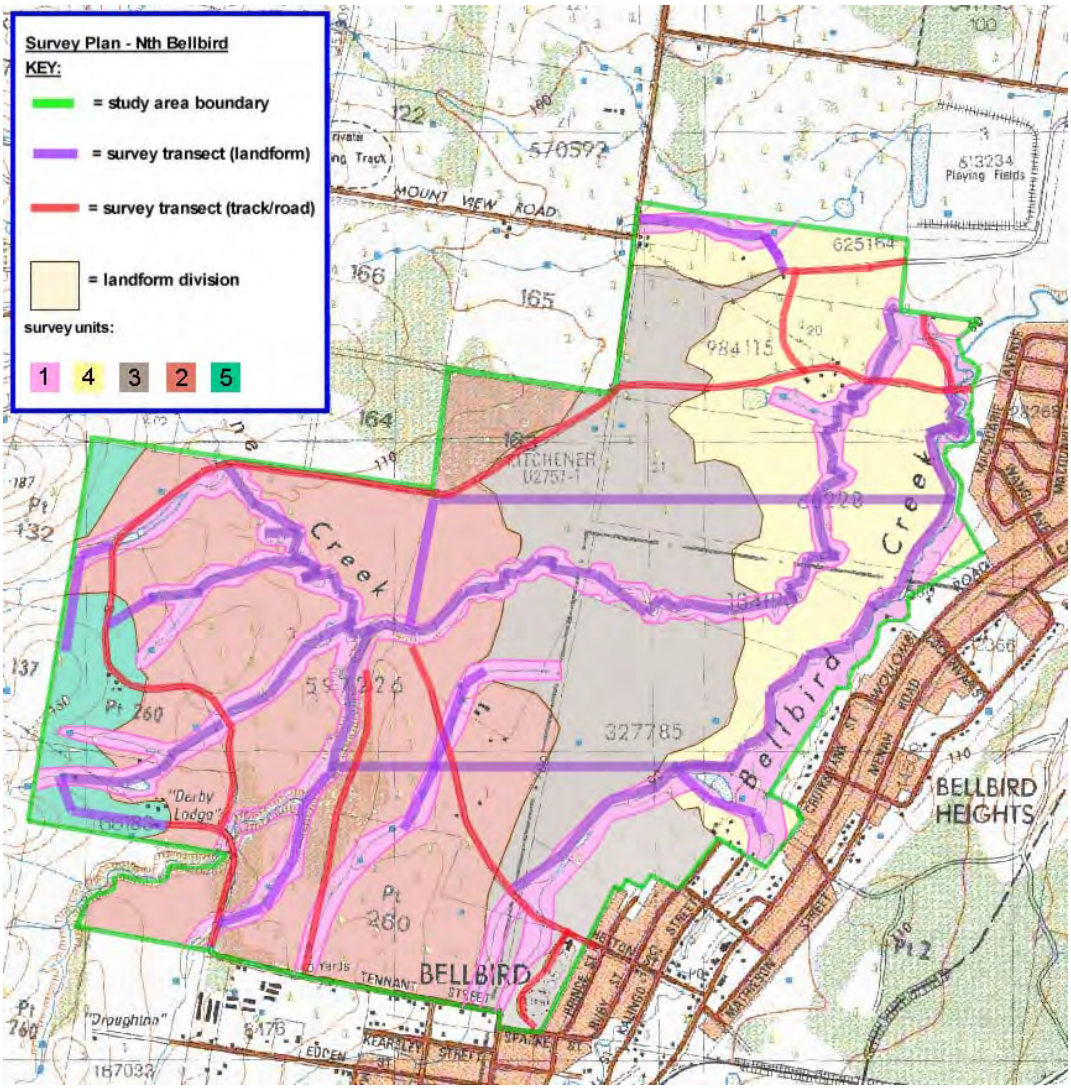


Figure 4.1 – Survey Units and Transects

TABLE 4.1 Effective Survey Coverage

Survey Unit	Ground Exposure %	Survey Coverage %	Degree of Soil Disturbance	Estimate of Effective Coverage %
1 – Open Depression	15 %	85 %	High	13 %
2 – Mid Slopes	8 %	25 %	Moderate	2 %
3 – Lower Slopes	2 %	15 %	Moderate	0.3 %
4 – Flats	5 %	20 %	Moderate	1 %
5 – Upper Slopes	5 %	15 %	Moderate	0.75 %

4.4 RESULTS OF THE SITE SURVEY

4.4.1 Preamble

This section presents the results of the archaeological survey. A general description and summary of results for each survey unit is provided, followed by a discussion of archaeological potential and a preliminary analysis of results. Detailed site record sheets are presented in Appendix 2 of the report. The locations of recorded sites are shown on figure 4.2 overleaf.

Twenty-one open artefact scatters and four isolated artefacts were located during the field survey. Given the large proportion of ground obscured by vegetation it is likely that more sites and isolated objects exist on the surface below pasture grasses, and in sub-surface deposits throughout the study area.

4.4.2 Survey Unit 1 – Open Depression



Survey Unit 1 comprised drainage lines, and their adjacent banks (approx 100 metres either side of stream channels). These "open depression" landforms cut across other landforms in the study area (as shown on figure 4.1). Open depression landforms within the study area comprised Bellbird Creek, Limestone Creeks, tributaries and minor ephemeral drainage lines.

Effective survey coverage was much higher on open depression landforms because creek bank erosion and gullying has exposed surface soils and soil profiles. This has biased the results of surface survey, potentially overstating the proportion of surface sites on this landform compared to other landforms[25].

Soils on creek banks have been heavily disturbed by past land uses, specifically:

- Rill and gully erosion resulting from vegetation removal on creek banks. These processes have removed original topsoils;

[25] NB: however, previous investigations across the Hunter Valley clearly show there is a higher frequency of sites adjacent to drainage lines.

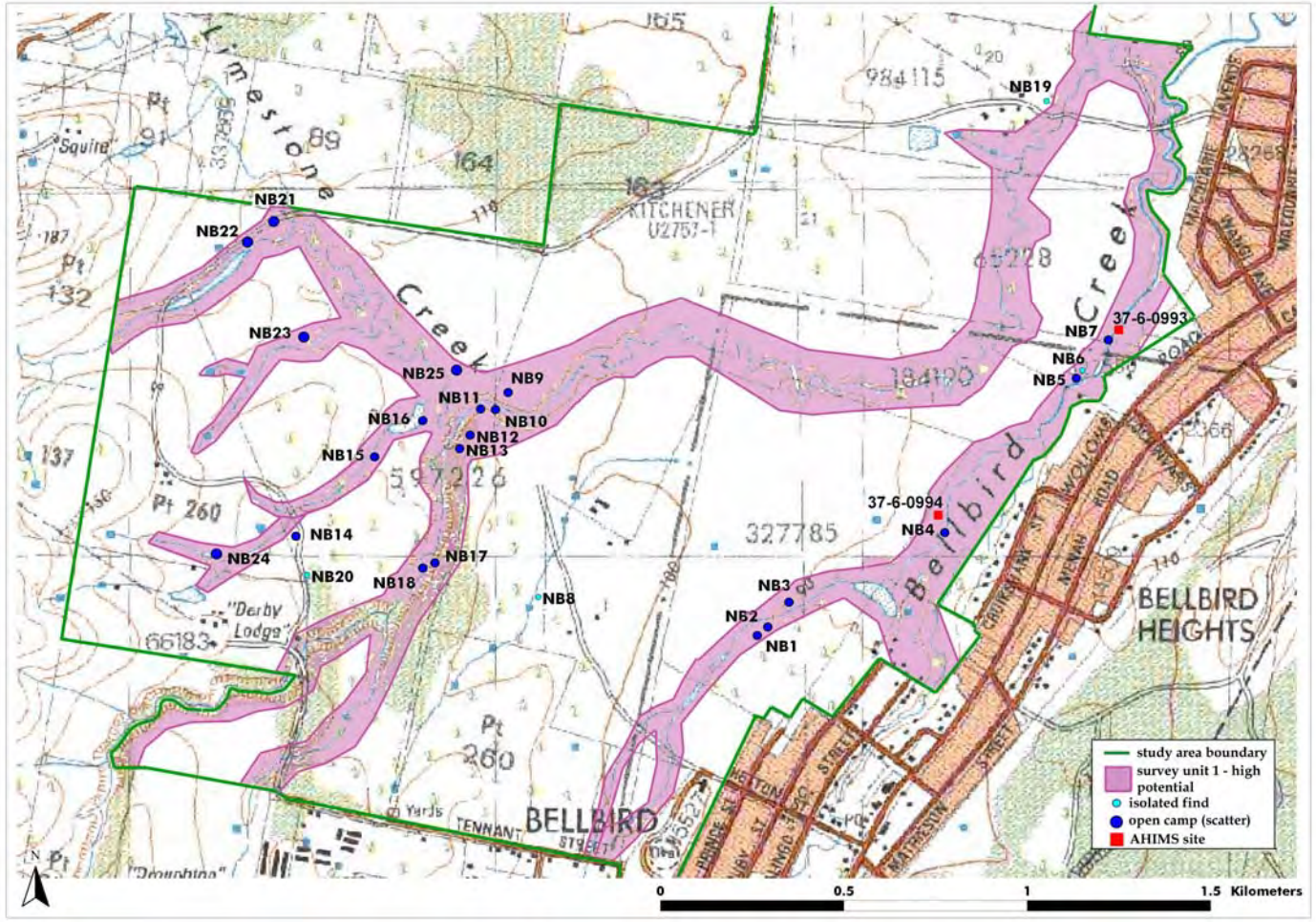


Figure 4.2 – Aboriginal sites and areas of high PAD identified during the survey.

- Flood scouring (severe in places) of creek banks. Scouring has effectively removed portions of the original river bank closest to the stream channel, straightening and widening the channel;
- Modifications such as fords at crossing points and dams to hold water; and
- Alluvial sediments deposited during flooding. These sediments are primarily found as overbank deposits immediately above the river bank.

A total of 19 open artefact scatters and 1 isolated find were recorded within survey unit 1. These sites were recorded in areas of exposed ground surface topsoil and exposed soil profiles on creek banks. Six open artefact scatters and one isolated find were identified on the margins of Bellbird Creek (this includes the two open camps previously recorded by *Insite Heritage* - AHIMS # 37-6-0994 and 37-6-0993). Thirteen open artefact scatters were identified on the margins of Limestone Creek and associated tributaries, including a complex of four sites referred to as "group 1" (NB-9, NB-10, NB-11 & NB-12) clustered around a former oxbow and lagoon on Limestone Creek. No sites were recorded on the margins of a small drainage line located on the northern margin of the study area. Here the drainage line has been heavily modified by a series of dams.

Bellbird Creek

The margins of Bellbird Creek have been heavily disturbed and modified by past land use, erosion and flooding. These processes have removed or disturbed original creek bank topsoils and also resulted in deposition of fluvial sediments. The southern portion of Bellbird Creek has low gradient margins with little discernable creek bank (figure 4.3). The channel in this portion is shallowly incised. Here, flooding has resulted in deposition of alluvium across the flood plain and only limited scouring of the creek channel. This is a function of the low gradient stream channel and surrounding flood plain. Areas adjacent to the creek on the low lying flats have been gullied through a gradual process of rill erosion. It is in these "rilled areas" of exposed ground that artefact scatters NB1, NB2 and NB3 were located on remnant A2-horizon topsoils.

The northern portion of Bellbird Creek has increasing gradients on side slopes and on the stream channel. This has resulted in a more steeply incised stream channel and pronounced creek banks that have been severely scoured during flooding (figure 4.4). There has also been less deposition of flood borne sediment due to the additional height of flooding required to top the high creek banks. Sites NB4 (AHIMS # 37-6-0994), NB5, NB6 and NB7 (AHIMS # 37-6-0993) were identified within areas of remnant topsoil on exposed ground and exposed soil profiles on the upper margins of creek banks where original topsoils are being actively exposed by erosion.



Figure 4.3 – Southern portion of Bellbird Creek, showing flat topography and low stream channel gradient.



Figure 4.4 – Northern portion of Bellbird Creek, showing steeply incised creek and evidence of flood scouring.

Limestone Creek

As with Bellbird Creek, the margins of Limestone Creek have been disturbed and modified by past land use, erosion and flooding. As already discussed, these processes have removed or disturbed original creek bank topsoils and also resulted in deposition of fluvial flood-borne sediments. The north-eastern portion of Limestone Creek has a deeply incised stream channel and pronounced creek banks that have been severely scoured (refer to figure 4.5). Above the creek bank, the land forms a broad creek flat with low slope gradients. The north-east portion of Limestone Creek resembles that of the northern portion of Bellbird Creek. No Aboriginal sites were identified on the margins of Limestone Creek in the north-east portion. However, it is noted that this was the part of the study area where *Insite Heritage* excavated stone artefact deposits within a sand levee interpreted as overbank flood deposit.



Figure 4.5 – North-east portion of Limestone Creek.

The south-west portion of Limestone Creek has increasing side slope gradients as the land rises to the west. Accordingly, the stream channel is increasingly incised further upstream to the south-west until the creek bank forms a sheer gully on the south-west margin of the study area (figure 4.6). Flood scouring is also more pronounced further to the south-west; however the potential for overbank flood deposits decreases due to the additional height of flooding required to top the high creek banks.



Figure 4.6 – south-western portion of Limestone Creek showing the lagoon around which NB9, NB10, NB11 and NB12 are located.

Thirteen open artefact scatters were identified on the bank margins of the south-western portion of Limestone Creek and associated tributaries where original topsoils are being actively exposed by erosion (NB9, NB10, NB11, NB12, NB15, NB16, NB17, NB18, NB21, NB22, NB23, NB24 & NB25). The artefact scatters were found on exposed lower portions of remnant A2 horizon topsoil, just above the interface with B horizon clay subsoil. No artefacts were found across areas of exposed upper portions of A1 and A2 horizon topsoil, despite good surface visibility in the form of cattle and vehicle tracks. This strongly suggests that stone artefacts are deflating through the soil profile to the base of the A-horizon profile at the interface with impermeable clay subsoil. This zone in the soil profile also corresponds with a gravel pan, indicating all stone materials have moved vertically down through the soil profile, stopping just above the hard clay.

A complex of four sites was found on the margins of a former oxbow and lagoon (NB9, NB10, NB11 & NB12), immediately downstream of the confluence of Limestone Creek with two second order tributaries. As described above, these sites were found across exposed lower portions of A2 topsoil in the interface zone with clay subsoil. The composition of the sites is described in detail in Appendix 2, however in summary, the stone artefact assemblage included a high density of material representing all stages of the reduction sequence from pebble primary

cores and initial decortication flakes through to retouched flakes and backed artefact implements.

The incidence of primary pebble cores, primary macro-flakes and high percentage of cortex, in combination with the wide variety of raw materials (rhyolite, silcrete, quartzite, tuff/indurated mudstone and chert) strongly suggest nearby sourcing of raw materials in the form of river cobbles and pebbles. Examination of cortex on the artefacts showed the material is exclusively derived from river-rolled stones, such as those that would be found in alluvial gravel deposits on Limestone Creek.

Three silcrete flakes found at NB11 were conjoined, indicating the scatter has some horizontal integrity. The complex of high density sites surrounding the lagoon and former oxbow may indicate the locale was an important resource zone in the past (eg. for stone sources and/or food/material resources associated with the lagoon wetland environment). It also fits the model that creek junctions were an important focus for Aboriginal occupation and use in the past.

4.4.3 Survey Unit 2 – Mid Slopes



Survey Unit 2 covers mid-slope landform on the western part of the study area. Unit 2 includes all the land between the 100 m and 130 m AHD contour lines (with the exception of drainage lines that comprise Survey Unit 1). The land across Unit 2 has very gentle north-east sloping gradients, although is generally steeper and has more deeply incised drainage lines than Survey Unit 3 and 4 (low slopes and flats).

Effective survey coverage was low (at 2 %) because ground surfaces are covered by grasses, shrubs and pockets of dry sclerophyll forest. Ground surface exposure was sporadic; found on small cattle tracks, ants nests, earthen dam walls and small areas of rill erosion.

Soils have been disturbed by past land uses, specifically:

- Surface soils have been disturbed by ploughing, cattle grazing and vehicular use;

- Original clearing of vegetation would have caused sheet erosion and loss of topsoil down slope. Removal of old growth trees may have destroyed scarred/carved trees;
- Rill erosion resulting from vegetation removal, vehicle and cattle tracks have removed original topsoils; and
- Modifications such as dams, farm buildings and fences have disturbed and/or removed original soils.

Two open artefact scatters (NB 13 and NB14) and two isolated finds (NB8 and NB20) were recorded within survey unit 2. These sites were recorded in areas of exposed ground surface topsoil on an earthen dam wall (NB8), cattle track (NB13), ants nest (NB20) and an area of rill erosion (NB14). The lack of ground surface exposure and, more particularly, lack of exposed soil profiles in cuttings (due to flat topography) made it difficult to assess the depth and potential integrity of sub-surface soils. Exposed profiles on Limestone Creek, in combination with the results of testing at Lot 101 Mt View Rd and Henry Kendall Retirement Village indicate that A horizon topsoils are likely to be thin (probably max 250 mm).



Figure 4.7 – Typical exposure seen across Survey Unit 2

As discussed in Section 4.4.1, it is likely that stone material, including artefacts, have moved vertically down through soil profiles, probably as a result of bioturbation, ploughing and cattle grazing. During survey across unit 2 no stone material was observed on exposed upper portions of A1-horizon topsoil. Stone material was only observed on exposed lower portions of A2-horizon topsoil and as a pan on top of B horizon clay. These observations may explain the paucity of surface sites found during survey and indicate that stone artefacts have deflated through the soil profile. If this is the case, archaeological deposits across this landscape probably have little or no vertical integrity.

4.4.4 Survey Unit 3 – Lower Slopes



Survey Unit 3 comprises lower slope landform across the centre ground of the study area. Unit 3 includes all the land between the 90 m and 100 m AHD contour lines (with the exception of drainage lines that comprise Survey Unit 1). The land across Unit 3 has very gentle east-north-east sloping gradients.

Effective survey coverage was extremely low (at 0.3 %) because ground surfaces are almost entirely covered with pasture grasses. Ground exposure was limited to a small number of cattle and vehicle tracks. Effective coverage across Unit 3 was at such a low level that the results of surface survey were virtually meaningless.

Soils have been disturbed by past land uses, specifically:

- Surface soils have been disturbed by ploughing, cattle grazing and vehicular use;
- Original clearing of vegetation would have caused sheet erosion and loss of topsoil down slope. Removal of old growth trees may have destroyed scarred/carved trees;
- Rill erosion resulting from vegetation removal, vehicle and cattle tracks have removed original topsoils; and
- Modifications such as dams, farm buildings and fences have disturbed and/or removed original soils.

No Aboriginal objects or sites were found in survey unit 3. Due to the extremely low level of ground surface visibility this result is hardly surprising. Recent test excavation at the Lot 101 Mt View Road site suggest that sub-surface stone artefact deposits may be found below current ground surfaces in areas where there is no surface evidence. In conclusion, extremely low effective coverage indicates that surface survey across Unit 3 was inadequate to effectively assess the presence, nature and distribution of the archaeological resource.

4.4.5 Survey Unit 4 – Flats

Survey Unit 4 covers creek flat landform across the north-eastern low-lying portion of the study area. Unit 4 comprises all the land below the 90 m AHD contour line (with the exception of drainage lines that comprise Survey Unit 1). The land across Unit 4 is virtually flat with only a very slight fall to the north-east.



Effective survey coverage was low (at 1 %) because ground surfaces are almost entirely covered with pasture grasses. Ground exposure was limited to a small number of cattle and vehicle tracks, and areas of rill erosion. Low effective coverage across Unit 4 suggests the survey did not adequately assess the presence, nature and distribution of the archaeological resource.

Soils have been disturbed by past land uses, specifically:

- Surface soils have been disturbed by ploughing, cattle grazing and vehicular use;
- Original clearing of vegetation would have caused sheet erosion and loss of topsoil down slope. Removal of old growth trees may have destroyed scarred/carved trees;
- Rill erosion resulting from vegetation removal, vehicle and cattle tracks have removed original topsoils; and
- Modifications such as dams, farm buildings and fences have disturbed and/or removed original soils.

One isolated find (NB 19) was recorded within survey unit 4. The site was found on the edge of an unsealed vehicle track, approximately 150 metres west of Limestone Creek. The lack of ground surface exposure and, more particularly, lack of exposed soil profiles in cuttings (due to flat topography) made it difficult to assess the depth and potential integrity of sub-surface soils. As previously discussed, exposed profiles on creeklines, in combination with the results of testing at Lot 101 Mt View Rd and Henry Kendall Retirement Village indicate that A horizon topsoils are likely to be thin (probably max 250 mm).

During survey across Unit 4, small silcrete pieces were observed on unsealed road surfaces within gravels used for road surfacing. None of these silcrete pieces showed evidence of percussion or bipolar flaking and all were consistently small "gravel" sized. This indicates the silcrete pieces are associated with the road ballast gravels and were probably imported for road surfacing after being processed through a gravel crusher or separator.

4.4.6 Survey Unit 5 – Upper Slopes



Survey Unit 5 included the upper slope landform on the western boundary of the study area where the *Pokolbin Soil Landscape* interleaves with the B*ranxton Soil Landscape*. Unit 5 includes all the land between the 130 m and 160 m AHD contour lines (with the exception of drainage lines that comprise Survey Unit 1). The land across Unit 5 has moderate east-north-east sloping gradients.

Effective survey coverage was very low (at 0.75 %) because ground surfaces are almost entirely covered with pasture grasses. Ground exposure was limited to an access road running up to the farm house on Lot 1, a few isolated erosion scalds and soils exposed across a vineyard on the western margin of Lot 1. The extremely low coverage across Unit 5 indicates the results of surface survey, regarding detection of Aboriginal sites and objects, were virtually meaningless.

Soils have been disturbed by past land uses, specifically:

- Surface soils have been disturbed by ploughing, cattle grazing and vehicular use;
- Original clearing of vegetation would have caused sheet erosion and loss of topsoil down slope (particularly the case on the steeper slopes that form survey unit 5). Removal of old growth trees may have destroyed scarred/carved trees;
- Rill erosion resulting from vegetation removal, vehicle and cattle tracks have removed original topsoils; and
- Modifications such as dams, farm buildings and fences have disturbed and/or removed original soils.

No Aboriginal objects or sites were found in survey unit 5. Extremely low effective coverage indicates that surface survey across Unit 3 was inadequate to effectively assess the presence, nature and distribution of the archaeological resource.

4.5 ARCHAEOLOGICAL POTENTIAL

4.5.1 Preamble

Archaeologists use the term 'Potential Archaeological Deposit (PAD)' to describe areas that have potential to contain intact sub-surface Aboriginal objects or sites. Surface survey results, predictive modelling, and assessment of past site formation processes are commonly used to identify PAD.

The concept of PAD was developed during the 1980's, primarily as a response to mechanisms and procedure for protection of Aboriginal cultural heritage enshrined in the NSW National Parks & Wildlife (NPW) Act 1974. While *Section 90* of the NPW Act 1974 provides protection for known physical evidence of Aboriginal occupation (such as stone artefacts that may be identified on modern ground surfaces), areas that contained sub-surface archaeological deposits not visible on ground surfaces were often overlooked in consulting reports produced during the 1980's. This represented poor archaeological practice and potentially exposed development proponents to breaching the NPW Act by disturbing and/or destroying sub-surface Aboriginal deposits during site development works.

As a result, the concept of PAD was developed to identify potential sub-surface deposits during initial surface survey and assessment work. NPWS allowed for

PADs to be recorded and registered on the NSW Aboriginal Sites Register (now the Aboriginal Heritage Information Management System – AHIMS). Even though PADs do not have any legally protected status under the NPW Act, they provide DEC (as the statutory authority) with information that Aboriginal deposits may be present in an area and provide development proponents with due warning that development works in areas of identified PAD may disturb Aboriginal deposits. PADs have therefore evolved to become an important and useful heritage management tool during the assessment process, particularly across landscapes that have little or no ground surface visibility.

4.5.2 Archaeological Potential at North Bellbird

The North Bellbird study area generally has a low level of ground surface visibility due to pasture grasses, vegetation and pockets of dry sclerophyll forest covering ground surfaces. This prevented effective detection of Aboriginal objects on current ground surfaces across much of the study area. Our analysis of effective survey coverage presented in table 4.1 highlights variability in effective coverage which has biased the results of surface survey in favour of areas with a higher level of effective coverage, such as Survey Unit 1 (effective coverage of 13 %). It also indicates that surface survey across the other Survey Units, particularly Unit 4, was largely ineffectual. Therefore on the basis of surface survey it is difficult to make accurate, unbiased conclusions about the nature and distribution of archaeological deposits across the study area.

Some broad conclusions we can draw from regional settlement patterning, the results of our survey at North Bellbird, and the results of previous test excavations at Lot 101 Mt View Road and the Henry Kendall Retirement Village site are described below.

Hunter Valley Regional Settlement Patterns

The frequency, density and complexity of Aboriginal sites increase with proximity to water sources (particularly within 100m of water). Sites generally reduce in size and complexity as associated stream order decreases, therefore on higher order streams (third order and above) sites are more common, larger and reflect more permanent or repeated occupation with evidence of more concentrated activities. Creek junctions, wetlands and resource intersection zones are often a particular focus of Aboriginal occupation and use.

Sites near stone sources include stone artefacts with a variety of size and cortex features. Size of artefacts and cortex both decrease with distance from source.

Survey at North Bellbird

Areas of remnant A horizon soil within Survey Unit 1 have a high potential to contain Aboriginal archaeological deposits, particularly near the confluence of Limestone Creek with its two tributaries, as demonstrated by the "Group 1" sites (NB9, NB10, NB11 and NB12).

Stone artefacts were consistently found on exposures of lower portions of A2 horizon soil and at the interface between A horizon topsoil and B horizon clay where stone gravel pan occurs. No artefacts or other stone materials were seen on exposures of upper A1 horizon topsoil. This indicates that stone materials, including Aboriginal artefacts, have deflated through the soil profile. It also suggests that there is little to no vertical (or stratigraphic) integrity of archaeological deposits across North Bellbird.

The potential of soils within Survey Units 2, 3, 4 & 5 to contain Aboriginal cultural deposits was inadequately assessed by the survey due to low levels of ground surface visibility.

The broad variety of stone raw materials, percentage of cortex on flakes and cores and proportion of primary reduction material observed at the recorded sites on Limestone Creek indicate possible local opportunistic sourcing of river pebbles and cobbles.

Excavations at Mt View Road and Henry Kendall Retirement Village

Excavation at Lot 101 Mt View Road demonstrates that significant densities of archaeological deposits are present across areas that contain no surface evidence.

Excavation of geo-morphological test pits for the Henry Kendall test excavation project demonstrate that river cobbles and pebbles are present within fluvial overbank flood deposits. The cobbles and pebbles are a potential local source of workable stone.

Excavations at both sites demonstrate that topsoil profiles are generally thin and have been disturbed by ploughing and cattle grazing (typically 150 mm thick).

4.5.3 Conclusions

Based on the above observations, the following conclusions regarding archaeological potential[26] are made:

- Areas of remnant A horizon topsoil within Survey Unit 1 have a high potential for archaeological deposits, particularly on the higher order Bellbird and Limestone Creeks;
- The potential for archaeological deposits is very high in the areas adjacent to the confluence of Limestone Creek with its two tributaries (including the "Group 1" area);
- Archaeological deposits are predicted to have little or no vertical integrity but may have horizontal integrity (as demonstrated by conjoined pieces at NB 11);
- The potential of Survey Units 2, 3, 4 and 5 is unclear, although likely to be lower than Survey Unit 1. Excavations at Mt View Road demonstrate that archaeological deposits will be found across these areas, however regional settlement patterning indicates frequency, density and complexity of sites will decrease with distance from water.

In summary, Survey Unit 1 is considered to have high potential. Survey Units 2, 3, 4 & 5 are likely to have a low – moderate potential. Given the limitations and biases noted regarding the surface survey, systematic landform-based test excavation will be required to accurately establish the nature, extent, distribution and significance of the archaeological resource within the study area. Test excavation would require a *Section 87 Permit* from the *Dept of Environment & Conservation* and should be undertaken during pre-DA planning (preferably prior to final detailed development design).

[26] NB: Archaeological potential refers to the likelihood of archaeological objects and/or deposits being present. It does not refer to their significance, which assessed in Chapter 6 of this report.

5.0 ABORIGINAL COMMUNITY CONSULTATION

5.1 DEVELOPMENT OF CONSULTATION

Consultation with the local Aboriginal community was undertaken in accordance with procedures set out in DEC's *Interim Community Consultation Requirements for Applicants 2005*. The following procedures were undertaken (a log of actions and correspondence regarding Aboriginal community consultation is presented in table 5.1 overleaf):

- Notification and Registration of Interests: stakeholder groups were identified by:
  (a) providing written notification to Mindaribba Local Aboriginal Land Council, Registrar of Aboriginal Owners, Native Title Services, Cessnock City Council and DEC; and
  (b) placing an advertisement in the *Cessnock Advertiser*.

  Registration of interest allowed 10 working days for groups to respond. Groups that registered their interest included the *Mindaribba Local Aboriginal Land Council*, *Yarrawalk*, *Wonnarua Nation Aboriginal Corporation*, *Barkuma Community Centre* and *Combined Council Hunter Valley Aboriginal Corporation*.

  Upper Hunter Heritage Consultants and *Hunter Valley Cultural Consultants* also registered their interest after the prescribed period and were too late to participate in the survey. They were, however, provided a draft copy of this report for comment and will be consulted regarding subsequent work.

- Preparation of the Assessment Methodology: The assessment and survey methodology was provided to the registered organisations for their review. Responses from the organisations were received within the 21 day prescribed period. At the same time, offers to provide archaeological survey assistance were received from the registered organisations.

- Archaeological Survey: Following our review of offers received from the registered organisations re: participation in the archaeological survey; the *Mindaribba Local Aboriginal Land Council*, *Yarrawalk*, *Wonnarua Nation Aboriginal Corporation*, *Barkuma Community Centre* and *Combined Council Hunter Valley Aboriginal Corporation* (now *ANTEC*) were engaged to assist in the survey work. The following representatives assisted during the field surveys:

  - Scott Franks, Tom Franks and Danny Franks of *Yarrawalk*;
  - Mark Hickey and Robert Lester of *Wonnarua Nation Aboriginal Corporation*;
  - Ann-Marie Hickey of *Barkuma Community Centre*;

- Margaret and John Matthews of *ANTEC*; and
- Alfred Whaledom, Phillip Hall, Joby Patten and Maria Griffiths of *Mindaribba Local Aboriginal Land Council.*

- Drafting, Review and Finalisation of the Assessment Report: Following completion of the draft Aboriginal Heritage Assessment, copies were provided to all Registered Stakeholders for comment. Comments received from the groups regarding the assessment results and recommendations were considered during finalisation of this report. All correspondence received from the Aboriginal community is included in Appendix 1.

***TABLE 5.1* - Aboriginal Community Correspondence Log – North Bellbird**

Date	Description	Method
26/4/05	Notification Letter to Mindaribba LALC	Post
26/4/05	Notification Letter to DEC	Post
26/4/05	Notification Letter to Native Title Services	Post
26/4/05	Notification Letter to Penrith City Council	Post
22/4/05	Placement of notification Add in Cessnock Advertiser for Weds 27th edition	Email
6/5/05	Call from Scott Franks, Manager of the Yarrawalk Aboriginal Corporation (m) 0422175839 (fax) 02 65410445, 10:15am. He will send a fax through registering their interest.	Phone
6/5/05	Fax from the Yarrawalk Aboriginal Corporation registering their interest in participating in the project.	Fax
9/5/05	Fax from John and Margaret, Site Officers from the Hunter Valley Aboriginal Corporation of Combined Council registering their interest in participating in the project.	Fax
3/5/05	Letter – Registration of Interest "Barkuma" Neighbourhood Centre	Letter
11/5/05	Fax – Registration of Interest of Mindaribba LALC	Fax
23/5/05	Letters of response, proposed survey method and request for formal proposal to provide services sent to Barkuma, Yarrawalk, Combined Council and MLALC.	Letters
25/5/05	Letter from Wonnarua Nation Aboriginal Corp requesting they be registered and consulted about the project	Email
25/5/05	Letter of response, proposed survey method and request for formal proposal to provide services sent to WNAC	Email
2/6/05	Request to provide Services received from Yarrawalk	Letter
17/6/05	Request to provide Service received from MLALC, Barkuma, WNAC and ANTEC	Fax
17/6/05	Fax from Upper Hunter Heritage Consultants requesting they be registered and consulted about the project	Fax
20/5/05	Fax from Hunter Valley Cultural Consultants requesting they be involved with the project	Fax
31/5/05	Registration of Interest from DEC NAHU	Letter
20/2/06	Letters of request to participate in additional survey work sent to WNAC, Barkuma, Yarrawalk, ANTEC and MLALC.	Letter
29/5/06	Draft AHIA reports distributed to registered stakeholders with request to provide written comments within 21 days	Express Post

8/6/06	Written comments on draft received from Barkuma Neighbourhood Centre	Letter
14/6/06	Written comments on draft received from Upper Hunter Heritage Consultants	Fax
19/7/06	FINALISATION OF AHIA REPORT	N/A

5.2 OUTCOMES OF CONSULTATION

The outcomes that have emerged to date as a result of consultation with the Aboriginal community regarding cultural heritage values of the study area and management of Aboriginal heritage during future development include the following general outcomes:

I. The registered stakeholders provided written and verbal endorsement of our methodology for survey and assessment of the subject land;
II. The registered groups requested consultation about, and involvement in, all stages of the Aboriginal heritage management process so that Aboriginal community views are considered in management outcomes;
III. The Aboriginal sites, potential deposits and traditional plant resources within the study area are culturally significant to the local Aboriginal community as an important demonstration of Aboriginal use and occupation of the landscape prior to European dispossession

Written comments on our draft AHIA report were received from Barkuma Neighbourhood Centre and Upper Hunter Heritage Consultants (their letters are included in Appendix 1). Written correspondence has not been forthcoming from the other registered stakeholders[27].

Specific comments received from Barkuma Neighbourhood Centre include:

- The amount of artefact material found during the survey strongly indicates further investigation is required; and
- Barkuma agree with the management recommendations of this report and support archaeological test excavation under a Section 87 permit.

[27] A period of 6 weeks has elapsed between distribution of draft reports to the registered groups and finalisation of this report.

Specific comments received from the Upper Hunter Heritage Consultants (UHHC) include:

- Surface collections should be undertaken for all artefacts located on the surface and a series of hand excavations on larger sites within the impact area;
- UHHC also recommended grader scrapes on other more vegetated areas with the option to stop for excavations if a site of significance is found; and
- UHHC would like to be involved in any future archaeological investigations at the site.

6.0 SIGNIFICANCE ASSESSMENT

6.1 BASIS FOR SIGNIFICANCE ASSESSMENT

Aboriginal sites are assessed in terms of three significance criteria: Archaeological (scientific), Cultural (Aboriginal) and Public Significance. These criteria recognise that Aboriginal sites are valuable in a number of ways. Namely:

- To the Aboriginal community as an aspect of their cultural heritage and as part of continuing traditions;
- To the broader community, for educational, historical and cultural enrichment values; and
- To the scientific community for potential research value.

The guidelines outlined in the *NSW National Parks and Wildlife* publication *Aboriginal Cultural Heritage: Standards and Guidelines Kit* provide the basis and background for the following discussion regarding evaluation of site significance.

6.2 ABORIGINAL CULTURAL SIGNIFICANCE

This area of assessment concerns the relationship and importance of sites to the Aboriginal community. Aspects of cultural significance include both people's traditional and contemporary links with a given site or landscape as well as an overall concern by Aboriginal people for sites and their continued protection.

Unmodified natural features in the landscape can signify sacred sites/places of significance. As such they are archaeologically invisible and can only be identified with the aid of Aboriginal interpretation. If such sites are known they may hold particular cultural significance to contemporary Aboriginal communities. Furthermore, sites of significance are not restricted to the period prior to contact with Europeans. Often events related to the Contact-period may be so important to local Aboriginal communities that they have become significant. If these events relate to a specific place in the landscape, then that place (i.e. the site) may become sacred or highly significant to the local Aboriginal communities.

The cultural (Aboriginal) significance is a matter for the local Aboriginal community. Please refer to Appendix 1 for correspondence received from the

Aboriginal community regarding the importance of the study area and their views regarding management of Aboriginal heritage during future development process.

The results of Aboriginal community consultation undertaken as part of this assessment indicate that the study area has cultural importance for a range of values.

6.3 PUBLIC SIGNIFICANCE

This category concerns a site's potential to educate people about the past. It also relates to the heritage value of particular sites as being representative examples of past lifestyles, why they are important, and why they should be preserved.

North Bellbird has some public significance for its ability to demonstrate aspects of past Aboriginal occupation and use across a typical Hunter Valley landscape. Public values include:

- Remnant and native vegetation within the study area has the potential for demonstrating aspects of traditional Aboriginal plant use and provides an environmental context for Aboriginal lifestyles prior to European colonisation;
- The "Group 1" sites identified on Limestone Creek have public significance for their ability to demonstrate aspects of Aboriginal settlement patterning, subsistence, economy and cultural life in the past. In that sense, the Aboriginal sites have some rarity in the local area because development and disturbance along the margins of Bellbird and Black Creek has destroyed many of the sites that would have originally been present; and
- Aboriginal sites on the urbanised fringe of Cessnock are a powerful demonstration of Aboriginal occupation and life prior to European colonisation. As such they show that a vibrant Aboriginal life existed in the area prior to dispossession.

6.4 SCIENTIFIC SIGNIFICANCE

The objective of undertaking Scientific significance assessment for a site is determine its research potential in terms of contribution to knowledge about the past. Criteria used to evaluate scientific potential include condition/integrity, representativeness and rarity.

Our assessment of the scientific significance of sites identified during the survey is described overleaf. Significance assessment is at the local level. None of the sites are considered to have rarity at a regional or state level.

6.4.1 Moderate-High Significance

NB7, NB9, NB10, NB11, NB12, NB15, NB16, NB17, NB18, NB22, NB23, NB24 & NB25 – Although there has been disturbance to upper portions of these sites caused by historic use and occupation, and stone artefacts have deflated through the soil profile, there appears to be some horizontal integrity at these sites (eg. site NB11 included conjoined flakes). On the horizontal plane, the artefacts at these sites appear to be in or near primary deposition. Although these sites have little potential to provide information about variation through time, they do have potential to provide information about variation across space.

These sites are representative of settlement patterning, site type and site composition across the Hunter Valley. The stone artefacts found at the sites (particularly the Group 1 sites), have potential to yield information about stone implement manufacturing techniques, finished tool forms and sourcing of stone. Analysis of retouch, use-wear and residues (if present) on stone implements may provide evidence about their uses, which in turn may indicate the nature of economic activities and resource use in the past. Evidence from the group 1 sites indicates possible local stone sourcing and "on-source" primary reduction. If excavation were undertaken at these sites, comparison of the results with excavations reported at Mt View Road and the Henry Kendall site, has the potential to add to our archaeological understanding of the area. Excavation of these sites would also allow more extensive testing of conclusions drawn from the nearby excavations, particularly in regard to conclusions about stone sourcing and procurement.

In summary, these sites are considered to have moderate-high archaeological significance at a local level for their horizontal integrity and potential to inform research questions about stone artefact reduction sequences, stone sourcing, economic activities associated with finished implements and settlement patterning. These sites have some local rarity given the history of landscape disturbance and have some research potential.

6.4.2 Low Significance

NB1, NB2, NB3, NB4, NB5, NB13 & NB21 – These sites comprise highly disturbed, sparse stone artefact scatters and are considered to have low research potential. Disturbance of the upper soil profile caused by historic use and occupation has heavily disturbed the shallow deposits across these areas and compromised their integrity. The vertical and horizontal integrity of artefacts found at these sites is

low and the taphonomy unclear (ie. the artefacts are not considered to be in-situ and may have been transported in by fluvial, colluvial and erosion processes).

In summary, these site are considered to have a low level of archaeological significance because of past land use disturbances which have compromised their integrity. They are typical of disturbed archaeological deposits commonly found on creek margins and agricultural landscapes and therefore have very little rarity.

6.4.3 Low-Nil Significance

NB6, NB8, NB14, NB19 & NB20 – These sites include isolated finds and an extremely disturbed small artefact scatter (NB 14). The isolated finds are essentially background scatter and are the result of either casual discard or dispersal of artefact scatters caused by historical disturbances and erosion processes. Their original provenance is unclear because the processes that led to their deposition at their present locations are unknown. As a result they have virtually no research potential because they have no potential to inform about past human behaviour they represent. Site NB 14 comprises two stone artefacts that have been washed into their present location with colluvial sediments moved downslope by erosion. Therefore the artefacts are not considered to be in-situ and therefore have virtually no potential to provide meaningful information about past Aboriginal use and occupation of the area.

In summary, these site are considered to have a very-low to nil archaeological significance because they have no integrity or rarity.

6.4.4 Potential Deposits

Assessment of the significance of sub-surface deposits would require controlled archaeological excavation. An assessment of scientific significance would take into account the condition, integrity, representativeness and rarity of finds recovered during excavation.

7.0 ABORIGINAL HERITAGE MANAGEMENT

7.1 PREAMBLE

The results of the site survey and predictive modelling indicate the study area is likely to contain significant evidence of Aboriginal use and occupation, including Aboriginal stone artefact surface scatters and sub-surface deposits. The distribution and nature of the archaeological resource is discussed in detail in Chapter 4. The significance of Aboriginal cultural deposits found at the site is assessed in Chapter 6.

The following sections provide a description of proposed rezoning, identification of development opportunities and constraints and a description of Aboriginal heritage management options. This information is critical in determining the best approach to managing Aboriginal heritage during future development processes.

7.2 RE-ZONING & FUTURE DEVELOPMENT

The North Bellbird land owners are preparing a re-zoning submission to assist Cessnock City Council with preparation of draft LEP for the subject land. The proposal is to re-zone the subject land for future mixed residential development. In support of their re-zoning submission, JPG are preparing a Master Plan and draft Development Control Plan (DCP).

The results of the Aboriginal heritage assessment and a range of environmental studies will be incorporated into Master Planning and into an evaluation of development constraints. At this early re-zoning planning stage, there are no detailed development design plans. Detailed heritage impact assessment will be undertaken during pre DA planning stages after the results of initial environmental and heritage studies have been considered and development design and master-planning has been finalised.

The following section identifies potential Aboriginal heritage constraints and opportunities regarding future development.

7.3 OPPORTUNITIES & CONSTRAINTS

7.3.1 Opportunities

The *Henry Kendall Retirement Village* holdings[28] have already been the subject of archaeological test excavation by *Insite Heritage* in accordance with a *Section 87* permit issued by DEC (the Henry Kendall holdings, Aboriginal sites and PADs are shown on figure 7.1 overleaf). The findings of the test excavation have been described in Section 3 of this report. The information derived from test excavation will form the basis for a *Section 90* application to DEC prior to development. As part of a future *Section 90* application, *Insite Heritage* have recommended[29]:

- Additional salvage excavation. The exact design of salvage to be determined once the artefact analysis is completed; and

- Retention of the confluence area of Bellbird Creek as a recreation area with no modifications to existing ground surfaces.

The strategy described above has been verbally endorsed by the Aboriginal representative groups involved in the project.

Although the additional salvage excavation work and recreation area recommended by *Insite Heritage* will represent a budgetary and lot yield constraint on future development of the Henry Kendall holdings[30], the advanced status of the Aboriginal heritage investigation and management process represents a potential time and cost minimisation opportunity.

A fairly intensive program of archaeological test excavation, assessment and Aboriginal community consultation has been completed. This work would not have to be repeated within the Henry Kendall holdings. This represents a significant reduction in costs that would have otherwise been associated with archaeological test excavation and consultation. It also represents a reduction in time constraints associated with DEC and Aboriginal community consultation processes associated with *Section 87* permit applications.

[28] Lot 1 DP1011544, Lot 1 DP 327580, Lot 211 DP 1012346 & Lot 212 DP 1012346
[29] Insite Heritage 2005, 9
[30] It should be noted that salvage would only be required once a DA is approved, therefore there would be some financial certainty regarding costs associated with the work.

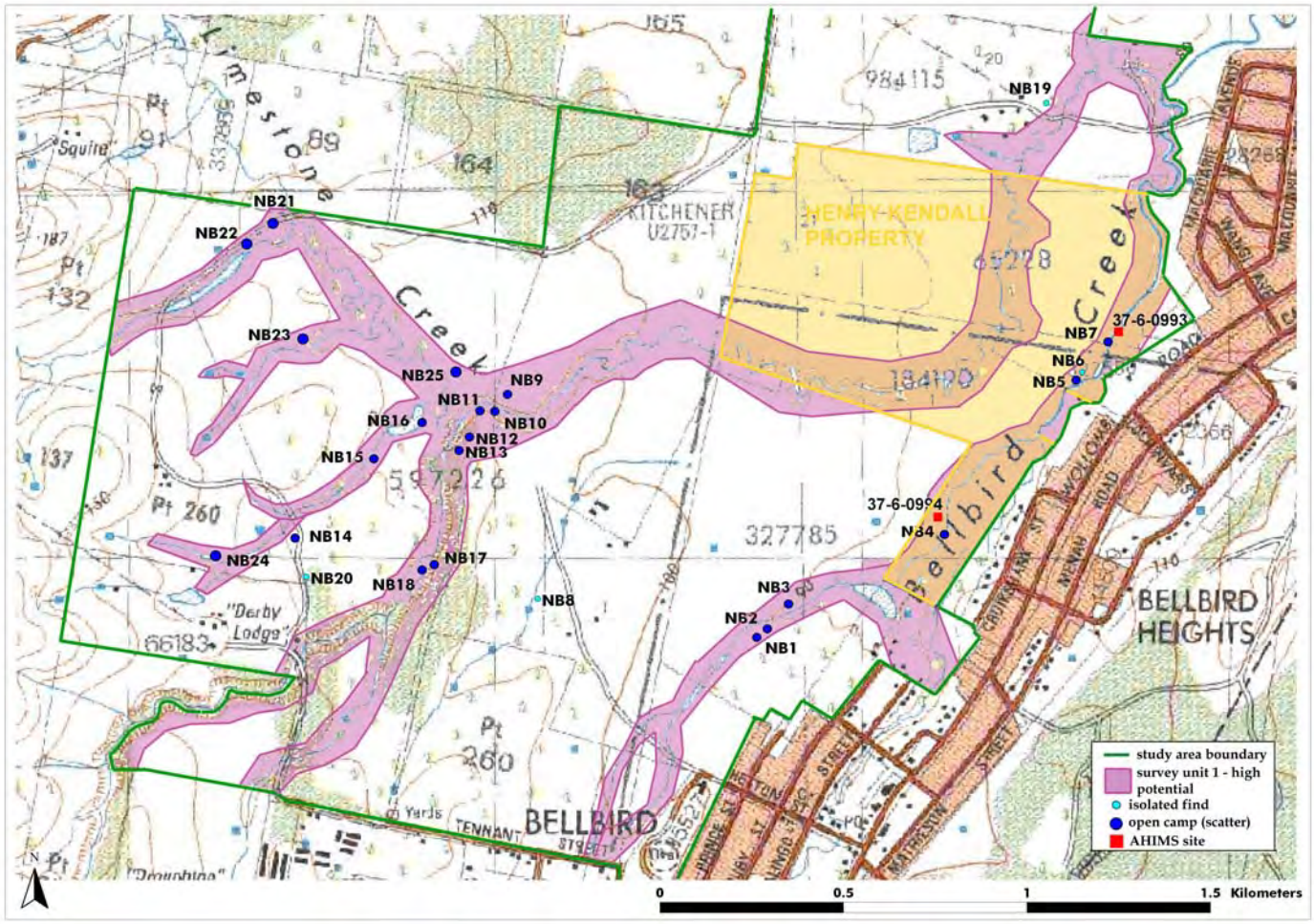


Figure 7.1 – Overlay of Henry Kendall holdings, Aboriginal sites and PADs.

7.3.2 Constraints

Any future development that may disturb or destroy Aboriginal sites/objects will require a *Section 90 Heritage Impact Permit* from the *Department of Environment & Conservation* (DEC). The survey identified 25 surface sites and although untested, it is likely that the majority of the study area contains sub-surface deposits of stone artefacts at varying densities. Any stone artefacts within the development area, regardless of significance, are protected and will require a *Section 90 permit* from DEC prior to any works that may disturb or destroy them.

It is DEC policy that *Section 90* applications will only be considered after consent authorities have provided conditional approval of a development application. Under the Integrated Development process, typically used for proposed development areas that contain Aboriginal sites and require *Section 90* approval from DEC, Council will request General Terms of Approval from DEC. The general terms of approval will state DEC's requirements for *Section 90* consent. The requirement for a *Section 90* permit will then be included as a condition of Council's development approval for the project. This usually means a *Section 90* permit must be approved by DEC and the requirements of the permit fulfilled prior to the development receiving a Construction Certificate from Council.

The inadequacies of effective survey coverage across the study area have already been discussed at length. The lack of ground surface visibility means the nature and extent of the archaeological resource could not be adequately assessed on the basis of surface survey. Therefore, in order to consider an application for a *Section 90* Permit, it is our opinion that DEC will require archaeological test excavation in accordance with *Section 87* of the *NP & W Act 1974* to accurately establish the nature, extent and significance of Aboriginal cultural heritage that may be impacted by development. DEC will require this information in order to consider proposals for conservation, salvage and/or consent to destroy Aboriginal heritage sites. Appropriate management will ultimately depend on the assessed cultural significance (to the Aboriginal community), public and scientific (archaeological) significance.

8.0 RECOMMENDATIONS

8.1 BASIS FOR RECOMMENDATIONS

The following recommendations are based upon:

- Requirements of the *National Parks and Wildlife Act of 1974 (as amended 2001);* in conjunction with
- Results of the archaeological assessment documented in this report; and
- Views and recommendations of the local Aboriginal community.

8.2 ABORIGINAL CONSULTATION

It is recommended that:

I. Liaison established with the registered Aboriginal community stakeholder groups should be maintained during the development process until all issues arising in relation to management of Aboriginal cultural heritage have been resolved;

II. Any future Aboriginal heritage investigations, assessments and/or Applications under *Section 87 / Section 90* of the National Parks & Wildlife Act 1974 should be undertaken in accordance with procedures set out in *DEC's Interim Requirements for Community Consultation 2005*; and

III. A copy of this report should be forwarded to the following registered stakeholder groups and they should be invited to provide written comment on the cultural significance of the study area and approaches to management of Aboriginal heritage within the study area:

Wonnarua Nation Aboriginal Corporation
ATTN: Robert Lester (Chairperson)
PO BOX 3066
SINGLETON DELIVERY CENTRE, NSW, 2330

Mindaribba Local Aboriginal Land Council
ATTN: Rick Griffiths
PO BOX 453
MAITLAND, NSW 2320

Barkuma Neighbourhood Centre
ATTN: Deb Dacey (Executive Program Manager)
76 Lang St
KURRI KURRI, NSW, 2327

ANTEC
ATTN: Margaret & John Matthews
31 Mitchell St
MUSWELLBROOK, NSW, 2333

Yarrawalk
ATTN: Scott Franks
PO BOX 906
MUSWELLBROOK, NSW, 2333

Hunter Valley Cultural Consultants
ATTN: Christine Matthews & Trevor Archbold
40 Humphries St
MUSWELLBROOK, NSW, 2333

Upper Hunter Heritage Consultants
ATTN: Darrel Matthews
33 Adams St
MUSWELLBROOK, NSW, 2333

8.3 ARCHAEOLOGICAL MANAGEMENT

Recommendations for management of Aboriginal heritage during future development are set out below.

I. In our opinion there are no Aboriginal heritage constraints on re-zoning the subject land because Aboriginal sites, objects and cultural values within the subject land can be managed as part of any future Development Application processes as recommended below.

II. a) Any future development options that impact Aboriginal sites or objects (including the sites recorded during the survey described in this report[31]) will require a *Section 90 Heritage Impact Permit* from the *Department of Environment & Conservation* (DEC);

[31] As required by Section 91 of the NP & W Act 1974, site recording forms will be submitted to and registered on the *NSW Aboriginal Heritage Information Management System.*

b) In order to consider an Application for a *Section 90* permit, in our opinion DEC will require archaeological test excavation in accordance with *Section 87* of the *NP & W Act 1974* to establish the nature, extent and significance of Aboriginal cultural heritage that may be impacted by development;

c) The proponent should arrange for a suitably qualified archaeologist to prepare an Application to DEC for a *Section 87 Preliminary Research Permit*. The permit will cover archaeological test excavation within areas of future development that may impact Aboriginal sites or objects (approval by DEC may take up to 8 weeks and there is a $ 100 fee for the application);

e) The test excavation methodology should provide for an adequate and systematic sample of all landforms within the subject land, preferably employing 5 metre by 1 metre trenches regularly spaced (at least every 50 metres) along a series of topo-sequence transects; and

f) The results of test excavation would form the basis for considering whole-of-development Aboriginal heritage management options that may include *Consent to Destroy*, archaeological salvage excavation and/or conservation areas.

III. If any Aboriginal burials are found during archaeological excavation, or at any time during the development process, excavation work must cease immediately. DEC should be notified and advice sought before work can re-commence. It should be noted that both *Section 87* and *Section 90* permits do not allow the excavation and removal of Aboriginal burials;

IV. In preparing a draft LEP and master-plan, the Proponent should make allowance for a conservation outcome for Aboriginal heritage, as this may be required as a condition for a future Section 90 Consent from DEC. The most suitable portion of the study area for conservation (also corresponding with ecological conservation priorities) is **shown on figure 8.1 overleaf**. This area is <u>likely</u> to contain the most intact Aboriginal heritage with the highest archaeological (research) significance within the study area. **<u>All or part of this area may be considered for conservation</u>**.

V. Two copies of the final version of this report should be sent to the DEC Northern Aboriginal Heritage Unit (NAHU). DEC NAHU address is:

DEC Northern Aboriginal Heritage Unit
ATTN: Claire Everett (Archaeologist)
PO BOX 6150,
COFFS HARBOUR, NSW, 2450.

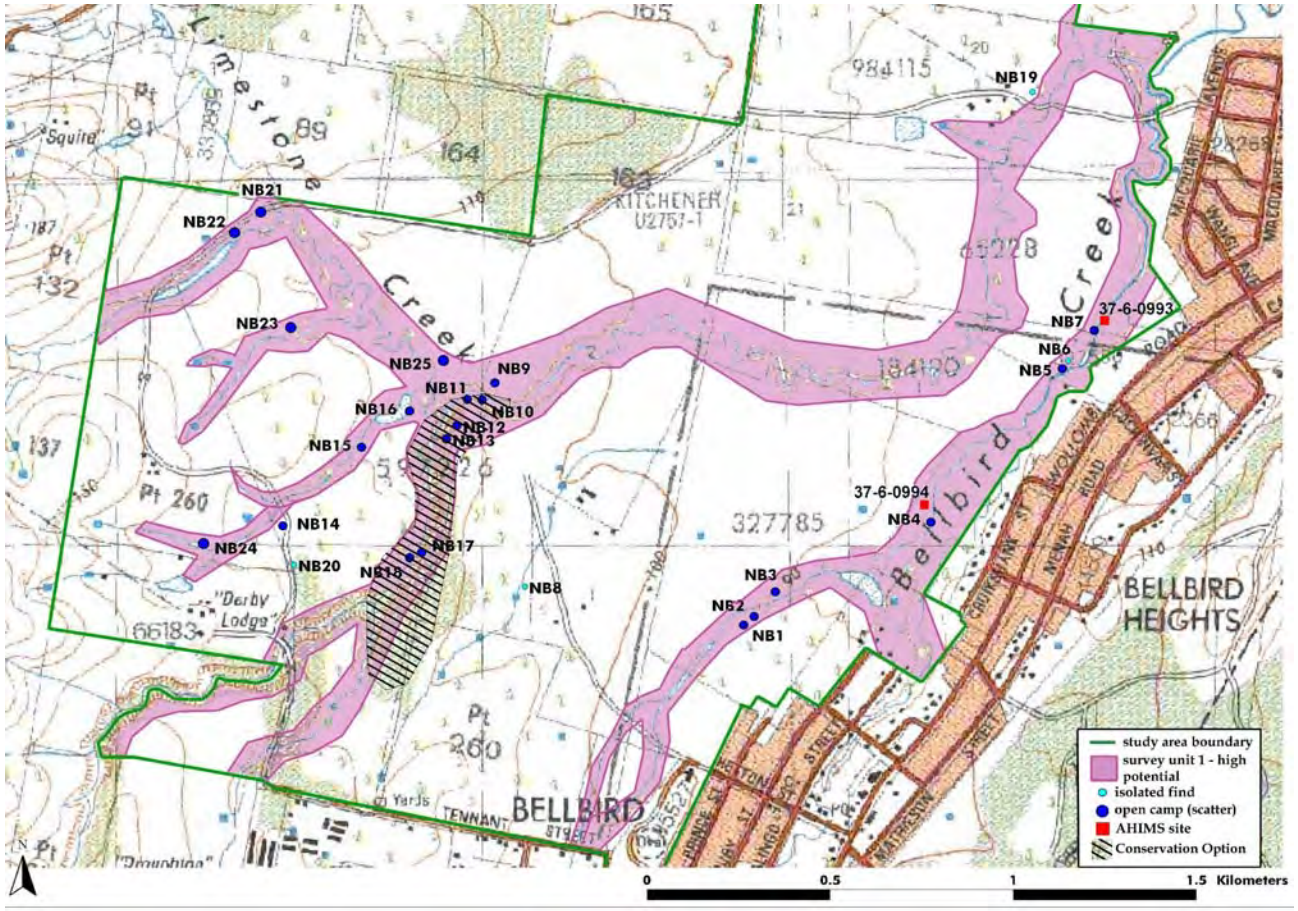


Figure 8.1 – Conservation outcome priority area (marked with black stripe shading) **63**

REFERENCES

Baker (1992)	N. Baker, *Stone Artefact Assessment and Analysis - Recording Techniques and Methodology*. Report to the Hunter Valley Aboriginal Sites Assessment Project. 1992
Baker (1994)	N. Baker, *Moffat's Swamp Dune: Preliminary Report on Archaeological Site Salvage, Testing and Artefact Analysis*. Report to RZM Mines Pty Ltd. 1994
Barber (1993)	M. Barber, *Proposed Mt Owen Extension, Archaeological Survey of Betty's Creek*. Report to Hunter Valley Coal Corp Pty Ltd.
Burramoko (1998)	Burramoko Archaeological Services, *Preliminary Archaeological Investigations of the Proposed Rothbury Country Resort Development Area, near Cessnock, NSW*. Report to New Horizons International Ltd. 1998.
ERM (2000)	ERM (2000) *Rothbury Temporary Substation; Archaeological Assessment*. Report to Energy Australia. 2000.
ERM (1997)	ERM Mitchell McCotter (1997) *Main Road 220 Review of Environmental Factors*. Report to Cessnock City Council. 1997.
Hiscock (1986)	P. Hiscock, "Technological Change in the Hunter Valley and its Implications for the Interpretation of Late Holocene Change in Australia." *Archaeology in Oceania* 21 (1):40-50. 1986
Hughes (2004)	P.J. Hughes, *A Geomorphological Assessment of Lot 101 Mt View Road, Cessnock, Hunter Valley, NSW*. Report to Stedinger Associates. 2004.
Hughes (1984)	P.J. Hughes, *An Overview of the Archaeology of the Hunter Valley, its Environmental Setting and the Impact of Development*. NSW National Parks and Wildlife Service, Hunter Valley Region Archaeology Project Stage 1, Vol. 1. 1984
Insite Heritage (2005)	Insite Heritage, *Archaeology Test Excavation Results and Management Plan*. Report to Henry Kendall Group Limestone Creek. 2005.
Koettig (1986a)	M. Koettig, *Assessment of Archaeological Sites Along the Proposed Singleton to Glennies Creek Water Pipeline Route and the Reservoir Site at Apex Lookout, Hunter Valley, NSW*. Report to Department of Public Works. 1986
Koettig (1986b)	M. Koettig, *Test Excavations at Six Locations Along the Proposed Pipeline Route Between Singleton and Glennies Creek Dam, Hunter Valley, NSW*. Report to Department of Public Works. 1986
Kovak & Lawrie (1991)	Kovak, M. & Lawrie J.W. *Soil Landscapes of the Singleton 1:250,000 Sheet*. Soil Conservation Service of N.S.W., Sydney. 1991.
Kuskie & Kamminga (2000)	P. Kuskie & J. Kamminga, *Salvage of Aboriginal Archaeological Sites in Relation to the F3 Freeway Near Lenaghans Drive, Black Hill, NSW*. Report to NSW Roads and Traffic Authority. 2000

Matthei (1995)	L E Matthei, *Soil Landscapes of the Newcastle 1:100 000 Sheet*. Dept of Land & Water Conservation including the Soil Conservation Service of NSW, Sydney. 1995
Moore (2000)	M.W. Moore, *Technology of Hunter Valley Microlith Assemblages, NSW*. In Australian Archaeology No. 51 pp. 28-39. 2000.
NSW NPWS (1997)	NSW National Parks and Wildlife Service. . *Aboriginal Cultural Heritage: Standards and Guidelines Kit.* Sydney. 1997
Richardson (2005)	N. Richardson, *Basic Analysis for Section 90 Application, Henry Kendall Retirement Village, Limestone Creek*. Report to Insite Heritage. 2005.
Speight 1990	J.G. Speight, *Landform.* In*: 'Australian soil and land survey. Field handbook'* Second edition (Eds. RC McDonald, RF Isbell, JG Speight, J, Walker, MS Hopkins). Inkata Press, Melbourne. 1990

APPENDICES

Appendix 1 – *Aboriginal Community Correspondence*

Appendix 2 – *Site Records*

Appendix 3 – *Survey Recording Sheet*

Appendix 4 – *Notification advertisement placed in the Cessnock Advertiser*

Appendix 1 – ***Aboriginal Community Correspondence.***

Barkuma Neighbourhood Centre Inc.

Meaning – To HELP & ASSIST

ABN: 58 290 659 800

8th June 2006

Archaeological & heritage management
Solutions Pty Ltd
Attn: Jim Wheeler
349 Annandale Street
Annandale NSW 2038

Re: North Bellbird Investigation Area – Draft Aboriginal Heritage Assessment.
Bellbird is considered to be one of the culturally significant areas in the Cessnock LGA. Given the rapid growth in the area and the future plans for the next 5 years, we are continuing to lose sites in the area due to development, we need to look at what will be left for future generations .The amount of artefact material that was found during the surface surveys strongly indicates further investigation is required. We agree with the management of Aboriginal heritage during any future development at the site. We also agree to archaeological test excavation under section 87 Permit.

Yours sincerely

A.M.H

Ann-Marie Hickey

76 Lang Street
KURRI KURRI
NSW 2327

Ph: 49371094 or 49364999
Fax: 49364449
Email: barkumanc@hotmail.com
www.aboriginalhunter.com/barkuma

14-JUN-06 WED 10:07 WANARUAH LALC FAX NO. 0265425377 P. 1

Upper Hunter Heritage Consultants

160 Sydney street
Muswellbrook
NSW 2333
PH: 0265413532
FAX: 0265413533
MOBILE: 0422910898
EMAIL: UHHC@BIGPOND.COM

ABN: [illegible]

Attention: Jim Wheeler
AHMS Fax: (02)95557005

Regarding: North Bellbird Investigation Area.

Mr Jim Wheeler,
Thank you for the copy of the report sent to us, I have read your report and U.H.H.C. Would recommend that Surface Collections are to be undertaken of all artifacts located on the surface and a serious of Hand excavations on larger sites within the impact area. U.H.H.C. Would also like to recommend that there be some grader scrapes on other more vegetated areas with option to stop for excavations to proceed if a site of significance is found.

U.H.H.C. Would like to be involved with all aspects works that are to be done on this project.

Thank you
Darrel & Melissa Matthews



Appendix 2 – ***Site Records.***

NB 1 **Open Artefact Scatter**



GPS (GDA94): 6363922N, 0342866E
Survey Unit: Unit 1
Location: SE margin of Bellbird Creek.
Aspect/Slope: South / Flat.
Dist to Water: < 10 metres.

Description: Small artefact scatter across an area 10m x 5m. The scatter consists of 1 red silcrete core (2 flake scars; cortex on dorsal surface), 2 red silcrete flakes (1 with bulb detached, no cortex; 1 with cortex on dorsal surface) and 1 yellow silcrete core (with two flake scars).

Soil: Thin remnant of loose sandy soil over B horizon clay subsoil.

Sub-surface Potential: Very Low – A horizon soils almost entirely removed.



Figure 5.7 - Artefacts recorded at Site NB1. (a) yellow silcrete core (b) red silcrete flake

NB 2 **Open Artefact Scatter**

GPS (GDA94): 6363953N, 0342881E

Survey Unit: Unit 1

Location: Alluvial flat SE of Bellbird Creek.

Aspect/Slope: None / Flat.

Dist to Water: 100 metres.



Description: Artefact scatter across an area 15m x 15m. The scatter consists of 5 red silcrete primary flakes and 1 chert flake.

Soil: Remnant thin A2 horizon soil overlying B horizon clay. The area has been exposed and partly disturbed by rilling.

Sub-surface Potential: Moderate – A1 removed by erosion, A2 partially intact but disturbed by rill (gully) erosion and cattle.

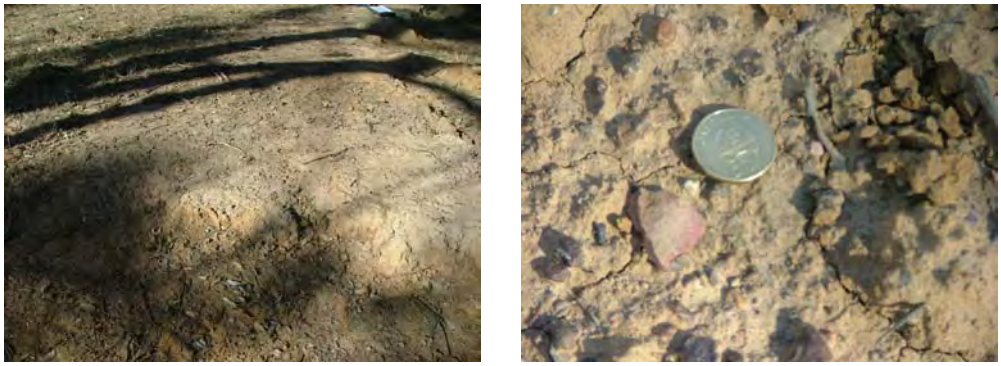


Figure 5.8 - Artefacts recorded at Site NB2. (a) ground exposure (b) silcrete flake

NB 3 **Open Artefact Scatter**

GPS (GDA94): 6364049N, 0342899E

Survey Unit: Unit 1

Location: North bank of Bellbird Creek.

Aspect/Slope: South / Flat.

Dist to Water: 2 metres.



Description: Artefact scatter across an area 15m x 15m. The scatter consists of 1 fine-grained red silcrete flake (no cortex), 1 pale red chert flaked piece (no cortex) and 1 red silcrete flake.

Soil: B horizon orangey-yellow clay. The area has been exposed and partly disturbed by erosion and cattle.

Sub-surface Potential: Low – eroding B horizon, A horizon topsoil removed by erosion, artefacts deflating.



Figure 5.9 - Artefacts recorded at Site NB3. (a) red silcrete flake (b) red chert flake piece

NB 4 (37-6-0994) Open Artefact Scatter



GPS (GDA94): 6364239N, 0343324E
Survey Unit: Unit 1
Location: West bank of Bellbird Creek.
Aspect/Slope: None / Flat.
Dist to Water: 5 metres.

Description: Artefact scatter across an area 5m x 10m on cattle tracks. The scatter consists of 1 pink silcrete macro-flake, 1 silcrete piece (non-diagnostic) and 1 buff rhyolite flake core (with positive bulbar scar surface). Site previously recorded by *Insite Heritage 2002*, register as AHIMS # 37-6-0994.

Soil: A2 / B interface. The area has been exposed and partly disturbed by cattle.

Sub-surface Potential: Moderate-Low – loss and disturbance of upper portions of A horizon through sheet/rill erosion and cattle.



Figure 5.10 - Artefacts recorded at Site NB4. (a) red silcrete piece (b) red silcrete macro flake and c) rhyolite flake-core

NB 5 **Open Artefact Scatter**

GPS (GDA94): 6364658N, 0343683E

Survey Unit: Unit 1

Location: West bank of Bellbird Creek.

Aspect/Slope: South-east / Steep Creek bank adjacent.

Dist to Water: 5 metres.



Description: Very small artefact scatter across an area 1m x 1m. The scatter consists of 1 rhyolite core (heavily weathered with 3 flake scars and cortex) and 1 red silcrete debitage spall (less than 10 mm).

Soil: Artefacts exposed on remnant sandy A horizon soil, pedestalled and held together by roots of a dead tree.

Sub-surface Potential: Very low – original topsoils surrounding dead tree have been completely removed by erosion.



Figure 5.11 - Artefacts recorded at Site NB5. (a) exposure of soil pedestalled between tree roots (b) rhyolite core

NB 6 **Isolated Find**

GPS (GDA94): 6364681N, 0343700E

Survey Unit: Unit 1

Location: West bank of Bellbird Creek.

Aspect/Slope: North-east/steep, terraced bank.

Dist to Water: 10 metres.



Description: 1 red silcrete modified flake with negative and positive bulbar scar surfaces. Possible use-wear chipping on long chord. Approx 20 % cortex, 2 platforms.

Soil: Artefact eroded out of A2 soil exposed on creek gully edge.

Sub-surface Potential: Moderate – back from gully face A horizon soils appear to be partially intact, though probably disturbed by cattle.



Figure 5.12 - Artefact recorded at Site NB6. (a) red silcrete flake (b) eroding profile

NB 7 (37-6-0993) Open Artefact Scatter



GPS (GDA94): 6364763N, 0343770E
Survey Unit: Unit 1
Location: West bank of Bellbird Creek. Site is bisected by a road cutting east-west across the site.
Aspect/Slope: North-east/moderately steep.
Dist to Water: 10 metres.

Description: Large artefact scatter across an area 5m x 20m. Site previously recorded by *Insite Heritage 2002* (AHIMS # 37-6-0993). The scatter includes:

- 1 banded chert pale yellow-brown tertiary flake;
- 1 red silcrete linear blade core (2 negative bulbar scars);
- 2 red silcrete debitage flakes;
- 1 large red silcrete secondary flake;
- 1 cream/red chert debitage flake;
- 1 weathered yellow-red silcrete flake (bulb detached); and
- 1 pale grey/yellow silcrete core (4 negative scars).

Soil: A2 / B interface on eroding margin of creek bank terrace.
Sub-surface Potential: Moderate – across intact ground back from eroding terrace edge and road cutting to the north.



Figure 5.13 - Artefact recorded at Site NB6. (a) red silcrete flake (b) eroding profile

NB 8 **Isolated Find**



GPS (GDA94): 6364064N, 0342216E

Survey Unit: Unit 2

Location: On an earthen embankment for a dam, to the west of an old disused dairy.

Aspect/Slope: North-east / Steep on embankment, gentle gradient on mid slope landform.

Dist to Water: 350 metres to Limestone Creek.

Description: 1 buff-yellow tuff or indurated mudstone flake.

Soil: Embankment fill.

Sub-surface Potential: Nil – the dam wall comprises fill pushed or imported to make dam.

NB 9 (GROUP 1) Open Artefact Scatter

GPS (GDA94): 6364619N, 0342134E

Survey Unit: Unit 1

Location: North bank of Limestone Creek overlooking lagoon – opposite NB 10.

Aspect/Slope: South-west / Moderate (terraced).

Dist to Water: 10 metres.



Description: Artefact scatter across an area 20 m x 20 m. The scatter consists of 1 chert modified primary flake (30 % cortex), 1 quartz (bi-polar) flake, 1 red silcrete exhausted core (4 negative scars), 1 buff rhyolite debitage flake and 1 red silcrete snapped flake.

Soil: Eroding A2 on upper gully terrace margin.

Sub-surface Potential: Moderate above eroding gully face.



Figure 5.14 - Artefacts recorded at Site NB9. (a) artefacts from NB9 (b) soil profile exposed on upper gully terrace

NB 10 (GROUP 1) Open Artefact Scatter



GPS (GDA94): 6364573N, 0342099E

Survey Unit: Unit 1

Location: South bank of Limestone Creek. Overlooking oxbow and lagoon, opposite NB 9 and adjacent to NB 11.

Aspect/Slope: North/moderately steep.

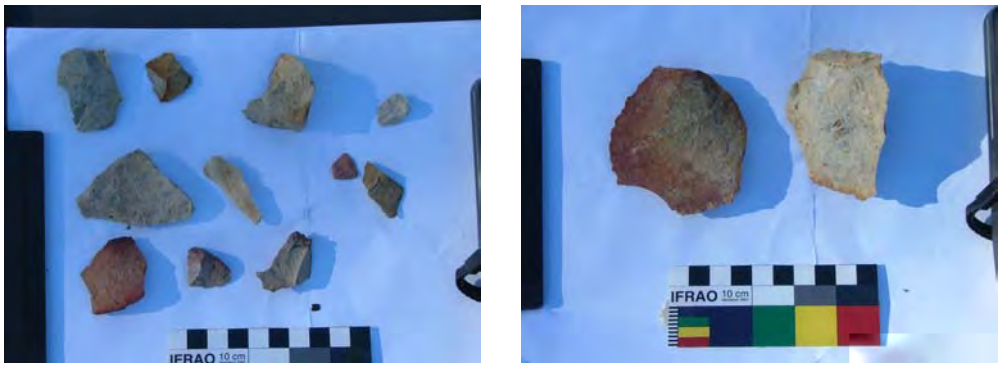
Dist to Water: 15 metres.

Description: Large artefact scatter across an area 20m x 10m. The scatter includes in excess of 50 flakes, pieces, cores, retouched flakes, backed artefacts and hammerstones, representing all stages of the reduction sequence (see figure 5.15 overleaf). This was clearly a large stone tool manufacturing site from primary reduction through to retouched implements.

A wide range of raw materials were represented, including: silcrete, chert, tuff/indurated mudstone, quartzite and rhyolite. Some cores had a high percentage of cortex. Cortex observed on flakes and cores indicates the source material was primarily river-rolled pebbles and cobbles. Observations about cortex and the wide range of raw materials represented suggest opportunistic (and possibly local) extraction of cobbles and pebbles in alluvial gravel deposits.

Soil: A2 / B interface on eroding margin of upper creek bank terrace. Approx 100 – 150 mm of A2 remnant soil, which is being actively eroded.

Sub-surface Potential: Moderate – No vertical integrity as stone has deflated down through soil profile. Possibly some horizontal integrity.



a) b)



b) d)



e) f)

Figure 5.15 - Artefacts recorded at Site NB10. (a) assorted flakes/cores/pieces; rhyolite and chert (b) rhyolite primary flakes, flake on left with denticulate retouch (c) large primary pebble core with two negative decortication scars (d) profile showing thin remnant A2 over B horizon clay (e) in-situ tuff flake in A2 soil – exposed by erosion (f) pebble hammer-stone with use-wear pitting.

NB 11 (GROUP 1) Open Artefact Scatter



GPS (GDA94): 6364574N, 0342059E

Survey Unit: Unit 1

Location: South of Limestone Creek channel on an 'island' of land between Limestone Ck and an oxbow to the south. Approx 30 m west of NB 10.

Aspect/Slope: Moderate / North.

Dist to Water: 10 metres.

Description: Small Artefact scatter across an area 10m by 5m. The scatter comprises 1 yellow chert core (heavily worked with multiple flake scars), 3 red chert flakes (conjoined), 1 yellow rhyolite flake (bulb detached) and 1 red silcrete flake.

Soil: Eroding thin A horizon over clay B horizon.

Sub-surface Potential: Moderate - Stone has probably deflated and been disturbed by cattle traffic. Conjoining flakes demonstrates some horizontal integrity to local artefact scatters.



Figure 5.16 - Site NB11. (a) artefacts from NB11 (b) 3 chert flakes conjoined.

NB 12 (GROUP 1) Open Artefact Scatter



GPS (GDA94): 6364503N, 0342030E
Survey Unit: Unit 1
Location: South-east of Limestone Creek on a cattle track leading up from valley.
Aspect/Slope: North-west / Moderate simple slope.
Dist to Water: approx 100 metres.
Description: Artefact scatter across an area 15m by 4m. The scatter consists of at least 20 flakes, cores and pieces. Raw materials include quartzite, rhyolite and silcrete. Examples include 1 buff/yellow rhyolite core with 3 primary flake scars and 55% river pebble cortex, 1 rhyolite primary flake with hinge termination and a quartzite core.
Soil: Eroding lower A2 at gravel pan.
Sub-surface Potential: Stone has probably deflated to gravel pan at A2/B interface and been disturbed by cattle traffic. Max 100mm of remnant eroding A2.



Figure 5.17 - Artefacts recorded at Site NB12. (a) artefacts from NB12 (b) large rhyolite core (left) and in-situ flake (right).

NB 13 **Open Artefact Scatter**



GPS (GDA94): 6364466N, 0342002E
Survey Unit: Unit 2
Location: South-east of Limestone Creek on exposed mid-slope ground.
Aspect/Slope: North / Steep.
Dist to Water: approx 110 metres.

Description: Artefact scatter across an area 5m by 10m. The scatter includes:

- 1 large silcrete nodule with 2 small negative flake scars;
- 1 red/white chert flake;
- 1 large quartzite core with 2 flake scars;
- 5 rhyolite flakes;
- 1 quartz flaked piece;
- 1 rhyolite core with at least 2 flake scars; and
- 1 yellow/brown chert flake with retouch.

Soil: Eroding lower A2 at gravel pan.

Sub-surface Potential: Low - stone has probably deflated to gravel pan at A2/B interface and been disturbed by cattle traffic.



Figure 5.18 - Artefacts recorded at Site NB13. (a) artefacts from NB12 (b) silcrete nodule with flake scars.

NB 14 **Open Artefact Scatter**



GPS (GDA94): 6364229N, 0341555E
Survey Unit: Unit 2
Location: Adjacent to western study area boundary fence, approx 120 m south of Limestone Creek tributary.
Aspect/Slope: North-west / Moderate.
Dist to Water: approx 120 metres.
Description: Artefact scatter across an area 10m x 10m. The scatter includes 2 chert secondary/primary flakes.
Soil: Recent colluvial slope wash below area of rill erosion.
Sub-surface Potential: Very Low – highly disturbed slope wash that includes glass bottles etc.



Figure 5.19 - Site NB14. (a) slope wash (b) chert flakes.

NB 15 **Open Artefact Scatter**

GPS (GDA94): 6364444N, 0341770E

Survey Unit: Unit 1

Location: upper bank terrace south side of Limestone Creek tributary.

Aspect/Slope: North-west / Moderate.

Dist to Water: 10 metres.



Description: Small artefact scatter across a 50 metre exposure on margin of creek bank terrace. The scatter includes 1 tuff primary flake, 1 chert debitage flake and 1 quartzite pebble core.

Soil: Artefacts eroding from remnant A2 on margin of creek bank terrace.

Sub-surface Potential: Moderate back from eroding face - 50-100mm remnant A2.



Figure 5.20 - Site NB15. (a) exposed profile (b) artefacts from NB15.

NB 16 **Open Artefact Scatter**



GPS (GDA94): 6364543N, 0341901E
Survey Unit: Unit 1
Location: South bank of Limestone Creek tributary, approx 100m upstream of confluence.
Aspect/Slope: West-north-west/ Steep.
Dist to Water: 15 metres.
Description: Small artefact scatter across a 10 metre exposure on margin of creek bank terrace. The scatter includes 1 secondary rhyolite flake and 1 secondary rhyolite core.
Soil: Artefacts eroding from remnant A2 on margin of creek bank.
Sub-surface Potential: Moderate – back from eroding face - 50-100mm of remnant A2.



Figure 5.21 - Site NB16. (a) exposed profile (b) artefacts from NB16.

NB 17 **Open Artefact Scatter**



GPS (GDA94): 6364156N, 0341934E
Survey Unit: Unit 1
Location: On eroded vehicle track that leads down to Limestone Creek.
Aspect/Slope: North-west / Steep.
Dist to Water: 20 metres.

Description: Artefact scatter across a 10m by 2m exposure on vehicle track. The scatter includes 1 orange silcrete flake, 2 grey-yellow rhyolite flakes, 1 yellow-orange chert flake, 1 yellow silcrete core (in situ), and 1 white quartz piece.

Soil: Interface between A2 and B horizons on gravel pan.

Sub-surface Potential: Moderate to High – in areas of intact ground, artefacts likely to be present under slope wash.



Figure 5.22 - Artefacts from NB 17.

NB 18 **Open Artefact Scatter**



GPS (GDA94): 6364142N, 0341901E
Survey Unit: Unit 1
Location: On eroded vehicle track that leads down to Limestone Creek.
Aspect/Slope: South / Slight incline.
Dist to Water: 10 metres.

Description: Small artefact scatter across a 1m by 1m exposure on vehicle track. The scatter includes 2 grey silcrete tertiary flakes with no cortex.
Soil: Sandy alluvium adjacent to creek.
Sub-surface Potential: Moderate potential adjacent to track on elevated flat ground flanking the creek.



Figure 5.23 - Artefacts from NB 18.

NB 19 **Isolated Find**



GPS (GDA94): 6365415N, 0343602E
Survey Unit: Unit 4
Location: On eroded vehicle track that leads down to Limestone Creek. West side of Creek
Aspect/Slope: East / Gentle.
Dist to Water: 110 metres.
Description: Isolated buff silcrete blade core on edge of vehicle track.
Soil: Remnant A2 and B exposed on track.
Sub-surface Potential: Very low – highly disturbed track.



Figure 5.24 - Artefacts from NB 19.

NB 20 **Isolated Find**



GPS (GDA94): 6364124N, 0341586E

Survey Unit: Unit 2

Location: Western margin of study area adjacent to fence.

Aspect/Slope: East / Gentle.

Dist to Water: > 200 metres.

Description: Isolated chert flake on ants nest.

Soil: Mixed A and B horizon comprising ants nest.

Sub-surface Potential: Very low, disturbed soils associated with ants nest. May be PAD on adjacent areas.

NB 21 **Open Artefact Scatter**



GPS (AGD 84): 6364894N, 0341391E

Survey Unit: Unit 1

Location: South of confluence of Limestone Ck and a 2nd order tributary. Adjacent to right of way at cattle fences (see picture to right).

Aspect/Slope: South-south-east/ Moderate.

Dist to Water: 30 metres.

Description: Artefact scatter along a section of 4WD track 20 m x 3 m leading down to tributary of Limestone Ck. The scatter consists of 2 small banded chert flakes with less than 5 % cortex (one with platform, bulbar surface and possible use-wear chipping) AND 1 silcrete primary flake with 20 % cortex and bulbar surface.

Soil: Eroding A2 and washed in sediment on 4WD track.

Sub-surface Potential: Low - Moderate adjacent to track and beneath sediment washed onto track surface.



Figure 5.25 - (a) banded chert flakes from NB21; (b) sub-soil exposed by erosion on the track.

NB 22 **Open Artefact Scatter**

GPS (AGD 84): 6364838N, 0341320E

Survey Unit: Unit 1

Location: South of Limestone Ck and south-west of NB21. Located on right of way - unsealed road.

Aspect/Slope: South-east/ Gentle.

Dist to Water: 45 metres.



Description: Artefact scatter along the right of way unsealed road, approx 40 m (nth-sth) x 4 m (est-wst). The scatter includes 1 tuff micro-blade core (with at least 6 negative scars and 30 % weathered cortex – ie not from river pebble !) and 1 tuff secondary flake (with platform, bulbar surface and 1 negative scar). The material appeared to be in-situ – exposed on compact but rilled A horizon soil exposed on right of way road.

Soil: Remnant A2 exposed on right of way road.

Sub-surface Potential: Moderate, particularly adjacent to the road on unmodified surfaces.

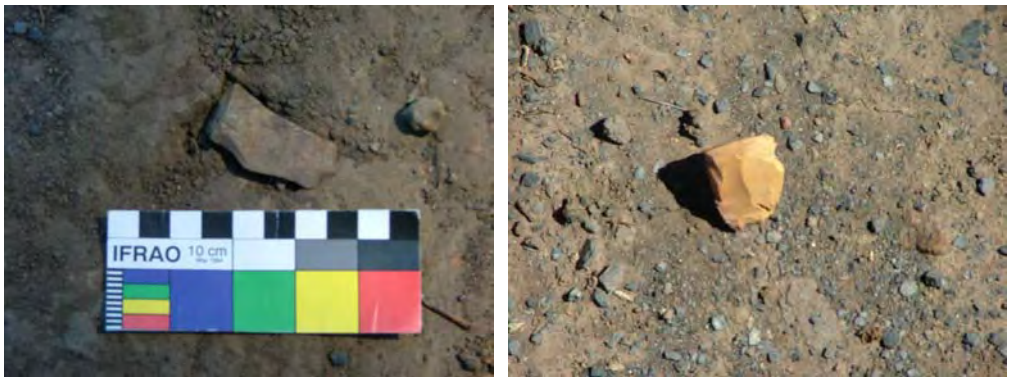


Figure 5.26 – Artefacts from NB22 - (a) tuff secondary flake (b) tuff core (probably an exhausted core).

NB 23 **Open Artefact Scatter**



GPS (AGD 84): 6364579N, 0341473E
Survey Unit: Unit 1
Location: South of Limestone Ck and west of a 1st order drainage line that runs into Limestone Ck. The artefacts are exposed on a cattle track.
Aspect/Slope: South-east/ Gentle.
Dist to Water: 15 metres (ephemeral source), 200 m (Limestone Ck).

Description: Artefact scatter on A horizon soils exposed on a cattle track. The scatter includes 2 small tuff spalls and 1 red silcrete backed artefact, trimmed on distal ends and thick in section (resembling a very small elouera).

Soil: Exposed A horizon soil on a cattle track.

Sub-surface Potential: Moderate

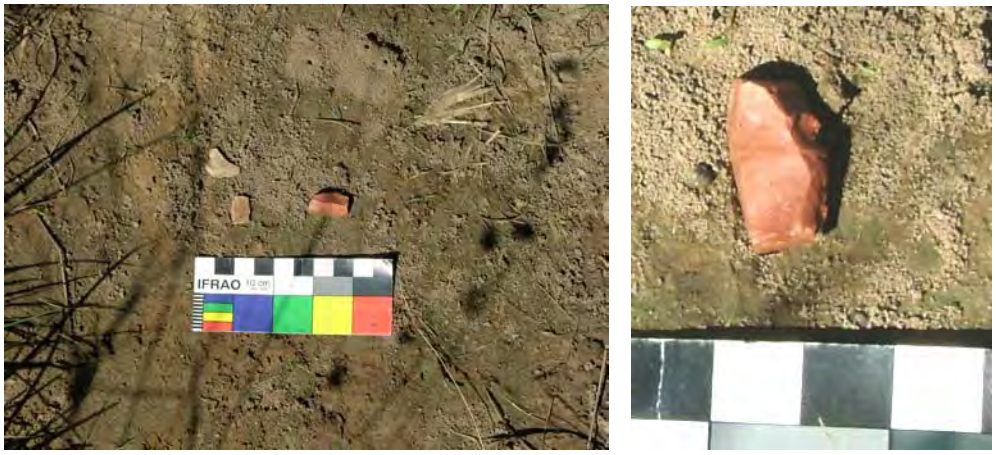


Figure 5.27 – Artefacts from NB23 - (a) artefacts exposed on cattle track; (b) detail of backed silcrete artefact.

NB 24 **Open Artefact Scatter**



GPS (AGD 84): 6363989N, 0341235E

Survey Unit: Unit 1

Location: On eroding bank of ephemeral drainage line adjacent to the *Derby Lodge* Property boundary.

Aspect/Slope: North / Moderate side slope.

Dist to Water: 5 metres (ephemeral source), 400 m (permanent source).

Description: Artefact scatter on remnant A2 horizon soil exposed by erosion scald on bank of ephemeral drainage line. The scatter includes 1 quartzite bipolar blade core with three negative flake scars; and 1 rhyolite primary flake with platform, bulbar surface and plunging termination (0 % cortex).

Soil: Exposed on very thin remnant A2 horizon soil above B horizon clay. The remnant A horizon is approx 50 mm thick.

Sub-surface Potential: Low

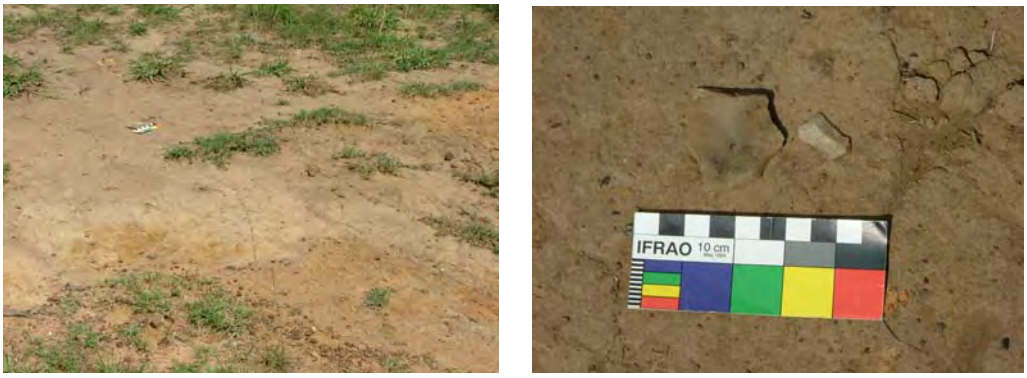
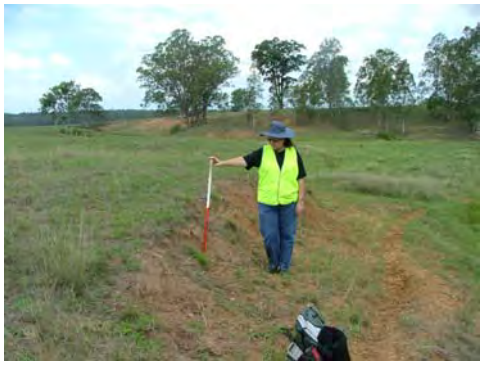


Figure 5.28 (a) thin remnant topsoil exposed at NB24; (b) artefacts found at NB24.

NB 25 **Open Artefact Scatter**



GPS (AGD 84): 6364489N, 0341889E

Survey Unit: Unit 1

Location: North bank of Limestone Creek, approx 100 m upstream of the large confluence.

Aspect/Slope: South-west / Flat (but terraced).

Dist to Water: 5 metres.

Description: Artefacts eroding our of A horizon profile exposed by creek bank erosion. The assemblage includes:

- 1 buff rhyolite secondary flake. 2 negative scars. 1 positive bulbar surface. 20 % cortex;
- 1 buff tertiary flake with 40 % cortex);
- 1 red rhyolite piece with 60 % weathered rind cortex (not river pebble source !!);
- 1 red tertiary rhyolite flake;
- 2 tuff debitage spalls;
- 1 red rhyolite linear blade (snapped) – possible backed artefact blank; and
- 1 red chert spall.

Soil: 300mm of grey silty loam A horizon topsoil overlying red-brown light clay B horizon subsoil. Soils exposed in eroding bank profile.

Sub-surface Potential: Moderate-High



Figure 5.29 (a) exposed soil profile; (b) artefacts found at NB25.

Appendix 3 – ***Survey Recording Sheet.***

North Bellbird - Aboriginal Archaeological Survey

SURVEY RECORDING SHEET

Survey Area	Transect	Site Name	Recorded By	Date

Site Type (circle)

OPEN CAMP ISOLATED FIND SCARRED TREE PAD GRIND-GROOVE

Description of Site

Checklist	
1) site size (visible area) / dimensions	
2) site contents	
3) distribution of artefacts	
4) soil description	
5) ground visibility %	
6) subsurface potential	
7) condition / land use	

Location

GPS Northing :		GPS Easting :	
Site Location Description :			
Landform:	Aspect:	Distance to Water:	Slope:

Brief description of finds (artefact types, rock types etc.)

Appendix 4 – Notification advertisement in the *Cessnock Advertiser* 27/4/2005.

NOTIFICATION & REGISTRATION OF ABORIGINAL INTEREST

AHMS Pty Ltd is undertaking an Aboriginal heritage assessment of land known as "North Bellbird" between Tennant St Bellbird, Bellbird Creek and Mount View Rd, Mountview. The study is being undertaken to inform the future possible rezoning of the land. As part of the assessment process, AHMS wish to consult with the local Aboriginal community in accordance with *Dept of Environment & Conservation* requirements for community consultation. The project may also require approvals under Part 6 of the *National Parks and Wildlife Act* 1974.

AHMS invites Aboriginal groups or individuals to register their interest in Aboriginal cultural heritage management during the project. Registrations must be received by the 12th May 2005. Please register in writing to:

Jim Wheeler
AHMS Pty Ltd.
349 Annandale St
ANNANDALE
NSW. 2038.

If you have any enquiries please contact Jim Wheeler or Fiona Leslie on (02) 9565 4000.

European Heritage Assessment

for the

North Bellbird Investigation Area.

May 2006

STEDINGER ASSOCIATES

PO Box 42, THE OAKS, NSW 2570

Tel.(02) 4657 2480, Fax.(02) 4657 1597, Mobile 0408 649 484

www.stedinger.com.au

For

Insite Planning and Engineering

on behalf of the Johnson Property Group Pty Ltd.

PO Box 93, CESSNOCK, NSW 2325

© Stedinger Associates.

Disclaimer: This document is intended solely for the use of the Client identified on this cover sheet and the regulatory agencies that are directly involved in this specified project. The report is only intended for the purpose for which this information has been prepared. Stedinger Associates undertakes no duty to and accepts no responsibility to any other party who may rely upon this document. Any representation, statement, opinion or advice, expressed or implied in this document is made in good faith but on the basis that Stedinger Associates is not liable (whether by reason of negligence, lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement or advice referred to above.

CONTENTS.

EXECUTIVE SUMMARY. 1

1. INTRODUCTION. 3
   - 1.1. Study Brief and Methodology. 3
   - 1.2. Site Boundaries and Location. 3
   - 1.3. Heritage Status. 4
   - 1.4. Author Identification. 5

2. THE PROPOSED DEVELOPMENT. 7

3. HISTORICAL CONTEXT. 9
   - 3.1. Land Grants and Farming. 9
   - 3.2. Vineyards. 11
   - 3.3. Coal Mining. 12
   - 3.4. Historical Themes. 17

4. SITE INSPECTION. 23
   - 4.1. Farming Landscape and Residences. 23
   - 4.2. Heritage in the Vicinity. 26
   - 4.3. Historical Archaeological Potential. 29
     - 4.3.1. Primary Industries 29
     - 4.3.2. Slaughter House 29
     - 4.3.3. The Red House 31
     - 4.3.4. Bellbird Mine 31
   - 4.4. Views (the Vineyards District) 32
   - 4.5. Photographs. 35

5. HERITAGE SIGNIFICANCE. 45

6. IMPACT OF THE PROPOSED SUBDIVISION. 49
   - 6.1. Impact. 49
   - 6.2. Mitigating measures. 50

7. STATUTORY OBLIGATIONS. 51
   - 7.1. Statutory Obligations. 51
   - 7.2. Cessnock Local Environmental Plan 1989 (updated 24 December 2004). 51
   - 7.3. Hunter Regional Environmental Plan 1989 (Heritage) 53
   - 7.4. The NSW Heritage Act, 1977. 53
   - 7.5. Development Control Plan No.28. 54

8. RECOMMENDATIONS. 56

BIBLIOGRAPHY. 58

APPENDIX 1. 60
   - Heritage Assessment Criteria. 60

APPENDIX 2. 62
   - Excavation Permit Application Form (s140). 62

EXECUTIVE SUMMARY.

This report on European heritage was commissioned by Insite Planning and Engineering on behalf of the Johnson Property Group Pty Limited. It is an assessment of European heritage within and adjacent to the investigation area and examines the impact of the proposed development on this heritage. The subject land comprises an area of 496 hectares in Bellbird, NSW, and is referred to in this report as the North Bellbird Investigation Area (refer to 1.2.).

It is envisaged that the future development of the site will include provision for a mixture of development and conservation, including: a mix of residential environments, a commercial and retail precinct, social and community infrastructure such as schools, community and recreational facilities and open space, additional infrastructure such as road access, public transport, integrated cycle and pedestrian linkages, reticulated service infrastructure and fire trails, conservation of quality remnant vegetation and rehabilitation of degraded riparian corridors to provide habitat linkages.

The proposed development is considered to have a potential impact on items of European environmental heritage. Specifically, these items are: the slaughterhouse, the site of the Red House, a cottage (c.1910) on Mt View Road (Lot 141, DP986905) and views to the Vineyards District. The farmhouse at 254 Wollombi Road is not considered to be a significant heritage item nor is its associated structures, its site or setting. No other items of European heritage were located during the present study.

In the vicinity of the subject land, the altered miners cottages and other residences are not considered to be significant heritage items that will be impacted by the development.

Indeed, most houses adjacent to the survey area, whether early or late twentieth century, consist of hardiplank cladding with aluminium windows. Similarly, cottages on the outskirts of the survey area are residential (medium density). The proposed development is also to be residential (mixed). As such, the development is not considered to impact heritage in the vicinity. Rather, it is likely to merge as an extension of the area's existing residential use.

In particular, the following recommendations for the proposed rezoning and development are included, among others, in Chapter 6 of this report.

- The proposed development should not be prevented on European heritage grounds;
- Ruins and potential subsurface remains exist at the Slaughterhouse site shown in Figure 4.1 (Lot 1, DP597226). These relics are older than 50 years and have the potential to contribute significant information on the local industries of Bellbird. Should excavation or other works involving ground disturbance be undertaken at the site of the slaughterhouse, then an excavation permit under section 140 of the NSW Heritage Act 1977 will be required from the NSW Heritage Office prior to these works. Standing and surface structures or features at this site should be thoroughly recorded prior to their removal.
- Should remains of the Red House be uncovered then an appropriate excavation permit should be sought from the NSW Heritage Office under section 140 of the NSW Heritage Act 1977.
- Should buildings be erected along the north half of Cruckshank Street (Lot 1, DP1011544), on the east side of Lot 1 (DP349452) or in Carmichael Park, the Client should consider continuing single storey structures so as to help preserve views to the Vineyards District.
- With regard to significant views in Lot 1 (DP196460), Lots 1 and 2 (DP66183), Part Lot 2 (DP597226), and Lot 3 (DP597226), the Client should note the requirements of *Cessnock Development Control Plan No.28* – Vineyards District. 1999 (As amended 1st February 2002).
- The cottage along Mt View Road (Lot 141, DP986905) should be retained as an intact example of a residence from c.1910 and to preserve an aesthetic heritage element in the area.

1. INTRODUCTION.

This report was commissioned on the 12th of April 2005 by Insite Planning and Engineering on behalf of the Johnson Property Group Pty Limited. The subject land comprises an area of 496 hectares in Bellbird, NSW, and is referred to in this report as the North Bellbird Investigation Area (refer to 1.2.). A European Heritage Assessment report was requested by the Client as part of a rezoning and development submission to Cessnock City Council.

1.1. Study Brief and Methodology.

This report has been prepared in accordance with the NSW Heritage Management System described in the *NSW Heritage Manual* and follows procedures and approaches outlined in *Statements of Heritage Impact and Assessing Heritage Significance*.[1] It supports the principals and practices outlined in the ICOMOS Burra Charter and has regard for statutory requirements. This Heritage Impact Assessment:

1. reviews the history of the subject land and its wider environment;
2. describes and documents the site, its cultural landscape, structures and potential subsurface remains;
3. examines the heritage significance of the subject land;
4. includes a description of the proposed development and assesses the impact of the rezoning and possible associated future works on heritage significance; and
5. proposes measures to mitigate or minimise negative impacts on identified heritage values.

1.2. Site Boundaries and Location.

The subject land proposed for rezoning (the North Bellbird Investigation Area) is located west of the town of Bellbird, 3 kilometres southwest of the Cessnock town centre. It lies in the local government area of Cessnock, west of Wollombi Road and Bellbird Creek, south of Mount View Road and north of Tennant Street. The Mount View Vineyards are elevated on the slopes of the Broken Back Range to the west and northwest. These hills are raised some 100 metres above the area proposed for rezoning.

---

[1] NSW Heritage Office and Department of Urban Affairs and Planning. 1996. *NSW Heritage Manual.* HO/DUAP, Sydney. *Statements of Heritage Impact* (update, 2002).
Assessing heritage significance (update 2001).
Marquis-Kyle and Walker. 1996. *The Illustrated Burra Charter.* Australia ICOMOS Inc.

The former Bellbird Colliery lies 0.6 kilometres to the southeast (from Carmichael Park).

Encompassing an area of 496 hectares, the site is properly described as: Part Lot 1 and Lot 2 (DP66183), Lot 1 (DP167004), Lot 1 (DP196460), Lot 1 (DP196997), Lot 1 (DP327580), Lot 1 (DP327785), Lot 1 (DP328497), Lot 1 (DP328498), Lot 1 (DP329071), Lot 1 (DP349452), Lot 261 (DP524058), Lots 1, 2 and 3 (DP597226), Lots 2 and 3 (DP624793), Lots 10 and 11 (DP806584), Part Lot 51 and Lot 52 (DP807540), Lot 3 (DP810827), Lots 10 and 11 (DP815485), Part Lot 13 (DP880374), Lot 141 (DP986905), Lots 1 and 2 (DP1011544), Lot 210 and Lot 211 (DP1012346), and Lot 212 (DP1053307).

1.3. Heritage Status.

Heritage registers which afford items statutory protection include: the State Heritage Register and heritage schedules in Local Environmental Plans and State or Regional Environmental Plans. Neither the subject land nor items upon or in the immediate vicinity of the subject land have been entered on the State Heritage Register or listed as items of environmental heritage in Schedule 3 of the Cessnock Local Environmental Plan 1989 (updated 24 December 2004). The Hunter Regional Environmental Plan 1989 (Heritage) applies, among other local government areas, to the City of Cessnock. Neither the subject land nor items upon or in the immediate vicinity of the subject land have been listed in Schedule 1 (Items of State environmental heritage), Schedule 2 (Items of regional environmental heritage), Schedule 3 (Items of local environmental heritage), Schedule 4 (Items requiring further investigation) or Schedule 5 (Conservation Areas) of the Hunter Regional Environmental Plan 1989 (Heritage). While the Bellbird Hotel is listed in Schedule 3 of the Hunter Regional Environmental Plan 1989 (Heritage), this item is located on Wollombi Road and is not in the immediate vicinity of the subject site. Similarly, the Bellbird Colliery is listed in Schedule 4 but does not occur in the immediate vicinity of the subject site.

Non-statutory registers include the National Trust Register and the Register of the National Estate, with the exception of Commonwealth owned items. The subject land, items upon and/or in the vicinity of the subject land have not been listed by the Australian Heritage Commission (Register of the National Estate). Both the *City of Cessnock Heritage Study* (1994) and the National Trust (NSW) have listed similar

conservation areas to the north and northwest in the Pokolbin district. These areas are referred to as the Pokolbin Vineyards Cultural Landscape and the Pokolbin Landscape Conservation Area.[2] As defined in Figures 1 and 2 of Development Control Plan No. 28, the 'Vineyards District' includes a small portion of the study area to the west and southwest (refer to Chapter 7 of this report).[3]

1.4. Author Identification.

Stedinger Associates inspected the area proposed for rezoning and its surrounds between the 14th and 19th of April 2005 and the 5th and 6th of March 2006. This report was written by Dr. Louise Steding, Mr Gerald Steding and Dr. Jill Mizzi.

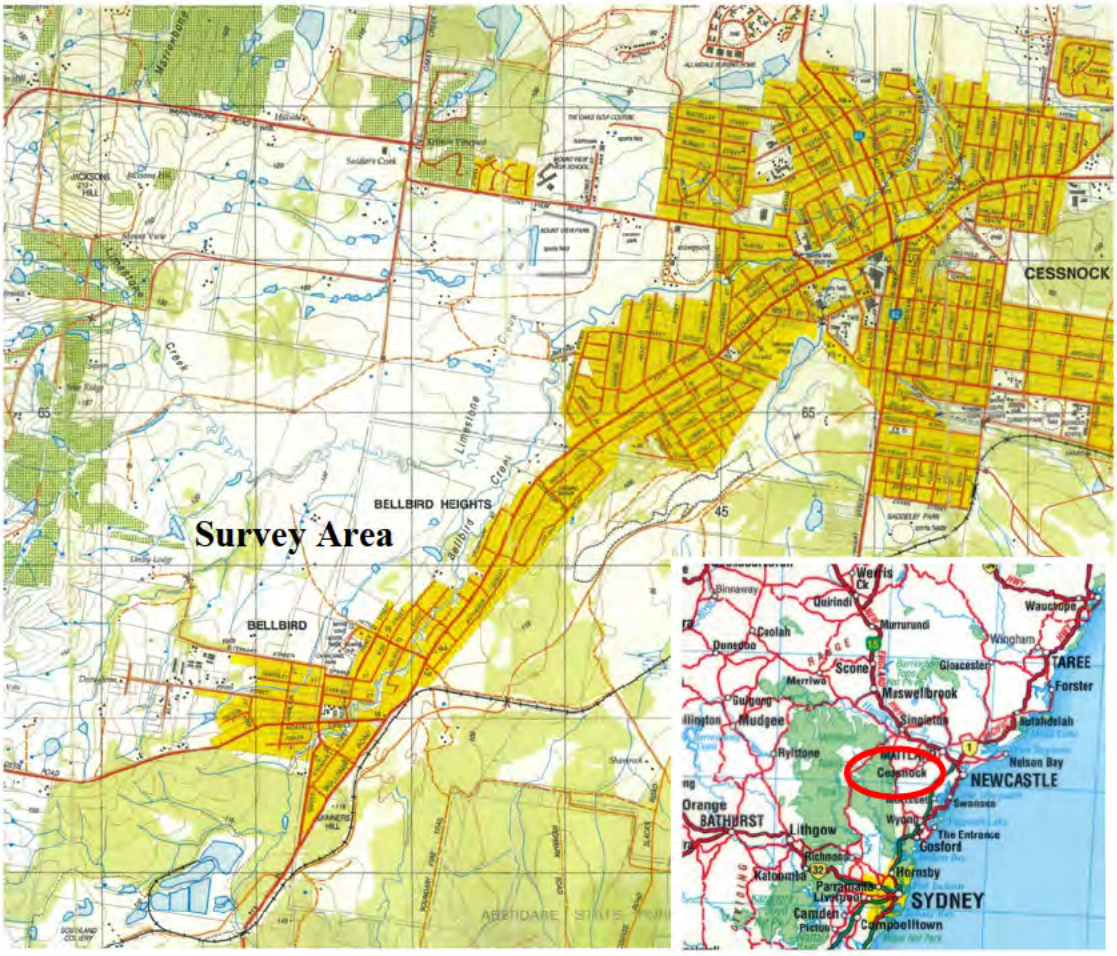


Figure 1.1. Location of the survey area west of Bellbird, NSW.

[2] Pike, Penelope and Meredith Walker & Assoc. 1994. *City of Cessnock Heritage Study*. Vol.2 p.7.
[3] *Cessnock Development Control Plan No.28* – Vineyards District. 1999 (As amended 1st February 2002).

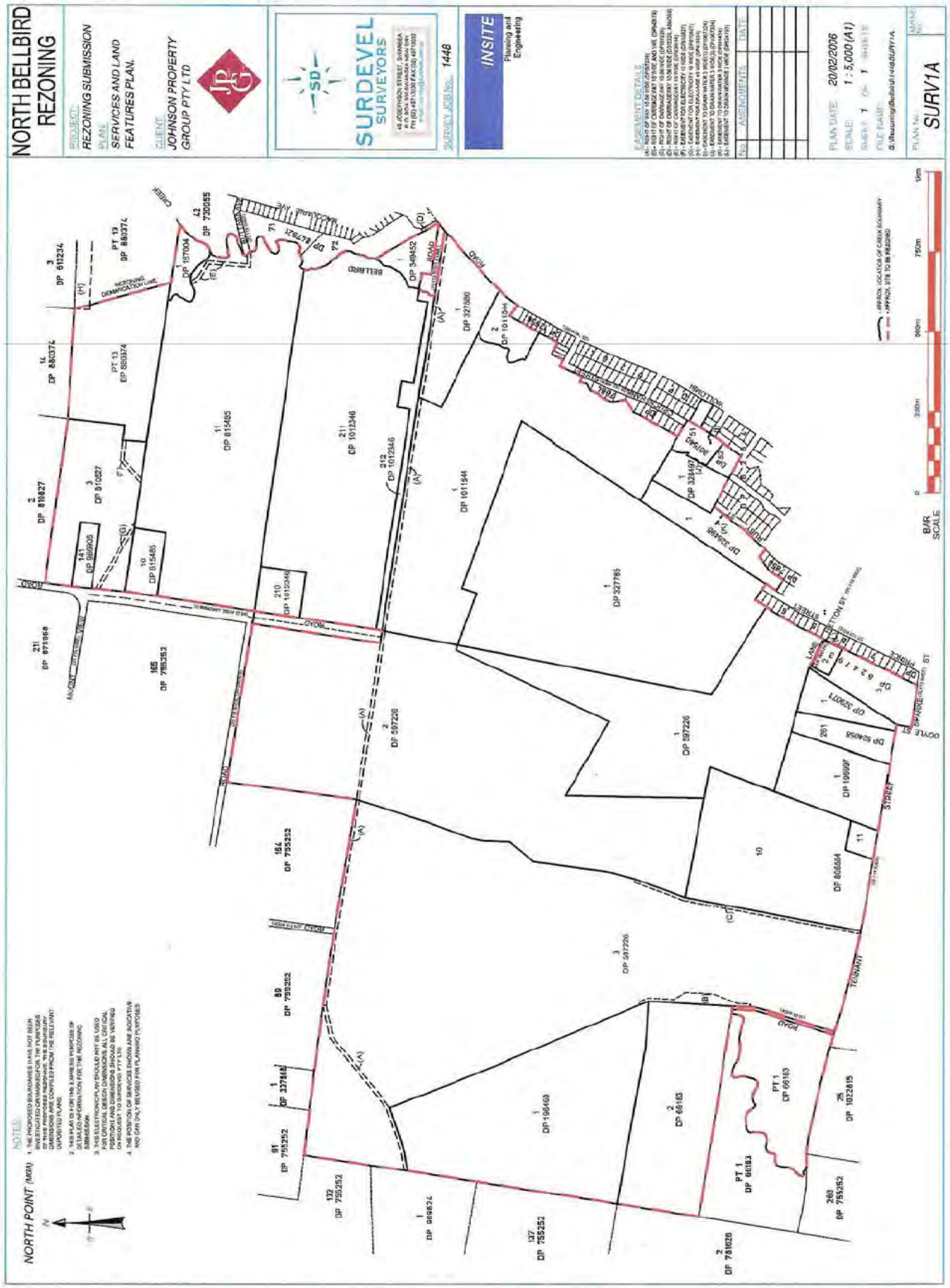


Figure 1.2. North Bellbird Investigation Area. Lot descriptions included in rezoning. By Surdevel Surveyors, 20 February 2006 (refer also to Figure 2.1).

2. THE PROPOSED DEVELOPMENT.

The subject site, comprising 496 hectares, is currently zoned Rural 1(a) and Rural 1(v) and is proposed for rezoning and development. This land has been identified in the Cessnock City Wide Settlement Strategy for rezoning to mixed residential densities, the rationalisation of open space and consideration of environmental features. The present proposal for rezoning is to be supported by a master plan, a Draft Development Control Plan for the site and a Draft Section 94 Contributions Plan for submission to Cessnock City Council.

The survey area is predominantly an open rural landscape. It also includes 16 buildings (mostly modern residential), several machinery and storage sheds and the ruins of a small slaughterhouse. The proposed development will involve the incorporation or demolition of the houses as well as excavation works for road construction, new footings and service trenches. Recommendations for the site of the slaughterhouse are made in Chapter 7 of this report. It is envisaged that the future development of the site will include provision for a mixture of development and conservation, including: a mix of residential environments, a commercial and retail precinct, social and community infrastructure such as schools, community and recreational facilities and open space, additional infrastructure such as road access, public transport, integrated cycle and pedestrian linkages, reticulated service infrastructure and fire trails, conservation of quality remnant vegetation and rehabilitation of degraded riparian corridors to provide habitat linkages.



Figure 2.1. Plan of the area proposed for rezoning, Bellbird (refer also to Figure 1.2).

3. HISTORICAL CONTEXT.

The following history of the subject land and its surrounds provides an historical context for the present assessment. This overview is an important framework with which to identify historical themes, assess the significance of the site, and locate and interpret potential subsurface remains.

3.1. Land Grants and Farming.

Europeans settled land in Greater Cessnock as early as anywhere in the Hunter Valley. In 1821, Benjamin Blackburn purchased 400 acres of land near Kurri Kurri and Pelaw Main.[4] Five years later, John Campbell was promised the 2560 acres known as "Cessnock" in the valley of Black Creek.[5] This private estate was passed to David Campbell in 1834. Governor-Major General Richard Bourke issued the grant to David Campbell on the 26th of October 1834.[6] After 1831 land was progressively auctioned "along the Quarrabolong creek system to the south, the Mulbring and Wallis Creek systems to the east, Swamp and Deep Creeks to the northeast and Bellbird and Black Creeks to the west and north."[7] The area known as "Bellbird Heights" occupies part of a 640 acre land grant promised before 1831 but not issued until 1839 to Andrew Sparke (a man noted in 1832 as a director of the Bank of Australia).[8] The town now known as Bellbird lies within a 1929 acre land grant called 'Doyle Brook estate'. The original grantee, Edward Carlton Atkinson, apparently relinquished his land grant. Promised the land by Sir Ralph Darling, Atkinson did not take possession, as authorised, on the 1st of November 1830.[9] Instead, in 1844, the land was sold for £320 to Cyrus Matthew Doyle of Midlorn near Maitland (the Irish-born son of Andrew Doyle, a convict transported to Australia for supporting the Irish rebellions of 1798 and 1801).[10] Doyle Brook was 1

[4] Parkes, W.S., Comerford, Jim and Lake, Max. 1979. *Mines, Wines and People: A History of Greater Cessnock*. Council of the City of Greater Cessnock. p.23.
[5] Parkes, W.S., Comerford, Jim and Lake, Max. 1979. *Mines, Wines and People: A History of Greater Cessnock*. Council of the City of Greater Cessnock. p.23.
[6] Bloomsfield, W.A.G. 1954. *Cessnock, 1826-1954: A History of the Greater Cessnock District with a special supplement on the Catholic Parish of Cessnock*. p.23.
[7] Pike, Penelope and Meredith Walker and Associates. 1994. *City of Cessnock Heritage Study*. Vol. 2. Inventory of Heritage Items. p.5.
[8] Cessnock City Council. 1974. *Historical Tours in Greater Cessnock.* Eagle Print. p.2.
Bloomsfield, W.A.G. 1954. *Cessnock, 1826-1954: A History of the Greater Cessnock District with a special supplement on the Catholic Parish of Cessnock*. p.26.
[9] Bloomsfield, W.A.G. 1954. *Cessnock, 1826-1954: A History of the Greater Cessnock District with a special supplement on the Catholic Parish of Cessnock*. p.26.
[10] Cessnock City Council. 1974. *Historical Tours in Greater Cessnock.* Eagle Print. p.2

mile wide (e-w) by 3 miles long (n-s) and joined the southwest corner of the 'Cessnock Estate'. Doyle's estate includes the subject survey area.

About 41 per cent of the landholders who purchased their private estates in the region between 1821 and 1856 were English born.[11] Approximately 23 per cent were Scottish, 16 per cent Irish and 18 per cent had been born in Australia.[12] Those settlers who purchased land along the creeks found that they had rich soil and ample water for agriculture. Many grew wheat, maize and vegetables and, in the early years of the 1830s and 1840s they harvested tobacco. But the tobacco industry faltered when the quality of local tobacco couldn't compete with that of imported supplies.[13] Many of the small farms, which were the rule in the area, kept a few cattle for dairying and established vineyards.[14]

The early settlers who purchased the poorer land back from the creeks and rivers, found it unsuitable for agriculture. Instead they exploited the region's timber resources, including iron bark, blue gum and cedar.[15] Landowners were able to supply wood to local saw mills; Hinchcliffe's at Millfield and George Brown's sawmill at Cessnock.[16] The region prospered and, by 1850, Cessnock could boast a small village with a police station, lock-up and inn. Through the 1860s and 1870s the timber industry worked feverishly to supply materials for the construction of the Great Northern Railway.[17] However, by the closing decades of the century the quality of the region's remaining

[11] Parkes, W.S., Comerford, Jim and Lake, Max. 1979. *Mines, Wines and People: A History of Greater Cessnock*. Council of the City of Greater Cessnock. p.23.
[12] Parkes, W.S.., Comerford, Jim and Lake, Max. 1979. *Mines, Wines and People: A History of Greater Cessnock*. Council of the City of Greater Cessnock. pp.23-24.
[13] Heritage Office and Department of Urban Affairs and Planning. 1996. *Regional Histories of New South Wales*. p.38.
[14] Bloomfield, W.A.G. 1954. *Cessnock, 1826-1954: A History of the Cessnock District with a special supplement on the Catholic Parish of Cessnock*. p.40.
[15] Andrews, Brian J. 2000. *An Independent Look at the Pioneering Days of the Coalfields*. No.7. For the Coalfield Heritage Group Inc. p.13;
Heritage Office and Department of Urban Affairs and Planning. 1996. *Regional Histories of New South Wales*. p.41.
[16] Bloomsfield, W.A.G. 1954. *Cessnock, 1826-1954: A History of the Greater Cessnock District with a special supplement on the Catholic Parish of Cessnock*. p.63.
[17] Andrews, Brian J. 2000. *An Independent Look at the Pioneering Days of the Coalfields*. No.12. For the Coalfield Heritage Group Inc. p.3.

timber was poor and the industry went into decline.[18] Landowners on the less fertile sections of land relied increasingly on the cattle they had introduced in the mid-1860s.[19]

3.2. Vineyards.

For some of Cessnock's farmers, there was a more profitable option; vineyards. David Campbell's original Cessnock land grant was subdivided into farms and allotments in 1853. Patrick O'Neill purchased 236 acres of this land in 1868 for £28 (blocks 19 and 20, land through which the Wollombi Road passes).[20] Like many other Cessnock farmers, O'Neill initially grew wheat, tobacco and a number of mixed crops, including vines. When he found that the vines grew a good grape he began to produce his own wines and, in 1890, opened a wine shop on the Wollombi Road. This wine shop became a regular stopover for wagoners travelling along the Great Northern Road. Patrick J. O'Neill's Wine Saloon (built by Patrick senior's son, Patrick junior) stands today on the Wollombi Road. It is dated 1917; possibly a replacement for the earlier wine shop situated on the same or adjoining site.[21]

The Bouffier family was also well known for its contribution to Cessnock's early wine-making industry. They planted a vineyard and built a wine cellar in the 1860s.[22] But wineries were established even earlier in the nearby Pokolbin area from the late 1850s.[23] The rich volcanic soils and relatively mild climate in the Polkobin Hills were ideal for viticulture. Even today the area is considered significant for "its evidence of the early viticulture industry and from which many of the present families and vignerons are related."[24] Mount View, located at the southern tip of Polkobin (and seen clearly from the subject area – see Chapter 3, Site Survey), has a more recent history of viticulture. There are a number of family wineries operating in Mount View. Ian

[18] Andrews, Brian J. 2000. *An Independent Look at the Pioneering Days of the Coalfields*. No. 7. For the Coalfield Heritage Group Inc. p.13.
[19] Andrews, Brian J. 2000. *An Independent Look at the Pioneering Days of the Coalfields*. No.12. For the Coalfield Heritage Group Inc. p.5;
Heritage Office and Department of Urban Planning. 1996. *Regional Histories of New South Wales*. p.38.
[20] Cessnock City Council. 1974. *Historical Tours in Greater Cessnock.* Eagle Print. p.2.
[21] Pike, Penelope and Meredith Walker and Associates. 1994. *City of Cessnock Heritage Study*. Set A. Vol. 6. 251-294. p.6.
[22] The wine cellar was demolished in 1925. Andrews, Brian J. 2000. *An Independent Look at the Pioneering Days of the Coalfields*. No.12. For the Coalfield Heritage Group Inc. pp.3-5.
[23] Bloomfield, W.A.G. 1954. *Cessnock, 1826-1954: A History of the Cessnock District with a special supplement on the Catholic Parish of Cessnock*. p.33.
[24] Pike, Penelope and Meredith Walker and Associates. 1994. *City of Cessnock Heritage Study*. Vol. 2. Inventory of Heritage Items. p.8.

Peterson established Peterson's Mount View winery, for example, after running a Hereford stud until the 1970s.[25] And the Robson vineyard was established by Harry Tulloch who followed in his family's wine-making tradition.[26]

Some of the region's earliest wines were undoubtedly stocked at the Bellbird Hotel, built on the Wollombi road near the subject area, early in the twentieth century (1906c. or 1913-14).[27] The fine two-story brick hotel was operational by 1914 when, according to the New South Wales Gazette, a licence was issued to Samuel Snape.[28] The Bellbird Hotel was built to cater for the tremendous influx of people into the region in this period. While the upstairs floor of the hotel now testifies to the travelling salesmen who frequented the area, the hotel predominantly served coalminers drawn to the region as the myriad of independent collieries (and in particular the Bellbird Colliery) were established.[29]

3.3. Coal Mining.

In 1864 an unnamed military officer made the first drawings of the Greta seam; sketching coal outcrops near Bellbird while surveying the Great Northern Road.[30] In 1886 T. W. Edgeworth David made a detailed geological survey of the seam. He found coal at a workable depth at Swamp Creek, Abermain (the South Maitland field); heralding a new period of prosperity and growth in the region.[31] As independent coal mines were established first at East Greta (in 1897) and then at Stanford Main and Pelaw Main (in 1900), Hebburn (in 1902) and Abermain (in 1903), the Cessnock-Kurri Kurri area became Australia's most productive early-twentieth-century coalfields.[32] An

[25] Paterson, David. 1984. *Hunter Wine Country*. Hunter Wine Country, Pokolbin. p.130.
[26] Paterson, David. 1984. *Hunter Wine Country*. Hunter Wine Country, Pokolbin. p.130.
[27] Pike, Penelope and Meredith Walker and Associates. 1994. *City of Cessnock Heritage Study*. Set A. Vol. 2. 051-100. pp.1-2.
[28] Pike, Penelope and Meredith Walker and Associates. 1994. *City of Cessnock Heritage Study*. Set A. Vol. 2. 051-100. p.2.
[29] Pike, Penelope and Meredith Walker and Associates. 1994. *City of Cessnock Heritage Study*. Set A. Vol. 2. 051-100. p.2.
[30] Parkes, W.S., Comerford, Jim and Lake, Max. 1979. *Mines, Wines and People: A History of Greater Cessnock*. p.174.
[31] Stedinger Associates. 2005. *Cessnock Home Central. Proposed Redevelopment. A Statement of Heritage Impact*. For Insite Planning Pty Ltd. p.6.
Andrews, Brian J. 2000. An Independent Look at the Pioneering Days of the Coalfields. No.12. For the Coalfield Heritage Group Inc. p.8.
[32] Bloomfield, W.A.G. 1954. *Cessnock, 1826-1954: A History of the Cessnock District with a special supplement on the Catholic Parish of Cessnock*. p.54.

extensive private railway haulage system was created to cater for the industry[33] and small villages such as Kitchener, Paxton and Kearsly grew up to provide workers for their local mine.[34]

Bellbird, like Cessnock, still remained a country village at the turn of the century.[35] In 1901 Cessnock, for example, had a population of 165 persons and 33 occupied dwellings.[36] With the promise of increasing coal mining activities, by 1903 a land boom had begun in Cessnock and the surrounding area. Rapid growth led to the proclamation of the "Village of Cessnock" on the 5th of August 1908, much of which would be developed over the rich Greta coal-seam.[37]

The Bellbird Colliery opened in 1908 and a private settlement immediately spread along the Wollombi Road. The settlement would initially have consisted of calico shelters around the mine head but as the land was subdivided, miners built timber cottages.[38] Numerous miner's cottages, built around 1910, can still be seen from the subject area which is relatively near to the Bellbird mine (see Chapter 4, Site Survey). By 1910 the railway was extended from Cessnock to Bellbird.[39] Two years later a government school was built.[40] As elsewhere in the region, the population of Bellbird burgeoned. Miners and their families relied heavily on the growth of service industries; not just hotels and shops, but also agriculture. The growing township needed local produce. Farmers likely sold cattle, sheep and pigs to the local abbettoir; possibly the small slaughterhouse built in the early-twentieth century on the MacDonald property located

[33] Pike, Penelope, Walker, Meredith and Associates. 1994. City of Cessnock Heritage Study. Vol. 2. Inventory of Heritage Items. pp.16-17.
[34] Heritage Office and Department of Urban Affairs and Planning. 1996. *Regional Histories of New South Wales*. p.41.
[35] after Bloomfield. 1954. *Cessnock 1826-1954. A History of the Cessnock District*. p.52.
[36] Bloomfield, W.A.G. 1954. *Cessnock, 1826-1954: A History of the Cessnock District with a special supplement on the Catholic Parish of Cessnock*. p.49.
[37] Bloomfield, W.A.G. 1954. *Cessnock, 1826-1954: A History of the Cessnock District with a special supplement on the Catholic Parish of Cessnock*. p.63;
PIX Magazine. 22 March 1952. *Cessnock – Coaltown*. p.1.
[38] Pike, Penelope, Walker, Meredith and Associates. 1994. *City of Cessnock Heritage Study.* Set A. Vol. 6. 251-294. p.4.
[39] Pike, Penelope, Walker, Meredith and Associates. 1994. *City of Cessnock Heritage Study.* Vol. 2. Inventory of Heritage Items. p.6.
[40] Pike, Penelope, Walker, Meredith and Associates. 1994. *City of Cessnock Heritage Study.* Set A. Vol. 6 251-294. p.4.

within the subject area (see Chapter 4 Site Survey).[41] The meat prepared at the MacDonald's slaughterhouse would have been transported by road to local butchers; at Bellbird, Westend, Paxton and Cessnock. [42] This particular slaughterhouse was handed from father to son and remained operational perhaps as late as the 1970s when the Bellbird mine closed down.

The town of Bellbird was supposedly named after a colony of bellbirds that made so much noise that the local bullockies couldn't hear their own bullock bells. When the Bellbird Colliery was opened and the surrounding groves of eucalypts cleared, the colony of bellbirds disappeared.[43] The mine operated without major incident until the Bellbird mining disaster of 1923.[44] On Saturday the 1st September 1923, twenty men went down the Bellbird mine for the afternoon shift. There was a mixture of Bellbird men (G. Sneddon, G. Locking, J. Graber, J. Morgan, J. Stewart, P. Roberts and M. Bailey) and Cessnock men (H. Richards, W. Griffiths, C. Mills, J. McLaughlin, G. Chapman, M. Hyames, A. Hines, G. Kelly, F. Lambert, W. Hartley, A. Corns, F. Fone and F. Moodie)[45]. Sometime between 1 and 2pm on that day the mine exploded. The men likely died in the initial blast. A rescue team was assembled and joined by John Brown, manager of the Aberdare Colliery.[46] As the men set off down the mine, they were cut off from the twenty miners by subsequent blasts. Brown was killed (from `poisonous gases') and the rest of the men were lucky to escape with their lives.[47] A brass plaque was installed at Cessnock School of Arts in recognition of the rescuers'

[41] The site survey indicates that the slaughterhouse consisted of cattle yards, a killing yard and two timber buildings. Interestingly, other slaughterhouses like the Canterbury Mill in Sydney, had a killing shed as well as a killing yard. The killing shed at Canterbury was one of the additional outbuildings constructed between 1908 and 1919. It could signify that the practice of killing animals in the open changes for the larger slaughterhouses in the early decades of the twentieth century, while smaller slaughterhouses could ill afford such a change. From Stedinger Associates. 2005. *Excavation Report on Redevelopment Works at the Former Australian Sugar Company Mill, Canterbury.* For Grosvenor Residential Pty Ltd. p8.

[42] Cessnock City Council. 1974. *Historical Tours in Greater Cessnock.* Eagle Print. p.2.

[43] Cessnock City Council. 1974. *Historical Tours in Greater Cessnock.* Eagle Print. p.2.

[44] Pike, Penelope and Meredith Walker and Associates. 1994. *City of Cessnock Heritage Study*. Set A. Vol. 1. 001-010. p.2.

[45] Cessnock City Council. 1974. *Historical Tours in Greater Cessnock.* Eagle Print. p.2. According to this source, M. Bailey's remains were discovered more than 40 years later and identified by the watch that his wife had given him.

[46] Parkes, W.S., Comerford, Jim and Lake, Max. 1979. *Mines, Wines and People: A History of Greater Cessnock*. p.207.

[47] Armstrong, John (ed.). 1983. *Shaping the Hunter*. Newcastle Division of the Institution of Engineers. p.48.

heroism. The plaque bares the symbol of the Royal Shipwreck-Relief and Humane Society of New South Wales.[48]

The Bellbird Colliery was suspended for about a year after the explosion but it was not closed indefinitely. The Bellbird Colliery continued production and many of the miners who had been at the site on the day of the explosion resumed work when the mine reopened.[49] The Bellbird mine was, afterall, a major employer in the region. In 1929 (only five years after the mine resumed operations), 700 miners were employed there.[50]

While explosions were not uncommon in the region's collieries and they sometimes led to fatalities, the miners had more to contend with than accidents.[51] They worked in an industry plagued by industrial unrest.[52] The mines were controlled by a small group of companies and, even in the earliest years of the Bellbird Colliery, the miners clashed with their employers. There were strikes throughout the coalfields in late 1907 and from November 1909 until March 1910.[53] Moreover, the years following the reopening of the Bellbird Colliery in 1924 saw increasing industrial unrest. In January 1929, the New South Wales Government met with coal owners to discuss ways to reduce their costs. They targeted miners' wages, asking the workers to agree to wage cuts. The miners refused.[54] On the 14th February of that year, the twenty coal owners told their ten thousand employees that they would lose their jobs unless they were prepared to accept a reduction in pay. When the men again refused they were locked out of mines throughout the Cessnock region.[55] Nine months later, with the miners still unable to return to work, the New South Wales' Government intervened. Premier Bavin announced that the state would take over three of the collieries and operate them, if necessary, with non-union labour.[56]

[48] Cessnock City Council. 1974. *Historical Tours in Greater Cessnock.* Eagle Print. p.2.
[49] McNicol, Steve. 1982. *Coals to Maitland*. Railmac Publications. p.79.
[50] Pike, Penelope and Meredith Walker and Associates. 1994. *City of Cessnock Heritage Study*. Set A. Vol. 1. 001-010. p.2.
[51] Armstrong, John (ed.). 1983. *Shaping the Hunter*. Newcastle Division of the Institution of Engineers. p.48.
[52] Heritage Office and Department of Urban Affairs and Planning. 1996. *Regional Histories of New South Wales*. p.41.
[53] Crowley, Frank (ed.). 1974. *A New History of Australia*. William Heinemann. p.298.
[54] Clark, Manning. 1993. *Manning Clark's History of Australia*. Melbourne University Press. p.509.
[55] Lowenstein, Wendy. 1978. *Weevils in the Flour: An Oral Record of the 1930s Depression in Australia*. Hyland House. p.77.
[56] Clark, Manning. 1993. *Manning Clark's History of Australia*. Melbourne University Press. p.513.

One of the three mines was Cessnock Colliery No. 2; which had opened in 1918 just south of Bellbird Heights, not far from the Bellbird mine.[57] On the 16th November 1929 Premier Bavin sent non-union labour to the mine under police protection. Several thousand miners, drawn from various Cessnock collieries, had erected a picket line to prevent the mine opening. When police attempted to break the picket line a battle ensued. Nine miners and several police were injured and one miner, Norman Brown, was shot and killed by police. Brown became a hero to the Australian working class; celebrated in Dorothy Hewett's poem "A Working Man Named Norman Brown". [58] On the 22nd May 1930 the miners capitulated, agreeing to return to work for reduced pay.[59]

Many believed that the dreams they had held – dreams of secure jobs, of savings and homes – were gone forever after the lock-out. While there were 22 000 coalminers in New South Wales in the 1920s, only 13 000 were employed by 1933 when the Depression drew to a close.[60] Many families had been evicted for non-payment of rent. Others had lost access to cottages owned by the mining companies. Some of these families moved to 'depression villages' on the outskirts of Cessnock; to tents and one-roomed shacks. Three of these depression villages were still in occupation in 1946; some seventeen years after the lock-out.[61]

While many of the region's mines resumed production when the worst of the depression years had passed, coal markets diminished in the 1950s. Coal was, by then, facing fierce competition from the growing oil industry. Unprofitable coal mines were once again forced to close down.[62] The Bellbird Colliery managed to survive until the 1970s. In 1976, however, the mine closed and the points and crossings on the railway were

[57] Stedinger Associates. 2005. *Cessnock Home Central. Proposed Redevelopment. A Statement of Heritage Impact*. For Insite Planning Pty Ltd. p.6;
Cessnock No. 2 Colliery, p.1;
`Coalmines and Railways of Greater Cessnock' map in Parkes, W.S., Comerford, Jim and Lake, Max. 1979. *Mines, Wines and People: A History of Greater Cessnock*. p.170.
[58] Clark, Manning. 1993. *Manning Clark's History of Australia*. Melbourne University Press. p.514; Lowenstein, Wendy. 1978. *Weevils in the Flour: An Oral Record of the 1930s Depression in Australia*. Hyland House. p.88.
[59] Clark, Manning. 1993. *Manning Clark's History of Australia*. Melbourne University Press. p.517.
[60] Lowenstein, Wendy. 1978. *Weevils in the Flour: An Oral Record of the 1930s Depression in Australia*. Hyland House. p.88.
[61] Lowenstein, Wendy. 1978. *Weevils in the Flour: An Oral Record of the 1930s Depression in Australia*. Hyland House. p.88.

removed. Eventually the colliery was demolished.[63] With the industries of coal, timber and even dairying in decline many of the towns in Greater Cessnock struggled to survive.

3.4. Historical Themes.

A number themes have emerged from the history discussed at local and state levels. These are:

• Land Tenure: Subdivision and land use.

The subject site was extensively used for cattle grazing and related industries in the nineteenth and twentieth centuries.

Local theme: Land use and subdivision.

State theme: Environment.

• Mining:

The subject site is situated a relatively short distance from the Bellbird coal mine.

Local themes: Coal Mines of the early-late twentieth century.
The Bellbird coal mining disaster.

State theme: Mining (Coal).

• Industry:

A slaughter house was located on the subject land.

Local theme: Local industries, slaughterhouses.

• Housing:

Many miners' cottages are located in the town of Bellbird and around (outside of) the study area.

Local theme: Miners' residences in the early twentieth century.

• Persons:

John Brown, mine manager of the Aberdare Colliery, died in rescue operations at the Bellbird mine.

Local theme: Mine managers.

[62]Stedinger Associates. 2005. *Cessnock Home Central. Proposed Redevelopment. A Statement of Heritage Impact*. For Insite Planning Pty Ltd. p.9.
[63] McNicol, Steve. 1982. *Coals to Maitland*. Railmac Publications. p.79.

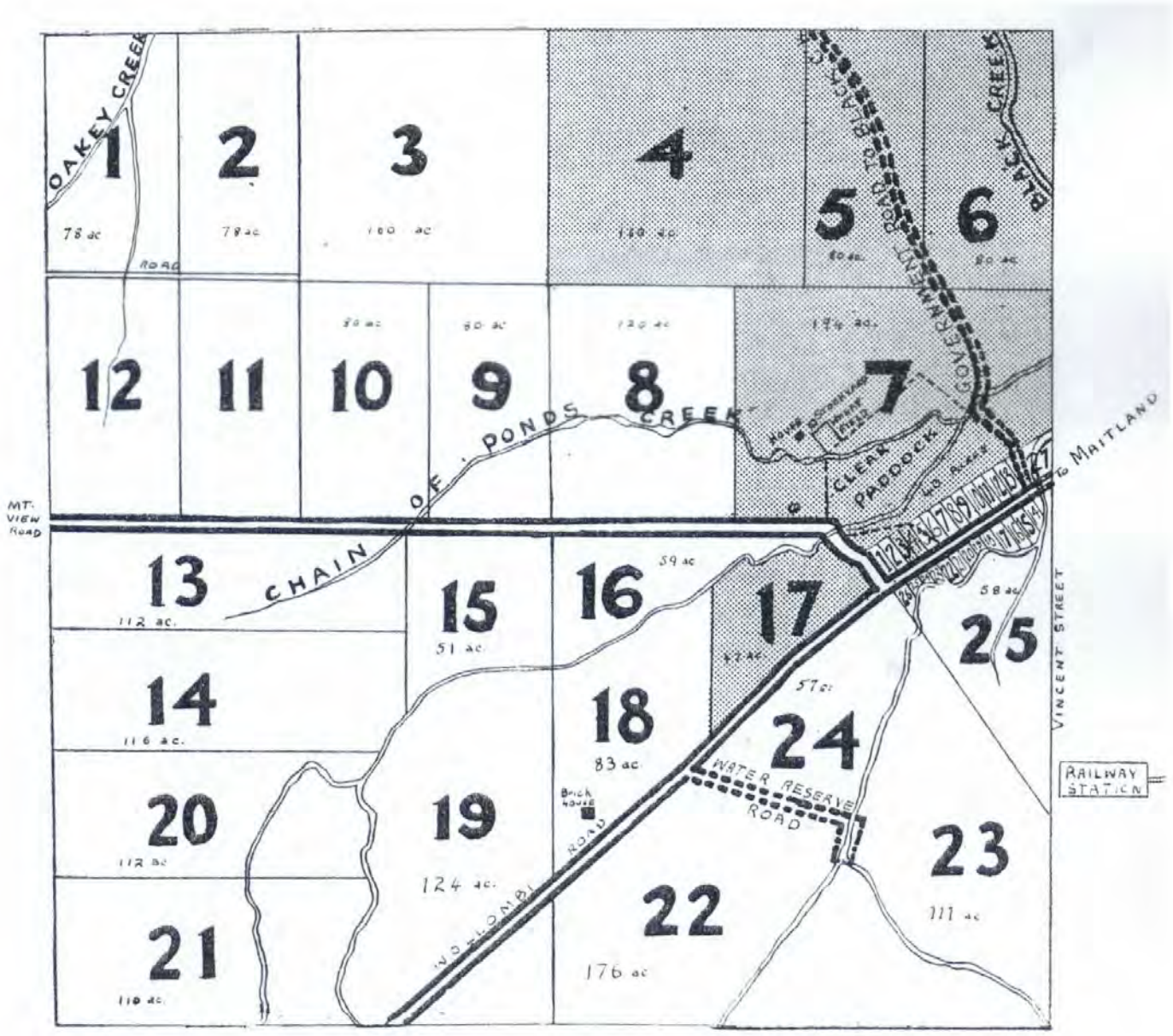


Figure 3.1. 'Cessnock Subdivision 1853'. In Wm. Bloomfield, 1954, *Cessnock 1826-1954. A History of the Cessnock District*. p.29.

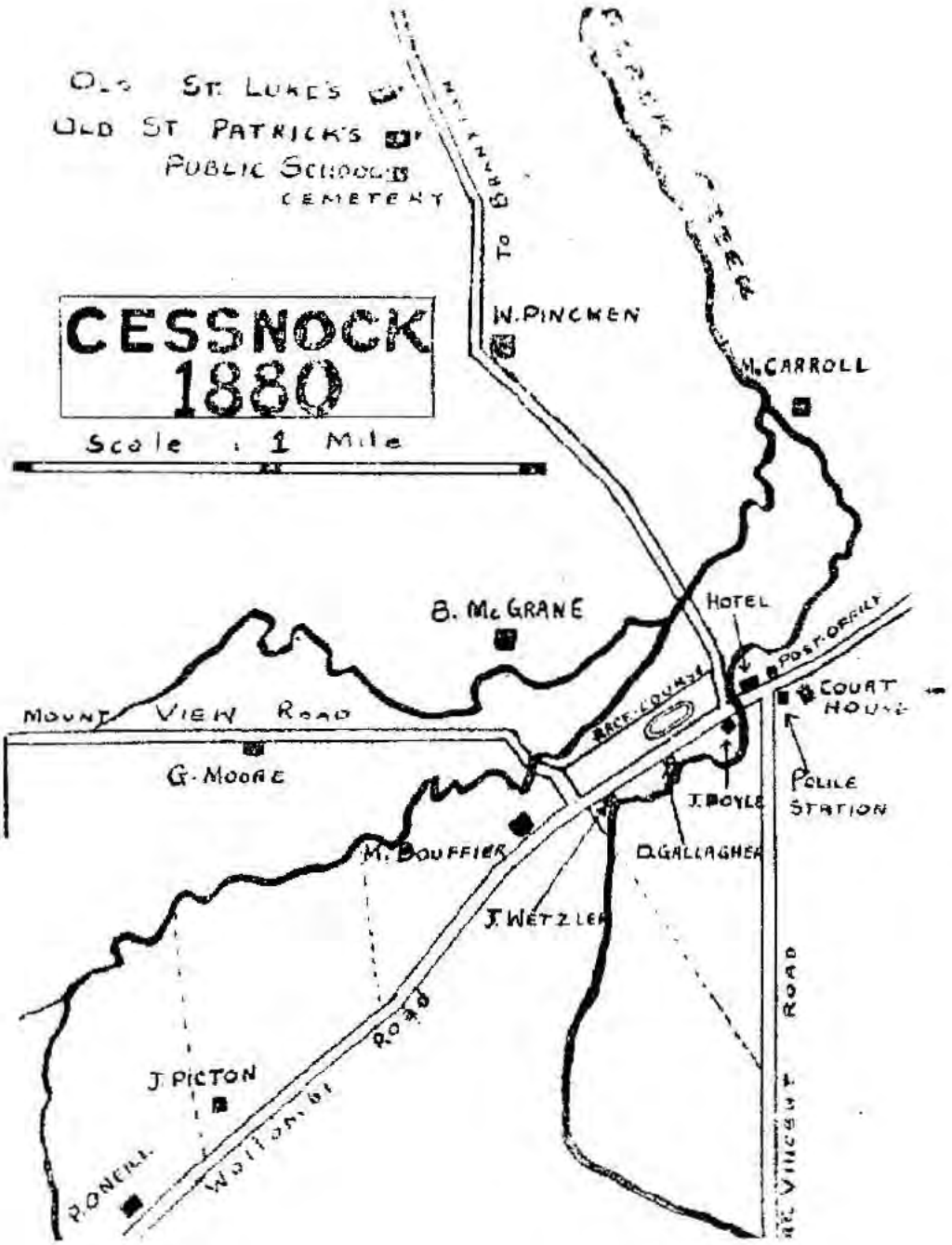


Figure 3.2. 'Cessnock 1880'. In Wm. Bloomfield, 1954, *Cessnock 1826-1954. A History of the Cessnock District*. p.42. The property of P. O'Neil is situated in the northeast portion of the study area.

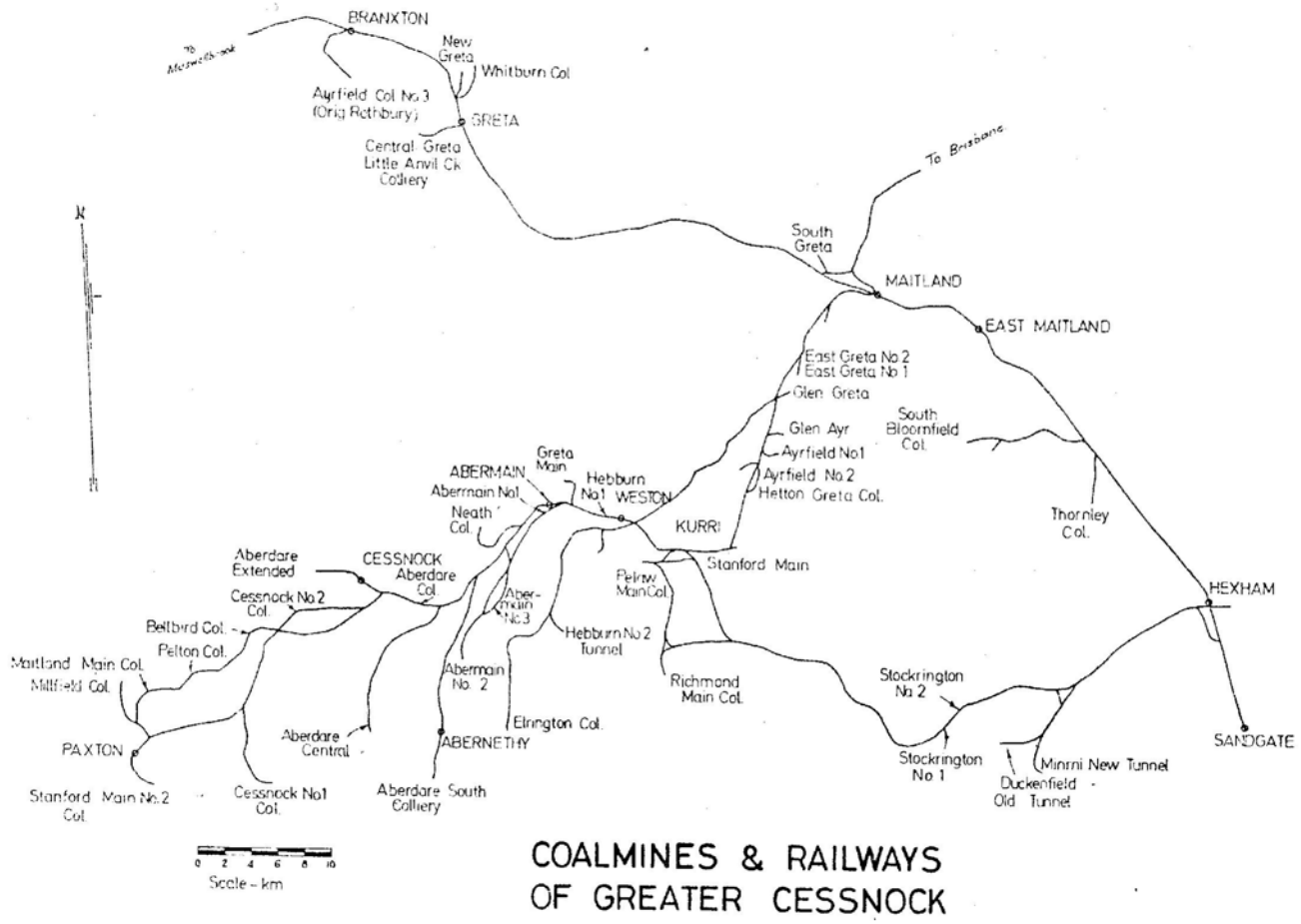


Figure 3.3 Coalmines & Railways' In Parkes, W.S., Comerford, Jim and Lake, Max. 1979. *Mines, Wines and People. A History of Greater Cessnock*. p.170.

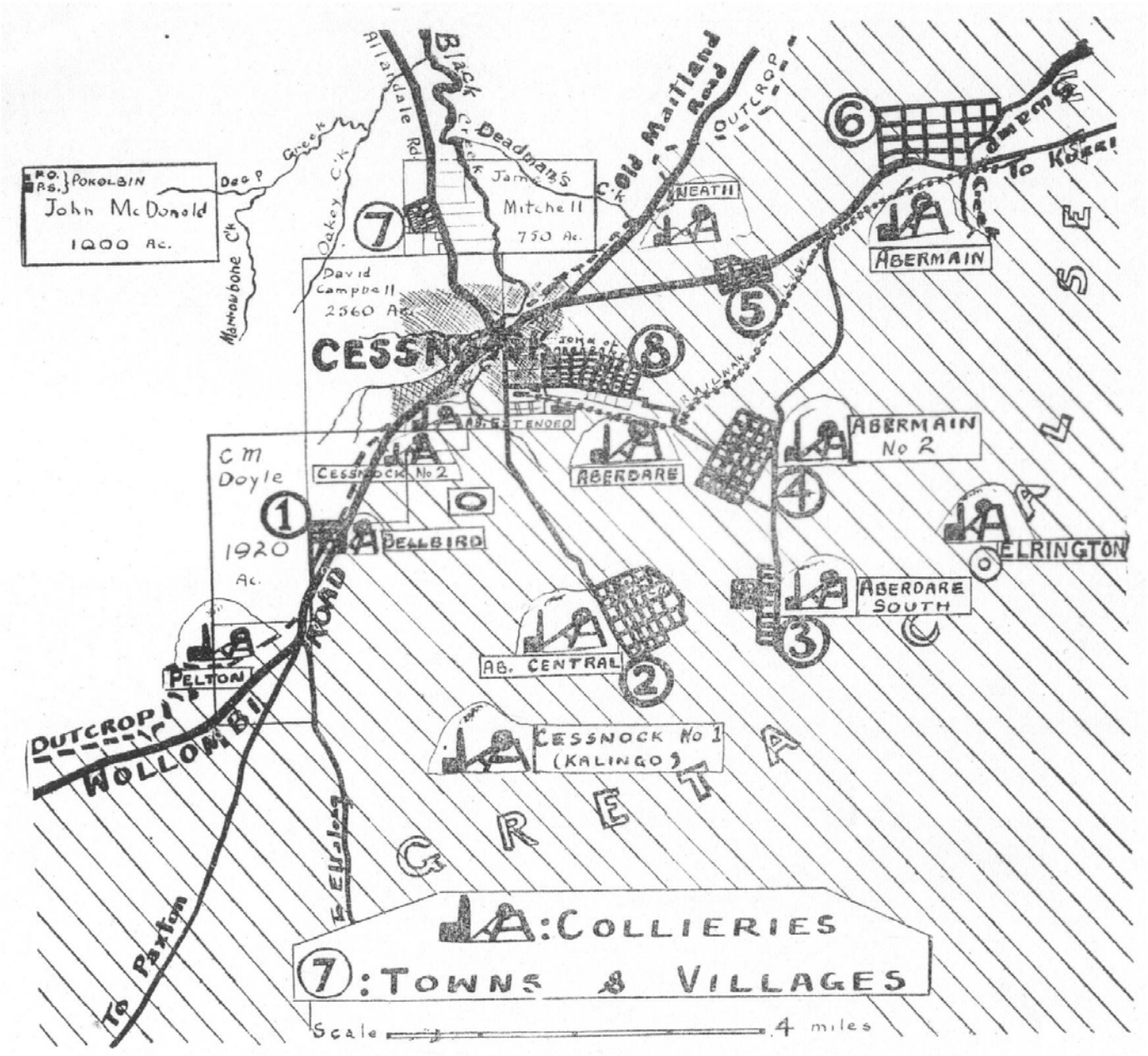


Figure 3.4. 'The Cessnock District 1954', showing earlier landowners. In Wm. Bloomfield, 1954, *Cessnock 1826-1954. A History of the Cessnock District*. p.58.

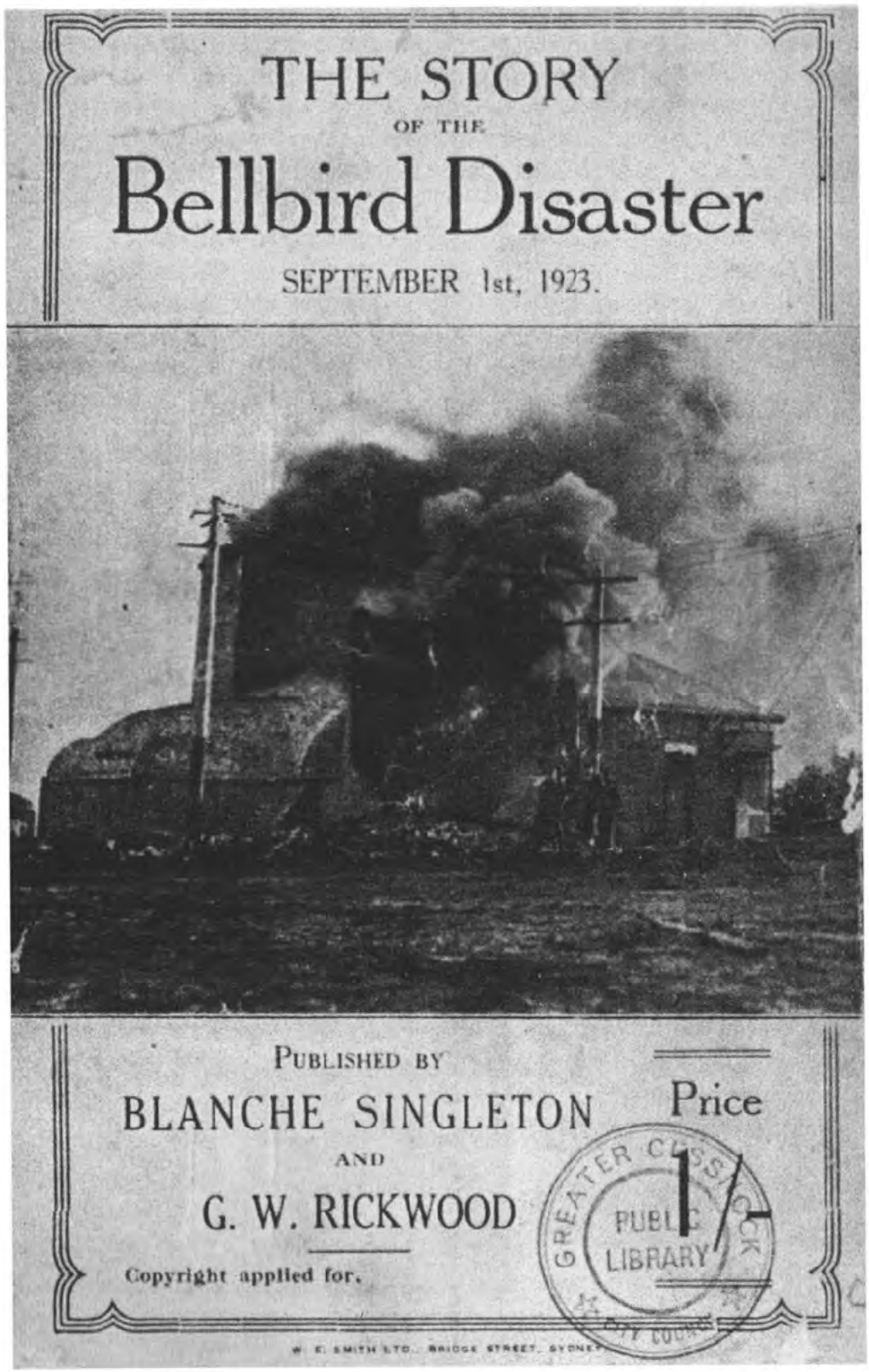


Figure 3.5. The cover page of a pamphlet published to raise money for the victims of the Bellbird Mine Disaster. In Parkes, W.S., Comerford, Jim and Lake, Max. 1979. *Mines, Wines and People. A History of Greater Cessnock*. Council of the City of Greater Cessnock. p.208.

4. SITE INSPECTION.

The site inspection was carried out by Dr. Louise Steding and Mr Gerald Steding between the 14th and 19th of April 2005 and the 5th and 6th of March 2006.

4.1. Farming Landscape and Residences.

The subject land has been a rural landscape for 170 years and, for the past century, has been overlooked by the miners' cottages of Bellbird to the south and east. Today, it continues as a vast area of mostly open cleared grazing land with scattered dams and occasional farmhouses. Limestone and Bellbird Creeks cut through the low-lying landscape from northeast to southwest, and patches of medium density bushland lie to the west, southwest and southeast. In more recent years, new residential developments have emerged on the outskirts of the survey area. To the north and northeast, the town of Cessnock is expanding towards the subject land, while to the southwest the town of Bellbird is growing.

Modern Buildings

In the northern portion of the survey area, existing farmhouses and associated sheds are mostly modern (mid-late twentieth century) or have been altered. Two modern brick and tile homes with modern iron sheds, for example, are located on the property of Mr Ray Mitchell (Items 1 & 2)(refer to Figure 4.1). No buildings have been erected on the northern portion of Ms Rumbel's property. On the west side of the survey area the Moore's residence consists of painted fibro cladding with aluminium windows and a new corrugated iron roof (Item 19). The garages are recent additions. Corrugated iron stables are located in the south paddock and another iron shed is associated with a cattle yard to the west. Few other structures have been erected. A large shed set on open land to the west is also modern (Item 3) and the cattle yards at 'Abbotsford' are only approximately 30 years old. A large modern shed colourbond, owned by Lovett's, is located in the southwest corner of the survey area (Item 4). Modern sheds have also been erected on the Moore's and Foggo's properties to the west (at Items 19 and 20). Additional cattle yards on the south side of the survey area along Tennant Street are approximately 40 years old (Item 5).

The south and southeast parts of the survey area contains mid to modern twentieth century housing and sports and recreational facilities. The Bellbird Bowling Club (Item

6), Charmichael Park, a tennis court, and a modern brick amenities block for the Soccer Club (Item 7) are located to the southeast. The bowling club is a rectangular building with a corrugated iron roof and aluminium windows. It has a rear timber addition from the c.1960s and a brick skillion addition from the c.1970s. Modern houses are located along the south side of the survey area. They include a recent two storey brick residence (Item 8), a single storey brick house from the 1980s (Item 9), a single storey weatherboard house built in c.1960 with more recent colourbond garages (Item 10), and a corrugated iron vehicle shed (Item 11).

Altered Residences

Earlier buildings in the survey area have been considerably altered. A third residence on Mitchell's property, for example, appears to have been built around c.1900 (Item 12). Similarly, the residence of Mr and Mrs Thompson is approximately 100 years of age (Item 13). Both buildings are now clad with hardi-plank, have aluminium windows, replaced roofs and later verandah additions. The residence on the Foggo's property is a single storey weatherboard house with a corrugated iron roof, brick chimney and extensive verandah (Item 20). Although it appears to have been erected in the early twentieth century, this house has been considerably altered. Much of the original wall cladding has been replaced at various stages. Walls have been added and others removed. Most windows have been replaced with either aluminium or timber. The verandah is a recent modification-addition. A new clip-lock garage has been added on the south side of the residence.

Heritage Items

349 Mt View Road

Less altered is an early small cottage situated at 349 Mt View Road to the northeast (Lot 141, DP986905)(Item 14). This cottage, belonging to Miss M. Willis, was built in c.1910-1915. It is a single storey, L-shaped, 3 bedroom, timber residence. This residence has retained much of its original cladding, its doors, verandah and pressed tin ceilings. Some double-hung sash timber windows, the verandah frieze and its corrugated iron roof have been replaced. The cottage is fronted to the north by a skillion roofed verandah and cottage style garden. Set on three acres, it is a country cottage rather than a farmhouse.

Slaughterhouse

A slaughterhouse complex was also located within the survey area (Item 15). Set back from the south it is reportedly situated on the property of Mrs M. Becket. The slaughterhouse appears to have been built in the 1890s with additions in the mid twentieth century. This complex is discussed below as an archaeological site (refer below to 4.3). A more recent residence (Item 18) is located east of the slaughterhouse complex.

254 Wollombi Road

On the east side of the survey area a few additional farming residences and sheds exist. In particular, on Lot 1 (DP 327580), 254 Wollombi Road is an earlier farming residence (Item 16). It appears to have been built around c.1900. The building is a weatherboard cottage erected on timber piers with a hipped roof and corrugated iron roof cladding. A flat roof verandah extends across the front and the northeast side of the building.

Originally L shaped in design, a weatherboard skillion addition has been erected at the rear of the residence. This addition appears to have been constructed soon after the main building and much of the rear verandah has been removed. Verandah additions to the front and northeast, however, are more recent. Piers beneath the front verandah are of concrete.

The building is in very poor condition. Many of its timber piers are rotted, wall cladding has deteriorated and fallen, doors have been replaced, the gutter has fallen and the roof is rusted and leaking. Part of the roof appears to have been replaced in the c.1930s. Considerable replacement of original fabric would be required for the repair of this building.

While the farmhouse at 254 Wollombi Road appears to be an earlier example of a farmhouse in the area, it is in poor condition and has been altered. The residence is not unusual in its style nor is it a part of the 'mining' cultural landscape typical of Bellbird. As such, restoration not considered warranted here. Furthermore, associated subsurface remains are not likely to provide substantial or significant information on the settlement of Bellbird or its district. Like other buildings in the south and east portions of the survey area, the Wollombi Road residence lies immediately opposite established

medium density housing of Bellbird and Bellbird Heights (refer below to 4.1.). The cottage has a setback of about 100 to 120 meters from Wollombi road.

A number of outbuildings are located a short distance from the house. To the northeast, is a small wooden shed with a pitched gable roof of corrugated iron. A skillion awning shelters its entrance. The shed appears to have been erected around the time as the residence and would have been used as a garden or storage shed. Its condition has deteriorated.

A larger corrugated iron shed lies a short distance to the northeast. It has a pitched gable roof and flat roof addition. This iron shed appears to be approximately 50 years old. Behind it, to the northwest, a small brick building with a pitched gable roof is a more recent structure which appears to be between 30 and 40 years old. A cattle yard and ramp is between the corrugated iron shed and the brick structure. This is also approximately 40 years old. The remains of a slightly earlier large corrugated iron shed and cattle yards lie collapsed to the west.

No. 2 Wollombi Road

Allotment 1 (DP) is located within the survey area along Wollombi Road immediately to the southwest of P.J. O'Neill's. Here, a single storey, altered weatherboard cottage fronts the allotment (No. 2 Wollombi Road) (Item 17). The building is not in good condition, though it has retained its corrugated iron roof, verandah and double hung sash windows. Some 10 corrugated iron sheds are located at the rear of the building. These sheds have been erected in the late twentieth century. While the building at No.2 Wollombi Road is not considered to be a heritage site worthy of retention, recording or listing, the allotment itself lies west of P.J. O'Neill's. An early 'Red House' built in the 1840s was reportedly erected on land to the west of O'Neill's (refer below to 4.3).

4.2. Heritage in the Vicinity.

In their inventory for the *City of Cessnock Heritage Study*[64], Pike and Walker recorded 6 heritage items in Bellbird. These are: the Bellbird Hotel (Item 053); the Bellbird Colliery (Item 049); a Building, Wollombi Road (Item 259); the Bellbird Uniting Church (Item 258); Bellbird Mines Disaster Memorial (Item 257); and Bellbird Public

School (Item 282). Other potential heritage items identified included St Matthews Church and Hall at 40-42 Kalingo Street (P3), a miner's cottage at 11 Edden Street (P4) and the Police House on the corner of Matthew and Cox Streets (P5).[65] None of these items are within or adjacent to the land proposed for rezoning.

Adjacent Housing

Beyond the survey area to the north and northwest, new brick housing developments lie along Mt View Road. Also, immediately adjacent the southwest corner of the survey area is a new development of single storey brick and tile houses.

To the east and south many houses are adjacent to the area proposed for subdivision. Along Wollombi Road (No.s 270 to 296), for example, a number of mostly L-shaped houses date from the 1920s to the 1980s. Of the older houses most have replaced iron roof cladding, modern aluminium windows and hardi-plank cladding. Similarly, much of the original fabric of an earlier residence at No.1 Cruckshank Street has been removed. This c.1920s cottage has replaced roof cladding, aluminium windows and hardiplank wall cladding. In particular, many houses along Cruckshank Street are of modern brick. However, on the west side two brick cottages (No.6 and No.10) were built in c.1900. These cottages abut the survey area. Further along the street, No. 14 and No.28 appear to date to the 1920s. No.6 has been altered with a changed roof, modified front verandah, rear skillion addition. No.10 is in poor condition with cracked walls and a partially replaced roof. The roofs of No.14 and No.28 have also been replaced. No.28 is now clad with hardiplank. The remaining houses in the street are either modern brick or hardiplank from the c.1970s.

While the overall character of this street is of a single storey cottage style, no residences are unusual, few are intact, and there is no sequence or series of intact heritage residences. Many similar cottages exist in the Bellbird and Cessnock townships which have retained more original fabric.

Modern brick, hardiplank and weatherboard residences with aluminium windows dominate the northern portion of Ruby Street. Most of the weatherboard houses were

[64] Pike, Penelope and Meredith Walker & Assoc. 1994. *City of Cessnock Heritage Study*.
[65] Pike, Penelope and Meredith Walker & Assoc. 1994. *City of Cessnock Heritage Study*. p.9, 12.

built in the 1950s to 1960s. Southwards, along Prince Street, the construction dates of houses range from 1910 to the 1960s. Most, however, are clad with hardiplank and have aluminium windows. Others from the 1970s and 1980s are of modern brick. A similar trend continues south along Prince Street, where houses date from the 1920s to the 1970s. Here, the entire streetscape is dominated by up to 80 percent hardiplank clad houses. The remainder are of modern brick. This streetscape of hardiplank cladding, aluminium windows and replaced roof cladding continues into Sparke Street to the southeast. Many of the houses in this street would have been erected in the 1920s and 1930s. Some modern brick houses are present. Mixed housing is located along Tennant Street to the south. It consists of mostly modern brick houses from the 1970s to the 1990s, hardiplank with aluminium windows from the 1920s to the 1960s, and some re-roofed weatherboard houses from the 1920s to the 1930s.

Nissen Huts

To northeast, approximately 30 'Nissen Huts' have been modified as economical housing with timber or hardiplank clad annexes. Invented by British Army Officer Peter Norman Nissen for use in World War II, the sheds are prefabricated buildings of corrugated steel in the shape of a half cylinder. They became standard army buildings. The sheds northeast of the survey area were re-located from the Greta Migrant Centre after its closure in the 1970s. In Greta, the Migrant centre operated from 1948-1978.[66] Set back from the survey area by some 300 metres, the new development is not considered to impact the Nissen Hut area.

Miners Cottages

Many of the cottages described above adjacent to the survey area would have been economical housing typically erected by and for the predominantly mining community. Their dates of construction range from c.1910 to c.1960. Today, however, most have been clad or re-clad with hardiplank, their windows are aluminium and their roofs colourbond.

Initially miners' houses in Bellbird would have been calico shelters around the mine head.[67] A mining landscape emerged by 1910 which was characterised by timber

[66] Darebins Australians. www.decc.org.au
[67] Pike, Penelope and Meredith Walker & Assoc. 1994. *City of Cessnock Heritage Study*. Vol. 6. p.4.

cottages centring around a mining village, villages separated by bushland which themselves followed the railway line. A mining landscape is typical of Bellbird. This landscape is characterised by derelict mines that were once served by railways and overlooked by dependent villages and towns.

O'Neill's Winebar

O'Neill's Winebar is a 2-storey brick hotel built in 1917 by Patrick O'Neill (junior). It is located at 4 Wollombi Road and adjoins the survey area proposed for rezoning.[68] This hotel is important for its association with early wine growing and selling, its connection to grower Patrick J. O'Neill.[69] Patrick O'Neill (senior) planted a vineyard and opened a wine shop in the 1890s on the Wollombi Road after giving up the growing of wheat and tobacco.[70] His son opened the brick hotel in 1917 beside his father's weatherboard and shingle saloon. It is said to have become a recognised stopping place for coachmen, bullockies and teamsters travelling along the Wollombi Road and Great Northern Road. The present shop, dated 1917, is a replacement of this earlier wine bar.[71]

4.3. Historical Archaeological Potential.

4.3.1. Primary Industries

The use of land for crops and grazing purposes does not by its nature leave substantial tangible evidence of the past. Both have been the main uses of the subject land for the past 170 years. Like many farmers of the area, in the late nineteenth century Patrick O'Neill (senior) grew wheat and tobacco and mixed crops, including vines for the production of wine. Old Wheat Paddocks were located on the land southwest of O'Neill's Hotel.[72] Such activities may leave furrows or postholes as physical evidence, for example. However, such subtle remnants are likely to have been disturbed by subsequent activities including the construction of sheds and continued crop farming.

4.3.2. Slaughter House

A slaughterhouse complex (Item 15) is located in the central-southwest part of the survey area on Lot 1 (DP597226) beside the boundary of Lot 10 (DP806584). Today

[68] The address of O'Neill's is also written as No.259 Wollombi Road (Pike, Penelope and Meredith Walker & Assoc. 1994. *City of Cessnock Heritage Study*. Vol.6. p.5-6).
[69] Pike, Penelope and Meredith Walker & Assoc. 1994. *City of Cessnock Heritage Study*. Vol.6. p.6.
[70] Cessnock City Council. *Historical Tours in Greater Cessnock.* Eagle Print. p.2.
[71] Pike, Penelope and Meredith Walker & Assoc. 1994. *City of Cessnock Heritage Study*. Vol.6. p.6.

the consists of three buildings – two barn-like structures and what appears to be an amenities block. The slaughterhouse appears to have been built in the late nineteenth century and modified in the 1920's or 1930's.

Building No.1 is a single storey barn construction where vertical round timber posts of about 200mm in diameter support a corrugated iron clad gable end roof. In the lower portion of the building a brick wall has been fitted inside the main barn protecting the inside of the building from the elements. Its support posts, however, remain exposed. The brickwork is likely to be a later addition. The upper half of the structure is partially clad with corrugated iron. Like the brickwork, the cladding appears to be a later addition. Both suggest the replacement of the original cladding at a later period of use. On the west side of the building fallen cladding has exposed the framework of the gable end. Here, a few boards of original timber cladding remain. This could explain the later additions of more durable brick and iron. To the east an awning with skillion roof has been erected and would have provided shelter for loading purposes. The structure is clad with corrugated iron and appears to have been built at the same time of the main barn.

Building No.2 is a freestanding is a single storey brick building with a pitched gable roof. It is located to the south of Building No.1 and appears to be a toilet block, as suggested by its size, and the form and elevated location of its windows.

Building No.3 has been constructed using the same principles applied for Building No.1. Round timber posts support a pitched gable end roof with corrugated iron cladding. Again, brickwork has been raised inside the lower portion of the main barn, leaving its support posts exposed to the weather. The walls of the upper portion of the building are clad with corrugated iron. The different lengths of iron used give a makeshift appearance.

A large cattle yard located to the west of building No.1. Its post and rail fences enclose a passage to the slaughterhouse guiding pigs, cattle and sheep to the entrance of the slaughterhouse. Some surviving cattle fences suggest that Building No.2 was also used as a slaughterhouse.

[72] Cessnock City Council. *Historical Tours in Greater Cessnock.* Eagle Print. p.2

All three buildings and the holding yard fences are severely deteriorated. Much of their original fabric has fallen or has been removed. Subsurface remains associated with the slaughterhouse complex and its operations are likely to exist in the vicinity of the buildings and possibly within the holding yards.

4.3.3. The Red House

An early 'Red House' built in the prior to 1843 was reportedly erected on land to the west of O'Neill's wine saloon. Here, in 1843, bushranger Patrick Bruin, who had been wounded at Black Creek was brought by Mr Crawford's servants. Bruin died from his wounds at Wollombi. By 1880 the building had been deserted, but was sometimes used by teamsters as a camping place.[73] Its former location on the farmland 'west of O'Neill's wine saloon' is unclear and no evidence of the Red House was visible during the present survey. O'Neill's Hotel (1917) and the site of his father's earlier wine bar (1890s) is located on Wollombi Road. If surviving within the survey area, subsurface remains of the 'Red House' (c.1843) may exist on Lot 1, DP 349452. Today, a weatherboard cottage (No.2 Wollombi Road) is located on this land with some 10 corrugated iron sheds situated at its rear.

4.3.4. Bellbird Mine

The Bellbird colliery was opened in 1908 and closed in 1976 and is historically important as a major employer in the region and as the site of the "Bellbird Disaster" of 1923. In April 1976 much of the later parts of the Bellbird Colliery were demolished.[74] By 1994, little remained of the colliery with the exception of some tramway piers.[75]

Although not in the immediate vicinity of the subject site, mining landscapes can extend over considerable distances. In this instance, the area mined was on the east side of the South Maitland Railway line, east away from the subject survey area. As such, shafts, dams and other mining landscape features are unlikely to occur on the subject land. During the present survey, no evidence of mine workings or associated remains were found.

[73] Cessnock City Council. *Historical Tours in Greater Cessnock.* Eagle Print. p.2.
[74] McNicol, Steve. 1982. *Coals to Maitland*. Railmac Publications. p.79.
[75] Pike, Penelope and Meredith Walker & Assoc. 1994. *City of Cessnock Heritage Study*. Vol. 2. p.2.

4.4. Views (the Vineyards District)

Parts of the survey area look out to the Vineyards District along the Broken Back Range (refer to Figure 4.2). In particular, the Pokolbin area is significant for its evidence of the nineteenth century viticulture industry and from which many of the present families and vignerons are related.

While many of the Mt View vineyards have developed only in the last 40 years or less, a new cultural landscape has emerged. The traditional landscape has been changed in recent years with the rapid expansion of the wine industry and the development of the Pokolbin area as a tourist area. The new landscape draws on draws on the heritage of European winemaking and early activities and is strongly influenced by the soil characteristics, the early road patterns, by patterns of residual forest and tree-lined watercourses and by the visual domination of the Broken Back Range.[76] Mt View Vineyards to emerge in the c.1970s and more recently include those of Harry Tulloch and Ian Peterson.[77]

Most of the general landscape itself is flat and low lying, offering no picturesque views over the farming landscape itself. However, views from limited parts of the subject land to the vineyards siding the Broken Back Range are considered prominent. From the west end of Tennant Street and at the west side of the survey area (including Lot 2 DP66183, Lot 1 DP196460, part Lot 3 DP597226 and Lot 2 DP597226) views extend uphill to the Mt View Vineyards in the west (refer to Figure 4.2) On the east side of the survey area views of the Vineyards District are also available from Cruckshank Street (north), Wollombi Road (at Items 16 and 17) and Carmichael Park, as shown in Figure 4.2.

Views from the southwest also extend over a recent housing development. Similarly, views from the survey area to the north look over the Mt View basin and recent housing developments. To the south and east, views extend out over Wollombi Road to the residential areas of Bellbird and Bellbird Heights.

[76] Pike, Penelope and Meredith Walker & Assoc. 1994. *City of Cessnock Heritage Study*. p.8, 17.
[77] Paterson David. 1984. *Hunter Wine Country*. Hunter Wine Country, Pokolbin. p.130, 140

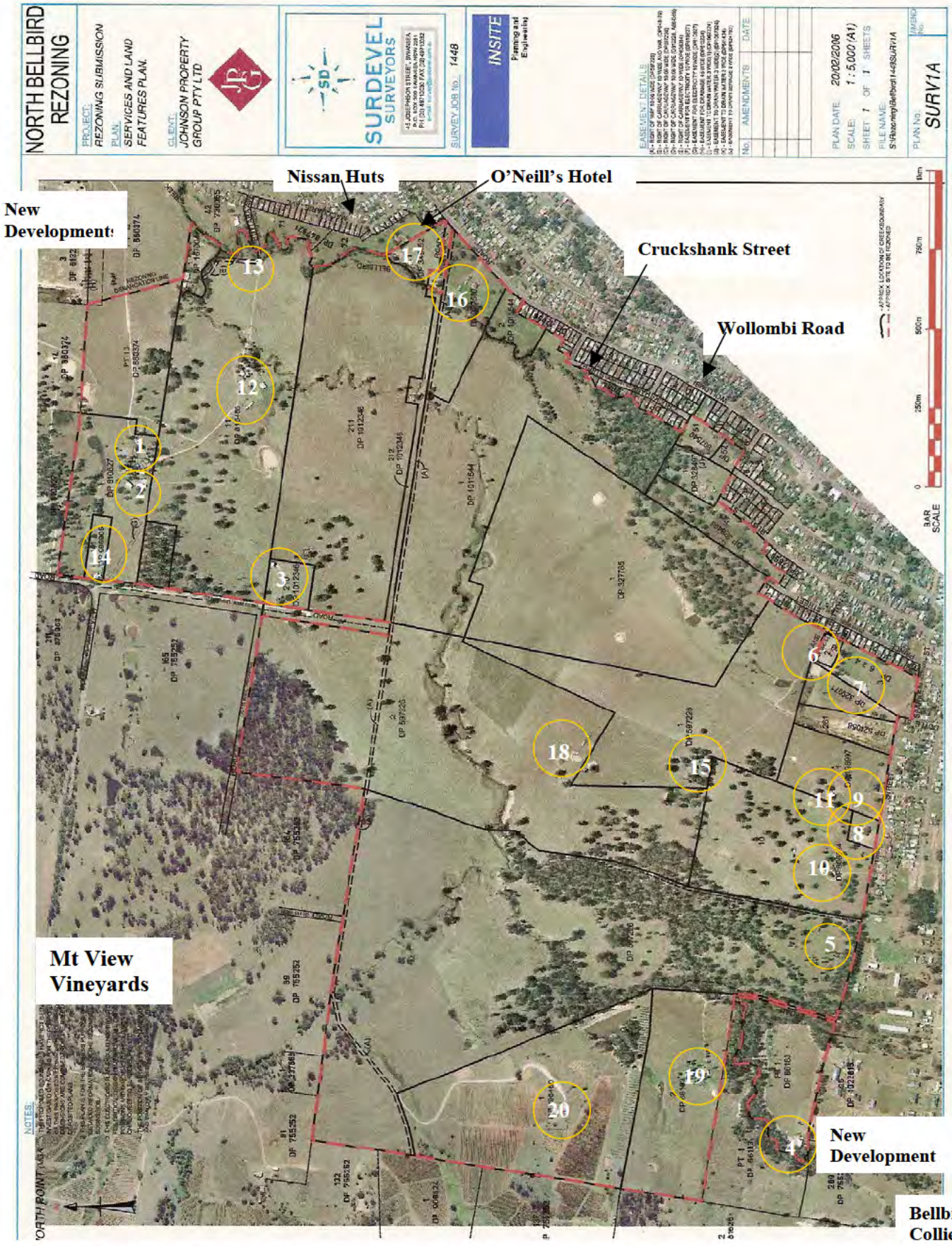


Figure 4.1: North Bellbird Rezoning. Items identified during survey and discussed in the text.

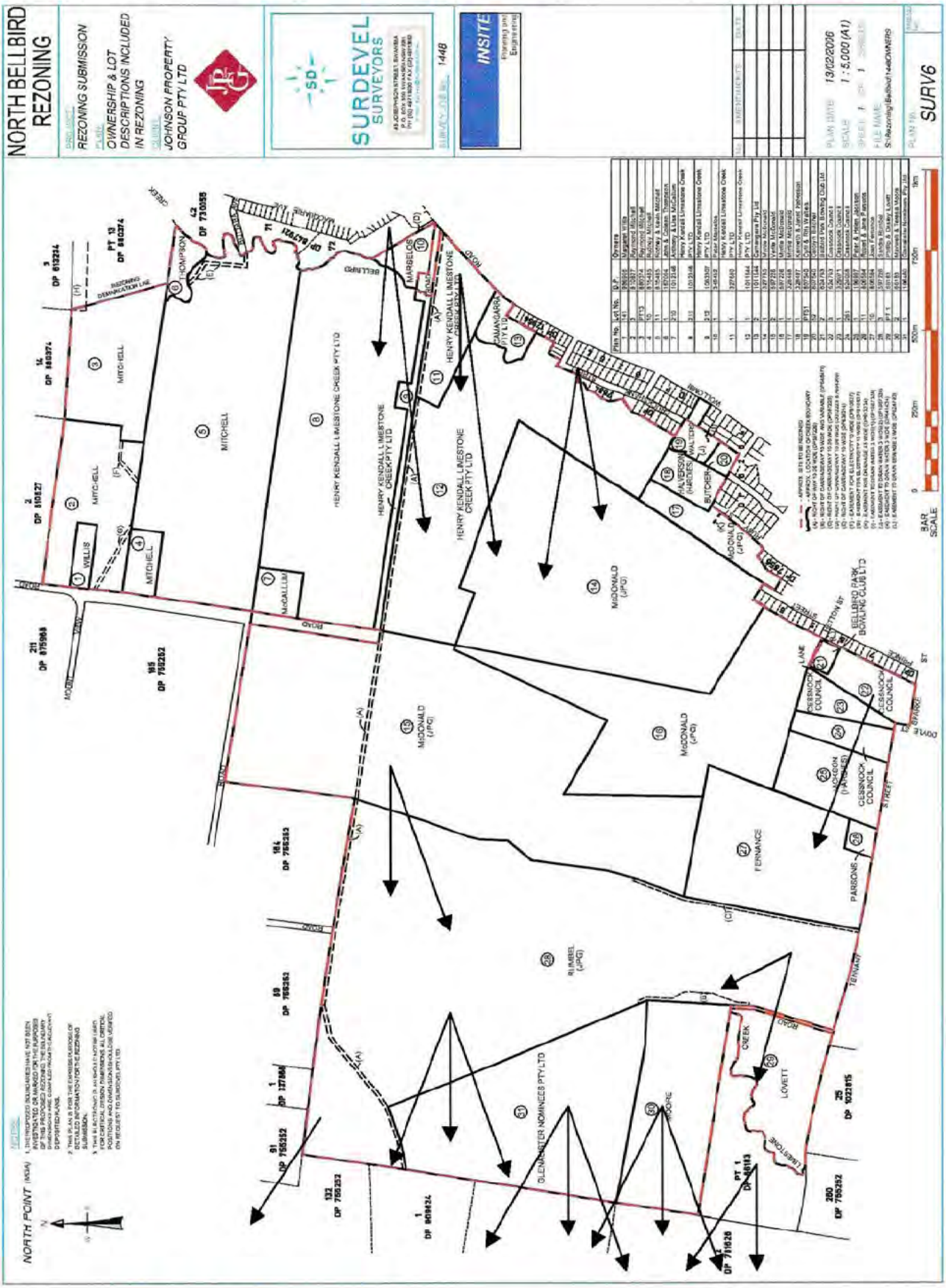


Figure 4.2. North Bellbird, where arrows show direction of views to the Vineyard District. By Surdevel Surveyors, 13 February 2006. For allotment numbers refer to Figure 1.2.

4.5. Photographs.



Plate 4.1. O'neill's Hotel, Wollombi Road, Bellbird Heights. Facing west. (Item 17)



Plate 4.2. No.2 Wollombi Road, south of O'neill's Hotel, Bellbird Heights. Facing west. (Item 17)



Plate 4.3. Corrugated iron sheds off Wollombi Road, near O'neill's Hotel, Bellbird Heights. Facing northwest.



Plate 4.4. View to the Brokenback Range from the rear of O'Neill's Hotel, Bellbird Heights. Facing west.



Plate 4.5. View to the Brokenback Range from 254 Wollombi Road, Bellbird Heights. Facing west. Item 16.



Plate 4.6. No. 254 Wollombi Road (Item 16), Bellbird Heights. Facing west.





Plate 4.7 (a & b). Outbuildings associated with No. 254 Wollombi Road (Item 16), Bellbird Heights. Facing west (a) and south (b).



Plate 4.8. A collapsed shed at No. 254 Wollombi Road (Item 16), Bellbird Heights. Facing west.



Plate 4.9. View of Cruckshank Street, outside the west boundary of the proposed development, Bellbird Heights. Facing southwest



Plate 4.10. View from the corner of Abbotsford and Ruby Street, southwest of the proposed development, area, Bellbird. Facing southwest.



Plate 4.11. View along Prince Street, showing approximately 80% of houses clad with hardiplank, Bellbird. Facing southwest.



Plate 4.12. The Bowling Club off Prince Street, southwest of the proposed development, Bellbird. Facing southwest. Item 6.



Plate 4.13. The Soccer Club off Prince Street, southwest of the proposed development, Bellbird. Facing southwest. Item 7.



Plate 4.14. View to the Brokenback Range from Charmichael Park, southwest of the proposed development, Bellbird. Facing northwest.



Plate 4.15. Examples of typically altered cottages within the survey



Plate 4.16. Examples of modern residences within the survey area.



Plate 4.17. An iron machinery shed situated in the survey area to the south. View from Charmichael Park, facing northwest.



Plate 4.18. One of several modern sheds set in a cleared landscape within the survey area. Facing northeast.



Plate 4.19. A restored cottage at 349 Mt View Road located within the survey area to the northwest. Facing south. Item 14.



Plate 4.20. A c.1950s residence along the north side of Tennant Street, adjoining the proposed development area. Facing north.



Plate 4.21. A modern residence along the north side of Tennant Street, adjoining the proposed development area. Facing northeast.



Plate 4.22. Cattle Yards on the north side of Tennant Street. Facing northwest.



Plate 4.23. A modern colourbond shed erected on Lovett's property in the southwest corner of the proposed development area.



Plate 4.24. Nissen Huts in Macquarie Avenue west of the proposed development area, Bellbird Heights. Facing west.



Plate 4.25. Slaughterhouse site, showing building 1 and amenities. Facing northwest. Item 15.



Plate 4.26. Slaughterhouse site, showing building 3. Facing north. Item 15.



Plate 4.27. Slaughterhouse site, showing building 3. Facing northeast. Item 15



Plate 4.28. Farmhouse at Lot 2, DP66183. The original building has been altered. Facing south. Item 19.





Plate 4.29 (a & b). The residence on Lot 1, DP196460 has been considerably altered. Facing southeast (a) and west (b). Item 20.



Plate 4.30. View across recent vineyards from the Moore's property (Lot 2, DP66183). Facing northwest



Plate 4.31. View across recent vineyards from the Foggo's property (Lot 1, DP196460). Facing north



Plate 4.32. View to the Vineyards District from the northern portion of S. Rundel's property at Lot 3, DP597226. Facing southwest. The Foggo's farmhouse is shown center-rear.



Plate 4.33. View across the proposed development area to the north from (Lot 1, DP196460). Facing northeast.



Plate 4.34. View from Lot 1, DP196460 across recent Vineyards to the Brokenback Range. Facing northwest.

5. HERITAGE SIGNIFICANCE.

The following assessment is intended to clarify the heritage significance of the land proposed for rezoning and/or sites upon that land. Criteria for assessing heritage significance in New South Wales have been have been standardised by the NSW Heritage Office and Planning N.S.W.[78] These criteria are: historical, aesthetic, social, scientific, rarity, representativeness and integrity (refer to Appendix 1).

North Bellbird Investigation Area.

Historical (a) ***(course or pattern)***

- The rural landscape has been a part of the development of Bellbird and is important for the pastoral activities and local industries represented (grazing and slaughter).

Historical (a): Applicable (local, low-moderate).
Inclusion guidelines satisfied:
- is associated with a significant activity and historical phase;
- maintains or shows the continuity of a historical process or activity.

Historical (b) ***(associated)***

- The site is associated with the early Doyle Brook estate, a 160 year old grant belonging to Cyrus Matthew Doyle.

Historical (b): Applicable (local, low).
Inclusion guidelines satisfied:
- is associated with a significant person.

Aesthetic (c)

- The general landscape itself is not particularly picturesque nor does it have landmark qualities. However, views from limited parts of the subject land to the vineyards siding the Broken Back Range are considered prominent;
- On the subject land most of the buildings, sheds and/or ruins are themselves not notable or particularly attractive features in the landscape;
- The cottage at 349 Mt View Road (Lot 141, DP986905), is an attractive and intact residence which dates to c.1910.

Aesthetic (c): Applicable (local, moderate - views to vineyards and cottage).
Inclusion guidelines satisfied:
- has landmark qualities (with regard to views to vineyards only);
- exemplifies a particular taste, style or technology (c1910 cottage).

[78] NSW Heritage Office and Department of Urban Affairs and Planning. *Assessing heritage significance,* HO/DUAP, Sydney, 2001.

Social (d)

- There is no strong or special association of the landscape or European sites upon this landscape with a particular community or cultural group in the area.

Social (d): Not Applicable.
Exclusion guidelines satisfied:
- is not associated with an identifiable group;
- is not important for a community's sense of place.

Scientific (e)

- From an archaeological perspective the slaughterhouse site is considered to be significant (Lot 1, DP597226). Despite disturbance to surface features and its deteriorated condition, the site has the potential to provide information not available from other sources and research opportunities that will substantially contribute to our knowledge of the past. Minimal disturbance to potential subsurface deposits has occurred. Little has been written on slaughterhouses *(Applicable, moderate)*;
- Subsurface remains of the 'Red House' (c.1843) may exist on Lot 1, DP 349452. However, its former location is unclear, being described as 'the farmland adjoining the western side of O'Neill's wine saloon'. O'Neill's Hotel (1917) and the site of his earlier wine bar (1890s) is located on Wollombi Road (refer to Chapter 4) *(Applicable, low-moderate)*;
- Workings associated with the Bellbird Mine are not located on the subject land. *(Not applicable)*
- With the exception of the slaughterhouse, most structures on the subject land post-date 50 years. *(Not applicable)*
- Subsurface remains associated with 254 Wollombi Road and 349 Mt View Road are not considered likely to provide substantial or significant information on the settlement of Bellbird or its district. *(Not applicable)*
- Remnants associated with grazing activities are not generally substantial or often tangible by their nature. *(Not applicable)*

Scientific (e): Applicable (moderate - Slaughterhouse and 'Red House' only).
Inclusion guidelines satisfied:
- has the potential to yield new or further substantial scientific and/or archaeological information (Slaughterhouse and 'Red House');
- is an important benchmark or reference site or type;
- provides evidence of past human cultures that is unavailable elsewhere.

Rarity (f)

- Few historical or archaeological studies of slaughterhouses have been carried out. *(Applicable, moderate)*
- Residences located within the study area are not rare. Most are typical houses which date from the 1960s to the 1980s. One dates as recently as c.2000 *(Not applicable)*
- The earlier farmhouse at 254 Wollombi Road is not unusual in its style nor is it a part of the 'mining' cultural landscape typical of Bellbird *(Not applicable).*
- The landscape itself is not rare or unusual *(Not applicable)*

- Miners' cottages in the vicinity of the subject land are not rare examples of their period and most have been considerably altered. Many miner' residences survive in Bellbird and the wider Cessnock area *(Not applicable).*

Rarity (f): Applicable (moderate, Slaughterhouse only).
Inclusion guidelines satisfied:
- demonstrates designs or techniques of exceptional interest;
- shows rare evidence of a significant human activity important to a community.

Representative (g)

- The subject landscape is not representative. It includes a mixture of relatively modern, residential and rural structures in a mostly open landscape. They do not demonstrate principal characteristics of a certain style or class. *(Not applicable)*
- The slaughterhouse may be a representative archaeological site type, particularly given the lack of research on this particular type of site. *(Applicable)*

Representative (g): Applicable (Moderate, Slaughterhouse only).
Inclusion guidelines satisfied:
- has the principal characteristics of an important class or group of items;
- has attributes typical of a particular way of life, philosophy, custom, significant process, design, technique or activity;

Integrity (Grades of Significance)

- The slaughterhouse is in a deteriorated condition. Much original fabric remains, which includes that of alterations made to the structure in the course of its operation. The ground itself does not appear to have been heavily disturbed. (Grade: Moderate).
- No visible evidence survives of the Red House. The location of potential subsurface remains is unclear. (Grade: Low).
- The c.1910 Cottage (Lot 141, DP986905) is in good condition and much of its original fabric remains. Some alterations have been made as part of the continued care of the residence (Grade: High).
- The farmhouse and associated structures at 254 Wollombi Road, are in poor repair. (Grade: Low).

Statement of Significance

As a whole, the subject land is not considered to have European historical, aesthetic, social or scientific heritage significance. It has only low local historical value for its association with the earlier Doyle Brook estate. While some areas contain prominent views to the Vineyards District (refer to Figure 4.2), the landscape itself is not aesthetically distinctive.[79] One cottage remains in tact from c.1910, that period associated with the mining history of Bellbird (Lot 141, DP986905). The wider

[79] The Vineyards District is significant for its evidence of the early winemaking industry and from which many of the present families and vignerons are related. With the rapid expansion of the wine industry and the development of the Vineyards District as a tourist area, a new cultural landscape has emerged along the visually prominent Broken Back Range.

landscape is not socially significant nor rare or representative. With the exception of the slaughterhouse and the site of the 'Red House', the site is not likely to contain relics that may provide information on the settlement or development of the Bellbird area.

The slaughterhouse is considered to have moderate historical and aesthetic scientific significance at a local level. It was part of local industry and the development of Bellbird. Although the slaughterhouse and associated structures are in a deteriorated condition, much original fabric remains. Phases of development can also be interpreted from the surviving structures. The ground itself does not appear to have been heavily disturbed, indicating a greater likelihood of in situ subsurface remains. The slaughterhouse may be a representative archaeological site type, particularly given the lack of research on this particular type of site. Few historical or archaeological studies of slaughterhouses have been carried out. The site has the potential to provide information not available from other sources and research opportunities that will substantially contribute to our knowledge of the past.

The site of the 'Red House' is considered to be of low historical and scientific significance at a local level. The site was that of Crawford's farmhouse (c.1843) where local bushranger Patrick Bruin was brought fatally wounded. Deserted by 1880, it was also used by teamsters as a camping place. However, no visible evidence survives of the Red House. Indeed, the location of potential subsurface remains is unclear, its former location being described as 'the farmland adjoining the western side of O'Neill's wine saloon'. Nonetheless, it is possible that subsurface remains of the Red House survive on Lot 1 DP 349452, off Wollombi Road. The site has some potential to provide information not available from other sources and research opportunities that may contribute to our knowledge of life at early nineteenth century farmhouses.

6. IMPACT OF THE PROPOSED SUBDIVISION.

6.1. Impact.

The proposed development is considered to have a potential impact on items of European environmental heritage. Specifically, these items are: the slaughterhouse, the site of the Red House, a cottage (c.1910) on Mt View Road (Lot 141, DP986905) and views to the Vineyards District. The farmhouse at 254 Wollombi Road is not considered to be a significant heritage item nor is its associated structures, its site or setting. No other items of European heritage were located during the present study.

In the vicinity of the subject land, the altered miners cottages and other residences are not considered to be significant heritage items that will be impacted by the development.

While the overall character of surrounding streets is of a single storey cottage style, no residences are unusual, much original fabric has been replaced and there is no sequence or series of intact heritage residences. Many similar cottages exist in the Bellbird and Cessnock townships which have retained a greater amount of original fabric. Indeed, most houses adjacent to the survey area, whether early or late twentieth century, consist of hardiplank cladding with aluminium windows.

The proposed development will involve the incorporation or demolition of the heritage items identified. Excavation works for road construction, new footings, service trenches and landscaping are likely to disturb potential subsurface remains. Views from vantage points (as shown in Figure 4.2) may also be impacted by the proposed development.

In the vicinity, O'Neill's Hotel is a public house situated on a main street (Wollombi Road) within a residential area. Similarly, cottages on the outskirts of the survey area are residential (medium density). The proposed development is also to be residential (mixed). As such, the development is not considered to impact heritage in the vicinity. Rather, it is likely to merge as an extension of the area's existing residential use.

6.2. Mitigating measures.

Archaeological sites.

Surface and subsurface relics at the Slaughterhouse and possibly the site of the Red House are by definition "material evidence" relating to the settlement of the Bellbird area that is "50 or more years old". Under the NSW Heritage Act 1977 these remains do constitute relics (refer to chapter 7). The proposed development may result in the disturbance of these relics. Given that these sites were found to be of moderate to low significance respectively, here their preservation is not considered to be warranted. However, measures should be taken to avoid the loss of archaeological information. As such, the slaughterhouse site should be recorded prior to and during development works that involve disturbance at the site (south west of Lot 1, DP597226) (refer to Chapter 8). Similar actions should be taken for the Red House should its remains be uncovered during works (possibly Lot 1, DP 349452) (refer to Chapter 8).

Views

Significant views, westward to the Broken Back Range may be obscured from Lots 1 and 2 (DP66183), Lot 1 (DP196460), Lot 3 (DP597226), further east from Cruckshank Street and on Lot 1 (DP34945) immediately southwest of O'Neill's Hotel (refer to Figure 4.2). Lots 1 and 2 (DP66183), Lot 1 (DP196460) and Lot 3 (DP597226) are already subject to *Cessnock Development Control Plan No.28* – Vineyards District in consideration of significant views. The northern half of Cruckshank Street (Lot 1, DP1011544) and the area immediately southwest of O'Neill's Hotel (Lot 1, DP34945) are located on higher ground and have clear views to the Vineyards District. Continuation of single storey housing along Cruckshank Street and southwest of O'Neill's Hotel, would help to preserve such views.

Heritage Buildings

The cottage on Mt View Road (Lot 141, DP986905) was found to be aesthetically significant and is associated with the historic period of rapid growth in Bellbird due to mining. Built in c.1910, the cottage has also retained much of its original fabric and should be considered for preservation. As a single storey residence (non-farming) on a relatively small allotment curtilage is not considered to be an issue.

7. STATUTORY OBLIGATIONS.

7.1. Statutory Obligations.

Statutory heritage listings are the principal means of protecting our State's heritage. In New South Wales the registers of statutory listings are:

• the State Heritage Register; and

• schedules to State, regional or local environmental plans (SEPP's, REP's and LEP's).

Various other non-statutory registers also exist including the National Trust Register and the Register of the National Estate (excluding Commonwealth-owned items).

Development Control Plans may also be produced with heritage guidelines. However, where inconsistencies exist between a DCP and an environmental planning instrument (SEPP, REP or LEP) the provisions of the environmental planning instrument will prevail.

The management of heritage items is shared between:

• local councils, responsible for items of local significance through heritage schedules to local environmental plans, and

• the Heritage Council, which retains its consent powers for alterations to items of State significance through the State Heritage Register.

The Subject Land.

The survey area, items on that land and/or items in its immediate vicinity have not been listed as items or places of environmental heritage in Schedule 3 of the Cessnock Local Environmental Plan 1989 (Update 2004), on the State Heritage Register (NSW), in the Hunter Regional Environmental Plan 1989 (Heritage) or on any other heritage register, either statutory or non-statutory (refer to Chapter 1).

7.2. Cessnock Local Environmental Plan 1989 (updated 24 December 2004).

Under Part 3(m) (Special Provisions) of the Cessnock Local Environmental Plan "development should protect the Aboriginal and European heritage values of the land". The present report has considered the European heritage value of the subject land and potential impacts of the proposed development on European heritage items situated on

the subject land, whether listed or unlisted in statutory or non-statutory heritage registers. Mitigating measures have been proposed in this report (refer to chapter 6).

Under Part 36 (Items of the environmental heritage) of the Cessnock Local Environmental Plan:
(1) A person shall not, in respect of a building, work, relic or place that is an item of the environmental heritage:
(a) demolish, renovate or extend that building or work,
(b) damage or despoil that relic or place or any part of that relic or place,
(c) excavate any land for the purpose of exposing or removing that relic,
(d) erect a building on the land on which that building, work or relic is situated or the land which comprises that place, or
(e) subdivide the land on which that building, work or relic is situated or the land which comprises that place,
except with the consent of Council.

(2) The Council shall not grant that consent unless it has made an assessment of:
(a) the significance of the item as an item of the environmental heritage of the City of Cessnock,
(b) the extent to which the carrying out of the development in accordance with the consent would affect the historic, scientific, cultural, social, archaeological, architectural, natural or aesthetic significance of the item and its site,
(c) whether the setting of the item and, in particular, whether any stylistic, horticultural or archaeological features of the setting should be retained, and
(d) whether the item constitutes a danger to the users or occupiers of that item or to the public.

The impact of the proposed development upon the European heritage significance of the subject land has been examined in chapter 6 of this report. Heritage significance has been assessed in Chapter 5 according to criteria standardized by the NSW Heritage Office (refer to Appendix 1). Relics are protected by State legislation. Refer below to the NSW Heritage Act 1977. Appropriate recommendations are made in Chapter 8 of this report.

7.3. Hunter Regional Environmental Plan 1989 (Heritage)

Part 13 Development in the vicinity of heritage items. "The Council shall not grant consent to an application to carry out development on land in the vicinity of a heritage item unless it has made an assessment of the effect the carrying out of that development will have on the heritage significance of the item and its setting". The present report has considered the heritage significance of and impact of the proposed development on heritage items in the vicinity of the subject land, whether listed or unlisted in statutory or non-statutory heritage registers. Mitigating measures have been proposed in this report (refer to chapter 6).

7.4. The NSW Heritage Act, 1977.

The relics provision of the NSW Heritage Act 1977 applies generally to all land in New South Wales. Relics are afforded automatic protection under the Act. Under Section 4(1) of the Act a 'relic' is defined as:

> Any deposit, object or material evidence relating to the settlement of the area that comprises New South Wales, not being Aboriginal settlement; and which is 50 or more years old.

For the protection of archaeological relics Section 139 of the *NSW Heritage Act 1977* provides that:

> (1) a person must not disturb or excavate any land knowing or having reasonable cause to suspect that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, moved, damaged or destroyed unless the disturbance or excavation is carried out in accordance with an excavation permit.
> (2) a person must not disturb or excavate any land on which the person has discovered or exposed a relic except in accordance with an excavation permit.

If a site is listed on the State Heritage Register or is the subject of an Interim Heritage Order then approval to excavate is required under section 60 of the NSW Heritage Act. If a site is not listed on the State Heritage Register or the subject of an Interim Heritage Order under the NSW Heritage Act then an excavation permit is required under section 140.

For the subject survey area at North Bellbird, where future works are likely to involve the disturbance or destruction of sub surface deposits or relics, the appropriate excavation permit (section 140) is required under the NSW Heritage Act 1977 prior to

the commencement of those works. Section 146 of the NSW Heritage Act requires that the accidental discovery of relics should be reported to the Heritage Council of NSW.

7.5. Development Control Plan No.28.

Under Part 9(g) of Development Control Plan No.28, it is an objective to "conserve the arboriginal archaeology and european heritage of the Vineyards District".[80]

As defined in Figures 1 and 2 of Development Control Plan No. 28, the 'Vineyards District' includes a small portion of the study area to the west and southwest (Refer to Figure 7.1). The DCP defines visually significant areas. Although not specifically designated themselves as "visually significant areas", the specified west and southwest portions of the study area are subject to DCP No.28. They include Lot 1 (DP196460), Lots 1 and 2 (DP66183), the northern part of Lot 2 (DP597226), and Lot 3 (DP597226).

[80] *Cessnock Development Control Plan No.28* – Vineyards District. 1999 (As amended 1st February 2002).

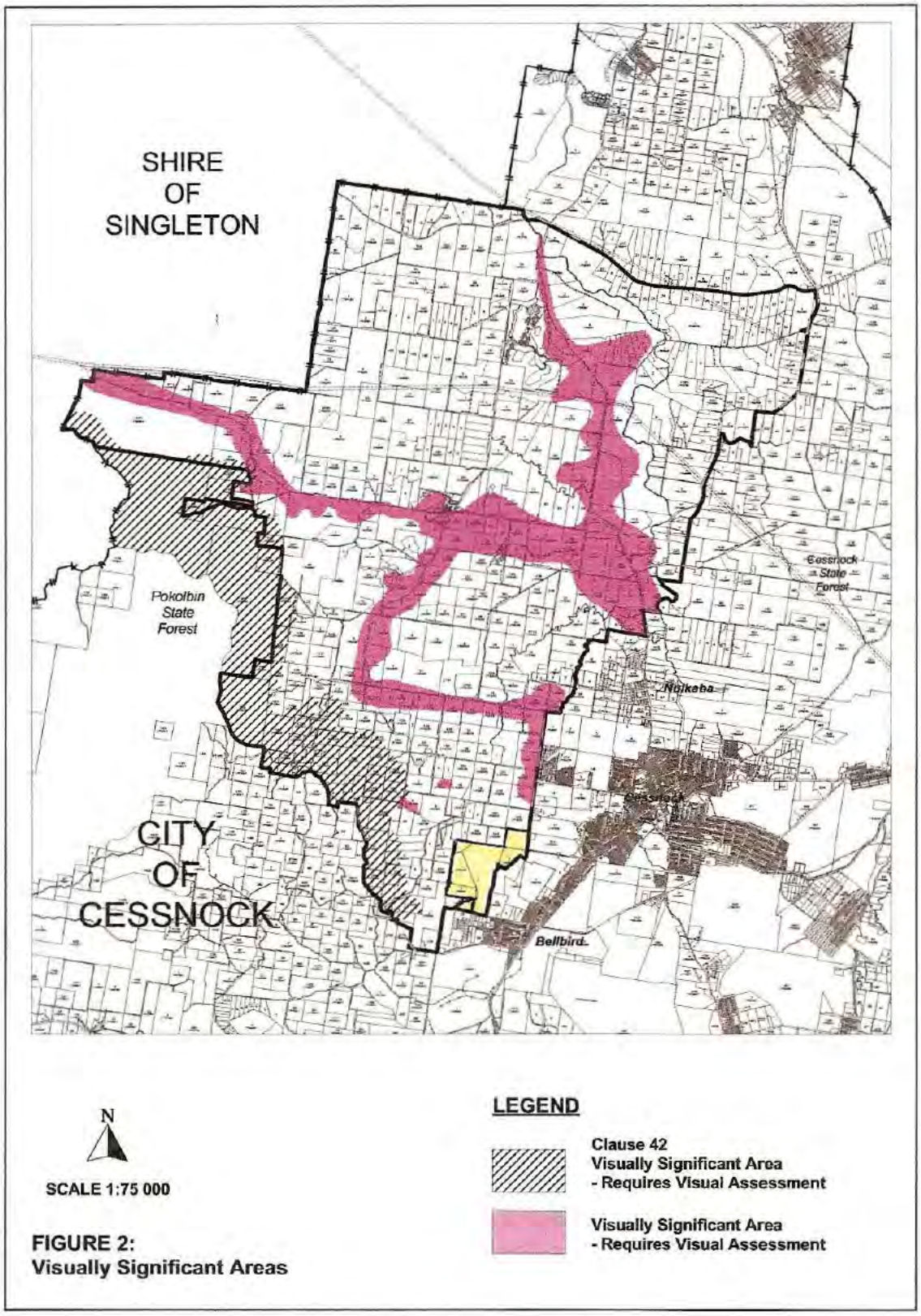


Figure 7.1. Visually Significant Areas, Figure 2 in *Cessnock Development Control Plan No.28* – Vineyards District. 1999 (As amended 1st February 2002). Those areas highlighted in yellow occur within the land subject to DCP No.28 and are also a part of the subject survey area.

8. RECOMMENDATIONS.

The following recommendations should be considered for the proposed rezoning and development at North Bellbird.

- The proposed development should not be prevented on European heritage grounds;
- Ruins and potential subsurface remains exist at the Slaughterhouse site shown in Figure 4.1 (Lot 1, DP597226). These relics are older than 50 years and have the potential to contribute significant information on the local industries of Bellbird. Should excavation or other works involving ground disturbance be undertaken at the site of the slaughterhouse, then an excavation permit under section 140 of the NSW Heritage Act 1977 will be required from the NSW Heritage Office prior to these works.[81] The appropriate application form is included as Appendix 2 of this report. Standing and surface structures or features at this site should be thoroughly recorded prior to their removal.
- Should remains of the Red House be uncovered then an appropriate excavation permit should be sought from the NSW Heritage Office under section 140 of the NSW Heritage Act 1977.
- Should buildings be erected along the north half of Cruckshank Street (Lot 1, DP1011544), on the east side of Lot 1 (DP349452) or in Carmichael Park, the Client should consider continuing single storey structures so as to help preserve views to the Vineyards District.
- With regard to significant views in Lot 1 (DP196460), Lots 1 and 2 (DP66183), Part Lot 2 (DP597226), and Lot 3 (DP597226), the Client should note the requirements of *Cessnock Development Control Plan No.28* – Vineyards District. 1999 (As amended 1st February 2002).
- The cottage along Mt View Road (Lot 141, DP986905) should be retained as an intact example of a residence from c.1910 and to preserve an aesthetic heritage element in the area.
- During any works at the subject site the accidental discovery of relics, other than those discussed in this report, should be reported immediately to the NSW

[81] As noted earlier in this report, no sites in the subject survey area are listed on the State Heritage Register or are the subject of an Interim Heritage Order.

Heritage Office and the appropriate excavation permit obtained (Heritage Act 1977, section 146).

- Should any Aboriginal objects be discovered during future works, or otherwise, then their accidental discovery should be reported to the Director General of the Department of Environment and Conservation (NSW) and the relevant permits should be obtained under section 91 of the National Parks and Wildlife Act 1974.

BIBLIOGRAPHY.

UNPUBLISHED SOURCES AND REPORTS.

Cessnock City Council. *Historical Tours in Greater Cessnock.* Eagle Print.

Cessnock No. 2 Colliery http://amol.org.au/Newcastle/greta/cs2.html

Darebins Australians. http://www.decc.org.au

Pike, Penelope and Meredith Walker & Assoc. 1994. *City of Cessnock Heritage Study*. Set A, Volume 1 (001-010)
Volume 2 (051-100)
Volume 6 (251-294)

Stedinger Associates. 2005. *Cessnock Home Central. Proposed Redevelopment. A Statement of Heritage Impact.* For Insite Planning Services Pty Ltd.

Stedinger Associates. 2005. *Excavation Report on Redevelopment Works at the Former Australian Sugar Company Mill, Canterbury.* For Grosvenor Residential Pty Ltd.

PUBLISHED SOURCES.

Andrews, Brian. J. 2000. *An Independent Look at the Pioneering Days of the Coalfields.* (No. 7) The Coalfield Heritage Group Inc.

Andrews, Brian. J. 2000. *An Independent Look at the Pioneering Days of the Coalfields*. (No. 12) The Coalfield Heritage Group Inc.

Armstrong, John (edt.). 1983. *Shaping the Hunter*. The Newcastle Division, Institution of Engineers, Australia

Bloomfield, Wm. A.G., 1954. Cessnock 1826-1954. *A History of the Cessnock District, with a special supplement on the Catholic Parish of Cessnock*. Catholic Church.

Cessnock Local Environmental Plan 1989 (updated 24 December 2004)

Clark, Manning. 1993. *Manning Clark's History of Australia*. Melbourne, Melbourne University Press.

Crowley, Frank (ed.). 1974. *A New History of Australia*. Melbourne, William Heinemann.

Delaney, John. 1998. *A History of the Greta Coal Measures (1861–1998).* Newcastle Regional Museum.

Cessnock Development Control Plan No.19 – Edden Street Bellbird. 1994.

Cessnock Development Control Plan No.28 – Vineyards District. 1999 (As amended 1st February 2002).

Hunter Regional Environmental Plan 1989 (Heritage).

Jay, Christopher. 1994. *The Coal Masters. The History of Coal & Allied 1844-1994.* Focus Publishing Pty Ltd.

Lowenstein, Wendy. 1978. *Weevils in the Flour: An Oral Record of the 1930s depression in Australia*. Melbourne, Hyland House.

Marquis-Kyle, P. and M. Walker, 1992. *The Illustrated Burra Charter. Making good decisions about the care of important places.* Australia ICOMOS Inc.

McNicol, Steve. 1982. *Coals to Maitland*. Railmac Publications

NSW Heritage Office and Department of Urban Affairs and Planning. 1996. *NSW Heritage Manual.* HO/DUAP, Sydney.

NSW Heritage Office and Department of Urban Affairs and Planning. 1996. *Regional Histories of New South Wales.* HO/DUAP, Sydney.
Supplements: • *Archaeological Assessments. Archaeological Assessment Guidelines.*1996.
• *Heritage Assessments.* 1996.
• *Statements of Heritage Impact.* 2001.

NSW Heritage Office and Department of Urban Affairs and Planning. 2001. *Assessing Heritage Significance.* Heritage Studies and Conservation Documents. HO/DUAP, Sydney.

PIX Magazine. 22 March 1952. *Cessnock – Coaltown.* 'Underground fires and bad industrial relations threaten the future of vital mining centre'.

Parkes, W.S., Comerford, Jim and Lake, Max. 1979. Mines, Wines and People. A History of Greater Cessnock. Council of the City of Greater Cessnock.

Paterson David. 1984. *Hunter Wine Country*. Hunter Wine Country, Pokolbin.

APPENDIX 1.

Heritage Assessment Criteria.

When assessing the significance of an item or site, four criteria are commonly used by heritage consultants and agencies in NSW. The criteria are derived from definitions in the Heritage Act 1977 (s.4), encompass values in the Australian ICOMOS Burra Charter, and have been standardised by the NSW Heritage Office and Planning N.S.W.[82] These criteria are: historical (evolution and association), aesthetic (scenic or architectural qualities, technical or creative accomplishment), social (contemporary community esteem) and scientific significance (archaeological, industrial, educational, research potential).

Further refining an assessment of significance, the degree of significance reflects the rarity, representativeness and integrity of an item or site. The level of significance is defined by whether an item or site is held to be significant in a state or local historical, geographical or community context. Some items may also be considered to be of National Significance.

In particular, archaeological significance depends upon the extent to which further studies of the physical evidence may reasonably be expected to provide information not available from other sources and to present the opportunity for research that will contribute to our understanding of the past. Here, the preservation of the site, the availability of comparative sites, and the extent of historical documentation are relevant.

Table 1. NSW heritage assessment criteria

(Gazetted following amendments to the Heritage Act in April 1999).

Criterion (a) ***Historical***	An item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area).
Criterion (b) ***Historical***	An item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local area).
Criterion (c) ***Aesthetic***	An item is important in demonstrating aesthetic characteristics and/ or a high degree of creative or technical achievement in NSW (or the local area).

[82] NSW Heritage Office and Department of Urban Affairs and Planning. *Assessing heritage significance,* HO/DUAP, Sydney, 2001.

Criterion (d) ***Social***	An item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons.
Criterion (e) ***Scientific***	An item has potential to yield information that will contribute to an understanding of cultural or natural history of NSW or the local area.
Criterion (f) ***Rarity***	An item possesses uncommon, rare or endangered aspects of cultural or natural history of NSW or the local area.
Criterion (g) ***Representativeness***	An item is important in demonstrating the principal characteristics of a class of cultural or natural places or cultural or natural environments of NSW or the local area.

Table 2. Grades of Significance.

Grading	**Justification**
Exceptional	Rare or outstanding element directly contributing to an item's local and state significance.
High	High degree of original fabric. Demonstrates a key element of the item's significance. Alterations do not detract from significance.
Moderate	Altered or modified elements. Elements with little heritage value, but which contribute to the overall significance of the item.
Little	Alterations detract from significance. Difficult to interpret.
Intrusive	Damaging to the item's heritage significance.

APPENDIX 2.

Excavation Permit Application Form (s140).

ANNE CLEMENTS & ASSOCIATES PTY. LIMITED
(ABN 41 077 242 365, ACN 077-160-939)
Environmental and Botanical Consultants
PO Box 1623, North Sydney 2059
Phone: (02) 9955 9733, Facsimile: (02) 9957 4343
Email: mail@acabotanic.com

25 July 2006

Flora assessment:

North Bellbird Investigation Area

Prepared by:

Dr AnneMarie Clements
Emma Laxton
Tony Rodd
Jane Rodd
Martin Sullivan

Prepared for:

Johnson Property Group Pty Ltd
Suite 3205 Level 32
Chifley Tower
2 Chifley Square
Sydney 2000
Phone: 02 9222 9900
Fax: 02 9232 5699

Contents

1.0 Introduction

2.0 Environmental Setting
2.1 Climate
2.2 Geology and soil landscape
2.2.1 Geology
2.2.2 Soil landscape
2.3 Land use

3.0 Flora
3.1 Previous studies
3.1.1 Previous studies on the Site
3.2 Current survey

3.2.1 Methods
3.2.2 Observations

4.0 Conservation significance
4.1 Communities
4.1.1 National
4.1.2 State
4.1.2.1 Comparison of the vegetation of the Site with the Final Determination for Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregion
4.1.2.1.1 Conclusions for Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregions
4.1.2.2 Comparison of the vegetation of the Site with the Final Determination for Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion
4.1.2.2.1 Conclusions for Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion
4.1.2.3 Conclusions for endangered ecological communities on the Site
4.2 Species
4.2.1 National
4.2.2 State

5.0 Noxious Weeds

6.0 NSW Rivers and Foreshores Improvement Act 1948

7.0 Conclusions

8.0 Recommendations

Acknowledgements

References

Figures
1. Location of the Site on the 1:25 000 Cessnock map sheet
2. Lot ownership overlain on the 2005/2006 aerial photograph
3. Cessnock LEP zoning map
4. Geology mapping (Brunker and Rose 1967)

5. Soil landscape mapping (Kovac and Lawrie 1985)
6. Vegetation Mapping (LHCCREMS 2003) overlain on 2005/2006 aerial photograph
7. Mapped creeklines, Sinclair Knight Merz Pty. Ltd. Study Area and Conacher Travers Study Area overlain on the 2005/2006 aerial photograph
8. Sampling Locations overlain on the 2005/2006 aerial photograph
9. Threatened Species and Endangered Ecological Communities recorded on the Site overlain on the 2005/2006 aerial photograph
10. Ecological constraints overlain on the 2005/2006 aerial photograph
11. Ecologically constrained land, constrained land to be cleared and vegetation to be re-established under a vegetation plan of management overlain on the 2005/2006 aerial photograph

Tables

1. Review of historical aerial photographs
2a. Species recorded in Quadrats on the Site
2b. Species recorded in Spot Locations on the Site
3. Maximum height and number of individuals for species >2m height within the quadrats

Appendices

1. Historical aerial photographs (1952, 1961, 1975, 1984, 1994 and 2004)
2. Description of Map units 17 and 19 (LHCCREMS 2003)
3. Photographic record
4. Final Determination for Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregion
5. Vegetation Classification (Specht *et al*. 1995)
6. Final Determination for Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion
7. Noxious Weeds in the Cessnock LGA

1.0 Introduction

This report assesses the vegetation of the approximately 500 ha at North Bellbird (the Site, Figure 1). The Site (Figure 2) consists of:

Lot	DP	Area	Access given
PT 1	66183	PT 9.785 ha	Yes.
2	66183	16.43 ha	Yes.
1	167004	1.4 ha	No. Viewed from aerial photograph.
1	196460	30.12 ha	No. Viewed over fences and from aerial photographs.
1	196997	6.726 ha	Yes.
1	327580	6.665 ha	Yes.
1	327785	47.84 ha	Yes.
1	328497	2.464 ha	Yes.
1	328498	4.191 ha	Yes.
1	329071	2.00 ha	Yes.
1	349452	1.897 ha	Yes.
261	524058	2.681 ha	Yes.
1	597226	28.35 ha	Yes.
2	597226	65.97 ha	Yes.
3	597226	93.71 ha	Yes.
2	624793	0.5561 ha	Yes.
3	624793	3.551 ha	Yes.
10	806584	19.4 ha	Yes.
11	806584	0.8237 ha	Yes.
PT51	807540	PT 1.162 ha	Yes.
52	807540	0.6239 ha	Yes.
3	810827	11.45 ha	No. Viewed from aerial photographs.
10	815485	2.00 ha	No. Viewed from aerial photographs.
11	815485	41.76 ha	No. Viewed from aerial photographs.
PT13	880374	PT 11.15 ha	No. Viewed from aerial photographs.
141	986905	1.2 ha	No. Viewed from aerial photographs.
1	1011544	34.97 ha	Yes.
2	1011544	2.397 ha	Yes.
210	1012346	2.00 ha	Yes.
211	1012346	40.73 ha	Yes.
212	1053307	2.52 ha	Yes.
		496.5 ha	

The Site is within the Cessnock Local Government Area (LGA).

On the Cessnock Local Environmental Plan 1989 (Figure 3), the Site is classified as:

- 1(a) - Rural "A" Zone; and
- 1 (v) - Rural (Vineyards) Zone.

In Cessnock Council City Wide Settlement Strategy (CWSS), the Site has been identified for investigation as urban development. The Stage 1 CWSS was adopted by Council on 10 December 2003 and endorsed by the Department of Infrastructure, Planning and Natural Resources (now the Department of Planning and the Department of Natural Resources) on 30 June 2004. It is described as:

> *The CWSS (Stage 1) sets future direction for population growth throughout the Cessnock LGA for the next 10 years, 'captures' land for closer residential settlement beyond the 10 year timeframe, provide the basis for new planning policy for rural tourism and the foundation for sustainable planning policy which balances growth with the natural, scenic and cultural assets of the LGA. It is intended that the Strategy will inform the content of a new planning instrument.*

Where land adjacent to land zoned 1(v) is considered suitable for development, consideration will need to be given to Cessnock City Council's DCP No.28 – Vineyards District, in particular clause 11.

2.0 Environmental Setting

The Site is bounded by (Figures 1 and 2):

- to the north, rural land with Mount View Park Sports Field to the north-east, and to the north of Mount View Road are The Oaks Golf Course, Mount View High School, the suburb of Mountview and vineyards;
- to the south, Tennant Street with the suburb of Bellbird south of Tennant Street;
- to the east, the suburb of Bellbird Heights; and
- to the west, rural grazing land with vineyards and olive groves in the south-west.

Aberdare State Forest is located about 1 km south-east of the southern section of the Site.

The Site is gently undulating, varying in altitude from 150 m AHD on the Derby Lodge vineyards in the south-west to 80 m AHD along Bellbird Creek in the east (Figure 1).

Bellbird Creek and Limestone Creek cross the Site. Limestone Creek joins Bellbird Creek in the north-east of the Site. There are approximately five north to north-east flowing tributaries of Limestone Creek draining from the higher land in the south-west of the Site (Figure 1).

2.1 Climate

The nearest meteorological station at Cessnock Post Office (Station No. 61009, elevation 80 m, operated from 1903 to 1992) is located approximately 2 km north-east of the Site.

From the recorded climate data for Cessnock (Bureau of Meteorology website (www.bom.gov.au/climate accessed 30 March 2006), the recorded mean annual daily maximum temperature is 25 ^{o}C, and the mean annual daily minimum temperature is 11°C. The highest mean monthly maximum temperature was recorded for January (30.2^{o}C) and the lowest mean monthly minimum temperature for July (4.2^{o}C).

The recorded mean annual rainfall is 748 mm, with highest average monthly rainfall in February (88 mm) and lowest in August (40 mm). The mean number of raindays per annum is 84 days.

2.2 Geology and soil landscape

2.2.1 Geology

The geology of the Site (Figure 4) has been mapped by Brunker and Rose (1967) at a scale of 1:500 000 as Dalwood Group (map unit Pd). Dalwood Group is of Permian origin and is described as:

Sandstone, siltstone, mudstone, shale, conglomerate, tuff, basalt, erratics.

The Dalwood geological map unit occurs to the north, west and south of the Site with Greta Coal Measures (map unit Pgc) to the east of the Site.

2.2.2 Soil landscape

The soil landscape (Figure 5) has been mapped by Kovac and Lawrie (1985) at a scale of 1:250 000 as:

- Branxton (map unit bx) over most of the Site. Branxton soil landscape consists of undulating rises to low hills and is described as:

  Permian sandstone, shale, mudstone, siltstone, tuff and coal seams. Undulating rises to low hills, relief 10-40 m, slopes to 5%.Yellow podsolic Soils on midslopes, with Red Podzolic Soils on crests. Yellow Soloths on lower slopes and in drainage lines. Alluvial Soils in some creeks;

- Polkobin (map unit pk) in the west . Polkobin soil landscape consists of undulating low hills and some rolling hills and is described as:

  Varied lithology includes Permian lithic sandstone, shale limestone, lava, conglomerate and coal. Undulating low hills and some rolling hills, relief 40-90 m, slopes 2-13%. Yellow Podzolic Soils on mid to upper slopes. Red Clays and Red Podzolic soils on higher slopes. Prairie Soils in large drainage systems with Chocolate soils on lower slopes. Red-brown Earths on crests of marl, with red Soloths on lower slopes. Xanthozems may also occur; and

- Aberdare (map unit ad) on the central southern boundary. Aberdare soil landscape consists of rolling low hills, some rolling hills and is described as:

  Permian sandstone, conglomerate and siltstone. Rolling low hills, some rolling hills, relief 60-100 m, slopes 12-15%. Yellow Podzolic Soils on upper to midslopes. Red Podzolic Soils on some steeper slopes. Brown Podzolic Soils also occur. Alluvial Soils are found in some drainage lines.

2.3 Land use

From the historic aerial photographs (1952, 1961, 1975, 1984, 1994, 2004 in Appendix 1, Table 1) of the Site held by Land and Property Information, there has been little change in land use over the past 54 years, except the clearing of forest vegetation upslope of the steep side gullies in the south in 1984.

The native forest trees were not cleared:

- in the naturally steep side valleys in the south of the Site,
- in the wetter areas of Bellbird Creek in the east; and

- the hill slopes above 110 m AHD in the central section adjoining the northern boundary.

The Site is agricultural and has been grazed with some cropping in paddocks and vineyards in the west. All of the land shows signs of grazing with the possible exception of the steep sided valley in the south.

3.0 Flora

3.1 Previous studies

The Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) (**2003)** mapped the vegetation of the Lower Hunter and Central Coast region at a scale of 1:25 000.

Two vegetation communities were mapped on the Site (Figure 6), namely:

- Lower Hunter Spotted Gum – Ironbark Forest (map unit MU 17); and
- Hunter Lowland Redgum Forest (map unit MU 19).

The full descriptions of these two units are given in Appendix 2.

Lower Hunter Spotted Gum – Ironbark Forest (map unit MU 17):

> *is widespread throughout the central to lower Hunter Valley*. Corymbia maculata *and* Eucalyptus fibrosa *typically dominate the canopy. In localised areas* Eucalyptus punctata *and/or* E. canaliculata *may occur as a dominant to codominant feature*. *There is a wide variety of infrequently occurring eucalypts reflecting subtle variations in substrate characteristics. These include the northern limit of* Corymbia eximia, Eucalyptus fergusonii *subsp*. fergusonii *and species common to the coastal ranges such as* E.acmenoides, E. umbra *and* E.paniculata. *The understorey is marked by prickly shrubs* Daviesia ulicifolia, Acacia parvipinnula *and* Melaleuca nodosa. Melaleuca nodosa *often forms dense shrub thickets. The ground layer is very diverse but notable by the frequent occurrence of* Cheilanthes sieberi *subsp*. sieberi, Entolasia stricta, Pomax umbellata, Pratia purpurascens, Themeda australis, Phyllanthus hirtellus, *and* Dianella revoluta *var.* revoluta.
>
> *Forests between Cessnock and Beresfield form the core of its distribution*…
>
> …*this assemblage is characterised by stands of young regrowth eucalypts from previous timber management activities. Evidence of regular fire disturbance is also apparent across its range.*

Hunter Lowland Redgum Forest (map unit MU 19):

> *is an open forest that characterises simple open depressions and drainage flats on the Permian Sediments of the Hunter Valley floor. An array of Eucalypts occurs, with the most frequently recorded being* Eucalyptus tereticornis *and* Eucalyptus punctata*. It is not uncommon that* Angophora floribunda*,* Eucalyptus crebra*,* Eucalyptus moluccana *and* Corymbia maculata *appear where the assemblage grades with the surrounding Spotted Gum-Ironbark Forests. The mid-strata are generally open with sparse shrubs of* Breynia oblongifolia, Leucopogon juniperinus, Daviesia ulicifolia*, and* Jacksonia scoparia*. More obvious is the consistent layer of grasses and herbs* Microlaena stipoides *var*. stipoides, Cymbopogon refractus*, and* Echinopogon caespitosus *var*. caespitosus*,* Cheilanthes sieberi *and* Pratia purpurascens*.*

Hunter Lowland Redgum Forest extends from Muswellbrook to the Lower Hunter where it appears on gentle slopes arising from depressions. Much of its former extent has been depleted for agricultural activities.

3.1.1 Previous studies on the Site

Conacher Travers (2003) assessed the vegetation of 2.397 ha of Lot 2 DP 1011544 Wollombi Road, Bellbird in the east of the Site (Figure 7). There was a total of 49 species observed with 14 native and 35 exotic species. Two communities were identified:

- Exotic Grassland; and
- Riparian Vegetation.

In terms of flora conservation significance, no listed species nor endangered ecological communities on the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, no species nor endangered ecological communities on the NSW Threatened Species Conservation Act 1995 were recorded.

It was recommended that:

- *Riparian Vegetation should be protected as part of the future development of the subject site.*
- *Where practicable, existing trees should be incorporated into future lot design.*

Sinclair Knight Merz Pty Ltd. (2004) on 82.365 ha of Lot 1 DP 1011544, Lot 211 DP 1012346 and Lot 1 DP 327580 Wollombi Road, Bellbird in the east of the Site (Figure 7) found:

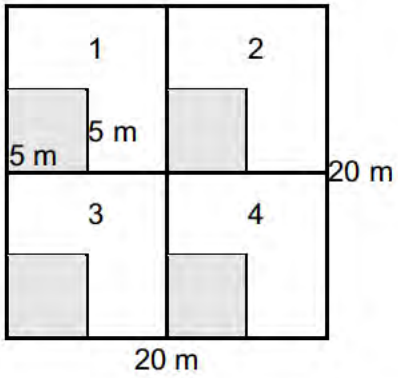
> *In all, one hundred and seventy-seven (177) different plant species from sixty-seven (67) families were represented (recorded from all field surveys). This total comprised of five (5) species of fern, sixty-one (61) species of monocotyledonsand one-hundred and eleven (111) species of dicotyledons. Of this total seventy (70) introduced species are present, comprising 39.5% of the total species recorded. A total of eight (8) flora species regarded as noxious were recorded within the study area.*
>
> *…No species regarded as threatened under the TSC Act or the EPBC Act were recorded within the study area despite detailed surveys of the study area. Additionally, no species regarded as Rare or Threatened Australian Plants (ROTAP) were detected…*
>
> *… One vegetation community listed as Endangered on the TSC Act was recorded…Hunter Lowland Red Gum Forest.*

3.2 Current survey

A total of 290 species (216 native and 74 exotic) were recorded (Figure 8, Tables 2a, 2b and 3) by Dr AnneMarie Clements, Tony Rodd, Jane Rodd, Emma Laxton and Martin Sullivan on 30 March to 3 April 2006.

3.2.1 Methods

The 20 m x 20 m quadrats consisted of four contiguous 10 m x 10 m subquadrats. The layout of the quadrats and sub-quadrats was as follows:



In each of the 10 m x 10 m sub-quadrats, the relative frequency of plant species in the quadrats was assessed by recording the presence/absence of each species in 5 m x 5 m sub-quadrats (Table 2a).

In each 10 m x 10 m quadrat, the numbers of individuals and heights of all tree species were recorded (Table 3). Plant species that were found in the 20 m x 20 m quadrat but not in any of the 5 m x 5 m sub-quadrats were also recorded.

Supplementary data was recorded at 17 Spot locations (A to Q) (Figure 8, Table 2b). The sampling consisted of recording species present within an approximately 10 m radius (Table 2b).

The sampling locations were photographed at the time of survey (Appendix 3).

Nomenclature is consistent with Harden (1990-1993, 2002) and Harden and Murray (2000) and subsequent taxonomic changes as published in *Telopea*, the Sydney Royal Botanic Gardens' journal of systematic botany, and in other Australian taxonomic literature. The Gardens' PlantNet web pages (plantnet.rbgsyd.nsw.gov.au) incorporating Flora Online is the major source for updated taxonomy.

3.2.2 Observations

The vegetation composition of the Site varied from cleared grazing paddocks across much of the Site to remnant forest vegetation in the south associated with the upper reaches of Limestone Creek.

Cleared grazing paddocks without remnant trees

The cleared grazing paddocks (sampled in Quadrats 6, 8, 11, 13, 14, 15, 16, 19, and Spot locations G and L) were dominated by the exotic pasture grasses *Paspalum dilatatum* (Paspalum), *Axonopus affinis* (Narrow-leaved Carpet Grass) and the cosmopolitan native grass species *Cynodon dactylon* (Couch).

33 (52%) of the 64 species recorded in cleared paddock sampling locations were exotic. Commonly recorded exotic species included *Hypochaeris radicata* (Catsear), *Senecio madagascariensis* (Fireweed) and *Setaria gracilis* (Slender Pigeon Grass).

Commonly recorded native species included *Microlaena stipoides* (Meadow Rice-grass), *Eragrostis brownii* (Brown's Lovegrass) and *Sporobolus creber* (Slender Rat's-tail Grass).

There was no canopy or midstorey present in these paddocks.

Grazing paddocks with remnant trees

The grazing paddock with remnant trees in the south of the Site had a canopy structure consisting of *Eucalyptus acmenoides* (White Mahogany) up to 15 m and *Eucalyptus fibrosa* (Broad-leaved Red Ironbark) up to 13 m (sampled in Quadrat 5). The grazing paddocks with remnant trees in the central and north-western areas of the Site had a canopy structure consisting of *Eucalyptus moluccana* (Grey Box) up to 18 m and *Eucalyptus tereticornis* (Forest Red Gum) up to 25 m (sampled in Quadrats 7 and 26).

Due to grazing pressure, the midstorey was absent in these sampling locations.

The groundcover recorded was diverse with 58 (74%) of the 78 recorded species being native and consisted of *Brunoniella australis* (Blue Trumpet), *Chloris ventricosa* (Tall Windmill Grass), *Cyperus gracilis* (Slender Sedge), *Dichondra repens* (Kidney-weed), *Einadia trigonos* (Fishweed), *Glycine tabacina*, *Microlaena stipoides* (Meadow Rice-grass), *Paspalidium distans*, and *Sporobolus creber* (Slender Rat's-tail Grass).

Exotic species recorded included the pasture grass *Paspalum dilatatum* (Paspalum), *Plantago lanceolata* (Plantain), *Sida rhombifolia* (Paddy's Lucerne) with the cosmopolitan native grass species *Cynodon dactylon* (Couch) and the noxious weeds *Lycium ferocissimum* (African Boxthorn), *Opuntia stricta* (Prickly Pear) and *Xanthium spinosum* (Bathurst Burr).

Forested vegetation along and adjoining Bellbird Creek

The forested vegetation in the east of the Site along and adjoining Bellbird Creek (sampled in Quadrats 10, 12 and Spot location E and J) was predominantly native with 55 (71%) of the 77 recorded species being native. The vegetation was of woodland structure with a variety of eucalypt canopy species recorded including: *Eucalyptus moluccana* (Grey Box) up to 20 m, *Eucalyptus tereticornis* (Forest Red Gum) up to 18 m, *Eucalyptus fibrosa* (Broad-leaved Red Ironbark) and *Eucalyptus acmenoides* (White Mahogany).

Melaleuca styphelioides (Prickly Paperbark) was recorded in all sampling locations along Bellbird Creek, with a particular dominance of the vegetation recorded at Spot Location I. A dense stand of *Casuarina glauca* (Swamp Oak) was recorded at Spot Location E, which suggests saline groundwater.

There was no midstorey present at these sampling locations possibly due to past land management practises such as logging, under-scrubbing and grazing.

The native groundcover was diverse and included *Brunoniella australis* (Blue Trumpet), *Carex appressa* (Tall Sedge), *Chrysocephalum apiculatum* (Common Everlasting), *Cyperus gracilis* (Slender Sedge), *Eragrostis leptostachya* (Paddock Lovegrass) and *Notodanthonia longifolia* with saplings of *Notelaea longifolia* (Mock-olive) recorded in Quadrats 10 and 12. The cosmopolitan native grass species *Cynodon dactylon* (Couch) was recorded in all sampling locations along and adjoining Bellbird Creek.

Commonly recorded exotic species included the pasture grass *Paspalum dilatatum* (Paspalum) with *Axonopus affinis* (Narrow-leaved Carpet Grass), and exotic herbaceous species *Verbena brasiliensis* being recorded less frequently.

The exotic tree *Schinus areira* (Pepper Tree, Peppercorn) was recorded adjoining the creek at Spot locations E and J.

The noxious weeds *Cestrum parqui* (Green Cestrum), *Lantana camara* (Lantana) and *Opuntia stricta* (Prickly Pear) were also recorded along and adjoining Bellbird Creek.

Vegetation of Limestone Creek in the central areas of the Site

The vegetation of Limestone Creek (sampled at Spot locations B, F, K, M, N) had a large proportion (41%, 31 of 75 species recorded) of exotic species. The creek vegetation has remained largely cleared since at least 1952.

Limestone Creek had scattered *Eucalyptus tereticornis* (Forest Red Gum) along its banks, with *Angophora floribunda* (Rough-barked Apple) being recorded at Spot Location M.

The midstorey was absent along Limestone Creek due to grazing pressure.

The groundcover was dominated by the pasture grass *Paspalum dilatatum* (Paspalum) and the cosmopolitan native grass species *Cynodon dactylon* (Couch).

Native groundcovers recorded included *Bothriochloa decipiens* (Redleg Grass), *Eragrostis leptostachya* (Paddock Lovegrass), *Rubus parvifolius* (Native Raspberry) and the climber *Cayratia clematidea* (Slender Grape) with *Typha orientalis* (Broad-leaf Cumbungi, Bulrush) in the creek.

Forest vegetation in the south of the Site adjoining Limestone Creek

The vegetation in the south of the Site adjoining Limestone Creek was primarily forest in structure, in good condition and with high species diversity with 128 (86%) of 148 species recorded being native.

The forest vegetation in the south of the Site adjoining Limestone Creek (sampled in Quadrat 1, 3, 20, 24, 25 and Spot Location A, C, D and P) had a canopy dominated by *Corymbia maculata* (Spotted Gum) up to 22 m, *Eucalyptus fibrosa* (Broad-leaved Red Ironbark) up to 30 m and *Eucalyptus moluccana* (Grey Box) up to 22 m with *Eucalyptus acmenoides* (White Mahogany), *Eucalyptus paniculata* (Grey Ironbark) and *Eucalyptus tereticornis* (Forest Red Gum) being recorded less frequently.

The midstorey was dominated by *Breynia oblongifolia* (Coffee Bush), *Bursaria spinosa* (Australian Boxthorn), *Daviesia ulicifolia* (Gorse Bitter-pea) and *Maytenus silvestris* with *Acacia parvipinnula* (Silver-stemmed Wattle), *Brachychiton populneus* subsp*. populneus* (Kurrajong) and *Dodonaea viscosa* subsp*. angustifolia* (Sticky Hopbush) being recorded less frequently.

The native groundcover was especially diverse with *Aristida ramosa* var*. ramosa* (Wiregrass), *Aristida vagans* (Threeawn Speargrass), *Arthropodium milleflorum* (Vanilla Lily), *Brunoniella australis* (Blue Trumpet), *Cheilanthes sieberi* subsp*. sieberi* (Rock Fern), *Commelina cyanea* (Blue Spiderwort), *Cymbopogon refractus* (Barbed Wire Grass), *Dianella longifolia* (Smooth Flax-lily), *Dichondra repens* (Kidney-weed,), *Einadia nutans* subsp*. linifolia* (Climbing Saltbush), *Einadia trigonos* (Fishweed), *Eragrostis leptostachya* (Paddock Lovegrass), *Eustrephus latifolius* (Wombat Berry), *Lomandra filiformis* subsp*. filiformis* (Wattle Mat-rush), *Lomandra*

multiflora (Many-flowered Mat-rush), *Microlaena stipoides* (Meadow Rice-grass), *Paspalidium distans* and *Themeda australis* being commonly recorded.

The vulnerable species *Prostanthera cineolifera* (Singleton Mint-bush) scheduled on the NSW TSC Act (1995) was recorded in Spot Location P.

The vegetation in the south of the Site adjoining Limestone Creek was relatively free of exotic species, with *Paspalum dilatatum* (Paspalum) and *Sida rhombifolia* (Paddy's Lucerne) only being recorded in half of the sampling locations. The noxious weeds *Bryophyllum delagoense* (Mother-of-Millions), *Lantana camara* (Lantana), *Lycium ferocissimum* (African Boxthorn) and *Opuntia stricta* (Prickly Pear, Common Pest Pear) were recorded in this area.

Forest vegetation in the south of the Site on the slopes of Limestone Creek

The forest vegetation in the south of the Site on the slopes of Limestone Creek (sampled in Quadrats 2, 4, 21, 22 and 23) had a canopy dominated by *Corymbia maculata* (Spotted Gum) up to 22 m and *Brachychiton populneus* subsp*. populneus* (Kurrajong) up to 13 m with *Eucalyptus acmenoides* (White Mahogany), *Eucalyptus fibrosa* (Broad-leaved Red Ironbark), *Eucalyptus moluccana* (Grey Box), *Eucalyptus paniculata* (Grey Ironbark) and *Eucalyptus tereticornis* being recorded less frequently.

The midstorey on the slopes of Limestone creek was particularly diverse with *Acacia parvipinnula* (Silver-stemmed Wattle), *Alectryon tomentosus* (Hairy Bird's-eye), *Breynia oblongifolia* (Coffee Bush), *Bursaria spinosa* (Australian Boxthorn), *Leucopogon juniperinus* (Long-flowered Beard-heath), *Maytenus silvestris* and *Notelaea longifolia* (Mock-olive) being recorded frequently.

Other species present in the midstorey but not frequently recorded included *Acacia floribunda* (White Sally), *Acacia implexa* (Hickory Wattle), *Backhousia myrtifolia* (Grey Myrtle), *Cassine australis* (Red Olive-Plum), *Clerodendrum tomentosum* (Hairy Clerodendrum), *Daviesia ulicifolia* (Gorse Bitter-pea) and *Exocarpos cupressiformis* (Cherry Ballart).

The vulnerable species *Prostanthera cineolifera* (Singleton Mint-bush) scheduled on the NSW TSC Act (1995) was recorded in Quadrat 2, with 13 individuals up to 6 m in height.

There was a significant component of vines in the forest vegetation on the slopes of Limestone Creek including *Cayratia clematidea* (Slender Grape), *Clematis glycinoides* (Headache Vine), *Eustrephus latifolius* (Wombat Berry), *Geitonoplesium cymosum* (Scrambling Lily), *Glycine tabacina*, *Hardenbergia violacea* (False Sarsaparilla), *Jasminum volubile* (Native Jasmine), *Kennedia rubicunda* (Dusky Coral-pea), *Maclura cochinchinensis* (Cockspur Thorn) and *Pandorea pandorana* (Wonga Vine),

The groundcover was diverse with *Aristida vagans* (Threeawn Speargrass), *Brunoniella australis* (Blue Trumpet), *Cheilanthes sieberi* subsp*. sieberi* (Rock Fern), *Cymbopogon refractus* (Barbed Wire Grass), *Desmodium varians* (Slender Tick-trefoil), *Dianella caerulea* var*. cinerascens* (Blue Flax-lily), *Glycine tabacina*, *Imperata cylindrica* (Blady Grass), *Lomandra filiformis* subsp*. filiformis* (Wattle Mat-rush), *Paspalidium distans*, *Phyllanthus gunnii* and *Themeda australis* (Kangaroo Grass) all being recorded frequently.

The exotic species component was low with 23 (15%) of 154 species recorded being exotic. Commonly recorded species included the pasture grass *Paspalum dilatatum* (Paspalum) and the noxious weed *Lantana camara* (Lantana).

Forest vegetation in the north of the Site

The vegetation in the north of the Site had a tree canopy of *Eucalyptus tereticornis* (Forest Red Gum) up to 23 m with *Eucalyptus moluccana* (Grey Box) up to 25 m (sampled in Quadrats 9 and 18) and *Corymbia maculata* (Spotted Gum) up to 20 m with *Eucalyptus fibrosa* (Broad-leaved Red Ironbark) up to 20 m (sampled in Quadrat 17).

The midstorey was depauperate due to the present management regimes of under-scrubbing and grazing. Species present in the midstorey were limited to *Bursaria spinosa* (Australian Boxthorn), *Daviesia ulicifolia* (Gorse Bitter-pea) and *Solanum stelligerum* (Devil's Needles).

The native groundcover consisted of *Aristida ramosa* var*. ramosa* (Wiregrass), *Brunoniella australis* (Blue Trumpet, Blue Yam), *Cymbopogon refractus* (Barbed Wire Grass), *Dichondra repens* (Kidney-weed, Mercury Bay Weed), *Eragrostis leptostachya* (Paddock Lovegrass), *Glycine tabacina*, *Microlaena stipoides* (Meadow Rice-grass), *Oxalis perennans*, *Paspalidium distans* and *Vernonia cinerea*.

Exotic species recorded included *Paronychia brasiliana* (Chilean Whitlow Wort), *Paspalum dilatatum* (Paspalum), *Plantago lanceolata* (Plantain, Ribwort), *Senecio madagascariensis* (Fireweed) and *Sida rhombifolia* (Paddy's Lucerne) with the noxious weeds *Lycium ferocissimum* (African Boxthorn) and *Xanthium spinosum* (Bathurst Burr) being recorded.

Low lying drainage depressions along Bellbird Creek

The low lying drainage depression in the east of the Site (sampled in Spot Locations I and H) was characterised by *Carex appressa* (Tall Sedge), *Juncus usitatus* and *Persicaria hydropiper* (Water Pepper).

In the more open waterbody at Spot location H, *Eleocharis sphacelata* (Tall Spike-rush) was recorded, as were *Ludwigia peploides* subsp*. montevidensis* (Water Primrose) and *Melaleuca linariifolia* (Flax-leaved Paperbark).

Other native species recorded at Spot location I included *Eleocharis pallens* (Pale Spike-rush).and *Melaleuca styphelioides* (Prickly Paperbark).

In the more open waterbody at Spot location H no exotic species were recorded, whereas nine exotics were recorded at Spot location I.

Agricultural dam

The agricultural dam in the north of the Site (sampled in Spot Location O) had a swampy vegetation structure consisting of *Typha orientalis* (Broad-leaf Cumbungi, Bulrush), *Potamogeton tricarinatus* (Floating Pondweed), *Ludwigia peploides* subsp*. montevidensis* (Water Primrose), Eleocharis pallens (Pale Spike-rush) and *Cyperus difformis* (Dirty Dora).

Olive grove

The olive grove in the southwest of the Site (Sampled in Spot Location O) appears to have been planted post 1994. The presence of *Olea europaea* subsp. *europaea* was observed from east of the property boundary.

4.0 Conservation significance

The conservation significance of the communities and species recorded in the Site were assessed at a:

- National level against the schedules of the Commonwealth Environment Protection and Biodiversity Conservation Act (1999) (EP&BC Act). The EP&BC Act lists threatened ecological communities and species, and is a Commonwealth assessment and approval system for:
  - Actions that have a significant impact on matters of national environmental significance;
  - Actions that have a significant impact on the environment of Commonwealth land and;
  - Actions carried out by the Commonwealth Government.
- State level against the schedules of the Threatened Species Conservation Act 1995 (TSC Act).

4.1 Communities

4.1.1 National

From a search of the EP&BC Act online database (www.deh.gov.au/epbc accessed on 31 March), no endangered ecological communities listed in the EP&BC Act are known to occur within a 10 km radius of the Site.

4.1.2 State

A search of the final determinations listed on the NPWS Website (www.nationalparks.nsw.gov.au accessed 31 March 2006) revealed six endangered ecological community are listed in the TSC Act as previously occurring in the Cessnock Local Government Area, namely:

Endangered Ecological Community	Habitat	Likely to occur on the Site?
Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	associated with periodic or semi-permanent inundation by freshwater, although there may be minor saline influence in some wetlands. They typically occur on silts, muds or humic loams in depressions, flats, drainage lines, backswamps, lagoons and lakes associated with coastal floodplains. Freshwater Wetlands on Coastal Floodplains generally occur below 20 m elevation in the NSW North Coast, Sydney Basin and South East Corner bioregions	No. The Site is not a coastal floodplain.
Hunter Lowland Redgum	found on gentle slopes arising from	Possible.

Forest in the Sydney Basin and NSW North Coast bioregion	depressions and drainage flats on permian sediments of the Hunter Valley floor	
Kurri sand swamp woodland in the Sydney Basin Bioregion	occurs on soils developed over poorly-drained Tertiary sand deposits that blanket Permian sediments around Kurri Kurri	No. The Site is on Permian deposits.
Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion	occurs principally on Permian geology in the central to lower Hunter Valley. The community is strongly associated with, though not restricted to, the yellow podsolic and solodic soils of the Lower Hunter soil landscapes of Aberdare, Branxton and Neath (Kovac and Lawrie 1991).	Possible.
Quorrobolong scribbly gum woodland in the Sydney Basin Bioregion.	occurring on a residual sand deposit overlying the Permian clay sediments in the Hunter Valley	No. The Site is on Permian deposits.
River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. River-Flat Eucalypt Forest on Coastal Floodplains generally occurs below 50 m elevation, but may occur on localised river flats up to 250 m above sea level	No. The Site is not a coastal floodplain.
Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner bioregions	associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains. Generally occurs below 20 m (rarely above 10 m) elevation	No. The Site is not a coastal floodplain.

It is possible that the endangered ecological communities, Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregion and Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion may occur on the Site.

4.1.2.1 Comparison of the vegetation of the Site with the Final Determination for Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregions

The Scientific Committee has found that:

> *1. Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions is the name given to the ecological community found on gentle slopes arising from depressions and drainage flats on permian sediments of the Hunter Valley floor in the Sydney Basin and NSW North Coast Bioregions and characterised by the following assemblage of species* [listed in Appendix 4]:

The Site at Bellbird North near Cessnock is in the Sydney Basin Bioregion (NPWS 2003), hence satisfying the location criteria.

The soil landscapes mapped by Kovac and Lawrie (1985) at a scale of 1:250 000 on the Site (Figure 5) are those of:

- undulating rises to low hills (Branxton map unit bx) over most of the Site,
- undulating low hills and some rolling hills in the west (Polkobin map unit pk); and
- rolling low hills, some rolling hills (Aberdare map unit ad) on the central southern boundary.

The Site is crossed by creeks with drainage depressions. .

The geology of the Site (Figure 4) has been mapped by Brunker and Rose (1967) at a scale of 1:500 000 as Dalwood Group (map unit Pd) of Permian origin.

The Site satisfies the landscape criteria described in paragraph 1 of the Final Determination.

> *and characterised by the following assemblage of species* [listed in Appendix 4]:

In the sampling locations, a total of 69% (25) of 36 characteristic species was recorded, with more than about 20% of characteristic species recorded in Quadrats 1 to 4, 7, 9, 10, 17, 18, 20, 22 to 26 and at Spot locations A, C, D, P:

Sampling locations	Total number of species recorded	Native	HLRF	% HLRF of listed characteristic species
Quadrat				
Q1	64	61	19	**53%**
Q2	67	55	14	**39%**
Q3	54	48	18	**50%**
Q4	67	61	17	**47%**
Q5	31	23	6	17%
Q6	17	9	3	8%
Q7	52	44	13	**36%**
Q8	15	8	3	8%
Q9	50	44	11	**31%**
Q10	40	33	10	**28%**
Q11	19	8	4	11%
Q12	39	25	6	17%
Q13	19	10	4	11%
Q14	16	8	5	14%
Q15	17	8	2	6%
Q16	15	6	1	3%
Q17	47	47	16	**44%**
Q18	37	24	8	**22%**
Q19	21	9	2	6%
Q20	52	48	12	**33%**
Q21	46	40	3	8%
Q22	83	76	17	**47%**
Q23	56	53	16	**44%**

Sampling locations	Total number of species recorded	Native	HLRF	% HLRF of listed characteristic species
Q24	44	36	7	**19%**
Q25	61	55	16	**44%**
Q26	40	25	8	**22%**
Spot Location				
A	42	36	11	**31%**
B	17	8	1	3%
C	25	20	7	**19%**
D	30	27	7	**19%**
E	20	12	2	6%
F	22	15	4	11%
G	25	9	3	8%
H	8	8	1	3%
I	16	7	0	0%
J	13	9	1	3%
K	8	4	0	0%
L	13	7	0	0%
M	45	27	4	11%
N	37	23	3	8%
O	11	9	0	0%
P	34	33	10	**28%**
Q	1	0	0	0%
All	290	216	25	**69%**

2. The total species list of the community is considerably larger than that given above, with many species present in only one or two sites or in very small quantity. The species composition of a site will be influenced by the size of the site, recent rainfall or drought condition and by its disturbance (including fire) history. The number of species, and the above ground relative abundance of species will change with time since fire, and may also change in response to changes in fire regime (including changes in fire frequency). At any one time, above ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

No additional comments.

3. Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions has been recorded from the local government areas of Maitland, Cessnock and Port Stephens (in the Sydney Basin Bioregion) and Muswellbrook and Singleton (in the NSW North Coast Bioregion) but may occur elsewhere in these bioregions.

The Site is in the Cessnock Local Government Area.

4. The Community is described and discussed in NSW NPWS (2000) as MU 19 – Hunter Lowland Redgum Forest.

Hunter Lowland Redgum Forest (Map unit 19) has been mapped by LHCCREMS (2003) on the hill slope in the central north, patches in the north, along parts of Bellbird Creek, fragments on the edge of MU 17 along Limestone Creek and the south of the Site (Figure 6)

> *5. The Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions is generally an open forest with most common canopy trees species being* Eucalyptus tereticornis *and* Eucalyptus punctata *although other frequently occurring canopy species are* Angophora costata, Corymbia maculata, Eucalyptus crebra *and* Eucalyptus moluccana, *with a number of other eucalypts being less frequently recorded.*

Open-forest is defined in Specht *et al.* (1995) (Appendix 5) as having 70-30% foliage projective cover of the tallest stratum with:

Height of tallest stratum	**Classification**
Trees > 30 m	tall open-forest
Trees 10-30 m	open-forest
Trees 5-10 m	low open-forest
Trees < 5m	very low open-forest

From the 2005/2006 aerial photograph, the areas with > 30% foliage projective cover of the tallest stratum (Figure 8) include the following sampling locations: Quadrats 1, 2, 3, 4, 5, 7, 9, 10, 12, 17, 18, 20, 21, 22, 23, 24, 25, 26 and Spot locations A, C, D, E, H, I, J, P.

Most common canopy trees species	**Quadrats**	**Spot locations**	
	With > 30% tree foliage projective cover		**Without < 30% tree foliage projective cover**
Common canopy species			
Eucalyptus tereticornis	1, 7, 9, 12, 18, 22, 26	E, F, M, N	F
Eucalyptus punctata	_	_	-
Other frequently occurring canopy species			
Angophora costata	-	-	
Corymbia maculata	1, 2, 3, 4, 14, 17, 22, 23, 24, 25	C, D, P	-
Eucalyptus crebra	-	-	
Eucalyptus moluccana	1, 3, 4, 7, 10, 12, 18, 20, 22, 23, 24, 26	C, J, P	-

> *The mid stratum is characterised as open with sparse shrubs of* Breynia oblongifolia, Leucopogon juniperinus, Daviesia ulicifolia *and* Jacksonia scoparia.

The characteristic shrub species recorded were:

Characteristic shrub species	Quadrats	Spot locations
Breynia oblongifolia	1, 2, 3, 4, 20, 21, 23, 24, 25	A, P
Leucopogon juniperinus	1, 2, 3, 4, 22, 23	A
Daviesia ulicifolia	1, 2, 3, 4, 17, 23, 25	A
Jacksonia scoparia	-	-

There is consistently a ground layer of grasses and herbs, characterised by Microlaena stipoides var. stipoides, Cymbopogon refractus, Echinopogon caespitosus *var.* caespitosus, Cheilanthes sieberi *subsp.* sieberi *and* Pratia purpurascens.

The characteristic ground layer species were:

Characteristic ground layer species	Quadrats	Spot locations
Microlaena stipoides var. stipoides	1 to 11, 13, 14, 15, 17, 18, 20, 22, 23 to 26	A, C, D, F, G, M
Cymbopogon refractus	1, 2, 3, 4, 7, 9, 16, 17, 18, 22, 23, 25	A, D, F, P
Echinopogon caespitosus var. *caespitosus*	24	-
Echinopogon sp.	7, 9, 10, 17, 20	-
Cheilanthes sieberi subsp. *sieberi*	1, 2, 3, 4, 10, 13, 17, 20, 21, 22, 23, 25	A, C, P
Pratia purpurascens	1, 2, 4, 5, 7, 9, 10, 12, 17, 20, 23, 25	-

6. Currently only a small area (less than 2% of total) of Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions is included in NPWS estate in the Lower Hunter (Wereketa) National Park. The majority of the remainder of the community is not on public land.

Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions is mapped by LHCCREMS (2003) as occurring in the Aberdare State Forest (about 1 km south-east of the Site) (Figure 6).

The eastern section of the Site is approximately 5 km west of Werakata National Park.

7. Modelling included in NSW NPWS (2000) shows that much of the pre-1750 extent of the community has been cleared. Only about 27% (less than 500 ha) of the original distribution survives and this is highly fragmented.

No additional comments.

8. Although much of the clearing occurred early in European settlement, clearing still continues at a high rate. Between 1988 and 2001 approx 2380 ha were approved for clearing (advice from Department of Infrastructure, Planning and Natural Resources August 2001). In addition to clearing and fragmentation other threats include grazing, weed invasion, altered fire frequency and, locally, rubbish dumping.

There has been little change in land use observable on the historic aerial photographs (earliest available 1952).

> *9. In view of the above the Scientific Committee is of the opinion that the Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.*

No additional comments.

4.1.2.1.1 Conclusions for Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregions

The sampling locations with more than 20% of the characteristic species recorded for the Hunter Lowland Redgum Forest and with the most common tree species recorded are Quadrats 1, 7, 9, 18, 22 and 26.

In Quadrat 10, there were 28% of the characteristic species recorded but the canopy consisted of *Eucalyptus moluccana*, which is described as “Other frequently occurring canopy species” in the Final Determination. The vegetation in these sampling locations appears to meet the listed criteria for Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregion.

In Quadrat 12, there were 17% of the characteristic species were recorded. The canopy included two individuals of *Eucalyptus tereticornis* up to 18 m a “common canopy species” and 28 individuals of an “Other frequently occurring canopy species” *Eucalyptus moluccana* up to 16 m height.

The vegetation in these sampling locations (Quadrats 1, 7, 9, 10, 12, 18, 22, and 26) appears to meet the listed criteria for Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregion (Figure 9).

4.1.2.2 Comparison of the vegetation of the Site with the Final Determination for Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion

The Scientific Committee has found that:

> *1. Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion is the name given to the ecological community that occurs principally on Permian geology in the central to lower Hunter Valley. The Permian substrates most commonly supporting the community belong to the Dalwood Group, the Maitland Group and the Greta and Tomago Coal Measures, although smaller areas of the community may also occur on the Permian Singleton and Newcastle Coal Measures and the Triassic Narrabeen Group (NSW Department of Mines 1966, 1969).*

The Site at Bellbird North near Cessnock is in the Sydney Basin (Herbert and Helby 1980).

The geology of the Site (Figure 4) has been mapped by Brunker and Rose (1967) at a scale of 1:500 000 as Dalwood Group (map unit Pd) of Permian origin.

The community is strongly associated with, though not restricted to, the yellow podsolic and solodic soils of the Lower Hunter soil landscapes of Aberdare, Branxton and Neath (Kovac and Lawrie 1991). These substrates are said to produce 'moderately fertile' soils (Kovac and Lawrie 1991).

The soil landscape (Figure 5) has been mapped by Kovac and Lawrie (1985) at a scale of 1:250 000 as:

- Branxton (map unit bx) over most of the Site;
- Polkobin (map unit pk) in the west; and
- Aberdare (map unit ad) on the central southern boundary.

Lower Hunter Spotted Gum – Ironbark Forest is dominated by Corymbia maculata, *(Spotted Gum) and* Eucalyptus fibrosa *(Broad-leaved Ironbark), while* E. punctata *(Grey Gum) and* E. crebra *(Grey Ironbark) occur occasionally. A number of other eucalypt species occur at low frequency, but may be locally common in the community. One of these species,* E. canaliculata, *intergrades extensively in the area with* E. punctata.

Dominant tree species	**Quadrats**	**Spot locations**
Corymbia maculata	1, 2, 3, 4, 14, 17, 22, 23, 24, 25	C, D, P
Eucalyptus fibrosa	3, 4, 5, 10, 17, 20, 24	A, C, D
With		
Eucalyptus punctata	-	-
Eucalyptus crebra	-	-

The understorey is marked by the tall shrub, Acacia parvipinnula, *and by the prickly shrubs,* Daviesia ulicifolia, Bursaria spinosa, Melaleuca nodosa *and* Lissanthe strigosa. *Other shrubs include* Persoonia linearis, Maytenus silvestris *and* Breynia oblongifolia.

Marked by the tall shrub		
Acacia parvipinnula	2, 3, 4, 22, 23, 25	A

by the prickly shrubs		
Daviesia ulicifolia	1, 2, 3, 4, 17, 23, 25	A
Bursaria spinosa	1, 2, 4, 17, 20 to 25	P
Melaleuca nodosa	-	A
Lissanthe strigosa	1, 3, 23	

Other listed shrubs		
Persoonia linearis	-	-
Maytenus silvestris	1, 2, 3, 4, 9, 20 to 25	A, D, P
Breynia oblongifolia	1, 2, 3, 4, 20, 21, 23, 24, 25	A, P

The ground layer is diverse; frequent species include Cheilanthes sieberi, Cymbopogon refractus, Dianella revoluta, Entolasia stricta, Glycine clandestina, Lepidosperma laterale, Lomandra multiflora, Microlaena stipoides, Pomax umbellata, Pratia purpurascens, Themeda australis *and* Phyllanthus hirtellus *(NPWS 2000, Hill 2003, Bell 2004).*

The characteristic ground layer species were:

Characteristic ground layer species	Quadrats	Spot locations
Cheilanthes sieberi	1, 3, 4, 10, 13, 17, 20, 21, 22, 23, 25	A, C, P
Cymbopogon refractus	1, 2, 3, 4, 7, 9, 16, 17, 18, 22, 23, 25	A, D, F, P
Dianella revoluta	1, 3, 22	-
Entolasia stricta	1, 2, 3, 4, 5, 17, 23, 25	D
Glycine clandestina	3, 4, 5, 7, 17, 20, 23	E
Lepidosperma laterale	2, 4, 23	-
Lomandra multiflora	1, 2, 3, 4, 17, 20, 22, 25	D, M, P
Microlaena stipoides	1 to 11, 13, 14, 15, 17, 18, 20, 22, 23 to 26	A, C, D, F, G, M
Pomax umbellata	1, 3, 17	-
Pratia purpurascens	1, 2, 4, 5, 7, 9, 10, 12, 17, 20, 23, 25	-
Themeda australis	1, 2, 3, 4, 6, 7, 9, 10, 11, 14, 17, 20, 22, 23, 25	A, B, D, P
Phyllanthus hirtellus	1	-

In an undisturbed condition the structure of the community is typically open forest. If thinning has occurred, it may take the form of woodland or a dense thicket of saplings, depending on post-disturbance regeneration.

In Specht *et al.* (1995) vegetation classification is defined (Appendix 5) as:

Height of tallest stratum	Foliage projective cover of the tallest stratum			
	100-70%	70-30%	30-10%	<10%
Trees > 30 m	tall closed-forest	tall open-forest	tall woodland	-
Trees 10-30 m	closed-forest	open-forest	woodland	open-woodland
Trees 5-10 m	low closed-forest	low open-forest	low woodland	low open-woodland
Trees < 5m	very low closed-forest	very low open-forest	very low woodland	very low open woodland

The required foliage projective cover for woodland and forest is at least 10% canopy cover in the 10 to 30 m height range,

From the 2005/2006 aerial photograph, the areas with > 10% foliage projective cover of the tallest stratum (Figure 8) include the sampling locations (Quadrat 1, 2, 3, 4, 5, 7, 9, 10, 12, 17, 18, 20, 21, 22, 23, 24, 25, 26 and Spot locations A, C, D, E, H, I, J, P).

2. Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion is characterised by the following assemblage of species [listed in Appendix 6]:

Of the 55 characteristic species for Lower Hunter Spotted Gum – Ironbark Forest, a total of 65% (36) of characteristic species were recorded. There were more than about 20% of the characteristic species recorded in Quadrats 1 to 4, 7, 17, 20, 22, 23, 25 and Spot locations A, D and P, namely:

Sampling location	Total number of species recorded	Native species recorded	% Native	Number of characteristic species recorded	% of characteristic species recorded
Quadrats					
Q1	64	61	95%	25	**45%**
Q2	67	55	82%	21	**38%**
Q3	54	48	89%	23	**42%**
Q4	67	61	91%	22	**40%**
Q5	31	23	74%	6	11%
Q6	17	9	53%	2	4%
Q7	52	44	85%	11	**20%**
Q8	15	8	53%	1	2%
Q9	50	44	88%	9	16%
Q10	40	33	83%	8	15%
Q11	19	8	42%	2	4%
Q12	39	25	64%	4	7%
Q13	19	10	53%	2	4%
Q14	16	8	50%	3	5%
Q15	17	8	47%	1	2%
Q16	15	6	40%	1	2%
Q17	47	47	100%	18	**33%**
Q18	37	24	65%	5	9%
Q19	21	9	43%	0	0%
Q20	52	48	92%	15	**27%**
Q21	46	40	87%	6	11%
Q22	83	76	92%	19	**35%**
Q23	56	53	95%	24	**44%**
Q24	44	36	82%	9	16%
Q25	61	55	90%	21	**38%**
Q26	40	25	63%	3	5%
Spot Locations					
A	42	36	86%	12	**22%**
B	17	8	47%	0	0%
C	25	20	80%	6	11%
D	30	27	90%	11	**20%**
E	20	12	60%	2	4%
F	22	15	68%	3	5%
G	25	9	36%	1	2%
H	8	8	100%	0	0%
I	16	7	44%	0	0%
J	13	9	69%	1	2%
K	8	4	50%	0	0%
L	13	7	54%	0	0%
M	45	27	60%	4	7%
N	37	23	62%	1	2%
O	11	9	82%	0	0%
P	34	33	97%	14	**25%**
Q	1	0	0%	0	0%
All	290	216	74%	36	**65%**

3. The total species list of the community is considerably larger than that given above, with many species present in only one or two sites or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought condition and by its disturbance (including fire and logging) history. The number of species, and the above ground relative abundance of species will change with time since disturbance, and may also change in response to changes in fire regime (including changes in fire frequency). At any one time, above ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. Some of these components of the community are poorly documented.

No additional comments

4. Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion is restricted to a range of approximately 65 km by 35 km centred on the Cessnock – Beresfield area in the Central and Lower Hunter Valley (NPWS 2000). Within this range, the community was once widespread. A fragmented core of the community still occurs between Cessnock and Beresfield. Remnants occur within the Local Government Areas of Cessnock, Maitland, Singleton, Lake Macquarie, Newcastle, Port Stephens and Dungog but may also occur elsewhere within the bioregion. Outliers are also present on the eastern escarpment of Pokolbin and Corrabare State Forests on Narrabeen Sandstone.

The Site is in the Cessnock Local Government Area.

5. Threatened species recorded within this community include Callistemon linearifolius, Grevillea parviflora *subsp.* parviflora*,* Persoonia pauciflora*,* Rutidosis heterogama*, Swift Parrot* Lathamus discolor *(Saunders 2002), Turquoise Parrot* Neophema pulchella*, Glossy Black Cockatoo* Calyptorhynchus latham*i, Regent Honeyeater* Xanthomyza phygria*, Black-chinned Honeyeater* Melithreptus gularis gularis*, Brown Treecreeper* Climacteris picumnus victoriae*, Powerful Owl* Ninox strenua*, Koala* Phascolarctos cinereus*, Yellow-bellied Glider* Petaurus australis*, Squirrel Glider* Petaurus norfolcensis *(Smith and Murray 2003), Common Bentwing Bat* Miniopterus schriebersii *and Eastern Freetail Bat* Mormopterus norfolkensis*.*

None of the listed threatened plant species (*Callistemon linearifolius, Grevillea parviflora* subsp. *parviflora, Persoonia pauciflora* and *Rutidosis heterogama*) were recorded on the Site.

6. Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion belongs to a complex of ecological communities that were identified in an analysis of floristic data gathered in a vegetation survey of the Lower Hunter – Central Coast region (NPWS 2000). The methods of survey and analysis employed by NPWS (2000) were found to produce a reliable regional-scale overview of native vegetation in the Lower Hunter – Central Coast area, although limitations apply to fine-scale uses of the map (Nicholls et al. 2003). This analysis, and subsequent analyses based on additional floristic data from the Hunter valley floor (e.g. Hill 2003, Bell 2004, Peake

unpubl. data), identified Lower Hunter Spotted Gum – Ironbark Forest as a distinct assemblage of species. Other assemblages that may include spotted gum as a dominant species, have geographically distinct distributions outside the core area where this community primarily occurs (Cessnock – Beresfield). These other assemblages include: Coastal Foothills Spotted Gum – Ironbark Forest, Seaham Spotted Gum – Ironbark Forest and Central Hunter Spotted Gum – Ironbark – Grey Box Forest (NPWS 2000). Analysis of additional data from north of the Hunter River and other parts of the Hunter valley indicates the existence of another distinct assemblage dominated by spotted gums and ironbarks on Carboniferous sediments of the footslopes of the Barrington plateau. Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion belongs to the Hunter - Macleay Dry Sclerophyll Forests vegetation class of Keith (2004).

Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion was mapped as occurring on the Site by LHCCREMS (2003) (Figure 6).

7. Eucalyptus fibrosa*,* Acacia parvipinnula *and prickly shrub species occur more frequently or in greater abundance in Lower Hunter Spotted Gum – Ironbark Forest than in any of the other communities mentioned above. Around the margins of its core distribution, Lower Hunter Spotted Gum – Ironbark Forest may intergrade with other communities (e.g Hill 2003). Toward the coast and south, Lower Hunter Spotted Gum – Ironbark Forest may be replaced by Coastal Foothills Spotted Gum – Ironbark Forest, in which* Eucalyptus umbra*,* E. siderophloia*,* Syncarpia glomulifera *and* Angophora costata *occur more frequently, as do* Polyscias sambucifolia*,* Imperata cylindrica *and* Pseuderanthemum variabile*. Toward the north-east, Lower Hunter Spotted Gum – Ironbark Forest may be replaced by Seaham Spotted Gum – Ironbark Forest, in which* Eucalyptus crebra*,* E. punctata*,* E. acmenoides*,* E. moluccana *and* E. siderophloia*, occur more frequently, along with* Acacia falcata*,* A. implexa*,* Leucopogon juniperinus*,* Aristida vagans *and* Pseuderanthemum variabile*. Seaham Spotted Gum – Ironbark Forest typically occurs on sediments of Carboniferous age, in contrast to the younger Permian sediments that support Lower Hunter Spotted Gum-Ironbark Forest, although the two communities intergrade where these substrates adjoin (NPWS 2000, Hill 2003). Toward the west and north-west, Lower Hunter Spotted Gum – Ironbark Forest may be replaced by Central Hunter Spotted Gum – Ironbark – Grey Box Forest, which has a higher frequency of* Eucalyptus crebra *and* E. moluccana *and a more open grassy understorey distinguished by herbs such as* Desmodium varians*,* Glycine tabacina*,* Dichondra repens*,* Brunoniella australis *and* Calotis lappulacea*. On open depressions and drainage flats within the Cessnock-Beresfield area, Lower Hunter Spotted Gum – Ironbark Forest may be replaced locally by Hunter Lowlands Redgum Forest, in which* Eucalyptus tereticornis*,* E. punctata*,* E. crebra *and* Angophora floribunda*, occur more frequently, as do* Breynia oblongifolia*,* Leucopogon juniperinus*,* Jacksonia scoparia *and* Brunoniella australis *(NPWS 2000).*

Eucalyptus fibrosa, Acacia parvipinnula and prickly shrubs were recorded in the following sampling locations:

Species	Quadrats	Spot locations
Eucalyptus fibrosa	3, 4, 5, 10, 17, 20, 24	A, C, D
Acacia parvipinnula	2, 3, 4, 22, 23, 25	A
Prickly shrubs		
Daviesia ulicifolia	1, 2, 3, 4, 17, 23, 25	A
Bursaria spinosa	1, 2, 4, 17, 20 to 25	P
Melaleuca nodosa	-	A
Lissanthe strigosa	1, 3, 23	

In terms of canopy and tall shrub species, the vegetation in forested areas on the Site appears to fit Lower Hunter Spotted Gum – Ironbark Forest and Hunter Lowland Redgum Forest better than the other communities listed in paragraph 7.

> *8. Clearing and other disturbances have resulted in a high degree of fragmentation of the community. Four large patches of Lower Hunter Spotted-Gum – Ironbark Forest are estimated to have covered nearly 50 000 ha prior to European settlement, representing 75% of the total distribution. The community is currently mapped as occurring in more than 4 800 fragments, of which more than 4 500 are less than 10 ha in area (House 2003). The four largest patches now cover about 7 000 ha, representing less than one-quarter of the current distribution, or about 10% of the estimated pre-European distribution (House 2003). Clearing of native vegetation is listed as a Key Threatening Process under the Threatened Species Conservation Act (1995).*

The Site has been largely cleared for agriculture. From the historical aerial photos, there has been little change in land use over the past 54 years, except the clearing of forest vegetation upslope of the steep side gullies in the south in 1984.

> *9. Using recently updated mapping of extant Lower Hunter Spotted Gum – Ironbark Forest based on fine-scale aerial photograph interpretation of extant woody native vegetation, House (2003) estimated that approximately 26 500 ha of the community remains with its tree canopy cover in a 'substantially unmodified' condition, representing approximately 40% of its pre-European distribution. However, this estimate is based on the collective canopy cover of trees (i.e. where tree canopy cover was estimated to be greater than 20%, the canopy was assumed to be 'unmodified' and not substantially thinned), and does not consider the growth stages of trees that contribute to the cover. Growth stage mapping is available for approximately 6 000 ha of Lower Hunter Spotted Gum Ironbark Forest on public land (RACAC 1995), of which only 3% was assessed as containing a sub-dominance of 'overmature' and 'senescent' tree crowns indicative of old growth forest. Seventy-five per cent of this area was assessed as 'young forest', indicating regeneration from past logging and wildfire. Some areas of Lower Hunter Spotted Gum – Ironbark Forest on private land also reflect a continuing history of degradation. In the Blackhill district, for example, much of the existing vegetation was cleared, and is now largely composed of dense stands of juvenile saplings. This regrowth has since been further affected by clearing and thinning, creation of electricity transmission easements, and ongoing grazing by goats and cattle. In addition, House (2003) estimated that there are a further 4 650 ha of Lower Hunter Spotted Gum – Ironbark Forest with a modified or substantially modified tree canopy cover.*

No additional comments.

10. The condition of the understorey has not been mapped systematically. There are no quantitative estimates of the area of the community that retains a substantially unmodified understorey. However, qualitative information suggests that there has been extensive disturbance to the understorey associated with logging, expansion of unplanned tracks and trails, rubbish dumping, off-road vehicle use, arson and weed invasion, even in stands that are currently within a conservation reserve (Bell 2004). These pressures are likely to intensify with the projected increases in the density of the human population within the region (Progress Economics 2004).

Some evidence of rubbish dumping was apparent on the Site. Weed invasion was clearly evident in the relatively intact vegetation in the south of the Site adjoining Limestone Creek.

11. Much of the remaining Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion shows evidence of disturbance. Past logging practices and fire regimes have heavily modified some parts of the community, resulting in a simplified structure and floristics. Production areas of State Forests are actively logged at intensities specified by regulations. Frequent fires (<3 years) dramatically simplify understorey vegetation (Bell 2004). Grazing, uncontrolled human access and associated dumping of solid and garden waste, as well as weed invasion (notably by Lantana camara and Solanum mauritianum, wild tobacco) have degraded the more accessible remnants of the community, while transport corridors and power and communication easements have further fragmented them. As a likely consequence of continuing habitat loss and degradation, local bird observers have noted declines in species associated with spotted gum/ironbark forests, including the Swift Parrot, Regent Honeyeater, Brown Treecreeper, Black-chinned Honeyeater, Diamond Firetail, Turquoise Parrot, Fuscous Honeyeater, Eastern Shriketit and Spotted Quailthrush.

Lantana camara (Lantana) was observed in Quadrats 2, 3, 4, 12, 21, 22 and Spot Locations M, N and P, but it was not observed in dense thickets.

12. Clearing pressures from rural residential and residential subdivisions, industrial developments and new cropping enterprises (e.g. vineyards) continue to threaten the community particularly in Cessnock Local Government Area where the core of this community occurs. Over the past 10 years, demand for housing lots in the Lower Hunter area has nearly doubled from 1 726 in 1991-92 to 3 904 in 2003-04 (Progress Economics 2004). The 'medium' forecast for housing demand in Lower Hunter is 2 500 lots/yr; the current supply of land zoned for housing is 12 000 lots and is projected to meet demand only for the next 5 years. Hence there are substantial pressures for rezoning land for housing within the next 10 years (Progress Economics 2004). A study of the Thornton-Killingworth sub-region projected the population to expand by 169 000 people, requiring 2 600 new dwellings annually over the next 25 years (Parsons Brinckerhoff 2003). Existing proposals to rezone land from rural to rural /residential around the villages of Millfield and Paxton and applications for clearing associated with rural residential and residential developments around Paxton, Bellbird, Ellalong and Mulbring will affect the ecological community. Loss of remnants of Lower Hunter Spotted Gum – Ironbark Forest will be associated with the Cessnock LEP Amendment No 60 - Hunter Economic Zone, Donaldson and Bloomfield coalmine sites at Thornton/Killingworth and F3 to Branxton National Highway link (Ecotone Ecological Consultants 1999, 2000; Connell Wagner 1997). In

the Maitland Local Government Area, Hill (2003) assessed Lower Hunter Spotted Gum – Ironbark Forest as exposed to high levels of threat from development, tree dieback and grazing, and under moderate levels of threat from fragmentation, weeds, and fire.

No additional comments.

13. Approximately 1 600 hectares of Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion occurs within Werakata National Park (Bell 2004). This represents less than 2.5% of the community's modelled pre-1750 distribution (House 2003), is distributed among several separate patches and is predominantly young regrowth forest (Bell 2004). Of an estimated 2 800 ha of the community currently within State Forests, approximately 1 770 ha is excluded from timber harvesting in Forest Management Zone reserves (State Forests of NSW, in litt.), although these areas may be subject to development of service easements, transport infrastructure and mineral exploration. Within the Hunter Employment Zone (HEZ), 460 ha of Lower Hunter Spotted Gum – Ironbark Forest is estimated to occur within zone 7(b) 'Environmental Protection'. However, 7(b) zoning does not exclude development for rural properties (buildings, roads, fences, bushfire hazard reduction) and coal mining.

No additional comments.

14. In view of the above the Scientific Committee is of the opinion that Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival cease to operate, or it might already be extinct.

No additional comments.

4.1.2.2.1 Conclusions for Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion

The sampling locations with more than 20% of the characteristic species of Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion and with the dominant tree species recorded are Quadrats 1, 2, 3, 4, 17, 20, 22, 23, 25 and Spot Locations A, D and P.

In Quadrat 24, there were 19% (7) of the 36 characteristic species of the Hunter Lowland Redgum Forest and 16% (9) of the 55 characteristic species of Lower Hunter Spotted Gum Ironbark Forest with:

- two of the “Other frequently occurring canopy species” for Hunter Lowland Redgum Forest, namely *Corymbia maculata* and *Eucalyptus moluccana*; and
- the two dominant species *Corymbia maculata* and *Eucalyptus fibrosa* of the Lower Hunter Spotted Gum Ironbark Forest.

Given the canopy species, the vegetation in Quadrat 24 is likely to better meet the criteria for Lower Hunter Spotted Gum Ironbark Forest.

At Spot location C, there were 19% (7) of the 36 characteristic species of the Hunter Lowland Redgum Forest and 11% (6) of the 55 characteristic species of Lower Hunter Spotted Gum Ironbark Forest with:

- two of the “Other frequently occurring canopy species” for Hunter Lowland Redgum Forest, namely *Corymbia maculata* and *Eucalyptus moluccana*; and

- the two dominant species *Corymbia maculata* and *Eucalyptus fibrosa* of the Lower Hunter Spotted Gum Ironbark Forest.

Given the canopy species, the vegetation in Spot location C is likely to better meet the criteria for Lower Hunter Spotted Gum Ironbark Forest, despite the low percentage occurrence (11%) of characteristic species for Lower Hunter Spotted Gum Ironbark Forest.

The vegetation in these sampling locations (Quadrats 1, 2, 3, 4, 17, 20, 22, 23, 24, 25 and Spot Locations A, C, D and P) appears to meet the listed criteria for Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin Bioregion (Figure 9).

4.1.2.3 Conclusions for endangered ecological communities on the Site

Quadrats 1 and 22 meet the criteria for both Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregion and Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion.

The forest/woodland areas of the Site (sampled in Quadrats 1 to 4, 7, 9, 10, 12, 17, 18, 20, 22 to 26 and at Spot locations A, C, D, P) meet the criteria for (Figure 9):

Endangered Ecological Community	Sampling locations meeting the criteria
Hunter Lowland Redgum Forest	Quadrats 1, 7, 9, 10, 12, 18, 22 and 26
Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion	Quadrats 1, 2, 3, 4, 17, 20, 22, 23, 24, 25 and Spot Locations A, C, D and P

4.2 Species

4.2.1 National

A search of the EP&BC Act Protected Matters Search Tool (www.deh.gov.au/epbc accessed on 31 March) found that seven species listed under the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EP&BC Act) were previously recorded within a 10 km radius of the Site, namely:

Species	Status	Habitat (Harden 1990 – 1993, 2002)	Likely to occur on the Site?
Angophora inopina	Vulnerable	Found in open woodlands with dense shrub understorey on deep white sandy soils over sandstone. Restricted to the Charmhaven – Wyee area.	No. Outside restricted area.
Cryptostylis hunteriana	Vulnerable	Grows in swamp-heath on sandy soils, chiefly in coastal districts, south from the Gibraltar Range.	No. Swamp heath not recorded on the Site.
Eucalyptus glaucina	Vulnerable	Locally frequent but very sporadic, in grassy woodland on deep, moderately fertile and well watered soils; near Casino and from Taree to Broke.	Unlikely. Not on deep, moderately fertile, well-watered soils.
Eucalyptus parramattensis	Vulnerable	Locally frequent, in dry sclerophyll woodland on sandy	Unlikely. Not on sandy soils.

subsp. *decadens*		soils in low, often wet, sites; Hunter Valley to Hill Top.	
Eucalyptus pumila	Vulnerable	Grows in sclerophyll scrubland; rare, known from a small area on skeletal soil on sloping sandstone near Pokolobin.	No. Not on sloping sandstone.
Grevillea parviflora subsp. *parviflora*	Vulnerable	Grows in heath or shrubby woodland, in sandy or light clay soils usually over thin shales; disjunct populations near Putty, Cessnock and Cooranbong, and possibly near Moss Vale.	Possible
Persoonia pauciflora	Critically Endangered	Grows in dry sclerophyll forest or woodlands on clay soils; North Rothbury.	Possible.

None of these species were recorded on the Site.

4.2.2 State

The following fourteen species listed in the Schedules of the TSC Act have been recorded in the Cessnock LGA (NPWS Wildlife Atlas online www.nationalparks.nsw.gov.au/wildlifeatlas accessed 31 March 2006):

Species	Status	Habitat (Harden 1990 – 1993, 2002)	Likely to occur on the Site?
Acacia bynoeana	E1	Decumbent shrub. Mainly in heath and dry sclerophyll forest on sandy soils; south of Dora Creek-Morisset area to Berrima and Illawarra region, west to the Blue Mountains; uncommon.	Not likely. The Site is north of the Dora Creek – Morisset area
Callistemon linearifolius	V	Shrub. Grows in dry sclerophyll forest on the coast and adjacent ranges, chiefly from Georges R. to the Hawkesbury R.	Unlikely. The Site is north of the Hawkesbury River.
Eucalyptus glaucina	V	See above in National listing	
Eucalyptus parramattensis subsp. *decadens*	V	See above in National listing	
Eucalyptus pumila	V	See above in National listing	
Grevillea parviflora subsp. parviflora	V	See above in National listing	
Melaleuca groveana	V	Shrub or small tree. Grows in heath, often in exposed sites; rare, restricted to higher areas, coastal districts north from Yengo N.P. and west to Werrikimbe N.P.; doubtfully recorded at Torrington in 1911.	No. Heath not recorded on the Site.

Species	Status	Habitat (Harden 1990 – 1993, 2002)	Likely to occur on the Site?
Olearia cordata	V	Shrub. Grows in dry sclerophyll forest and open shrubland, on sandstone; chiefly from Wisemans Ferry to Wollombi.	Possible.
Persicaria elatior	V	Erect herb. Grows in damp places; infrequent.	Possible.
Persoonia hirsuta subsp. nov.? Yengo National Park	E1	*Persoonia hirsuta:* Putty district to Glen Davis to Hill Top, at 350-600 m altitude.	No. Site is 80-150 m altitude
Persoonia pauciflora	E1	See above in National listing	
Rutidosis heterogama	V	Perennial herb. Grows mostly in heath, often along disturbed roadsides; chiefly in coastal districts from Maclean to the Hunter Valley, and inland to Torrington.	Possible.
Tetratheca juncea	V	Prostrate shrub. Grows in sandy, occasionally swampy heath and in dry sclerophyll forest; chiefly in coastal districts from Bulahdelah to Lake Macquarie, also recorded from Port Jackson to Botany Bay from which it is possibly extinct.	Possible.
Velleia perfoliata	V	Perennial herb. Grows in heath on shallow sandy soil over sandstone; the Hawkesbury district to the upper Hunter Valley.	No. Not on shallow sandy soils over sandstone.

None of these species were recorded in the Site.

One species that is listed as vulnerable on Schedule 2 of the TSC Act, namely *Prostanthera cineolifera* (Singleton Mint-bush), was recorded on the Site in Quadrat 2 and Spot Location P (Figure 9).

The plants of *Prostanthera cineolifera* were not in flower or fruit at the time of survey. Although no specimen was lodged with the NSW National Herbarium, there was no doubt as to the identification of all plants of *Prostanthera* encountered. Growth habit, leaf and twig characters matched precisely with the published botanical descriptions of *P. cineolifera*. Also, the crushed leaves had a strong odour of cineole ('eucalyptus oil'), a distinctive feature of this species and the basis for its specific epithet, published by Sydney essential oil chemists Baker and Smith in 1912.

Prostanthera cineolifera is described in PlantNet (plantnet.rbgsyd.nsw.gov.au searched 7 April 2006) as:

> *Erect shrub, 1-4 m high, strongly aromatic; branches moderately to densely covered with short, curled hairs and +/- sessile glands.*
>
> *Leaves with lamina +/- narrow-ovate, 12-50 mm long, 4-12 mm wide; apex obtuse; base cuneate to obtuse; margins entire; surfaces light green, mostly*

glabrous, sparsely to densely hairy on midrib on lower surface, densely glandular with +/- sessile glands; petiole 2-7 mm long.

Flowers in a terminal botryoid; bracteoles not persistent, 1-2 mm long. Calyx 3-4 mm long; tube 2-2.5 mm long; upper lobe 1-2 mm long, not enlarged in fruit. Corolla 8-11 mm long, pale mauve to dark purple-mauve, darker in throat. Anthers with appendage ca 1 mm long.

Flowering: Sept.-Oct.

Distribution and occurrence: Apparently grows in sclerophyll forest. The distribution of this taxon is uncertain.
NSW subdivisions: NC, CC



From a search of the Site, the distribution of the species appears to be restricted to edges of the steep-sided gully in the central south of the Site, which contains a tributary of Limestone Creek. The restricted distribution of *Prostanthera cineolifera* (Singleton Mint-bush) on the Site may be a consequence of the intensity of grazing, with the only areas not grazed being these gullies.

5.0 Noxious Weeds

The NSW Agriculture Noxious Weeds List (www.dpi.nsw.gov.au/agriculture/noxweed/ accessed 31 March 2006) identifies 95 noxious weeds for the Cessnock Local Government Area (Appendix 7). Eight of the 74 exotic species recorded in the current survey of the Site are declared noxious weed in the Cessnock Local Government Area, namely:

Botanical name	Common name	Control category	Sampling locations recorded
Lycium ferocissimum	African Boxthorn	4	Quadrats 9, 24, 26 and Spot Locations C, M and N
Xanthium spinosum	Bathurst Burr	4	Quadrats 18, 26 and Spot Location G
Rubus discolor	Blackberry	4	Quadrat 2
Asparagus asparagoides	Bridal Creeper	5	Quadrats 2, 21, 22
Cestrum parqui	Green Cestrum	3	Quadrat 21 and Spot Location E
Lantana camara	Lantana	4	Quadrats 2, 3, 4, 12, 21 and 23

Bryophyllum delagoense	Mother-of-Millions	3	Quadrats 3, 4, 20 and Spot Location D
Opuntia stricta	Prickly Pear, Common Pest Pear	4	Quadrats 2, 3, 7, 10, 24, 25 and Spot Location C

Control categories:

3. The plant must be fully and continuously suppressed and destroyed

4. The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority

5. The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with

6.0 Water Management Act 2000 (NSW Rivers and Foreshores Improvement Act 1948)

On the 1:25 000 scale topographic map, the tributaries of Limestone Creek, Limestone Creek and Bellbird Creek are mapped on the Site (Figure 1).

The Department of Land and Water Conservation (now DIPNR) guidelines for the Rivers and Foreshores Improvement Act 1948 (R&FI Act) state that the Act:

> *applies to natural and artificial water bodies, which are known as protected waters, and which include:*
> - *all clearly defined drainage lines;*
> - *perennial (flowing) or intermittent (often dry) streams;*
> - *modified stream channels;*
> - *artificial channels diverting natural stream channels;*
> - *estuaries, coastal lakes or lagoons;*
> - *any perennial or intermittent lakes having a stream running into or from them and coastal lakes.*
>
> *Part 3A of the R&FI Act also applies to **protected land**, which includes the bank, shore or bed of these water bodies, adjacent land within 40 metres of the top of their banks or shores, .. , and associated deposits of material. However, Part 3A may also apply to land further than 40 metres from a water body, if an activity poses a threat to protected waters or protected land.*

7.0 Conclusions

From the flora assessment of the approximately 500 ha Site at North Bellbird, it was found that:

- A total of 290 species (216 native and 74 exotic) were recorded in 26 quadrats (20 m x 20 m in size) and 17 Spot locations (Figure 8);
- No Nationally listed species of conservation significance (EP&BC Act) were recorded;
- One State listed species *Prostanthera cineolifera* (Singleton Mint-bush), of conservation significance (TSC Act) was recorded in the steep sided valley in the south of the Site;
- No Nationally listed endangered ecological communities (on the schedules of the Environment Protection and Biodiversity Conservation Act 1999 (EP&BC Act)) were recorded;

- Two State listed endangered ecological communities (on the schedules of the NSW Threatened Species Conservation Act 1995 (TSC Act)) were recorded, namely:
    - Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregion; and
    - Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion
- Eight noxious weeds (NSW Agriculture *Noxious Weeds List)* were recorded on the Site.

8.0 Recommendations

It is recommended that:

- the majority of the vegetation with more than 30% tree canopy cover (Figure 10) be retained and enhanced, especially vegetation of the steep sided valley in the south of the Site. The steep side valley in the south of the Site was the recorded habitat of *Prostanthera cineolifera*;
- local native vegetation be retained and enhanced in the riparian corridors on the Site. Much of the vegetation within the riparian corridor requires re-establishment using plant material collected on Site or nearby;
- a vegetation plan of management be prepared in conjunction with a development control plan and/or a concept plan;
    - as a minimum an area of three times the area to be cleared must be re-established as native vegetation (Figure 11); and
    - no major clearing of habitat of the vulnerable species *Prostanthera cineolifera* is to be cleared.

The bushland plan of management is to include:

- Clear aims;
- Realistic targets;
- Regular monitoring (1, 3, 6, 12, 18, 24 monthly then yearly) which includes monitoring of any corrective action requests in reports;
- objectives;
- Regular reporting (including corrective action requests and reassessment of targets as required) within one month post monitoring;
- The bush regeneration works are to be carried out by qualified bush regenerators under the supervision of a bush regenerator/restoration ecologist with at least 5 years experience.

Acknowledgements

We wish to thank:

- the landowners for access to their land, especially Len McDonald.

References

Brunker R.L. and Rose G (1967)
NSW 1:500 000 Geological Sheet (Sydney Basin). Geological Survey of New South Wales, Division of Regional Geology.

Conacher Travers (2003)
Flora and Fauna Assessment: Lot 2 DP 1011544 Wollombi Road, Bellbird. Dated August 2003.

Harden G.J. (1990-93, 2002)
Flora of New South Wales Volumes 1 to 4. University of New South Wales Press, Kensington.

Harden G.J. and Murray L.J. (2000)
Supplement to Flora of New South Wales – Volume 1. University of New South Wales Press, Kensington.

Kovac M. and Lawrie J. (1985)
Soil Landscape series sheet SI 56-1. SOILCON Natural Resource Mapping, Soil Conservation Service of NSW.

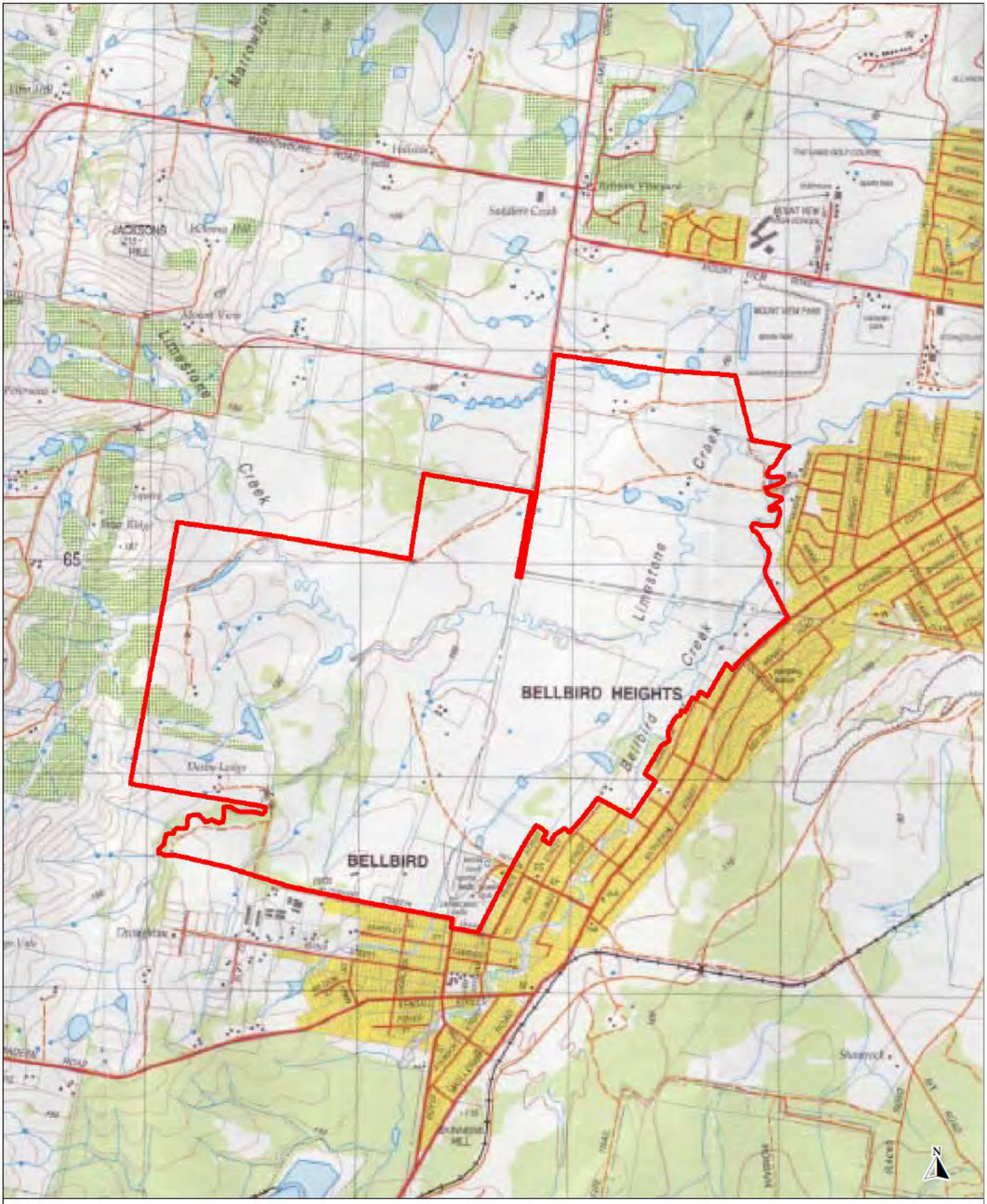
Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) (2003)
Lower Hunter & Central Coast Extant Vegetation Map 2003 & Pre 1750 Vegetation Map 2003. Lower Hunter & Central Coast Regional Biodiversity Conservation Strategy. Dated August 2003.

NSW National Parks and Wildlife Service (NPWS) (2003)
The Bioregions of New South Wales: their biodiversity, conservation and histor.y
NSW National Parks and Wildlife Service, Hurstville.

Sinclair Knight Merz Pty Ltd. (2004)
Proposed Retirement Village at Limestone Creek, Bellbird: Threatened Species Assessment Report. Final Report dated 30 September 2004.

Specht R., Specht A., Whelan M. and Hegarty E. (1995)
Conservation Atlas of Plant Communities in Australia. Centre for Coastal Management, Southern Cross University, Lismore NSW.

Figures



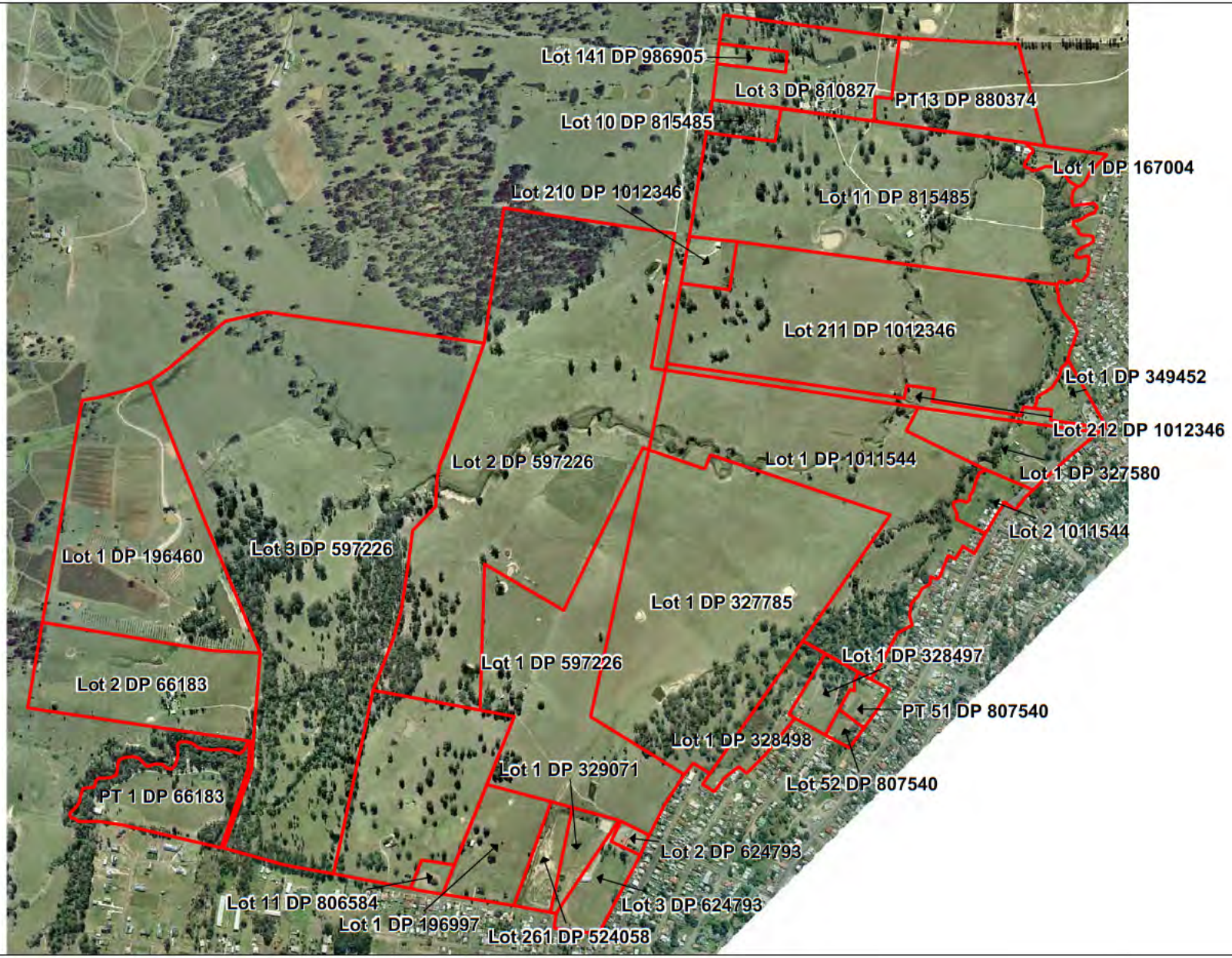
Legend

Site boundary

kilometres

0 0.5 1

Figure 1.
Location of the Site on the 1:25 000 Cessnock Map Sheet



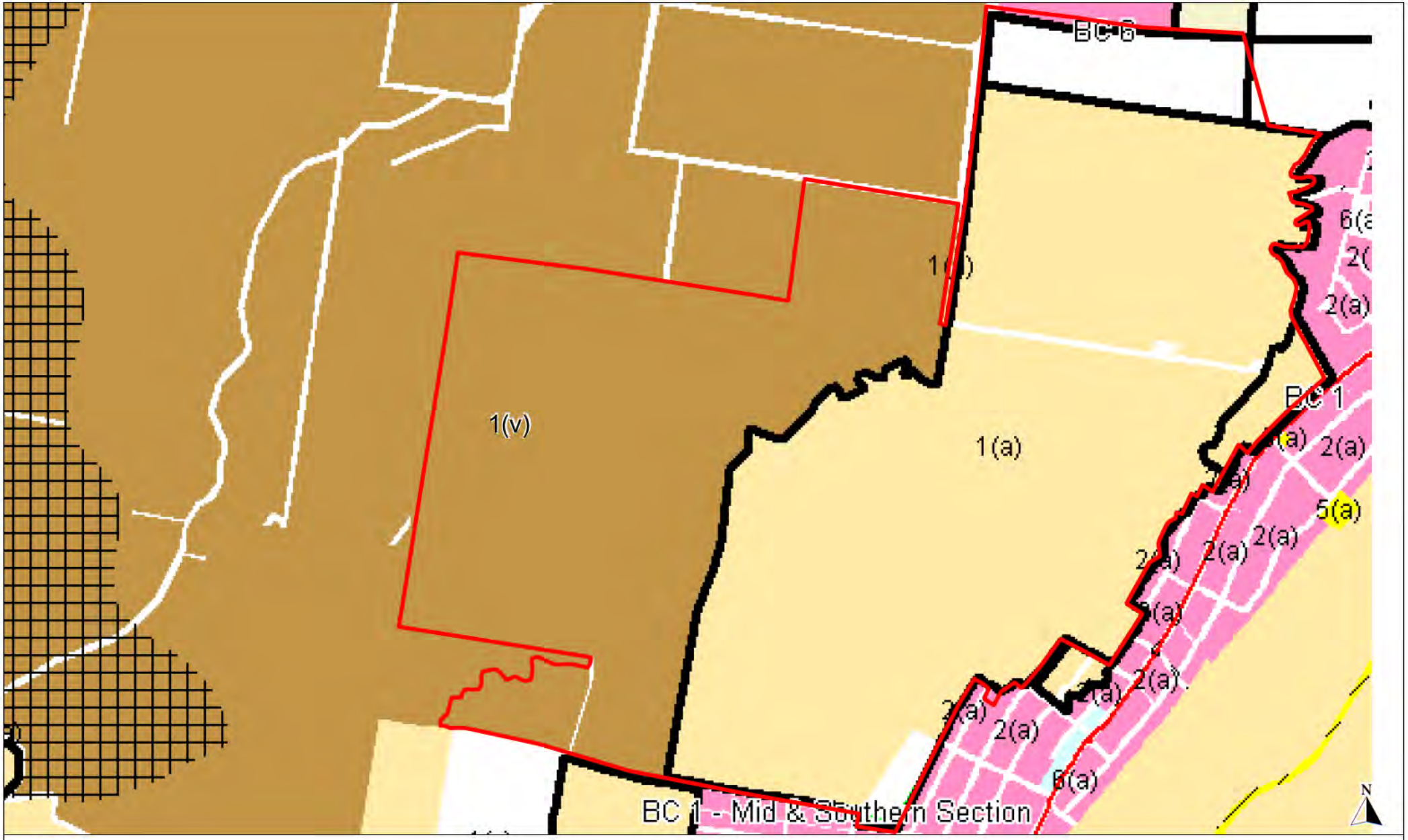
Legend

Site boundary

metres

0 340 680

Figure 2.
Lot ownership overlain on the 2005/2006 aerial photograph



Legend

Site boundary

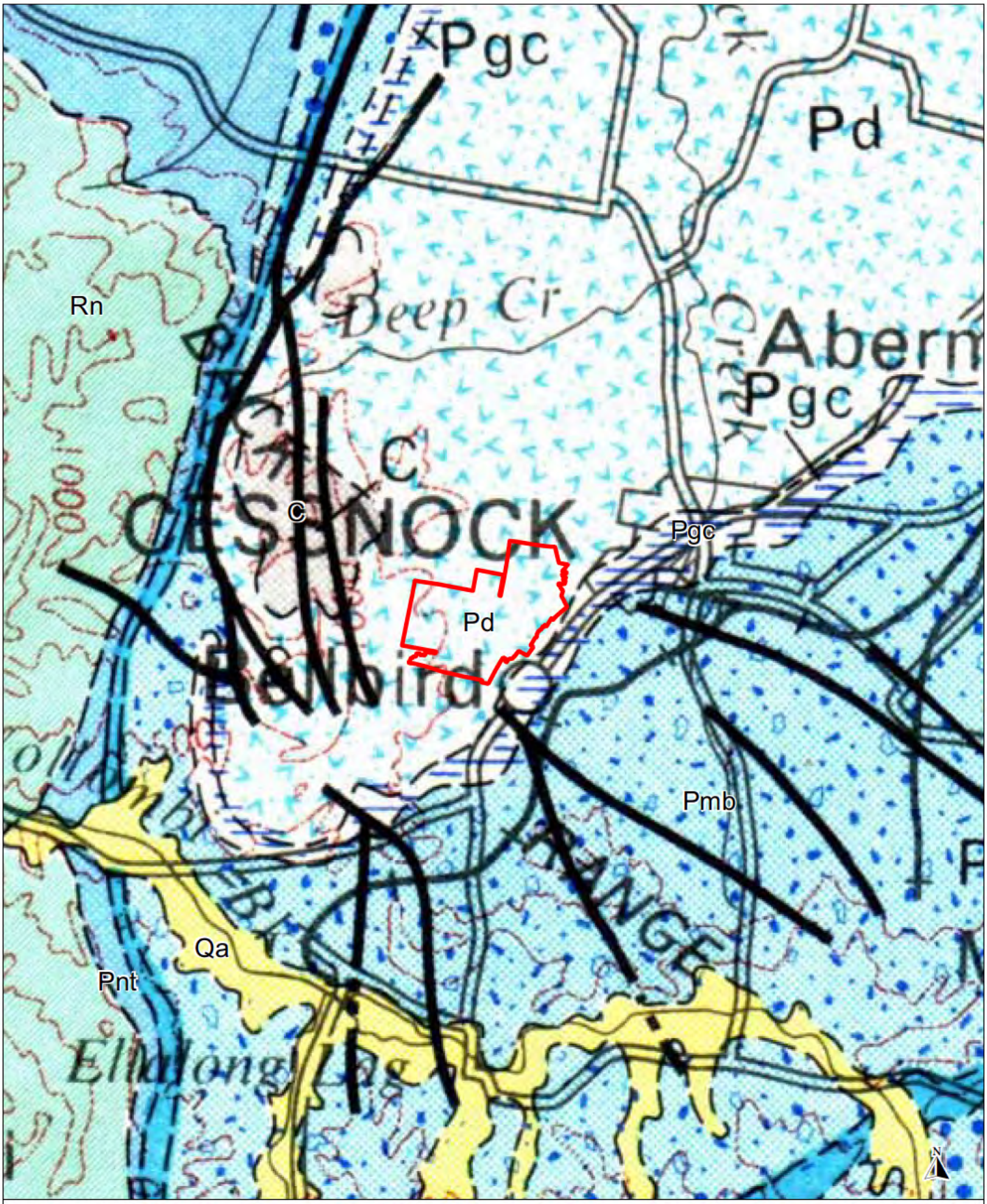
1(a) - Rural "A" Zone

1(v) - Rural (Vineyards) Zone

metres

0 340 680

Figure 3.
Cessnock LEP zoning map



Legend

Site boundary

kilometres

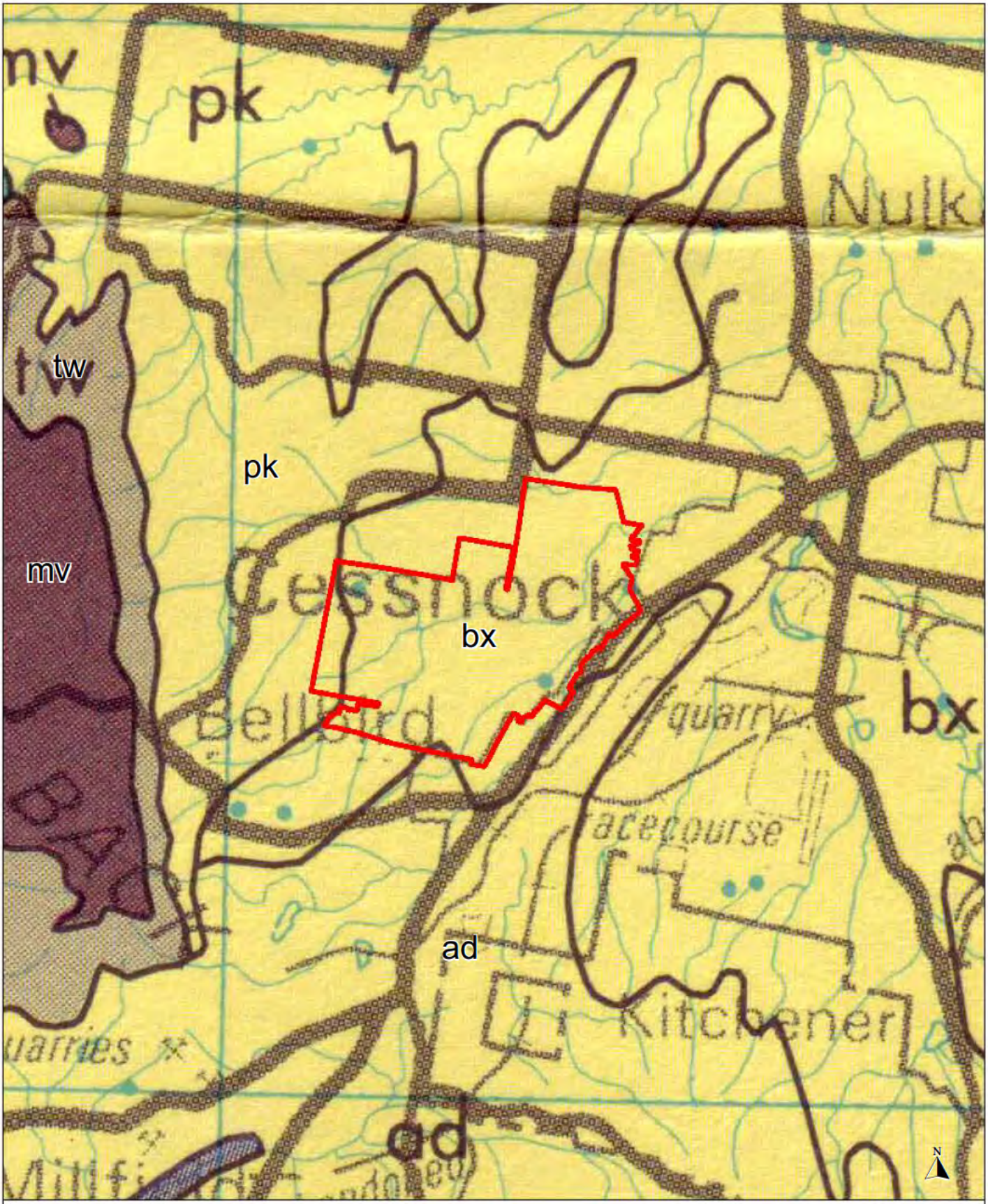
0 2 4

Map units

Pd - Dalwood
Pgc - Greta Coal Measures
Pmb - Branxton Formation
Qa - Quaternary Deposits

C - Undifferentiated
Rn - Narrabeen Group
Pnt - Singleton Coal Measures

Figure 4.
Geology mapping (Brunker and Rose 1967)



Legend

Site boundary

kilometres

0 1 2

Map units

bx - Branxton

ad - Aberdare

pk - Pokolbin

tw - Three Ways

mv - Mount View

Figure 5.
Soil landscape mapping (Kovac and Lawrie 1985)

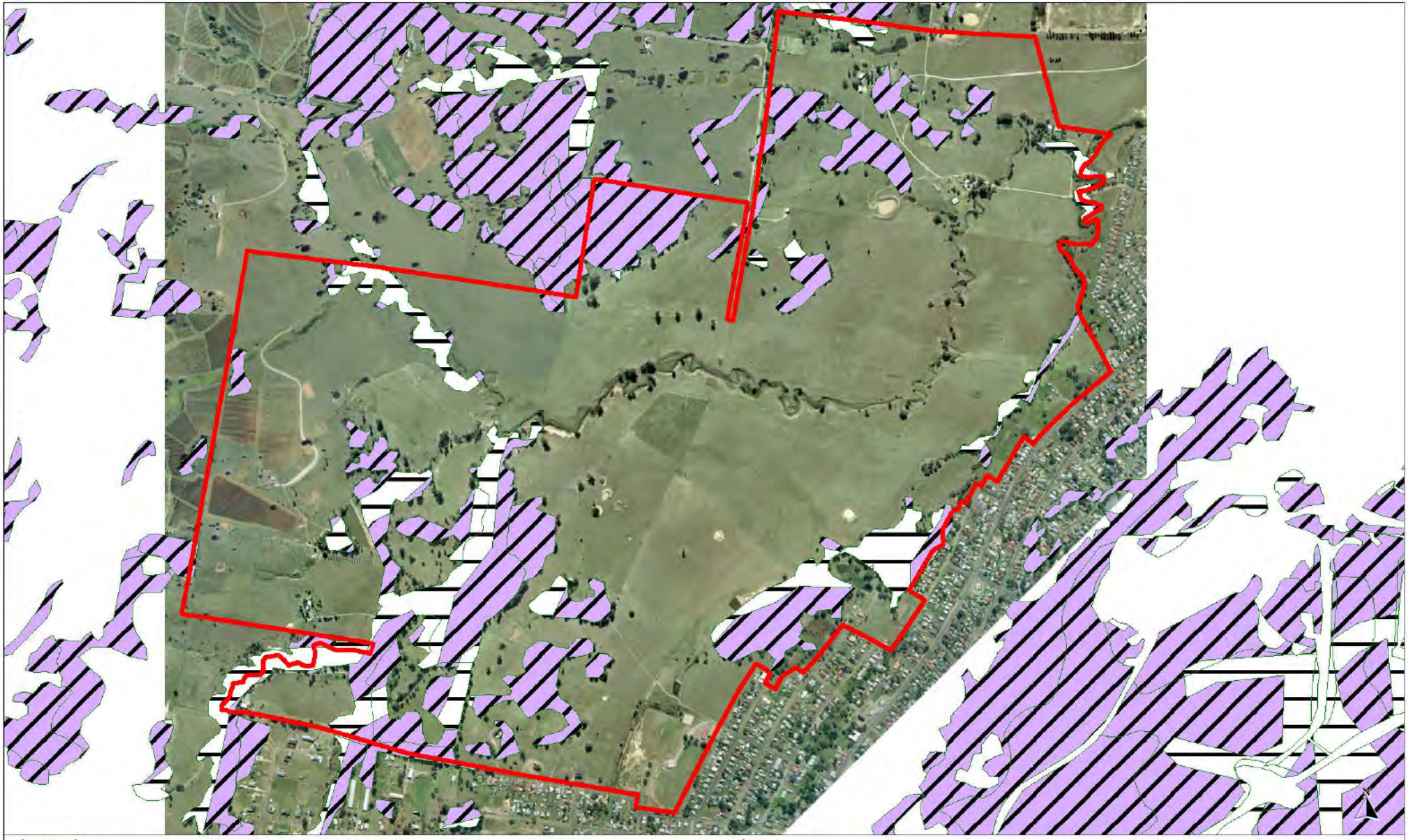
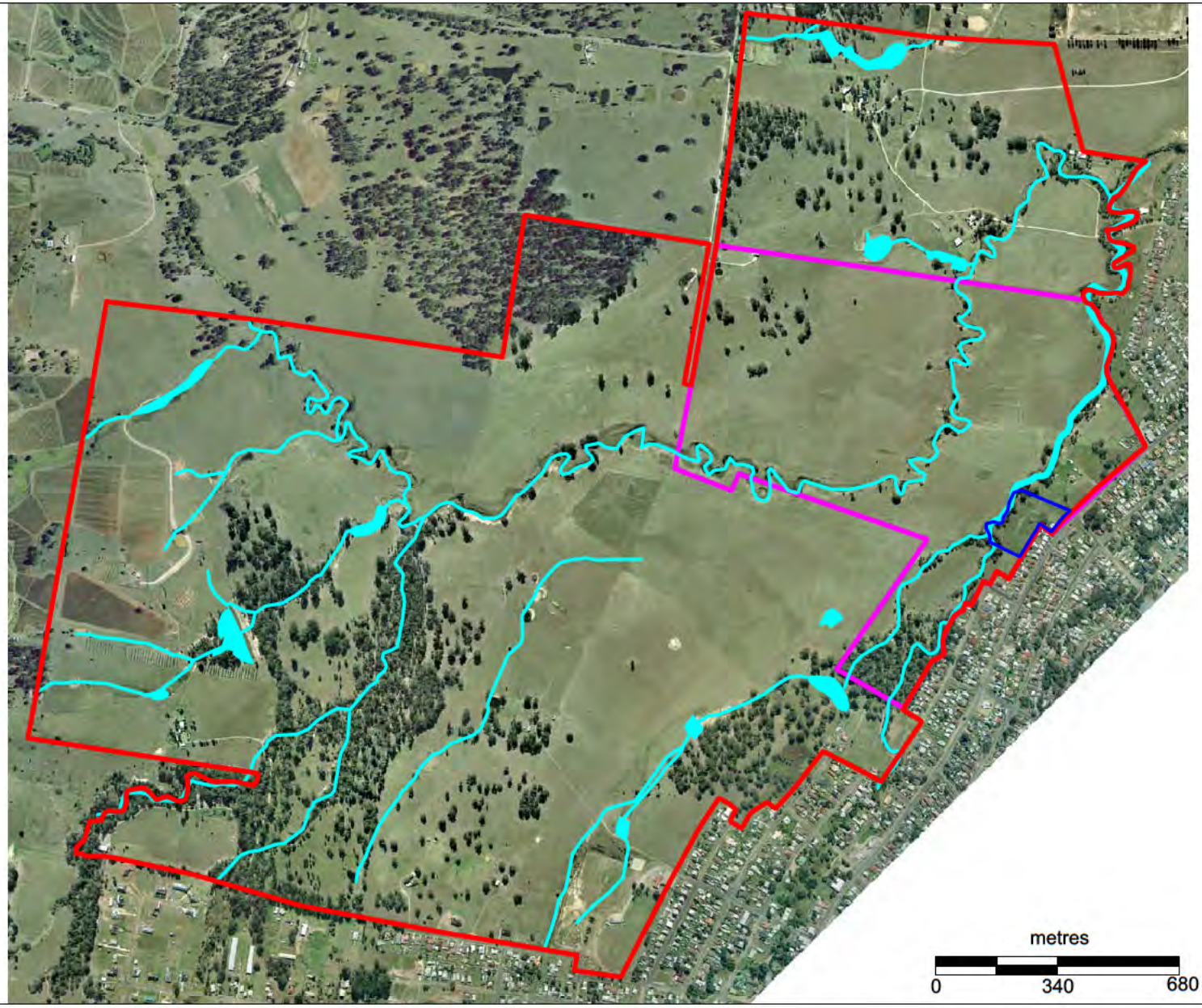


Figure 6.
Vegetation Mapping (LHCCREMS 2003) overlain on 2005/2006 aerial photograph



Legend

- S te boundary
- S nc a r Kn ght Merz Pty Ltd. Study Area
- Conacher Travers Study Area
- Creek nes

Figure 7.
Mapped creeklines, Sinclair Knight Merz Pty. Ltd. Study Area and
Conacher Travers Study Area overlain on the 2005/2006 aerial photograph

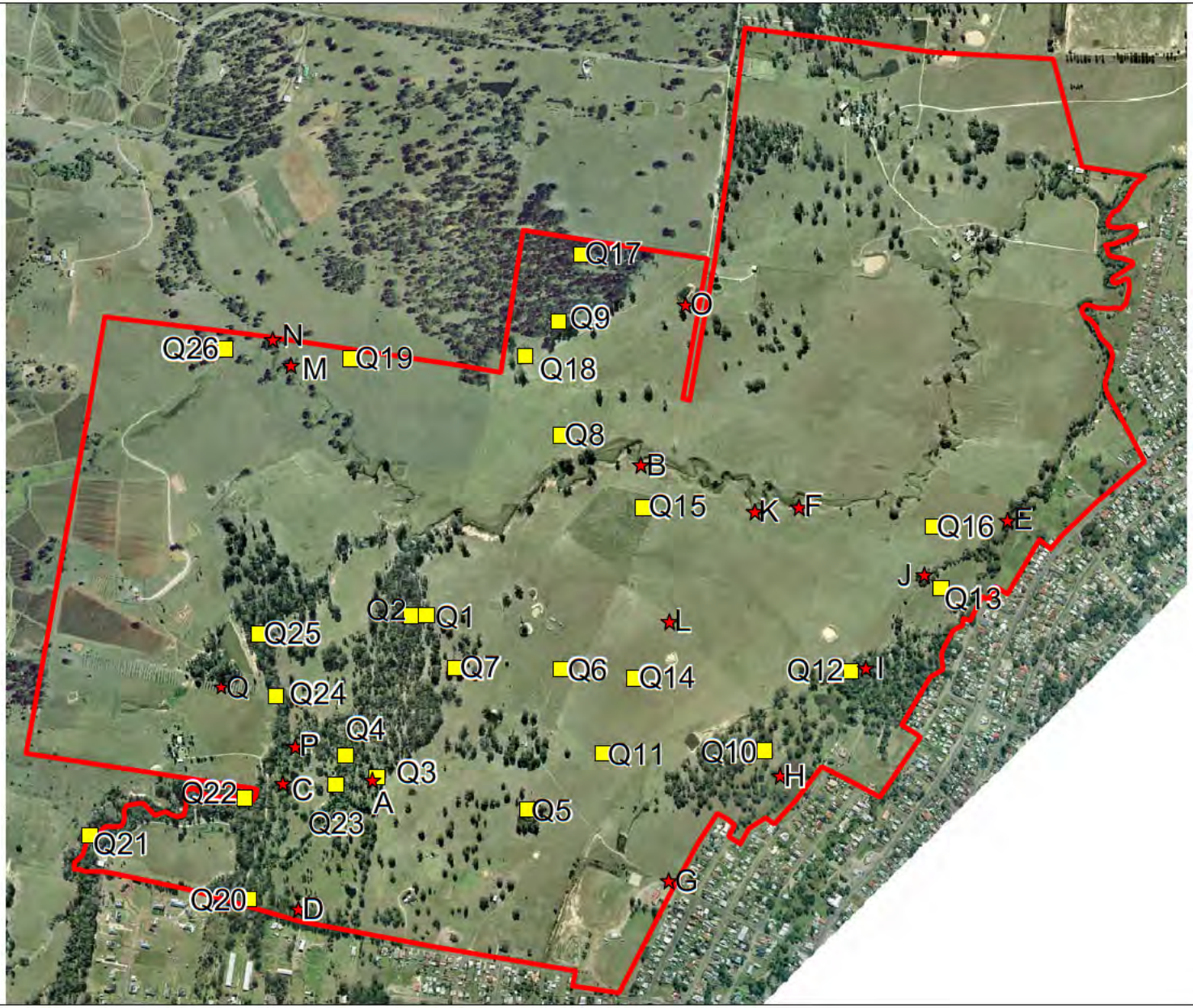


Figure 8.
Sampling locations overlain on the 2005/2006 aerial photograph

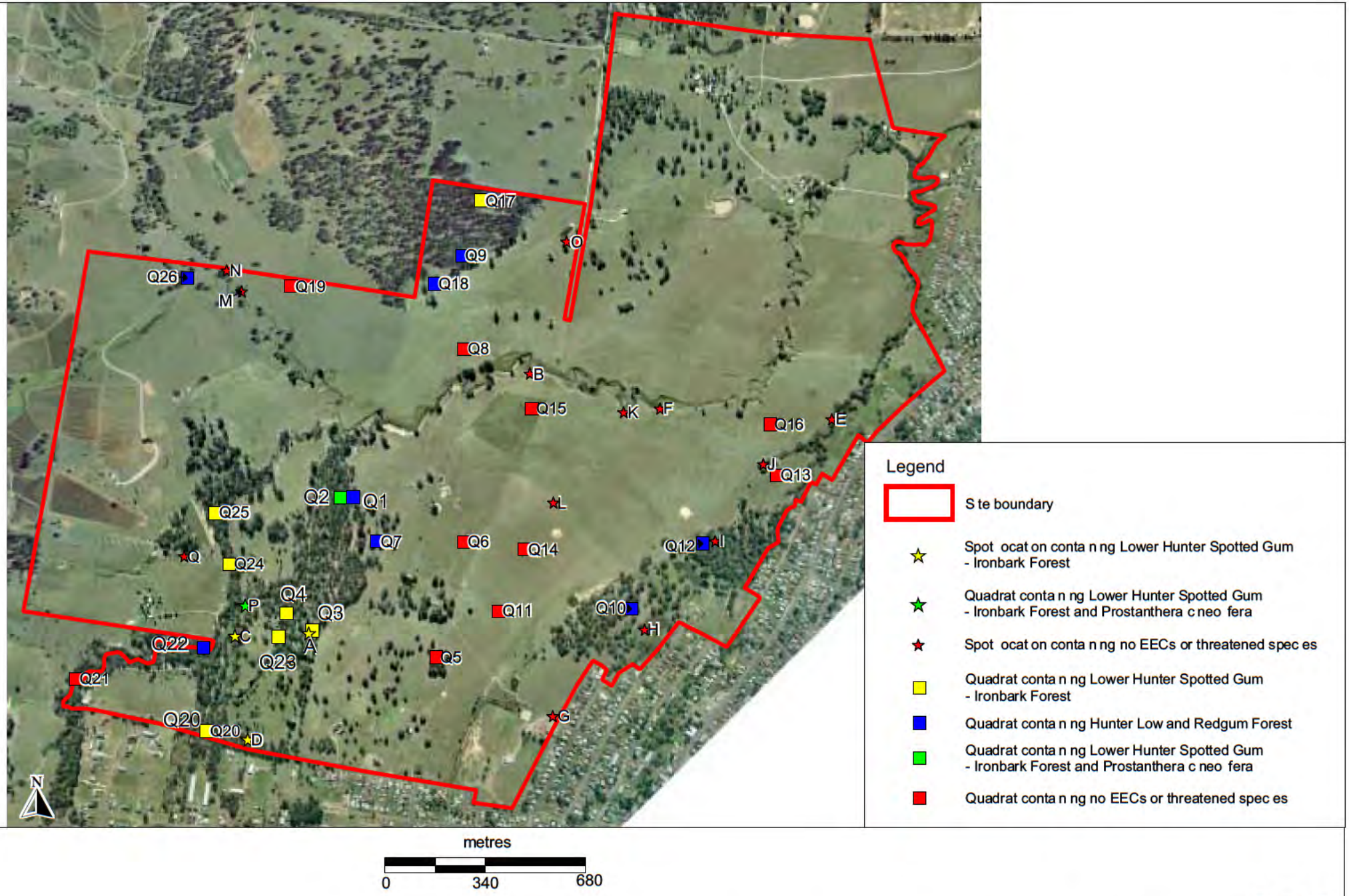
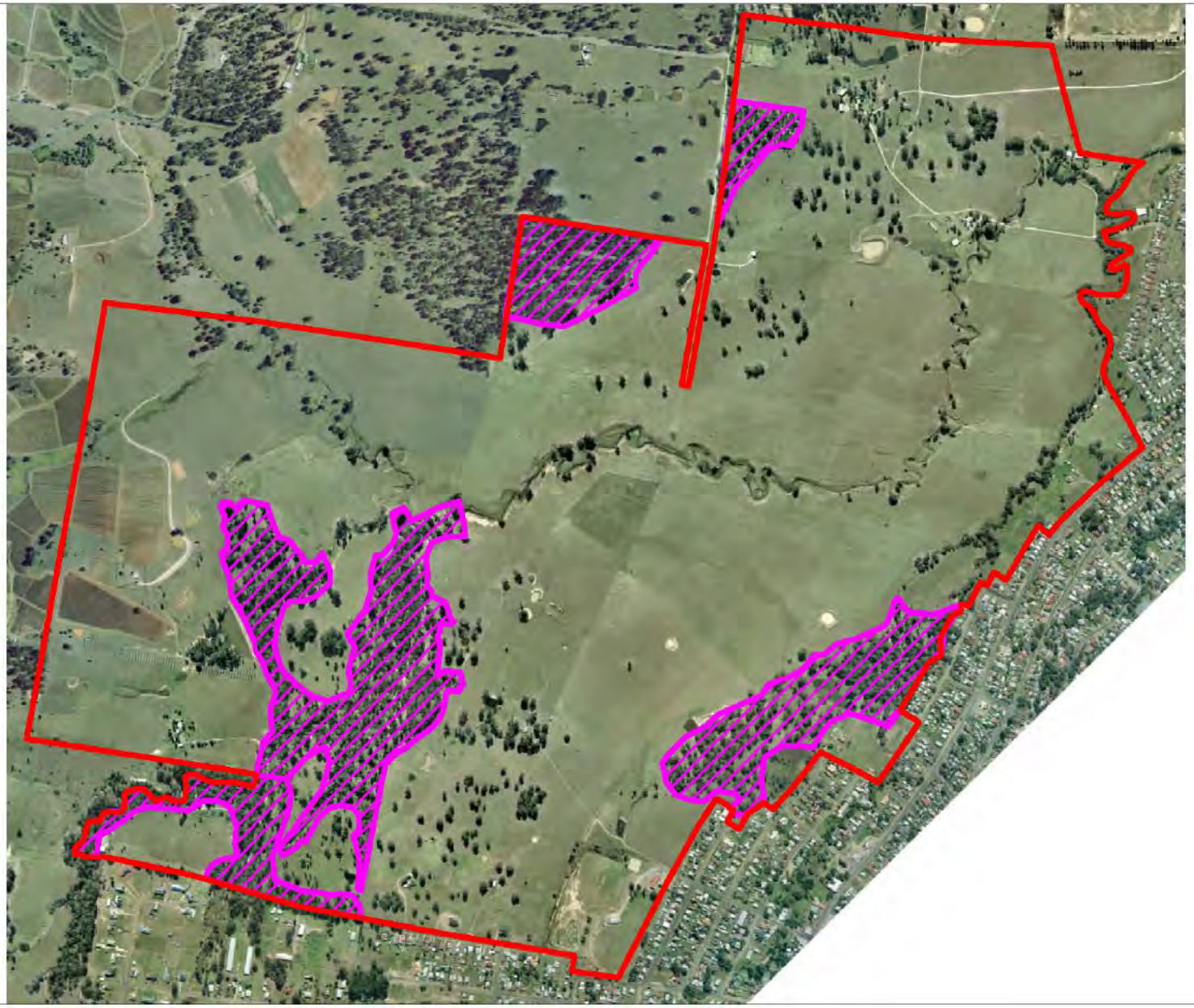


Figure 9.

Threatened Species and Endangered Ecological Communities recorded on the Site overlain on the 2005/2006 aerial photograph



Legend

Site boundary

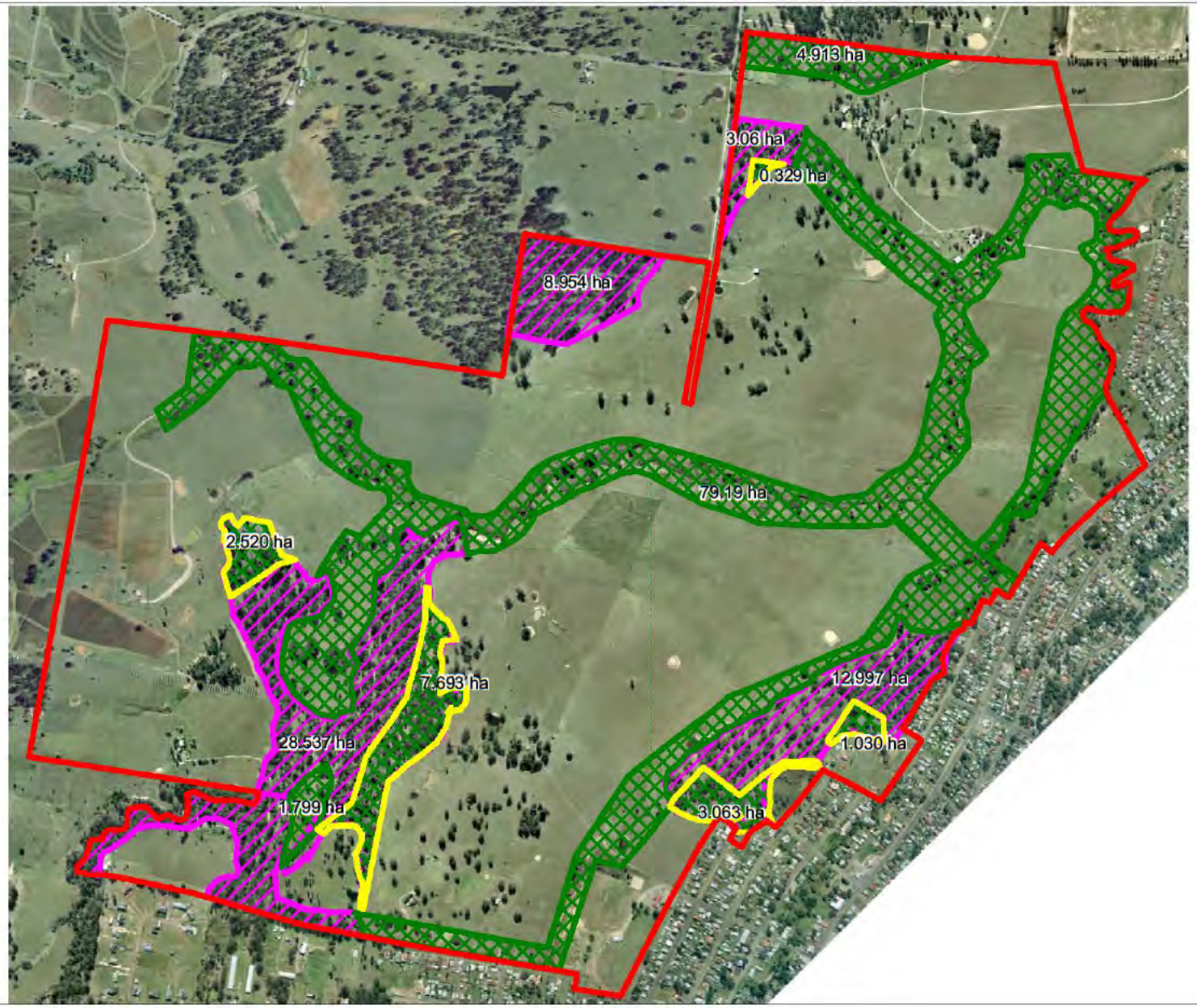
Ecologically constrained land

metres

0 340 680

N

Figure 10.
Ecological constraints overlain on the 2005/2006 aerial photograph



Legend

- S te boundary
- Eco og ca y constra ned and
- Constra ned and to be c eared
- Vegetat on to be re-estab shed

metres

0 340 680

Figure 11.
Ecologically constrained land, constrained land to be cleared and vegetation to be re-established under a vegetation plan of management overlain on the 2005/2006 aerial photograph

Tables

Table 1.
Review of historical aerial photographs

Year	On the Site	Surrounding
1952	Predominantly agricultural land. Cleared paddocks in the west and north-east. Forest vegetation adjoining the southern tributary of Limestone Creek, central eastern section adjoining Bellbird Creek and on the hill in the north-west to the west of Oakey Creek Road.	North - agriculture land and some treed areas along Limestone Creek and extending on the hill in the central north. South - Urban development and agricultural land with relatively intact vegetation further to the south. East - urban development with vegetation further east. West - agricultural land
1961	Similar to 1952 with some cleared paddocks.	Similar to 1952.
1975	Similar to 1952.	Similar to 1952.
1984	Similar to 1975. Vineyards to the west, as well as to the east and centre. The retained vegetation has been partially cleared to the south.	Similar to 1952. Further clearing for agriculture and roads to the north.
1994	Similar to 1975. Vineyards not evident on Site.	Similar to 1952.
2004	Similar to 1994. Vineyard with adjoining house to the west	Similar to 1952.

Table 2a - Species recorded in Quadrats on the Site

Notes: 1. Asterisk before botanical name signifies exotic species.
2. Families are grouped under headings 1. Pteridophytes, 2. Gymnosperms, 3. Dicotyledons, 4. Monocotyledons.
One or more of these plant groups may be absent from this site.

Botanical name	Common name	Sampling location																									
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
1. Pteridophytes																											
Adiantaceae																											
Adiantum aethiopicum	Common Maidenhair Fern				1																	3		1			
Adiantum hispidulum	Rough Maidenhair Fern																					2					
Aspleniaceae																											
Asplenium flabellifolium	Necklace Spleenwort Necklace Fern																					3					
Sinopteridaceae																											
Cheilanthes distans	Bristly Cloak-fern																	1								1	
Cheilanthes sieberi subsp sieberi	Rock Fern	2		3	4						1			1				4			1	1	3	2		2	
Pellaea paradoxa																						2					
2. Gymnosperms																											
Zamiaceae																											
Macrozamia flexuosa	Blackfellows Pineapple Zamia	1	1		1																			1			
3. Dicotyledons																											
Acanthaceae																											
Brunoniella australis	Blue Trumpet Blue Yam	2	1	1		4		3		4	2		1					3	2		4	2	2	1		3	1
Pseuderanthemum variabile																						1					
Amaranthaceae																											
Alternanthera denticulata	Common Joyweed																										
* Alternanthera pungens	Khaki Weed																										
Alternanthera sp A	Joyweed					3				3	1		2						2						1		
* Amaranthus viridis	Green Amaranth																										1
Anacardiaceae																											
* Schinus areira	Pepper Tree Peppercorn																						1			1	

Botanical name	Common name	Sampling location																								
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
Apiaceae																											
* Apium graveolens	Celery																										
Centella asiatica	Pennywort																										
* Ciclospermum leptophyllum	Slender Celery																1										
Apocynaceae																											
Parsonsia lanceolata																		1				3					
Asclepiadaceae																											
* Gomphocarpus fruticosus	Narrow-leaved Cotton Bush																									1	
Asteraceae																											
* Arctotheca calendula	Capeweed																										
* Aster subulatus	Wild Aster		1																								
* Bidens pilosa	Farmer's Friend Cobblers Pegs Begga												1										1				
* Bidens subalternans	Greater Beggar's Ticks												1											1	2		
Brachycome diversifolia var diversifolia	Large-headed Daisy				3													1				1	1			2	
Calotis cuneifolia	Purple Burr-daisy	1		2				2																			
Calotis lappulacea	Yellow Burr-daisy																	2									
Cassinia quinquefaria					1																			1			
Chrysocephalum apiculatum	Common Everlasting Yellow Buttons	1		2				1			1							2					1				
* Cirsium vulgare	Black Thistle Spear Thistle																		2	2							1
* Conyza albida	Tall Fleabane		1						1								3			2							
* Conyza bonariensis	Flaxleaf Fleabane							1				1	2	2		3											
Eclipta platyglossa	Yellow Twin-heads												1														
Epaltes australis	Spreading Nut-heads										1																
* Facelis retusa												1															
Glossogyne tannensis	Cobbler's Tack																						1				
* Gnaphalium coarctatum	Cudweed						3					2			1												
* Hypochaeris radicata	Catsear False Dandelion		1			2	4	2	4			4	1	2		1	1		3	4				1			
Lagenifera gracilis										1																	
Olearia viscidula	Wallaby Weed Sticky Daisy-bush		1		2																		2	4			
Ozothamnus diosmifolius	White Dogwood			2														4									
Senecio hispidulus var hispidulus	Hill Fireweed Rough Fireweed																						1				
* Senecio madagascariensis	Fireweed Madagascar Ragwort	1			1		4	4	1	1	2	4	2	3	3	3			3	2			1			1	2
* Soliva sessilis	Bindii Bindi-eye Jo-Jo																			1							
* Sonchus oleraceus	Common Sow-thistle Milk-thistle																		1								

Botanical name	Common name	Sampling location																									
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
* Taraxacum officinale	Dandelion																										
Vernonia cinerea		1						2		4	2							3					2			3	
Vittadinia sulcata																											
* Xanthium spinosum	Bathurst Burr																		1								1
Bignoniaceae																											
Pandorea pandorana	Wonga Vine	2	3		2																	1	3	2			
Brassicaceae																											
* Lepidium africanum	Common Peppercress																								2		1
* Lepidium bonariense	Cut-leaf Peppercress					1																					1
* Rorippa nasturtium-aquaticum	Watercress																										
Cactaceae																											
* Opuntia stricta	Prickly Pear Common Pest Pear		1	1				2			2														1	1	
Campanulaceae																											
Wahlenbergia communis	Australian Bluebell																						1				
Wahlenbergia gracilis	Sprawling Bluebell							1			1																
Wahlenbergia luteola	Australian Bluebell																										
Wahlenbergia planiflora								1			1																
Caryophyllaceae																											
* Paronychia brasiliana	Chilean Whitlow Wort					4				4									3	4					1		3
Casuarinaceae																											
Casuarina cristata	Belah			2																							
Casuarina glauca	Swamp Oak Swamp She-oak																										
Celastraceae																											
Cassine australis	Red Olive-Plum																					1	1				
Maytenus silvestris		1	1	1	2					1											4	3	1	4	2	4	
Chenopodiaceae																											
* Chenopodium album	Fat Hen																										
Chenopodium carinatum																				1							
Einadia hastata	Berry Saltbush												1								1				1		
Einadia nutans subsp linifolia	Climbing Saltbush	1								1											3				1	1	1
Einadia nutans subsp nutans	Climbing Saltbush					1				2											2				1	2	1
Einadia trigonos	Fishweed	2				4		2		2									3		4				4	2	4

Botanical name	Common name	Sampling location																								
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
Maireana microphylla	Eastern Cottonbush																								4		
Convolvulaceae																											
Dichondra repens	Kidney-weed Mercury Bay Weed	1	1	1	1	3		3		1	1		2					2	3	2	2		3		1	1	4
Crassulaceae																											
* Bryophyllum delagoense	Mother-of-Millions			1	2																3						
Cunoniaceae																											
Aphanopetalum resinosum	Gum Vine																					3					
Dilleniaceae																											
Hibbertia pedunculata				2																							
Elaeocarpaceae																											
Elaeocarpus obovatus	Hard Quandong		4																								
Epacridaceae																											
Acrotriche divaricata					2																			1			
Leucopogon juniperinus	Long-flowered Beard-heath	1	1	3	1																		3	2			
Lissanthe strigosa	Peach Heath	2		3																				2			
Euphorbiaceae																											
Breynia oblongifolia	Coffee Bush	1	2	2	3																1	4		1	1	1	
Chamaesyce drummondii	Caustic Weed Flat Spurge												1														
* Euphorbia sp																											
Glochidion ferdinandi	Cheese Tree																					2					
Phyllanthus gunnii																						1	2	2			
Phyllanthus hirtellus	Thyme Spurge	1																									
Phyllanthus virgatus				2				3		2													1				1
Fabaceae Faboideae																											
Bossiaea prostrata																		3									
Daviesia ulicifolia	Gorse Bitter-pea	4	2	3	2													1						2		2	
Desmodium brachypodum	Large Tick-trefoil																										
Desmodium rhytidophyllum	Tick-trefoil	1	1		2													1			2					2	
Desmodium varians	Slender Tick-trefoil	2	2		1			3		1								3			2		1	1		2	
Glycine clandestina	Twining Glycine			3	3	1		1										1			1			1			
Glycine microphylla		1																									
Glycine tabacina			1		1	3		2		4			1					4	3		3		4	2	1	1	2

Botanical name	Common name	Sampling location																									
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
Hardenbergia violacea	False Sarsaparilla	3	2	1														3			1		2	1		1	
ndigofera australis	Native ndigo																									2	
Kennedia rubicunda	Dusky Coral-pea																						1				
Pultenaea cunninghamii	Grey Bush-pea			2																				2			
* Trifolium repens	White Clover															1											
* Trifolium sp	Clover					1														4							
Zornia dyctiocarpa	Zornia	2						1															1				
Fabaceae Mimosoideae																											
Acacia floribunda	White Sally		1																								
Acacia implexa	Hickory Wattle																					2	3	1			
Acacia parramattensis	Parramatta Wattle Sydney Green Wattl																						2	1			
Acacia parvipinnula	Silver-stemmed Wattle		1	2	2																		1	1		1	
Gentianaceae																											
* Centaurium sp	Centaury											1		2			1										
Geraniaceae																											
Geranium solanderi	Native Geranium		1																								
Goodeniaceae																											
Goodenia rotundifolia		1	2															4			1		1			2	
Lamiaceae																											
Mentha diemenica	Slender Mint																										
Plectranthus parviflorus																					1					2	
Prostanthera cineolifera	Singleton Mint-bush		2																								
Lobeliaceae																											
Lobelia alata	Angled Lobelia																										
Pratia purpurascens	Whiteroot	1	1		3	1		2		4	2		1					2			2			3		2	
Loranthaceae																											
Amyema miquelii	Box Mistletoe Drooping Mistletoe																										
Dendrophthoe vitellina	Long-flowered Mistletoe				1																						
Malvaceae																											
Abutilon oxycarpum			1																								
* Malva sp	Mallow																										1
Malvastrum coromandelianum	Prickly Malvastrum		1																								

Botanical name	Common name	Sampling location																									
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
* Modiola caroliniana	Red-flower Mallow																										
Sida corrugata	Corrugated Sida Sage Weed	1	2																		1		4			3	
* Sida rhombifolia	Paddy's Lucerne			2		4		1		1			3						3	2			1		3	1	4
Menyanthaceae																											
Villarsia reniformis																											
Moraceae																											
Maclura cochinchinensis	Cockspur Thorn																					2					
Streblus brunonianus	Whalebone Tree																					4					
Myoporaceae																											
Eremophila debilis	Winter Apple Amulla	1		1				1		2								1					1				
Myrsinaceae																											
Rapanea variabilis	Muttonwood																					2	1				
Myrtaceae																											
Angophora floribunda	Rough-barked Apple																										
Backhousia myrtifolia	Grey Myrtle ronwood				2																	4					
Callistemon salignus	White Bottlebrush Pink-tips																										
Corymbia maculata	Spotted Gum	4	3	3	4										1			2					3	2	1	4	
Eucalyptus acmenoides	White Mahogany		2		2	3							1											3		3	
Eucalyptus fibrosa	Broad-leaved Red ronbark			4	4	1					2							2			4				2		
Eucalyptus moluccana	Grey Box	1		1				1			4		1						1		1		2	3	1		2
Eucalyptus paniculata	Grey ronbark	1	1																				2				
Eucalyptus tereticornis	Forest Red Gum	3						2		2			1						1				4				3
Melaleuca linariifolia	Flax-leaved Paperbark																										
Melaleuca nodosa	Ball Honey-myrtle																										
Melaleuca styphelioides	Prickly Paperbark				2						1		1									2		1			
Ochnaceae																											
* Ochna serrulata	Mickey Mouse Plant																					4					
Oleaceae																											
Jasminum volubile	Native Jasmine		1		1													1				3	1				
* Ligustrum sinense	Small-Leaved Privet Chinese Privet																										
Notelaea longifolia	Mock-olive				4			1			1		2					1				4	2	3		2	1
Notelaea ovata	Mock-olive			1																				1			
* Olea europaea	Olive																										

Botanical name	Common name	Sampling location																								
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
Onagraceae																											
Ludwigia peploides subsp montevidensis	Water Primrose																										
Oxalidaceae																											
Oxalis exilis	Creeping Oxalis					4			1	1	1	2															
Oxalis perennans				1	1		1			1				2	1			4	3	4	4						2
Pittosporaceae																											
Bursaria spinosa	Australian Boxthorn	3	2		4													4			2	1	4	4	1	4	
Pittosporum multiflorum	Orange Thorn																					2					
Pittosporum revolutum	Yellow Pittosporum																					1					
Plantaginaceae																											
Plantago debilis		1																									
Plantago gaudichaudii											1																
* Plantago lanceolata	Plantain Ribwort		1		1	1		2		2	3		2	2					3								2
* Plantago major	Large Plantain		1																								
Polygonaceae																											
Persicaria hydropiper	Water Pepper																										
Rumex brownii	Slender Dock							1					2						2	1							2
* Rumex conglomeratus	Clustered Dock		1																								
Portulacaceae																											
Portulaca oleracea	Pigweed Purslane					1						1			2	1				3							1
Ranunculaceae																											
Clematis glycinoides	Headache Vine Traveller's Joy Old Ma	1	2		2																			2			
Rhamnaceae																											
Alphitonia excelsa	Red Ash Soap Tree																						1				
Rosaceae																											
* Rubus discolor	Blackberry		2																								
Rubus parvifolius	Native Raspberry		1																				1				
Rubiaceae																											
Asperula conferta	Common Woodruff		1					2																			
Galium binifolium																							1	1			
Opercularia diphylla	Stinkweed	2																3								1	

Botanical name	Common name	Sampling location																									
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
Opercularia hispida	Stinkweed																						2				
Pomax umbellata	Pomax	1		2														2									
* Richardia humistrata																											
* Richardia stellaris	Field Madder										2																
Rutaceae																											
Geijera salicifolia	Green Satinhearts																									1	
Santalaceae																											
Exocarpos cupressiformis	Cherry Ballart Native Cherry																					1	2				
Sapindaceae																											
Alectryon tomentosus	Hairy Bird's-eye Woolly Rambutan		1		1																	3	1			2	
Dodonaea triquetra	Hopbush			1																							
Dodonaea viscosa subsp angustifolia	Sticky Hopbush	1																					2			1	
Scrophulariaceae																											
Veronica plebeia	Creeping Speedwell							1		1																	
Solanaceae																											
* Cestrum parqui	Green Cestrum																					2					
* Lycium ferocissimum	African Boxthorn									1															3		3
Solanum prinophyllum	Forest Nightshade				1																2						1
* Solanum pseudocapsicum	Jerusalem Cherry												1														
Solanum sp										2								2									
Solanum stelligerum	Devil's Needles		1			4				1											2		1	1	2	2	
Stackhousiaceae																											
Stackhousia viminea	Slender Stackhousia	1		1				2		1								3					2	1			
Sterculiaceae																											
Brachychiton populneus subsp populneu	Kurrajong	1		1	3																	2	2	2		2	
Thymelaeaceae																											
Pimelea latifolia subsp elliptifolia																						1		1			
Verbenaceae																											
Clerodendrum tomentosum	Hairy Clerodendrum																					2	1				
* Lantana camara	Lantana		1	1	3								2									3	2				
* Verbena bonariensis	Purpletop		1																								
* Verbena brasiliensis													2														

Botanical name	Common name	Sampling location																									
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
* Verbena rigida	Purple Verbena	1					1												1								1
Violaceae																											
Hybanthus enneaspermus subsp stellari	Spade Flower				1																		1				
Vitaceae																											
Cayratia clematidea	Slender Grape		1		2																	4	2				1
4. Monocotyledons																											
Anthericaceae																											
Arthropodium milleflorum	Vanilla Lily	1			2					1								4			1	2			1	1	
Tricoryne elatior	Yellow Rush Lily			1																							
Arecaceae																											
* Phoenix canariensis	Canary sland Date																										
Asparagaceae																											
* Asparagus asparagoides	Bridal Creeper		1																			2	1				
Asphodelaceae																											
* Aloe vera	Aloe Vera																				2						
Commelinaceae																											
Commelina cyanea	Blue Spiderwort	3	1					4		1								3	1		2				2	2	
Murdannia graminea										1															1		
Cyperaceae																											
Carex appressa	Tall Sedge												1														
Carex inversa	Knob Sedge																										
* Cyperus aggregatus						1		1																			
* Cyperus brevifolius	Mullumbimby Couch																					1					
Cyperus difformis	Dirty Dora																										
Cyperus gracilis	Slender Sedge	2				4		3		4	2		2						4		4				1	2	3
* Cyperus sesquiflorus														4													
Cyperus trinervis					1																						
Eleocharis pallens	Pale Spike-rush																										
Eleocharis sphacelata	Tall Spike-rush																										
Fimbristylis dichotoma		1		1						1	1		2	2									1			1	
Gahnia aspera	Rough-leaved Saw-sedge																					1					

Botanical name	Common name	Sampling location																									
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
Lepidosperma laterale	Variable Sword-sedge		1		1																			1			
Scleria mackaviensis			2																								
Juncaceae																											
* Juncus acutus	Spiny Rush																										
* Juncus capillaceus									1			1															
Juncus continuus																											
Juncus subsecundus								2																	1		
Juncus usitatus					1					2	1								1								
Juncaginaceae																											
Triglochin sp																											
Lomandraceae																											
Lomandra filiformis subsp coriacea	Wattle Mat-rush	3	2							1											1						
Lomandra filiformis subsp filiformis	Wattle Mat-rush	3	3	4	3			4		3								2	1		3	1	4	2	1	3	
Lomandra longifolia	Honey Reed Spike Mat-rush				1																			1			
Lomandra multiflora	Many-flowered Mat-rush	4	2	3	2													3			2		1			2	
Philesiaceae																											
Eustrephus latifolius	Wombat Berry	2	3		4																1	4	4	2		2	
Geitonoplesium cymosum	Scrambling Lily	1	2		2																2	2	2	1			
Phormiaceae																											
Dianella caerulea var cinerascens	Blue Flax-lily	1	2	2	4			2														3	3	4		3	
Dianella longifolia	Smooth Flax-lily			2																					1	3	
Dianella revoluta	Blue Flax-lily Spreading Flax-lily	3		2																			2				
Poaceae																											
Aristida ramosa var ramosa	Wiregrass							1	1	1								1	3		2			1	1	1	3
Aristida vagans	Threeawn Speargrass	4	1	4	4			4		1	1							4			1		2	1	1	2	
Austrodanthonia auriculata	Lobed Wallaby Grass															1											
Austrodanthonia fulva	Wallaby Grass																						1				
Austrodanthonia racemosa	Wallaby Grass									1																	
Austrodanthonia sp	Wallaby Grass																	1	2		1						1
Austrodanthonia tenuior	Wallaby Grass			1				1																			
Austrostipa ramosisssima	Bamboo Speargrass																								2		
Austrostipa rudis					3																		1	1			
Austrostipa verticillata	Slender Bamboo Grass																				4						

Botanical name	Common name	Sampling location																								
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
* Axonopus affinis	Narrow-leaved Carpet Grass						4		4		1	3	1	3	3		2			3							
Bothriochloa decipiens	Redleg Grass Pitted Bluegrass												2			4			2								
Bothriochloa macra			1			1		4			1		1	3			2		4		3			1			3
Bothriochloa sp							3		4	1																	
* Bromus catharticus	Prairie Grass				1														1								
Capillipedium spicigerum	Scented-top Grass																										
* Chloris gayana	Rhodes Grass																1										
Chloris truncata	Windmill Grass										2						4			1							
Chloris ventricosa	Tall Windmill Grass					4		2		2			2						4		2				2		3
Cymbopogon refractus	Barbed Wire Grass	3	1	3	1			4		1							1	3	1		2		3	1		3	
Cynodon dactylon	Couch Bermuda Grass	1	1	2		4	4	2	4	3	4	4	3	3	4	3	4		4	4	1		1	1	2		4
Dichanthium sericeum	Silky Blue-grass		1																		1						
Dichelachne micrantha	Shorthair Plumegrass																						1				
Digitaria breviglumis		1																					2				
Digitaria ciliaris															3												
Digitaria didactyla	Queensland Blue Couch							3																	2		
Digitaria diffusa		1		2	1	3				2	1												1			1	
Digitaria parviflora	Smallflower Finger Grass																						1	1		2	
Digitaria ramularis					2													1					1				
Digitaria sp							1	1																			
* Echinochloa crus-galli	Barnyard Grass																										
Echinopogon caespitosus	Tufted Hedgehog Grass																								1		
Echinopogon sp								1		1	1							1			1						
* Ehrharta erecta	Panic Veldgrass																					3			3	1	
* Eleusine indica	Crowsfoot Grass														1	1											1
* Eleusine tristachya	Crabgrass Goose Grass						2								2	2				3							2
Enteropogon acicularis	Curly Windmill Grass										3										1						
Entolasia stricta	Wiry Panic	2	2	2	2	1												4						2		3	
Eragrostis brownii	Brown's Lovegrass	2		3			3	1	1	1	3	2		1				2					1				
Eragrostis elongata	Clustered Lovegrass	1					3																		1		
Eragrostis leptostachya	Paddock Lovegrass			1	2			3	1	4	2	3	1		1	4		2	2	1			1		2	2	1
* Eragrostis pilosa	Soft Lovegrass												2				1										
Eriochloa pseudoacrotricha	Early Spring Grass				1								2								1		1		3		
* Holcus lanatus	Yorkshire Fog																										
mperata cylindrica	Blady Grass	1	1		2																		1	1			
Microlaena stipoides	Meadow Rice-grass Weeping Grass	4	1	1	3	4	3	4	2	4	4	1		2	2	3		4	4		4		4	2	4	2	4

Botanical name	Common name	Sampling location																									
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26
Notodanthonia longifolia					1	1		1			1		2					1			2		1			2	
Oplismenus imbecillis	Narrow-leaved Basket Grass		2		2																	4					
Panicum effusum	Hairy Panic	1			1									1			1						3		1	1	
Panicum simile	Two-colour Panic		1	1																						2	
Paspalidium distans		2	3	3	2	1		3		3	2		1	3	2			4	1		4		2		2	4	1
* Paspalum dilatatum	Paspalum	1	1	2	1	3	3	1	4	1	2	4	2		3	3	4		4	3	1		2	2			4
Paspalum distichum	Water Couch																										
* Pennisetum clandestinum	Kikuyu											4			3	1									1		
Phragmites australis	Common Reed																						1				
Poa sieberiana var sieberiana	Snow Grass Fine-leaf Tussock Grass				1																					1	
* Polypogon littoralis	Perennial Beardgrass																										
* Setaria gracilis	Slender Pigeon Grass			1			3				1		1	3		2	2		2	1	1						
Sorghum leiocladum	Wild Sorghum																						3				
* Sporobolus africanus	Parramatta Grass								2			2		2	3				1								
Sporobolus creber	Slender Rat's-tail Grass			2		1	4	4	4	3	1	3		1		3	4		2	4					2		2
* Stenotaphrum secundatum	Buffalo Grass																										
Themeda australis	Kangaroo Grass	4	3	4	4		1	4		1	3	2			1			4			2		4	4		1	
Potamogetonaceae																											
Potamogeton tricarinatus	Floating Pondweed																										
Typhaceae																											
Typha orientalis	Broad-leaf Cumbungi Bulrush																										

Table 2b - Species recorded in Spot locations on the Site

Notes: 1. Asterisk before botanical name signifies exotic species.
2. Families are grouped under headings 1. Pteridophytes, 2. Gymnosperms, 3. Dicotyledons, 4. Monocotyledons. One or more of these plant groups may be absent from this site.

Botanical name	Common name	Sampling location																
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1. Pteridophytes																		
Adiantaceae																		
Adiantum aethiopicum	Common Maidenhair Fern																	
Adiantum hispidulum	Rough Maidenhair Fern																	
Aspleniaceae																		
Asplenium flabellifolium	Necklace Spleenwort Necklace Fern																	
Sinopteridaceae																		
Cheilanthes distans	Bristly Cloak-fern	X					X								X		X	
Cheilanthes sieberi subsp sieberi	Rock Fern	X		X													X	
Pellaea paradoxa																		
2. Gymnosperms																		
Zamiaceae																		
Macrozamia flexuosa	Blackfellows Pineapple Zamia																	
3. Dicotyledons																		
Acanthaceae																		
Brunoniella australis	Blue Trumpet Blue Yam				X												X	
Pseuderanthemum variabile																		
Amaranthaceae																		
Alternanthera denticulata	Common Joyweed									X								
* Alternanthera pungens	Khaki Weed													X	X			
Alternanthera sp A	Joyweed																	
* Amaranthus viridis	Green Amaranth																	
Anacardiaceae																		
* Schinus areira	Pepper Tree Peppercorn					X					X							

Botanical name	Common name	Sampling location																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
Apiaceae																			
* Apium graveolens	Celery													X					
Centella asiatica	Pennywort									X									
* Ciclospermum leptophyllum	Slender Celery																		
Apocynaceae																			
Parsonsia lanceolata				X		X													
Asclepiadaceae																			
* Gomphocarpus fruticosus	Narrow-leaved Cotton Bush																		
Asteraceae																			
* Arctotheca calendula	Capeweed							X											
* Aster subulatus	Wild Aster									X				X					
* Bidens pilosa	Farmer's Friend Cobblers Pegs Begga							X						X					
* Bidens subalternans	Greater Beggar's Ticks					X									X				
Brachycome diversifolia var diversifolia	Large-headed Daisy																X		
Calotis cuneifolia	Purple Burr-daisy	X																	
Calotis lappulacea	Yellow Burr-daisy	X												X					
Cassinia quinquefaria																			
Chrysocephalum apiculatum	Common Everlasting Yellow Buttons							X			X								
* Cirsium vulgare	Black Thistle Spear Thistle		X												X				
* Conyza albida	Tall Fleabane		X					X					X	X	X				
* Conyza bonariensis	Flaxleaf Fleabane																		
Eclipta platyglossa	Yellow Twin-heads																		
Epaltes australis	Spreading Nut-heads																		
* Facelis retusa																			
Glossogyne tannensis	Cobbler's Tack																		
* Gnaphalium coarctatum	Cudweed																		
* Hypochaeris radicata	Catsear False Dandelion							X				X							
Lagenifera gracilis																			
Olearia viscidula	Wallaby Weed Sticky Daisy-bush																X		
Ozothamnus diosmifolius	White Dogwood	X																	
Senecio hispidulus var hispidulus	Hill Fireweed Rough Fireweed																		
* Senecio madagascariensis	Fireweed Madagascar Ragwort			X			X	X				X	X	X					
* Soliva sessilis	Bindii Bindi-eye Jo-Jo																		
* Sonchus oleraceus	Common Sow-thistle Milk-thistle													X	X				

Botanical name	Common name	Sampling location																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
* Taraxacum officinale	Dandelion										X								
Vernonia cinerea																	X		
Vittadinia sulcata				X															
* Xanthium spinosum	Bathurst Burr							X											
Bignoniaceae																			
Pandorea pandorana	Wonga Vine													X					
Brassicaceae																			
* Lepidium africanum	Common Peppercress										X				X				
* Lepidium bonariense	Cut-leaf Peppercress																		
* Rorippa nasturtium-aquaticum	Watercress									X				X					
Cactaceae																			
* Opuntia stricta	Prickly Pear Common Pest Pear			X															
Campanulaceae																			
Wahlenbergia communis	Australian Bluebell													X					
Wahlenbergia gracilis	Sprawling Bluebell							X											
Wahlenbergia luteola	Australian Bluebell						X				X	X	X		X				
Wahlenbergia planiflora																			
Caryophyllaceae																			
* Paronychia brasiliana	Chilean Whitlow Wort							X						X	X				
Casuarinaceae																			
Casuarina cristata	Belah																		
Casuarina glauca	Swamp Oak Swamp She-oak					X													
Celastraceae																			
Cassine australis	Red Olive-Plum																		
Maytenus silvestris		X			X												X		
Chenopodiaceae																			
* Chenopodium album	Fat Hen							X											
Chenopodium carinatum																			
Einadia hastata	Berry Saltbush	X		X	X														
Einadia nutans subsp linifolia	Climbing Saltbush													X	X				
Einadia nutans subsp nutans	Climbing Saltbush				X														
Einadia trigonos	Fishweed			X	X	X								X	X				

Botanical name	Common name	Sampling location																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
Maireana microphylla	Eastern Cottonbush														X				
Convolvulaceae																			
Dichondra repens	Kidney-weed Mercury Bay Weed													X	X		X		
Crassulaceae																			
* Bryophyllum delagoense	Mother-of-Millions				X														
Cunoniaceae																			
Aphanopetalum resinosum	Gum Vine																		
Dilleniaceae																			
Hibbertia pedunculata																			
Elaeocarpaceae																			
Elaeocarpus obovatus	Hard Quandong																		
Epacridaceae																			
Acrotriche divaricata																			
Leucopogon juniperinus	Long-flowered Beard-heath	X																	
Lissanthe strigosa	Peach Heath																		
Euphorbiaceae																			
Breynia oblongifolia	Coffee Bush	X															X		
Chamaesyce drummondii	Caustic Weed Flat Spurge																		
* Euphorbia sp								X											
Glochidion ferdinandi	Cheese Tree																		
Phyllanthus gunnii																			
Phyllanthus hirtellus	Thyme Spurge																		
Phyllanthus virgatus		X																	
Fabaceae Faboideae																			
Bossiaea prostrata																			
Daviesia ulicifolia	Gorse Bitter-pea	X																	
Desmodium brachypodum	Large Tick-trefoil																X		
Desmodium rhytidophyllum	Tick-trefoil																		
Desmodium varians	Slender Tick-trefoil							X											
Glycine clandestina	Twining Glycine					X													
Glycine microphylla																			
Glycine tabacina														X	X		X		

Botanical name	Common name	Sampling location																
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Hardenbergia violacea	False Sarsaparilla																X	
ndigofera australis	Native ndigo																	
Kennedia rubicunda	Dusky Coral-pea																	
Pultenaea cunninghamii	Grey Bush-pea																	
* Trifolium repens	White Clover																	
* Trifolium sp	Clover							X		X								
Zornia dyctiocarpa	Zornia																	
Fabaceae Mimosoideae																		
Acacia floribunda	White Sally																	
Acacia implexa	Hickory Wattle																X	
Acacia parramattensis	Parramatta Wattle Sydney Green Wattl			X														
Acacia parvipinnula	Silver-stemmed Wattle	X																
Gentianaceae																		
* Centaurium sp	Centaury																	
Geraniaceae																		
Geranium solanderi	Native Geranium																	
Goodeniaceae																		
Goodenia rotundifolia								X										
Lamiaceae																		
Mentha diemenica	Slender Mint													X				
Plectranthus parviflorus																		
Prostanthera cineolifera	Singleton Mint-bush																X	
Lobeliaceae																		
Lobelia alata	Angled Lobelia													X				
Pratia purpurascens	Whiteroot																	
Loranthaceae																		
Amyema miquelii	Box Mistletoe Drooping Mistletoe	X																
Dendrophthoe vitellina	Long-flowered Mistletoe																	
Malvaceae																		
Abutilon oxycarpum				X														
* Malva sp	Mallow							X										
Malvastrum coromandelianum	Prickly Malvastrum			X														

Botanical name	Common name	Sampling location																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
* Modiola caroliniana	Red-flower Mallow														X				
Sida corrugata	Corrugated Sida Sage Weed																X		
* Sida rhombifolia	Paddy's Lucerne	X		X	X	X		X						X	X				
Menyanthaceae																			
Villarsia reniformis									X										
Moraceae																			
Maclura cochinchinensis	Cockspur Thorn																		
Streblus brunonianus	Whalebone Tree																		
Myoporaceae																			
Eremophila debilis	Winter Apple Amulla																		
Myrsinaceae																			
Rapanea variabilis	Muttonwood																		
Myrtaceae																			
Angophora floribunda	Rough-barked Apple													X					
Backhousia myrtifolia	Grey Myrtle ronwood																		
Callistemon salignus	White Bottlebrush Pink-tips					X													
Corymbia maculata	Spotted Gum			X	X												X		
Eucalyptus acmenoides	White Mahogany																X		
Eucalyptus fibrosa	Broad-leaved Red ronbark	X		X	X														
Eucalyptus moluccana	Grey Box			X							X						X		
Eucalyptus paniculata	Grey ronbark																X		
Eucalyptus tereticornis	Forest Red Gum					X	X							X	X				
Melaleuca linariifolia	Flax-leaved Paperbark								X										
Melaleuca nodosa	Ball Honey-myrtle	X																	
Melaleuca styphelioides	Prickly Paperbark					X				X	X								
Ochnaceae																			
* Ochna serrulata	Mickey Mouse Plant																		
Oleaceae																			
Jasminum volubile	Native Jasmine													X					
* Ligustrum sinense	Small-Leaved Privet Chinese Privet									X									
Notelaea longifolia	Mock-olive			X													X		
Notelaea ovata	Mock-olive																		
* Olea europaea	Olive																	X	

Botanical name	Common name	Sampling location																
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Onagraceae																		
Ludwigia peploides subsp montevidensis	Water Primrose								X							X		
Oxalidaceae																		
Oxalis exilis	Creeping Oxalis																	
Oxalis perennans			X			X	X											
Pittosporaceae																		
Bursaria spinosa	Australian Boxthorn																X	
Pittosporum multiflorum	Orange Thorn																	
Pittosporum revolutum	Yellow Pittosporum																	
Plantaginaceae																		
Plantago debilis																		
Plantago gaudichaudii																		
* Plantago lanceolata	Plantain Ribwort		X	X				X						X	X			
* Plantago major	Large Plantain																	
Polygonaceae																		
Persicaria hydropiper	Water Pepper								X	X								
Rumex brownii	Slender Dock					X								X	X			
* Rumex conglomeratus	Clustered Dock									X								
Portulacaceae																		
Portulaca oleracea	Pigweed Purslane							X										
Ranunculaceae																		
Clematis glycinoides	Headache Vine Traveller's Joy Old Ma																	
Rhamnaceae																		
Alphitonia excelsa	Red Ash Soap Tree																	
Rosaceae																		
* Rubus discolor	Blackberry																	
Rubus parvifolius	Native Raspberry		X											X	X			
Rubiaceae																		
Asperula conferta	Common Woodruff													X	X			
Galium binifolium																	X	
Opercularia diphylla	Stinkweed																	

Botanical name	Common name	Sampling location																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
Opercularia hispida	Stinkweed																		
Pomax umbellata	Pomax																		
* Richardia humistrata		X																	
* Richardia stellaris	Field Madder																		
Rutaceae																			
Geijera salicifolia	Green Satinhearts																		
Santalaceae																			
Exocarpos cupressiformis	Cherry Ballart Native Cherry																		
Sapindaceae																			
Alectryon tomentosus	Hairy Bird's-eye Woolly Rambutan													X	X				
Dodonaea triquetra	Hopbush	X																	
Dodonaea viscosa subsp angustifolia	Sticky Hopbush			X															
Scrophulariaceae																			
Veronica plebeia	Creeping Speedwell																		
Solanaceae																			
* Cestrum parqui	Green Cestrum					X													
* Lycium ferocissimum	African Boxthorn			X										X	X				
Solanum prinophyllum	Forest Nightshade			X	X														
* Solanum pseudocapsicum	Jerusalem Cherry									X									
Solanum sp														X					
Solanum stelligerum	Devil's Needles				X														
Stackhousiaceae																			
Stackhousia viminea	Slender Stackhousia																		
Sterculiaceae																			
Brachychiton populneus subsp populneu	Kurrajong																X		
Thymelaeaceae																			
Pimelea latifolia subsp elliptifolia																			
Verbenaceae																			
Clerodendrum tomentosum	Hairy Clerodendrum																		
* Lantana camara	Lantana													X	X		X		
* Verbena bonariensis	Purpletop	X												X					
* Verbena brasiliensis			X			X				X									

Botanical name	Common name	Sampling location																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
* Verbena rigida	Purple Verbena	X																	
Violaceae																			
Hybanthus enneaspermus subsp stellari	Spade Flower																		
Vitaceae																			
Cayratia clematidea	Slender Grape	X	X											X	X				
4. Monocotyledons																			
Anthericaceae																			
Arthropodium milleflorum	Vanilla Lily	X																	
Tricoryne elatior	Yellow Rush Lily																		
Arecaceae																			
* Phoenix canariensis	Canary sland Date					X													
Asparagaceae																			
* Asparagus asparagoides	Bridal Creeper																		
Asphodelaceae																			
* Aloe vera	Aloe Vera																		
Commelinaceae																			
Commelina cyanea	Blue Spiderwort				X	X											X		
Murdannia graminea																			
Cyperaceae																			
Carex appressa	Tall Sedge								X	X									
Carex inversa	Knob Sedge						X												
* Cyperus aggregatus							X												
* Cyperus brevifolius	Mullumbimby Couch																		
Cyperus difformis	Dirty Dora															X			
Cyperus gracilis	Slender Sedge						X								X				
* Cyperus sesquiflorus																			
Cyperus trinervis																			
Eleocharis pallens	Pale Spike-rush									X						X			
Eleocharis sphacelata	Tall Spike-rush								X										
Fimbristylis dichotoma		X					X												
Gahnia aspera	Rough-leaved Saw-sedge																		

Botanical name	Common name	Sampling location																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
Lepidosperma laterale	Variable Sword-sedge																		
Scleria mackaviensis																			
Juncaceae																			
* Juncus acutus	Spiny Rush		X																
* Juncus capillaceus																			
Juncus continuus													X						
Juncus subsecundus																			
Juncus usitatus									X	X						X			
Juncaginaceae																			
Triglochin sp													X						
Lomandraceae																			
Lomandra filiformis subsp coriacea	Wattle Mat-rush				X														
Lomandra filiformis subsp filiformis	Wattle Mat-rush	X		X	X									X					
Lomandra longifolia	Honey Reed Spike Mat-rush																		
Lomandra multiflora	Many-flowered Mat-rush				X									X			X		
Philesiaceae																			
Eustrephus latifolius	Wombat Berry				X									X			X		
Geitonoplesium cymosum	Scrambling Lily														X				
Phormiaceae																			
Dianella caerulea var cinerascens	Blue Flax-lily				X												X		
Dianella longifolia	Smooth Flax-lily	X			X														
Dianella revoluta	Blue Flax-lily Spreading Flax-lily																		
Poaceae																			
Aristida ramosa var ramosa	Wiregrass			X	X						X			X	X				
Aristida vagans	Threeawn Speargrass				X														
Austrodanthonia auriculata	Lobed Wallaby Grass																		
Austrodanthonia fulva	Wallaby Grass												X				X		
Austrodanthonia racemosa	Wallaby Grass														X				
Austrodanthonia sp	Wallaby Grass																		
Austrodanthonia tenuior	Wallaby Grass																		
Austrostipa ramosisssima	Bamboo Speargrass			X															
Austrostipa rudis																	X		
Austrostipa verticillata	Slender Bamboo Grass																		

Botanical name	Common name	Sampling location																
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
* Axonopus affinis	Narrow-leaved Carpet Grass							X										
Bothriochloa decipiens	Redleg Grass Pitted Bluegrass				X							X	X	X	X			
Bothriochloa macra		X																
Bothriochloa sp			X				X				X							
* Bromus catharticus	Prairie Grass																	
Capillipedium spicigerum	Scented-top Grass		X															
* Chloris gayana	Rhodes Grass																	
Chloris truncata	Windmill Grass	X																
Chloris ventricosa	Tall Windmill Grass	X			X		X								X			
Cymbopogon refractus	Barbed Wire Grass	X			X		X										X	
Cynodon dactylon	Couch Bermuda Grass	X	X			X	X	X			X	X	X	X	X	X		
Dichanthium sericeum	Silky Blue-grass				X													
Dichelachne micrantha	Shorthair Plumegrass																	
Digitaria breviglumis																		
Digitaria ciliaris																		
Digitaria didactyla	Queensland Blue Couch	X																
Digitaria diffusa					X													
Digitaria parviflora	Smallflower Finger Grass																	
Digitaria ramularis																		
Digitaria sp							X											
* Echinochloa crus-galli	Barnyard Grass												X	X		X		
Echinopogon caespitosus	Tufted Hedgehog Grass																	
Echinopogon sp																		
* Ehrharta erecta	Panic Veldgrass									X								
* Eleusine indica	Crowsfoot Grass																	
* Eleusine tristachya	Crabgrass Goose Grass						x						X		X			
Enteropogon acicularis	Curly Windmill Grass				X													
Entolasia stricta	Wiry Panic				X													
Eragrostis brownii	Brown's Lovegrass	X						X										
Eragrostis elongata	Clustered Lovegrass															X		
Eragrostis leptostachya	Paddock Lovegrass	X		X			X								X		X	
* Eragrostis pilosa	Soft Lovegrass																	
Eriochloa pseudoacrotricha	Early Spring Grass	X																
* Holcus lanatus	Yorkshire Fog						X											
mperata cylindrica	Blady Grass	X	X											X				
Microlaena stipoides	Meadow Rice-grass Weeping Grass	X		X	X		X	X						X				

Botanical name	Common name	Sampling location																
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Notodanthonia longifolia											X				X		X	
Oplismenus imbecillis	Narrow-leaved Basket Grass																	
Panicum effusum	Hairy Panic																	
Panicum simile	Two-colour Panic																	
Paspalidium distans		X		X					X									
* Paspalum dilatatum	Paspalum	X	X		X	X	X	X		X	X	X	X	X	X	X		
Paspalum distichum	Water Couch												X					
* Pennisetum clandestinum	Kikuyu		X			X												
Phragmites australis	Common Reed					X												
Poa sieberiana var sieberiana	Snow Grass Fine-leaf Tussock Grass	X																
* Polypogon littoralis	Perennial Beardgrass													X				
* Setaria gracilis	Slender Pigeon Grass	X					X	X					X					
Sorghum leiocladum	Wild Sorghum																	
* Sporobolus africanus	Parramatta Grass		X											X				
Sporobolus creber	Slender Rat's-tail Grass	X					X	X			X				X	X		
* Stenotaphrum secundatum	Buffalo Grass		X				X					X						
Themeda australis	Kangaroo Grass	X			X												X	
Potamogetonaceae																		
Potamogeton tricarinatus	Floating Pondweed															X		
Typhaceae																		
Typha orientalis	Broad-leaf Cumbungi Bulrush		X									X		X		X		

Table 3. Maximum height and number of all species >2 m height in the Quadrats

	Subquadrat 1		Subquadrat 2		Subquadrat 3		Subquadrat 4	
Species	**Number**	**Height**	**Number**	**Height**	**Number**	**Height**	**Number**	**Height**
Quadrat 1								
Corymbia maculata	2	12 m	4	13 m	7	15 m	10	15 m
Eucalyptus tereticornis			4	13 m	1	9 m	5	12 m
Eucalyptus moluccana			1	11 m				
Bursaria spinosa			3	3 m			1	3 m
Brachychiton populneus			1	3 m				
Dodonea viscosa subsp. *angustifolia*					1	3 m		
Quadrat 2								
Acacia floribunda							1	2 m
Acacia parvipinnula							2	3 m
Allocasuarina torulosa	1	8 m					1	9 m
Backhousia myrtifolia			1	2 m				
Bursaria spinosa	2	3 m	5	4 m				
Bursaria spinosa							5	3 m
Brachychiton populneus	1	3 m	1	7 m			2	6 m
Corymbia maculata	5	13 m	1	14 m			6	14 m
Daviesia ulicifolia	1	2 m						
Elaeocarpus obovatus	11	8 m	1	5 m	2	7 m	3	5 m
Eucalyptus acmenoides	2	18 m	1	11 m				
Eucalyptus fibrosa			1	9 m				
Notelaea longifolia	1	2 m	2	3 m	1	3 m	2	4 m
Olearia viscidula	1	3 m						
Prostanthera cineolifera	7	6 m					6	6 m
Punica granatum			1	2 m				
Scolopia braunii	1	2 m						
Quadrat 3								
Acacia parvipinnula			1	6 m			1	5 m
Brachychiton populneus							2	2 m
Casuarina cristata	5	11 m	2	2 m			2	4 m
Corymbia maculata			1	12 m	1	13 m	1	11 m
Dodonea triquetra					1	3 m		
Eucalyptus fibrosa	1	5 m	2	6 m	1	3 m	1	23 m
Eucalyptus moluccana	1	8 m						
Ozothamnus diosmifolius	3	2 m			1	2 m		
Pultenaea cunninghamii					3	3 m		
Quadrat 4								
Acacia parvipinnula					1	2 m	1	2 m
Backhousia myrtifolia	3	8 m			4	10 m		
Brachychiton populneus	2	5 m	6	5 m	1	13 m		
Breynia oblongifolia							1	2 m
Bursaria spinosa	2	6 m	4	6 m	3	3 m	2	2 m
Corymbia maculata	30	13 m	22	18 m	25		8	14 m
Eucalyptus acmenoides	1	9 m			3	16 m		
Eucalyptus fibrosa	2	6 m	4	12 m	1	11 m	1	6 m
Melaleuca styphelioides	1	4 m			1	7 m		
Notelaea longifolia	3	5 m	2	6 m	1	5 m	1	2 m
Quadrat 5								
Eucalyptus acmenoides	1	13 m	2	15 m			1	10 m
Eucalyptus fibrosa					1	13 m		
Quadrat 6								
no trees								
Quadrat 7								
Eucalyptus moluccana					1	15 m		
Eucalyptus tereticornis	1	20 m	1	20 m				
Quadrat 8								
no trees								

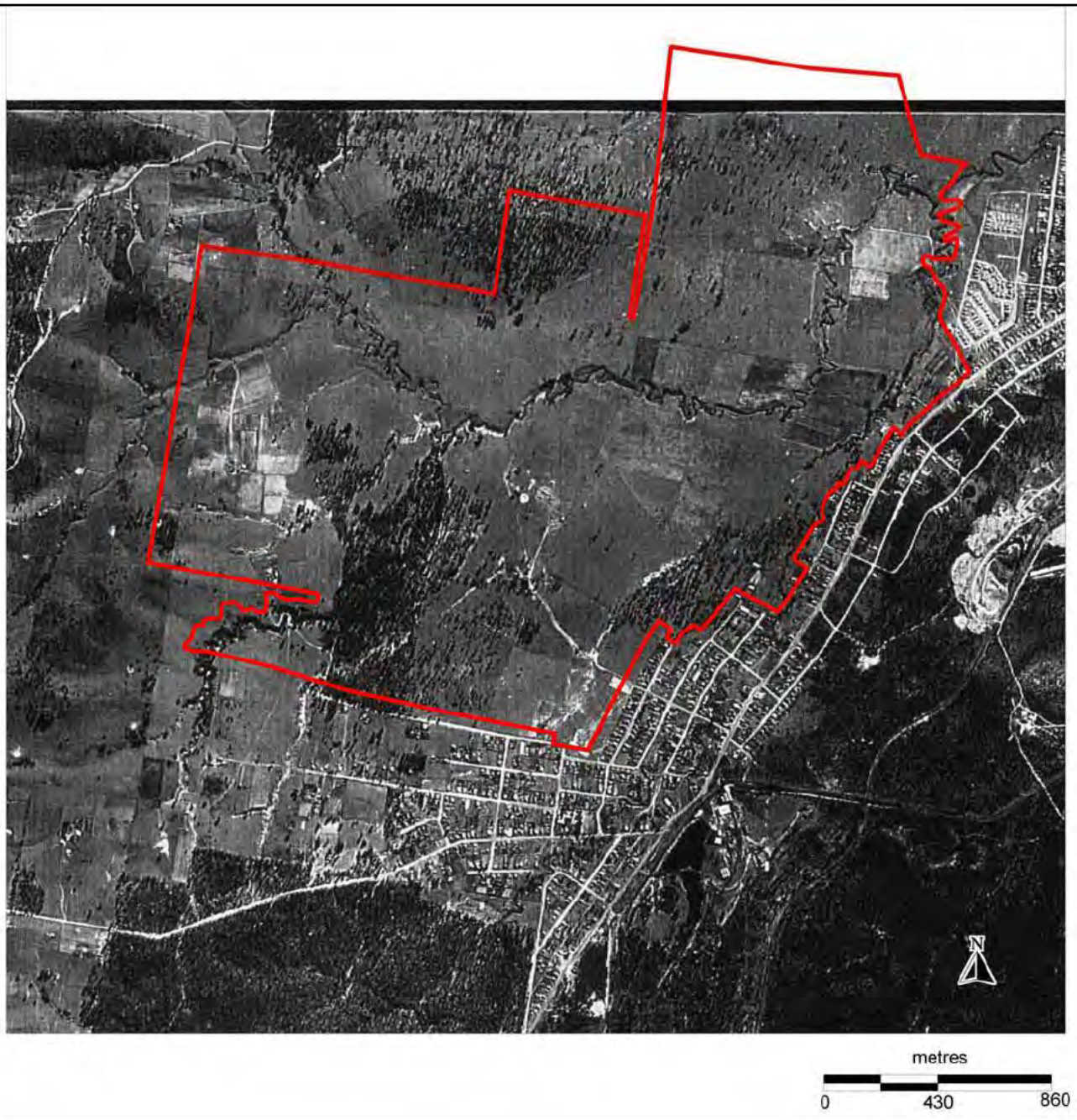
	Subquadrat 1		Subquadrat 2		Subquadrat 3		Subquadrat 4	
Species	**Number**	**Height**	**Number**	**Height**	**Number**	**Height**	**Number**	**Height**
Quadrat 9								
Eucalyptus tereticornis	3	20 m	3	20 m				
Quadrat 10								
Eucalyptus moluccana			1	20 m	1	20 m	1	20 m
Quadrat 11								
no trees								
Quadrat 12								
Eucalyptus moluccana	10	16 m	10	14 m			8	10 m
Eucalyptus tereticornis	1	18 m	1	12 m				
Quadrat 13								
no trees								
Quadrat 14								
no trees								
Quadrat 15								
no trees								
Quadrat 16								
no trees								
Quadrat 17								
Bursaria spinosa	1	5 m					3	2 m
Corymbia maculata			1	20 m	1	20 m		
Eucalyptus fibrosa	4	20 m					1	18 m
Notelaea longifolia	1	2 m						
Quadrat 18								
Eucalyptus moluccana					1	25 m		
Eucalyptus tereticornis							1	23 m
Quadrat 19								
no trees								
Quadrat 20								
Eucalyptus fibrosa	1	20 m	1	20 m	2	20 m	1	20 m
Eucalyptus moluccana	1	20 m						
Quadrat 21								
Acacia implexa					1	3 m		
Alectryon tomentosus	1	8 m	2	6 m	1	9 m		
Backhousia myrtifolia	8	8 m	4	9 m	7	10 m	3	4 m
Brachychiton populneus			1	2 m	2	6 m		
Breynia oblongifolia			1	3 m			2	3 m
Bursaria spinosa							5	5 m
Cassine australis	1	9 m						
Clerodendrum tomentosum							2	3 m
Exocarpos cupressiformis							1	4 m
Glochidion ferdinandi							1	7 m
Melaleuca styphelioides			5	18 m	1	12 m		
Notelaea longifolia	1	2 m	3	3 m	2	6 m	3	3 m
Streblus brunonianus	1	3 m	8	7 m	6	6 m	1	5 m

	Subquadrat 1		Subquadrat 2		Subquadrat 3		Subquadrat 4	
Species	**Number**	**Height**	**Number**	**Height**	**Number**	**Height**	**Number**	**Height**
Quadrat 22								
Acacia implexa			1	3 m			2	3 m
Acacia parramattensis			3	5 m	2	3 m		
Acacia parvipinnula	1	3 m						
Alphitonia excelsa							1	5 m
Brachychiton populneus	2	5 m	1	3 m				
Breynia oblongifolia							2	2 m
Bursaria spinosa	1	4 m	6	8 m	4	3 m	4	3 m
Clerodendrum tomentosum			3	4 m				
Corymbia maculata	1	22 m	1	18 m			1	16 m
Dodonea viscosa subsp. *angustifolia*	11	4 m			3	3 m		
Eucalyptus moluccana			1	6 m	1	2 m		
Eucalyptus paniculata	2	4 m			1	3 m		
Eucalyptus tereticornis	3	24 m	1	3 m	1	3 m	1	10 m
Exocarpos cupressiformis	5	3 m			1	2 m		
Notelaea longifolia	2	3 m			1	4 m		
Olearia viscidula	1	2 m	1	2 m				
Rapanea variabilis					1	2 m		
Schinus areira			1	6 m				
Quadrat 23								
Acacia implexa			1	4 m				
Acacia parvipinnula	2	4 m						
Brachychiton populneus	1	2 m						
Bursaria spinosa	3	4 m	5	4 m	1	4 m	5	3 m
Cassinia quinquefaria					1	2 m		
Corymbia maculata			2	15 m			1	13 m
Eucalyptus acmenoides	3	12 m					5	15 m
Eucalyptus moluccana	1	9 m	1	8 m	1	2 m		
Melaleuca styphelioides	1	8 m						
Notelaea longifolia	4	8 m	3	5 m	2	3 m		
Olearia viscidula	2	2 m	4	2 m	3	2 m	3	2 m
Pultenaea cunninghamii	1	2 m						
Quadrat 24								
Bursaria spinosa							1	2 m
Corymbia maculata					1	20 m		
Eucalyptus moluccana							2	22 m
Eucalyptus fibrosa	1	30 m					1	18 m
Lycium ferocissimum	1	3 m	1	2 m			1	3 m
Quadrat 25								
Alectryon tomentosus			1	5 m				
Breynia oblongifolia					1	2 m		
Bursaria spinosa	3	3 m	8	5 m	8	6 m	5	4 m
Corymbia maculata	1	18 m	2	18 m	5	20 m	1	22 m
Eucalyptus acmenoides	3	15 m			3	9 m	1	15 m
Notelaea longifolia	1	2 m					1	3 m
Quadrat 26								
Eucalyptus moluccana			1	18 m			1	18 m
Eucalyptus tereticornis	1	16 m	1	20 m			1	25 m

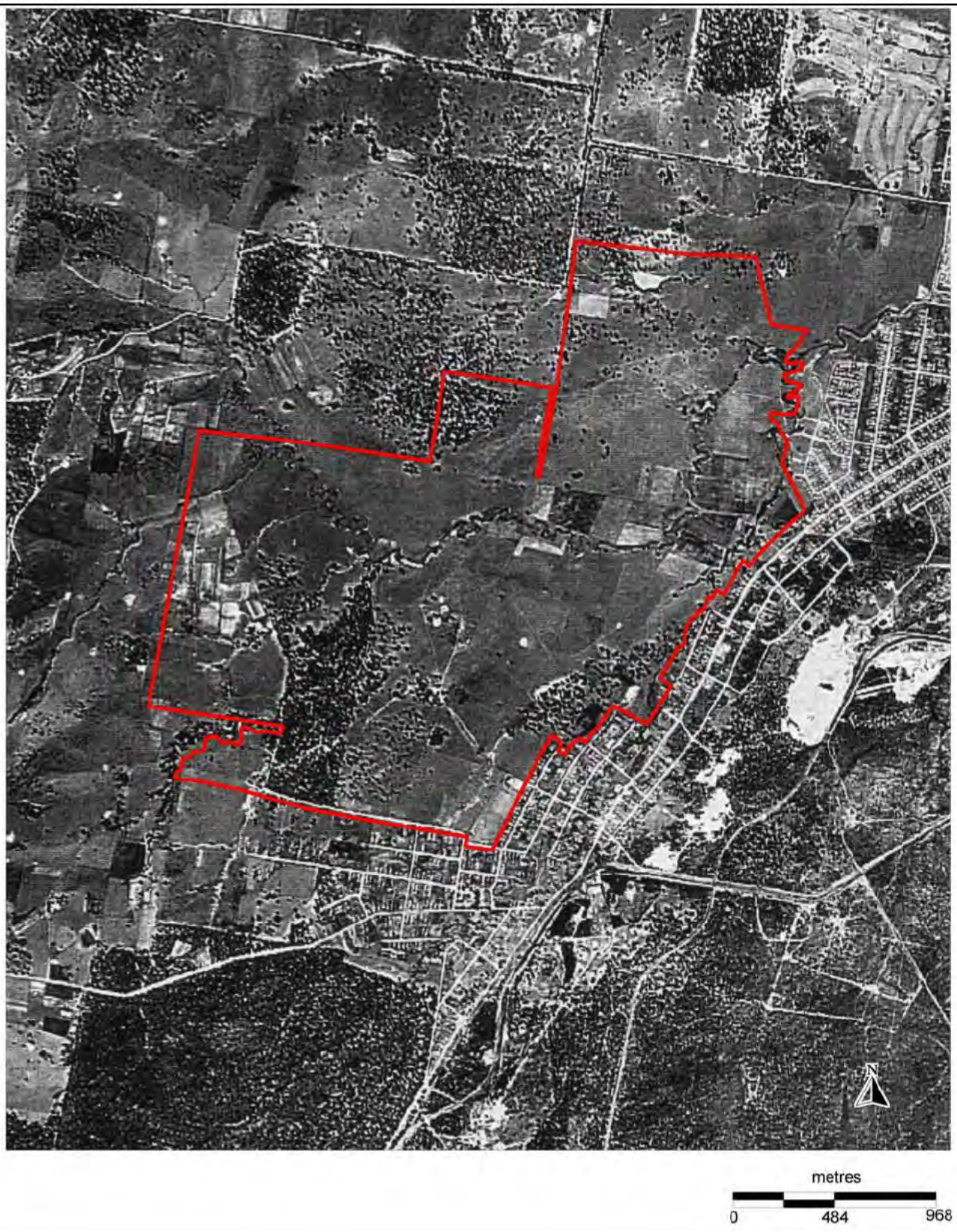
Appendices

Appendix 1

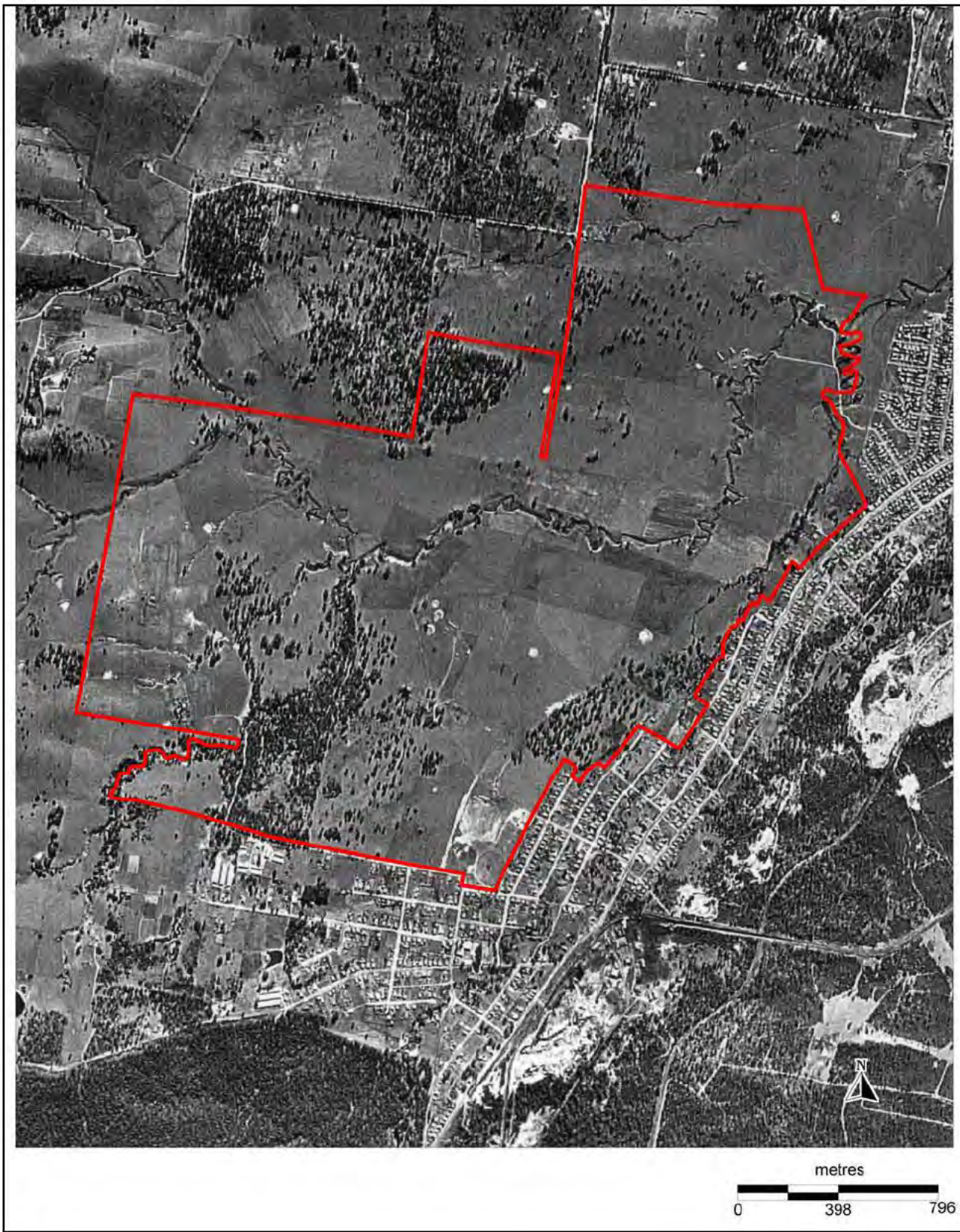
Historical aerial photographs (1952, 1961, 1975, 1984, 1994 and 2004)



1952



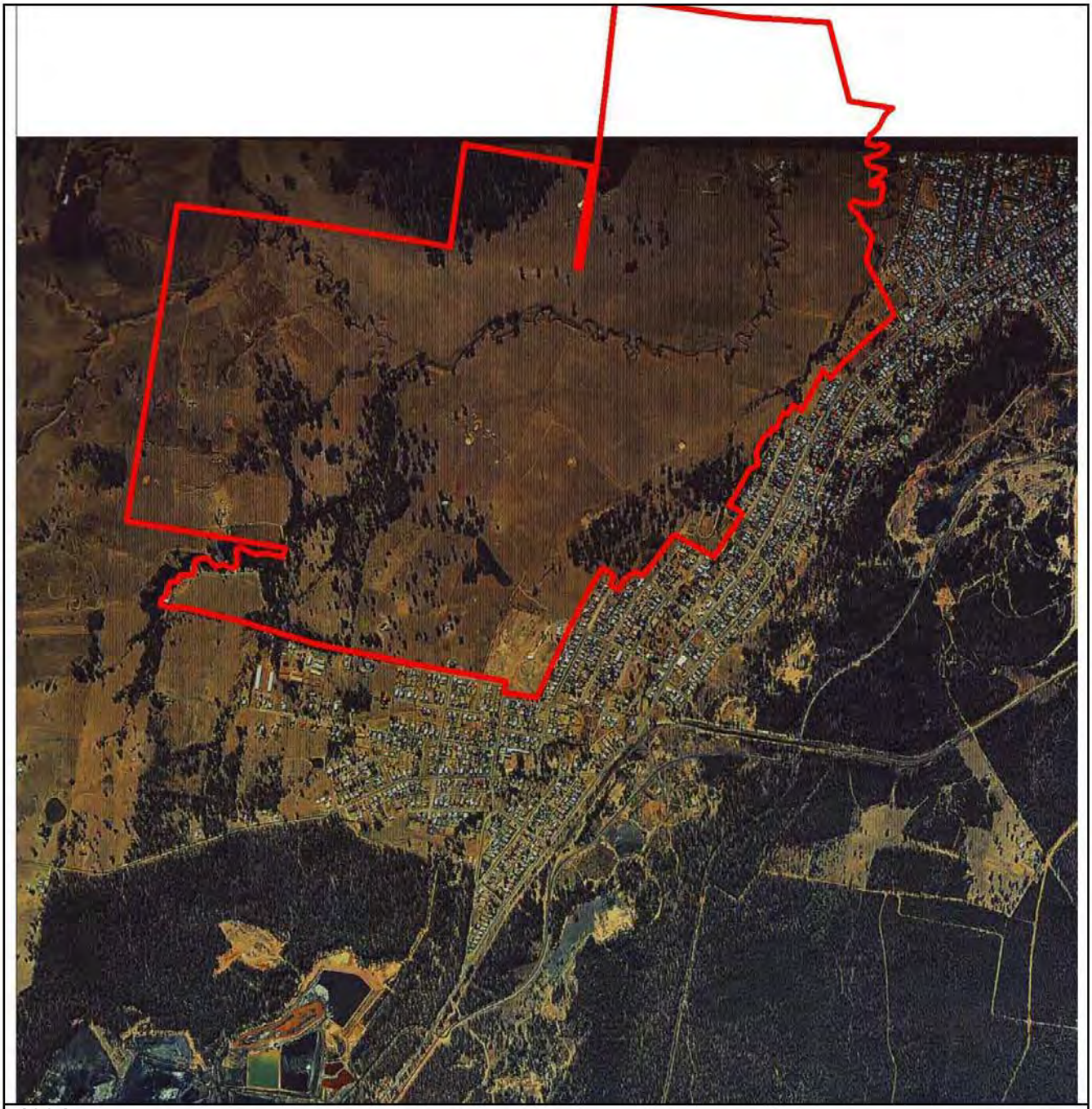
1961



1975



1984



1994



2004

Appendix 2

Description of Map units 17 and 19 (LHCCREMS 2003)

MU17. Lower Hunter Spotted Gum - Ironbark Forest

Canopy Label: *C. maculata* / *E. fibrosa* / *E. punctata*

No. sites: 95

Structural Classification (Specht): Woodland Open Forest

Description

Lower Hunter Spotted Gum Ironbark Forest is widespread throughout the central to lower Hunter Valley. *Corymbia maculata* and *Eucalyptus fibrosa* typically dominate the canopy. In localised areas *Eucalypus punctata* and/or *E. canaliculata* may occur as a dominant to codominant feature. There is a wide variety of infrequently occurring eucalypts reflecting subtle variations in substrate characteristics. These include the northern limit of *Corymbia eximia*, *Eucalyptus fergusonii sub sp. fergusonii* and species common to the coastal ranges such as *E.acmenoides*, *E. umbra* and *E.paniculata.* The understorey is marked by prickly shrubs *Daviesia ulicifolia, Acacia parvipinnula* and *Melaleuca nodosa. Melaleuca nodosa* often forms dense shrub thickets. The ground layer is very diverse but notable by the frequent occurrence of *Cheilanthes sieberi subsp sieberi*, *Entolasia stricta*, *Pomax umbellata*, *Pratia purpurascens*, *Themeda australis, Phyllanthus hirtellus*, and *Dianella revoluta var revoluta.*

Forests between Cessnock and Beresfield form the core of its distribution. At Beresfield this assemblage merges with Map Unit 15 Coastal Foothills Spotted Gum Ironbark Forest where higher rainfall supports the dominance of the Grey Ironbarks *E. paniculata* and *E. siderophloia* and White Mahoganies *E. acmenoides* and *E. umbra.* A number of outliers of this assemblage can be found on the eastern escarpment of Pokolbin and Corrabare State Forests on Narabeen Sandstones.

Similar to Map Unit 18 this assemblage is characterised by stands of young regrowth eucalypts from previous timber management activities. Evidence of regular fire disturbance is also apparent across its range.

A similar forest ecosystem in the adjacent northern region is not evident in NPWS (1999a).

Mean Species richness: 40.2 ± 10 (0.04 ha)

Vegetation Structure (n 80)

Stratum	Mean height (m)	Range (m)	Mean cover (%) (sd)	N
T	21.30	8 30	27.63 (6.8)	80
M	4.14	0 8	24.39 (19.8)	44
M1	9.31	2 20	17.94 (13.4)	36
M2	3.03	0 10	22.31 (16.9)	36
L	1.03	0 3	38.13 (20.9)	77

Diagnostic plant species

		Within Community		Other Communities		
Stratum	Species	Frequency	c/a	Frequency	c/a	Fidelity Class
Tallest	*Corymbia maculata*	87%	3	10%	3	positive
	Eucalyptus fibrosa	73%	3	9%	2	positive
	Eucalyptus punctata	36%	2	24%	2	positive
	Eucalyptus crebra	20%	2	13%	2	uninformative
	Eucalyptus moluccana	10%	2	4%	2	uninformative
	Eucalyptus agglomerata	9%	2	3%	2	uninformative
	Eucalyptus umbra	8%	3	7%	3	uninformative
	Corymbia gummifera	8%	2	16%	2	uninformative
	Syncarpia glomulifera	7%	2	18%	2	uninformative

	Eucalyptus globoidea	7%	1	2%	2	uninformative
	Eucalyptus siderophloia	5%	2	4%	2	uninformative
	Eucalyptus paniculata subsp paniculata	4%	2	3%	2	uninformative
	Eucalyptus sparsifolia	4%	2	14%	2	uninformative
	Angophora costata	4%	1	22%	2	uninformative
	Eucalyptus acmenoides	3%	2	2%	3	uninformative
	Eucalyptus fergusonii subsp fergusonii	3%	2	0%	3	uninformative
	Eucalyptus tereticornis	3%	2	4%	2	uninformative
	Eucalyptus nubila	2%	2	1%	3	uninformative
	Corymbia eximia	2%	1	6%	2	uninformative
Mid	*Daviesia ulicifolia*	55%	2	9%	1	positive
	Acacia parvipinnula	46%	2	6%	2	positive
	Melaleuca nodosa	38%	3	6%	3	positive
	Oxylobium ellipticum	1%	1	0%	0	positive
	Daviesia leptophylla	1%	1	0%	0	positive
	Persoonia linearis	38%	1	44%	1	uninformative
	Lissanthe strigosa	34%	2	3%	1	uninformative
	Breynia oblongifolia	32%	1	24%	1	uninformative
	Pultenaea cunninghamii	22%	2	2%	2	uninformative
Lowest (<1m)	*Cheilanthes sieberi subsp sieberi*	82%	2	24%	2	positive
	Entolasia stricta	82%	2	40%	2	positive
	Pomax umbellata	73%	2	26%	1	positive
	Pratia purpurascens	67%	2	25%	2	positive
	Dianella revoluta var revoluta	65%	2	17%	1	positive
	Glycine clandestina	57%	2	23%	2	positive
	Lepidosperma laterale	55%	2	29%	1	positive
	Microlaena stipoides var stipoides	54%	2	21%	2	positive
	Themeda australis	52%	3	25%	2	positive
	Phyllanthus hirtellus	50%	2	24%	1	positive
	Vernonia cinerea var cinerea	47%	2	10%	1	positive
	Cymbopogon refractus	42%	2	10%	2	positive
	Aristida lignosa	1%	2	0%	0	positive
	Austrodanthonia induta	1%	1	0%	0	positive
	Calotis cuneata var cuneata	1%	2	0%	0	positive
	Pterostylis ophioglossa	1%	1	0%	0	positive
	Solanum papaverifolium	1%	2	0%	0	positive
	Sporobolus caroli	1%	1	0%	0	positive

Rare/endangered Species: *Macrozamia flexuosa*, *Persoonia pauciflora, Grevillea montana, Eucalyptus fergusonii subsp fergusonii*

MU19. Hunter Lowlands Redgum Forest

Canopy Label: *E. tereticornis* / *E. punctata* / *E. crebra*/ *A. floribunda* / *C. maculata*

No. sites: 20

Structural Classification (Specht): Open Forest

Description

Hunter Lowlands Redgum Forest is an open forest that characterises simple open depressions and drainage flats on the Permian Sediments of the Hunter Valley floor. An array of Eucalypts occurs, with the most frequently recorded being *Eucalyptus tereticornis* and *Eucalyptus punctata*. It is not uncommon that *Angophora floribunda*, *Eucalyptus crebra*, *Eucalyptus molucanna* and *Corymbia maculata* appear where the assemblage grades with the surrounding Spotted Gum Ironbark Forests. The mid strata are generally open with sparse shrubs of *Breynia oblongifolia*, *Leucopogon juniperinus*, *Daviesia ulicifolia*, and *Jacksonia scoparia*. More obvious is the consistent layer of grasses and herbs *Microlaena stipoides var stipoides*, *Cymbopogon refractus*, and *Echinopogon caespitosus var caespitosus*, *Cheilanthes sieberi* and *Pratia purpurascens*.

Hunter Lowland Redgum Forest extends from Muswellbrook to the Lower Hunter where it appears on gentle slopes arising from depressions. Much of its former extent has been depleted for agricultural activities.

A comparable Forest Ecosystem for the North Coast (1999a) does not easily equate with Hunter Lowlands Redgum Forest. Forest Ecosystem 47: Redgum Apple describes a forest of similar structure and some similarity in shrub and grass species. However canopy species differ and do not reflect the frequency and abundance of those recorded in this Map Unit.

Species richness: 56.35 $\pm$ 11.6 (0.04 ha)

Vegetation Structure (n 19)

Stratum	Mean Upper height (m)	Range (m)	Mean cover (%) (sd)	n
T	24.42	10 30	27.11 (7.1)	19
M	5.25	1 10	18.75 (6.4)	8
M1	10.45	1 15	21.82 (14.0)	11
M2	3.09	0 5	28.64 (19.9)	11
L	0.95	0 1	59.44 (30.0)	18

Diagnostic plant species (n=20)

		Within Community		Other Communities		
Stratum	Species	Frequency	c/a	Frequency	c/a	Fidelity Class
Tallest	*Eucalyptus tereticornis*	60%	3	3%	2	positive
	Eucalyptus punctata	55%	2	25%	2	positive
	Eucalyptus crebra	50%	3	13%	2	positive
	Angophora floribunda	45%	3	14%	2	positive
	Corymbia maculata	40%	3	13%	3	positive
	Eucalyptus moluccana	20%	3	4%	2	uninformative
	Eucalyptus eugenioides	20%	1	1%	2	uninformative
	Eucalyptus globoidea	15%	3	2%	2	uninformative
	Eucalyptus fibrosa	15%	1	11%	3	uninformative
	Eucalyptus pilularis	10%	3	4%	3	uninformative
	Eucalyptus paniculata subsp paniculata	10%	2	3%	2	uninformative
	Angophora costata	5%	3	22%	2	uninformative
	Eucalyptus acmenoides	5%	3	2%	3	uninformative
	Eucalyptus amplifolia subsp amplifolia	5%	3	0%	1	uninformative
	Eucalyptus umbra	5%	3	7%	3	uninformative

	Syncarpia glomulifera	5%	3	17%	2	uninformative
Mid	*Breynia oblongifolia*	65%	2	24%	1	positive
	Leucopogon juniperinus	60%	2	4%	1	positive
	Daviesia ulicifolia	45%	2	11%	1	positive
	Persoonia linearis	40%	2	44%	1	positive
	Jacksonia scoparia	35%	2	5%	2	positive
Lowest (<1m)	*Cheilanthes sieberi subsp sieberi*	100%	2	25%	2	positive
	Microlaena stipoides var stipoides	100%	2	22%	2	positive
	Pratia purpurascens	95%	2	26%	2	positive
	Cymbopogon refractus	80%	2	11%	2	positive
	Lomandra multiflora subsp multiflora	75%	2	21%	1	positive
	Pomax umbellata	70%	2	28%	1	positive
	Dichondra repens	65%	2	20%	2	positive
	Vernonia cinerea var cinerea	65%	2	11%	1	positive
	Brunoniella australis	60%	2	7%	2	positive
	Echinopogon caespitosus var caespitosus	60%	2	7%	2	positive
	Lagenifera stipitata	55%	2	9%	1	positive
	Desmodium varians	50%	2	19%	2	positive
	Eragrostis leptostachya	50%	2	2%	2	positive
	Imperata cylindrica var major	50%	3	19%	2	positive
	Panicum simile	50%	2	14%	2	positive
	Solanum prinophyllum	50%	2	6%	1	positive
	Themeda australis	50%	2	26%	2	positive
	Digitaria parviflora	45%	2	6%	1	positive
	Entolasia stricta	45%	2	42%	2	positive
	Billardiera scandens	40%	2	27%	1	positive
	Lomandra longifolia	40%	2	31%	1	positive
	Eragrostis brownii	35%	2	7%	2	positive
	Paspalidium distans	35%	2	5%	2	positive
	Austrodanthonia monticola	5%	2	0%	0	positive
	Glycine clandestina	80%	2	24%	2	positive

Rare/endangered Species:

Appendix 3

Photographic record

Photographic Record



Quadrat 1



Quadrat 2



Quadrat 3



Quadrat 4



Quadrat 5



Quadrat 6



Quadrat 7



Quadrat 8



Quadrat 9



Quadrat 10



Quadrat 11



Quadrat 12



Quadrat 13



Quadrat 14



Quadrat 15



Quadrat 16



Quadrat 17



Quadrat 18



Quadrat 19



Quadrat 20



Quadrat 21



Quadrat 22



Quadrat 23



Quadrat 24

Photographic Record



Quadrat 25



Quadrat 26



Spot Location A



Spot Location B



Spot Location C



Spot Location D



Spot Location E



Spot Location F



Spot Location G



Spot Location H



Spot Location I



Spot Location J



Spot Location K



Spot Location L



Spot Location M



Spot Location N



Spot Location O



Spot Location P

Appendix 4

Final Determination for Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregion

Hunter lowland redgum forest in the Sydney Basin and NSW North Coast bioregions - endangered ecological community listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions is the name given to the ecological community found on gentle slopes arising from depressions and drainage flats on permian sediments of the Hunter Valley floor in the Sydney Basin and NSW North Coast Bioregions and characterised by the following assemblage of species:

- *Angophora costata*
- *Austrodanthonia monticola*
- *Billardiera scandens*
- *Breynia oblongifolia*
- *Brunoniella australis*
- *Cheilanthes sieberi* subsp. *sieberi*
- *Corymbia maculata*
- *Cyanthillium cinereum*
- *Cymbopogon refractus*
- *Daviesia ulicifolia*
- *Desmodium varians*
- *Dichondra repens*
- *Digitaria parviflora*
- *Echinopogon caespitosus* var. *caespitosus*
- *Entolasia stricta*
- *Eragrostis brownii*
- *Eragrostis leptostachya*
- *Eucalyptus crebra*
- *Eucalyptus moluccana*
- *Eucalyptus punctata*
- *Eucalyptus tereticornis*
- *Glycine clandestina*
- *Imperata cylindrica* var. *major*
- *Jacksonia scoparia*
- *Lagenifera stipitata*
- *Leucopogon juniperinus*
- *Lomandra longifolia*
- *Lomandra multiflora* subsp. *multiflora*
- *Microlaena stipoides* var. *stipoides*
- *Panicum simile*
- *Paspalidium distans*
- *Persoonia linearis*

- *Pomax umbellata*
- *Pratia purpurascens*
- *Solanum prinophyllum*
- *Themeda australis*

2. The total species list of the community is considerably larger than that given above, with many species present in only one or two sites or in very small quantity. The species composition of a site will be influenced by the size of the site, recent rainfall or drought condition and by its disturbance (including fire) history. The number of species, and the above ground relative abundance of species will change with time since fire, and may also change in response to changes in fire regime (including changes in fire frequency). At any one time, above ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

3. Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions has been recorded from the local government areas of Maitland, Cessnock and Port Stephens (in the Sydney Basin Bioregion) and Muswellbrook and Singleton (in the NSW North Coast Bioregion) but may occur elsewhere in these bioregions.

4. The Community is described and discussed in NSW NPWS (2000) as MU 19 – Hunter Lowland Redgum Forest.

5. The Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions is generally an open forest with most common canopy trees species being *Eucalyptus tereticornis* and *Eucalyptus punctata* although other frequently occurring canopy species are *Angophora costata*, *Corymbia maculata*, *Eucalyptus crebra* and *Eucalyptus moluccana*, with a number of other eucalypts being less frequently recorded. The mid stratum is characterised as open with sparse shrubs of *Breynia oblongifolia*, *Leucopogon juniperinus*, *Daviesia ulicifolia* and *Jacksonia scoparia*. There is consistently a ground layer of grasses and herbs, characterised by *Microlaena stipoides* var. *stipoides*, *Cymbopogon refractus*, *Echinopogon caespitosus* var. *caespitosus*, *Cheilanthes sieberi* subsp. *sieberi* and *Pratia purpurascens*.

6. Currently only a small area (less than 2% of total) of Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions is included in NPWS estate in the Lower Hunter (Wereketa) National Park. The majority of the remainder of the community is not on public land.

7. Modelling included in NSW NPWS (2000) shows that much of the pre-1750 extent of the community has been cleared. Only about 27% (less than 500 ha) of the original distribution survives and this is highly fragmented.

8. Although much of the clearing occurred early in European settlement, clearing still continues at a high rate. Between 1988 and 2001 approx 2380 ha were approved for clearing (advice from Department of Infrastructure, Planning and Natural Resources August 2001). In addition to clearing and fragmentation other threats include grazing, weed invasion, altered fire frequency and, locally, rubbish dumping.

9. In view of the above the Scientific Committee is of the opinion that the Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Proposed Gazettal date: 13/12/02

Exhibition period: 13/12/02 – 31/01/03

Reference:

NSW NPWS (2000) *Vegetation Survey and Mapping – Lower Hunter and Central Coast Region.* Report prepared for the Lower Hunter and Central Coast Regional Environment Management Strategy, Version 1.1 April 2000. 178pp

About the NSW Scientific Committee

Copyright Department of Environment & Conservation (NSW) - Disclaimer - Privacy - Help
Last amended: 16 December 2004.

Appendix 5

Vegetation Classification (Specht *et al*. 1995)

Table 1: Structural formations in Australia (MARK IV Version)

Life form and height of tallest stratum		Foliage Projective Cover of the Tallest Stratum (%)			
		100-70 (4)#	70-30** (3)	30-10 (2)	<10 (1)
Trees* > 30m	(T)#	tall closed-forest	tall open-forest	tall woodland	~
Trees 10-30m	(M)	closed-forest	open-forest	woodland	open-woodland
Trees 5-10m	(L)	low closed-forest	low open-forest	low woodland	low open-woodland
Trees < 5m	(VL)	v. low closed-forest	v. low open-forest	v. low woodland	v. low open-woodland
Shrubs* > 2m	(S)	closed-scrub	open-scrub	tall shrubland	tall open-shrubland
Shrubs 0.25-2m sclerophyllous & semi-sclerophyllous	(Z)	closed heathland	heathland	open-heathland	sparse heathland
non-sclerophyllous	(C)	low closed-scrub	low open-scrub	low shrubland	low open-shrubland
Shrubs < 0.25m sclerophyllous & semi-sclerophyllous	(D)	~	~	dwarf open-heathland (fell-field)	dwarf sparse-heathland (fell-field)
non-sclerophyllous	(W)	~	~	dwarf open-shrubland	dwarf sparse-shrubland
Hummock grasses	(H)	~	dense hummock grassland	hummock grassland	open hummock grassland
Herbaceous layer					
graminoids & grass	(G)	closed (tussock) grassland	(tussock) grassland	open (tussock) grassland	sparse (tussock) grassland
sedges	(Y)	closed-sedgeland	sedgeland	open-sedgeland	sparse-sedgeland
herbs	(X)	closed-herbland	herbland	open-herbland	sparse-herbland
ferns	(F)	closed-fernland	fernland	~	~
reeds/rushes	(R)	closed-reedland	reedland	~	~

* a tree is defined as a woody plant usually with a single stem; a shrub is a woody plant with many stems arising at or near the base.

Symbols and numbers given in parentheses may be used to describe the formation, e.g. tall closed-forest = T4

** this cover class may be subdivided into cover intervals 70-50% and 50-30% to distinguish commercial forests

The complex structure of rainforests (closed-forests to closed-scrubs) may be subdivided further using leaf characteristics, presence of lianes, buttresses, etc. (Webb 1959, 1968): -

1. Emergent trees (e.g. *Araucaria, Eucalyptus*) emergent above the main foliage canopy.
2. Overstorey canopy -
   complex (many tree species with compound leaves; lianes and epiphytes common).
   simple (most tree species with simple leaves; lianes and epiphytes inconspicuous).
3. Leaf longevity - evergreen, semi-deciduous, deciduous
4. Leaf size (after Raunkiaer 1934) - mesophyll, notophyll, microphyll, nanophyll.
5. Lianes - present or absent.
6. Ferns and mosses in the understorey - present or absent.

Appendix 6

Final Determination for Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion

Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion - endangered ecological community listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion is the name given to the ecological community that occurs principally on Permian geology in the central to lower Hunter Valley. The Permian substrates most commonly supporting the community belong to the Dalwood Group, the Maitland Group and the Greta and Tomago Coal Measures, although smaller areas of the community may also occur on the Permian Singleton and Newcastle Coal Measures and the Triassic Narrabeen Group (NSW Department of Mines 1966, 1969). The community is strongly associated with, though not restricted to, the yellow podsolic and solodic soils of the Lower Hunter soil landscapes of Aberdare, Branxton and Neath (Kovac and Lawrie 1991). These substrates are said to produce 'moderately fertile' soils (Kovac and Lawrie 1991). Lower Hunter Spotted Gum – Ironbark Forest is dominated by *Corymbia maculata,* (Spotted Gum) and *Eucalyptus fibrosa* (Broad-leaved Ironbark), while *E. punctata* (Grey Gum) and *E. crebra* (Grey Ironbark) occur occasionally. A number of other eucalypt species occur at low frequency, but may be locally common in the community. One of these species, *E. canaliculata*, intergrades extensively in the area with *E. punctata*. The understorey is marked by the tall shrub, *Acacia parvipinnula,* and by the prickly shrubs, *Daviesia ulicifolia, Bursaria spinosa, Melaleuca nodosa* and *Lissanthe strigosa*. Other shrubs include *Persoonia linearis, Maytenus silvestris* and *Breynia oblongifolia*. The ground layer is diverse; frequent species include *Cheilanthes sieberi, Cymbopogon refractus, Dianella revoluta, Entolasia stricta, Glycine clandestina, Lepidosperma laterale, Lomandra multiflora, Microlaena stipoides, Pomax umbellata, Pratia purpurascens, Themeda australis* and *Phyllanthus hirtellus* (NPWS 2000, Hill 2003, Bell 2004). In an undisturbed condition the structure of the community is typically open forest. If thinning has occurred, it may take the form of woodland or a dense thicket of saplings, depending on post-disturbance regeneration.

2. Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion is characterised by the following assemblage of species:

Acacia parvipinnula	*Angophora costata*
Aristida vagans	*Billardiera scandens*
Breynia oblongifolia	*Bursaria spinosa*
Cheilanthes sieberi	*Corymbia eximia*
Corymbia gummifera	*Corymbia maculata*
Cymbopogon refractus	*Daviesia leptophylla*
Daviesia ulicifolia	*Dianella revoluta*
Dianella caerulea	*Digitaria parviflora*
Entolasia stricta	*Eucalyptus acmenoides*
Eucalyptus agglomerata	*Eucalyptus canaliculata* intergrades
Eucalyptus crebra	*Eucalyptus fergusonii*
Eucalyptus fibrosa	*Eucalyptus globoidea*
Eucalyptus moluccana	*Eucalyptus nubila*

Eucalyptus paniculata	*Eucalyptus punctata*
Eucalyptus siderophloia	*Eucalyptus sparsifolia*
Eucalyptus tereticornis	*Eucalyptus umbra*
Glycine clandestina	*Goodenia hederacea* subsp. *hederacea*
Grevillea montana	*Hardenbergia violacea*
Laxmannia gracilis	*Lissanthe strigosa*
Lepidosperma laterale	*Lomandra filiformis*
Lomandra longifolia	*Lomandra multiflora*
Macrozamia flexuosa	*Maytenus silvestris*
Melaleuca nodosa	*Microlaena stipoides*
Persoonia linearis	*Ozothamnus diosmifolius*
Panicum simile	*Phyllanthus hirtellus*
Pomax umbellata	*Pratia purpurascens*
Syncarpia glomulifera	*Themeda australis*
Vernonia cinerea	

3. The total species list of the community is considerably larger than that given above, with many species present in only one or two sites or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought condition and by its disturbance (including fire and logging) history. The number of species, and the above ground relative abundance of species will change with time since disturbance, and may also change in response to changes in fire regime (including changes in fire frequency). At any one time, above ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. Some of these components of the community are poorly documented.

4. Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion is restricted to a range of approximately 65 km by 35 km centred on the Cessnock – Beresfield area in the Central and Lower Hunter Valley (NPWS 2000). Within this range, the community was once widespread. A fragmented core of the community still occurs between Cessnock and Beresfield. Remnants occur within the Local Government Areas of Cessnock, Maitland, Singleton, Lake Macquarie, Newcastle, Port Stephens and Dungog but may also occur elsewhere within the bioregion. Outliers are also present on the eastern escarpment of Pokolbin and Corrabare State Forests on Narrabeen Sandstone.

5. Threatened species recorded within this community include *Callistemon linearifolius*, *Grevillea parviflora* subsp. *parviflora*, *Persoonia pauciflora, Rutidosis heterogama,* Swift Parrot *Lathamus discolor* (Saunders 2002), Turquoise Parrot *Neophema pulchella,* Glossy Black Cockatoo *Calyptorhynchus lathami,* Regent Honeyeater *Xanthomyza phygria,* Black-chinned Honeyeater *Melithreptus gularis gularis,* Brown Treecreeper *Climacteris picumnus victoriae,* Powerful Owl *Ninox strenua,* Koala *Phascolarctos cinereus,* Yellow-bellied Glider *Petaurus australis,* Squirrel Glider *Petaurus norfolcensis* (Smith and Murray 2003), Common Bentwing Bat *Miniopterus schriebersii* and Eastern Freetail Bat *Mormopterus norfolkensis*.

6. Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion belongs to a complex of ecological communities that were identified in an analysis of floristic data gathered in a vegetation survey of the Lower Hunter – Central Coast region (NPWS 2000). The methods of survey and analysis employed by NPWS (2000) were found to produce a reliable regional-scale overview of native vegetation in the Lower Hunter – Central Coast area, although limitations apply to fine-scale uses of the map (Nicholls *et al*. 2003). This analysis, and subsequent analyses based on additional floristic data from the Hunter valley floor (e.g. Hill 2003, Bell 2004, Peake unpubl. data), identified Lower Hunter Spotted Gum – Ironbark Forest as a distinct assemblage of species. Other assemblages that may include spotted gum as a dominant species, have geographically distinct distributions outside the core area where this community primarily occurs (Cessnock – Beresfield). These other assemblages include: Coastal Foothills Spotted Gum – Ironbark Forest, Seaham Spotted Gum – Ironbark Forest and Central Hunter Spotted Gum –

Ironbark – Grey Box Forest (NPWS 2000). Analysis of additional data from north of the Hunter River and other parts of the Hunter valley indicates the existence of another distinct assemblage dominated by spotted gums and ironbarks on Carboniferous sediments of the footslopes of the Barrington plateau. Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion belongs to the Hunter - Macleay Dry Sclerophyll Forests vegetation class of Keith (2004).

7. Eucalyptus fibrosa, Acacia parvipinnula and prickly shrub species occur more frequently or in greater abundance in Lower Hunter Spotted Gum – Ironbark Forest than in any of the other communities mentioned above. Around the margins of its core distribution, Lower Hunter Spotted Gum – Ironbark Forest may intergrade with other communities (e.g Hill 2003). Toward the coast and south, Lower Hunter Spotted Gum – Ironbark Forest may be replaced by Coastal Foothills Spotted Gum – Ironbark Forest, in which *Eucalyptus umbra, E. siderophloia, Syncarpia glomulifera* and *Angophora costata* occur more frequently, as do *Polyscias sambucifolia, Imperata cylindrica* and *Pseuderanthemum variabile*. Toward the north-east, Lower Hunter Spotted Gum – Ironbark Forest may be replaced by Seaham Spotted Gum – Ironbark Forest, in which *Eucalyptus crebra, E. punctata, E. acmenoides, E. moluccana* and *E. siderophloia*, occur more frequently, along with *Acacia falcata, A. implexa, Leucopogon juniperinus, Aristida vagans* and *Pseuderanthemum variabile*. Seaham Spotted Gum – Ironbark Forest typically occurs on sediments of Carboniferous age, in contrast to the younger Permian sediments that support Lower Hunter Spotted Gum-Ironbark Forest, although the two communities intergrade where these substrates adjoin (NPWS 2000, Hill 2003). Toward the west and north-west, Lower Hunter Spotted Gum – Ironbark Forest may be replaced by Central Hunter Spotted Gum – Ironbark – Grey Box Forest, which has a higher frequency of *Eucalyptus crebra* and *E. moluccana* and a more open grassy understorey distinguished by herbs such as *Desmodium varians, Glycine tabacina, Dichondra repens, Brunoniella australis* and *Calotis lappulacea.* On open depressions and drainage flats within the Cessnock-Beresfield area, Lower Hunter Spotted Gum – Ironbark Forest may be replaced locally by Hunter Lowlands Redgum Forest, in which *Eucalyptus tereticornis, E. punctata, E. crebra* and *Angophora floribunda*, occur more frequently, as do *Breynia oblongifolia, Leucopogon juniperinus, Jacksonia scoparia* and *Brunoniella australis* (NPWS 2000).

8. Clearing and other disturbances have resulted in a high degree of fragmentation of the community. Four large patches of Lower Hunter Spotted-Gum – Ironbark Forest are estimated to have covered nearly 50 000 ha prior to European settlement, representing 75% of the total distribution. The community is currently mapped as occurring in more than 4 800 fragments, of which more than 4 500 are less than 10 ha in area (House 2003). The four largest patches now cover about 7 000 ha, representing less than one-quarter of the current distribution, or about 10% of the estimated pre-European distribution (House 2003). Clearing of native vegetation is listed as a Key Threatening Process under the Threatened Species Conservation Act (1995).

9. Using recently updated mapping of extant Lower Hunter Spotted Gum – Ironbark Forest based on fine-scale aerial photograph interpretation of extant woody native vegetation, House (2003) estimated that approximately 26 500 ha of the community remains with its tree canopy cover in a 'substantially unmodified' condition, representing approximately 40% of its pre-European distribution. However, this estimate is based on the collective canopy cover of trees (i.e. where tree canopy cover was estimated to be greater than 20%, the canopy was assumed to be 'unmodified' and not substantially thinned), and does not consider the growth stages of trees that contribute to the cover. Growth stage mapping is available for approximately 6 000 ha of Lower Hunter Spotted Gum Ironbark Forest on public land (RACAC 1995), of which only 3% was assessed as containing a sub-dominance of 'overmature' and 'senescent' tree crowns indicative of old growth forest. Seventy-five per cent of this area was assessed as 'young forest', indicating regeneration from past logging and wildfire. Some areas of Lower Hunter Spotted Gum – Ironbark Forest on private land also reflect a continuing history of degradation. In the Blackhill district, for example, much of the existing vegetation was cleared, and is now largely composed of dense stands of juvenile saplings. This regrowth has since been further affected by clearing and thinning, creation of electricity transmission easements, and ongoing grazing by goats and cattle. In addition, House (2003) estimated that there are a further 4 650 ha of Lower Hunter Spotted Gum – Ironbark Forest with a modified or substantially modified tree canopy cover.

10. The condition of the understorey has not been mapped systematically. There are no

quantitative estimates of the area of the community that retains a substantially unmodified understorey. However, qualitative information suggests that there has been extensive disturbance to the understorey associated with logging, expansion of unplanned tracks and trails, rubbish dumping, off-road vehicle use, arson and weed invasion, even in stands that are currently within a conservation reserve (Bell 2004). These pressures are likely to intensify with the projected increases in the density of the human population within the region (Progress Economics 2004).

11. Much of the remaining Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion shows evidence of disturbance. Past logging practices and fire regimes have heavily modified some parts of the community, resulting in a simplified structure and floristics. Production areas of State Forests are actively logged at intensities specified by regulations. Frequent fires (<3 years) dramatically simplify understorey vegetation (Bell 2004). Grazing, uncontrolled human access and associated dumping of solid and garden waste, as well as weed invasion (notably by *Lantana camara* and *Solanum mauritianum,* wild tobacco) have degraded the more accessible remnants of the community, while transport corridors and power and communication easements have further fragmented them. As a likely consequence of continuing habitat loss and degradation, local bird observers have noted declines in species associated with spotted gum/ironbark forests, including the Swift Parrot, Regent Honeyeater, Brown Treecreeper, Black-chinned Honeyeater, Diamond Firetail, Turquoise Parrot, Fuscous Honeyeater, Eastern Shriketit and Spotted Quailthrush.

12. Clearing pressures from rural residential and residential subdivisions, industrial developments and new cropping enterprises (e.g. vineyards) continue to threaten the community particularly in Cessnock Local Government Area where the core of this community occurs. Over the past 10 years, demand for housing lots in the Lower Hunter area has nearly doubled from 1 726 in 1991-92 to 3 904 in 2003-04 (Progress Economics 2004). The 'medium' forecast for housing demand in Lower Hunter is 2 500 lots/yr; the current supply of land zoned for housing is 12 000 lots and is projected to meet demand only for the next 5 years. Hence there are substantial pressures for rezoning land for housing within the next 10 years (Progress Economics 2004). A study of the Thornton-Killingworth sub-region projected the population to expand by 169 000 people, requiring 2 600 new dwellings annually over the next 25 years (Parsons Brinckerhoff 2003). Existing proposals to rezone land from rural to rural /residential around the villages of Millfield and Paxton and applications for clearing associated with rural residential and residential developments around Paxton, Bellbird, Ellalong and Mulbring will affect the ecological community. Loss of remnants of Lower Hunter Spotted Gum – Ironbark Forest will be associated with the Cessnock LEP Amendment No 60 - Hunter Economic Zone, Donaldson and Bloomfield coalmine sites at Thornton/Killingworth and F3 to Branxton National Highway link (Ecotone Ecological Consultants 1999, 2000; Connell Wagner 1997). In the Maitland Local Government Area, Hill (2003) assessed Lower Hunter Spotted Gum – Ironbark Forest as exposed to high levels of threat from development, tree dieback and grazing, and under moderate levels of threat from fragmentation, weeds, and fire.

13. Approximately 1 600 hectares of Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion occurs within Werakata National Park (Bell 2004). This represents less than 2.5% of the community's modelled pre-1750 distribution (House 2003), is distributed among several separate patches and is predominantly young regrowth forest (Bell 2004). Of an estimated 2 800 ha of the community currently within State Forests, approximately 1 770 ha is excluded from timber harvesting in Forest Management Zone reserves (State Forests of NSW, *in litt*.), although these areas may be subject to development of service easements, transport infrastructure and mineral exploration. Within the Hunter Employment Zone (HEZ), 460 ha of Lower Hunter Spotted Gum – Ironbark Forest is estimated to occur within zone 7(b) 'Environmental Protection'. However, 7(b) zoning does not exclude development for rural properties (buildings, roads, fences, bushfire hazard reduction) and coal mining.

14. In view of the above the Scientific Committee is of the opinion that Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin Bioregion is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival cease to operate, or it might already be extinct.

Dr Lesley Hughes
Chairperson
Scientific Committee

Proposed Gazettal date: 18/02/05
Exhibition period: 18/02/05 – 15/05/05

References

Bell SAJ (2004) The vegetation of Werakata National Park, Hunter Valley New South Wales. *Cunninghamia* **8**, 331-347.

Connell Wagner (1997) 'Fauna Impact Statement of proposed highway link F3 Freeway to Branxton.' Roads and Traffic Authority of NSW, Sydney.

Ecotone Ecological Consultants (1999) 'Flora and fauna investigations and planning assessment for the Tomalpin Employment Zone within the Cessnock Local Government Area.' Cessnock City Council, Cessnock.

Ecotone Ecological Consultants (2000) 'Additional flora and fauna investigations within the Tomalpin Employment Zone - supplementary report.' Cessnock City Council, Cessnock.

Hill L (2003) 'The natural vegetation of the Maitland Local Government Area.' Maitland City Council, Maitland.

House S (2003) 'Lower Hunter and Central Coast Regional Biodiversity Conservation Strategy, Technical Report, Digital Aerial Photo Interpretation and Updated Extant Vegetation Community Map, May 2003.' Lower Hunter and Central Coast Regional Environmental Management Strategy, Callaghan.

Keith DA (2004) 'Ocean shores to desert dunes: the native vegetation of New South Wales and the ACT.' (NSW Department of Environment and Conservation: Sydney.)

Kovac M, Lawrie JW (1991) 'Soil landscapes of the Singleton 1:250 000 sheet.' Soil Conservation Service of NSW, Sydney.

Nicholls AO, Doherty M Newsome AE (2003) 'Evaluation of Data, Modelling Techniques and Conservation Assessment Tools for the Lower Hunter Central Coast Regional Biodiversity Conservation Strategy.' CSIRO Sustainable Ecosystems, Canberra.

NSW Department of Mines (1966) 'Newcastle. 1:250 000 geological sheet S1 56-2.' NSW Government Printer, Sydney.

NSW Department of Mines (1969) 'Singleton. 1:250 000 geological sheet S1 56-1.' NSW Government Printer, Sydney.

National Parks and Wildlife Service (2000) 'Vegetation Survey, Classification and Mapping: Lower Hunter and Central Coast Region.' NSW National Parks and Wildlife Service, Sydney.

Parsons Brinckerhoff (2003) Thornton-Killingworth sub-regional conservation and development strategy. Department of Infrastructure, Planning and Natural Resources, Sydney.

Progress Economics (2004) An analysis of the projected demand and supply of land in the Lower Hunter from 2004-05 to 2013-14. A report prepared for the Urban Development Institute of Australia, Sydney.

RACAC (1995) Draft Interim Forestry Assessment. Resource and Conservation Assessment Council, Sydney. Retrieved December 2004 from http://www.racac.nsw.gov.au/reports/iap/.

Saunders D (2002) 'Assessment of Swift Parrot sites near Cessnock, Lower Hunter valley region, NSW.' National Parks and Wildlife Service, Sydney.

Smith A, Murray M (2003) Habitat requirements of the Squirrel Glider (*Petaurus norfolcensis*) and associated possums and gliders on the New South Wales Central Coast. *Wildlife Research* **30**, 291-301.

More information

- About the NSW Scientific Committee

Copyright Department of Environment & Conservation (NSW) - Disclaimer - Privacy - Help
Last amended: 14 February 2005.

Appendix 7

Noxious Weeds in the Cessnock LGA

Noxious weed declarations

Noxious weed declarations for Cessnock City Council

This is a print friendly page
Return to start page

The following weeds are declared noxious in the control area of Cessnock City Council:

Weed	Class	Legal requirements
African boxthorn [Lycium ferocissimum]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
African feathergrass [Pennisetum macrourum]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
African turnipweed [Sisymbrium runcinatum]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
African turnipweed [Sisymbrium thellungii]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Alligator weed [Alternanthera philoxeroides]	3	The plant must be fully and continuously suppressed and destroyed
Anchored water hyacinth [Eichhornia azurea]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Annual ragweed [Ambrosia artemisiifolia]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Arrowhead [Sagittaria montevidensis]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Artichoke thistle [Cynara cardunculus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Athel tree [Tamarix aphylla]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Bathurst/Noogoora/Californian/cockle burrs [Xanthium species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Black knapweed [Centaurea nigra]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Blackberry [Rubus fruticosus aggregate species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the

		local control authority and the plant may not be sold, propagated or knowingly distributed This is an All of NSW declaration
Bridal creeper [Asparagus asparagoides]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Broomrapes [Orobanche species] Includes all Orobanche species except the native O. cernua variety australiana and O. minor	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Burr ragweed [Ambrosia confertiflora]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Cabomba [Cabomba caroliniana]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Californian burrs [Xanthium species]		See Bathurst/Noogoora/Californian/cockle burrs
Cape tulip [Moraea species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Cayenne snakeweed [Stachytarpheta cayennensis]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Chilean needle grass [Nassella neesiana]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Chinese violet [Asystasia gangetica subspecies micrantha]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Clockweed [Gaura lindheimeri]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Clockweed [Gaura parviflora]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Cockle burrs [Xanthium species]		See Bathurst/Noogoora/Californian/cockle burrs
Columbus grass [Sorghum x almum]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Corn sowthistle [Sonchus arvensis]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Crofton weed [Ageratina adenophora]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority

Dodder [Cuscuta species] Includes All Cuscuta species except the native species C. australis, C. tasmanica and C. victoriana	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
East Indian hygrophila [Hygrophila polysperma]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Espartillo [Achnatherum brachychaetum]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Eurasian water milfoil [Myriophyllum spicatum]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Fine-bristled burr grass [Cenchrus brownii]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Fountain grass [Pennisetum setaceum]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Gallon's curse [Cenchrus biflorus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Giant Parramatta grass [Sporobolus fertilis]	3	The plant must be fully and continuously suppressed and destroyed
Glaucous starthistle [Carthamus glaucus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Golden thistle [Scolymus hispanicus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Green cestrum [Cestrum parqui]	3	The plant must be fully and continuously suppressed and destroyed
Harrisia cactus [Harrisia species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed This is an All of NSW declaration
Hawkweed [Hieracium species]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Horsetail [Equisetum species]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Hygrophila [Hygrophila costata]	2	The plant must be eradicated from the land and the land must be kept free of the plant

Hymenachne [Hymenachne amplexicaulis]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Italian bugloss [Echium species]		See Paterson's curse, Vipers bugloss, Italian bugloss
Johnson grass [Sorghum halepense]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Karoo thorn [Acacia karroo]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Kochia [Bassia scoparia]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Lagarosiphon [Lagarosiphon major]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Lantana [Lantana species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Lantana [Lantana species]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Long-leaf willow primrose [Ludwigia longifolia]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Long-leaf willow primrose [Ludwigia longifolia]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Mexican feather grass [Nassella tenuissima]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Mexican poppy [Argemone mexicana]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Miconia [Miconia species]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Mimosa [Mimosa pigra]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Mossman River grass [Cenchrus echinatus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Mother-of-millions [Bryophyllum species and hybrids]	3	The plant must be fully and continuously suppressed and destroyed and the plant may not be sold, propagated or knowingly

		distributed
Noogoora burrs [Xanthium species]		See Bathurst/Noogoora/Californian/cockle burrs
Onion grass [Romulea species] Includes all Romulea species and varieties except R. rosea var. australis	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Oxalis [Oxalis species and varieties] Includes all Oxalis species and varieties except the native species O. chnoodes, O. exilis, O. perennans, O. radicosa, O. rubens, and O. thompsoniae	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Pampas grass [Cortaderia species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Parthenium weed [Parthenium hysterophorus]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Paterson's curse, Vipers bugloss, Italian bugloss [Echium species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Pond apple [Annona glabra]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Prickly acacia [Acacia nilotica]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Prickly pear [Cylindropuntia species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed This is an All of NSW declaration
Prickly pear [Opuntia species except O. ficus-indica]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed This is an All of NSW declaration
Red rice [Oryza rufipogon]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Rhus tree [Toxicodendron succedanea]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority This is an All of NSW declaration
Rubbervine [Cryptostegia grandiflora]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration

Sagittaria [Sagittaria platyphylla]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Salvinia [Salvinia molesta]	3	The plant must be fully and continuously suppressed and destroyed
Sand oat [Avena strigosa]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Senegal tea plant [Gymnocoronis spilanthoides]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Serrated tussock [Nassella trichotoma]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Siam weed [Chromolaena odorata]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Smooth-stemmed turnip [Brassica barrelieri subspecies oxyrrhina]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Soldier thistle [Picnomon acarna]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Spiny burrgrass [Cenchrus incertus]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Spiny burrgrass [Cenchrus longispinus]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Spiny emex [Emex australis]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Spotted knapweed [Centaurea maculosa]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
St. John's wort [Hypericum perforatum]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Texas blueweed [Helianthus ciliaris]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Vipers bugloss [Echium species]		See Paterson's curse, Vipers bugloss, Italian bugloss

Water caltrop [Trapa species]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Water hyacinth [Eichhornia crassipes]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Water lettuce [Pistia stratiotes]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Water soldier [Stratiotes aloides]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Willows [Salix species] Includes all Salix species except S. babylonica, S. x reichardtii, S. x calodendron	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration
Witchweed [Striga species] Includes all Striga species except native species and Striga parviflora	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Yellow burrhead [Limnocharis flava]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an All of NSW declaration
Yellow nutgrass [Cyperus esculentus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an All of NSW declaration

Privacy | Legal | Report a problem
© State of New South Wales, 2005 | ServiceNSW

05452

HWR

ecological research & innovation

Bushfire Planning Assessment for North Bellbird Investigation Area

Report to Insite Planning & Engineering on behalf of Johnson Property Group

Nigel Cooper & Geoff Winning

28 May 2006

HWR PTY LIMITED ABN 71 094 286 147

Highfields Office
PO Box 55, KOTARA 2289
p 02 4942 4346
f 02 4947 8853
e geoff@hunterwetlands.com.au

Thornton Office
PO Box 229, THORNTON 2322
p 02 4966 0513
f 02 4966 0513
e johnp@hwr.biz

Document Control

Issue Date	Purpose of Issue	Changes from Previous Issue	Authors	Checked	Director Authorisation
15 Mar 2006	Draft for client review	NA	NC	GW	GW
22 May 2006	Second draft for client review	Minor edits & amendments.	GW	GW	GW
28 May 2006	Final report	Redrawn maps, some additional explanatory text.	GW	GW	GW

Executive Summary

This bushfire planning assessment has been prepared for Insite Planning and Engineering on behalf of the Johnson Property Group. The report addresses the potential risks to development of the investigation area deriving from bushfires in native vegetation retained within the proposed future development.

The topography of the subject site comprises both gentle flats cleared of vegetation and rolling hills with east facing slopes that run down into a drainage line which splits the investigation area in half. Patches of woodland remain within and adjacent to the investigation area, and some of the paddocks support scattered trees.

The report identifies building set-backs around patches of vegetation retained within the identified development footprint based on the assumption that these patches of vegetation would remain in there existing condition. Specified set-backs range from 20 metres to 40 metres.

As this is a rezoning study, the set-backs should be seen as preliminary, with the final APZs needing to be determined and designed in the detailed design stage.

There are no matters within respect to bushfire risk to preclude development within the North Bellbird Investigation Area.

Contents

1. Introduction 1
1.1 Background 1
1.2 Bushfire Planning Assessment 1
1.3 Scope of this Report 1
2. The 'Planning for Bushfire Protection Guidelines' 3
2.1 Site Analysis 3
2.2 Asset Protection Zones 3
2.3 Building Construction Standards 4
3. Site Assessment for North Bellbird 5
3.1 North Bellbird Investigation Area and Bushfire Threats 5
3.2 Vegetation and Slope Assessment 5
4. Bushfire Planning Assessment for North Bellbird 9
4.1 Development Context 9
4.2 Building Set-backs Required for Bushfire Protection 9
4.3 Building Construction Standards 9
4.4 Site Access 9
References 11

List of Figures

Figure 1 - Study Area 2
Figure 2 – Existing Vegetation 7
Figure 3 – Bushfire Set-backs 10

1. Introduction

1.1 Background

HWR Ecological Pty Ltd was engaged by INSITE Planning Pty Ltd to undertake a bushfire planning assessment of the North Bellbird Investigation Area (Figure 1). The North Bellbird Investigation Area is 496 hectares and comprises the land parcels listed in Table 1.

Table 1. Properties included in the North Bellbird Investigation Area.

Lot	DP	Lot	DP	Lot	DP	Lot	DP	Lot	DP
141	986905	210	1012346	2	1011544	52	807540	11	806584
3	810827	211	1012346	1	327785	2	624793	10	806584
pt13	880374	212	1053307	2	597226	3	624793	3	597226
10	815485	1	349452	1	597226	1	329071	pt1	66183
11	815485	1	327580	1	328498	261	524058	2	66183
1	167004	1	1011544	pt51	807540	1	196997	1	196460
1	328497								

1.2 Bushfire Planning Assessment

The *Planning for Bushfire Protection* guidelines ("the guidelines"), which are in force under the *Rural Fires Act 1997*, sets down two major considerations for precinct level development proposals:

(1) the provision of asset protection zones (APZs) to assist in the protection of residential buildings from bushfire;
(2) identification of building construction standards (while this latter consideration is strictly only appropriate at the construction stage, it is generally applied at the planning stage to clarify future construction constraints within the development).

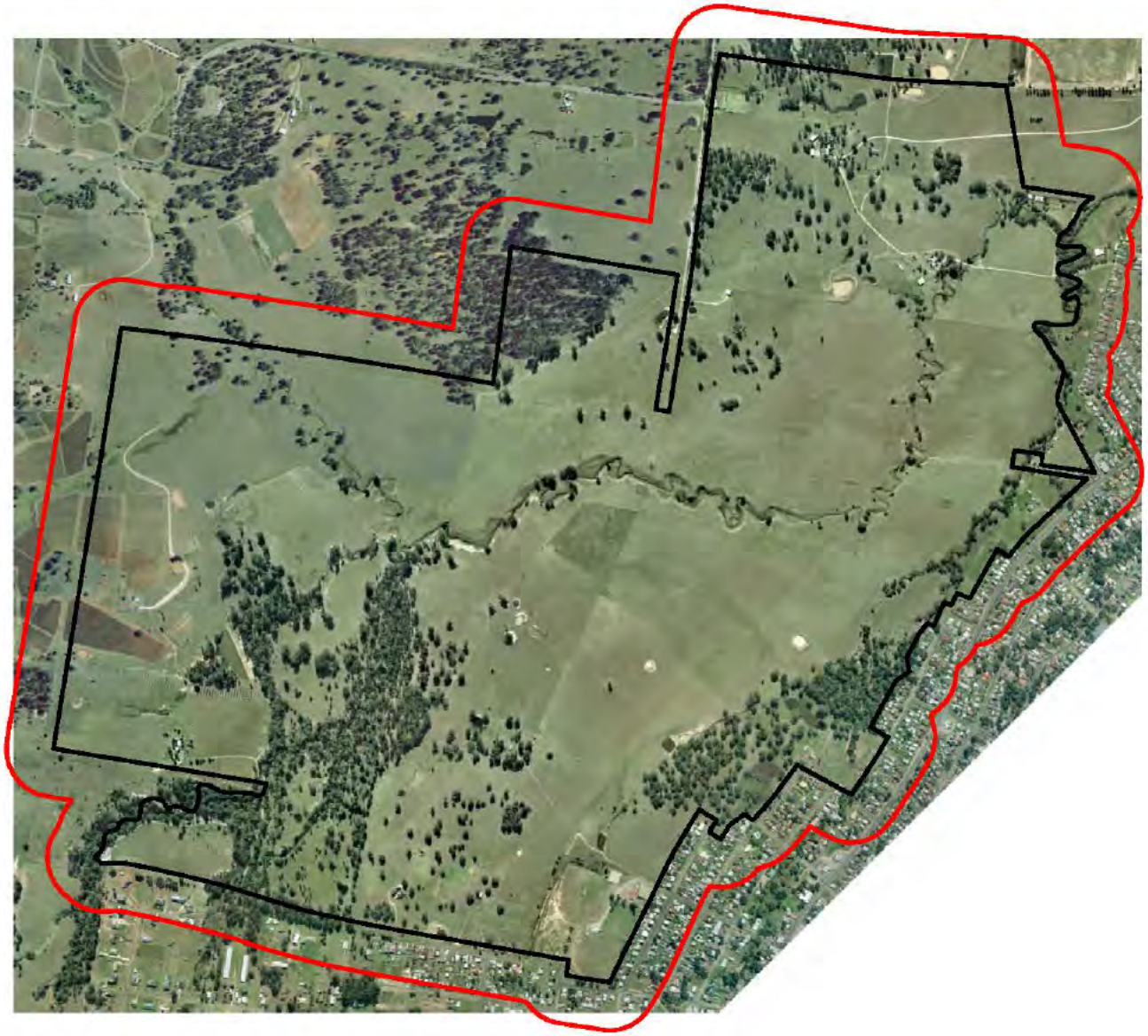
1.3 Scope of this Report

Bushfire planning assessments undertaken by HWR are, in-effect, the application of the guidelines to data derived from an ecological site assessment. HWR's role is to provide a specialist analysis of the vegetation on and in the vicinity of the subject site, and to interpret the guidelines with respect to set-back requirements and building construction standards in light of the field data.

Vegetation and slope data are used to derive a site analysis map which depicts minimum required set-backs between vegetation and future dwellings. These set-backs are, in effect, "raw APZs" which provide guidance to the project's planners. The final configuration of APZs is determined as part of the detailed design of the residential development.

North Bellbird Investigation Area

Study Area (140m around) Investigation Area)



HWR
ecological research & innovation

Scale	1:20,000
Projection	MGA / GDA 94
Drafter	Nigel Cooper & Geoff Winning
Prepared	7 March 2006
Last amended	28 May 2006

N

Study Area

Figure 1

2. The 'Planning for Bushfire Protection Guidelines'

2.1 Site Analysis

The guidelines present minimum specifications for APZs and building construction standards based on vegetation and slope. An analysis of the vegetation involves identification of the structural form of the predominant vegetation communities. Slopes between vegetation and proposed building areas are combined with vegetation groups to derive bushfire constraints.

2.2 Asset Protection Zones

Under the guidelines, asset protection zones (APZs) are strips of managed vegetation between developed areas and remnant native vegetation. Most APZs may comprise an inner protection area (IPA) and an outer protection area (OPA), the widths of which a specified by the guidelines. The IPA could comprise mown lawns, roadways, pathways and similar low fuel areas. Generally, trees and shrubs should not be included in an IPA, although scattered trees well removed from dwellings are acceptable. The OPA should comprise, as a minimum, slashed grassland (<10cm high), and can include remnant or planted trees and shrubs providing they do not form a continuous canopy layer.

Determination of APZs is a two step process comprising:

(1) allocation of each area of vegetation to one of three groups of vegetation types based on its structural form as set out in Table 2;

(2) determination of the width and composition of APZs by tabular comparison of vegetation groups with the direction and degree of slopes between the vegetation and proposed residential areas, as set out in Table 3.

Table 2. Vegetation groups used in the guidelines (modified from *Planning for Bushfire Protection*).

Vegetation Group	Vegetation Types Included in Group
1	wet sclerophyll forest, dry sclerophyll forest
2	woodland, scrub (tall heath), open shrub, closed heath, pine plantation
3	rainforest (closed forest), open woodland, mallee or mulga scrub, chenopod shrubland, native grassland, pasture

Table 3. Minimum specifications for APZs for residential areas under the guidelines (modified from *Planning for Bushfire Protection*).

Slope	Vegetation				
	Group 1		Group 2		Group 3
	APZ (m)	IPA(m) + OPA(m)	APZ (m)	IPA(m) + OPA(m)	APZ (m)
Veg upslope					
>5º	20	20 + 0	20	20 + 0	20
5-0º	30	10 + 10	30	10 + 10	20
Veg downslope					
>0-5º	40	30 + 10	35	25 + 10	20
>5-10º	50	40 + 10	40	40 + 10	20
>10-15º	60	50 + 10	50	50 + 10	20
>15-18º	70	60 + 10	60	60 + 10	20

2.3 Building Construction Standards

The guidelines essentially adopt the Australian Standard on *Construction of Buildings in Bushfire-prone Areas* (AS3959-1999) for building construction standards. It involves categorising the bushfire attack for the site, based on vegetation structural form and degree of slope. The bushfire attack assessment presented in the guidelines differs somewhat from the approach used in AS3959-1999, and the guidelines should therefore be followed for this purpose (as is done in this report). The bushfire attack category then determined the level of construction required (level 1 for medium bushfire attack, level 2 for high, and level 3 for extreme). The overall process is summarised in Table 4.

Detailed information on building construction levels should be obtained directly from AS3959-1999.

Table 4. Determination of construction standard (modified from *Planning for Bushfire Protection*).

Distance from vegetation	< 20m	20-30m			>30-50m			>50-80m			>80-100m		
Slope*	all	>15°	>5-15°	0-5°	>15°	>5-15°	0-5°	>15°	>5-15°	0-5°	>15°	>5-15°	0-5°
Vegetation Structural Form	**Specified Construction Standard**												
Forest	Z	Z	Z	3	Z	3	2	3	3	1	3	2	0
Woodland	Z	Z	3	1	3	2	0	3	0	0	1	0	0
Shrub/Heath	Z	Z	Z	3	Z	3	2	3	2	1	2	2	0
Mallee	Z	1	0	0	0	0	0	0	0	0	0	0	0
Rainforest	Z	2	0	0	0	0	0	0	0	0	0	0	0
Grassland	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-vegetated	0	0	0	0	0	0	0	0	0	0	0	0	0

0	= no specified construction standard - low bushfire attack
1	= Level 1 construction standard - medium bushfire attack
2	= Level 2 construction standard - high bushfire attack
3	= Level 3 construction standard - extreme bushfire attack
Z	= within Flame Zone (construction outside the scope of AS3959-1999)

* Direction of slope does not affect this assessment.

3. Site Assessment for North Bellbird

3.1 North Bellbird Investigation Area and Bushfire Threats

Virtually all of the North Bellbird Investigation Area is designated as fire prone land by Cessnock City Council (other than two small areas cleared of all vegetation in Lot1 DP196460 and Lot11 DP815485). The provisions of the bushfire planning guidelines therefore apply to the investigation area.

The investigation area comprises rolling hills and flats that have been previously cleared for past agricultural development. Current agricultural management regimes occurring both on and adjacent the investigation area includes cattle grazing, crop production (e.g. olives) and viticulture.

A bushfire hazard is regarded as anything which may result in a fire or increase the severity of a fire and result in the death or damage to life or property. Remnant patches of vegetation occur within the investigation and are considered to be potential bushfire hazards. Remnant vegetation mainly occurs in riparian corridors and as scattered pasture trees. Maintained (i.e. slashed or grazed) woodland and open forest remnants greater than 1 hectare also occur within the investigation area and adjacent properties.

3.2 Vegetation and Slope Assessment

3.2.1 Vegetation Assessment

An assessment of the vegetation structure is required under the guidelines to categorise the level of threat posed by these communities.

Depending upon the size and isolation of remnant vegetation some remnants may not be considered to be a hazard because they are not large enough to produce fire or a fire of such intensity that it will threaten dwellings (RFS 2003). These areas include:

- bushland areas of less than 1 hectare more than 100m from a high hazard area;
- strips of vegetation less than 20m wide (e.g. road or river corridor); and
- vegetation not mapped as Bush Fire Prone.

Predominant vegetation classes were determined following Appendix 2 of the Bushfire Protection guidelines (RFS 2001) which require that the vegetation structure of all remnant vegetation within 140 metres of the proposed development be classified by an appropriately qualified person.

Classification of vegetation for bushfire assessment was based on tree height and canopy cover (Figure A2.2 in RFS 2001) and habitat descriptions of vegetation units (as provided in Table A2.1 in RFS 2001). Where a mix of vegetation types occur the type providing the greater hazard is considered to predominate (RFS 2001). This definition has been extended within this report to include areas that will regenerate rapidly once existing management practices cease.

Existing vegetation in the study area, as classified by this assessment, is shown in Figure 2 and described in Table 5.
Field surveys identified that there were 6 vegetation classes (Figure 3) present based on the RFS guidelines (2001 and 2003). The classes were:

Table 5. Predominant vegetation classes within the investigation area.

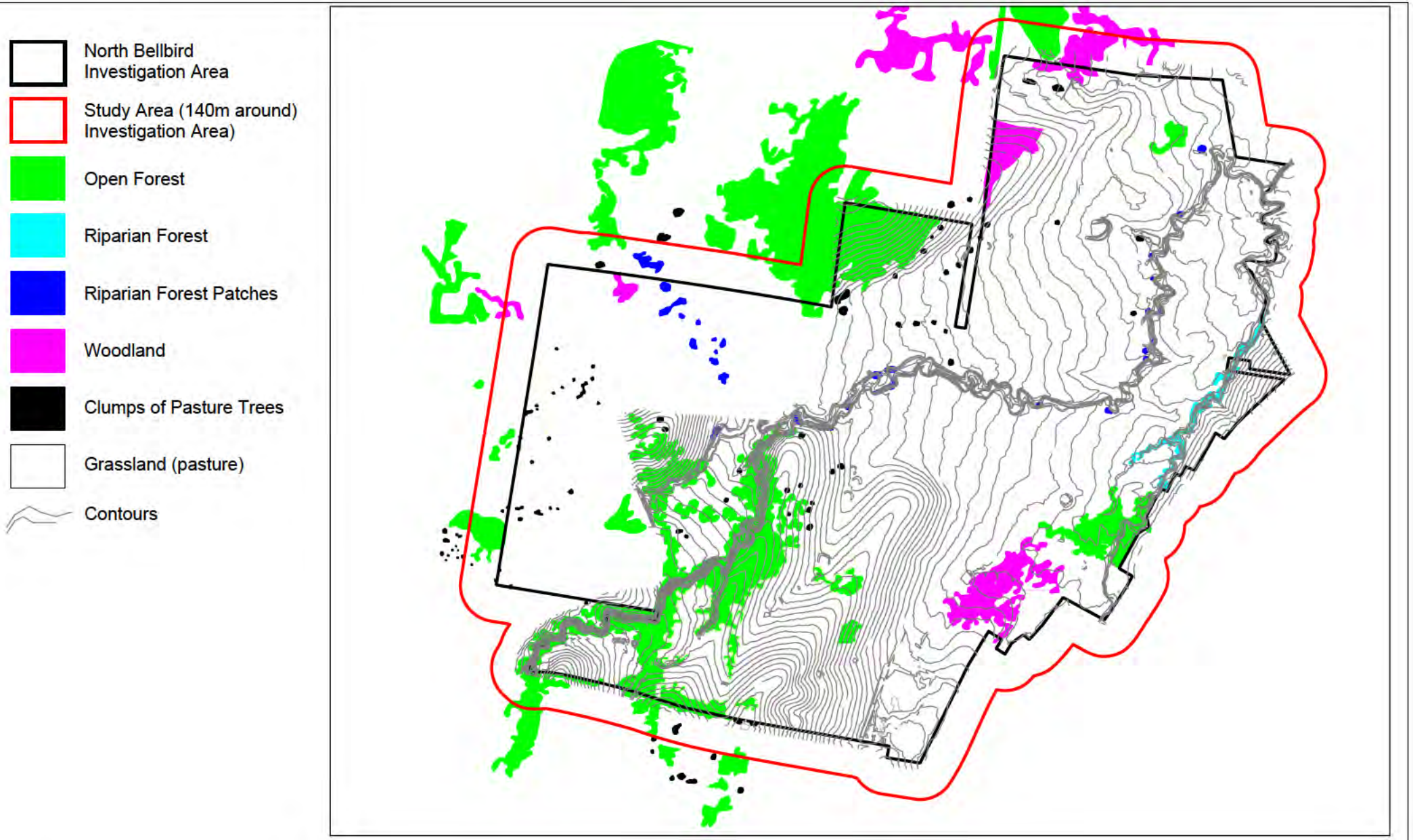
RFS Vegetation Group	Vegetation Classification	Description
1	Open forest	Trees 10-30m high; 30-70% foliage cover; understorey of sclerophyllous low trees and tall shrubs. Dominated by eucalypts.
1	Riparian forest	Trees 10-30m high; 30-70% foliage cover; understorey of sclerophyllous low trees and tall shrubs. Dominated by Forest Red Gum.
2	Woodland	Trees 10-30m high; 30-70% foliage cover dominated by eucalypts; understorey of low trees to tall shrubs dominated by *Acacia* or Casuarinaceae.
3	Clumps of paddock trees	Low trees and shrubs 2-10m high; foliage cover <30%; dominated by eucalypts and *Acacia*. Often have a grassy understorey or low shrubs.
3	Grassland (pasture)	Usually dominated by introduced grass species.
3	Patches of riparian vegetation	Small patches and strips of vegetation less than 20m wide within the riparian zone.

3.2.2 Slope Assessment

The topography of a site can not only influence the intensity of a fire but the rate of spread, soil moisture content, wind patterns, and the vegetation type and structure. Upward facing slopes can increase the spread of a fire and likelihood of crown fires especially in the right weather and depending upon the vegetation type and structure (RFS 2001). Generally, downward slopes inhibit fire by increasing the loss of radiant heat (RFS 2001).

Average slope was measured using an inclinometer to measure the slope to the threat approximately 100 metres away. The threat was regarded as any remnant vegetation which contained fuel that could be considered a bushfire risk.

The topography of the subject site comprises both gentle flats cleared of vegetation and rolling hills with east facing slopes that run down into a drainage line which splits the investigation area in half. Contours prepared by the project surveyor showing the slope of the land are shown in Figure 2.



HWR
ecological research & innovation

Scale	1:20,000
Projection	MGA / GDA 94
Drafter	Nigel Cooper & Geoff Winning
Prepared	7 March 2006
Last amended	28 May 2006

N

Existing Vegetation

Figure 2

The topography of the north-eastern section of the investigation generally comprises cleared flats with scattered trees forming woodlands. The gentle easterly sloping hills contain Group 1 vegetation especially along the ridgetop, therefore the general slope classification for the development is >5° upslope. The woodlands (Group 2 vegetation) contained on the flats in the northern section of the investigation area have a gentle slope of between 5-0 ^{o} and >5° upslope.

The eastern section of the investigation area is generally comprised of gently sloped flats and as a result is used for pasture. Group 1 (Open Forest) and Group 2 (woodland) vegetation is located on the eastern boundary abutting residential development. The general slope classification for the eastern side for development is >0 - 5° downslope.

The southern section of the investigation area consists of easterly facing slopes and northerly facing slopes and gullies creating a tributary to Limestone Creek. The area consists of Group 1 vegetation within the riparian corridors with average slopes of >0 - 5° downslope. Group 3 (open woodland) was vegetation predominant in the gentle foothills on the eastern side and cleared pasture on the western side.

The western section of the investigation area consists steeply sloped north-easterly facing hills and gullies. These hills are generally devoid of vegetation and are utilized for pasture and viticulture. The average slope in these areas is >5° upslope.

4. Bushfire Planning Assessment for North Bellbird

4.1 Development Context

As part of the rezoning process, a structure plan is being developed for the North Bellbird Investigation Area which includes a development footprint. This footprint was adopted as the for the bushfire planning assessment, and the analysis was based on the assumption that the existing mix of vegetation in areas not with the footprint (as shown in Figure 1) would be maintained. Any deviation from this assumption would require a review of the bushfire assessment (e.g. any proposed replanting or regeneration of forest in retained areas would require wider set-backs for adjoining residential areas).

4.2 Building Set-backs Required for Bushfire Protection

In general, all areas of residential development adjoining vegetation require a minimum building set-back of 20 metres. This is increased with denser vegetation types and steeper slopes between the vegetation and the residential development (as detailed in Section 2.2, above).

Forest vegetation (Group 1) along and in the vicinity of creek lines, mainly in the southern part of the investigation area, requires a minimum set-back of 40 metres, and an area of woodland vegetation (Group 2) in the east of the investigation area requires a 35 metres set-back (Figure 3).

As noted in Section 2.2, above, there are a number of possible treatments that can be employed to the design APZs to meet these set-back requirements. For example, It is likely that 20 metres set-backs could be catered for within a perimeter road reserve.

4.3 Building Construction Standards

As explained in Section 2.3, above, specific building construction standards may be required for dwellings adjacent to remnant vegetation areas. While determination of these standards is more appropriately undertaken in the detailed design phase, it can be noted at this early stage that dwellings separated from the remnant vegetation by the required set-backs are unlikely to be required to satisfy any specific level of construction for bushfire protection.

4.4 Site Access

The bushfire planning guidelines (RFS 2001) require that the public road system provide alternative access or egress for fire fighters and residents during bushfire emergency if part of the road system is cur by fire. The routes of these roads should be such that both are unlikely to be cut by a fire at the same time. Fire tracks may form part of the public access.

As a general guide, an asset protection zone should include either a perimeter road of a fire track as part of the IPA. Public roads and fire tracks should be designed in accordance with the specifications presented in the bushfire planning guidelines (RFS 2001).

North Bellbird Investigation Area

Draft Development Footprint

Retained Vegetation

Open Forest (Group 1)

Riparian Forest (Group 1)

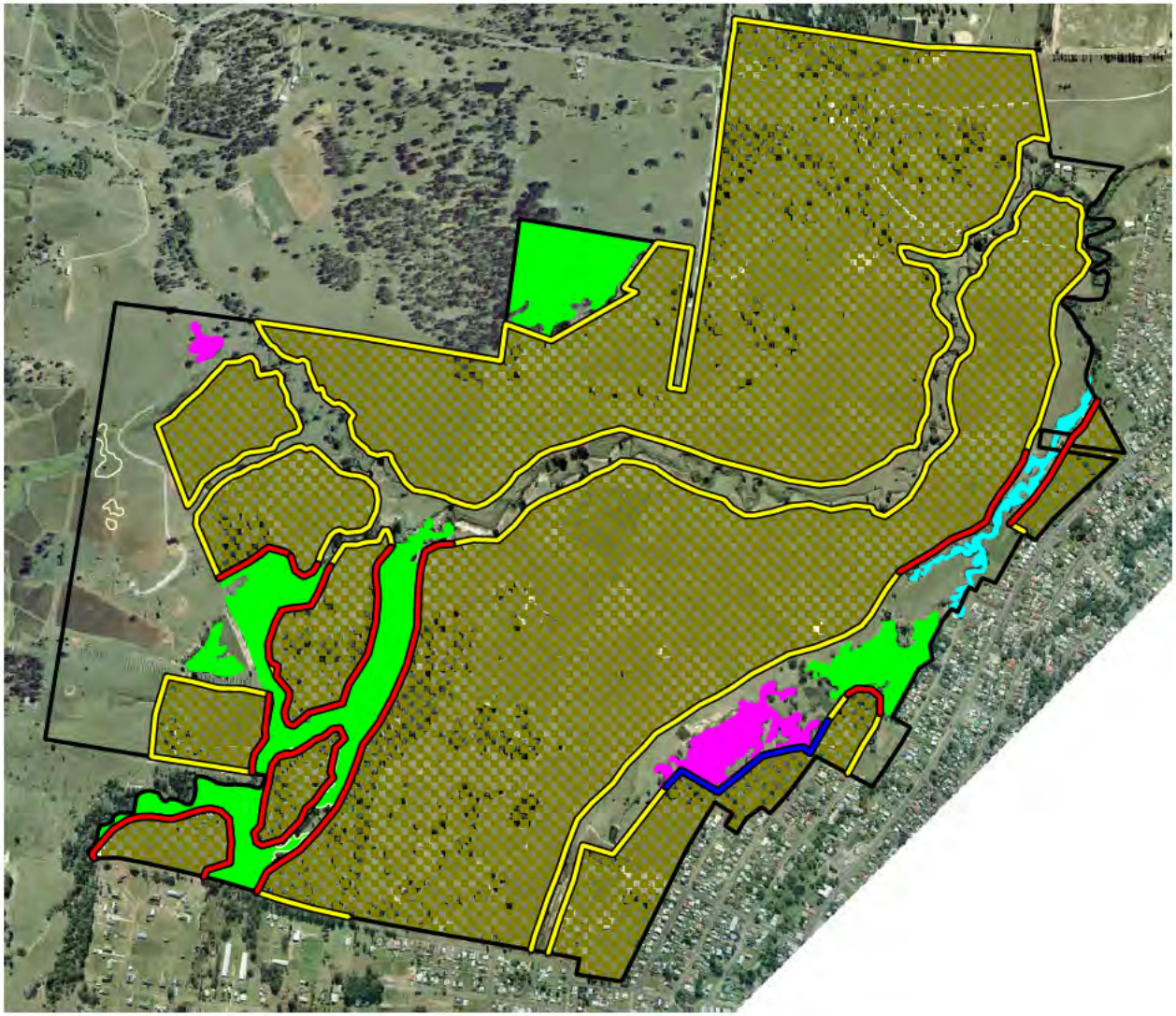
Woodland (Group 2)

Bushfire Set-backs

20m

35m

40m



HWR
ecological research & innovation

Scale	1:20,000
Projection	MGA / GDA 94
Drafter	Nigel Cooper & Geoff Winning
Prepared	7 March 2006
Last amended	28 May 2006

N

Bushfire Set-backs

Figure 3

References

NSW Rural Fire Service (2003) "*Guidelines for Asset Protection Zones*".

NSW Rural Fire Service (2004) "*Guidelines for Single Dwelling Development Applications*"

NSW Rural Fire Service (2001) "*Planning for Bushfire Protection*".

Viticultural Soils Assessment of the North Bellbird Investigation Area

For

Insite Planning and Engineering
on behalf of the
Johnson Property Group and the
Landowners of the North Bellbird
Investigation Area

March 2006

Allynbrook Pty Ltd
26 Canna Street
Bolwarra
NSW 2320

Steve Gell
ph 4930 6981
fax 4930 6982

Table of Contents

1 Executive Summary 3
2 Introduction 5
3 Property Description 6
3.1 Lot 3 DP 597226 6
3.2 Part Lot 2 DP 597226 6
3.3 Lot 1 DP 196460 7
3.4 Lot 1 DP 66183 7
4 Field Results 8
4.1 Part Lot 2 DP 597226 8
4.2 Lot 1 DP 196460. 8
4.3 Lot 2 DP 66183 9
4.4 Lot 1 DP 66183 9
5 Laboratory Analysis of Soil Samples 9
6 Summary of Soil Analysis 11
7 Classifications “Viticultural Soil Groups” and “Rural Land Evaluation (1988) .. 11
8 Conclusion 12
9 Descriptions of Photos of Surveyed Area 12

Appendix 1 Pit Profile Descriptions
Appendix 2 Laboratory Analysis Table
Appendix 3 Glossary
Appendix 4 Soil Pit Locality Map
Appendix 5 Viticultural Soil Groups Map
Appendix 6 Pit profile Diagrams
Appendix 7 Photos

1 Executive Summary

The Viticultural Soils Assessment has been prepared by Allynbrook Pty Ltd for Insite Planning and Engineering on behalf of the Johnson Property Group and the land owners of the North Bellbird Investigation Area.

This report assesses the suitability of soils for wine grape production currently subject to the 1(v) Rural Zone under the Cessnock LEP, and in particular the location of prime viticultural soils. **Prime viticultural soils are well drained with good aeration and adequate nutrition. They must have good water holding capacity and vine rootzones down to a minimum of 80cm below the surface. The soils should have a neutral to slightly alkaline soil reaction trend (pH 7 to 8 in calcium chloride) and be free of grapevine pathogens and any toxic substances, such as salt**.

The land subject to soil sampling, located in the 1(v) Zone includes: -

- Lot 3, DP 597226;
- Lot 2, DP 597226;
- Lot 1, DP 196460;
- Lot 2, DP 66183; and
- Lot 1, DP 66183

The above properties form a part of the North Bellbird Investigation Area which includes the following properties: -

Lot / DP	**Lot / DP**	**Lot / DP**	**Lot / DP**	**Lot / DP**
141 / 986905	210 / 1012346	2 / 1011544	52 / 807540	11 / 806584
3 / 810827	211 / 1012346	1 / 327785	2 / 624793	10 / 806584
PT13 / 880374	212 / 1053307	2 / 597226	3 / 624793	3 / 597226
10 / 815485	1 / 349452	1 / 597226	1 / 329071	PT 1 / 66183
11 / 815485	1 / 327580	1 / 328498	261 / 524058	2 / 66183
1 / 167004	1 / 1011544	PT 51 / 807540	1 / 196997	1 / 196460
261 / 524058				

The North Bellbird Investigation Area has a total area of 496 hectares and will accommodate between 9,100 and 12,000 residents. For the purposes of this report it is understood that the North Bellbird Investigation Area will be developed to contain the following: -

- a mix of residential environments provided through sequential staging,
- a commercial and retail precinct including mixed use development capable of serving the needs of the North Bellbird community;

- social and community infrastructure including schools, community and recreational facilities including open space;
- infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails;
- conservation of quality remnant vegetation; and;
- rehabilitation of degraded riparian corridors to provide habitat linkages.

It is recommended that the North Bellbird Structure Plan contain appropriate buffers, in accordance with Council's requirements (DCP 28), between the prime viticultural soils and existing vineyards, as identified in this report.

This report establishes that the prime viticultural soils are limited to the north western extremity of the surveyed site. The majority of the area surveyed is unsuited to any viticultural or horticultural activities and thus considered free from this constraint.

In this regard this report concludes that there is no objection to the rezoning of land that does not contain prime viticultural soils or existing vineyards for urban development. This conclusion is made with the provision that appropriate buffers, in accordance with Council's requirement, are applied to reduce conflict between land uses and avoid the sterilisation of prime viticultural soils for viticultural purposes.

2 Introduction

Allynbrook Pty Ltd has been engaged by the Johnson Property Group and the landowners of the North Bellbird Investigation Area to carry out a detailed soil survey over the North Bellbird Precinct. The survey includes the following lots:

1. Lot 3 DP 597226
2. Part Lot 2 DP 597226 (that part north of Limestone Creek)
3. Lot 1 DP 196460
4. Lot 2 DP 66183
5. Lot 1 DP 66183.

The Lots are currently zoned "Rural 1(v) – Vineyards" and this soil survey has been carried out to determine whether the proposed re-zoning to allow urban development (for which the land is currently being investigated) is appropriate. The purpose of the survey is to ascertain whether these sites contain prime viticultural soils. The surveyed area is shown on the map included with this report.

The field work and report were completed in March 2006. Eighty-one test holes were excavated throughout the surveyed area and the location of each site is shown on the map attached. Soil profiles were described in accordance with the *Australian Soil and Land Survey Field Handbook* in terms of:

- Depth of horizon
- Texture
- pH (field)
- Soil Colour
- Presence of mottling
- Pedality (structure)
- Topsoil depth
- Potential rootzone depth
- Readily available water holding capacity (RAW) in the rootzone.

The results are presented in the tables attached to this report. The potential rootzone depth in the table has been calculated for evaluation of horticultural and agricultural suitability of the surveyed area. The Readily Available Water (RAW) represents that amount of water that can be held within the rootzone, which is easily available to the vines or trees. Soils well suited to horticulture typically have RAW values of more than 50mm and rootzones of 80cm to 100cm deep.

3 Property Description

The Soil Landscapes of Singleton 1:250,000 Sheet (Soil Conservation Service NSW 1991) shows that most of the area surveyed is in the Aberdare Soil Landscape, which describes the soils on the lower slopes as yellow podzolic soils. The general description given for this landscape is:

Topsoils	Dark brown to yellowish brown loamy sands to sandy clay loams, apedal or weak structure; pH 5.5 to 6. A2 horizon bleached yellowish orange to yellowish brown, single grained; pH 5.5 to 6.5.
Subsoils	Sharp to gradual change to bright reddish brown or yellowish brown light clay to heavy clays, with strong structure and mottled; pH 5 to 5.5, increasing with depth.

These yellow podzolic soils are described as hard setting with imperfect drainage and permeability. They are of low fertility and high erodibility. This description applies to Lot 1 DP 66183, Part Lot 2 DP 597226, the lower area of Lot 1 DP 196460 and Lot 2 DP 66183 and most of Lot 3 DP 597226.

The northwestern area of Lot 3 DP 597226 as well as Lot 1 DP 196460 and Lot 2 DP 66183 are actually in the Mount View Soil Landscape. The chocolate soils and euchrozems of the Mount View Soil Landscape are generally well drained, with good moisture holding capacity, and therefore they are well suited to agricultural and horticultural enterprises. These better soils are located on the steeper slopes on the western side of Lot 1 DP 196460 and the north west corner of Lot 3 DP 597226.

More detailed descriptions by block are as follows.

3.1 Lot 3 DP 597226

This lot is generally flat to slightly undulating, rising to a steeper slope in the far northwestern corner. The creeks meandering through the property are dry at present and the owner advised me that they had not flowed since 1990.

The cleared areas are used for beef cattle grazing and the pastures are unimproved native and naturalized grasses, including blady grass, carpet grass and couch. These grasses are of low productivity and low nutritional value to livestock. The uncleared areas have regrowth eucalypts including spotted gum and ironbark, and an undergrowth of melaleuca and other native bushes typically found growing on poor soils.

3.2 Part Lot 2 DP 597226

The area of this lot that was surveyed is that north of Limestone Creek. The topography is mostly flat, with a low ridge area in the northwest corner of this lot. The flat grazing paddocks north of the creek are predominately covered with naturalised grasses, including couch grass, carpet grass and patches of paspalum.

The eucalypt covered ridge in the northwest corner is predominantly a woodlot of grey gum, narrow-leafed ironbark and the occasional grey box. The predominant grass species around these trees are spear grass and kangaroo grass with pockets of couch grass and carpet grass.

3.3 Lot 1 DP 196460

This block is undulating to steep. Native trees have been cleared for grazing and horticulture, including wine grape and olive production. The steeper areas on the western side of the property contain the Mount View soils, good deep chocolate loams and red clays. These soils are very well suited to viticulture and produce premium grapes. The Shiraz planted on this block is well regarded by Hunter winemakers.

The lower slopes and flat to undulating areas on the eastern half of the property are grazing areas of unimproved grass species, including couch and carpet grass. A small vineyard block has recently been established on this lower area. The owner advised me that the soils required extensive amelioration with lime, gypsum, composts and fertilizers prior to planting. The planting material had to be grafted to special rootstock able to tolerate the poorer soil conditions within the soil profiles in this area.

Lot 2 DP 66183
Located south of and adjacent to Lot 1 DP 196460, this block has been cleared of trees. The property is used for grazing beef cattle. Some pasture improvement has been carried out with super phosphate spreading and the introduction of clovers.

The property is flat on the eastern side with low undulating ridges giving way to steeper ridges and slopes on the western side of the property. No horticulture is practised on this property.

3.4 Lot 1 DP 66183

This small lot is located in the southwestern corner of the surveyed area. Only the soils south of the creek were surveyed for this report. The southern boundary of this lot adjoins a housing development. The topography is flat along the drainage lines on the northern and eastern boundaries with a gentle slope running to the top of the ridge on the boundary adjoining the new housing development.

This area is open grassland with several shade trees, including paperbarks and eucalypts. The drainage line and small creek bank area contain melaleucas and eucalypt species, predominantly ironbark, spotted gum and grey gum. Predominant pasture species are couch grass, carpet grass, spear grass and patches of paspalum.

4 Field Results

Lot 3 DP 597226

The soil profiles vary greatly throughout this block. The profiles with deeper topsoils and better-drained subsoils are restricted to the following areas:

- The alluvial creek soils on the western side of the dry creek represented by test sites 13, 14 and 15, and the western side of Limestone Creek, represented by test sites 43, 49 and 54.
- The chocolate and red soils in the northwest corner represented by test sites 44, 45, and 46.

Most of this block contains yellow podzolic soils, which consist of shallow sandy clay loam topsoils (A1 horizon) with weak structure over poorly structured clayey sand and sandy clay loam A2 horizon topsoils. Topsoil depth is typically 25cm or less.

The subsoils are yellowish brown sandy clays, which are poorly structured and mottled, indicating that they are prone to periodic waterlogging. These poorly structured subsoils are compacted, impervious and not at all friable. Both topsoils and subsoils are moderately to strongly acidic with field tests pH 5 to pH 6.These soils are therefore not suited to horticultural or viticultural production.

4.1 Part Lot 2 DP 597226

The soil profiles are reasonably uniform in this block. Typically, a shallow sandy clay loam A1 horizon (15cm to 25cm deep) overlies a very sandy A2 horizon that is bleached and showing orange mottles. Both these topsoils are poorly structured and field tests indicate that they are also acidic (pH 5 to pH 6.5).

The subsoils below are yellowish brown sandy clays. They are poorly structured and show a moderate to high degree of mottling, increasing with depth. This soil colour and mottling are typical of poorly drained clays, which are periodically waterlogged. Such clays are not at all well suited to agricultural and horticultural enterprises. Field pH tests indicate that these clay subsoils are generally acidic (pH 5.5 to pH 7).

4.2 Lot 1 DP 196460.

This area is located on the western side of Lot 3 DP 597226.

The soil profiles in this block vary from fair, rootzone depths 50cm to 70cm, to very good, with rootzones 80cm and deeper. The better soils occur on the slopes in the higher vineyard blocks. The soil profiles here consist of quite deep clay loam topsoils overlying well-structured red clays. The presence of limestone has resulted in these soils having high calcium levels and therefore good structure as well as a more neutral soil reaction trend with a more desirable soil pH range. These soils in the higher areas are prime viticultural soils and the vineyard blocks planted in these soils do produce high quality fruit. Briar Ridge, Petersons and Tallavera vineyards are planted on similar soils.

4.3 Lot 2 DP 66183

This block is located on the southern boundary of Lot 1 DP 196460 and includes test sites 74 to 81. The property is quite flat on the eastern end with low ridges running westward, becoming steeper as you head west. The soils are of low to moderate productivity. None of the test sites in the steeper western area (sites 74, 75, 80 and 81) include the rich clay loam topsoils or red basalt clays. Only test site 77 down on the flat contains red clay in the B1 horizon.

4.4 Lot 1 DP 66183

Soil profiles vary somewhat in this block. Typically, the topsoil is a shallow sandy clay loam (15cm to 25cm deep) that is moderately to strongly acidic. Field pH tests show a range from pH 5 to pH 5.5. The subsoils range from a reasonably well-structured reddish brown medium clay to a yellowish brown heavy clay that is poorly structured and therefore mottled and poorly drained.

The better-drained clay was present in test holes 3 and 4, resulting in these two test holes having deeper potential rootzones and RAW values. However, even these two holes show impervious clay below 40cm to 55cm and these sites cannot be considered to be prime horticultural soils. These subsoils are also acidic, field pH tests ranging from pH 5 to pH 6.

5 Laboratory Analysis of Soil Samples

Fifty-three soil samples were collected for analysis by CSBP Soil Laboratories. A summary of these results is presented in table form and annexed to this report.

pH

The ideal range for topsoil and subsoil pH is between 6.5 and 7.5 (1:5 $CaCl_2$). The laboratory results show topsoil pH values range from 4.4 to 6.2 with most being below pH 5. Therefore these topsoils are moderately to strongly acidic. Subsoil analysis shows a pH range of 4 to 6.7, with most below 5.5. Therefore the subsoils are also moderately to strongly acidic. Acidic soils have low nutrient availability because the nutrients are insoluble in acidic soil water, especially calcium, phosphorus and nitrogen. Some trace elements are highly soluble in acidic soils and they can be toxic to plants. Examples are aluminium and manganese. These soils would require heavy applications of agricultural lime, and incorporation of this lime to raise the pH and make them less acidic.

Major Nutrients

Analysis shows that most of the topsoils and subsoils are low to deficient in nitrogen, phosphate, calcium and potassium. Those samples from the chocolate loams and red clays in the western part of Lot 1 DP 196460 and the northwestern corner of Lot 3 DP 597226 proved to have good levels of calcium. However, their levels of phosphate and nitrogen were quite low. The magnesium level is moderate to high in most samples tested. The majority of these soils would require substantial and

prolonged applications of fertilizers containing major nutrients, especially nitrogen, phosphorus and potassium. This heavy fertilizer requirement is not in line with the desired approach to sustainable agriculture.

Electrical Conductivity

Soils in which ECe values are greater than 2 dS/m are considered saline. Some grape varieties are affected when ECe values are above 1.5 dS/m. Most of the samples tested are non-saline. However, nine samples have ECe values greater than 1.5 dS/m, and another three results are greater than 1.2 dS/m.

Cation Exchange Capacity and Exchangeable Cations

The Cation Exchange Capacity (CEC) represents the total bank of available cations. This reflects the soil's ability to hold cations (i.e. positively charged ions). The relative percentage of the five most common cations is most important, especially the percentage of CEC for calcium, magnesium and sodium. These figures indicate the structural stability of the clays, which determines how well structured and therefore how well drained and well aerated the soils will be. The desirable range for these cation percentages of CEC is:

- Calcium 60-85% of CEC
- Magnesium 10-15% of CEC
- Sodium <5% of CEC.
- Potassium 5-10%
- Aluminium < 1% of CEC

Most topsoils analysed have low CEC values due to their sandy texture and low organic matter content, the exceptions being the heavier clay loams and better topsoils in the western and northwestern area surveyed.

The subsoils being clays have adequate to good CEC values. However, they tend to have low calcium, and high magnesium and sodium levels. Therefore, many of these subsoils are sodic and dispersive. Again, the exceptions are the well-structured red clays in the western area of Lot 1 DP 196460 and the northwestern corner of Lot 3 DP 597226. Here the calcium levels are very high with moderate magnesium levels, so they have good calcium / magnesium ratios. These high calcium levels are responsible for the good structure that these clays exhibit.

Many samples (24) have exchangeable aluminium levels greater than 1% of CEC and are therefore toxic. This high aluminium level is due to the fact that the soils are strongly acidic. This hampers the establishment of grapevines and results in poor root development. Amelioration with high rates of agricultural lime is required to alleviate this problem.

Organic matter

Most topsoils analysed have adequate levels of organic matter. However, these topsoils are shallow, most being 25cm or less. The subsoils below have very low organic matter levels, so the soil profiles are deficient in organic matter. Organic matter has an important role in soil structure, moisture retention, and soil microbial activity, as well as storing nutrients. Soils with low organic matter levels have low nutrient holding capacity.

6 Summary of Soil Analysis

The laboratory analysis confirms and explains the results of the field survey. Most areas contain soils that are acidic, deficient in many essential plant nutrients and low in organic matter. The yellow brown clay subsoils are sodic, low in calcium and dispersive. They are therefore poorly structured and prone to periodic waterlogging as indicated by the high percentage of mottling evident in the clays. Only the red clays on the hills in the western area of the survey are well drained.

Many of the soils also contain toxic levels of exchangeable aluminium, and some are slightly salty.

In summary, the majority of the area surveyed contains soils that are not prime viticultural or horticultural soils. They are in fact of low agricultural value. Only the Mount View soils in the steeper western part of the survey area could be described as "prime" viticultural soils.

7 Classifications "Viticultural Soil Groups" and "Rural Land Evaluation (1988)

According to the map of viticultural soil groups prepared for Cessnock City Council by the Department of Agriculture in 1993, most of the area surveyed for this report is outside the zone classified as well suited for viticulture. Much of the area surveyed is within classification '4 – unsuitable soils'. The area of this survey that is within that classified as suitable for viticulture is in the north western corner of Lot 3 DP 597226 and the western side of Lot 1 DP 196460 and Lot 2 DP 66183.

Most of the area surveyed is class '4' based on rural land evaluation 1988 guidelines used by NSW Agriculture's Suitability Classification. Class 4 land is "land suitable for grazing, but not for cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques."

Therefore only the steeper western and northwestern portion of the surveyed area is land classified by NSW Agriculture as well suited for vineyard development, as shown on the Viticultural Soil Groups map annexed. Hence, any urban development of the lower area surveyed for this report will not contradict with Council's objective to "maintain prime viticultural land and enhance the economic and ecological sustainability of the Vineyards District", nor will it create any " conflict between viticultural and non-viticultural land uses' [Zone No 1(v) objectives (a) and (c) respectively.]

8 Conclusion

- This soil survey and the laboratory analysis confirm that the area surveyed has been incorrectly classified in both the Cessnock City Council's "Viticultural Soil Groups" and NSW Agriculture's "Agricultural Suitability Classification". The majority of the area surveyed is unsuitable for viticulture or horticultural development.

- The current Rural 1(v) - Vineyards zoning is not considered reflective of the land's viticultural capability and therefore would be an inappropriate zoning.

- Urban development of the area surveyed should not conflict with Council's zoning objectives as regards zoning for vineyards.

9 Descriptions of Photos of Surveyed Area

(See photos at Appendix 7 as last pages of report)

Photos 1, 2, 3 and 4. Lot 3 DP 597226

These are taken from the southern end of the block on Tennant Street looking northward across the surveyed area. These photos show the scrubby nature of the block and the predominance of eucalypt and melaleuca species associated with poorly drained, acidic soils.

Photos 5 and 6 and 7. Lot 1 DP 66183

Photos 5 and 6 are taken from the southeast corner of Lot 1 DP 66183. They show the subdivision and housing adjoining the southern boundary of this Jackson block. **Photo 7** is taken from the same position as photos 5 and 6, but looking west across the lower part of the area surveyed. This photo shows the scrubby eucalypt and melaleuca growth along the dry creek and watercourse.

Photos 8 and 9. Part Lot 2 DP 597226

These two photos were taken from the northern boundary of the surveyed area looking south. The poor quality of pasture is obvious in both photos. The eucalypt woodlot area on the northeast ridge can be seen in photo 9. Predominant pasture species are couch and carpet grass, which are of low productivity and low nutritive value. These species proliferate on poorly drained acidic soils.

Photo 10 Lot 1 DP 196460

This photo is taken from the very northwest corner of Lot 3 DP 597226 looking south over Lot 1 DP 196460. The higher vineyard block that is on the right is on the rich red mount View soils. The lower vineyard block on the left is on the poorer yellow podzolic soils.

Photo 11 Lot 3 DP 597226

This photo shows the alluvial creek flats on Limestone Creek.

North Bellbird Precinct

Mar-06

Pit No	Depth Topsoil (cm)	Depth Rootzone (cm)	RAW (mm)	Depth Layer (cm)	Horizon	Texture	pH Field	Colour			Pedality		Gravel
								Narrative	Munsell	Mottle	Grade	Type	
1	20	40	26	0-5	A	SCL	5.5	dark greyish brown	10YR4/2	~	W	SB	~
				5-20	A	LSCL	6	greyish brown	10YR5/2	~	G	NIL	~
				20-50+	B	SC	5.5	yellowish brown	10YR5/6	20-30% greyish brown	W	LE	~
2	25	45	30	0-10	A	SCL	6	dark greyish brown	10YR4/2	~	W	SB	~
				10-25	A	LSCL	6	greyish brown	10YR5/2	~	G	NIL	~
				25-60+	B	SC	5.5	yellowish brown	10YR5/6	10-20% greyish brown	W	LE	~
3	20	60	34	0-20	A	SCL	5.5	yellowish red	5YR4/6	~	M	SB	~
				20-40	B	MC	6	reddish brown	5YR4/4	~	M	SB	~
				40-60+	B	HC	5.5	yellowish red	5YR5/8	20-30% yellowish brown	W	PR	~
4	20	70	40	0-20	A	SCL	5	yellowish red	5YR4/6	~	M	SB	~
				20-55	B	MC	6	reddish brown	5YR4/4	~	M	SB	~
				55-70+	B	HC	5.5	yellowish red	5YR5/8	10-20% yellowish brown	W	PR	~
5	15	35	22	0-15	A	SCL	5	dark yellowish brown	10YR4/4	~	W	SB	~
				15-30	B	MC	5.5	yellowish red	5YR5/6	>30% yellowish brown	W	PR	~
				30-60+	B	SC	5	yellowish brown	10YR5/6	>50% orange grey	W	PR	~
6	25	45	29	0-25	A	SCL	5	brown	10YR4/3	~	W	SB	~
				25-45	B	MC	5.5	yellowish red	5YR5/6	20-30% yellowish brown	M	PR	~
				45-60+	B	HC	5	yellowish brown	10YR5/6	>30% grey	W	PR	~
7	30	50	33	0-10	A	SCL	5.5	dark greyish brown	10YR4/2	~	W	SB	~
				10-30	A	LSCL	5.5	greyish brown	10YR5/2	~	G	NIL	~
				30-60	B	SC	5	yellowish brown	10YR5/6	20-30% yellowish brown	W	LE	~

North Bellbird Precinct

Mar-06

Pit No	Depth Topsoil (cm)	Depth Rootzone (cm)	RAW (mm)	Depth Layer (cm)	Horizon	Texture	pH Field	Colour			Pedality		Gravel
								Narrative	Munsell	Mottle	Grade	Type	
8	25	45	30	0-10	A	SCL	6	dark greyish brown	10YR4/2	~	W	SB	~
				10-25	A	LSCL	6	greyish brown	10YR5/2	~	G	NIL	~
				25-60+	B	SC	5.5	yellowish brown	10YR5/6	20-30% yellowish brown	W	LE	~
9	30	50	33	0-10	A	SCL	5.5	dark greyish brown	10YR4/2	~	W	SB	~
				10-30	A	LSCL	5.5	yellowish brown	10YR5/4	~	G	NIL	~
				30-60+	B	SC	5	dark yellowish brown	10YR4/4	30-40% orange	W	LE	~
10	20	40	26	0-5	A	SCL	6	dark greyish brown	10YR4/2	~	W	SB	~
				5-20	A	LSCL	5.5	greyish brown	10YR5/2	~	G	NIL	~
				20-50+	B	SC	5	yellowish brown	10YR5/6	20-30% orange	W	LE	~
11	40	80	51	0-15	A	SCL	5.5	dark yellowish brown	10YR3/4	~	W	SB	~
				15-40	A	SCL	5.5	yellowish brown	10YR5/4	~	G	NIL	~
				40-60+	B	SC	5	strong brown	10YR5/6	10-20% greyish brown	W	SB	~
12	25	45	29	0-10	A	SCL	6	dark greyish brown	10YR4/2	~	W	SB	~
				10-25	A	SCL	5.5	yellowish brown	10YR5/4	~	G	NIL	~
				25-50+	B	SC	5	yellowish red	5YR4/6	30-40% yellowish brown	W	PR	~
13	30	80	50	0-20	A	SCL	6.5	dark yellowish brown	10YR3/4	~	W	SB	~
				20-30	A	LSCL	6	yellowish brown	10YR5/4	~	G	NIL	~
				30-70+	B	SC	5.5	strong brown	10YR5/6	~	W	SB	~
14	25	75	47	0-15	A	SCL	6.5	dark yellowish brown	10YR3/4	~	W	SB	~
				15-25	A	LSCL	6	yellowish brown	10YR5/4	~	G	NIL	~
				25-70+	B	SC	6	strong brown	10YR5/6	~	W	SB	~

North Bellbird Precinct

Mar-06

Pit No	Depth Topsoil (cm)	Depth Rootzone (cm)	RAW (mm)	Depth Layer (cm)	Horizon	Texture	pH Field	Colour			Pedality		Gravel
								Narrative	Munsell	Mottle	Grade	Type	
15	30	50	33	0-15	A	LSCL	5.5	dark greyish brown	10YR4/2	~	W	SB	~
				15-30	A	SCL	5.5	yellowish brown	10YR5/4	~	G	NIL	~
				30-60+	B	SC	5	dark yellowish brown	10YR4/4	20-30% orange	W	LE	~
16	35	55	35	0-20	A	LSCL	5.5	brown	10YR4/3	~	W	SB	~
				20-35	A	CS	5.5	yellowish brown	10YR5/4	~	G	NIL	~
				35-60+	B	SC	5	dark yellowish brown	10YR4/6	20-30% orange	W	LE	~
17	25	45	28	0-15	A	LSCL	5.5	brown	10YR4/3	~	W	SB	~
				15-25	A	CS	5.5	yellowish brown	10YR5/4	~	G	NIL	~
				25-60+	B	SC	5	dark yellowish brown	10YR4/6	20-30% orange	W	LE	~
18	30	50	32	0-20	A	SL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				20-30	A	LSCL	5.5	yellowish brown	10YR5/4	~	G	NIL	~
				30-60+	B	SC	5	dark yellowish brown	10YR4/4	20-30% red/orange	W	LE	~
19	40	60	39	0-20	A	SL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				20-40	A	LSCL	5	yellowish brown	10YR5/4	~	G	NIL	~
				40-50+	B	SC	5	dark yellowish brown	10YR4/4	20-30% red/orange	W	LE	~
20	30	50	33	0-10	A	SL	5.5	dark greyish brown	10YR4/2	~	W	SB	~
				10-30	A	LSCL	5.5	yellowish brown	10YR5/4	~	G	NIL	~
				30-50+	B	SC	5.5	dark yellowish brown	10YR4/4	10-20% red/orange	W	LE	~
21	25	45	28	0-10	A	LSCL	5.5	dark greyish brown	10YR4/2	~	W	SB	~
				10-25	A	CS	5.5	yellowish brown	10YR5/4	~	G	NIL	~
				25-50	B	SC	5	dark yellowish brown	10YR4/4	20-30% orange	W	LE	~

North Bellbird Precinct

Mar-06

Pit No	Depth Topsoil (cm)	Depth Rootzone (cm)	RAW (mm)	Depth Layer (cm)	Horizon	Texture	pH Field	Colour			Pedality		Gravel
								Narrative	Munsell	Mottle	Grade	Type	
22	25	45	26	0-25	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				25-60+	B	HC	6.5	dark yellowish brown	10YR4/4	20-30% grey	W	PR	<5%
23	35	55	30	0-15	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				15-35	B	SC	6.5	dark greyish brown	10YR4/2	20-30% orange	W	PR	~
				35-60+	B	HC	6.5	dark yellowish brown	10YR4/4	20-30% grey	W	PR	~
24	15	35	22	0-15	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				15-60+	B	SC	6.5	dark yellowish brown	10YR4/4	20-30% orange	W	PR	~
25	35	55	34	0-15	A	SCL	6	very dark greyish brown	10YR3/2	~	W	SB	~
				15-35	A	LSCL	6.5	yellowish brown	10YR5/4	10% orange	G	NIL	<10%
				35-60+	B	SC	7	dark yellowish brown	10YR4/4	10-20% orange	W	PR	<10%
26	25	45	29	0-20	A	SCL	6	very dark greyish brown	10YR3/2	~	W	SB	~
				20-25	A	LSCL	6.5	yellowish brown	10YR5/4	10% orange	G	NIL	~
				25-60+	B	SC	7	dark yellowish brown	10YR4/4	10-20% orange	W	PR	~
27	20	40	26	0-20	A	SCL	6	very dark greyish brown	10YR3/2	~	W	SB	~
				20-60+	B	SC	7	dark greyish brown	10YR4/2	20-30% orange	W	PR	~
28	25	45	29	0-15	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				15-25	A	LSCL	6	dark greyish brown	10YR4/2	>10% orange	G	NIL	~
				25-60+	B	SC	7	dark yellowish brown	10YR4/6	20-30% orange	W	PR	~

North Bellbird Precinct

Mar-06

Pit No	Depth Topsoil (cm)	Depth Rootzone (cm)	RAW (mm)	Depth Layer (cm)	Horizon	Texture	pH Field	Colour			Pedality		Gravel
								Narrative	Munsell	Mottle	Grade	Type	
29	25	45	29	0-15	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				15-25	A	LSCL	6.5	dark greyish brown	10YR4/2	~	G	NIL	~
				25-60+	B	SC	6.5	dark yellowish brown	10YR4/6	20-30% orange	W	PR	~
30	30	50	33	0-10	A	SCL	6	very dark greyish brown	10YR3/2	~	W	SB	~
				10-30	A	LSCL	6.5	yellowish brown	10YR5/4	>10% orange	G	NIL	~
				30-70+	B	SC	6.5	dark yellowish brown	10YR4/6	10-20% orange	W	PR	~
31	25	45	29	0-15	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				15-25	A	LSCL	6	brown	10YR4/3	~	G	NIL	~
				25-75+	B	SC	6.5	dark yellowish brown	10YR4/4	10-20% orange	W	PR	~
32	30	50	31	0-10	A	SCL	6	dark greyish brown	10YR4/2	~	W	SB	~
				10-30	A	CS	6.5	brown	10YR5/3	~	G	NIL	~
				30-70+	B	SC	7	dark yellowish brown	10YR4/6	10%+ orange	W	PR	~
33	15	35	22	0-15	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				15-60+	B	SC	6	dark yellowish brown	10YR3/4	10-20% orange	W	PR	~
34	15	35	22	0-15	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				15-60+	B	SC	6	dark yellowish brown	10YR3/4	0-10% orange	W	PR	~
35	30	60	38	0-15	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				15-30	A	LSCL	6	dark greyish brown	10YR4/2	~	G	NIL	~
				30-45	B	SC	5.5	very dark greyish brown	10YR3/2	~	W	SB	<10%
				45-70+	B	HC	5	dark yellowish brown	10YR3/4	10% grey	W	PR	~

North Bellbird Precinct

Mar-06

Pit No	Depth Topsoil (cm)	Depth Rootzone (cm)	RAW (mm)	Depth Layer (cm)	Horizon	Texture	pH Field	Colour			Pedality		Gravel
								Narrative	Munsell	Mottle	Grade	Type	
36	15	35	22	0-15	A	SCL	6.5	very dark greyish brown	10YR3/2	~	W	SB	~
				15-60+	B	SC	7	dark yellowish brown	10YR4/4	10% grey	W	PR	~
37	55	75	31	0-25	A	SCL	5.5	very dark brown	10YR2/2	~	W	SB	10%
				25-55	A	CS	6	yellowish brown	10YR5/4	10-20% orange	G	NIL	>60%
				55-75+	B	SC	5.5	dark yellowish brown	10YR4/4	10-20% grey	W	PR	30-40%
38	35	55	36	0-35	A	SCL	5.5	very dark brown	10YR2/2	~	W	SB	~
				35-70+	B	SC	6	dark red	2.5YR3/6	20-30% yellowish brown /grey	W	PR	~
39	45	65	41	0-25	A	SCL	5	very dark brown	10YR2/2	~	W	SB	~
				25-45	B	SC	6	dark red	2.5YR3/6	10-20% yellowish brown/grey	W	LE	~
				45-80+	B	SC	5.5	yellowish brown	10YR5/6	>20% grey	W	PR	~
40	25	45	29	0-20	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				20-25	A	LSCL	6	yellowish brown	10YR5/4	~	G	NIL	~
				25-70+	B	SC	6.5	dark yellowish brown	10YR4/4	20% orange	W	PR	~
41	20	40	26	0-20	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				20-60+	B	SC	6.5	dark yellowish brown	10YR4/4	20-30% orange	W	PR	~
42	25	45	29	0-25	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				25-70+	B	SC	6	dark yellowish brown	10YR4/4	20-30% orange	W	PR	~
43	40	90	57	0-40	A	SCL	5	brown	10YR4/3	~	W	SB	~
				40-50	B	MC	5	yellowish brown	10YR5/4	~	W	SB	~
				50-80+	B	SC	6	yellowish red	5YR5/6	~	W	SB	~

North Bellbird Precinct

Mar-06

Pit No	Depth Topsoil (cm)	Depth Rootzone (cm)	RAW (mm)	Depth Layer (cm)	Horizon	Texture	pH Field	Colour			Pedality		Gravel
								Narrative	Munsell	Mottle	Grade	Type	
44	25	75	46	0-25 25-70+	A B	SCL MC	5 5.5	dusky red dark red	10R3/4 10R3/6	~ ~	M M	GR SB	~ ~
45	25	75	45	0-25 25-70+	A B	CL MC	5 5.5	dusky red dark red	10R3/4 10R3/6	~ ~	M M	GR SB	~ ~
46	20	70	42	0-20 20-80+	A B	CL MC	5 6	dusky red dark red	10R3/4 10R3/6	~ ~	M M	GR SB	~ ~
47	20	55	34	0-20 20-35 35-60+	A B B	SCL MC SC	4.5 5 5	dark brown reddish brown yellowish brown	10YR3/3 5YR4/4 10YR5/4	~ ~ ~	M W W	SB SB PR	~ ~ ~
48	25	75	46	0-25 25-70+	A B	SCL SC	5 5.5	dark brown reddish brown	10YR3/3 5YR4/6	~ ~	M W	SB SB	~ ~
49	50	100	71	0-20 20-50 50-90+	A A B	SCL SCL SCL	5.5 6 7	dark reddish brown dark reddish brown reddish brown	5YR3/3 5YR3/4 5YR4/4	~ ~ ~	M M W	SB SB SB	~ ~ ~
50	25	45	29	0-25 25-60+	A B	SCL SC	5.5 6	very dark greyish brown dark yellowish brown	10YR3/2 10YR4/4	~ >20% orange	W W	SB PR	~ ~
51	25	45	29	0-25 25-70+	A B	SCL SC	5.5 6	very dark greyish brown dark greyish brown	10YR3/2 10YR4/2	greyish brown orange	W W	SB PR	~ ~

North Bellbird Precinct

Mar-06

Pit No	Depth Topsoil (cm)	Depth Rootzone (cm)	RAW (mm)	Depth Layer (cm)	Horizon	Texture	pH Field	Colour			Pedality		Gravel
								Narrative	Munsell	Mottle	Grade	Type	
52	20	40	22	0-20	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				20-60+	B	HC	6	dark yellowish brown	10YR4/4	20-30% grey	W	PR	~
53	25	45	26	0-25	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				25-60+	B	HC	6	dark yellowish brown	10YR3/4	~	W	PR	~
54	35	85	53	0-25	A	SCL	5.5	dark reddish brown	5YR3/3	~	M	SB	~
				25-35	A	SCL	6	dark reddish brown	5YR3/4	~	M	SB	~
				35-80+	B	SC	6	reddish brown	5YR4/6	10-20% yellowish brown	W	SB	~
55	25	70	43	0-25	A	SCL	5	dark brown	7.5YR3/2	~	M	SB	~
				25-50	B	SC	5	reddish brown	5YR4/6	<20% yellowish brown	W	SB	~
				50-70+	B	SC	6	red	2.5YR4/6	20-30% greyish brown	W	PR	~
56	20	65	40	0-20	A	SCL	5	dark brown	10YR3/3	~	M	SB	~
				20-45	B	MC	5.5	reddish brown	5YR4/6	~	W	SB	~
				45-70+	B	SC	4.5	yellowish brown	10YR5/4	20-30% greyish brown	W	PR	~
57	15	55	33	0-15	A	CL	5.5	dark brown	10YR3/3	~	M	SB	~
				15-35	B	MC	5	dark yellowish brown	10YR4/4	~	W	SB	~
				35-65	B	SC	4.5	yellowish brown	10YR5/6	20% greyish brown	W	PR	~
58	25	60	38	0-25	A	SCL	6	dark brown	10YR3/3	~	W	SB	~
				25-40	B	MC	5.5	reddish brown	10YR3/4	10% yellowish brown	W	SB	~
				40-90+	B	SC	5	yellowish brown	10YR5/8	30-40% grey	W	PR	~

North Bellbird Precinct

Mar-06

Pit No	Depth Topsoil (cm)	Depth Rootzone (cm)	RAW (mm)	Depth Layer (cm)	Horizon	Texture	pH Field	Colour			Pedality		Gravel
								Narrative	Munsell	Mottle	Grade	Type	
59	20	70	43	0-20	A	SCL	5.5	dark brown	7.5YR3/2	~	M	SB	~
				20-50	B	SC	4.5	dusky red	10R3/3	<10% yellowish brown	W	SB	~
				50-70+	B	SC	4.5	dark yellowish brown	10YR4/6	~	W	PR	~
60	20	60	37	0-20	A	SCL	5.5	dark brown	7.5YR3/2	~	M	SB	~
				20-40	B	SC	5	dusky red	10R3/4	10% yellowish brown	W	SB	~
				40-70+	B	SC	4.5	dark yellowish brown	10YR4/6	~	W	PR	~
61	40	90	57	0-20	A	SCL	6	dark brown	7.5YR3/2	~	M	SB	~
				20-40	A	SCL	6	dark brown	7.5YR3/3	~	W	SB	~
				40-80+	B	SC	5.5	yellowish brown	10YR5/6	red	W	SB	~
62	40	60	40	0-15	A	SCL	5.5	brown	10YR4/3	~	W	SB	~
				15-40	A	SCL	6	light yellowish brown	10YR6/4	~	G	NIL	~
				40-65	B	SC	5	yellowish brown	10YR5/4	orange	W	PR	~
63	20	70	42	0-20	A	CL	6	dark brown	7.5YR3/3	~	M	GR	~
				20-70	B	LC	5.5	red	10R4/6	10-20% yellowish brown	M	GR	~
64	20	60	36	0-20	A	CL	5.5	yellowish red	5YR4/6	~	M	GR	~
				20-40	B	LC	4.5	red	2.5YR4/6	~	M	SB	~
				40-70+	B	LC	4.5	yellowish brown	10YR4/4	~	W	PR	~
65	30	80	48	0-30	A	CL	6.5	dark reddish brown	2.5YR3/4	~	M	GR	~
				30-80	B	LC	5	red	10R4/8	~	M	GR	~

North Bellbird Precinct

Pit No	Depth Topsoil (cm)	Depth Rootzone (cm)	RAW (mm)	Depth Layer (cm)	Horizon	Texture	pH Field	Colour			Pedality		Gravel
								Narrative	Munsell	Mottle	Grade	Type	
66	35	85	51	0-35	A	CL	7	dark reddish brown	2.5YR3/4	~	M	GR	~
				35-90	B	LC	5.5	red	10R4/8	~	M	GR	~
67	20	70	42	0-20	A	CL	7	reddish brown	5YR4/4	~	M	GR	~
				20-50	B	MC	5.5	yellowish red	5YR4/6	~	W	SB	~
				50-80+	B	SC	5	yellowish red	5YR5/6	20-30% greyish brown	W	SB	~
68	30	80	48	0-30	A	CL	7	reddish brown	2.5YR4/4	~	M	GR	~
				30-70	B	MC	5.5	red	2.5YR4/8	10% yellowish brown	W	SB	~
				70-90+	B	SC	5	yellowish red	5YR5/6	30% greyish brown	W	PR	~
69	15	65	36	0-15	A	CL	7	reddish brown	5YR4/4	~	M	GR	~
				15-50	B	MC	5.5	red	2.5YR4/8	~	W	SB	~
				50-70	B	HC	4.5	red	10R4/8	30-40% yellowish brown	W	PR	~
70	35	55	37	0-25	A	SCL	5.5	dark yellowish brown	10YR3/4	~	W	SB	~
				25-35	A	LSCL	5.5	yellowish brown	10YR5/4	~	G	NIL	~
				35-70+	B	SC	5	dark yellowish brown	10YR4/4	20-30% orange	W	PR	~
71	20	40	26	0-15	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				15-20	A	LSCL	5.5	light yellowish brown	10YR6/4	~	W	SB	~
				20-70+	B	SC	5	yellowish brown	10YR5/6	30% greyish brown	W	PR	~
72	20	70	43	0-20	A	SCL	5.5	very dark greyish brown	10YR3/2	~	W	SB	~
				20-50	B	MC	5	red	10R4/6	~	M	SB	~
				50-70+	B	SC	5	yellowish brown	10YR5/8	30-40% greyish brown	W	PR	~

North Bellbird Precinct

Pit No	Depth Topsoil (cm)	Depth Rootzone (cm)	RAW (mm)	Depth Layer (cm)	Horizon	Texture	pH Field	Colour			Pedality		Gravel
								Narrative	Munsell	Mottle	Grade	Type	
73	30	80	48	0-30	A	CL	7	dark reddish brown	2.5YR3/4	~	M	GR	~
				30-80	B	LC	5.5	red	10R4/8	~	M	GR	~
74	20	60	37	0-20	A	SCL	5.5	dark brown	10YR3/3	~	W	SB	~
				20-45	B	SC	5.5	yellowish red	5YR4/6	30-40% yellowish brown	W	SB	~
				45-70+	B	SC	5	yellowish brown	10YR5/8	40% greyish brown	W	PR	~
75	20	40	37	0-20	A	SCL	5.5	dark brown	10YR3/3	~	W	SB	~
				20-60+	B	SC	5	yellowish brown	10YR5/8	30% greyish brown	W	PR	~
76	25	45	29	0-15	A	SCL	5	very dark greyish brown	10YR3/2	~	W	SB	~
				15-25	A	SCL	5.5	light yellowish brown	10YR6/4	~	W	SB	~
				25-60+	B	SC	6	yellowish brown	10YR5/6	30-40% greyish brown	W	PR	~
77	40	80	51	0-40	A	SCL	5.5	dark brown	10YR3/3	~	M	SB	~
				40-70	B	MC	5	dark red	10R3/6	~	M	SB	~
				70-80+	B	SC	5	greyish brown	10YR5/2	20-30% red	W	PR	~
78	25	60	38	0-25	A	SCL	5.5	dark brown	10YR3/3	~	W	SB	~
				25-50	B	SC	5	yellowish brown	10YR5/8	red/orange	W	SB	~
				50-70+	B	SC	4.5	yellowish brown	10YR5/8	grey	W	PR	~
79	25	60	36	0-25	A	SL	5.5	brown	10YR4/3	~	G	NIL	~
				25-40	B	SC	5	yellowish brown	10YR5/8	red/orange	W	SB	~
				40-70+	B	SC	4.5	yellowish brown	10YR5/8	grey	W	PR	~

North Bellbird Precinct

Mar-06

Pit No	Depth Topsoil (cm)	Depth Rootzone (cm)	RAW (mm)	Depth Layer (cm)	Horizon	Texture	pH Field	Colour			Pedality		Gravel
								Narrative	Munsell	Mottle	Grade	Type	
80	20	60	36	0-20	A	SCL	5.5	dark brown	10YR3/3	~	W	SB	~
				20-40	B	SC	5	yellowish red	5YR4/6	20% yellowish brown	W	SB	50-10%
				40-70+	B	SC	5	light brownish grey	10YR6/2	30-40% yellowish red	W	PR	~
81	25	60	36	0-25	A	SCL	5.5	dark brown	10YR3/3	~	W	SB	~
				25-45	B	SC	5	yellowish red	5YR4/6	20-30% yellowish brown	W	SB	10-15%
				45-70+	B	SC	5	light brownish grey	10YR6/2	30-40% yellowish red	W	PR	~

LABORATORY ANALYSIS TABLE

North Bellbird Precinct

March-06

Sample No	Pit No	Horizon	Depth (cm)	Texture	pH $CaCl_2$	Electrical Conductivity ECse dS/m	Total Nitrogen (ppm)	Phosphate (ppm)	Organic Carbon %	Cation Exchange Capacity CEC (meq)	Percentage of CEC					Calcium / Magnesium :1
											Ca	Mg	Na	K	Al	
1	1,2,8	A	0-10	SCL	4.6	0.8	4	11	2.9	6.04	40.9	37.9	7.0	4.1	10.1	1.1
2	1,2,8	A2	10-25	LSCL	4.7	1.2	3	5	1.2	2.91	26.1	49.1	13.7	4.5	6.5	0.5
3	1,2,8	B	25-55	SC	4.6	1.4	3	4	0.8	10.71	7.8	67.4	16.5	2.4	5.8	0.1
4	9	A	0-30	SCL	4.6	0.5	6	8	2.4	5.13	70.0	18.7	2.5	5.1	3.7	3.7
5	9	B	30-60	SC	4.2	0.3	5	3	0.6	9.07	41.0	32.6	6.4	2.8	17.2	1.3
6	16,17	A	0-15	LSCL	4.4	1.2	7	30	1.9	3.98	60.1	18.1	5.3	4.8	11.8	3.3
7	18,19	A	0-20	SL	4.5	0.5	3	11	1.2	2.72	48.5	23.5	4.0	7.4	16.5	2.1
8	18,19	B	35-55	SC	4.4	1.9	3	3	0.7	12.97	5.5	64.1	21.0	1.9	7.4	0.1
9	12	A2	10-25	SCL	4.7	0.6	4	5	1.0	8.01	76.0	18.2	0.7	4.7	0.2	4.2
10	12	B	25-50	SC	4.6	2.4	3	5	0.9	10.06	38.1	37.1	14.8	3.4	6.7	1.0
11	13,14	A	0-20	SCL	5.4	0.6	4	7	2.4	15.90	76.2	18.9	1.0	4.0	0.0	4.0
12	13,14	B	25-70	SCL	4.7	0.3	4	6	0.7	12.02	60.1	31.0	3.0	3.0	2.9	1.9
13	22	A	0-25	SCL	4.9	0.7	10	18	2.5	14.89	63.3	32.7	1.5	2.3	0.2	1.9
14	22	B	25-60+	HC	5.6	0.4	3	6	1.0	28.39	55.1	39.8	3.6	1.5	0.0	1.4
15	25	A	0-15	SCL	4.7	0.7	4	10	2.5	10.95	52.4	35.7	2.1	9.1	0.6	1.5

LABORATORY ANALYSIS TABLE

North Bellbird Precinct

March-06

Sample No	Pit No	Horizon	Depth (cm)	Texture	pH $CaCl_2$	Electrical Conductivity ECse dS/m	Total Nitrogen (ppm)	Phosphate (ppm)	Organic Carbon %	Cation Exchange Capacity CEC (meq)	Percentage of CEC					Calcium / Magnesium :1
											Ca	Mg	Na	K	Al	
16	25	A2	15-35	CS	5.3	0.9	3	4	0.8	6.04	65.9	21.4	3.1	9.1	0.5	3.1
17	25	B	35-60+	SC	5.9	0.7	4	3	0.6	17.27	58.4	33.5	4.5	3.6	0.0	1.7
18	30	A	0-10	SCL	4.6	0.9	4	12	2.3	5.19	60.9	14.6	1.3	18.1	5.0	4.2
19	30	A2	10-30	CS	5.3	0.8	4	3	0.4	3.87	62.3	22.2	2.1	11.9	1.6	2.8
20	30	B	30-70+	SC	5.7	0.6	3	3	0.7	15.83	58.4	33.9	2.9	4.7	0.0	1.7
21	32	A	0-10	SCL	5.1	1.3	10	21	2.2	8.16	78.2	15.6	3.2	2.1	1.0	5.0
22	32	A2	10-30	CS	5.7	0.9	3	7	0.7	6.15	74.3	20.3	3.4	2.0	0.0	3.7
23	32	B	30-70+	SC	6.0	0.7	3	2	0.8	20.72	64.6	29.4	4.3	1.7	0.0	2.2
24	38	A	0-35	SCL	4.6	1.6	3	4	4.1	9.16	17.1	51.3	11.2	11.8	8.5	0.3
25	38	B	35-70+	SC	5.1	4.8	3	3	0.8	13.03	6.6	62.2	25.9	3.4	1.9	0.1
26	45	A	0-25	CL	5.4	0.4	4	4	2.7	nt	nt	nt	nt	nt	nt	nt
27	45	B	25-70+	MC	5.9	0.4	5	1	1.4	29.82	90.9	6.8	1.1	1.1	0.0	13.3
28	47	A	0-20	SCL	4.6	0.7	8	8	2.6	nt	nt	nt	nt	nt	nt	nt
29	47	B	20-35	MC	5.3	0.4	5	2	0.7	18.55	52.8	40.4	4.7	1.8	0.2	1.3
30	47	B2	35-60+	SC	nt	nt	nt	nt	0.6	22.58	53.1	38.8	5.8	1.6	0.7	1.4

LABORATORY ANALYSIS TABLE

North Bellbird Precinct

March-06

Sample No	Pit No	Horizon	Depth (cm)	Texture	pH $CaCl_2$	Electrical Conductivity ECse dS/m	Total Nitrogen (ppm)	Phosphate (ppm)	Organic Carbon %	Cation Exchange Capacity CEC (meq)	Percentage of CEC					Calcium / Magnesium :1
											Ca	Mg	Na	K	Al	
31	49	A	0-20	SCL	4.9	1.6	40	8	1.4	nt	nt	nt	nt	nt	nt	nt
32	49	A2	20-50	SCL	5.9	1.3	7	4	0.5	8.07	79.1	16.6	2.6	1.7	0.0	4.8
33	49	B2	50-90+	SCL	6.7	1.7	nt	nt	nt	nt	nt	nt	nt	nt	nt	nt
34	53	A	0-25	SCL	5.0	0.4	12	10	1.9	nt	nt	nt	nt	nt	nt	nt
35	53	B	25-60+	HC	5.0	0.3	4	4	1.0	20.91	56.0	35.5	6.7	1.4	0.4	1.6
36	55	A	0-25	SCL	4.5	0.6	3	10	2.5	nt	nt	nt	nt	nt	nt	nt
37	55	B	25-50	SC	nt	nt	nt	nt	0.7	16.15	7.9	60.2	11.6	2.0	18.3	0.1
38	55	B2	50-70+	SC	nt	nt	nt	nt	0.6	17.60	5.0	57.3	15.3	1.6	20.9	0.1
39	59	A	0-20	SCL	4.6	0.6	11	5	2.2	nt	nt	nt	nt	nt	nt	nt
40	59	B	20-50	SC	nt	nt	nt	nt	1.0	15.46	13.0	71.3	8.3	3.2	4.1	0.2
41	61	A	0-20	SCL	4.8	1.6	20	11	3.2	nt	nt	nt	nt	nt	nt	nt
42	61	A2	20-40	SCL	4.9	0.5	5	3	0.8	nt	nt	nt	nt	nt	nt	nt
43	61	B	40-80+	SC	nt	nt	nt	nt	0.9	18.52	12.5	68.7	12.5	2.0	4.3	0.2
44	64	A	0-10	SCL	5.6	6.9	21	52	2.4	14.93	66.7	25.1	2.3	6.0	0.0	2.7
45	64	B	10-50	MC	4.3	0.8	3	7	0.8	14.76	16.4	55.8	7.4	6.1	14.3	0.3

LABORATORY ANALYSIS TABLE — North Bellbird Precinct — March-06

Sample No	Pit No	Horizon	Depth (cm)	Texture	pH $CaCl_2$	Electrical Conductivity ECse dS/m	Total Nitrogen (ppm)	Phosphate (ppm)	Organic Carbon %	Cation Exchange Capacity CEC (meq)	Percentage of CEC					Calcium / Magnesium :1
											Ca	Mg	Na	K	Al	
46	66	A	0-30	CL	6.2	0.8	26	14	1.9	27.68	88.2	9.5	0.7	1.7	0.0	9.3
47	66	B	30-80	LC	4.0	0.7	16	5	0.6	19.33	60.7	14.3	0.9	1.1	22.9	4.2
48	71	A	0-30	SCL	4.9	1.6	6	11	2.9	12.26	45.1	43.8	5.2	3.3	2.6	1.0
49	71	B	30-50	SC	4.4	0.9	7	5	0.6	14.38	8.1	70.9	8.7	3.8	8.6	0.1
50	77	A	0-40	SCL	4.4	0.4	5	6	1.9	nt	nt	nt	nt	nt	nt	nt
51	77	B	40-70	MC	nt	nt	nt	nt	0.7	13.41	22.8	58.7	3.6	3.6	11.3	0.4
52	79	A	0-25	SL	4.5	1.0	7	6	2.1	nt	nt	nt	nt	nt	nt	nt
53	79	B	25-40	SC	nt	nt	nt	nt	0.7	13.07	8.7	64.9	13.8	1.9	10.7	0.1

nt not tested

GLOSSARY OF TERMS AND ABBREVIATIONS USED

HORIZONS

A	Zone of mineralisation (topsoil)
B	Zone of accumulation (subsoil)
C	Zone of degrading parent material (DPM): a mix of soil and rock
D	Bedrock or parent material

TEXTURE

S	Sand	SCL	Sandy clay loam
LS	Loamy sand	CL	Clay loam
CS	Clayey sand	LC	Light clay
LSCL	Light sandy clay loam	SC	Sandy clay
SL	Sandy loam	MC	Medium clay
L	Loam	HC	Heavy clay

PEDALITY (OR STRUCTURE)

Grade

G	Single grain
W	Weak pedality
M	Moderate pedality
S	Strong pedality

Type

PR	Prismatic	-	dense / impermeable
PL	Platy	-	"
CO	Columnar	-	"
LE	Lenticular	-	"
AB	Angular blocky	-	friable / permeable
SB	Subangular blocky	-	"
GR	Granular	-	"

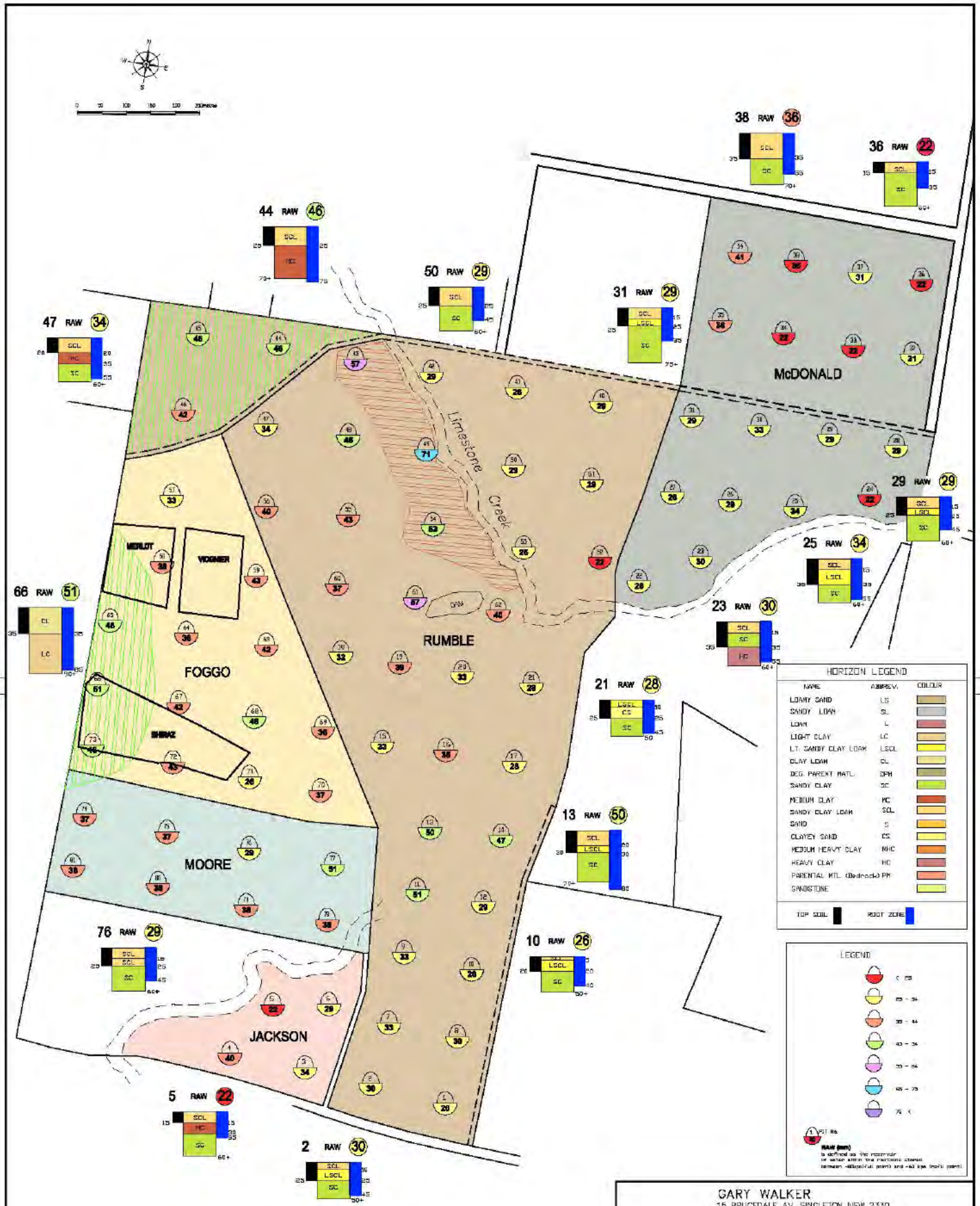
ROOTZONE DEPTH

Potential rootzone depth, based on the pedality (structure) of the subsoil and depth of topsoil. This is an estimated potential depth to which grapevine roots will grow at the various pit sites.

SOIL COLOUR

Munsell Colour Charts:

red hues	-	well drained
yellow hues	-	less well drained
greys	-	poorly drained

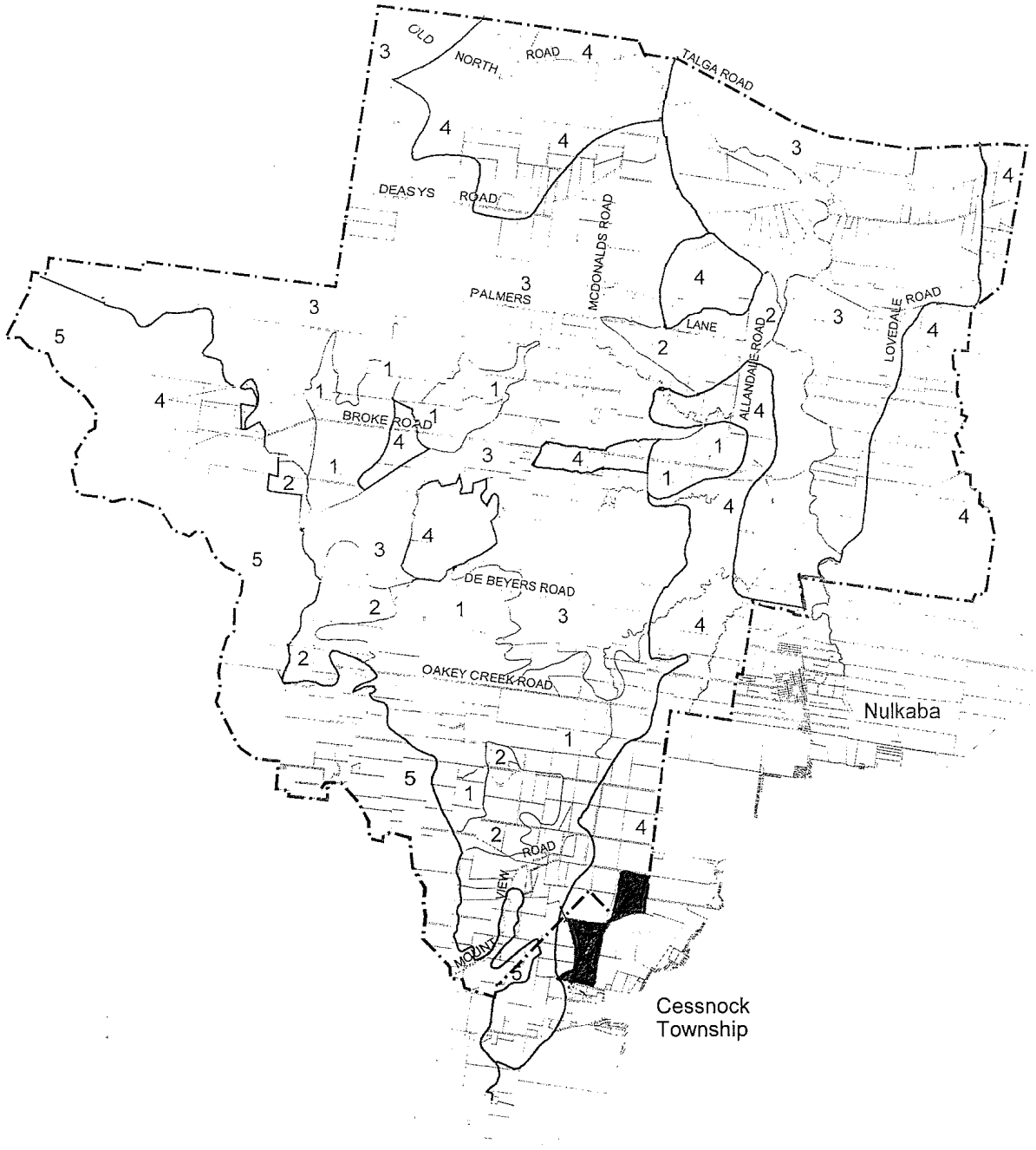


GARY WALKER
15 BRUCEDALE AV, SINGLETON NSW 2330
TEL.(02) 65 723 832 MOBILE: 0412 995 445

ALLYNBROOK PTY LTD

JOHNSON PROPERTY GROUP
RUMBLE, JACKSON, MOORE, McDONALD AND FOGGO PROPERTIES
SOIL SURVEY

SCALE	AS SHOWN			A3	DWG. No. 06-0302A P
		DRAWN	GBW		REV. 26/7/06
		CHECKED			
DATE	30/3/06	APPROVED			PLT. FILE



1 First class vineyards

2 First class - steeper slopes

3 Second class

4 Unsuitable soils

5 Steep slopes

Lots containing vines - at time of Dept. of Agriculture assessment (may not be total parcel)

Information Source:

Department of Agriculture 1993
Extends beyond Council's study area

0 .5 1 2 3km

Figure 5

Viticultural Soil Groups (Dept. of Agriculture)

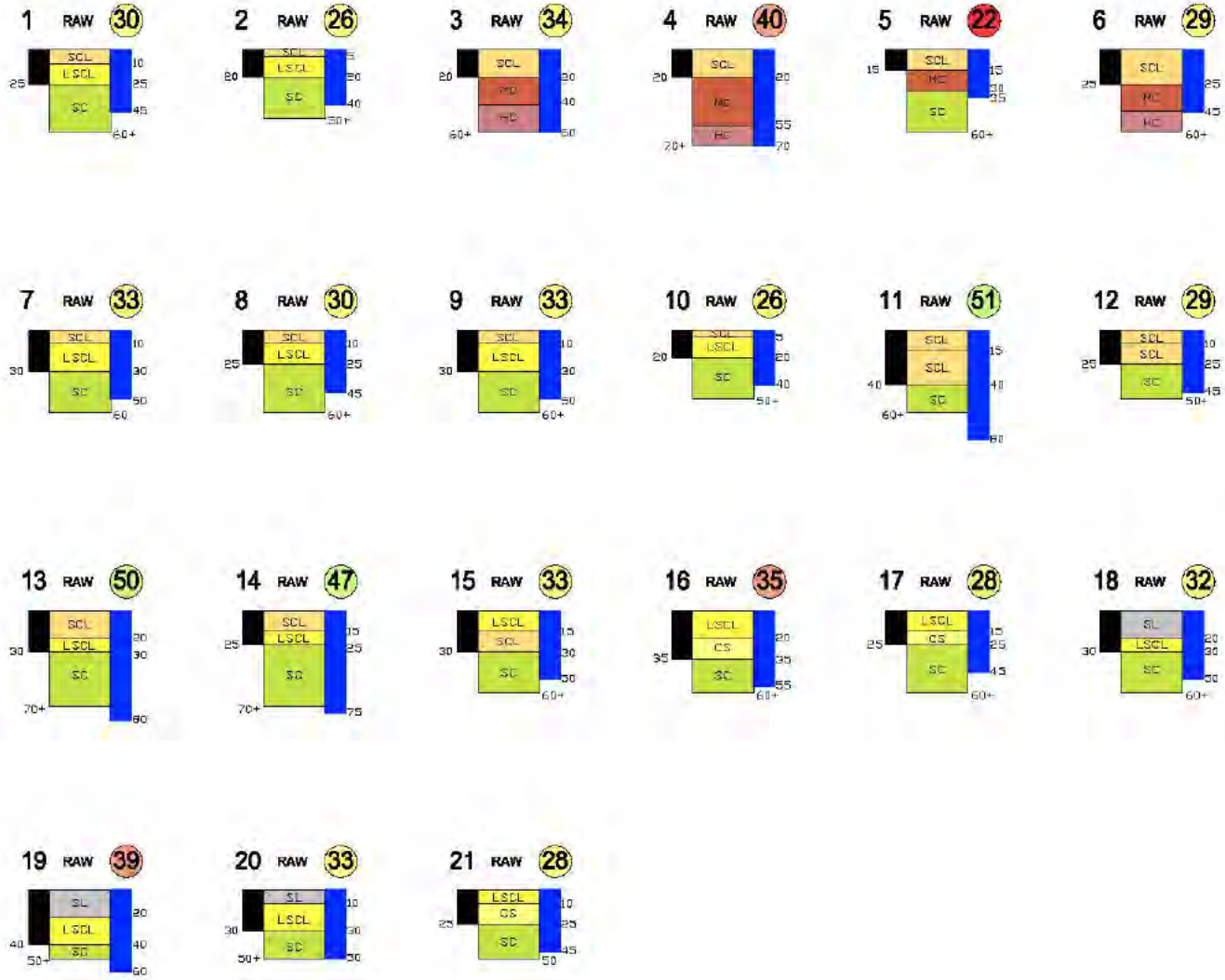
Vineyards District Planning Review

Cessnock City Council

Andrews.Neil
ARCHITECTS.PLANNERS.LANDSCAPE CONSULTANTS
207 ALBANY STREET NORTH
P.O.BOX 566 GOSFORD NSW 2250
TELEPHONE: 043 24 3633
FACSIMILE: 043 24 3771

Date: March 1997
Cad Ref fig5a1.dw2

Drawing No. D05
Project No: 96142



HORIZON LEGEND

NAME	ABBREV.	COLOUR
LOAMY SAND	LS	
SANDY LOAM	SL	
LOAM	L	
LIGHT CLAY	LC	
LT. SANDY CLAY LOAM	LSCL	
CLAY LOAM	CL	
DEG. PARENT MATL.	DPM	
SANDY CLAY	SC	
MEDIUM CLAY	MC	
SANDY CLAY LOAM	SCL	
SAND	S	
CLAYEY SAND	CS	
MEDIUM HEAVY CLAY	MHC	
HEAVY CLAY	HC	
PARENTAL MTL (Bedrock)	PM	
SANDSTONE		

TOP SOIL ROOT ZONE

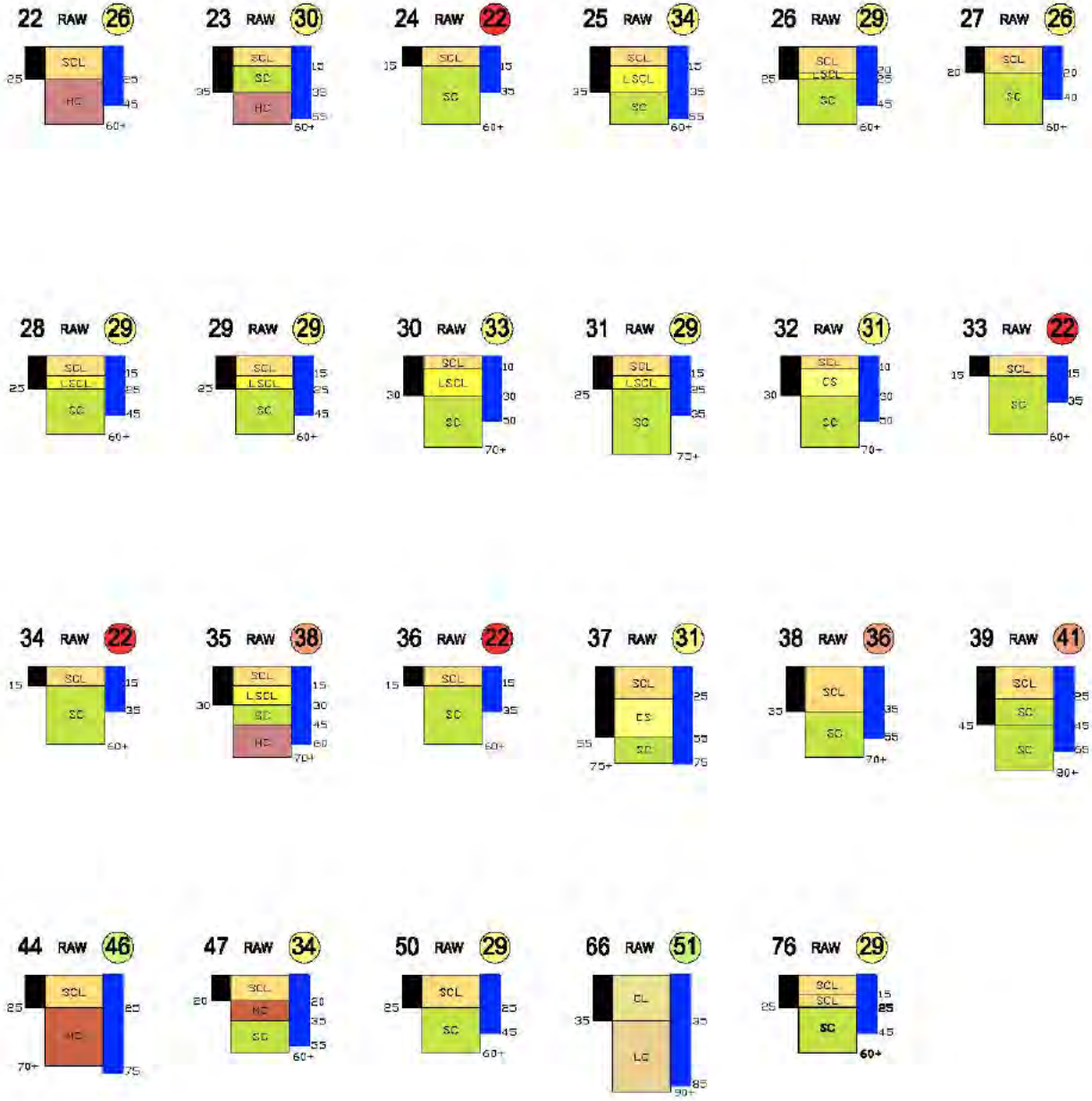


GARY WALKER
15 BRUCEDALE AV, SINGLETON NSW 2330
TEL.(02) 65 723 832 MOBILE: 0412 995 445 ABN 71 995 879 425

ALLYNBROOK PTY LTD

JOHNSON PROPERTY GROUP
NORTH BELLBIRD PRECINCT
SOIL PROFILE DIAGRAMS
SHEET 1 OF 2

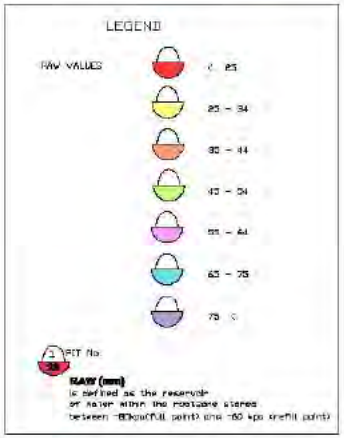
SCALE	NTS			A3	DWG. No. 06-0302 R1
		DRAWN	GBW		REV. 1
		CHECKED	SG		
DATE	3/4/06	APPROVED			PLT. FILE



HORIZON LEGEND

NAME	ABBREV.	COLOUR
LOAMY SAND	LS	
SANDY LOAM	SL	
LOAM	L	
LIGHT CLAY	LC	
LT. SANDY CLAY LOAM	LSCL	
CLAY LOAM	CL	
DEG. PARENT MATL.	DPM	
SANDY CLAY	SC	
MEDIUM CLAY	MC	
SANDY CLAY LOAM	SCL	
SAND	S	
CLAYEY SAND	CS	
MEDIUM HEAVY CLAY	MHC	
HEAVY CLAY	HC	
PARENTAL MTL (Bedrock)	PM	
SANDSTONE		

TOP SOIL ROOT ZONE



GARY WALKER
15 BRUCEDALE AV. SINGLETON NSW 2330
TEL.(02) 65 723 833 MOBILE: 0412 995 445 ABN 71 995 879 425

ALLYNBROOK PTY LTD

JOHNSON PROPERTY GROUP
BELLBIRD NORTH PRECINCT
SOIL PROFILE DIAGRAMS
SHEET 2 OF 2

SCALE	NTS			A3	DWG. No. 08-0302 R2
		DRAWN	GBW		REV. 1
		CHECKED	SG		
DATE	3/4/08	APPROVED			PLT. FILE

PHOTO 1



PHOTO 2



PHOTO 3



PHOTO 4



PHOTO 5



PHOTO 6



PHOTO 7



PHOTO 8



PHOTO 9



Photo 10



Photo 11



INSITE
PLANNING &
ENGINEERING



SERVICING REPORT

BELLBIRD DEVELOPMENT

Town Planning · Civil Engineering · Project Management · Urban Design

TABLE OF CONTENTS

EXECUTIVE SUMMARY **3**

1.0 INTRODUCTION **4**

1.1 PROPOSAL 4
1.2 SITE DETAILS 4

2.0 OBJECTIVES **8**

3.0 DEMAND **9**

4.0 RETICULATED WATER SUPPLY **10**

4.1 BACKGROUND 10
4.2 LOCATION OF EXISTING SERVICES 10
4.3 EXISTING CAPACITY 10
4.4 SERVICEABILITY 10
4.5 CONCLUSION 11

5.0 WASTEWATER SERVICES **12**

5.1 BACKGROUND 12
5.2 LOCATION OF EXISTING SERVICES 12
5.3 EXISTING CAPACITY 12
5.4 SERVICEABILITY 12
5.5 CONCLUSION 13

6.0 ELECTRICITY SUPPLY **14**

6.1 BACKGROUND 14
6.2 LOCATION OF EXISTING SERVICES 14
6.3 EXISTING CAPACITY 14
6.4 SERVICEABILITY 14
6.5 CONCLUSION 14

7.0 NATURAL GAS SUPPLY **15**

7.1 BACKGROUND 15
7.2 LOCATION OF EXISTING SERVICES 15
7.3 EXISTING CAPACITY 15
7.4 SERVICEABILITY 15
7.5 CONCLUSION 15

8.0 TELECOMMUNICATION SERVICES **16**

8.1 BACKGROUND 16
8.2 LOCATION OF EXISTING SERVICES 16
8.3 EXISTING CAPACITY 16
8.4 SERVICEABILITY 16
8.5 CONCLUSION 16

Appendix 1 – Hunter Water Corporation Responses
Appendix 2 – Energy Australia Response
Appendix 3 – Agility Response
Appendix 4 – Telstra Countrywide Response

EXECUTIVE SUMMARY

This report has been prepared on behalf of the Johnson Property Group and the land owners of the North Bellbird Investigation Area. It looks at the servicing of this area which was identified in Cessnock City Council's City Wide Settlement Strategy as suitable for investigation for rezoning to residential and subsequently identified in the draft Lower Hunter Regional Strategy. The report has been prepared to accompany a rezoning application to Cessnock City Council.

The North Bellbird Investigation Area has been assessed with respect to its capacity to sustain a mix of development and conservation including:-

- A mix of residential environments provided through sequential staging,
- A commercial and retail precinct including mixed use development capable of serving the needs of the North Bellbird community;
- Social and community infrastructure including schools, community and recreational facilities including open space;
- Infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails;
- Conservation of quality remnant vegetation; and;
- Rehabilitation of degraded riparian corridors to provide habitat linkages.

The North Bellbird Investigation Area is currently used for grazing and other agricultural / rural land uses however lies adjacent to existing residential areas in Bellbird and Cessnock South. It is estimated that from the total land area of 496 hectares that 322 hectares is suitable for development producing a lot yield of between 3,500 and 5,000 lots. This expected lot yield has been used in seeking public utility authority's advice as to the serviceability of the North Bellbird Investigation Area.

In this respect the following service providers have been contacted for advice;

1. Hunter Water Corporation (water and sewer),
2. Energy Australia (electricity),
3. Telstra Countrywide (telecommunications); and
4. Agility (gas).

From this advice it has been concluded that there is no matter associated with servicing that would preclude urban development within the North Bellbird Investigation Area, or which can not be addressed at the detailed design stage.

Due to the size of the North Bellbird Investigation Area major upgrades of the water, sewer and electricity infrastructure in the area will be required for the ultimate development of the site. However sufficient capacity exists in the existing infrastructure to cater for the initial stages of the development thereby allowing these initial stages to proceed while planning and construction of the major upgrades occur.

From a servicing aspect it is considered that the initial stages of the North Bellbird Investigation Area should be located adjacent to existing infrastructure in Bellbird and Cessnock South to reduce the cost of extending the existing infrastructure to service these lots.

Finally the report also looks at the provision of external road works, community facilities and drainage for the North Bellbird Investigation Area. Whilst it is expected that the developers will fund many of these required elements within the site the development will increase demand on some services external to the site. It is therefore likely that Council will require the preparation of suitable S94 plans or Developer Agreements for the site which will set appropriate contributions for the sequential staging of the development. These contributions can then be used by Council to upgrade external services which the development may impact upon e.g. Wollombi Road, libraries, swimming pools etc.

1.0 INTRODUCTION

1.1 PROPOSAL

Insite Planning and Engineering Services have been engaged by the Johnson Property Group and the land owners of the North Bellbird Investigation Area to prepare a Planning Report on the provision of services to a proposed residential development on land known as the North Bellbird Investigation Area in the Cessnock Local Government Area (LGA). The subject land is approximately bordered by Mount View Road to the north and west, Tennant Street to the south and Bellbird Creek / Wollombi Road to the east. The general locality of the site is depicted in Figure 1.1.

This report provides information on the essential services required to be provided to a proposed residential development on the site. It has been prepared as part of the planning process required to masterplan the site and prepare a rezoning application to be lodged in the near future with Cessnock City Council.

1.2 SITE DETAILS

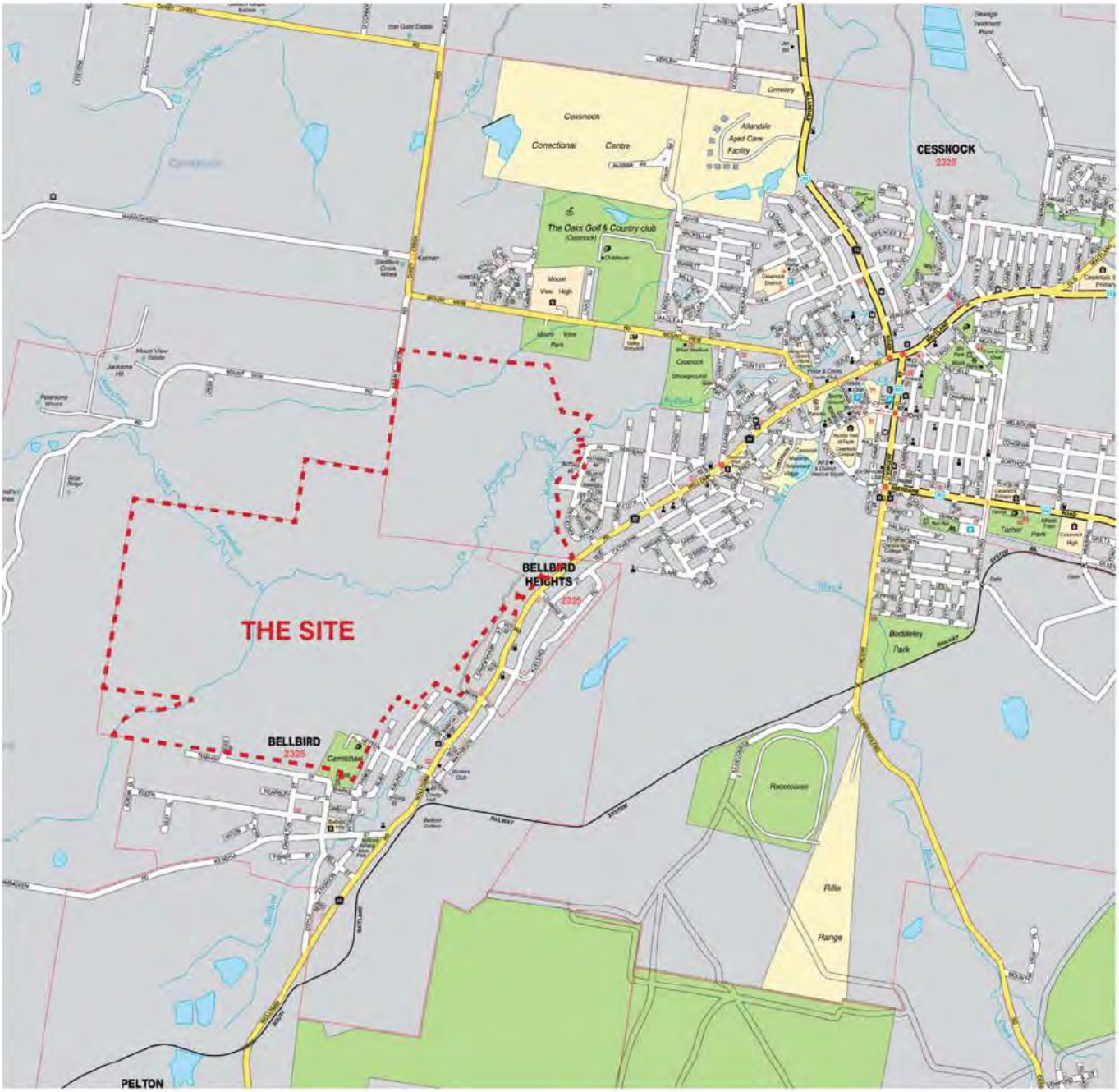
The North Bellbird Investigation Area is currently in several ownerships and zoned 1(a) Rural and 1(v) Rural (Vineyards). However it has been identified in Cessnock City Council's Citywide Settlement Strategy as suitable for rezoning to Investigation Zone (future urban).

Lot descriptions for the North Bellbird Investigation Area are shown in Table 1 and a map showing ownership areas is shown in Figure 2.

Lot / DP	Lot / DP	Lot / DP	Lot / DP	Lot / DP
141 / 986905	210 / 1012346	2 / 1011544	52 / 807540	11 / 806584
3 / 810827	211 / 1012346	1 / 327785	2 / 624793	10 / 806584
PT13 / 880374	212 / 1053307	2 / 597226	3 / 624793	3 / 597226
10 / 815485	1 / 349452	1 / 597226	1 / 329071	PT 1 / 66183
11 / 815485	1 / 327580	1 / 328498	261 / 524058	2 / 66183
1 / 167004	1 / 1011544	PT 51 / 807540	1 / 196997	1 / 196460



Figure 1.1 – Regional Location Plan

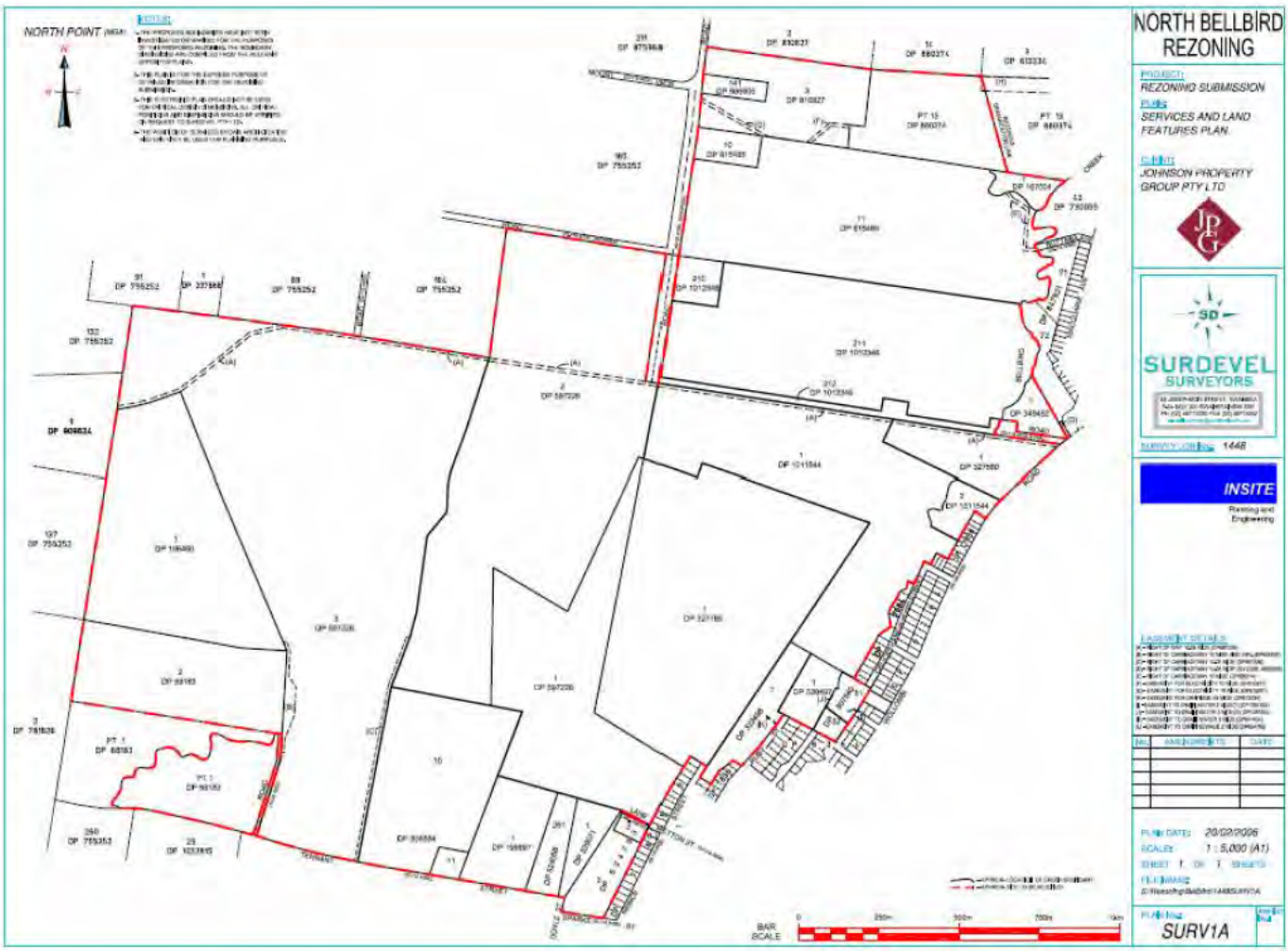


Location Plan

Figure 1.2 – Locality Plan



Figure 2 – Survey Plan



2.0 OBJECTIVES

The objectives of this planning report are to:-

Determine the location and capacity of the following existing services in the vicinity of the North Bellbird Investigation Area:

- Reticulated Water Supply,
- Wastewater System,
- Electricity Supply,
- Natural Gas Supply,
- Telecommunications systems (telephone, internet etc).
- Roads and Drainage Infrastructure.

- Determine and advise on the serviceability of the North Bellbird Investigation Area in respect of the provision of the following services:
  - Reticulated Water Supply,
  - Wastewater System,
  - Electricity Supply,
  - Natural Gas Supply,
  - Telecommunications systems (telephone, internet etc).
  - Roads and Drainage Infrastructure.

- Identify any significant issues in respect of the following services:
  - Reticulated Water Supply,
  - Wastewater System,
  - Electricity Supply,
  - Natural Gas Supply,
  - Telecommunications systems (telephone, internet etc).
  - Roads and Drainage Infrastructure.





3.0 DEMAND

As the proposal is currently being masterplanned detailed subdivision plans and lot yields are not available. In the absence of such detailed information an assumed lot yield has been used to determine service requirements for the proposal.

The assumed lot yield has been determined following a basic constraints and opportunities analysis of the site as well as advice from the Department of Planning in regard to their Lower Hunter Settlement Strategy which has targeted lot yields of around 13 – 15 lots per hectare.

It also took into account the preliminary vision of the North Bellbird Investigation Area which is best described as follows:

- A mix of residential environments provided through sequential staging,
- A commercial and retail precinct including mixed use development capable of serving the needs of the North Bellbird community;
- Social and community infrastructure including schools, community and recreational facilities including open space;
- Infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails;
- Conservation of quality remnant vegetation; and;
- Rehabilitation of degraded riparian corridors to provide habitat linkages.

As such all service providers have been requested to comment and advise on the serviceability of the North Bellbird Investigation Area, including specific issues and requirements, on the basis that the expected lot yield and thus demand for services will be in the vicinity of 3,500 to 5,000 equivalent tenements.

4.0 RETICULATED WATER SUPPLY

4.1 BACKGROUND

Hunter Water Corporation (HWC) is the service provider responsible for delivering reticulated water services in the Cessnock City Local Government Area. As such HWC is the appropriate authority to seek advice on the availability and feasibility of providing reticulated water to the North Bellbird Investigation Area.

HWC's Business and Urban Development Section has advised that reticulated water is available in the vicinity of the North Bellbird Investigation Area and could be extended to supply the ultimate development. However due to the size of the North Bellbird Investigation Area a servicing strategy will need to be prepared by the developer in conjunction with HWC to identify the options for supply of water and augmentation requirements for the Cessnock and Bellbird bulk water distribution network.

HWC are currently carrying out a regional servicing strategy for the Cessnock water supply system with a completion date expected in the near future. This strategy is to determine system augmentation options for both existing development and identified growth areas. Unfortunately despite the North Bellbird Investigation Area being clearly identified as a possible future growth area in Cessnock Council's City Wide Settlement Strategy, the site has not been included in HWC's regional water servicing strategy. Therefore, it is unlikely that any additional information will come out of this report that will aid master planning of this precinct, except perhaps the available capacity within the system for the early stages of the development. Thus a separate servicing strategy will need to be commissioned which takes into account land release staging, sequencing and timing for the development. The site is likely to be serviced by two water networks known as Cessnock and Pelton. This servicing strategy should commence once a structure plan is adopted and would need to be completed for the first stage of subdivision at the detail design stage.

Copies of correspondence to and received from HWC are attached to this report in Appendix 1.

4.2 LOCATION OF EXISTING SERVICES

Existing reticulated water services are located in the residential areas surrounding the development in Bellbird and Cessnock. A plan showing the location of existing reticulated water services is shown in Appendix 5.

4.3 EXISTING CAPACITY

HWC have advised that there may be limited opportunity to connect some initial stages of the development to existing infrastructure, where they are located adjacent to existing serviced areas and where spare capacity is available.

"There is no impediment to the supply of reticulated water to the North Bellbird Investigation Area."

4.4 SERVICEABILITY

With reticulated water being available adjacent to the site in both Bellbird and Cessnock there is no real impediment to the supply of water to the proposed development apart from available capacity. HWC have advised that there may be limited capacity to accommodate initial stages of the development where adjacent to existing infrastructure. Certainly from a cost perspective the closer the development is to existing infrastructure the lower the cost to extend the service to the development.

Therefore from a water service perspective the master planning of the North Bellbird Investigation Area should look to provide the initial stages of the development close to the existing residential areas in Bellbird eg Tennant Street, Hetton Street, and Abbotsford Street. See attached Figure 3. From this short term perspective there would appear to be limited competition for this existing spare capacity in the Bellbird area however a number of developments in the west Cessnock area may provide some competition for the available capacity in the Cessnock area.

For full development of the site a water servicing strategy would need to look at the options for increasing the capacity of the existing reticulated water network in Bellbird and Cessnock and the extension of the service to the whole of the North

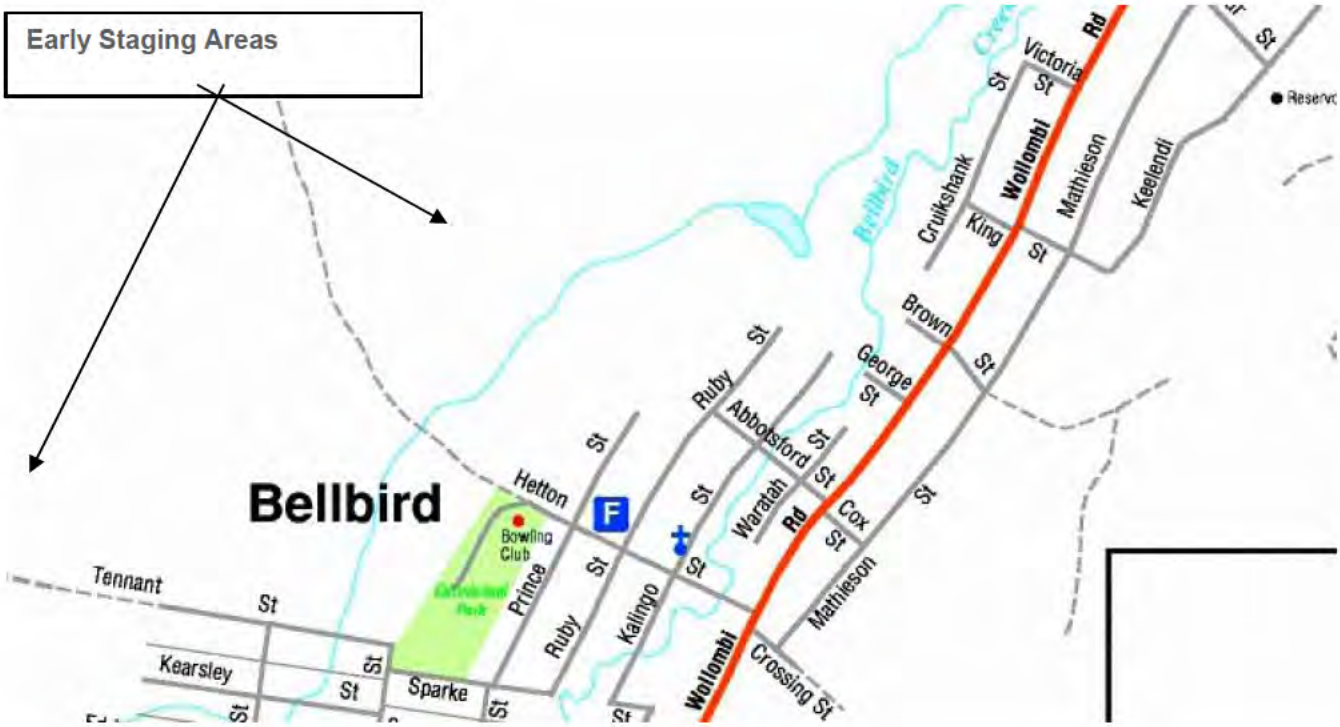
Bellbird Investigation Area. Staging plans, sequences and timing will be important considerations in this strategy as will the method of augmentation i.e. new trunk and carrier mains or parallel trunk and carrier mains.

4.5 CONCLUSION

On the information provided by HWC it is concluded that there is no impediment to the supply of reticulated water to the North Bellbird Investigation Area. A suitable servicing strategy will however need to be developed in conjunction with HWC during the planning process.

Some capacity is available in the existing network to allow early stages of the development to proceed; however, once capacity has been reached upgrading of the network will be required. HWC has advised that typically upgrading works take between 5 and 7 years to complete from the initial planning stages therefore the commissioning of a servicing strategy should commence as soon as the initial stages of the master planning process has been completed and a lot yield and structure plan has been adopted.

Figure 3



5.0 WASTEWATER SERVICES

5.1 BACKGROUND

Hunter Water Corporation (HWC) is the service provider responsible for providing wastewater services in the Cessnock City Local Government Area. As such HWC is the appropriate authority to seek advice on the availability and feasibility of providing wastewater services to the North Bellbird Investigation Area.

HWC's Business and Urban Development Section has advised that wastewater services are available in the vicinity of the development and could be extended to supply the North Bellbird Investigation Area. However due to the size of the ultimate development a servicing strategy will need to be prepared by the developer in conjunction with HWC to identify the options for supply of wastewater services to the development and the augmentation requirements for the Cessnock wastewater network.

The Cessnock Wastewater Treatment Works is currently being upgraded to meet existing and projected loadings determined in a recently completed regional servicing strategy. This work to be completed in 2007 will provide an additional treatment capacity for about 2,800 ET. This has not been allocated to any developments in the area and is available on a first come basis. It is unlikely that any development in the Cessnock area would seek to tie up this amount of capacity at any one time therefore it is concluded there should be sufficient capacity in the system for the early stages of this development.

Ultimately however further upgrades of the Cessnock Wastewater Treatment Works and associated wastewater network will be required to cater for the full development of the North Bellbird Investigation Area. The required servicing strategy will therefore need to identify the required upgrades taking into account land release staging, sequencing and timing for the development. This servicing strategy could and should commence once a structure plan is adopted and would need to be completed for the first stage of subdivision at the detail design stage.

Copies of correspondence to and received from HWC are attached to this report in Appendix 1.

5.2 LOCATION OF EXISTING SERVICES

Existing wastewater infrastructure is located in the residential areas surrounding the development in Bellbird and Cessnock. A plan showing the location of existing wastewater services is shown in Appendix 5.

5.3 EXISTING CAPACITY

HWC have advised that there may be limited opportunity to connect some initial stages of the development to existing infrastructure, where they are located adjacent to existing serviced areas and where spare capacity is available. The Cessnock Wastewater Treatment Works is currently undergoing an upgrade which will provide an additional capacity of 2,800 ET by 2007. It is unlikely that any land releases in the North Bellbird Investigation Area will occur before this time.

"There is no impediment to the provision of wastewater to the North Bellbird Investigation Area."

5.4 SERVICEABILITY

With wastewater infrastructure being available adjacent to the site in both Bellbird and Cessnock there is no impediment to the provision of wastewater services to the North Bellbird Investigation Area apart from available capacity. HWC have advised that there may be limited capacity to accommodate initial stages of the development where adjacent to existing infrastructure. Certainly from a cost perspective the closer the development is to existing infrastructure the lower the cost to extend the service to the development.

Therefore from a wastewater perspective the master planning of the site should look to provide the initial stages of the development close to the existing residential areas in Bellbird eg Tennant Street, Hetton Street, and Abbotsford Street. See Figure 3 above. There would appear to be limited competition for the existing spare capacity in the Bellbird area however a number of developments in the west Cessnock area may provide some competition for the available capacity in the Cessnock area.

For the full development of the site the wastewater servicing strategy would need to look at the options for increasing the capacity of the existing wastewater network in Bellbird and Cessnock and the extension of the service to the whole of the development. Staging plans, sequences and timing will be important considerations in this strategy as will the method of augmentation.

5.5 CONCLUSION

Based on the information provided from HWC it is concluded that there is no impediment to the provision of wastewater to the North Bellbird Investigation Area provided a suitable servicing strategy is developed in conjunction with HWC during the planning process for the development and the developer is prepared to contribute to the required upgrading of the existing wastewater network.

Some capacity will be available in the existing network by 2007 to allow early stages of the development to proceed, however once capacity has been reached upgrading of the network will be required. HWC has advised that typically upgrading works take between 5 and 7 years to complete from the initial planning stages therefore the commissioning of a servicing strategy should commence as soon as the initial stages of the master planning process has been completed and a lot yield and structure plan has been adopted.



6.0 ELECTRICITY SUPPLY

6.1 BACKGROUND

Energy Australia is the service provider responsible for providing electricity services in the Cessnock City Local Government Area. As such Energy Australia is the appropriate authority to seek advice on the availability and feasibility of providing electrical services to the North Bellbird Investigation Area.

Energy Australia's Network – Planning and Negotiations Lower Hunter division has advised that electricity services are available in the vicinity of the development and could be extended to supply the development in accordance with Energy Australia's current ES8 – Capital Contributions Guidelines – July 2002. Copies of correspondence to and received from Energy Australia are attached to this report in Appendix 2.

6.2 LOCATION OF EXISTING SERVICES

Existing electricity infrastructure is located in the residential areas surrounding the development in Bellbird and Cessnock. A plan showing the location of existing electricity services is shown in Appendix 5.

6.3 EXISTING CAPACITY

Energy Australia has advised that the backbone of the existing network supplying the site has sufficient capacity to cater for the North Bellbird Investigation Area. These feeders have recently been rebuilt and have capacity for future growth. Some sections of the 11,000 volt supply coming from the network backbone will need to be augmented as part of the connection costs or the 11,000 volt network may be required to be extended to allow for the connection of the development. This will depend on staging and can be discussed further with Energy Australia once a structure plan and / or staging plan has been adopted.

6.4 SERVICEABILITY

With existing electricity infrastructure being adjacent to the development site and advice from Energy Australia that the network has the capacity to service the development it is concluded that there are no impediments to the supply of electricity to the North Bellbird Investigation Area. Some augmentation of the 11,000 volt supply to the site will be required at some stage depending on the staging of the development.

In this respect then it seems that early stages of the development should be located adjacent to existing residential areas in Bellbird (see Figure 3) with further discussions with Energy Australia recommended once a structure plan and/or staging plan for the development has been adopted.

6.5 CONCLUSION

Based on the information provided by Energy Australia it is concluded that there is no impediment to the supply of electricity to the North Bellbird Investigation Area as the existing infrastructure has the capacity to cater for the future growth in the area.

The developer will be responsible for the cost of providing the infrastructure to the development. Some augmentation of the 11,000 volt supply lines adjacent to the development may be required depending on the staging of the development.



When considering the staging of the development it may be prudent to continue discussions with Energy Australia to determine the more economical connection points to the existing systems. Again this is likely to mean that the early stages of the development may need to be located adjacent to existing residential development in Bellbird.

7.0 NATURAL GAS SUPPLY

7.1 BACKGROUND

Agility (AGL) is the service provider responsible for delivering natural gas services in Cessnock City Local Government Area. As such Agility is the appropriate authority to seek advice on the availability and feasibility of providing natural gas to the North Bellbird Investigation Area. Whilst natural gas is not considered an essential service it is becoming a popular fuel source particularly for heating and cooking and is important when trying to meet the criteria set by BASIX. As such the supply of natural gas to the development would be considered an attraction for potential buyers and would result in a higher value being placed on the development.

Agility's Network Account Manager for the area has advised that natural gas is available in the vicinity of the development and could be extended to supply the development provided it was economically viable. Copies of correspondence to and received from Agility are attached to this report in Appendix 3.

"Based on the proximity of the site to existing natural gas services… …the North Bellbird Investigation Area can be serviced with natural gas."

7.2 LOCATION OF EXISTING SERVICES

Agility has advised that the natural gas mains for the area generally run along the eastern boundary of the development site and various connection points are available depending on final road layouts. A plan showing the location of existing natural gas mains is shown in Appendix 5. These plans show gas mains in the vicinity of Prince Street and Wollombi Road, Bellbird, Macquarie Street, Cessnock and to the north of the site.

7.3 EXISTING CAPACITY

Agility have been unwilling to provide advice on existing capacity and the requirement for upgrades as a result of the development until final load profiles are supplied and a commencement date confirmed. Whilst this is not really helpful at this strategic stage, as natural gas is not considered an essential service to provide it is not considered essential information required to continue the master planning of the development. An economic decision can be made as to whether to supply natural gas to the development at the construction stage of the development.

7.4 SERVICEABILITY

With natural gas in the vicinity of the development and on the advice of Agility it is concluded that natural gas can be supplied to the North Bellbird Investigation Area if it is deemed economically viable by Agility or the developer funds the infrastructure.

In this regard it is considered the important issues to be assessed in determining the economic viability would include potential demand for the service, cost of providing new mains and the cost of upgrading the existing infrastructure in this area.

In regard to potential demand it is expected that a 5,000 lot subdivision would generate sufficient demand for the expansion of the natural gas network into the development economically viable for Agility even if some upgrading of the existing network is required.

7.5 CONCLUSION

Based on the proximity of the site to existing natural gas services and the likely demand for such services generated by a 5,000 lot subdivision it is reasonable to conclude that the North Bellbird Investigation Area can be serviced with natural gas.



8.0 TELECOMMUNICATION SERVICES

8.1 BACKGROUND

Telstra Country Wide is the service provider responsible for providing telecommunication services in the Cessnock City Local Government Area. As such Telstra Country Wide is the appropriate authority to seek advice on the availability and feasibility of providing telecommunication services to the North Bellbird Investigation Area.

Telstra's Strategic Planning division has advised that telecommunication services are available in the vicinity of the development and could be extended to supply the development. Copies of correspondence to and received from Telstra Country Wide are attached to this report in Appendix 4.

8.2 LOCATION OF EXISTING SERVICES

Existing telecommunications services are located in the residential areas surrounding the development in Bellbird and Cessnock. A plan showing the location of existing telecommunication services is shown in Appendix 5.

8.3 EXISTING CAPACITY

As Telstra are bound by law to provide telecommunications services to new development the issue of existing capacity is irrelevant. Telstra will therefore be required to upgrade any of its infrastructure to meet the demand created by the North Bellbird Investigation Area at its own cost. Thus it can be assumed that there is sufficient capacity in the existing infrastructure to accommodate the development.

8.4 SERVICEABILITY

Due to the close proximity of the site to the existing telecommunications services located in Bellbird and Cessnock, the North Bellbird Investigation Area will be easily serviced with telecommunications services.

8.5 CONCLUSION

Telstra being bound by law to provide telecommunication services to new developments can provide a telecommunications service to the North Bellbird Investigation Area.

North Bellbird Investigation Area

Traffic and Accessibility Assessment

June 2006

Johnson Property Group

PARSONS BRINCKERHOFF

Parsons Brinckerhoff Australia Pty Limited ACN 078 004 798 and
Parsons Brinckerhoff International (Australia) Pty Limited ACN 006 475 056
trading as Parsons Brinckerhoff ABN 84 797 323 433

Suite 1 3rd Floor
55 Bolton Street
Newcastle NSW 2300
PO Box 1162
Newcastle NSW 2300
Australia
Telephone +61 2 4929 3900
Facsimile +61 2 4929 7299
Email newcastle@pb com au

ABN 84 797 323 433
NCSI Cert fied Qual ty System ISO 9001

2122527a
pr_0919 Traff&Access.doc

©Parsons Brinckerhoff Australia Pty Limited and Parsons Brinckerhoff International (Australia) Pty Limited trading as Parsons Brinckerhoff ("PB"). **[2006]**

Copyright in the drawings, information and data recorded in this document ("the information") is the property of PB. This document and the information are solely for the use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that for which it was supplied by PB. PB makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information.

Author: Kari Armitage

Reviewer: Ian Hill

Approved by: Bruce Gunn

Signed:

Date: June 2006

Distribution:

Executive Summary

This Traffic and Accessibility Assessment Report has been prepared for Johnson Property Group. The investigation area of the proposed development is 496 hectares, situated on a greenfields site approximately 6.6 km south west of Cessnock. There is expected to be approximately 322 hectares suitable for development with a lot yield of between 3,500 and 5,000 lots.

The North Bellbird Investigation Area has been assessed with respect to its capacity to sustain a mix of development and conservation including:

- a mix of residential environments provided through sequential staging;
- a commercial and retail precinct including mixed use development capable of serving the needs of the North Bellbird community;
- social and community infrastructure including a primary school, a high school, a multipurpose community centre, local parks and playing fields;
- infrastructure capable of servicing the needs of the community, including road access, interconnecting cycle and walkways, all reticulated services, fire trails, and public transport;
- environmental improvements including the retention and rehabilitation of high quality remnant vegetation and the rehabilitation of riparian corridors.

The main external road network includes Wollombi Road (MR181) which connects to Cessnock, Kurri Kurri and Maitland to the east, Pokolbin to the north east and the township of Wollombi to the west. The most convenient route to Sydney is south via Vincent Street at Cessnock and via Aberdare Road (MR220), which joins Leggett's Road and the Sydney to Newcastle F3 Freeway. The most convenient route to Newcastle is along Wollombi Road, via Maitland Road (MR588) to Kurri Kurri, John Renshaw Drive and the New England Highway.

The growth in traffic flow expected from the development was examined over a 15 to 20 year timeframe. With the use of RTA traffic guidelines an increase of 1,800 two-way daily vehicle trips is expected per year. The increase is likely to distributed over 4 separate intersections along Wollombi Road with at least one of the intersections requiring signalisation as the level of service decreases. This will occur when the average delay per vehicle exceeds 57 seconds (LOS E). Wollombi Road will need to upgraded from its current 2 lanes to 4 at approximately 3 years into the development.

Several different access points leading into the precinct were examined to determine their suitability. These were checked to determine site distance requirements and found to comply with Austroads standards.

This traffic and accessibility assessment found there are no reasons to preclude urban development within the North Bellbird Investigation Area. Further investigations including a traffic impact assessment will be completed at the design stage.

Contents

Page Number

Executive Summary i

1. Introduction and Background 1
- 1.1 Objectives 1
- 1.2 Site Description 1
- 1.3 Proposed Development 2

2. Population and Growth 4

3. Existing External Road Network 5
- 3.1 Existing Cessnock City Council Data 5

4. Development Traffic Generated 7
- 4.1 Destinations 7

5. Proposed Access 9
- 5.1 Existing Roads off Wollombi Road 9
  - 5.1.1 Wollombi Road 9
  - 5.1.2 Victoria, Abbotsford and Hetton Streets 10
- 5.2 Prince Street 16
- 5.3 Tennant Street 17
- 5.4 Buttaba Avenue 18
- 5.5 Mount View Road. 21

6. Road Hierarchy 26

7. Public Transport, Pedestrians and Cyclists 27

8. Pavement Markings and Signage 29

9. Conclusion and Recommendations 30

List of Photographs

Photograph 1: Looking north east along Wollombi Road 10
Photograph 2: Looking south west along Wollombi Road 10
Photograph 3: Looking east at intersection of Wollombi Rd and Victoria St 11
Photograph 4: Looking north west towards the site off the end of Victoria St 11
Photograph 5: A typical section of Abbotsford St 12
Photograph 6: The existing bridge on Abbotsford St 12
Photograph 7: Looking south east at the intersection of Abbotsford St & Wollombi Rd 13
Photograph 8: Looking north from the end of Abbotsford St 13
Photograph 9: Looking west from the end of Hetton St 14
Photograph 10: A typical section of Hetton St 14
Photograph 11: Looking south at the existing bridge on Hetton St 15
Photograph 12: The intersection of Wollombi Rd and Hetton St 15
Photograph 13: Looking north east from the end of Prince St 16
Photograph 14: A typical section of Prince St 16
Photograph 15: Looking west along Tennant St 17
Photograph 16: Looking east along Tennant St from the cul-de-sac end 18
Photograph 17: Looking west along Tennant St 18
Photograph 18: Looking west from the end of Buttaba Av 19
Photograph 19: Existing small bridge on Buttaba Av 19
Photograph 20: A typical section of Macquarie Av 20
Photograph 21: A typical section of Wangi Av 20
Photograph 22: Looking north at the intersection of Wollombi Rd and Wangi Av 21
Photograph 23: Looking south from Mount View Rd 21
Photograph 24: Looking south, towards the site from the existing gravel road 22
Photograph 25: Looking back toward Mount View Rd from the gravel access road 22
Photograph 26: Looking north at the intersection of Mount View & Oakley Creek Roads 23
Photograph 27: Looking east at the intersection of Mount View & Oakley Creek Roads 23
Photograph 28: Looking north west at the intersection of Mount View & Oakley Creek Roads 24
Photograph 29: Looking south at the intersection of Mount View & Wollombi Roads 24

List of Tables

Table 1: Road Hierarchy 26
Table 2: Site Distance Assessment 30

Figures

Map 1: Cessnock AADT's 6
Map 2: Wider Road Network 8

Figure 1: Locality Plan with Proposed Access Points

Figure 2: Overall Site Plan
Figure 3: Regional Road Network
Figure 4: Locality Plan with Recommended Access Points

1. Introduction and Background

Parsons Brinckerhoff (PB) was engaged by Johnson Property to undertake a traffic and accessibility assessment for a large site known as the North Bellbird Investigation Area. It is understood that this report will accompany the rezoning submission to Cessnock City Council (CCC).

1.1 Objectives

A traffic analysis consists of two phases as follows:

Phase 1: Traffic and Accessibility Assessment (this report)

- assessment of existing local traffic and investigations of access requirements;
- investigate options for access to the existing road network;
- assessment of sight distances, access requirements and available space;
- assessment of local traffic and determination existing loadings in the area; and
- collation of any existing RTA or Council data on traffic in the area.

Phase 2: Traffic Impact Assessment (completed following rezoning)

- note key intersection layouts, road network configuration, and identify the key elements of the proposed development that could lower impact on the surrounding road network;
- undertake traffic counts at key intersections;
- compute traffic generation based on RTA/Council guidelines;
- develop intersections model by SIDRA /INTANAL to determine the existing and future operational performance;
- assess critical period traffic generation and distribution along with impact on key intersections; and
- summarise traffic and transport impacts and mitigation.

It is envisaged that the modelling and any associated traffic counts will be done at a later stage once the master plan and development concept has been approved.

1.2 Site Description

The site has an area of 496Ha and is located at North Bellbird, approximately 6.6 km south west of Cessnock. A locality plan of the site is provided in *Figure 1*. All figures are shown at the end of the report.

The site is bounded by Tennant Street to the south, Bellbird Creek to the east, Mount View Road to the north and rural land to the west.

The site comprises the following parcels of land, which are currently zoned Rural 1(a) and Rural 1(v) (i.e. vineyards):

- Part Lot 1 DP 66183
- Lot 3 DP 597226
- Lot 10 DP 806584
- Lot 1 DP 196997
- Lot 261 DP 524058
- Lot 1 DP 597226
- Lot 1 DP 327785
- Lot 2 DP 597226
- Lot 1 DP 328498
- Lot 1 DP 327580
- Part Lot 51 DP 807540
- Lot 2 DP 66183
- Lot 2 DP 624793
- Lot 211 DP 1012346
- Lot 212 DP 1053307
- Lot 1 DP 328497
- Lot 52 DP 807540
- Lot 1 DP 349452
- Lot 210 DP 1012346
- Lot 11 DP 815485
- Lot 10 DP 815485
- Lot 3 DP 810827
- Part Lot 13 DP 880374
- Lot 1 DP 167004
- Lot 141 DP 986905
- Lot 11 DP 806584
- Lot 1 DP 196460
- Lot 1 DP 329071
- Lot 3 DP 624793
- Lot 2 DP 1011544
- Lot 1 DP 1011544

The majority of the site consists of cleared rural land with scattered rural dwellings. A number of farm dams are also located on the site.

Levels across the site vary from approximately 130m AHD in the south west corner of the site to approximately 80m AHD in the north east corner of the site. Slopes range from approximately 1.5% to 10%.

1.3 Proposed Development

The site was identified in the Cessnock City Wide Settlement Strategy – Stage 1 (CCC, 2003) for rezoning to mixed residential densities, rationalisation of open space and environmental features. There is approximately 322Ha suitable for development, with an expected lot yield of between 3500 and 5000 lots. *Figure 2* shows the extent of the potential development area.

The North Bellbird Investigation Area has been assessed with respect to its capacity to sustain a mix of development and conservation including:

- a mix of residential environments provided through sequential staging;

- a commercial and retail precinct including mixed use development capable of serving the needs of the North Bellbird community;
- social and community infrastructure including a primary school, a high school, a multipurpose community centre, local parks and playing fields;
- infrastructure capable of servicing the needs of the community, including road access, interconnecting cycle and walkways, all reticulated services, fire trails, and public transport;
- environmental improvements including the retention and rehabilitation of high quality remnant vegetation and the rehabilitation of riparian corridors.

2. Population and Growth

The project is expected to be developed over the next 15 to 20 years and have a population of between 9,100 and 13,000 residents housed in 3,500 to 5,000 dwellings.

No staging plan is currently available to determine the growth pattern for the development. It is assumed that a uniform population and traffic growth will result from the staged development of the site. Hence, annual growth rates in the order of 200 dwellings per annum and 520 residents per annum may be expected.

Traffic planning will accommodate the above vehicular from the site, but the real effect of this growth on the road network cannot be fully determined until the growth due the development of the site can be superimposed onto the expected growth in the surrounding road network.

3. Existing External Road Network

The main external road network includes Wollombi Road (MR181) which connects to Cessnock, Kurri Kurri and Maitland to the east, Pokolbin to the north east and the township of Wollombi to the west. The most convenient route to Sydney is south via Vincent Street at Cessnock and via Aberdare Road (MR220), which joins Leggett's Road and the Sydney to Newcastle F3 Freeway. The most convenient route to Newcastle is along Wollombi Road, via Maitland Road (MR588) to Kurri Kurri, John Renshaw Drive and New England Highway. *Figure 3* at the back of the report indicates the main roads near the proposed development.

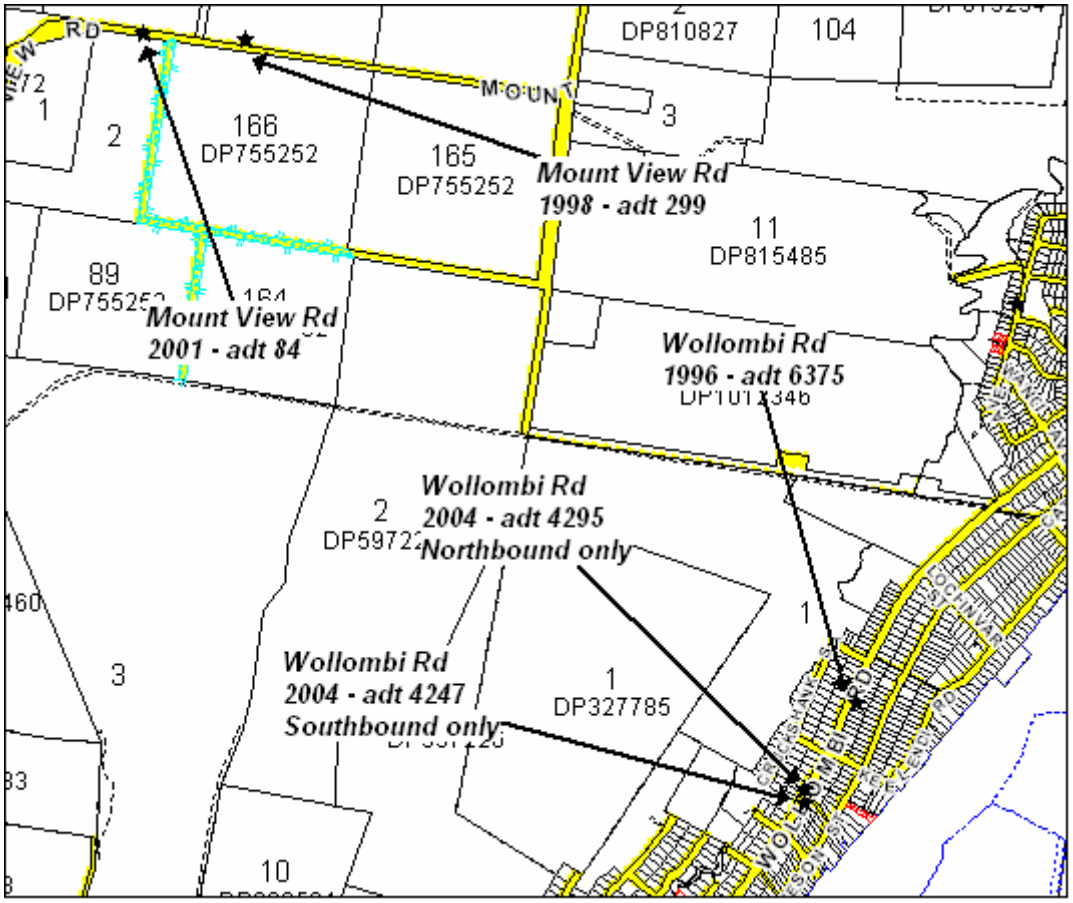
Maitland Road (MR588), Allandale Road (MR220) and Vincent Street (MR220) are all classified as State Roads and are therefore under RTA control. Wollombi Road is classified as a regional road by the RTA, who provides funding to CCC for upgrades as part of the Regional Road Repair Program.

Mount View Road could potentially provide access to the northern part of the site. Mount View Road currently links Wollombi Road to Oakey Creek Road providing access to Pokolbin/Nulkaba to the north and access to the northern part of the site if you follow Mount View Road towards the south. The standard of Mount View Road for this portion is generally high.

The intersection of Mount View Road with Wollombi Road has been the subject of previous intersection analysis. The results obtained showed that although the intersection overall is operating at an acceptable Level of Service (LOS), traffic turning right out of Mount View Road was delayed on average for 34 seconds, which suggests the approach is almost at capacity (SKM, Limestone Creek Development Traffic Impact, 2004). This intersection requires an upgrade by the relevant road authority as it is an existing capacity issue.

3.1 Existing Cessnock City Council Data

Traffic count data has been sourced from Cessnock City Council for the area. A map showing the Annual Average Daily Traffic (AADT) is presented in *Map 1*.



Map 1: Cessnock AADT's

It can be seen from the above diagram that the AADT on Wollombi Road for 2004 is approximately 4,300 vehicles in each direction. This would generate a peak hour of close to 387 vehicles per hour in each direction, along that stretch of Wollombi Road south of O'Neil Street.

4. Development Traffic Generated

The RTA Guide to Traffic Generating Developments assumes a traffic generation rate of 9 daily vehicle trips per dwelling, with 0.85 vehicle trips per dwelling during the weekday peak hour. As 200 new dwellings are expected per year, this equates to an increase of 1,800 two–way daily vehicle trips per year or 170 during the peak hour.

If the proposed development consists ultimately of 5,000 dwellings, the number of trips likely to be generated by the proposed residential development is therefore expected to be about 45,000 two-way daily vehicle trips. Assuming 10% of this traffic uses the northern access to Mount View Road via Oakley Creek Road, 40,500 trips would be generated on to Wollombi Road per day. This translates to 3,825 vehicle trips in the weekday peak hour.

If the 40,500 trips were to be spread over the 4 intersections of Wollombi Road with Hetton, Abbotsford, Kendall and Doyle Streets, 10,125 trips would be assigned through each intersection per day. In accordance with the RTA trip generation guidelines, this would result in approximately 9% of 10,125 (911) trips through each intersection in the am and pm peak hours.

The existing AADT on Wollombi Road may be over 7 times greater on full development. Further traffic modelling needs to be undertaken to determine the LOS of the intersections with the future development traffic. Even with the distribution of traffic over 4 separate intersections, it is likely that at least one of the intersections will require signalisation. This will occur when the average delay per vehicle exceeds 57 seconds (LOS E).

The number of lanes on Wollombi Road will need to be increased when the one-way traffic exceeds around 900 vehicles per hour or 10,000 vehicles per day (RTA Guide to Traffic Generating Developments, 1993). Superimposing the expected traffic growth onto the current AADT, Wollombi Rd north of Kendall St will need to be upgraded to 4 lanes at approximately 3 years into the development.

4.1 Destinations

The likely destinations for traffic from the proposed development are as follows:

- Cessnock via Wollombi Road, approx. 6.6km; or
- Maitland via Cessnock, Kurri Kurri, Cliftleigh and Gilleston Heights on Wollombi Road and Cessnock Road, approx. 33.4km; or
- Newcastle via Cessnock Road, John Renshaw Drive and New England Highway, approx. 56.1km; or
- Sydney via Aberdare Road, Leggatts Road, F3 approx. 161km; or
- Wollombi via Wollombi Road to the west.

A wider road network showing the site in relation to destinations is presented in *Map 2*.



Map 2: Wider Road Network

5. Proposed Access

5.1 Existing Roads off Wollombi Road

The obvious access points to the eastern part of the site are via extension of the existing local streets of Victoria, Abbotsford, Prince, Hetton and Ruby Streets and by creating "T" intersections along Wollombi Road between Wangi Avenue and Victoria Street. The southern part of the site can be accessed by creating 'T' intersections along Tennant Street between Doyle Street and the site boundary. Practical access points are also available at the extension of Buttaba Avenue to the north east of the site and via an existing power easement off Mount View Road to the north of the site.

Each of these access points has been assessed for space requirements and intersection sight distance. In the absence of detailed survey it is difficult to obtain accurate sight distance measurements, however measurements have been taken in the field and the sight distance assessed against Austroads Part 5 *"Intersections at Grade"* Table 5.3 criteria. The proposed access points are shown in *Figure 1*.

It should be noted that a utility services investigation has been undertaken in assessing the potential access routes. Only obvious existing services such as overhead power lines and other pits have been commented upon in this report. A more thorough utility services investigation should be carried out at concept and detailed design stages.

5.1.1 Wollombi Road

Wollombi Road between Wangi Avenue and Victoria Street is the stretch that provides the access points to the site. *Photograph 1* and *Photograph 2* shows the stretch of Wollombi Road where access can be achieved. This section is of a rural standard with a gravel shoulder and power is located overhead adjacent to the site boundary.

There is ample room for 'T' or 4 way intersections to be provided and site distance criteria can be satisfied. In order to access the site from its location, a new crossing would be required over Bellbird Creek and the flood prone land between Wollombi Road and the development. The road reserve is also wide enough to provide additional lanes, although some relocation of utilities may be required.

Sections of the road are in a poor condition with significant deterioration of the pavement evident. It has been classified as a regional road by the RTA, previously identified as MR 181. Sections of the road have been upgraded in recent times as it is part of the Regional Road Repair Program. However, sufficient funds may not be available for a full upgrade of all sections. It is understood that Council may seek contributions from developers along Wollombi Road to assist in the rehabilitation program.



Photograph 1: Looking north east along Wollombi Road



Photograph 2: Looking south west along Wollombi Road

5.1.2 Victoria, Abbotsford and Hetton Streets

Victoria, Abbotsford and Hetton Streets run perpendicularly off Wollombi Road and access to the site may be gained via extension of these local streets.

Victoria Street is shown in *Photograph 3* and *Photograph 4.*

The pavement at the intersection of Victoria is in fairly poor condition with some edge deterioration but the majority of the pavement along the length of the street is generally in good condition. Victoria Street is classified as a local road and has available area for widening if necessary. Table drainage is provided; the verges are grassed and contain power poles and other utility services.

The intersection of Wollombi Road and Victoria Street was examined for sight distance and found to be acceptable to Austroads criteria. The intersection is shown in *Photograph 3.*



Photograph 3: Looking east at intersection of Wollombi Rd and Victoria St

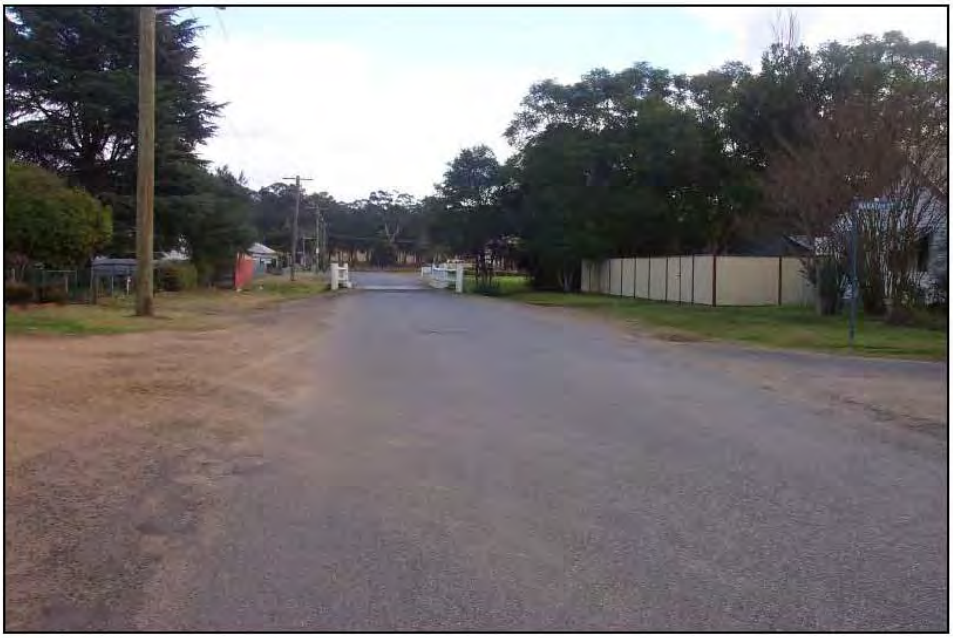


Photograph 4: Looking north west towards the site off the end of Victoria St

Abbotsford Street is shown in *Photograph 5, 6, 7 and 8*. The pavement is generally in a poor condition with surface potholing. The street is classified as a local road and is of a rural standard with room for widening.

Two existing small timber bridges (Abbotsford Street is shown in *Photograph 6*) on Abbotsford and Hetton Streets may require upgrading if these are to be used as a major

access to the site. As an alternative, these bridges could possibly be designed to act as traffic "squeeze points" in conjunction with an overall traffic management strategy, subject to concept and detailed design.



Photograph 5: A typical section of Abbotsford St



Photograph 6: The existing bridge on Abbotsford St

The intersection of Wollombi Road and Abbotsford Street was examined for sight distance and was found to be acceptable to Austroads criteria. The intersection is shown in *Photograph 7*.

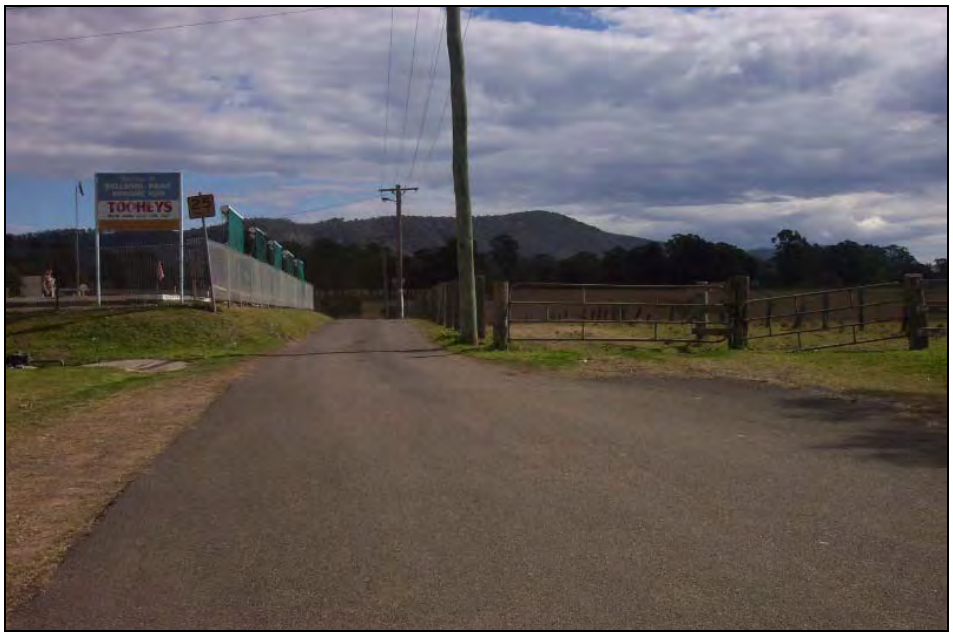


Photograph 7: Looking south east at the intersection of Abbotsford St & Wollombi Rd



Photograph 8: Looking north from the end of Abbotsford St

Photograph 9, 10 and 11 shows views of Hetton Street. *Photograph 9* shows the end of the existing pavement at a driveway to the Bowling Club. Likely upgrading of the road to service the development would require relocation of existing power poles and modification of access to the Bowling Club. In addition, the existing crest would require modification to meet criteria for sight distance. Hetton Street, like Abbotsford Street, is a classified as a local road of a rural standard with some room for widening if required.



Photograph 9: Looking west from the end of Hetton St



Photograph 10: A typical section of Hetton St

The intersection of Wollombi Road and Hetton Street was examined for sight distance and found to meet Austroads criteria. The intersection is shown in *Photograph 12.*

Hetton Street also has a narrow timber bridge, shown in *Photograph 11*. The pavement condition is fairly poor with dilapidated edges. Accordingly, despite the reasonable intersection geometry and in view of all the other considerations above, Hetton Street is not recommended as a major site access point.



Photograph 11: Looking south at the existing bridge on Hetton St



Photograph 12: The intersection of Wollombi Rd and Hetton St

Wollombi Road has a relatively high AADT compared to the adjoining local streets. As traffic grows on Wollombi Road, it will become increasingly difficult for sign post controlled “T” intersections to allow for the entering traffic. It is likely that once modelling of the traffic growth has been undertaken, a roundabout or signals will be required to slow/ stop traffic in certain areas on Wollombi Road to allow for the traffic entering from the side streets.

5.2 Prince Street

Prince Street runs parallel with Wollombi Road and is accessed via Hetton Street. It could be extended to provide access to the site parallel to Wollombi Road and create a desired grid like road pattern.

Photograph 13 and *Photograph 14* show sections of Prince Streets which is a bitumen sealed carriageway with unsealed shoulders, overhead power and generally poor pavement condition.



Photograph 13: Looking north east from the end of Prince St



Photograph 14: A typical section of Prince St

5.3 Tennant Street

Tennant Street is the southern perimeter road along the site boundary (refer to *Photograph 15, 16* and *17*). The road is straight with a gentle gradient which is suitable to provide adequate sight distance for access points. Overhead power is provided on the southern side of the road and therefore unlikely to conflict with new road connections.

Existing traffic volumes are low and it is considered that access to the development would have minimal impacts on the existing Tennant Street road users. Accordingly, it is recommended that Tennant Street be considered further for the provision of site access.



Photograph 15: Looking west along Tennant St



Photograph 16: Looking east along Tennant St from the cul-de-sac end



Photograph 17: Looking west along Tennant St

5.4 Buttaba Avenue

A possible access to the northern portion of the site is via an extension of Buttaba Avenue which is accessed via Macquarie Street, Wangi Avenue and Wollombi Road. *Photograph 18* and *Photograph 19* shows the existing Buttaba Avenue at the western end close to the site. Buttaba Avenue is classified as a local road.



Photograph 18: Looking west from the end of Buttaba Av



Photograph 19: Existing small bridge on Buttaba Av

Macquarie Road and Wangi Roads are narrow local streets, (shown in *Photograph 20, 21 and 22*), that form a part of a grid like street pattern in the surrounding area. Alternative, though less direct access to Buttaba Avenue is also via Hickey, Edith and Arcadia Streets. These streets are of a similar standard to Macquarie Street and Wangi Avenue.



Photograph 20: A typical section of Macquarie Av



Photograph 21: A typical section of Wangi Av

In order to provide a logical and effective access to the site, it should not be necessary to make more than three turns at intersections to get from the main road network to the site. The Buttaba Avenue route would require three such turns and is through a relatively developed existing road network and is not recommended as a major link to the development.



Photograph 22: Looking north at the intersection of Wollombi Rd and Wangi Av

5.5 Mount View Road.

The site extends to the north and is bounded by open farm land. An opportunity exists to provide access to the northern part via Mount View Road and an existing gravel access track, as shown in *Photograph 23, 24 and 25.* Mount View Road continues past the site to join Wollombi Road in the east and links Millfield in the west.



Photograph 23: Looking south from Mount View Rd



Photograph 24: Looking south, towards the site from the existing gravel road



Photograph 25: Looking back toward Mount View Rd from the gravel access road

The standard of Mount View Road to the east of the new access point through to the intersection with Wollombi Road is of a high standard due to recent upgrading works carried out along its length. It is classified as a local road and is currently on a program for rehabilitation by CCC. The intersection of Mount View Road and Oakey Creek Road has recently been upgraded and is shown in *Photograph 26, 27 and 28.*



Photograph 26: Looking north at the intersection of Mount View & Oakley Creek Roads



Photograph 27: Looking east at the intersection of Mount View & Oakley Creek Roads



Photograph 28: Looking north west at the intersection of Mount View & Oakley Creek Roads

The intersection of the proposed access road and Mount View Road is on a fairly sharp left hand bend. The bend does not pose sight distance problems as the intersection is proposed for the outside of the bend. There appears to be room for widening of the road and the intersection, though the cadastral boundaries would need to be confirmed by a surveyor to determine the exact space available.

The "T" intersection of Wollombi Road and Mount View Road to the east of the site is shown in Photograph 29. This will become a key intersection to this development if major access from Mount View Road. As stated previously in the report it requires upgrading by Council and the RTA to provide for right and left turning vehicles and to improve the accident potential at this site.



Photograph 29: Looking south at the intersection of Mount View & Wollombi Roads

It is expected that further intersection upgrading works may be required at the Wollombi Road and Mount View Road intersection to accommodate increased traffic from the Bellbird North development and will be the subject of concept and detailed design.

Any required additional treatment of the intersections of the roads connecting through to the proposed development and the main road network can be determined upon receipt of a development layout and the undertaking of traffic modelling work.

6. Road Hierarchy

Road hierarchy is an important factor in the planning and design of new developments as it is critical that the intended use of each road is clear.

The guidelines used for this section of the assessment were the Cessnock City Council *Subdivision Guidelines - DCP No. 35, November, 2001*. Table 6-1 below is published directly from the DCP and is a guideline for road reserve and carriageway widths. This report assumes that all future residential areas will be developed in an urban manner and new roads will consist of kerb and gutter with underground pipe drainage.

Table 1: Road Hierarchy

No. of Allotments	Road Reserve width (m)	Carriageway Width (m)	Parking Provision	Kerb Type
Less than 10	13	6	Verge	Roll
10 to 200	18	8	Carriageway	Roll or upright
200 to 400	20	11	Carriageway	Upright
Over 400	20	13	Carriageway	Upright

7. Public Transport, Pedestrians and Cyclists

An allocation for pedestrian footpaths should be provided as part of the standard Council road design. A grid pattern of road network is efficient for allowing pedestrians a direct path to the extent of the site and into commercial areas or on to the external road network.

There is not expected to be a high volume of cyclists in the area due to its remoteness from large centres. It is noted the route along Wollombi Road adjacent to the proposed development does not provide for cyclists.

All future residential developments should be designed to optimise the walkable access to centres and public transport, the street network should encourage and facilitate walking, cycling and use of public transport. The intention should be that the majority of dwellings are within a 300 to 400m walk from a bus stop and that traffic management devices used will be bus friendly.

The local bus company, Rover Coaches provides a daily service from Cessnock to Bellbird (Route 166) which runs via Cessnock CBD joining Wollombi Road through West Cessnock to Bellbird. In Bellbird the service operates via Hetton, Prince and Doyle Streets to Mary Street following Kendall Street to join Wollombi Road back to Cessnock CBD. Rover provides eight services (four am, four pm) to Bellbird each weekday with extra in the morning for school children only. On weekends, two morning and two afternoon services are provided on Saturdays and one morning and one afternoon on Sundays.

Early staging of the development will utilise the existing bus service and this service will be extended within 3 years after the development progresses.

Strategies detailing how the bus and transport system can be integrated into the development as it comes on line are as follows:

- Extend the bus service to travel along Tennant St and enter the development at the southern end
- Travel a route through the internal road network of the site and exit at the northern end via Mount View Rd or to the east at Wollombi Rd
- All services would then return to the Cessnock CBD via Wollombi Rd

There is not expected to be a high volume of pedestrians and cyclists in the area immediately external to the development due to its remoteness from large city centres and the routes along Wollombi Road to Cessnock do not provide continuity for cyclists. The street network however, should promote activity internally within the new residential areas. Links should also flow to the lower flood prone areas which would be likely to become public open space or recreational areas and from there on to the external road network to provide access to main arterial routes.

Any collector roads that provide main access through the development to the external road network should be considered for shared pedestrian/ cycleway paths to ensure the easy link between different centres.

8. Pavement Markings and Signage

All pavement markings and signage within the development shall be in accordance with Cessnock City Council's code.

It is recommended that the master plan incorporate traffic control measures including:

- establishment of considered and logical road hierarchy;
- intersection controls by roundabout, stop signs and give way signs where required; and
- use of traffic calming measures such as "slow points", pavement narrowing, different pavement textures, shared road facilities, etc.

The following points provide a guide to the pavement markings and signage expected:

- any "Slow Point" chicanes should be visible from at least 60m on approach and if not then advance warning should be signposted;
- stop signs should be provided at 4 way intersections and "T" intersections and any landscaping should be kept to low growing vegetation, less than 0.5m so as not to obscure signs or sight distance to drive ways; and
- indented bays may be provided to formalise parking, better delineate the narrower travel lane and break up long lines of parked cars. The indented bays should not be in the vicinity of pedestrian thoroughfares as pedestrians may incorrectly perceive them as being a device which gives them priority over vehicles. Planting out of such bays will ensure they are not wrongly perceived as pedestrian crossing points.

9. Conclusion and Recommendations

The preliminary conclusions that can be drawn from the above assessment into the North Bellbird Investigation Area are as follows:

- the recommended major access points to the site as detailed in *Figure 4* are:
  - < Victoria Street to the south;
  - < Abbotsford Street to the south;
  - < Tennant Street to the south;
  - < Wollombi Road to the east;
  - < Mount View Road to the north;
- the above intersections have all been preliminarily assessed for sight distance and comply with Austroads design guidelines; as shown in *Table 2* below

Table 2: Site Distance Assessment

Road	Design Speed (km/h)	Safe I/sect Sight Dist (m)	Site Distance Achieved
Victoria St	50	96	Yes
Abbotsford St	50	96	Yes
Tennant St	50	96	Yes
Wollombi Rd	60	121	Yes
Mount View Rd	60	121	Yes

- a key intersection critical to this development is identified as the existing intersection of Mount View Road and Wollombi Road at Cessnock. This intersection has been analysed in the past and was found to require an upgrade;
- Wollombi Road will require an upgrade to 4 lanes when the one-way peak hour traffic volume exceeds 900 vehicles and this was calculated at approximately 3 years into the development; and
- once the masterplan has been further developed, the internal road network should be assessed by a traffic engineer.

This traffic and accessibility assessment found there are no reasons to preclude urban development within the North Bellbird Investigation Area. Further investigations including a traffic impact assessment will be completed at the design stage.

Figures

Client: Johnson Property Group
Project: Traffic and Accessability Assessment
Location: Cessnock, NSW

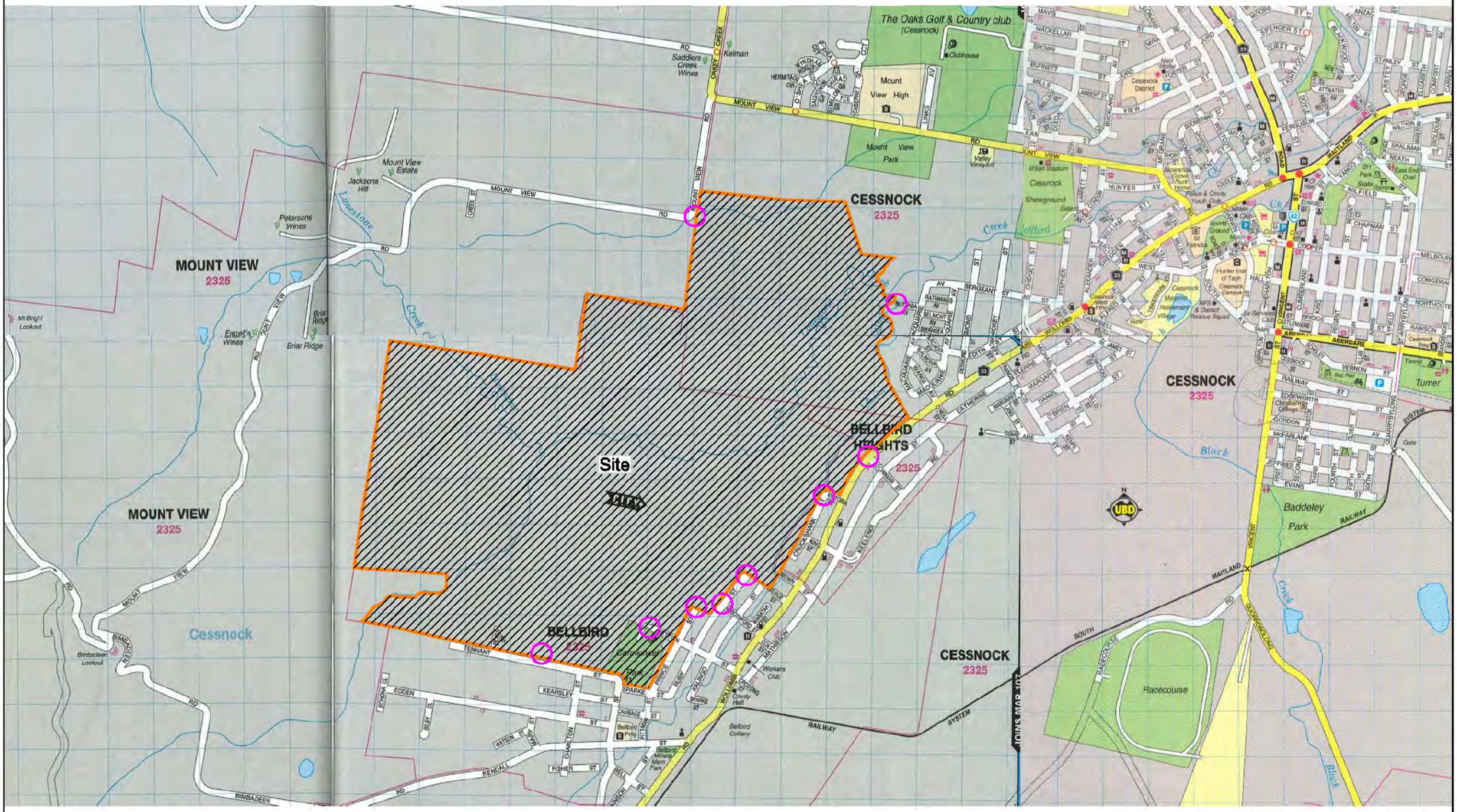
0 500 1000 m

Scale 1: 20,000

PARSONS BRINCKERHOFF

Legend

Proposed Access Points



Locality Plan and Proposed Access Points
Figure 1

Map reproduced with permission of UBD. Copyright Universal Publishers Pty Ltd, DG 10/03.

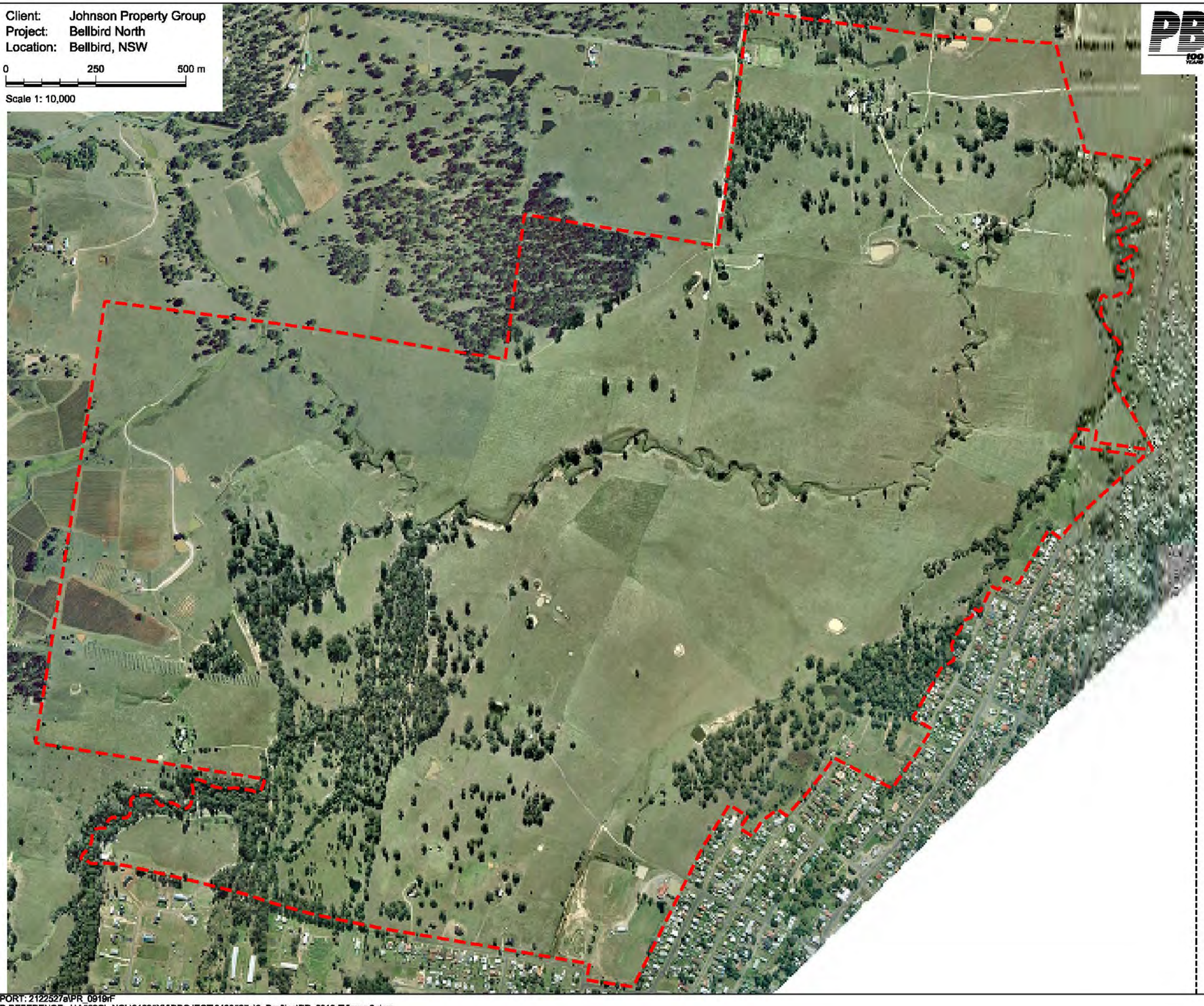
REPORT: 2122527a\PR_0919rF
CAD REFERENCE: J:\A502CL-NCL\21225\XX\PROJ\2122527A\9_Drafting\PR_0919rF\FIGURE 1.dwg

Client: Johnson Property Group
Project: Bellbird North
Location: Bellbird, NSW

0 250 500 m

Scale 1: 10,000

PB PARSONS BRINCKERHOFF

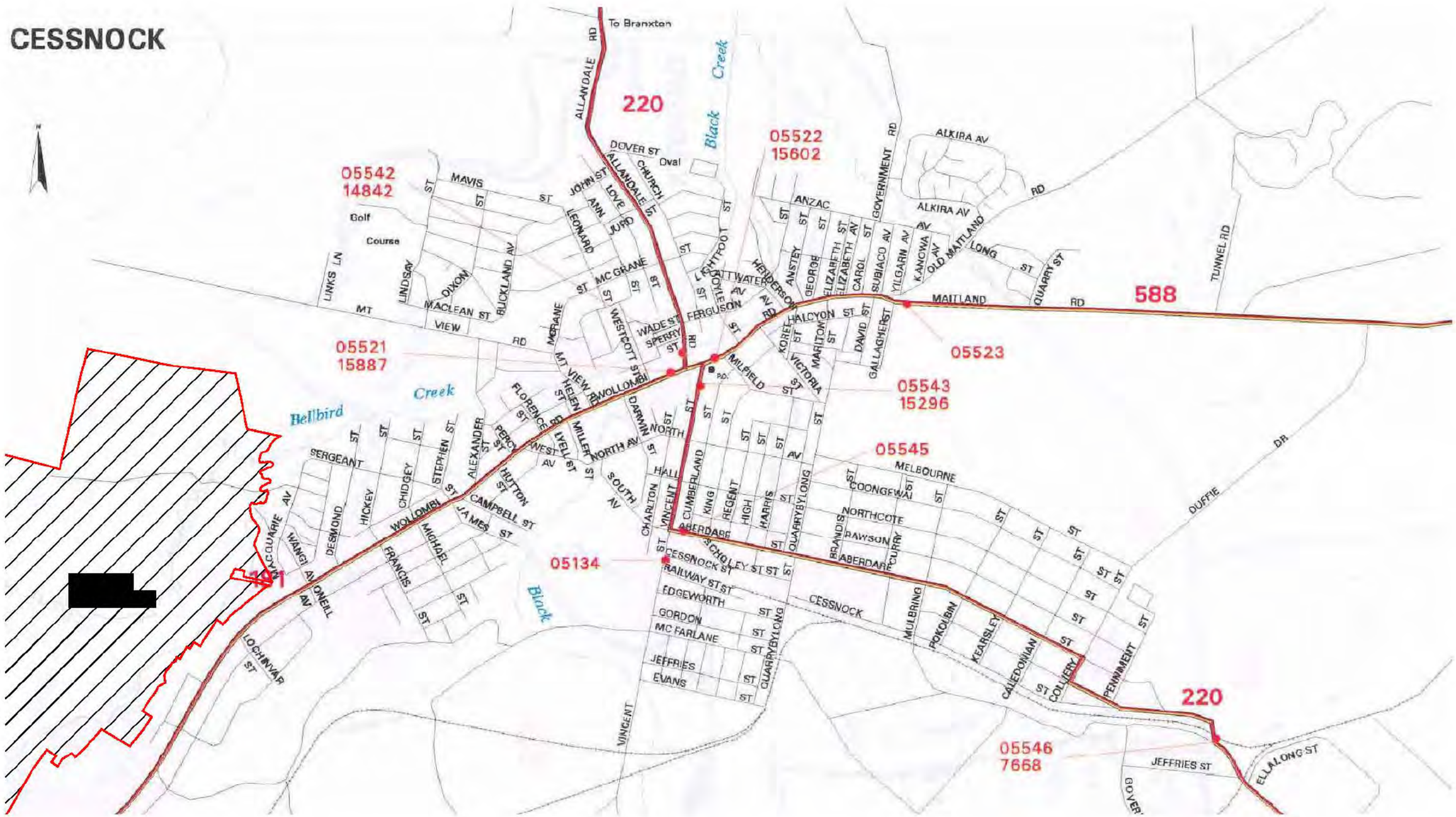


Overall Site Plan
Figure 2

REPORT: 2122527a\PR_0919rF
CAD REFERENCE: J:\A502CL-NCL\21225XX\PROJECT\2122527a\9_Drafting\PR_0919rF\figure 2.dwg

Client: Johnson Property Group
Project: Bellbird North
Location: Bellbird, NSW

PB PARSONS BRINCKERHOFF



Main Roads in the Area
Figure 3

REPORT: 2122527a\PR_0919rF
CAD REFERENCE: J:\A502CL-NCL\21225XX\PROJECT\2122527a\9_Drafting\PR_0919rF\figure 3.dwg

Client: Johnson Property Group
Project: Traffic and Accessability Assessment
Location: Cessnock, NSW

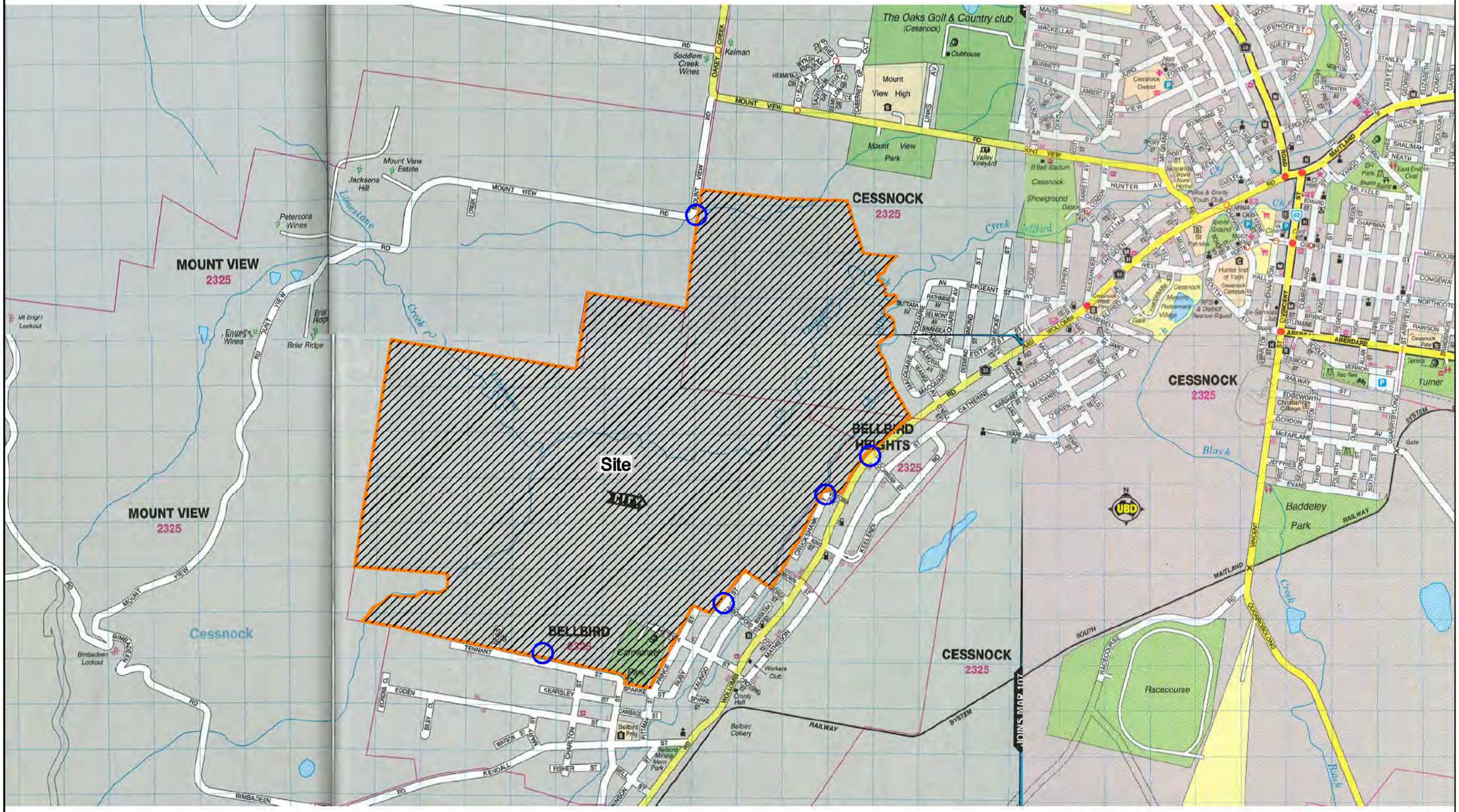
0 500 1000 m

Scale 1: 20,000

Legend

Recommended Access Points

PB PARSONS BRINCKERHOFF



Locality Plan and Recommended Access Points
Figure 4

Map reproduced with permission of UBD. Copyright Universal Publishers Pty Ltd, DG 10/03.

REPORT: 2122527A\PR_0919rF
CAD REFERENCE: J:\A502CL-NCL\21225XX\PROJ\2122527A\9_Drafting\PR_0919rF\FIGURE 4.dwg

North Bellbird Investigation Area

Flooding and Stormwater Assessment

May, 2006

Johnson Property Group

Parsons Brinckerhoff Australia Pty Limited ACN 078 004 798 and Parsons Brinckerhoff International (Australia) Pty Limited ACN 006 475 056 trading as Parsons Brinckerhoff ABN 84 797 323 433

Suite 1, Level 3,
55 Bolton Street
Newcastle NSW 2300
PO Box 1162
Newcastle NSW 2300
Australia
Telephone +61 2 4929 3900
Facsimile +61 2 4929 7299
Email newcastle@pb.com.au

ABN 84 797 323 433
NCSI Certified Quality System ISO 9001

2122527A-PR_0872rC

©Parsons Brinckerhoff Australia Pty Limited and Parsons Brinckerhoff International (Australia) Pty Limited trading as Parsons Brinckerhoff ("PB"). [2006]

Copyright in the drawings, information and data recorded in this document ("the information") is the property PB. This document and the information are solely for the use of the authorised recipient and this document may not be used, copied or reproduced in whole or part for any purpose other than that for which it was supplied by PB. PB makes no representation, undertakes no duty and accepts no responsibility to any third party who may use or rely upon this document or the information.

Author: Adam Shaw.....

Signed: .....

Reviewer: Shane Scott.....

Signed: .....

Approved by: Ian Hill.....

Signed: .....

Date: .....

Distribution: .....

Contents

Page Number

Executive summary **1**

1. Introduction **3**

1.1 Background 3
1.2 Objectives 3
1.3 Site Description 3
1.4 Proposed Development 4
1.5 Drainage Catchment 5
1.6 Previous Studies 6
1.7 Available Data 6

2. Methodology **8**

2.1 Hydrology 8
2.2 Hydraulics 8
2.3 Water quality 9

3. Water Quantity - Existing Conditions **10**

3.1 Hydrology 10
3.1.1 Catchment Plan 10
3.1.2 Design Rainfall 10
3.1.3 Model Parameters 10
3.1.4 Peak Discharges 11
3.2 Flooding 14
3.2.1 Modelling Parameters 14
3.2.2 Flood Levels 18
3.2.3 Sensitivity Analysis of Channel Roughness Parameters 19
3.2.4 Suitability of Land for Urban Use 19

4. Water Quantity - Developed Conditions **21**

4.1 Hydrology 21
4.1.1 Potential Impacts of Development 21
4.1.2 Model Parameters 21
4.1.3 Peak Discharges 22
4.2 Preliminary Detention Volume Estimates 23
4.3 Flooding 24

5. Water Quality **25**

5.1 General 25
5.1.1 Existing baseline 25
5.1.2 Potential Impacts of Development 26
5.1.3 Post-Construction Water Quality Treatment Objectives 26
5.2 Modelling parameters 27
5.2.1 Catchment plan 27
5.2.2 Rainfall and evapotranspiration 27
5.2.3 Time step 27
5.2.4 Land use 27
5.2.5 Hydrology 28
5.2.6 Event mean concentrations 28
5.3 Model calibration 29
5.3.1 Hydrology 29
5.3.2 Pollutant export 29
5.4 Existing conditions 30
5.5 Developed conditions 31
5.6 Preliminary WQCP Sizing 32
5.6.1 Treatment train parameters 32
5.6.2 Pollutant loads 33

6. Stormwater Management **36**

6.1 Stormwater Management Requirements 36

Contents (continued)

Page Number

6.2 Site Constraints 36
6.3 Stormwater Management Devices 37
6.3.1 General 37
6.3.2 Stormwater Harvesting 37
6.3.3 Porous Pavements 39
6.3.4 Grassed Swales and Buffer Strips 39
6.3.5 Bioretention Structures 40
6.3.6 Gross Pollutant Traps 40
6.3.7 Constructed Wetlands 40
6.3.8 Detention Storage 41
6.3.9 Water Quality Control Ponds 41
6.4 Soil and Water Management during Construction 42

7. General Design Considerations 43

7.1 Batter Slopes 43
7.2 Access for Maintenance 43
7.3 Geotechnical Investigation and Design 43
7.4 Signage 43
7.5 Landscaping 43
7.6 Development Controls 44

8. Conclusions and Recommendations 45

9. References 46

List of tables

Table 1: Existing Peak Discharges for the 5, 10, 20 and 100 Year ARI Storm Events 11
Table 2: Comparison of PRM and XP-RAFTS Peak Discharges – Bellbird and Limestone Creek Catchments only 12
Table 3: Existing Peak Discharges for PMF Event 13
Table 4: Existing Peak Discharge, Peak Storage and Peak Water Level at Mount View Road Detention Basin 13
Table 5: Comparison of XP-RAFTS and PRM Peak Existing Discharges at Westcott Street for Development Site Only 14
Table 6: Existing Peak Flows Adopted in 100 yr Hydraulic Model 15
Table 7: Existing Peak Flows Adopted in PMF Hydraulic Model 17
Table 8: Developed Peak Flow Estimates at Westcott Street (node BEL.23) and Ash Street (node BEL.25) 22
Table 9: Developed Peak Flow Estimates at Westcott Street (node BEL.23) 23
Table 10: Volume of Storage and Indicative Area Required for Detention Basins 24
Table 11: Water Quality Treatment Criteria from Australian Runoff Quality (Engineers Australia, 2006) 26
Table 12: Monthly Average Areal Potential Evapotranspiration Values 27
Table 13: MUSIC Hydrology Parameters for Each Land Use 28
Table 14: Baseflow and Stormflow Pollutant Mean Concentrations for Each Land Use 29
Table 15: Comparison of Typical and Predicted Volumetric Runoff Coefficients 29
Table 16: Predicted Pollutant Export Rates for 1 Hectare Catchment 30
Table 17: Predicted Average Annual Pollutant Loads Leaving the Each Drainage Catchment for Existing Conditions 30
Table 18: Comparison of Existing and Developed Average Annual Pollutant Loads 31
Table 19: Adopted MUSIC GPT Removal Efficiencies 33
Table 20: Adopted MUSIC Water Quality Control Pond Parameters 33
Table 21: Comparison of Developed and Mitigated Average Annual Pollutant Loads for Option 1 ... 34

Contents (continued)

Page Number

List of figures

Figure 1: Locality Plan
Figure 2: Land Tenure and Topography
Figure 3: Bellbird Creek Subcatchment Layout
Figure 4: Local Development Subcatchment Layout
Figure 5: Location of HEC-RAS Cross Sections – 100 year Model
Figure 6: Location of HEC-RAS Cross Sections – PMF Model
Figure 7: Existing Flood Envelopes Site Plan
Figure 8: Existing Flood Envelopes Sheet 1
Figure 9: Existing Flood Envelopes Sheet 2
Figure 10: Existing Flood Envelopes Sheet 3
Figure 11: Existing Flood Envelopes Sheet 4
Figure 12: Nominal Development Areas and Location of Detention Basins/WQCP's

List of photos

Photo 1: Bellbird Creek Looking Westwards from Victoria Street 5

List of appendices

Appendix A Cessnock IFD
Appendix B Subcatchment Parameters – Bellbird, Limestone and Lavender Creek Catchments
Appendix C Subcatchment Parameters – Development Local Catchment
Appendix D Height-Storage-Discharge Relationship for Mount View Road Detention Basin
Appendix E PRM Peak Flow Rate Estimates
Appendix F PMP Calculations
Appendix G Existing Hydrographs at Westcott Street and Ash Street
Appendix H Summary of HEC-RAS Results – Existing Situation
Appendix I Developed Hydrographs at Westcott Street and Ash Street
Appendix J Results from Sensitivity Analysis on Channel Roughness Parameters
Appendix K MUSIC Model Data

Executive summary

Parsons Brinckerhoff (PB) was engaged Johnson Property Group to provide an assessment of flooding and stormwater management in the context of future development within the North Bellbird Investigation Area comprising of approximately 496ha.

The North Bellbird Investigation Area has been assessed by others in the respect to its capacity to sustain a mix of development and conservation including:

- a mix of residential environments provided through sequential staging
- a commercial and retail precinct including mixed use development capable of serving the needs of the North Bellbird community
- social and community infrastructure including schools, community and recreational facilities including open space
- infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails
- conservation of quality remnant vegetation
- rehabilitation of degraded riparian corridors to provide habitat linkages.

Hydraulic modelling of drainage lines crossing the site indicated that approximately 77ha (16%) of the proposed development site is subject to inundation during the 100 year flood event. This results in a reduced area available for development. However, some gain in developable site area may be achieved with localised filling of marginal flood areas and provision of engineered drainage lines, subject to further hydraulic analysis.

Hydrologic modelling of existing and developed conditions suggests that there will be a negligible change in peak discharges for the 1, 5, 10, 20 and 100 year ARI storm events operating on the scale of the Bellbird Creek catchment to the outlet of the development site. This indicates that the proposed development is unlikely to result in increased flooding downstream of the site for events operating on a catchment scale, producing the most extreme flow rates.

Hydrologic modelling of existing and developed conditions suggests however that there will be an increase in existing peak discharges for the 1, 5, 10, 20 and 100 year ARI storm events operating on the local development catchment scale. It is recommended that detention storage be provided as part of future development to mitigate developed flows from the local site to existing conditions, and that this detention storage be provided offline from all existing major flow paths. For ease of implementation, detention storage may be incorporated into water quality control ponds. Additional storage should be provided on all allotments in the form of rainwater tanks, with harvested water reused for toilet flushing, clothes washing and garden watering.

Preliminary water quality modelling was undertaken using MUSIC software, and indicated that the development is likely to result in significantly increased pollutant loads if treatment devices are not implemented. Water quality solutions for the site for the treatment of runoff from developed areas may include gross pollutant traps, grassed swales, water quality control ponds, bioretention devices and constructed wetlands. The selection of the appropriate water quality solution should be made at development application stage in conjunction with more detailed water quality analyses, and further

investigation to the extent of salinity within the site. Water quality devices should also be situated off-line to major flow paths.

The abovementioned results from this investigation do not preclude future residential development on lower lying marginal flood areas so long as further detailed, and site specific, flood analysis is undertaken and appropriate engineering controls are implemented for the management of quality and quantity of local runoff. The results of future flood analysis of possible engineering solutions should indicate negligible impact on the existing flooding environment at, and upstream of the investigation area. Design of water quality management structures should account for the guidelines in Australian Runoff Quality (Engineers Australia, 2006). Design of water quantity management structures should be in accordance with Cessnock City council's drainage handbook.

1. Introduction

1.1 Background

Parsons Brinckerhoff (PB) was engaged by Johnson Property Group to examine flooding and stormwater management within the investigation area. A locality plan of the investigation area is provided in Figure 1.

It is understood that this report will accompany the rezoning submission to Cessnock City Council (CCC).

1.2 Objectives

This report considers flooding and stormwater management issues for the site, including water quality control. The study objectives are to:

- confirm the existing 100 year modelling and flood envelope documented in the draft *Lavender and Bellbird Creek Flood Study* prepared by Patterson Britton (January 2005)
- model the proposed development area to determine existing and developed flood hydrographs for the 1, 5, 10, 20 and 100 year average recurrence interval (ARI) and probable maximum flood (PMF) events
- determine existing water levels for the 1, 5, 10, 20 and 100 year average recurrence interval (ARI) and probable maximum flood (PMF) events
- prepare flood maps showing the extent of inundation for each analysed storm event;
- determine whether detention storage is required, and if so propose preferred locations and provide indicative detention volume estimates
- provide advice for the future stormwater management strategy using best practice stormwater quantity and quality controls, including the principles of water sensitive urban design (WSUD)
- estimate existing and developed pollutant loads from the site using MUSIC water quality model
- undertake preliminary investigation into water quality management for the site.

1.3 Site Description

The proposed development site has an area of approximately 496Ha and is located at North Bellbird, approximately 2.5 km south-west of Cessnock. A plan showing existing land tenure is provided in Figure 2.

The site is bounded by Tennant Street to the south, Bellbird Creek to the east, Mount View Road to the north, and rural land to the west.

The site comprises the following parcels of land, which are currently zoned Rural 1(a) and Rural 1(v) (i.e. vineyards):

- Lot 141 DP 986905
- Lot 3 DP 310827
- Part Lot 13 DP 880374
- Lot 10 DP 815485
- Lot 11 DP 815485
- Lot 1 DP 167004
- Lot 2 DP 1011544
- Lot 1 DP 327785
- Lot 2 DP 597226
- Lot 1 DP 328498
- Part Lot 51 DP 807540
- Lot 11 DP 806584
- Lot 3 DP 597226
- Lot 2 DP 66183
- Lot 251 DP 524058
- Lot 210 DP 1012346
- Lot 211 DP 1012346
- Lot 212 DP 1053307
- Lot 1 DP 349452
- Lot 1 DP 327580
- Lot 1 DP 1011544
- Lot 52 DP 807540
- Lot 2 DP 624793
- Lot 1 DP 329071
- Lot 261 DP 524058
- Lot 1 DP 196997
- Lot 10 DP 806584
- Part Lot 1 DP 66183
- Lot 1 DP 196460

The majority of the site consists of cleared rural land with scattered rural dwellings. A number of farm dams are also located on the site. Some patches of remnant native vegetation are located in the south western and north western corners of the site, and along Bellbird Creek to the east.

Levels across the site vary from approximately 155m AHD in the south west corner to approximately 80m AHD in the north east corner of the site. Slopes range from approximately 1.5% to 10%.

1.4 Proposed Development

The site was identified in the Cessnock City Wide Settlement Strategy – Stage 1 (CCC, 2003) for rezoning to mixed residential densities, rationalisation of open space and environmental features.

The North Bellbird Investigation Area has been assessed by others with respect to its capacity to sustain a mix of development and conservation including:

- a mix of residential environments provided through sequential staging
- a commercial and retail precinct including mixed use development to service the needs of the North Bellbird community

- social and community infrastructure including schools, community and recreational facilities including open space
- infrastructure capable to service the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails
- conservation of quality remnant vegetation
- rehabilitation of degraded riparian corridors to provide habitat linkages.

1.5 Drainage Catchment

Bellbird and Limestone Creeks flow through the study area with Lavender Creek along the northern boundary. Both Bellbird and Limestone Creeks are natural, earth lined, ephemeral creeks that are deeply incised. Bellbird Creek flows in a northerly direction along the eastern portion of the site. A photograph of Bellbird creek looking westwards from Victoria Street is shown in Photo 1.



Photo 1: Bellbird Creek Looking Westwards from Victoria Street

Limestone Creek, a tributary of Bellbird Creek, flows in a northerly direction through the middle of the site. The confluence of Limestone and Bellbird Creek is located at the site's north east boundary. Bellbird Creek discharges to Black Creek, a tributary of the Hunter River, located downstream of Cessnock.

The Bellbird Creek catchment down to Westscott Street, West Cessnock, has an area of approximately 2,954Ha. The headwaters of Bellbird Creek are in the Broken Back Range and elevations in the catchment vary from 450m AHD to less than 75m AHD at Westcott Street.

Slopes in the upper catchment are extremely steep and are densely vegetated while slopes in the lower catchment are as low as 1.5%, and are generally cleared for rural landuses. The towns of Bellbird, Bellbird Heights and West Cessnock are located in the lower catchment.

A number of farm dams and mine water storages (associated with Pelton and Southland Collieries) are located within the catchment. These dams and storages would provide some storage of runoff during storm events, depending on how full they are at the start of the event.

A large regional detention basin is located immediately upstream of *The Oaks Golf Course* and to the south of Mount View Road along Lavender Creek. Runoff from a small portion of the northern part of the site drains to this basin. The basin consists of an open grassed area that is used as a sports field, and which is surrounded by an earth embankment. Runoff discharges from the basin via a 1200mm diameter culvert located in the north east corner, and via a side-flow spillway (RL 80.7m AHD) located at the north west corner. The maximum water depth in the basin is approximately 4m, with a maximum storage area of approximately 18Ha and maximum capacity of approximately 250ML (Patterson Britton & Partners, January 2005).

1.6 Previous Studies

Lavender and Bellbird Creek Flood Study, Patterson Britton and Partners (January 2005)

The *Lavender and Bellbird Creek Flood Study* was prepared by Patterson Britton and Partners (January 2005) on behalf of Cessnock City Council to allow estimation of peak flows and flood levels within the Lavender, Limestone and Bellbird Creek catchments. Estimates were made for the 5, 20, 50 and 100 year ARI storm events and the PMF.

Hydrologic modelling was undertaken using XP-RAFTS software. The hydraulic model chosen was a one-dimensional steady state model.

The report considered storage provided by the Mount View Road detention basin, and stage-storage and stage-discharge relationships for this basin were provided.

Henry Kendall Limestone Creek Retirement Village – Site Flood Assessment, Patterson Britton and Partners (February 2003)

A flood assessment of Limestone Creek was undertaken for a proposed 300 unit retirement village located on Lot 1 DP 1011544 and Lot 211 DP 1012346. The assessment was an extension of modelling work undertaken for the Lavender and Bellbird Creek flood study and aimed to determine the proposals susceptibility to flooding.

The assessment concluded that ‘the majority of the development site west of Limestone Creek is relatively unaffected by flooding in events up to and including the 100 year recurrence flood’ (PBP, 2003).

1.7 Available Data

The following data was used in this report:

- aerial survey of the study area provided by Survdevel Surveyors
- 1:25,000 orthophoto maps covering the Bellbird and Limestone Creek catchments
- *Lavender and Bellbird Creek Flood Study* prepared by Patterson Britton and Partners (January 2005)
- Henry Kendall Limestone Creek Retirement Village – Site Flood Assessment prepared by Patterson Britton and Partners (February 2003).

Site inspections of the study area were undertaken on 21 April 2005 and 13 July 2005 for familiarisation purposes and to allow identification of any critical features that may influence flooding and drainage.

2. Methodology

The flood modelling methodology comprised hydrologic and hydraulic modelling to determine existing and post-development flood levels within Bellbird, Limestone and Lavender Creeks. Provided below is a brief description of the methodology.

2.1 Hydrology

Peak discharges from Bellbird, Limestone and Lavender Creek catchments for the 1, 5, 10, 20 and 100 year ARI and the PMF storm events were estimated using the XP-RAFTS hydrologic model. Loss parameters for XP-RAFTS were determined from quasi-calibration of the existing model to flow estimates documented in the *Lavender and Bellbird Creek Flood Study* prepared by Patterson Britton and Partners (January 2005). The storage provided by the Mount View Road detention basin was also included in the model for the attenuation of hydrographs from the upper reaches of Lavender Creek. Another reason for inclusion of Lavender Creek and Mount View Road detention basin was to determine if flooding from Lavender Creek would impact upon the proposed development site.

Following quasi-calibration, existing flows from the catchment were compared with estimates obtained using the probabilistic rational method (PRM). The catchment extent for this calculation extended to Westcott Street. PRM estimates are based on the regional method calculation for time of concentration.

Development will result in an increase in the proportion of impervious to pervious areas within the local site. The impact on peak discharges by this increase in impervious area within the Bellbird, Limestone and Lavender Creek catchments was examined through adjustment of the proportion of impervious to pervious areas within the existing model. In the absence of a master plan for the site, modelling was undertaken under the assumption that the areas of the local site following development will comprise of 50% impervious and 50% pervious. This is a reasonable assumption given that the proposed land uses will include rural residential, commercial, vineyard, light residential and medium density residential

It is possible that a partial-area storm may occur over the proposed development area. A second model considering only the development area was produced in order to determine the effect of development upon stormwater management for a partial-area storm. This model was produced using similar parameters to those used within the model for the entire Bellbird Creek and Limestone Creek catchments.

2.2 Hydraulics

Flood levels within Bellbird, Limestone and Lavender Creeks were estimated using the HEC-RAS water surface profile model. All creeks were modelled using the peak 1, 5, 10, 20 and 100 year ARI flows determined from XP-RAFTS. Creek cross sections were determined from available aerial survey.

The developed flood envelope for the 1, 5, 10, 20 and 100 year flood flows was also determined by inputting developed flows determined from XP-RAFTS.

Within the study area, flood flow regimes for the PMF event are more complex than the 5, 10, 20 and 100 year ARI events. Flows from Limestone Creek are diverted through overland paths and enter Bellbird Creek. This increased complexity required the development of a second hydraulic model, incorporating additional survey data outside of the study area to the east digitised from 1:4000 topographic maps.

2.3 Water quality

An estimate of pollutant loads from the current land use was undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 3.01). The pollutants considered in the modelling were suspended solids, total nitrogen and total phosphorus, which are typical components of urban stormwater runoff.

All input parameters to the MUSIC model were derived from either climatological data supplied by the Bureau of Meteorology or estimated from the MUSIC model manual (2003) and other published papers. Note that the MUSIC model implements continuous modelling using historical rainfall data.

There has been no baseline water quality monitoring undertaken for the site. As a result, predicted pollutant loads and runoff volumes from the MUSIC model were compared against typical values from literature for similar land uses.

Pollutant loads were estimated for the proposed development layout and compared against existing pollutant loads. The effectiveness of one possible treatment train to sufficiently reduce developed pollutant loads from the developed portions of the site was examined.

3. Water Quantity - Existing Conditions

This section describes hydrologic flow estimates and peak water levels for the existing situation.

3.1 Hydrology

In order to determine the relative impact of development within the study area on existing catchment hydrology, it is necessary to establish existing flow conditions. Provided below are estimates of existing flow rates at selected locations.

3.1.1 Catchment Plan

A detailed breakdown of the Bellbird, Limestone and Lavender Creek catchments into subcatchments extending down to Westcott Street, Cessnock, is shown in Figure 3. Also shown is the XP-RAFTS node and link arrangement. Subcatchments outside of the proposed development site have been delineated using topographic information provided on 1:25,000 topographic maps.

Subcatchments located within the proposed development site have been further delineated using available survey information provided by Surdevel Surveyors. A detailed breakdown of the development site into subcatchments is shown in Figure 4. Also shown is the XP-RAFTS node and link arrangement.

3.1.2 Design Rainfall

Rainfall intensity-frequency-duration (IFD) data for the Cessnock area was sourced from CCC's engineering guidelines and input into the model. A copy of the Cessnock IFD table is provided in Appendix A.

Design rainfall pluviographs for the XP-RAFTS model were generated by the XP-RAFTS software, which uses the temporal patterns from AR&R [2] (1987).

3.1.3 Model Parameters

The XP-RAFTS model accounts for rainfall losses across a subcatchment by implementing an Initial Loss-Continuing Loss Rate model. The residual rainfall following the removal of all rainfall losses from a rainfall pluviograph is referred to as rainfall excess. Other subcatchment parameters such as average slope, roughness and percentage impervious govern the rate at which rainfall excess is routed to each subcatchment outlet. The result of this surface routing is a runoff hydrograph.

A summary of subcatchment model parameters for the Bellbird, Limestone and Lavender Creek catchments, and the study area, are provided in Appendix B and C respectively.

3.1.4 Peak Discharges

Regional Catchment

A comparison was made between PB estimated peak discharges and those documented within the *Lavender and Bellbird Creek Flood Study* prepared by Patterson Britton and Partners (January 2005). The comparison was made at two locations with the first being at Westcott Street (node BEL.23) in order to confirm the Bellbird and Limestone Creeks catchment containing the majority of development area had been successfully modelled. The second location where comparison was made was at the junction of Black Creek and Bellbird Creek (node BEL.25), near Ash Street. The second location was compared in order to determine that the Lavender Creek catchment, which includes the Mount View Road detention basin, had been successfully modelled.

The height-storage and height-discharge relationship for Mount View Road detention basin is shown in Appendix D. Critical storm durations of 540 minutes were predicted for the 1, 5, 10, 20, and 100 year ARI storm events. Comparison between the model estimates and Patterson Britton and Partners (January 2005) estimates are provided in Table 1.

The peak flows allow for existing development in the catchment. Additionally, the peak flow rates stated for Ash Street (node BEL.25) allow for storage provided by the Mount View Road detention basin.

Table 1: Existing Peak Discharges for the 5, 10, 20 and 100 Year ARI Storm Events

Location	ARI	Patterson Britton Estimate (m^3/s)^	XP-RAFTS Estimate (m^3/s)	Percentage Difference
Westcott Street	1	-	27.1	-
Westcott Street	5	75.3	75.4	0%
Westcott Street	10	-	92.3	-
Westcott Street	20	127.5	115.3	-10%
Westcott Street	100	146.3	161.8	+11%
Ash Street	1	-	28.6	-
Ash Street	5	86.7	79.5	-8%
Ash Street	10	-	97.2	-
Ash Street	20	121.8	121.1	-1%
Ash Street	100	163.5	170.1	+4%

^ Flows taken from the Lavender and Bellbird Creek Flood Study (January 2005)

Table 1 above shows that the peak flow results from the PB RAFTS model vary from -10% and +11% from Patterson Britton and Partners estimates for the 5, 20 and 100 year ARI events. Note that the 1 and 10 year ARI event results were not published within the *Lavender and Bellbird Creek Flood Study* prepared by Patterson Britton and Partners (January 2005). The differences between the estimates may be attributed to:

- slight variations in model setup (node and link arrangement)
- refinement of subcatchments within the study area due to the use of detailed survey information.

To provide additional comparison of the flow estimates derived in XP-RAFTS, a comparison was also made with flow estimates derived using the probabilistic rational method (PRM). This comparison was made at Westcott Street (node BEL.23) for the 1, 5, 10, 20 and 100 year ARI storm events, and a summary is provided in Table 2. Critical storm durations of 540 minutes were predicted for the 1, 5, 10, 20, and 100 year ARI storm events. Note that these flow estimates do not account for flows within Lavender Creek, which contains the Mount View Road detention basin. PRM calculations may be found in Appendix E.

Table 2: Comparison of PRM and XP-RAFTS Peak Discharges – Bellbird and Limestone Creek Catchments only

Location	ARI	PRM Estimate (m^3/s)	XP-RAFTS Estimate (m^3/s)	Percentage Difference
Westcott Street	1	20.8	27.1	+30%
Westcott Street	5	47.8	75.4	+58%
Westcott Street	10	60.9	92.3	+52%
Westcott Street	20	78.3	115.3	+47%
Westcott Street	100	125.8	161.8	+29%

Table 2 shows that the XP-RAFTS model predicts higher discharges than the PRM for all ARI events. AR&R (1987) suggests that the accuracy of the probabilistic rational method is decreased when the catchment area exceeds $25km^2$. Engineering experience has also indicated previously that the PRM tends to under estimate the peak discharges for catchments, particularly when this occurs. A number of limitations that attribute to this and include:

- only a peak flow estimate is provided and the hydrograph shape is not considered
- a constant rainfall intensity is adopted with the temporal variability of rainfall not accounted for
- the estimation of time of concentration and runoff coefficient is subjective
- does not explicitly allow for catchment surface storage and routing, which may tend to produce high flow estimates in steep catchments.

The probably maximum flood (PMF) is estimated using probable maximum precipitation (PMP). Calculation of PMP is based upon the document entitled *Bulletin 53 – The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method* (Bureau of Meterology, 1994). Application of these principles yielded a series of PMP events, from which the critical storm duration could be determined by hydrologic modelling of the catchment.

A summary of existing peak discharges at Westcott Street (node BEL.23) and Ash Street (node BEL.25) for the PMF storm event is provided in Table 3. Also provided are peak discharge estimates documented in the Patterson Britton and Partners (PBP) flood study (January 2005) at the same locations. The critical PMP storm duration that produced the peak flow rate was the 120 minute storm event. Calculations for the probable maximum precipitation (PMP) and temporal patterns used within the model are provided in Appendix F.

Table 3: Existing Peak Discharges for PMF Event

Location	Patterson Britton Peak Discharge Estimate (m^3/s)^	PB Estimated Peak Discharge (m^3/s)
Westcott Street (BEL.23)	1033	1133
Ash Street (BEL.25)	1149	1156

^ PBP peak discharge estimate has been provided for comparative purposes only.

Existing peak PMF discharges for Westcott Street and Ash Street were 10% and 1% higher respectively than estimates documented in *Lavender and Bellbird Creek Flood Study* prepared by Patterson Britton and Partners (January 2005). This difference may in part be due to the use of a 2.5 hour PMP storm duration by PBP for the *Lavender and Bellbird Creek Flood Study (Patterson Britton and Partners, 2005).* Conversely, PB's modelling suggests that the critical duration PMP event is 2 hours. Another reason for the discrepancy may be due to variations in model setup as mentioned earlier.

A summary of existing peak discharges, peak storage and peak water level at Mount View Road Detention Basin for the 1, 5, 10, 20, 100 year ARI and PMF storm events are provided in Table 4.

Table 4: Existing Peak Discharge, Peak Storage and Peak Water Level at Mount View Road Detention Basin

ARI	Existing Peak Discharge (m^3/s)	Critical Storm Duration (min)	Peak Storage (m^3)	Peak Water Level (m AHD) ^
1	3.6	540	4,625	77.2
5	10.8	540	44,380	78.4
10	13.4	540	61,760	78.6
20	16.9	540	89,120	78.9
100	23.6	540	156,950	79.4
PMF	176.2	120	480,790	81.5

^ Detention basin crest elevation 80.0m.

The 100 year peak storage level within the Mount View Road detention basin quoted in the *Lavender and Bellbird Creek Flood Study (Patterson Britton and Partners, 2005*) is 156,000m^2, which compares favourably with PB's estimate of 156,950m^3.

The XP-RAFTS modelling predicted that the Mount View Road detention basin would be overtopped during the PMF event. This results in substantially higher flows when compared to the 100 year ARI event, and is comparable with the Patterson Britton and Partners estimate of 156.2m^3/s *(Patterson Britton and Partners, 2005*).

Estimated hydrographs at Westcott Street (node BEL.23) and Ash Street (node BEL.25) for the 1, 5, 10, 20 and 100 year ARI and the PMF critical duration storm event are provided in Appendix G for the existing situation.

Local Catchment

Existing peak discharges for the 1, 5, 10, 20 and 100 year ARI storm events were estimated for a local storm event over the proposed development area only. The estimates of existing flows can be compared with predictions of flows arising from the development of the site in

order to allocate sufficient stormwater mitigation infrastructure. The existing flow estimates from the XP-RAFTS model were compared with estimates obtained using the PRM method. Details of PRM calculations for a storm event contained within the development site are in Appendix E.

XP-RAFTS flow rate estimates at the site outlet and PRM comparison estimates for the 1, 5, 10, 20 and 100 year ARI storm events are provided in Table 5. Event durations of 540 minutes produced the greatest peak discharge at the site catchment outlet for the 1, 5, 10, 20, and 100 year ARI storm events.

Table 5: Comparison of XP-RAFTS and PRM Peak Existing Discharges at Westcott Street for Development Site Only

ARI	PRM Estimate (m^3/s)	XP-RAFTS Estimate (m^3/s)	Percentage Difference
1	6.0	8.8	+46%
5	13.6	22.2	+63%
10	17.3	26.7	+54%
20	22.1	32.6	+48%
100	35.3	43.8	+24%

Table 5 above shows that estimates of the peak discharge from storm events situated within the development site for 1, 5, 10, 20 and 100 year ARI are between 24% and 63% higher than estimates using the PRM. This relative variation is generally considered acceptable, given the assumptions and limitations of the PRM, described earlier.

3.2 Flooding

3.2.1 Modelling Parameters

The HEC-RAS (Version 3.1.2, April 2004) computer model, developed by the Hydrologic Engineering Centre, U.S. Army Corps of Engineers was used to determine flood profiles across the site. The model software uses the standard step method to determine water surface profiles for gradually varied flow.

The hydraulic analysis has been undertaken as a steady state simulation. A brief discussion on model parameters is provided below. Storage within the Mount View Road detention basin has been accounted for in the hydrologic model described in Section 3.1.

Flow Regime

A mixed flow regime (subcritical and supercritical) analysis was undertaken for the portions of Bellbird, Limestone and Lavender Creeks situated within the site.

Boundary Conditions

For mixed flow, both upstream and downstream boundary conditions are required for model simulation. The upstream boundary conditions assumed normal flow with a creek slope varying from 0.005 to 0.02. The sensitivity of the model to this slope has not been examined but is likely to be negligible.

The downstream boundary condition comprised a fixed water level that was obtained for the 5 and 100 year ARI, and PMF events from the *Lavender and Bellbird Creek Flood Study* prepared by Patterson Britton and Partners. The downstream boundary condition for the 10 and 20 year ARI events were interpolated. The downstream boundary condition for the 1 year event was assumed to be normal flow. The sensitivity of the model to these starting levels has not been examined. It is anticipated however that the downstream starting water level will have negligible effect on predicted peak water levels on the site as it is situated a sufficient distance downstream.

Peak Flows

A summary of changes in peak flow rates used within the 100 year and PMF hydraulic models are provided in Table 6 and Table 7, respectively. These flows were taken from the XP-RAFTS model with storm duration of 540 minutes for 1, 5, 10, 20 and 100 year ARI event, and 120 minutes for the PMF.

Table 6: Existing Peak Flows Adopted in 100 yr Hydraulic Model

HEC-RAS Cross-section	XP-RAFTS Node	Creek	Flow Rate for ARI (m^3/s)				
			1	5	10	20	100
1-797.79	BEL.23	Bellbird	27.1	75.4	92.3	115.3	161.8
1-852.20	BEL.22	Bellbird	26.8	74.8	91.5	114.4	160.7
1-1322.89	BEL.21	Bellbird	12.6	33.1	40.5	51.0	73.6
1-1680.73	BEL.20	Bellbird	12.5	32.9	40.3	50.7	73.2
1-2307.32	BEL.19	Bellbird	12.3	32.3	39.6	49.9	72.1
1-2570.42	BEL.7 & 17	Bellbird	12.6	32.8	40.4	51.0	73.6
1-3033.38	BEL.7 & BEL.13	Bellbird	12.2	32.8	40.4	51.0	73.6
1-2126.46	BEL.7	Bellbird	8.4	24.3	30.3	38.9	57.8
1-3989.52	BEL.7	Bellbird	8.4	24.3	30.3	38.9	57.8
2-1527.17	BEL.12	Bellbird	2.5	5.6	6.6	7.9	10.3
2-1752.32	BEL.11	Bellbird	0.2	0.4	0.5	0.6	0.7
2-1908.81	BEL.10	Bellbird	2.1	4.4	5.1	6.1	7.9
2-2224.07	BEL.9	Bellbird	1.7	3.6	4.2	5.0	6.5
2-2652.62	BEL.8	Bellbird	1.1	2.5	2.9	3.5	4.6
3-854.72	BEL.14, BEL.15, BEL.16	Bellbird	0.9	2.1	2.3	2.9	3.6
3-1087.72	BEL.14	Bellbird	0.7	1.5	1.7	2.1	2.7
3-1952.20		Bellbird	0.2	0.8	0.9	1.1	1.4
4-441.75	LIM.26	Limestone	14.1	41.5	50.8	62.9	86.4
4-563.13	LIM.25	Limestone	14.1	41.3	50.6	62.8	86.1
4-824.41	LIM.22 & LIM.24	Limestone	14.1	41.7	51.2	63.3	87.1
4-1018.59	LIM.22	Limestone	13.0	38.6	47.4	58.7	80.8
4-1370.53	LIM.21	Limestone	12.8	38.2	46.9	58.2	80.0
4-1693.24	LIM.20	Limestone	12.7	38	46.8	58.0	79.8
4-2927.10	LIM.19	Limestone	12.7	37.9	46.6	57.8	79.6
4-3521.91	LIM.18	Limestone	12.6	37.7	46.4	57.5	79.2

HEC-RAS Cross-section	XP-RAFTS Node	Creek	Flow Rate for ARI (m^3/s)				
			1	5	10	20	100
4-3997.61	LIM.17	Limestone	12.4	37.2	45.7	56.7	78.1
4-4352.51	LIM.16	Limestone	8.1	24.3	30	37.3	51.6
4-4744.42	LIM.13	Limestone	7.8	23.4	28.9	36.0	49.8
4-5445.31	LIM.11	Limestone	7.4	22.4	27.7	34.5	47.8
4-5735.28	LIM.8	Limestone	5.8	17.2	21.2	26.3	36.2
5-317.61	LIM.24	Limestone	1.1	3.1	3.8	4.6	6.3
6-164.27	LIM.7	Limestone	3.9	11.0	13.5	16.6	22.8
6-712.85	LIM.6	Limestone	3.8	10.8	13.2	16.3	22.4
6-928.69	LIM.5	Limestone	2.6	8.1	10	12.4	17.3
6-1872.78	LIM.4	Limestone	2.3	7.0	8.7	10.8	15.1
7-78.45	LIM.3	Limestone	1.1	2.5	3	3.6	4.8
7-309.37	LIM.2	Limestone	1.0	2.3	2.8	3.3	4.4
7-697.21	LIM.1	Limestone	0.7	1.8	2.2	2.6	3.4
8-924.19	LIM.14	Limestone	0.4	1.3	1.5	1.9	2.6
8-1872.78		Limestone	0.1	0.3	0.4	0.5	0.7
9-447.9		Limestone	0.1	0.3	0.4	0.5	0.7
10-400.3	LIM.12	Limestone	0.2	0.4	0.5	0.6	0.8
10-664.21		Limestone	0.1	0.2	0.3	0.3	0.4
11-93.39	LIM.10	Limestone	1.7	5.4	6.7	8.5	11.9
11-619.52	LIM.9	Limestone	1.425	4.6	5.8	7.4	10.4
12-333.13	UKN.3	Lavender	3.1	9.2	11.3	14.2	19.6
12-725.22	UKN.1	Lavender	1.1	3.3	4	5.1	7

Table 7: Existing Peak Flows Adopted in PMF Hydraulic Model

HEC-RAS Cross-section	Flow for PMF (m^3/s)
P1-4105.74	442
P1-2746.93	1072
P1-2339.47	1082
P1-2063.22	1087
P1-1579.34	1110
P1-1254.75	1121
P1-928.83	1133
P2-3159.91	265
P2-2886.13	348
P2-2187.91	354
P2-1786.07	372
P2-1455.89	534
P2-1071.23	590
P3-1161.75	9
P3-533.9	18
P4-1872.78	112
P4-712.85	162
P5-668.29	25
P6-1156.46	5
P6-697.52	18
P7-420.77	5
P8-633.62	6
P9-529.76	80
P9-326.04	90
P10-333.13	52
P10-725.22	144

Energy Loss Coefficients

Several types of loss coefficients are utilised by the program to evaluate head losses. These are:

- Manning's 'n' values for friction losses in the defined creek line and overbank regions. The Manning's 'n' for the defined creek line was assumed to vary between 0.015 and 0.1 with that for the overbank regions being between 0.03 and 0.05 (U.S. Army Corps of Engineers, 1998).
- Contraction and expansion coefficients to evaluate creek transition losses. For gradual transitions, the contraction coefficient was assumed to be 0.1 with the expansion coefficient being 0.3 (U.S. Army Corps of Engineers, 1998).

Cross section Geometry

Boundary geometry for the analysis of flow in natural watercourses is specified in terms of ground surface profiles (cross sections) and the measured distance between these profiles (reach lengths).

Creek cross sections were determined from aerial survey of the site. The locations of all cross sections utilised in this analysis are shown in Figure 5.

A sensitivity analysis was undertaken on the values adopted for channel manning roughness.

Reach Length

The measured distances between cross sections are referred to as reach lengths and are typically measured along the centreline of the defined creek line. Distances between overbank regions are measured between upstream and downstream cross section overbank regions.

Hydraulic Control

No hydraulic controls have been modelled as part of this analysis.

3.2.2 Flood Levels

Output from the HEC-RAS models including predicted water levels and average flow velocities is shown in Appendix H for the existing situation. The extent of the existing 1, 5, 10, 20 and 100 year recurrence floods and PMF is shown in Figures 7, 8, 9, 10 and 11.

Water levels within Bellbird Creek for the 100 year recurrence flood vary from 79.5m AHD in the north-eastern corner of the site (immediately downstream of the confluence of Bellbird and Limestone Creeks) to 88.1m AHD immediately downstream of George Street on Bellbird Creek.

Water levels within Limestone Creek for the 100 year recurrence flood vary from 80.0m AHD at the confluence with Bellbird Creek to 110.5m AHD at the western boundary of Lot 1 DP 196460.

Water levels within Bellbird Creek for the PMF vary from 81.1m AHD in the north-eastern corner of the site (immediately downstream of the confluence of Bellbird and Limestone Creeks) to 90.2m AHD immediately downstream of George Street on Bellbird Creek.

Water levels within Limestone Creek for the PMF vary from 81.5m AHD at the confluence with Bellbird Creek to 111.3m AHD at the western boundary of Lot 1 DP 196460.

It is noted that the north western portion of the proposed development site is expected to become one floodplain during the PMF event, with an interaction of flows expected between Limestone and Bellbird Creeks.

Examination of Figure 7 to 11 indicates that approximately 77ha (16%) of the proposed development site is subject to inundation during the 100 year flood event, and approximately 151ha (31%) is subject to inundation during the PMF.

It is recommended that all finished floor levels of residential dwellings be situated a minimum 500mm above the estimated 100 year flood level. It is recommended that the requirements

for finished floor levels of other building classifications and critical infrastructure are determined in consultation with Council.

3.2.3 Sensitivity Analysis of Channel Roughness Parameters

It is understood that landscaping of the riparian zone may lead to an increase in channel and overbank roughness. A sensitivity analysis on the selection of values for the channel roughness parameter was undertaken. The sensitivity analysis examined two scenarios for +20% and -20% of the originally adopted manning roughness values. The results from the sensitivity analysis are presented in Appendix J. The following observations were made from the sensitivity analysis:

- Limestone Creek would be likely to experience a relative increase in water depth of up to 44% in the western portion of Lot 1 DP 196460 in the 100 year ARI event.
- The majority of Limestone Creek however only exhibited a relative increase in predicted water depth between +3% and +5%.
- Minor tributaries of Limestone Creek in the west of the development site experienced an increase in water levels up to 40% in the 100 year event. However, given that the water depth in the minor tributaries is generally less than 1m, the increase in water levels would be manageable by implementing localised filling and regrading in areas where landscaping is likely to increase channel and overbank roughness.
- A relative reduction in water depths in Limestone Creek was observed of up to -14% in the scenario considering a 20% reduction in channel roughness, or by providing engineered drainage lines.
- It is anticipated that the maximum relative increase in water depths within Bellbird Creek will be +9% in the 100 year event. The majority of Bellbird Creek however is only expected to increase minor relative increase in water depth between +3 and +5%.
- A relative reduction in water depths in Bellbird Creek was observed of up to -10% in the scenario considering a 20% reduction in channel roughness.

It is recommended that a review of flood envelopes be undertaken at the development application stage, in accordance with the site master plan and landscape plan, to further examine in detail the localised effects of planting on flood water levels.

3.2.4 Suitability of Land for Urban Use

Based on the results of hydraulic modelling, approximately 16% of the total site is subject to inundation during the 100 year ARI event.

A number of options exist for flood proofing those parts of the study area that are subject to inundation and include:

- Filling of sections of the Bellbird, Limestone and Lavender Creek defined channels and floodplains, and adjacent tributaries. The impact of any proposed filling within defined channels and floodplains needs to be quantified to ensure adjacent and upstream landholders are not affected.
- Providing engineered drainage lines to convey flows from southern portions of the site through to Bellbird Creek. These engineered drainage lines may be contained within the

trunk drainage system of roadways, subject to an assessment of the magnitude of flows to be conveyed and economical feasibility.

- Provision of suitable evacuation paths. The development layout should be designed to allow for evacuation of low lying portions of the development that are subject to inundation during flood events in excess of the 100 year ARI flood.

4. Water Quantity - Developed Conditions

This section describes hydrologic flow estimates and flood levels for the developed situation.

4.1 Hydrology

4.1.1 Potential Impacts of Development

Urban development typically results in an increase in the impervious surfaces within a catchment and engineering works to collect and convey runoff. Without appropriate management, numerous potential impacts result from development. These include:

- increased frequency of runoff events
- increased runoff volume, peak flow and velocity
- decreased groundwater base flows and lowering of the watertable.

These impacts may in turn lead to:

- inundation of downstream property and infrastructure
- change in existing channel form and sediment transport
- damage to riparian and aquatic vegetation
- damage to existing aquatic ecosystems and natural wetlands.

4.1.2 Model Parameters

The extent of developable area across the site has been determined from the flood constraints mapping undertaken in Section 3.2. Figure 12 shows the nominated development areas for the purposes of hydrologic modelling.

The estimation of developed peak flow rates at Westcott Street and Ash Street required inclusion of impervious surfaces within the existing XP-RAFTS model. Alterations to subcatchment data were only made for nodes pertaining to the local development. Details of XP-RAFTS developed model catchment data are summarised in Appendix C.

Node locations used in the XP-RAFTS developed model are identical to those for the existing model and are shown in Figures 2 and 3.

It is understood that the final land uses is intended to be a combination of rural residential, light and medium density residential, commercial and vineyard areas. The overall site, based on these land uses, was assumed to be on average 50% impervious in its developed state. This percentage has been selected on the basis of engineering judgement. It is recommended that this estimate will be refined to reflect the masterplan landuses at development application stage, following successful rezoning of the site.

The impact of site development on both regional and local hydrology has been assessed and is presented below.

4.1.3 Peak Discharges

Regional Catchment

Predicted developed flow rates within Bellbird, Limestone and Lavender Creeks for the 1, 5, 10, 20 and 100 year ARI and the PMF storm events are summarised in Table 8. Also shown are existing peak flow rates and the percentage change in flow resulting from development. Runoff hydrographs for the critical duration storm that produced the largest peak flow estimate are provided in Appendix I for developed conditions. The critical storm duration that produced the peak flow rate at Westcott Street and Ash Street was the 540 minute storm for the 1, 5, 10, 20 and 100 year ARI events. The storm durations that produced the peak flow rate at Westcott Street and Ash Street for the PMF event was the 120 minute storm.

Table 8: Developed Peak Flow Estimates at Westcott Street (node BEL.23) and Ash Street (node BEL.25)

Location	ARI	Existing Peak Flow Rate (m^3/s)	Developed Peak Flow Rate (m^3/s)	Percentage Change
Westcott Street	1	27.1	26.8	-1%
Westcott Street	5	75.4	72.0	-5%
Westcott Street	10	92.3	88.0	-5%
Westcott Street	20	115.3	109.6	-5%
Westcott Street	100	161.8	154.6	-5%
Westcott Street	PMF	1133	1095	-3%
Ash Street	1	28.6	28.2	-1%
Ash Street	5	79.5	76.1	-4%
Ash Street	10	97.2	92.8	-5%
Ash Street	20	121.1	115.8	-5%
Ash Street	100	170.1	163.3	-4%
Ash Street	PMF	1156	1118	-3%

Table 8 illustrates that the proposed development results in negligable change in the critical duration peak flow rate at Westcott and Ash Streets for the 1, 5, 10, 20, 100 year ARI and PMF storm events operating on a catchment level.

Examination of Figure 2 shows the proposed development area to be located near the outlet of the analysed catchment, which extends as far as Westcott Street. The introduction of impervious surfaces at this location increases the rate of runoff from the lower portions of the catchment allowing runoff to enter Black Creek before the overall catchment flood peak.

Additionally, the increased rate of runoff allows runoff from the lower portion of the Bellbird Creek catchment to enter Black Creek before the peak from Lavender Creek. This occurs as the Lavender Creek catchment has its discharges attenuated by the Mount View Road detention basin. These observations are further supported by examination of the developed runoff hydrographs for the critical duration storm events contained within Appendix I, which show a small spike on the rising limb of the hydrographs when compared to the existing runoff hydrographs at the same location.

Local Catchment

A comparison of existing and developed peak flow rates for the 1, 5, 10, 20 and 100 year ARI storm events for a partial-area storm operating on the local development site is shown in Table 9. The critical duration predicted for all storms in the developed situation was the 120 minute storm, compared to the 540 minute storm for the existing situation.

For the purposes of this analysis it was assumed that no site development occurred within the Lavender Creek catchment as the existing contributing catchment area is only small.

Table 9: Developed Peak Flow Estimates at Westcott Street (node BEL.23)

Location	ARI	Existing Peak Flow Rate (m^3/s)	Developed Peak Flow Rate (m^3/s)	Percentage Change
Westcott Street	1	8.8	17.5	+99%
Westcott Street	5	22.2	31.7	+43%
Westcott Street	10	26.7	37.0	+39%
Westcott Street	20	32.6	44.3	+36%
Westcott Street	100	43.8	60.0	+37%

It can be seen from Table 9 that preliminary modelling in XP-RAFTS predicts that an increase in peak flow rates between 36% and 99% is expected from the local site following development. This increase in flow rate may result in excessive creek bed erosion and increased frequency of localised flooding from minor storm events if sufficient attenuation is not provided.

4.2 Preliminary Detention Volume Estimates

The location of proposed detention structures based on the nominated development areas is shown in Figure 12.

XP-RAFTS modelling for the nominated development areas was undertaken to determine preliminary detention volume estimates for the 100 year storm event. The outlet configuration for each basin was selected with the objective of reducing the 100 year peak flow back to existing levels. Detention basins are to be located off-line from Bellbird, Limestone and Lavender Creeks, and contain a staged outlet pipe configuration to attenuate flows arising from the 5, 10, 20 and 100 year ARI storm events.

The volume of storage required for each detention basin, and an indication of the area required for the detention basin are summarised in Table 10**Error! Reference source not found.**. Note that the area required for the detention basin has been approximated by assuming a depth of ponding of 0.5m, which is provided on top of the permanent water volume for water quality treatment. This does result in descrepencies between the surface area provided for water quality treatment and the basin area provided for stormwater detention. However, the purpose of this investigation was to illustrate that stormwater-related issues on the site are manageable. These discrepancies would be resolved during development application and detail design phase of these structures, by incorporating various cells to each pond, as well as implementing other stormwater management devices discussed in Section 6.

Detention basin volumes quoted in this report should be confirmed at the development application phase utilizing the proposed development layout.

Table 10: Volume of Storage and Indicative Area Required for Detention Basins

Basin	Volume Required (m^3)	Area Required (ha) for Maximum Average Detention Depth of 0.5m
1	9800	2.0
2	8900	1.8
3	8200	1.6
4	5700	1.1
5	5900	1.2
6	1900	0.4
7	4600	0.9
8	2310	0.5
9	3840	0.8
10	3450	0.7
11	1500	0.3

4.3 Flooding

The comparison of existing and developed peak discharges provided in Table 8 demonstrated that site development will have negligible impact on regional flow rates within the Bellbird (and Lavender) Creek catchment. As such, it was considered unnecessary to recalculate the extent of flood inundation using developed flow rates in HEC-RAS. The flood envelopes presented in Section 3 are considered to represent an upper limit to flooding within the study area.

Additional HEC-RAS modelling will be required where any filling of the defined creekline and floodplain of Bellbird, Limestone and Lavender Creeks is proposed as part of future development on the site.

5. Water Quality

This section contains a discussion on the quality of runoff from the site for existing and post-developed situations. Water quality modelling us undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 3.01), to illustrate that water quality is manageable within the development by implementing suitable engineering controls.

5.1 General

5.1.1 Existing baseline

Pollutants entering the receiving waters of the site are typically from diffuse sources primarily associated with urban development and agricultural activities. The activities that have occurred on and around the site that may influence ambient water quality include land clearing, cattle grazing, fertiliser application, residential development, coal mining, road construction and stormwater management works.

There is no existing information available on water quality specifically in Bellbird, Limestone and Lavender Creeks. However, the *City Wide Settlement Strategy – Stage 1* (CCC, 2003) provides information on existing water quality in Black Creek. It is worth noting that the Bellbird and Lavender Creek catchments are major contributors to flow in Black Creek at Cessnock. The strategy indicates that:

> *"nitrate nitrogen and pH levels in streams sampled in the Black Creek catchment meet the recommended guidelines whilst orthophosphates and conductivity levels exceed the recommended levels required for the maintenance of aquatic ecosystems, agriculture and potable supply (ANZECC, 1992). Black Creek is classified as being very highly saline and consequently unsuitable for irrigation, stock watering, potable supply and for the maintenance of aquatic ecosystems (ANZECC, 1992). The presence of faecal contamination renders Black Creek unsuitable for potable supply (NHMRC, 1987) but acceptable for recreational and agricultural uses (ANZECC, 1992)."*

The Department of Infrastructure, Planning and Natural Resources (formerly the Department of Land and Water Conservation) Groundwater Vulnerability Map (1995) indicates that the Black Creek catchment is rated as having a low to moderate groundwater vulnerability classification (CCC, 2003).

The Black Creek catchment is generally regarded as a degraded catchment suffering from saline water ingress and subsequent adverse effects due to the extraction for irrigation and stock watering. Point and diffuse pollution into Black Creek and its tributaries (from urban and agricultural runoff and associated soil erosion, saline ingresses, effluent disposal and discharges from operating and abandoned mines) has also affected its aesthetic appeal and health (CCC, 2003).

Existing farm dams situated within the Bellbird, Limestone and Lavender Creek catchments and across parts of the site are likely to provide some water quality control for runoff. The majority of urban runoff from Bellbird, Bellbird Heights and West Cessnock presently discharges untreated to Bellbird Creek.

Bellbird, Limestone and Lavender Creeks are likely to be environmentally sensitive waterways. As such it is imperative that stormwater runoff from the proposed development precincts is treated prior to discharging to these watercourses to ensure the protection of aquatic flora and fauna.

5.1.2 Potential Impacts of Development

The majority of the potential pollutant load from the proposed development is likely to be from diffuse sources and will be composed of particles of soil, organic matter and other non-soluble material. The following categories are considered the main potential pollutants from stormwater runoff:

Suspended solids, especially sediment, which reduces:

- light penetration in water and effects growth of aquatic plants
- suitability of habitat for some aquatic flora and fauna
- aesthetic appeal of the water.

Other pollutants may also exist such as:

- nutrients, which can promote rapid growth of aquatic plants leading to processes such as eutrophication
- trash, which is commonly washed from road pavements and can be at high levels, especially in 'first flush' waters
- toxic materials such as pesticides, heavy metals and hydrocarbons.

5.1.3 Post-Construction Water Quality Treatment Objectives

Australian Runoff Quality (ARQ) (Engineers Australia, 2006) recommends adopting the percentage reduction in developed pollutant loads approach to water quality management. Table 11 documents the percentage removal for TSS, TN and TP, as documented in ARQ.

Table 11: Water Quality Treatment Criteria from Australian Runoff Quality (Engineers Australia, 2006)

Pollutant	Stormwater Treatment Objective
Suspended Solids	80% retention of average annual load
Total Phosphorus	45% retention of average annual load
Total Nitrogen	45% retention of average annual load
Litter	Retention of litter greater than 50mm for flows up to the 3-month ARI peak flow
Coarse Sediment	Retention of sediment coarser than 0.125mm for flows up to the 3-month ARI peak flow

5.2 Modelling parameters

5.2.1 Catchment plan

The site was divided into 11 water quality drainage catchment, labelled numerically. The drainage catchments were selected to coincide with the most likely orientation of detention basins / water quality control ponds, and are provided in Figure 12.

For the purposes of water quality modelling, only the total areas of each of the major catchments were considered in the MUSIC model. This is reasonable, as this relative impact analysis considers only the mean annual load (kg/ha) for each catchment, and the summation of the individual nominal development areas.

MUSIC Catchment data is provided in Appendix K. Note that the major development catchments were deduced from the nominal development area only and the summation of catchment areas in MUSIC will not be equal to the total site area.

5.2.2 Rainfall and evapotranspiration

Six minute rainfall data for Millfield was obtained from the BOM for input into the model. This data spans a period of approximately 22 years and results in a mean average annual rainfall of 772mm. This station was selected for input because it is located only 6.6 kilometres from the site and results in a mean annual rainfall figure closest to the range of 800-1000mm, as provided on maps provided by the Bureau of Meterology for the Cessnock area.

Monthly average areal potential evapotranspiration values for the area were obtained from the *Climatic Atlas of Australia – Evapotranspiration* (BOM, 1999). Evapotranspiration values are given in Table 12. The total annual evapotranspiration was 1340mm.

Table 12: Monthly Average Areal Potential Evapotranspiration Values

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evapo-transpiration (mm/month)	180	145	135	90	65	55	50	70	95	135	145	170

5.2.3 Time step

The model was run with a time step of 30 minutes that spanned the period 1958 to 1981. This time step was considered to provide a reasonable compromise between computational speed, file size and model reliability.

5.2.4 Land use

The following land uses were defined within the model:

- Existing – This represents the existing situation and for the purposes of the analysis was assumed fully pervious open space area.
- Developed – This represents the proposed developed situation and comprises 50% pervious and 50% impervious.

5.2.5 Hydrology

MUSIC hydrology parameters adopted for each land use are summarised in Table 13. As the purpose of this water quality modelling is to present a relative impact analysis of developed and existing conditions, the choice of hydrology parameters is not critical so long as runoff coefficients are within an acceptable range.

Table 13: MUSIC Hydrology Parameters for Each Land Use

Parameter	Existing	Developed
Impervious Area	0%	50%
Rainfall Threshold (mm)	1	1
Pervious Area Properties:		
Soil Storage Capacity (mm)	100	100
Initial Storage (%)	30	30
Field Capacity (mm)	100	100
Infiltration Capacity Coefficient, a	100	100
Infiltration Capacity Exponent, b	2	2
Groundwater Properties:		
Initial groundwater Depth (mm)	10	10
Daily Recharge Rate (%)	25	25
Daily Baseflow Rate (%)	5	5
Daily Deep Seepage Rate (%)	0	0

5.2.6 Event mean concentrations

The MUSIC model requires pollutant generation parameters for baseflow and stormflow conditions. Baseflow is derived from the groundwater store, which is recharged from the pervious soil store. Stormflow is generally generated from the impervious area, and under some conditions the pervious area as well.

The pollutant parameters for each land use are based on concentrations documented in *Urban Stormwater Quality: A Statistical Overview (*Duncan, 1999) for urban areas.

A summary of event mean concentrations adopted for baseflow and stormflow conditions are provided in Table 14. Note that the mean concentrations of TSS, TN and TP for residential land use and agricultural land use presented in Duncan (1999) are similar.

Table 14: Baseflow and Stormflow Pollutant Mean Concentrations for Each Land Use

Flow	Existing and Developed Mean Concentrations		
	Total Suspended Solids	Total Phosphorous	Total Nitrogen
	(mg/L)	(mg/L)	(mg/L)
Baseflow	10	0.1	1.0
Stormflow	100	0.25	1.8

5.3 Model calibration

Due to the absence of site specific runoff and pollutant data, accurate calibration of the MUSIC model could not be undertaken. Instead, the predicted volumetric runoff coefficients and export rates have been compared against typical volumetric runoff coefficients and export rates for similar land uses.

5.3.1 Hydrology

A comparison of model predicted and typical volumetric runoff coefficients is summarised in Table 15 for each land use. Predicted volumetric runoff coefficients were calculated using the predicted runoff volume and the average annual rainfall reported in the model for the analysed rainfall period.

Table 15: Comparison of Typical and Predicted Volumetric Runoff Coefficients

Landuse	Description	Volumetric Runoff Coefficient	
		Typical	MUSIC Predicted
Existing	Open Space / Agricultural	0.1 – 0.3	0.11
Developed	Varying land use	0.2 – 0.6	0.48

Volumetric runoff coefficients predicted by the MUSIC model compare well with the typical volumetric runoff coefficients documented in *Managing Urban Stormwater: Strategic Framework* (DEC, 1997).

5.3.2 Pollutant export

Predicted export rates for a 1 hectare catchment of each land use are summarised in Table 16 and are based on the event mean concentrations provided in Table 14. Typical nutrient export rates for urban development are also shown in Table 16. These typical rates were sourced from the *Constructed Wetlands Manual* (Department of Infrastructure, Planning and Natural Resources, 1998). It should be noted that the Constructed Wetlands Manual does not include typical export rates of total suspended solids from urban catchments, nor does it include typical pollutant export rates for roof areas.

Table 16: Predicted Pollutant Export Rates for 1 Hectare Catchment

Landuse		Pollutant Export Rate (kg/ha/yr)		
		Total Suspended Solids	Total Phosphorous	Total Nitrogen
Existing	MUSIC Predicted	113	0.25	1.7
	Typical (range)^	-	0.3 (0.1 – 0.7)	6.6 (3.2 – 22.4)
Developed	MUSIC Predicted	487	1.1	7.3
	Typical (range)^	-	1.0 (0.4 – 3.6)	6.6 (3.2 – 22.4)

^ Typical export rates for bushland and urban development/roads have been sourced from the Constructed Wetlands Manual (Department of Infrastructure, Planning and Natural Resources, 1998).

As can be seen from these results, with the exception of TN for the existing situation, predicted export rates from the MUSIC model are within the range of export rates recommended in the Constructed Wetlands Manual for urban catchment. The information presented in section 5.1 suggests that total phosphorus is a more likely contributor to pollution in the downstream watercourses however and so the discrepancy in the nitrogen concentration is considered minor.

5.4 Existing conditions

The predicted average annual pollutant loads leaving each of the existing drainage catchments is provided in Table 17. Pollutant load estimates are provided for suspended solids, total phosphorus and total nitrogen. The pollutant load estimates provided in Table 17 form the baseline for assessing the performance of the relative impact of the proposed development on water quality.

Table 17: Predicted Average Annual Pollutant Loads Leaving the Each Drainage Catchment for Existing Conditions

Outfall	Runoff Volume (ML/yr)	Average Annual Pollutant Load (kg/yr)		
		Total Suspended Solids	Total Phosphorus	Total Nitrogen
1	49.7	6,740	15.1	100.4
2	38.2	5,200	11.7	75.2
3	33.4	4,280	9.7	67.5
4	25.2	3,140	7.2	50.9
5	26.0	3,330	7.4	50.7
6	8.2	1,030	2.4	15.9
7	19.9	2,480	5.7	38.1
8	10.6	1,360	3.1	21.0
9	17.2	2,210	5.1	33.8
10	16.2	2,100	4.8	33.0
11	6.4	830	1.9	12.5
Total Site	251.0	32,700	74.1	499.0

Note that existing pollutant loads from the site will be higher than those expected from a site covered in natural bushland.

5.5 Developed conditions

A comparison of existing and developed (with no mitigation) average annual pollutant loads is provided in Table 18 for each drainage catchment and the sum of each drainage catchments. Note that, as explained earlier, the summation of area for each of the water quality catchments is not equal to the total site area.

Table 18: Comparison of Existing and Developed Average Annual Pollutant Loads

Outfall	Parameter	Existing	Developed	Relative Difference (%)
1	Flow (ML/yr)	49.7	223.0	+349%
	Suspended Solids (kg/yr)	6,740	28,600	+324%
	Total Phosphorus (kg/yr)	15.1	65.0	+330%
	Total Nitrogen (kg/yr)	100.4	445.0	+343%
2	Flow (ML/yr)	38.2	171.0	+348%
	Suspended Solids (kg/yr)	5,200	22,700	+337%
	Total Phosphorus (kg/yr)	11.7	50.7	+333%
	Total Nitrogen (kg/yr)	75.2	339.0	+351%
3	Flow (ML/yr)	33.4	149.0	+346%
	Suspended Solids (kg/yr)	4,280	19,400	+353%
	Total Phosphorus (kg/yr)	9.7	43.7	+351%
	Total Nitrogen (kg/yr)	67.5	295.0	+337%
4	Flow (ML/yr)	25.2	113.0	+348%
	Suspended Solids (kg/yr)	3,140	14,800	+371%
	Total Phosphorus (kg/yr)	7.2	33.2	+361%
	Total Nitrogen (kg/yr)	50.9	224.0	+340%
5	Flow (ML/yr)	26.0	116.0	+346%
	Suspended Solids (kg/yr)	3,330	15,000	+350%
	Total Phosphorus (kg/yr)	7.4	34.3	+364%
	Total Nitrogen (kg/yr)	50.7	230.0	+354%
6	Flow (ML/yr)	8.2	36.6	+346%
	Suspended Solids (kg/yr)	1,030	4,650	+351%
	Total Phosphorus (kg/yr)	2.4	10.6	+342%
	Total Nitrogen (kg/yr)	15.9	72.5	+356%
7	Flow (ML/yr)	19.9	89.0	+347%
	Suspended Solids (kg/yr)	2,480	11,900	+380%
	Total Phosphorus (kg/yr)	5.7	26.6	+367%
	Total Nitrogen (kg/yr)	38.1	176.0	+362%

Outfall	Parameter	Existing	Developed	Relative Difference (%)
8	Flow (ML/yr)	10.6	47.4	+347%
	Suspended Solids (kg/yr)	1,360	6,150	+352%
	Total Phosphorus (kg/yr)	3.1	13.9	+348%
	Total Nitrogen (kg/yr)	21.0	92.7	+341%
9	Flow (ML/yr)	17.2	76.7	+346%
	Suspended Solids (kg/yr)	2,210	9,730	+340%
	Total Phosphorus (kg/yr)	5.1	22.2	+335%
	Total Nitrogen (kg/yr)	33.8	150.0	+344%
10	Flow (ML/yr)	16.2	72.4	+347%
	Suspended Solids (kg/yr)	2,100	9,360	+346%
	Total Phosphorus (kg/yr)	4.8	21.2	+342%
	Total Nitrogen (kg/yr)	33.0	143.0	+333%
11	Flow (ML/yr)	6.4	28.5	+345%
	Suspended Solids (kg/yr)	830	3,730	+349%
	Total Phosphorus (kg/yr)	1.9	8.4	+341%
	Total Nitrogen (kg/yr)	12.5	55.9	+347%
Total Site	Flow (ML/yr)	251	1,123	+347%
	Suspended Solids (kg/yr)	32,700	146,020	+347%
	Total Phosphorus (kg/yr)	74.1	330.0	+345%
	Total Nitrogen (kg/yr)	499	2,223	+346%

Table 18 shows an increase in the concentration of TSS, TP and TN for the developed site, emphasising the importance of incorporating water quality treatment devices within the future stormwater and water quality management strategy for the proposed development.

5.6 Preliminary WQCP Sizing

Preliminary sizing of WQCP's was undertaken using the MUSIC model. WQCP's are assumed to be located within the base of all detention basins shown on Figure 12. A GPT was included in the model before each conceptual WQCP to reduce sediment load on each pond. Note that the following results detail an illustration of one possible water quality solution for the North Bellbird Investigation Area, and should not be considered a full solution to addressing water quality. A full solution should also consider the general principles of WSUD and other WSUD elements, described in Section 6.

5.6.1 Treatment train parameters

The parameters used within the MUSIC model for the two treatment train models are provided in Tables 19 and 20.

Table 19: Adopted MUSIC GPT Removal Efficiencies

Pollutant	% Removal Efficiency^
Total Suspended Solids (TSS)	70%
Total Nitrogen (TN)	20%
Total Phosphorus (TP)	20%

^ Source: (CRC, 1999)

Table 20: Adopted MUSIC Water Quality Control Pond Parameters

Catchment	Surface Area (m^2)^	Permanent Volume (m^3) ^^	Extended Detention Depth (m)
1	11560	8670	0.5
2	8900	6675	0.5
3	7740	5805	0.5
4	5860	4395	0.5
5	6020	4515	0.5
6	1900	1425	0.5
7	4620	3465	0.5
8	2460	1845	0.5
9	3980	2985	0.5
10	3760	2820	0.5
11	1480	1110	0.5

^ Area assumed 2% of contributing developed catchment

^^ Permanent volume calculated using 0.75m permanent depth and vertical walls

Note that water quality control pond outlet structures were sized such that the volume of storage contained within the extended detention depth was released over a period of approximately 48 hours.

5.6.2 Pollutant loads

A comparison of existing and mitigated average annual pollutant loads from the MUSIC model for each of the water quality catchments and the total developable catchment using conceptual GPTs and WQCPs is provided in Table 21.

Table 21: Comparison of Developed and Mitigated Average Annual Pollutant Loads for Option 1

Outfall	Parameter	Developed	Mitigated	Relative Difference (%)
1	Flow (ML/yr)	223.0	207.0	-7%
	Suspended Solids (kg/yr)	28,600	3,940	-86%
	Total Phosphorus (kg/yr)	65.0	48.3	-26%
	Total Nitrogen (kg/yr)	445.0	23.7	-95%
2	Flow (ML/yr)	171.0	160	-6%
	Suspended Solids (kg/yr)	22,700	3,040	-87%
	Total Phosphorus (kg/yr)	50.7	21.1	-58%
	Total Nitrogen (kg/yr)	339.0	209.0	-38%
3	Flow (ML/yr)	149.0	139.0	-7%
	Suspended Solids (kg/yr)	19,400	2,640	-86%
	Total Phosphorus (kg/yr)	43.7	18.4	-58%
	Total Nitrogen (kg/yr)	295.0	180.0	-39%
4	Flow (ML/yr)	113.0	105.0	-7%
	Suspended Solids (kg/yr)	14,800	1,990	-87%
	Total Phosphorus (kg/yr)	33.2	13.8	-58%
	Total Nitrogen (kg/yr)	224.0	136.0	-39%
5	Flow (ML/yr)	116.0	108.0	-7%
	Suspended Solids (kg/yr)	15,000	2,050	-86%
	Total Phosphorus (kg/yr)	34.3	14.4	-58%
	Total Nitrogen (kg/yr)	230.0	141.0	-39%
6	Flow (ML/yr)	36.6	34.1	-7%
	Suspended Solids (kg/yr)	4,650	647	-86%
	Total Phosphorus (kg/yr)	10.6	4.55	-57%
	Total Nitrogen (kg/yr)	72.5	44.1	-39%
7	Flow (ML/yr)	89.0	82.8	-7%
	Suspended Solids (kg/yr)	11,900	1,570	-87%
	Total Phosphorus (kg/yr)	26.6	10.9	-59%
	Total Nitrogen (kg/yr)	176.0	109.0	-38%
8	Flow (ML/yr)	47.4	44.1	-7%
	Suspended Solids (kg/yr)	6,150	855	-86%
	Total Phosphorus (kg/yr)	13.9	5.9	-58%
	Total Nitrogen (kg/yr)	92.7	57.3	-38%
9	Flow (ML/yr)	76.7	71.3	-7%
	Suspended Solids (kg/yr)	9,730	1,350	-86%
	Total Phosphorus (kg/yr)	22.2	9.4	-58%
	Total Nitrogen (kg/yr)	150.0	92.5	-38%

Outfall	Parameter	Developed	Mitigated	Relative Difference (%)
10	Flow (ML/yr)	72.4	67.4	-7%
	Suspended Solids (kg/yr)	9,360	1,300	-86%
	Total Phosphorus (kg/yr)	21.2	9.9	-53%
	Total Nitrogen (kg/yr)	143.0	87.2	-39%
11	Flow (ML/yr)	28.5	26.5	-7%
	Suspended Solids (kg/yr)	3,730	496	-87%
	Total Phosphorus (kg/yr)	8.4	3.46	-59%
	Total Nitrogen (kg/yr)	55.9	34.7	-38%
Total Site	Flow (ML/yr)	1,123	1,045	-7%
	Suspended Solids (kg/yr)	146,020	19,878	-86%
	Total Phosphorus (kg/yr)	330.0	160	-52%
	Total Nitrogen (kg/yr)	2,223	1,115	-50%

From Table 21 it follows that a treatment train consisting of a GPT and WQCP may be able to provide sufficient treatment capacity in accordance with the recommendations of ARQ, when considering the discharges from the total treatment area. Further refinement of the treatment measures for each of the water quality drainage catchments may achieve the ARQ recommended treatment objectives for each subcatchment.

This exercise has been documented to illustrate that the site is likely to result in an increase in pollutant loads from the development. However, the effect of the proposed development on water quality is manageable and does not impact the ability to develop the site.

The approach to managing water quality should not only be limited to providing standard treatment items such as a GPT and WQCP, and should consider a range of treatment options as described in Section 6. The selection of the appropriate treatment train should be made following more detailed analysis of the localised constraints and opportunities for water quality management within the development.

6. Stormwater Management

The future stormwater management strategy for the site should adopt a water sensitive urban design (WSUD) approach and include both at-source and end-of-pipe devices for water quantity and quality control. Provided below is a description of the recommendations for water quantity and quality management.

6.1 Stormwater Management Requirements

The proposed stormwater management strategy is required to cater for the increased flow and pollutant loads that are likely to result following development of the study area. In addition, all concentrated stormwater discharge points will require suitable erosion protection to prevent scour at outlets.

It is common practice to design end-of-pipe water quality structures to achieve 50% reduction of total phosphorus and total nitrogen loads. This removal performance can be increased through the implementation of at-source control structures.

6.2 Site Constraints

The major constraints to stormwater management within the site are:

- soil types
- salinity
- inundation due to flooding
- land availability.

From the geotechnical report for the investigation area (Network Geotechnics Ref: G25058/1-D), the soil types mainly comprise of low to medium plasticity clays. Typically, these clays would have low to medium permeability and infiltration of stormwater in future strategies may not be a viable option. The geotechnical report also indicated that several samples returned a high erosion hazard, which may lead to sediment-laden runoff from the site particularly during construction.

In addition, there may be salinity issues near the defined creeklines. The extent of salinity within the study area should be examined further prior to development of a stormwater strategy for the site. If salinity is found to be an issue, groundwater recharge should generally be avoided.

Approximately 16% of the site is subject to inundation from the 100 year recurrence flood. Filling of those portions of the development area prone to flooding may alleviate this problem, however this filling may result in the loss of conveyance and flood storage, and subsequent increases in adjacent flood levels.

These constraints do not exclude development within the North Bellbird investigation area, but indicate that further investigation and analysis will be required at future stages of the application process. Sediment-laden runoff may be managed through development of a soil

and water management plan for the site, erosion and sediment control plans for construction on individual allotments, and by designing the water quality control ponds and gross pollutant traps to manage the amount of sediment being discharged from the area. Infiltration swales and basins may still be incorporated in future strategies, incorporating impermeable membranes to prevent groundwater recharge if salinity is found to be an issue in the investigation area. Localised filling of marginal flood areas may still proceed following further hydraulic analysis to evaluate the impact on existing flood levels at, and upstream of the investigation area.

All major end-of-pipe stormwater management structures (detention basins and water quality control ponds) should be situated offline from flows in Bellbird, Limestone and Lavender Creeks in order to reduce their size.

6.3 Stormwater Management Devices

6.3.1 General

The study area consists of several local drainage catchments that discharge into Bellbird, Limestone and Lavender Creeks. The stormwater management strategy for the development site will manage both runoff quantity and quality. A plan showing each drainage catchment and the location of central drainage structures is shown in Figure 12. It is important that the management devices discussed below are integrated, where practical, into the urban form as part of the master planning process.

Runoff volumes, flow rates and pollutant loads from the proposed development site will be managed using a combination of at-source and end-of-pipe controls in line with the current best practice principles of water sensitive urban design (WSUD) and include:

- stormwater harvesting for reducing runoff volumes
- porous pavements
- grassed swales and buffer strips
- bioretention structures
- gross pollutant traps
- constructed wetlands
- detention storage
- water quality control ponds.

Provided below is a brief description of each control structure.

6.3.2 Stormwater Harvesting

Water Quantity – Allotment Scale

On 1 July 2004, the Building Sustainability Index (BASIX) was introduced into the NSW development approval process. The introduction of BASIX requires that people who wish to build new homes need to include a BASIX Certificate with their development proposals.

BASIX focuses on reducing the amount of mains supply water used in, and greenhouse gases emitted from, residential development.

As of 1 July 2005, a BASIX application will be required for all new dwellings throughout NSW. In recognition of the need for BASIX compliance for any new home, rainwater tanks have been incorporated into the stormwater management strategy.

The collection and use of rainwater from the roofs of houses can provide substantial economic, social and environmental benefits which include:

- reduced costs through smaller downstream drainage infrastructure;
- increased lot yield due to reduction in the number and size of end-of-pipe facilities;
- reduced maintenance of end-of-pipe stormwater infrastructure;
- reduced stormwater pollution, erosion and in-stream velocities;
- opportunity for developer to negotiate reduced infrastructure charges; and
- reduced mains water usage and peak demands.

A rainwater tank will only provide a significant reduction in mains water usage and stormwater discharge when the tank water level is constantly drawn down. This is achieved by using the harvested rainwater for both indoor and outdoor applications. Typical applications include:

- toilet flushing;
- clothes washing (cold water only); and
- garden watering.

Rainwater tanks should be fitted with a first flush bypass device to intercept the first volume of runoff and prevent it entering the tank. Water captured by the bypass device should be discharged to surrounding garden areas.

The use of rainwater tanks can substantially reduce both the peak flows for minor events and annual discharge volumes. The tanks could be designed to include both an upper temporary storage volume for peak flow attenuation plus a lower permanent storage volume for water reuse. Overflows from rainwater tanks should be directed to an infiltration trench or designated soakage area on each allotment.

Water Quantity – Development Scale

Another approach involves stormwater harvesting for non-potable reuse such as irrigation of large open spaces such as parklands that may be situated within the development site. This can be undertaken on a catchment basis by storing runoff in storage dams for later reuse, possibly after treatment, provided existing creek and river flow objectives are not compromised. This can reduce the amount of potable water imported for watering purposes.

Water Quality

Rainwater tanks provided for the collection of roof runoff will reduce the volume of ‘clean’ water being discharged directly to the drainage system and subsequently lead to a potential reduction in the transport of contaminants from each development catchment.

6.3.3 Porous Pavements

Water Quantity

Porous pavements promote stormwater infiltration and come in two forms, namely monolithic and modular. Monolithic structures include porous concrete and porous pavement whilst modular structures include porous pavers and modular lattice structures.

Porous pavements are usually laid on sand or fine gravel, which is underlain by a geofabric and layer of coarse aggregate. The pavement design is to ensure that the required traffic load can be carried.

Porous pavements may be incorporated into:

- Pathways – usage of stabilised gravel materials or loose stone, rather than concrete of asphalt surfacing.
- Carparking spaces and driveways – these areas may be surfaced with loose stone or proprietary permeable pavements provided adequate subsurface drainage is constructed to ensure trafficability during wet weather.

A shallow storage layer of aggregate material, typically 300 to 500mm thick, should be provided beneath permeable pavements for temporary storage of stormwater prior to collection in perforated pipes. Permeable pavements should only be used in areas where the depth to the local water table is greater than 1m.

Water Quality

Porous pavements improve water quality through:

- filtering through the pavement media and underlying material;
- potential biological activity within the pavement and base material; and
- reduction of pollutant loads, as a result of reduced runoff volumes.

The use of porous pavements should be maximised on each allotment.

6.3.4 Grassed Swales and Buffer Strips

Water Quantity

Grassed swales should be incorporated into the urban design of the development and situated on the lowside of roadways where considered practical. Grassed swales provide temporary storage of runoff and as such may help to reduce peak flow rates from frequent storm events. Some seepage may also occur through the base of these structures.

These structures should be considered in combination with pit and pipe networks throughout the development site.

Water Quality

Grassed swales incorporated into road reserves and other open space areas provide an effective at-source treatment technique for the removal of sediment and other pollutants.

Buffer strips should be provided downslope of impervious surfaces such as driveways and footpaths for the removal of sediment and other pollutants. Buffer strips are generally grassed and should precede landscape mounding areas.

6.3.5 Bioretention Structures

Water Quantity

Bioretention structures may take the form of a swale or basin and can help to reduce peak flow rates by providing temporary storage above the filter layer. Water that filters through the filter media will be collected in a drainage layer consisting of perforated pipes.

Some seepage into the underlying soil may also occur from bioretention structures.

Water Quality

Bioretention structures operate by passing runoff through a selected filtration media that is planted with vegetation. The filter media provides stormwater treatment through fine filtration, extended detention and biological uptake.

The vegetated filtration layer is generally a sandy loam and will be situated above the infiltration device for pollutant removal. The vegetation that grows in the filter media enhances its function by preventing erosion of the filter medium, continuously breaking up the soil through plant growth to prevent clogging of the system and providing biofilms on plant roots that pollutants can absorb to.

6.3.6 Gross Pollutant Traps

Water Quantity

Gross pollutant traps provide no benefit to the management of runoff volumes and peak flow rates from urban areas.

Water Quality

Gross pollutant traps will be provided at the outlet of roadway pipe drainage systems for the removal of gross pollutants, coarse sediment, and oils and grease.

Gross pollutant traps will be sized to treat stormwater flows up to and including the 1 year ARI event (sometimes limited to the 3 month ARI storm event) and will precede other treatment structures such as biofiltration devices and water quality control ponds.

6.3.7 Constructed Wetlands

Water Quantity

The temporary treatment storage afforded by constructed wetlands provides some attenuation of runoff from high recurrence storm events. Flows from larger events should be diverted around constructed wetlands to prevent re-entrainment of pollutants and removal of biofilms from macrophytes.

Water Quality

Constructed wetlands generally should be located off-line from the main creeklines and used to treat events up to and including the 1 year storm event. Constructed wetlands should contain deep water and macrophytes zones for the removal of sediment and nutrient uptake. A gross pollutant trap would precede the constructed wetland for the removal of gross pollutants.

Temporary treatment storage would be provided above the permanent water area of the wetland to improve treatment performance.

6.3.8 Detention Storage

Water Quantity

Detention storage would be provided offline from existing major creeklines for the attenuation of peak flow rates from the development site. Detention storage could be provided with a wet (see water quality control ponds below) or dry base. Wet detention basins would contain permanent and temporary treatment storage for water quality control, with sufficient air-space being provided above these storages for mitigating flow rates. Dry detention basins could be incorporated into dual purpose facilities and used by the community during dry weather.

Additional detention storage would be achieved immediately upstream of all road crossings of existing drainage lines. Culverts will be placed beneath the road embankment at these locations and the available ponding storage situated upstream will be used for the attenuation of peak flow rates.

Water Quality

Detention storages provide very little water quality benefit on there own but can encourage sedimentation if detention times are sufficient. In instances where detention storage is built into WQCP's then much greater pollutant removal is achieved.

6.3.9 Water Quality Control Ponds

Water Quantity

Sufficient air space would be provided above the temporary treatment storage of all WQCP's for the attenuation of peak flow rates from the development site.

Water Quality

Permanent water bodies would be situated within detention structures to provide additional water quality control from the development site.

WQCP's would be provided with an extended detention depth and an orifice outlet to drawdown the temporary treatment storage over a 2 day period.

In some instances, it may be practical to augment existing farm dams located on the site to achieve the required level of treatment. Minor improvement works in the form of

embankment raising and formalising outlet structures would be needed if existing farm dams are to be used.

Appropriate scour protection and embankment stabilisation works would be provided on all outlets. Degraded dam banks would be stabilised with macrophyte plant species endemic to the area. Some minor excavation of existing dams may also be required for the planting of emergent macrophytes and provision of safe egress paths.

6.4 Soil and Water Management during Construction

Soils across the proposed development site would be disturbed during earthworks for the construction of roads and drainage leading to potential soil erosion and sediment export. Potential impacts occurring directly from the soil eroded during the construction phase of each development site include:

- increased turbidity in receiving water bodies
- damage to aquatic biota
- siltation of downstream waterways.

An Erosion and Sediment Control Plan (ESCP) would be prepared at the detailed design stage using the principles provided in 'Managing Urban Stormwater – Soils and Construction' (the Blue Book). Management techniques would include:

- stabilising disturbed areas with vegetation as soon as practicable after completion of construction
- minimising site disturbance by containing machinery access to site areas required for approved construction works, access tracks or material stockpiling
- reducing erosion potential by managing runoff fetches and velocities with measures such as contour drains, silt fences and level spreaders
- use of sediment filters such as silt fences, hay bales, or turf strips, downstream of disturbed areas
- shaker hump placed at the construction exit to remove excess mud from truck tyres/underbodies
- revegetation of cut batters, fill embankments and site regrading areas
- WQCPs and temporary sediment basins for treatment of disturbed runoff prior to discharge.

7. General Design Considerations

This section discusses other factors that should be considered for the design of water quantity and quality structures.

7.1 Batter Slopes

All batters within and around storage structures are to be maximum 1V:4H with 1V:6H considered desirable for safety and maintenance purposes. In instances where steeper batter slopes are required, planting with suitable vegetation is to be provided. Egress paths from permanent water holding structures should be no steeper than 1V:8H.

7.2 Access for Maintenance

Vehicle and plant access to major drainage elements is essential to ensure efficient functioning. Generally, access paths should be:

- trafficable under all weather conditions
- structurally designed to suit the intended vehicle
- provided with a suitable turning head to allow manoeuvrability of intended vehicle
- provided with a lockable gate to prevent unauthorised entry
- clear of overhead obstructions.

7.3 Geotechnical Investigation and Design

The location of all water holding structures should be assessed by a geotechnical engineer to confirm subsurface conditions. Storage embankments are to be designed to withstand the anticipated hydrostatic loads.

7.4 Signage

Flood warning signs should be erected around storage structures and adjacent to major drainage lines for improving public safety. Additional educational signage for water quality structures may be required outlining device function and operation.

7.5 Landscaping

Landscaping of all open space areas should be compatible with the surrounding area. The planting of shrubs and trees within detention storages should be avoided where possible due to the potential for loss of storage.

Macrophytes species are to be provided within permanent water structures for bank stabilisation and water quality treatment.

7.6 Development Controls

Controls on development levels relative to creek flood levels and detention basin designs are necessary to make allowance for accuracy of water level estimation, pipe blockages, wave action and extreme events. All residential development (habitable areas) should have a finished floor level at least 500mm higher than the estimated 100 year water level.

8. Conclusions and Recommendations

The site has an area of 496 hectares and is situated within the Bellbird and Lavender Creek catchments. The majority of the study area drains in a north-easterly direction to the township of Cessnock.

Hydraulic modelling of drainage lines crossing the site indicate that approximately 77ha (16%) of the proposed development site is subject to inundation during the 100 year flood event.

An extreme flood event such as the PMf will result in additional inundation over and above the 100 year ARI flood event. An emergency evacuation plan will need to be developed in consultation with Council and SES. An evacuation plan may also include locations elevated above the PMF level, where residents may safely congregate during an extreme flood event.

Hydrologic modelling of existing and developed conditions suggests that there will be a negligible change in peak discharges for the 1, 5, 10, 20 and 100 year ARI storm events operating on the scale of the Bellbird Creek catchment to the outlet of the development site. Thus, it is unlikely that downstream flooding from events operating on a catchment scale, and producing the greatest flow rates, will be exacerbated as a result of developing the site.

Hydrologic modelling of existing and developed conditions suggests however that there will be an increase in existing peak discharges for the 1, 5, 10, 20 and 100 year ARI storm events operating on the local development catchment scale. It is recommended that detention storage be provided as part of future development to mitigate developed flows to existing conditions.

Detention storage will be provided offline from all existing major flow paths and, for ease of planning and implementation, incorporated into water quality control ponds. Additional storage will be provided on all allotments in the form of rainwater tanks, with harvested water reused for toilet flushing, clothes washing and garden watering.

All water quality control devices for the treatment of runoff from developed areas will also be situated offline from major flow paths and may include a combination of gross pollutant traps, grassed swales, bioretention devices and constructed wetlands.

This North Bellbird Flooding and Stormwater Assessment report documents a study that examined, at a high strategic level, existing flooding and stormwater management constraints in the North Bellbird Investigation Area. The results from this investigation do not preclude future residential development on marginal flood areas so long as further detailed, and site specific, flood analysis is undertaken and appropriate engineering controls are implemented for the management of quality and quantity of local runoff. The results of future flood analysis of possible engineering solutions should indicate negligible impact on the existing flooding environment at, and upstream of the investigation area.

Future water quality solutions for the site should be analysed and designed in accordance with the recommendations of Australian Runoff Quality (Engineers Australia, 2006). Water quantity management structures should be designed in accordance with Cessnock City Council's drainage handbook.

9. References

- Bureau of Meteorology (BOM), 1999, Climatic atlas of Australia: evapotranspiration
- Cessnock City Council, December 2003, Stage 1 City Wide Settlement Strategy.
- Institution of Engineers Australia, 1997, Australian Rainfall and Runoff.
- Engineers Australia, 2006, Australian Runoff Quality
- Patterson Britton & Partners, January 2005, Lavender and Bellbird Creek Flood Study – Issue 3.
- Department of Environment and Conservation (DEC); Environment Protection Authority (EPA), 1997, *Managing urban stormwater strategic framework*
- Department of Infrastructure Planning and Natural Resources (DPNR), 1998, *Constructed wetlands manual*
- Duncan H P, 1999, *Urban stormwater quality: a statistical overview*, Cooperative Research Centre for Catchment Hydrology (CRC)
- U.S. Army Corps of Engineers, 1997, HEC-RAS River Analysis System, Hydraulic Reference Manual.
- Bureau of Meteorology, 1994, Bulletin 53 – The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-duration Method.

Figures

Figure 1: Locality Plan

Figure 2: Land Tenure and Topography

Figure 3: Bellbird Creek Subcatchment Layout

Figure 4: Local Development Subcatchment Layout

Figure 5: Location of HEC-RAS Cross Sections – 100 year Model

Figure 6: Location of HEC-RAS Cross Sections – PMF Model

Figure 7: Existing Flood Envelopes Site Plan

Figure 8: Existing Flood Envelopes Sheet 1

Figure 9: Existing Flood Envelopes Sheet 2

Figure 10: Existing Flood Envelopes Sheet 3

Figure 11: Existing Flood Envelopes Sheet 4

Figure 12: Nominal Development Areas and Location of Detention Basins/WQCP's

Appendix A

Cessnock IFD

IFD ANALYSIS BASED ON AUSTRALIAN RAINFALL & RUNOFF (1987)

Site name: CESSNOCK

Site latitude = 32.86 degrees S
longitude = 151.32 degrees E
skewness = .06

2-year ARI, 1 hour intensity = 27.40 mm/hr
12 hour intensity = 5.80 mm/hr
72 hour intensity = 1.75 mm/hr

50-year ARI, 1 hour intensity = 49.70 mm/hr
12 hour intensity = 11.65 mm/hr
72 hour intensity = 3.50 mm/hr

IFD Table for Various ARIs and Durations

Duration	1 yr	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr	200 yr	500 yr
5 min	70.44	90.37	116.64	132.20	152.81	180.08	201.06	222.52	251.79
6 min	65.97	84.58	108.98	123.40	142.52	167.80	187.25	207.12	234.21
10 min	53.87	68.93	88.33	99.73	114.90	134.92	150.28	165.94	187.26
12 min	49.77	63.63	81.36	91.76	105.62	123.89	137.89	152.16	171.57
15 min	44.95	57.41	73.21	82.44	94.78	111.02	123.45	136.12	153.32
18 min	41.20	52.58	66.89	75.23	86.40	101.08	112.31	123.74	139.25
20 min	39.12	49.90	63.39	71.24	81.76	95.59	106.16	116.92	131.50
24 min	35.67	45.46	57.60	64.65	74.12	86.55	96.04	105.69	118.76
30 min	31.73	40.39	51.02	57.17	65.45	76.30	84.58	92.98	104.36
45 min	25.39	32.25	40.49	45.22	51.64	60.02	66.39	72.86	81.59
1.0 hr	21.53	27.30	34.13	38.03	43.34	50.26	55.51	60.83	68.01
1.5 hr	16.78	21.33	26.84	30.02	34.31	39.92	44.19	48.53	54.39
2.0 hr	14.01	17.84	22.56	25.29	28.97	33.79	37.47	41.20	46.26
3.0 hr	10.83	13.83	17.61	19.81	22.76	26.64	29.61	32.63	36.73
4.5 hr	8.36	10.70	13.72	15.50	17.86	20.98	23.37	25.81	29.13
6.0 hr	6.96	8.93	11.50	13.03	15.04	17.71	19.76	21.86	24.72
9.0 hr	5.38	6.92	8.98	10.20	11.82	13.96	15.62	17.31	19.63
12.0 hr	4.49	5.78	7.53	8.58	9.96	11.80	13.22	14.67	16.67
18.0 hr	3.48	4.48	5.84	6.65	7.72	9.14	10.24	11.36	12.90
24.0 hr	2.90	3.73	4.86	5.53	6.42	7.60	8.52	9.45	10.73
30.0 hr	2.51	3.23	4.20	4.79	5.55	6.58	7.37	8.17	9.28
36.0 hr	2.22	2.86	3.72	4.24	4.92	5.83	6.52	7.24	8.22
48.0 hr	1.82	2.35	3.06	3.48	4.04	4.78	5.35	5.94	6.74
72.0 hr	1.35	1.74	2.27	2.58	3.00	3.54	3.97	4.40	5.00

IFD Polynomial: ln I = a + b*ln(D) + c*ln(D)**2 + d*ln(D)**3 + e*ln(D)**4 + f*ln(D)**5 + g*ln(D)**6
where duration D is in hrs and average intensity I is in mm/hr

ARI	a	b	c	d	e	f	g	Max % error
1	3.0659984	-.5938048	-.0340206	.0080459	.0006577	-.0002646	-.0000118	.36
2	3.3051064	-.5934464	-.0302330	.0080699	.0002933	-.0002586	-.0000030	.19
5	3.5327774	-.5924426	-.0198056	.0081367	-.0007100	-.0002423	.0000213	.26
10	3.6434206	-.5919112	-.0142842	.0081721	-.0012413	-.0002336	.0000342	.51
20	3.7761103	-.5914689	-.0096890	.0082015	-.0016835	-.0002264	.0000448	.71
50	3.9265567	-.5909673	-.0044788	.0082348	-.0021849	-.0002183	.0000570	.93
100	4.0275511	-.5906307	-.0009812	.0082572	-.0025214	-.0002128	.0000651	1.09
200	4.1204602	-.5903210	.0022363	.0082778	-.0028311	-.0002078	.0000726	1.23
500	4.2336758	-.5899436	.0061572	.0083029	-.0032083	-.0002016	.0000817	1.40

IFD ANALYSIS BASED ON AUSTRALIAN RAINFALL & RUNOFF (1987)

Overland Flow Travel Time Aid
Table of t*I**0.4 where t = time in min and I = intensity in mm/h

Duration	1 yr	2 yr	5 yr	10 yr	20 yr	50 yr	100 yr	200 yr	500 yr
5 min	27.43	30.30	33.55	35.26	37.36	39.89	41.69	43.41	45.60
6 min	32.05	35.40	39.19	41.19	43.64	46.59	48.69	50.70	53.26
7 min	36.52	40.34	44.64	46.91	49.69	53.04	55.42	57.70	60.60
8 min	40.87	45.13	49.92	52.44	55.54	59.27	61.92	64.46	67.69
9 min	45.11	49.80	55.05	57.82	61.22	65.32	68.22	71.00	74.55
10 min	49.25	54.36	60.06	63.06	66.75	71.19	74.34	77.36	81.21
12 min	57.27	63.19	69.73	73.17	77.41	82.52	86.14	89.61	94.02
14 min	64.99	71.68	79.02	82.87	87.64	93.37	97.43	101.32	106.27
16 min	72.45	79.88	87.98	92.23	97.50	103.83	108.31	112.60	118.06
18 min	79.69	87.84	96.67	101.30	107.04	113.94	118.83	123.51	129.46
20 min	86.74	95.59	105.12	110.10	116.31	123.77	129.05	134.10	140.52
22 min	93.61	103.13	113.35	118.69	125.34	133.34	139.00	144.41	151.29
24 min	100.33	110.51	121.39	127.07	134.17	142.69	148.72	154.48	161.81
26 min	106.90	117.73	129.26	135.28	142.80	151.84	158.23	164.34	172.10
28 min	113.34	124.81	136.98	143.32	151.27	160.81	167.55	174.00	182.19
30 min	119.67	131.75	144.55	151.22	159.58	169.61	176.70	183.49	192.10
40 min	149.78	164.84	180.65	188.87	199.21	211.62	220.39	228.77	239.41

Appendix B

Subcatchment Parameters – Bellbird, Limestone and Lavender Creek Catchments

PB PARSONS BRINCKERHOFF

North Bellbird Flooding and Stormwater Assessment

Existing RAFTS Model Subcatchment Data

Node	Total Area (ha)	% Imperv	EXISTING MODEL						
			Pervious Area (ha) (#1)	Impervious Area (ha) (#2)	Slope (%)	Losses - Perv (#1)	Losses - Imperv (#2)	'n' Pervious (#1)	'n' Impervious (#2)
BEL.1	205.3	0%	205.3	0.0	3.5%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
BEL.2	171.3	0%	171.3	0.0	1.5%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
BEL.3	58.5	10%	52.7	5.9	8.5%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.4	156.2	0%	156.2	0.0	15.0%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
BEL.5	296.4	0%	296.4	0.0	5.0%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
BEL.6	56.1	50%	28.1	28.1	1.3%	IL15 CL4.5	IL10 CL0.0	0.05	0.025
BEL.7	57.4	40%	34.4	23.0	1.5%	IL15 CL2.5	IL10 CL0.0	0.05	0.025
BEL.8	46.9	20%	37.5	9.4	2.2%	IL15 CL2.5	IL10 CL0.0	0.05	0.025
BEL.9	19.6	0%	19.6	0.0	4.5%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.10	13.6	0%	13.6	0.0	4.5%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.11	6.6	0%	6.6	0.0	3.5%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.12	19.9	0%	19.9	0.0	2.0%	IL15 CL2.5	IL10 CL0.0	0.08	0.025
BEL.13	21.3	0%	21.3	0.0	2.0%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.14	26.4	0%	26.4	0.0	3.5%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.15	5.9	0%	5.9	0.0	3.5%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.16	2.9	0%	2.9	0.0	3.5%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.17	19.4	0%	19.4	0.0	2.0%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.18	12.9	0%	12.9	0.0	2.0%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.19	8.7	0%	8.7	0.0	1.0%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.20	15.6	0%	15.6	0.0	1.0%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.21	6.1	0%	6.1	0.0	1.0%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.22	14.3	0%	14.3	0.0	1.0%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.23	18.1	0%	18.1	0.0	1.5%	IL15 CL2.5	IL10 CL0.0	0.06	0.025
BEL.24	184.4	60%	73.8	110.6	1.5%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
BEL.25	38.8	65%	13.6	25.2	1.5%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
LIM.1	35.3	10%	31.8	3.5	5.5%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
LIM.2	9.1	0%	9.1	0.0	3.0%	IL15 CL2.5	IL10 CL0.0	0.05	0.025
LIM.3	3.9	0%	3.9	0.0	3.0%	IL15 CL2.5	IL10 CL0.0	0.05	0.025
LIM.4	185.3	5%	176.0	9.3	5.0%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
LIM.5	26.5	0%	26.5	0.0	3.0%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
LIM.6	7.1	0%	7.1	0.0	2.5%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
LIM.7	4.6	0%	4.6	0.0	2.5%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
LIM.8	417.3	0%	417.3	0.0	10.0%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
LIM.9	135.1	0%	135.1	0.0	10.0%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
LIM.10	17.1	0%	17.1	0.0	10.0%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
LIM.11	0.0	0%	0.0	0.0	10.0%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
LIM.12	8.3	0%	8.3	0.0	10.0%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
LIM.13	13.9	0%	13.9	0.0	9.0%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
LIM.14	27.8	0%	27.8	0.0	10.0%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
LIM.15	15.6	0%	15.6	0.0	8.0%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
LIM.16	22.2	0%	22.2	0.0	7.5%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
LIM.17	0.0	0%	0.0	0.0	0.0%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
LIM.18	13.7	0%	13.7	0.0	5.5%	IL15 CL4.5	IL10 CL0.0	0.12	0.025
LIM.19	6.0	0%	6.0	0.0	2.5%	IL15 CL4.5	IL10 CL0.0	0.06	0.025
LIM.20	3.4	0%	3.4	0.0	2.0%	IL15 CL4.5	IL10 CL0.0	0.06	0.025
LIM.21	4.8	0%	4.8	0.0	2.0%	IL15 CL4.5	IL10 CL0.0	0.06	0.025
LIM.22	12.0	0%	12.0	0.0	2.0%	IL15 CL4.5	IL10 CL0.0	0.06	0.025
LIM.23	24.2	0%	24.2	0.0	5.0%	IL15 CL4.5	IL10 CL0.0	0.06	0.025
LIM.24	46.8	0%	46.8	0.0	2.5%	IL15 CL4.5	IL10 CL0.0	0.06	0.025
LIM.25	12.7	0%	12.7	0.0	2.0%	IL15 CL4.5	IL10 CL0.0	0.06	0.025
LIM.26	4.8	0%	4.8	0.0	2.0%	IL15 CL4.5	IL10 CL0.0	0.06	0.025
UKN.1	81.9	0%	81.9	0.0	4.5%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
UKN.2	145.9	0%	145.9	0.0	6.0%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
UKN.3	0.0	0%	0.0	0.0	0.0%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
UKN.4	70.1	10%	63.1	7.0	1.2%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
UKN.5	25.8	20%	20.6	5.2	3.0%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
UKN.6	29.6	20%	23.7	5.9	50.0%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
UKN.7	32.1	65%	11.2	20.9	2.5%	IL15 CL4.5	IL10 CL0.0	0.07	0.025
UKN.8	29.1	60%	11.6	17.5	3.0%	IL15 CL4.5	IL10 CL0.0	0.05	0.025
Totals	**2954.6**		**2683.3**	**271.3**					

Appendix C

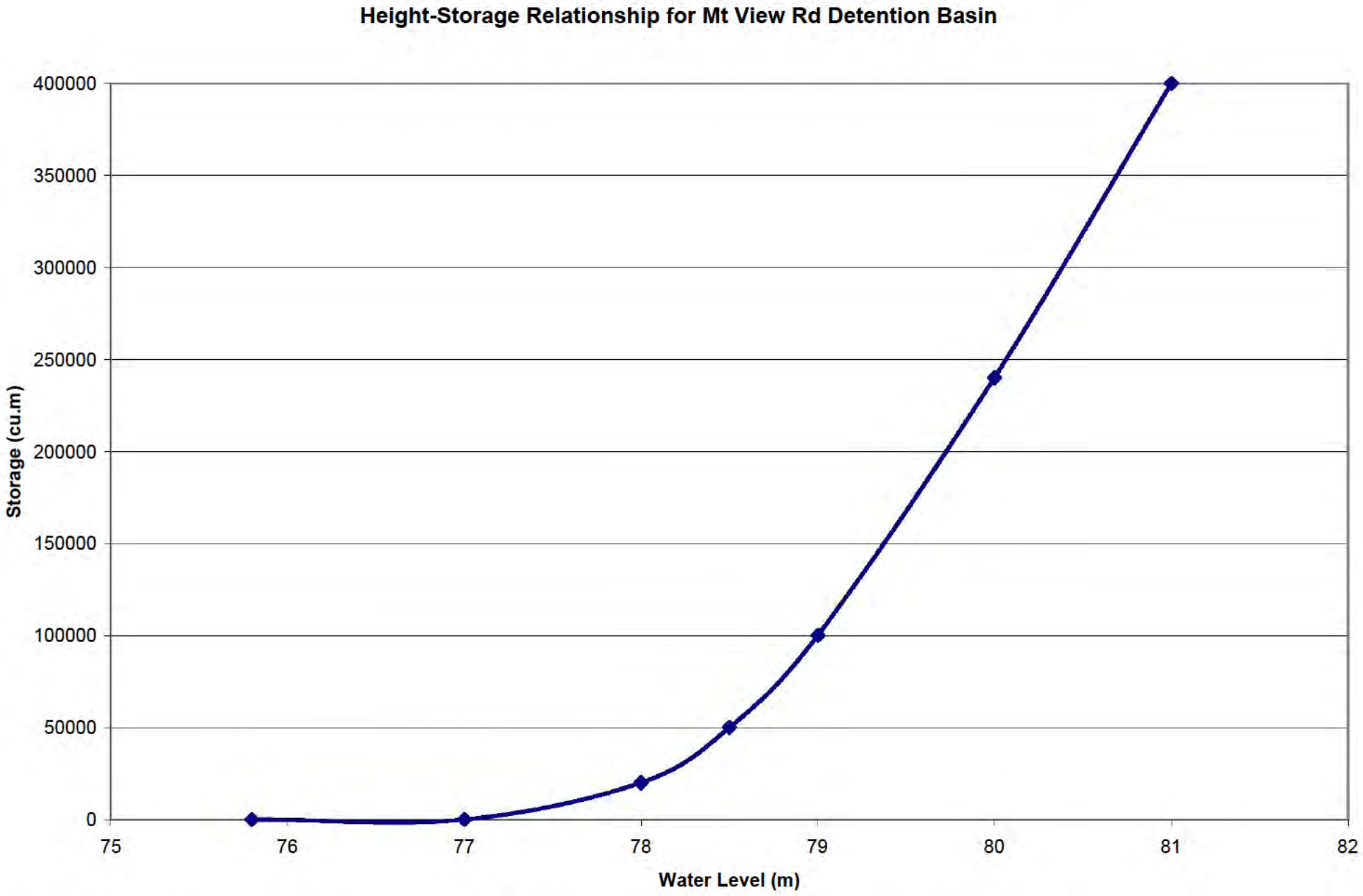
Subcatchment Parameters – Local Development Catchment

Developed RAFTS Model Subcatchment Data

Node	DEVELOPED MODEL						
	Pervious Area (ha) (#1)	Impervious Area (ha) (#2)	Slope (%)	Losses - Perv (#1)	Losses - Imperv (#2)	'n' Pervious (#1)	'n' Impervious (#2)
BEL.1	205.3	0.0	3.5%	IL15 CL4.5	Developed	0.12	0.025
BEL.2	171.3	0.0	1.5%	IL15 CL4.5	Developed	0.12	0.025
BEL.3	52.7	5.9	8.5%	IL15 CL2.5	Developed	0.06	0.025
BEL.4	156.2	0.0	15.0%	IL15 CL4.5	Developed	0.12	0.025
BEL.5	296.4	0.0	5.0%	IL15 CL4.5	Developed	0.12	0.025
BEL.6	28.1	28.1	1.3%	IL15 CL4.5	Developed	0.05	0.025
BEL.7	34.4	23.0	1.5%	IL15 CL4.5	Developed	0.05	0.025
BEL.8	37.5	9.4	2.2%	IL15 CL4.5	Developed	0.05	0.025
BEL.9	9.8	9.8	4.5%	IL15 CL2.5	Developed	0.06	0.025
BEL.10	6.8	6.8	4.5%	IL15 CL2.5	Developed	0.06	0.025
BEL.11	3.3	3.3	3.5%	IL15 CL2.5	Developed	0.06	0.025
BEL.12	10.0	10.0	2.0%	IL15 CL2.5	Developed	0.08	0.025
BEL.13	10.7	10.7	2.0%	IL15 CL2.5	Developed	0.06	0.025
BEL.14	13.2	13.2	3.5%	IL15 CL2.5	Developed	0.06	0.025
BEL.15	3.0	3.0	3.5%	IL15 CL2.5	Developed	0.06	0.025
BEL.16	1.5	1.5	3.5%	IL15 CL2.5	Developed	0.06	0.025
BEL.17	9.7	9.7	2.0%	IL15 CL2.5	Developed	0.06	0.025
BEL.18	6.5	6.5	2.0%	IL15 CL2.5	Developed	0.06	0.025
BEL.19	4.4	4.4	1.0%	IL15 CL2.5	Developed	0.06	0.025
BEL.20	7.8	7.8	1.0%	IL15 CL2.5	Developed	0.06	0.025
BEL.21	3.1	3.1	1.0%	IL15 CL2.5	Developed	0.06	0.025
BEL.22	7.2	7.2	1.0%	IL15 CL2.5	Developed	0.06	0.025
BEL.23	9.1	9.1	1.5%	IL15 CL2.5	Developed	0.06	0.025
BEL.24	73.8	110.6	1.5%	IL15 CL4.5	Developed	0.07	0.025
BEL.25	13.6	25.2	1.5%	IL15 CL4.5	Developed	0.07	0.025
LIM.1	31.8	3.5	5.5%	IL15 CL4.5	Developed	0.07	0.025
LIM.2	4.6	4.6	3.0%	IL15 CL2.5	Developed	0.06	0.025
LIM.3	2.0	2.0	3.0%	IL15 CL2.5	Developed	0.06	0.025
LIM.4	176.0	9.3	5.0%	IL15 CL4.5	Developed	0.07	0.025
LIM.5	13.3	13.3	3.0%	IL15 CL4.5	Developed	0.06	0.025
LIM.6	3.6	3.6	2.5%	IL15 CL4.5	Developed	0.06	0.025
LIM.7	2.3	2.3	2.5%	IL15 CL4.5	Developed	0.06	0.025
LIM.8	417.3	0.0	10.0%	IL15 CL4.5	Developed	0.07	0.025
LIM.9	135.1	0.0	10.0%	IL15 CL4.5	Developed	0.12	0.025
LIM.10	8.6	8.6	10.0%	IL15 CL4.5	Developed	0.12	0.025
LIM.11	0.0	0.0	10.0%	IL15 CL4.5	Developed	0.12	0.025
LIM.12	4.2	4.2	10.0%	IL15 CL4.5	Developed	0.12	0.025
LIM.13	7.0	7.0	9.0%	IL15 CL4.5	Developed	0.12	0.025
LIM.14	13.9	13.9	10.0%	IL15 CL4.5	Developed	0.12	0.025
LIM.15	7.8	7.8	8.0%	IL15 CL4.5	Developed	0.12	0.025
LIM.16	11.1	11.1	7.5%	IL15 CL4.5	Developed	0.12	0.025
LIM.17	0.0	0.0	0.0%	IL15 CL4.5	Developed	0.12	0.025
LIM.18	6.9	6.9	5.5%	IL15 CL4.5	Developed	0.12	0.025
LIM.19	3.0	3.0	2.5%	IL15 CL4.5	Developed	0.06	0.025
LIM.20	1.7	1.7	2.0%	IL15 CL4.5	Developed	0.06	0.025
LIM.21	2.4	2.4	2.0%	IL15 CL4.5	Developed	0.06	0.025
LIM.22	6.0	6.0	2.0%	IL15 CL4.5	Developed	0.06	0.025
LIM.23	12.1	12.1	5.0%	IL15 CL4.5	Developed	0.06	0.025
LIM.24	23.4	23.4	2.5%	IL15 CL4.5	Developed	0.06	0.025
LIM.25	6.4	6.4	2.0%	IL15 CL4.5	Developed	0.06	0.025
LIM.26	2.4	2.4	2.0%	IL15 CL4.5	Developed	0.06	0.025
UKN.1	81.9	0.0	4.5%	IL15 CL4.5	Developed	0.07	0.025
UKN.2	145.9	0.0	6.0%	IL15 CL4.5	Developed	0.07	0.025
UKN.3	0.0	0.0	0.0%	IL15 CL4.5	Developed	0.07	0.025
UKN.4	63.1	7.0	1.2%	IL15 CL4.5	Developed	0.07	0.025
UKN.5	20.6	5.2	3.0%	IL15 CL4.5	Developed	0.07	0.025
UKN.6	23.7	5.9	50.0%	IL15 CL4.5	Developed	0.07	0.025
UKN.7	11.2	20.9	2.5%	IL15 CL4.5	Developed	0.07	0.025
UKN.8	11.6	17.5	3.0%	IL15 CL4.5	Developed	0.05	0.025
	2435.4	**519.2**					

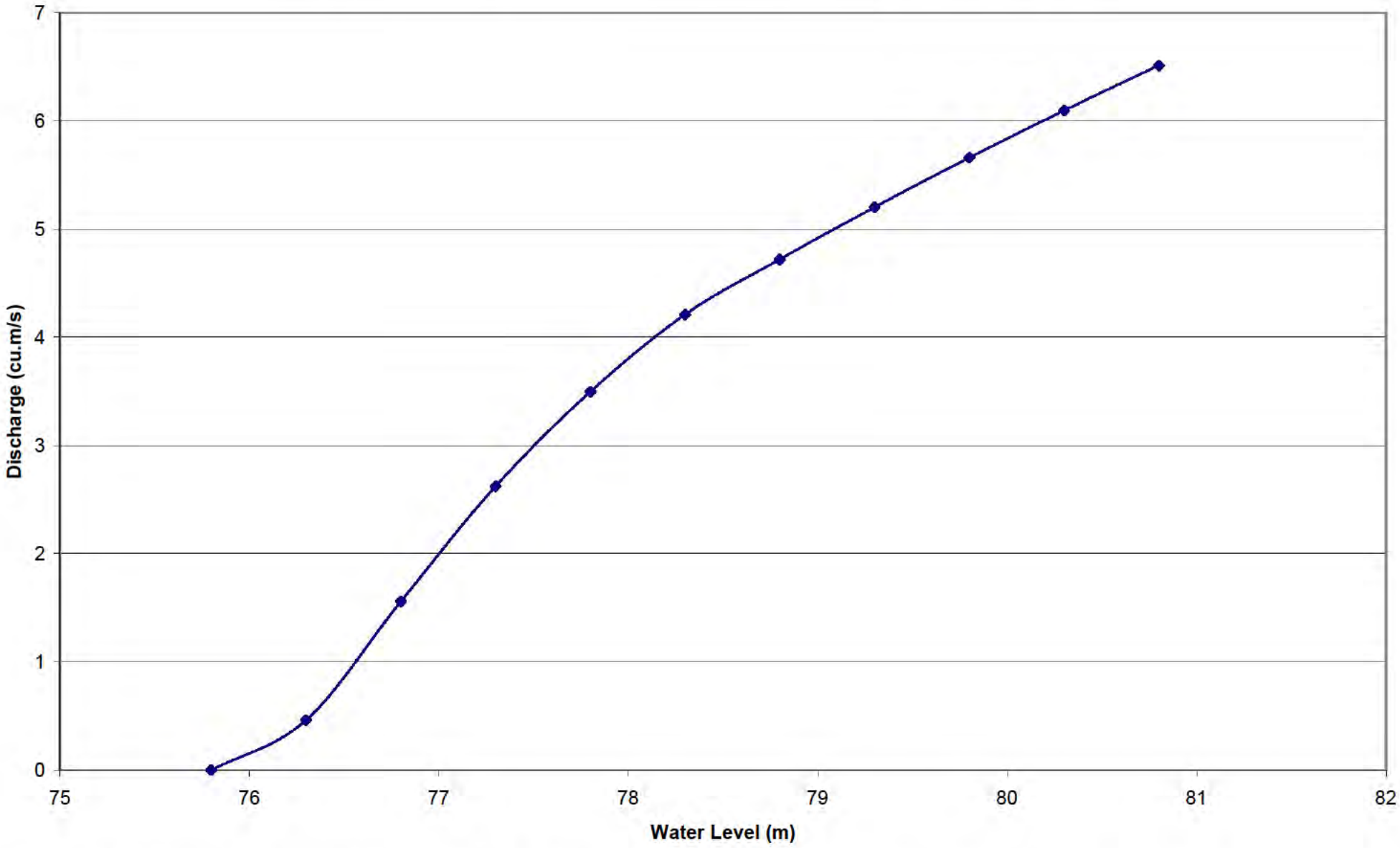
Appendix D

Height-Storage-Discharge Relationship for Mount View Road Detention Basin



J:\A502-NCL\PROJ\21225XX\2122527A\5_WrkPapers\PR0872rC Flooding\Appendix D - Mt View Detention Basin Height-Storage-Discharge.xls

Height-Discharge Relationship for Culvert at Mt View Rd Detention Basin



J:\A502-NCL\PROJ\21225XX\2122527A\5_WrkPapers\PR0872rC Flooding\Appendix D - Mt View Detention Basin Height-Storage-Discharge.xls

Appendix E

PRM Peak Flow Rate Estimates

North Bellbird Flooding and Stormwater Assessment
Johnson Property Group
Job No: 2122527A
PRM Calcs - Bellbird - 1yr ARI
27/06/2005 AS

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	1	$^{10}I_1$ =	38.03	mm/h
C10	0.4	Min Tc		5
Rainfall Data for:		CESSNOCK		

Minimum tc	5
Me hod for tc	2

1 = Bransby Williams
2 = Regional $tc=0.76A^{0.38}$
3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural (Zone B)	FFy	0.62	0.74	0.88	1	1.12	1.2548	1.3889
Urban	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			TIME OF CONC.		RAINFALL	CA	**FLOW**
	Area	%Imperv.	FFy	C	CA	L	S	n	Bransby.W	Regional	Kinema ic	tc	L	v	t	u/s	his	INTENSITY		
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
BEL.23 (Whole Catchment)	2540	0.0%	0.62	0.248	629.92					155.9		155.9				0.0	155.9	11.9	629.9	20.81

North Bellbird Flooding and Stormwater Assessment
Johnson Property Group
Job No: 2122527A
PRM Calcs - Bellbird - 5yr ARI
27/06/2005 AS

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	5	$^{10}I_1$ =	38.03	mm/h
C10	0.4	Min Tc		5
Rainfall Data for:		CESSNOCK		

Minimum tc	5
Me hod for tc	2

1 = Bransby Williams
2 = Regional $tc=0.76A^{0.38}$
3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural (Zone B)	FFy	0.62	0.74	0.88	1	1.12	1.2548	1.3889
Urban	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			TIME OF CONC.		RAINFALL	CA	**FLOW**
	Area	%Imperv.	FFy	C	CA	L	S	n	Bransby.W	Regional	Kinema ic	tc	L	v	t	u/s	his	INTENSITY		
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
BEL.23 (Whole Catchment)	2540	0.0%	0.88	0.352	894.08					155.9		155.9				0.0	155.9	19.2	894.1	47.75

North Bellbird Flooding and Stormwater Assessment
Johnson Property Group
Job No: 2122527A
PRM Calcs - Bellbird - 10yr ARI
27/06/2005 AS

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	10	$^{10}I_1$ =	38.03	mm/h
C10	0.4	Min Tc		5
Rainfall Data for:		CESSNOCK		

Minimum tc	5
Me hod for tc	2

1 = Bransby Williams
2 = Regional tc=0.76Á$^{0.38}$
3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural (Zone B)	FFy	0.62	0.74	0.88	1	1.12	1.2548	1.3889
Urban	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			TIME OF CONC.		RAINFALL	CA	**FLOW**
	Area	%Imperv.	FFy	C	CA	L	S	n	Bransby.W	Regional	Kinema ic	tc	L	v	t	u/s	his	INTENSITY		
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
BEL.23 (Whole Catchment)	2540	0.0%	1	0.400	1016 00					155.9		155.9				0.0	155.9	21.6	1016 0	60.92

North Bellbird Flooding and Stormwater Assessment
Johnson Property Group
Job No: 2122527A
PRM Calcs - Bellbird - 20yr ARI
27/06/2005 AS

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	20	$^{10}I_1$ =	38.03	mm/h
C10	0.4	Min Tc		5
Rainfall Data for:		CESSNOCK		

Minimum tc	5
Me hod for tc	2

1 = Bransby Williams
2 = Regional tc=0.76$A^{0.38}$
3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural (Zone B)	FFy	0.62	0.74	0.88	1	1.12	1.2548	1.3889
Urban	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			TIME OF CONC.		RAINFALL	CA	**FLOW**
	Area	%Imperv.	FFy	C	CA	L	S	n	Bransby.W	Regional	Kinema ic	tc	L	v	t	u/s	his	INTENSITY		
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
BEL.23 (Whole Catchment)	2540	0.0%	1.12	0.448	1137 92					155.9		155.9				0.0	155.9	24.7	1137 9	78.24

North Bellbird Flooding and Stormwater Assessment
Johnson Property Group
Job No: 2122527A
PRM Calcs - Bellbird - 100yr ARI
27/06/2005 AS

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	100	$^{10}I_1$ =	38.03	mm/h
C10	0.4	Min Tc		5
Rainfall Data for:		CESSNOCK		

Minimum tc	5
Me hod for tc	2

1 = Bransby Williams
2 = Regional tc=0.76Á$^{0.38}$
3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural (Zone B)	FFy	0.62	0.74	0.88	1	1.12	1.2548	1.3889
Urban	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			TIME OF CONC.		RAINFALL	CA	**FLOW**
	Area	%Imperv.	FFy	C	CA	L	S	n	Bransby.W	Regional	Kinema ic	tc	L	v	t	u/s	his	INTENSITY		
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
BEL.23 (Whole Catchment)	2540	0.0%	1.3889	0.556	1411.15					155.9		155.9				0.0	155.9	32.1	1411 2	125.78

North Bellbird Flooding and Stormwater Assessment
Johnson Property Group
Job No: 2122527A
PRM Calcs - Local - 1yr ARI
27/06/2005 **AS**

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	1	$^{10}I_1$ =	38.03	mm/h
C10	0.4	Min Tc	5	
Rainfall Data for:		CESSNOCK		

Minimum tc	5
Method for tc	2

1 = Bransby Williams
2 = Regional tc=0.76$A^{0.38}$
3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural (Zone B)	FFy	0.62	0.74	0.88	1	1.12	1.2548	1.3889
Urban	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			TIME OF CONC.		RAINFALL INTENSITY	CA	**FLOW**
	Area	%Imperv.	FFy	C	CA	L	S	n	Bransby.W	Regiona	Kinematic	tc	L	v	t	u/s	this			
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
BEL.23 (Local Catchments)	496	0.0%	0.62	0.248	123.01				#DIV/0!	83.8	#DIV/0!	83.8				0.0	83.8	17.5	123.0	6.00

North Bellbird Flooding and Stormwater Assessment
Johnson Property Group
Job No: 2122527A
PRM Calcs - Local - 5yr ARI
27/06/2005 **AS**

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	5	$^{10}I_1$ =	38.03	mm/h
C10	0.4	Min Tc	5	
Rainfall Data for:		CESSNOCK		

Minimum tc	5
Method for tc	2

1 = Bransby Williams
2 = Regional tc=0.76$A^{0.38}$
3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural (Zone B)	FFy	0.62	0.74	0.88	1	1.12	1.2548	1.3889
Urban	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			TIME OF CONC.		RAINFALL INTENSITY	CA	**FLOW**
	Area	%Imperv.	FFy	C	CA	L	S	n	Bransby.W	Regiona	Kinematic	tc	L	v	t	u/s	this			
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
BEL.23 (Local Catchments)	496	0.0%	0.88	0.352	174.59				#DIV/0!	83.8	#DIV/0!	83.8				0.0	83.8	28.0	174.6	13.60

North Bellbird Flooding and Stormwater Assessment
Johnson Property Group
Job No: 2122527A
PRM Calcs - Local -10yr ARI
27/06/2005 **AS**

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	10	$^{10}I_1$ =	38.03	mm/h
C10	0.4	Min Tc	5	
Rainfall Data for:		CESSNOCK		

Minimum tc	5
Method for tc	2

1 = Bransby Williams
2 = Regional tc=0.76$A^{0.38}$
3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural (Zone B)	FFy	0.62	0.74	0.88	1	1.12	1.2548	1.3889
Urban	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			TIME OF CONC.		RAINFALL INTENSITY	CA	**FLOW**
	Area	%Imperv.	FFy	C	CA	L	S	n	Bransby.W	Regiona	Kinematic	tc	L	v	t	u/s	this			
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
BEL.23 (Local Catchments)	496	0.0%	1	0.400	198.40				#DIV/0!	83.8	#DIV/0!	83.8				0.0	83.8	31.3	198.4	17.28

North Bellbird Flooding and Stormwater Assessment
Johnson Property Group
Job No: 2122527A
PRM Calcs - Local -20yr ARI
27/06/2005 **AS**

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	20	$^{10}I_1$ =	38.03	mm/h
C10	0.4	Min Tc	5	
Rainfall Data for:		CESSNOCK		

Minimum tc	5
Me hod for tc	2

1 = Bransby Williams
2 = Regional tc=0.76A$^{0.38}$
3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural (Zone B)	FFy	0.62	0.74	0.88	1	1.12	1.2548	1.3889
Urban	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			T ME OF CONC.		RAINFALL NTENSITY	CA	**FLOW**
	Area	%Imperv.	FFy	C	CA	L	S	n	Bransby.W	Regiona	Kinematic	tc	L	v	t	u/s	his			
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
BEL.23 (Local Catchments)	496	0.0%	1.12	0.448	222.21				#DIV/0!	83.8	#DIV/0!	83.8				0.0	83.8	35.8	222.2	22.11

North Bellbird Flooding and Stormwater Assessment
Johnson Property Group
Job No: 2122527A
PRM Calcs - Local -100yr ARI
27/06/2005 **AS**

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	100	$^{10}I_1$ =	38.03	mm/h
C10	0.4	Min Tc		5
Rainfall Data for:		CESSNOCK		

Minimum tc	5
Method for tc	2

1 = Bransby Williams
2 = Regional tc=0.76$A^{0.38}$
3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural (Zone B)	FFy	0.62	0.74	0.88	1	1.12	1.2548	1.3889
Urban	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			TIME OF CONC.		RAINFALL INTENSITY	CA	**FLOW**
	Area	%Imperv.	FFy	C	CA	L	S	n	Bransby.W	Regiona	Kinematic	tc	L	v	t	u/s	this			
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
BEL.23 (Local Catchments)	496	0.0%	1.388931034	0.556	275.56				#DIV/0!	83.8	#DIV/0!	83.8				0.0	83.8	46.1	275.6	35.30

Appendix F

PMP Calculations

Location Information		
Catchment	Bellbird	
State	NSW	
Latitude	32(deg)51'	S
Longitude	151(deg)17'	E
Area	30	km^2
Duration Limit	6	hours
tion of Area Considered:		
Rough (R)	0	[-]
Smooth (S)	1	[-]

Elevation Adjustment Factor (EAF)		
Mean Elevation	150	m
Adjustment for Elevation	N/A	
EAF	1	

Moisture Adjustment Factor (MAF)	
MAF	0.67

PmP Values (mm)

Duration (mins)	DF (Fig 4)	PMP=D_F.MAF.EAF)
15	210	140
30	310	210
45	380	250
60	460	310
90	520	350
120	580	390
150	625	420
180	660	440
240	720	480
300	770	520
360	830	560

Temporal Pattern		Rainfall Per Time Interval (RAFTS) (mm)										
% Time	% PMP (Inc.)	15	30	45	60	90	120	150	180	240	300	360
0	0	0	0	0	0	0	0	0	0	0	0	0
5	4	6	8	10	12	14	16	17	18	19	21	22
10	6	8	13	15	19	21	23	25	26	29	31	34
15	8	11	17	20	25	28	31	34	35	38	42	45
20	7	10	15	18	22	25	27	29	31	34	36	39
25	7	10	15	18	22	25	27	29	31	34	36	39
30	7	10	15	18	22	25	27	29	31	34	36	39
35	7	10	15	18	22	25	27	29	31	34	36	39
40	6	8	13	15	19	21	23	25	26	29	31	34
45	7	10	15	18	22	25	27	29	31	34	36	39
50	5	7	11	13	16	18	20	21	22	24	26	28
55	6	8	13	15	19	21	23	25	26	29	31	34
60	5	7	11	13	16	18	20	21	22	24	26	28
65	5	7	11	13	16	18	20	21	22	24	26	28
70	5	7	11	13	16	18	20	21	22	24	26	28
75	4	6	8	10	12	14	16	17	18	19	21	22
80	3	4	6	8	9	11	12	13	13	14	16	17
85	3	4	6	8	9	11	12	13	13	14	16	17
90	2	3	4	5	6	7	8	8	9	10	10	11
95	2	3	4	5	6	7	8	8	9	10	10	11
100	1	1	2	3	3	4	4	4	4	5	5	6

Temporal Pattern		Cumulative Rainfall (mm)										
% Time	% PMP (Cum.)	15	30	45	60	90	120	150	180	240	300	360
0	0	0	0	0	0	0	0	0	0	0	0	0
5	4	6	8	10	12	14	16	17	18	19	21	22
10	10	14	21	25	31	35	39	42	44	48	52	56
15	18	25	38	45	56	63	70	76	79	86	94	101
20	25	35	53	63	78	88	98	105	110	120	130	140
25	32	45	67	80	99	112	125	134	141	154	166	179
30	39	55	82	98	121	137	152	164	172	187	203	218
35	46	64	97	115	143	161	179	193	202	221	239	258
40	52	73	109	130	161	182	203	218	229	250	270	291
45	59	83	124	148	183	207	230	248	260	283	307	330
50	64	90	134	160	198	224	250	269	282	307	333	358
55	70	98	147	175	217	245	273	294	308	336	364	392
60	75	105	158	188	233	263	293	315	330	360	390	420
65	80	112	168	200	248	280	312	336	352	384	416	448
70	85	119	179	213	264	298	332	357	374	408	442	476
75	89	125	187	223	276	312	347	374	392	427	463	498
80	92	129	193	230	285	322	359	386	405	442	478	515
85	95	133	200	238	295	333	371	399	418	456	494	532
90	97	136	204	243	301	340	378	407	427	466	504	543
95	99	139	208	248	307	347	386	416	436	475	515	554
100	100	140	210	250	310	350	390	420	440	480	520	560

Appendix G

Existing Hydrographs at Westcott Street and Ash Street

PB PARSONS BRINCKERHOFF

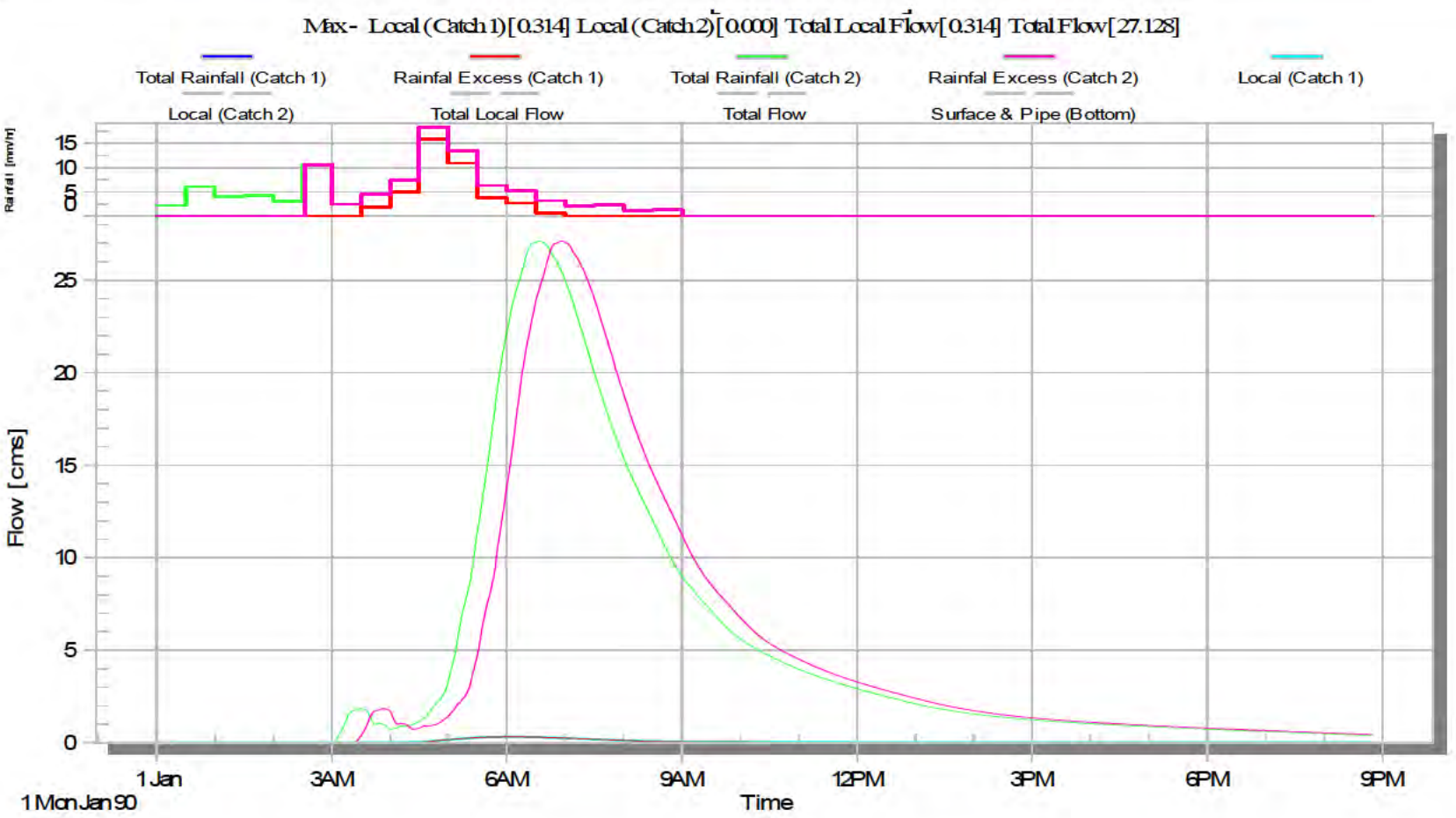
North Bellbird Flooding and Stormwater Assessment

Project No. 2122527A
Client Ref. 0

Existing Hydrographs at Westcott and Ash Street

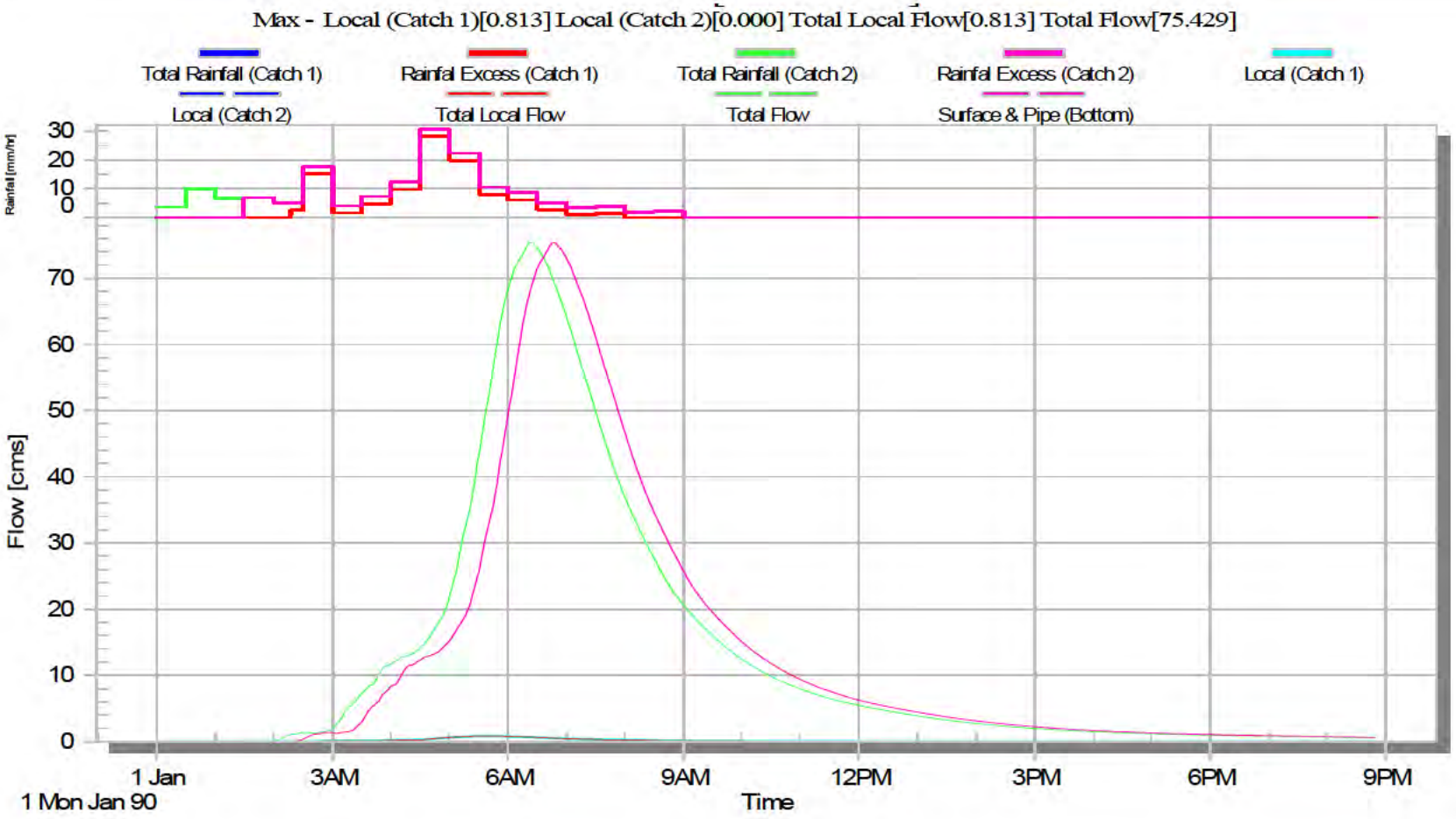
Date: 29-Mar-06

1yr ARI - Westcott Street



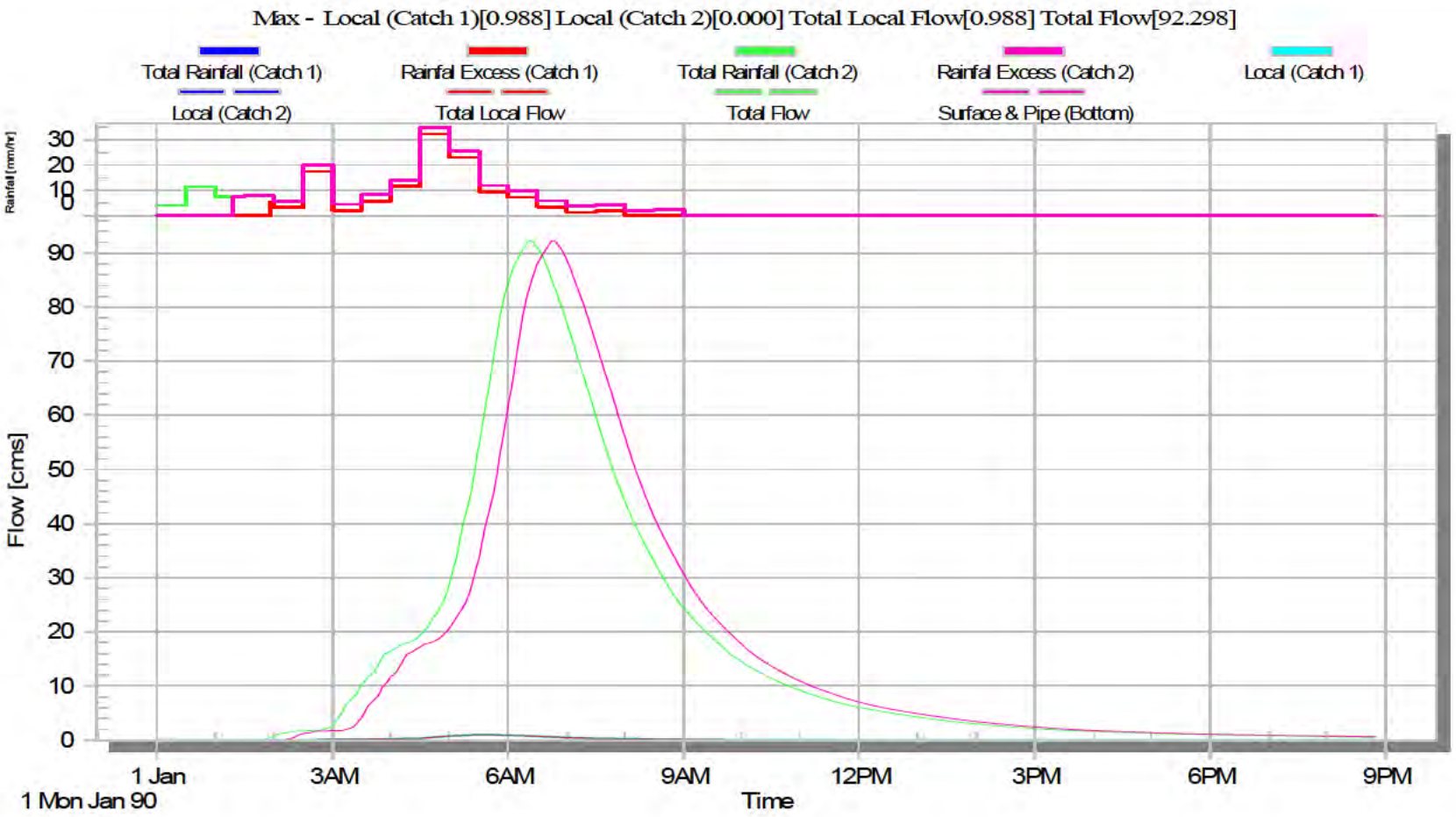
PARSONS BRINCKERHOFF

5yr ARI - Westcott Street



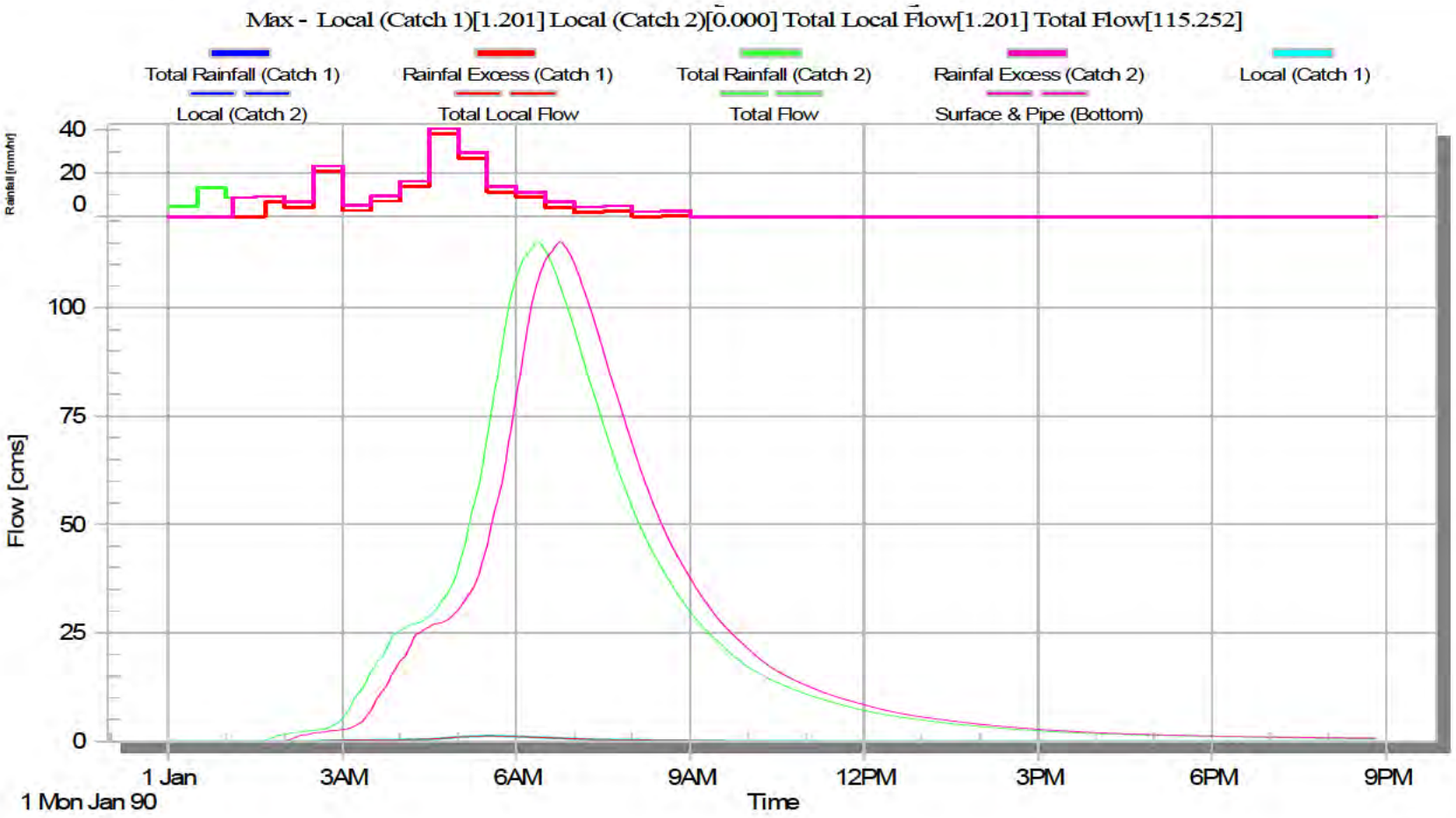
PARSONS BRINCKERHOFF

10yr ARI - Westcott Street



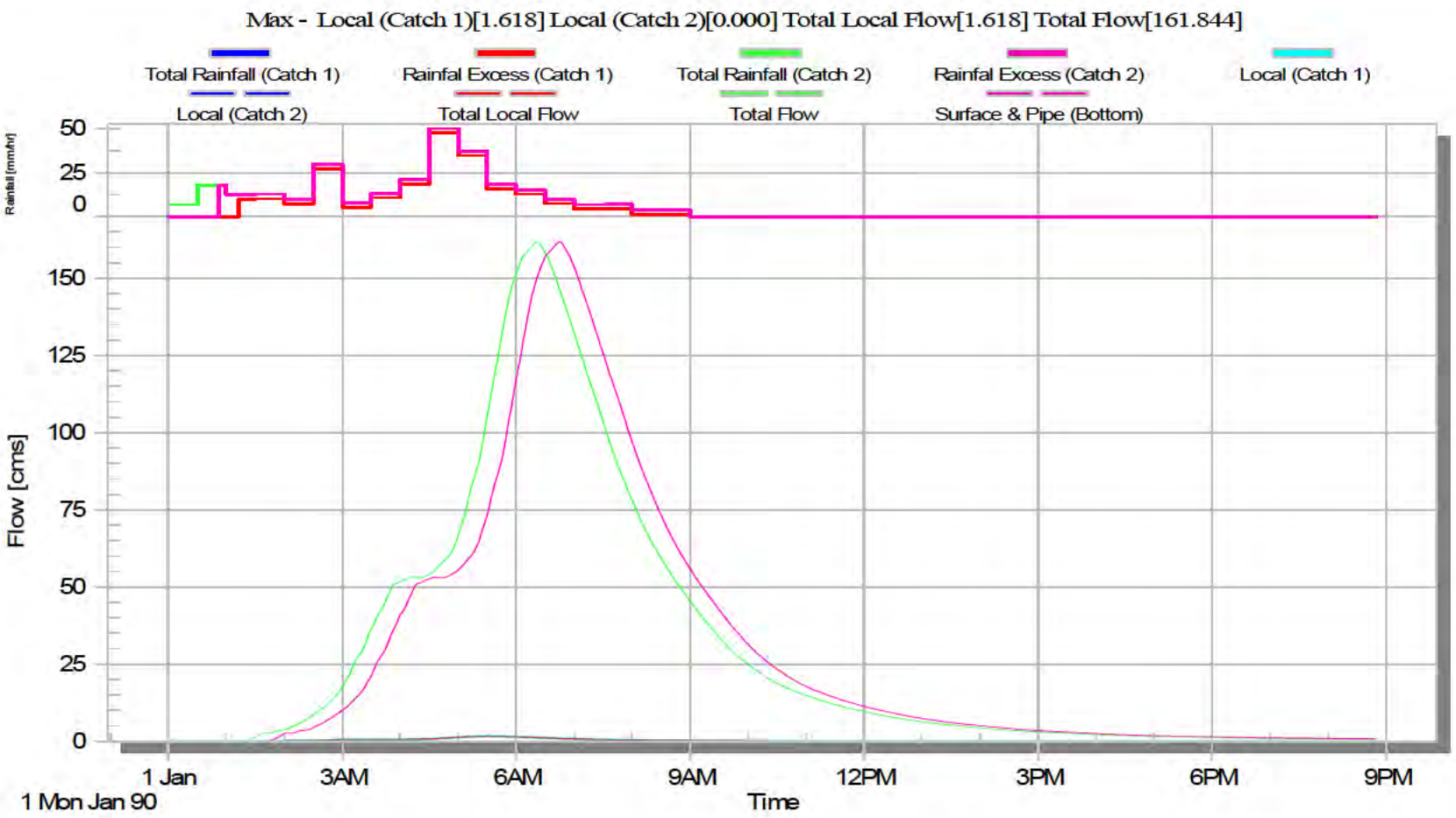
PARSONS BRINCKERHOFF

20yr ARI - Westcott Street



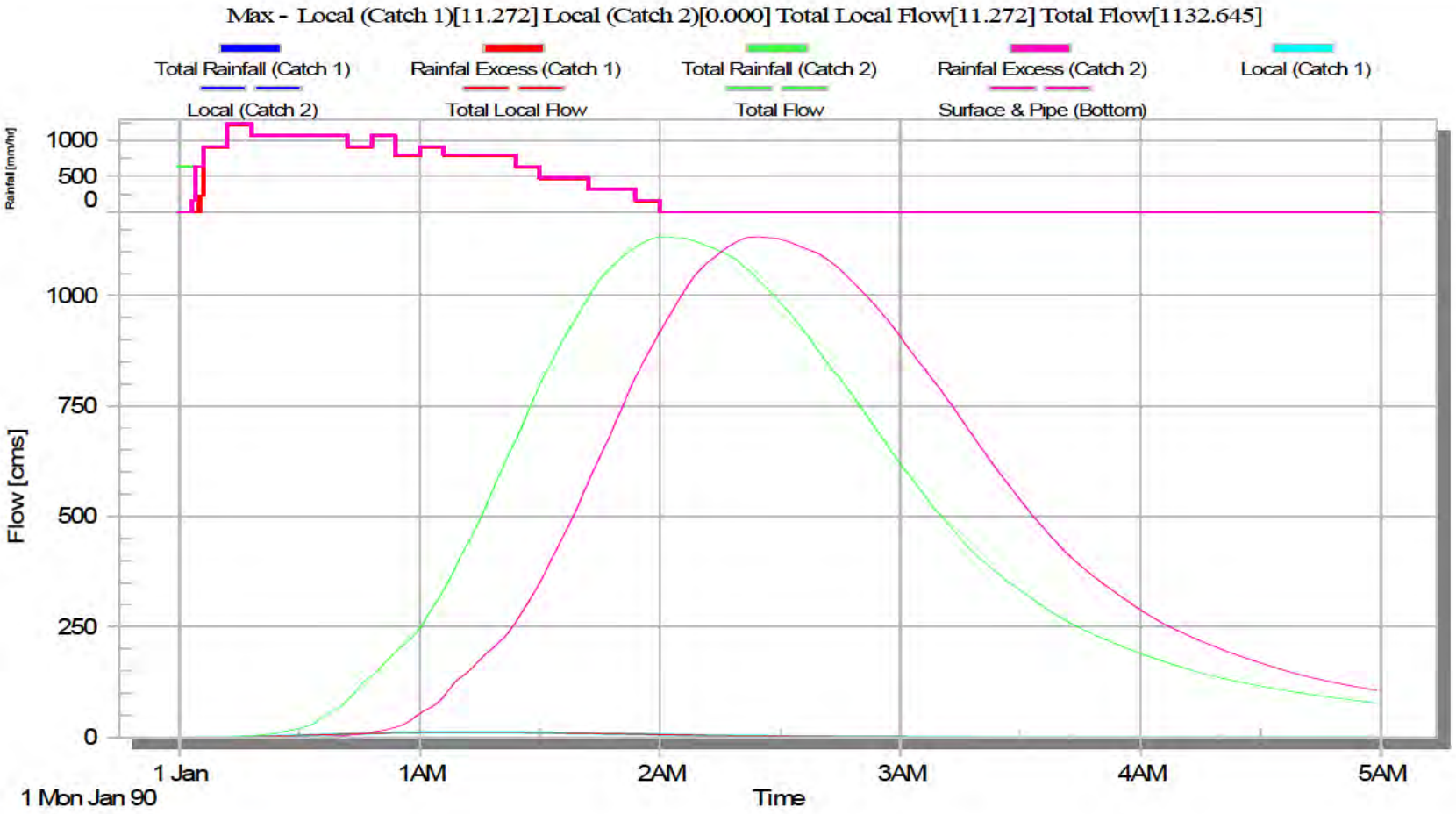
PARSONS BRINCKERHOFF

100yr ARI - Westcott Street



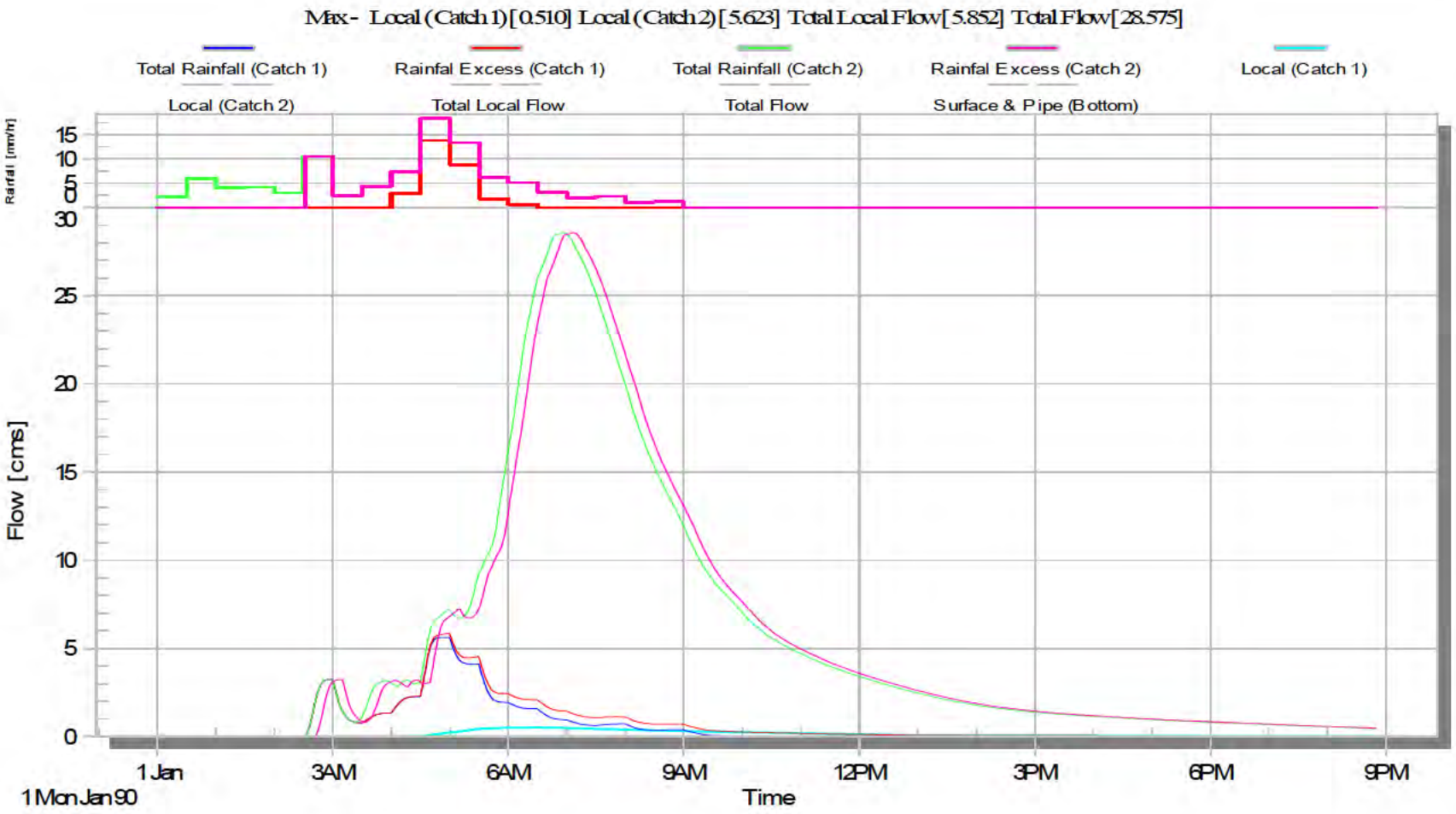
PARSONS BRINCKERHOFF

PMF - Westcott Street



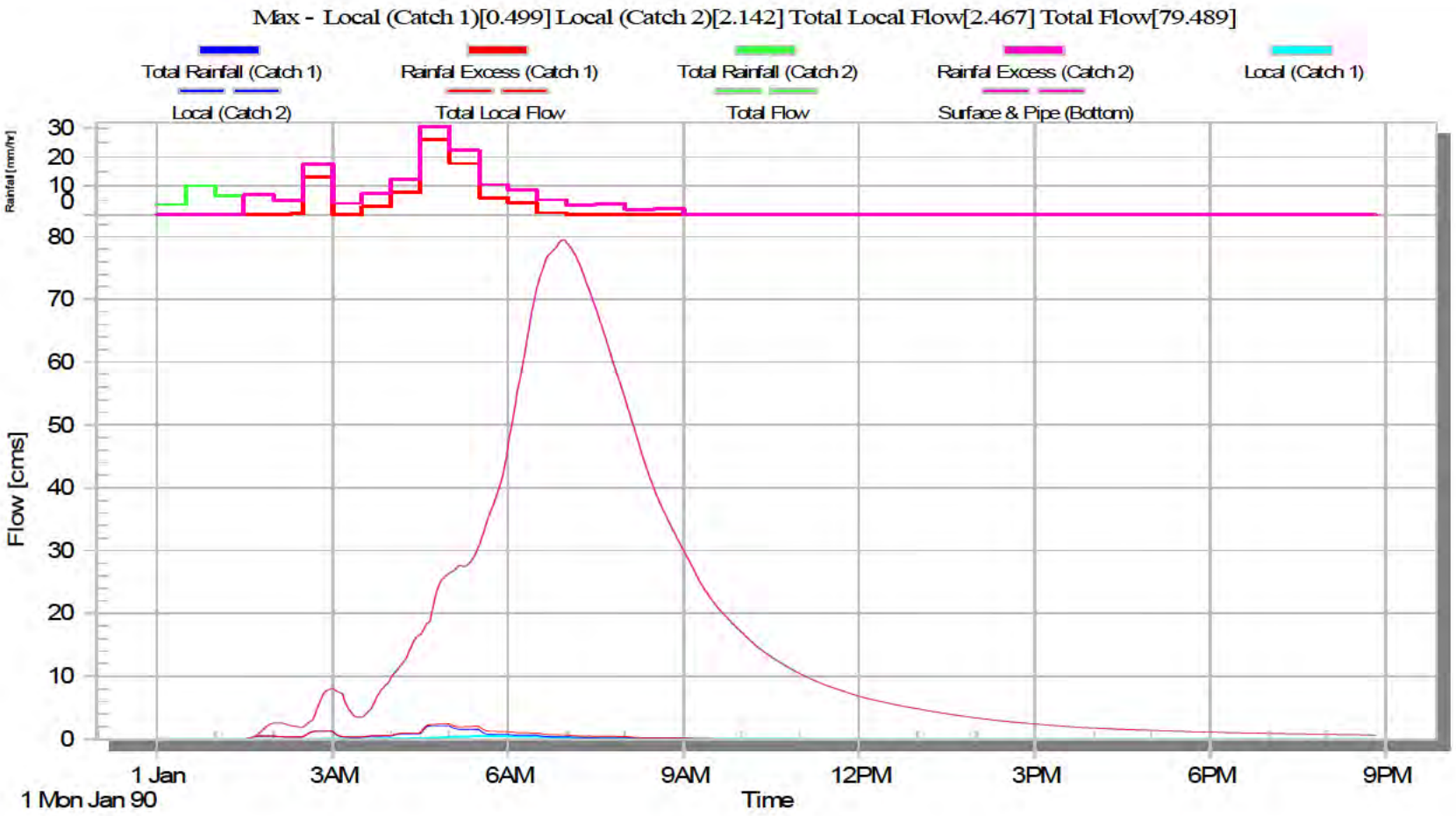
PB PARSONS BRINCKERHOFF

1yr ARI - Ash Street



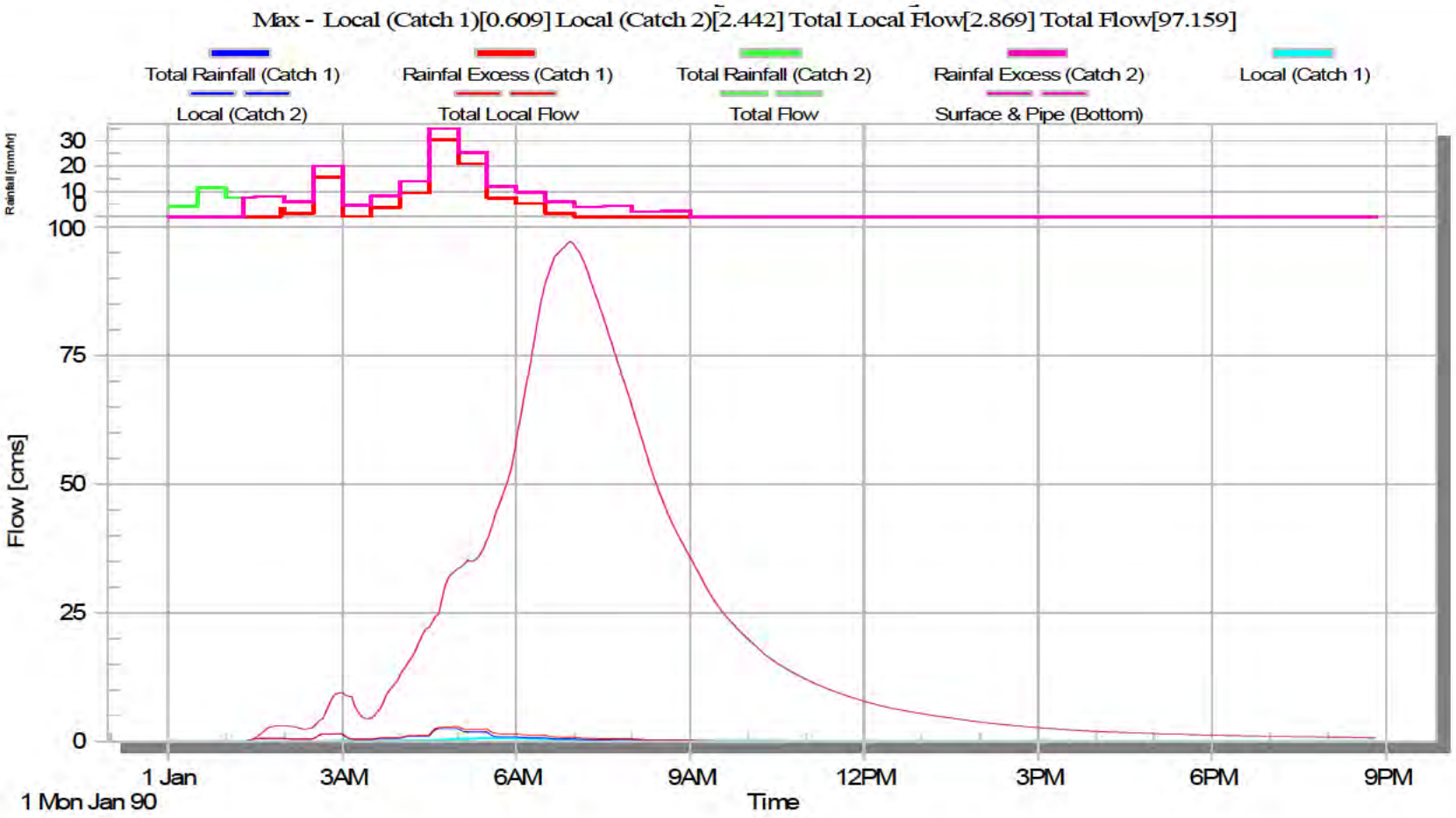
PARSONS BRINCKERHOFF

5yr ARI - Ash Street



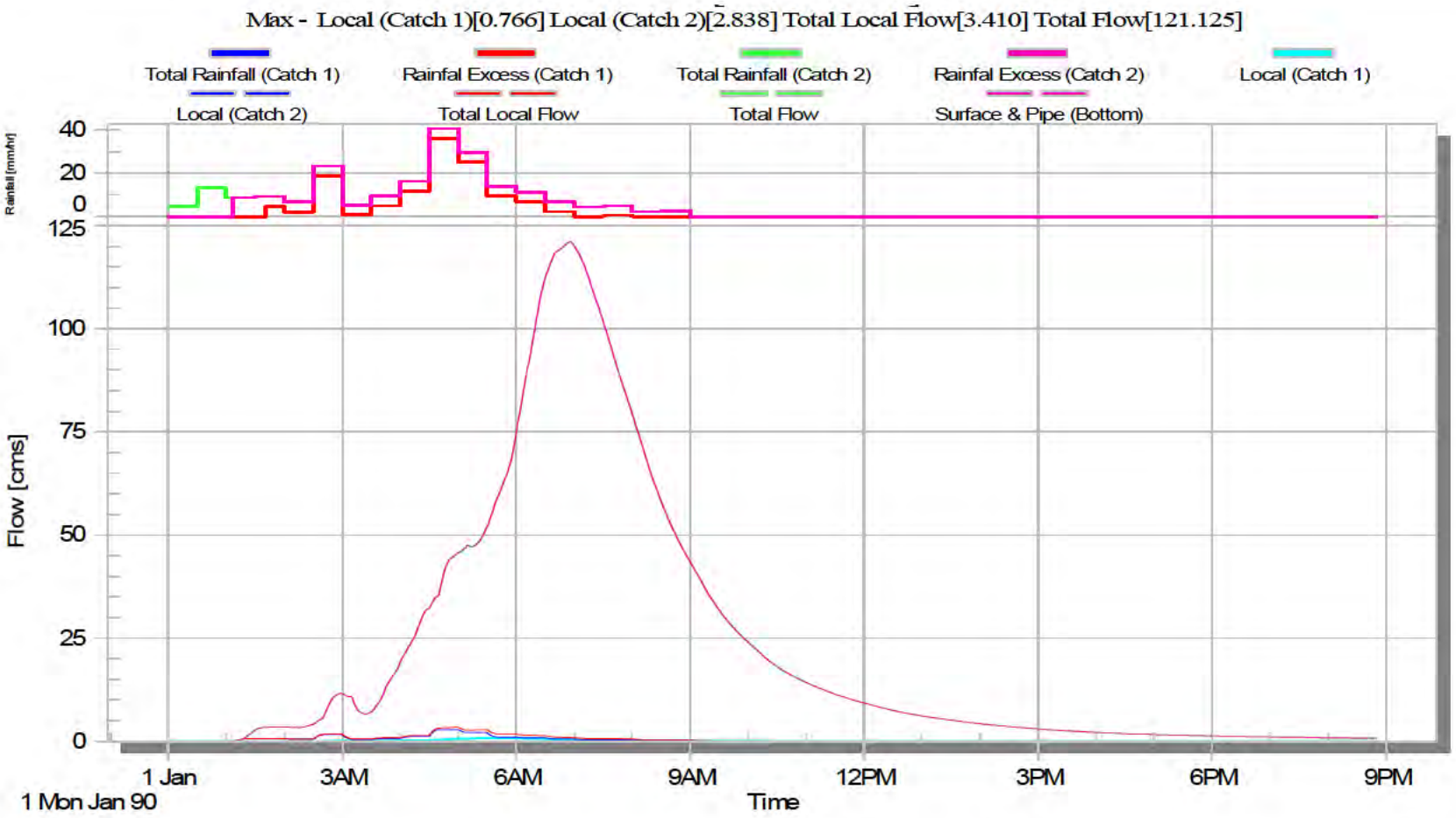
PARSONS BRINCKERHOFF

10yr ARI - Ash Street



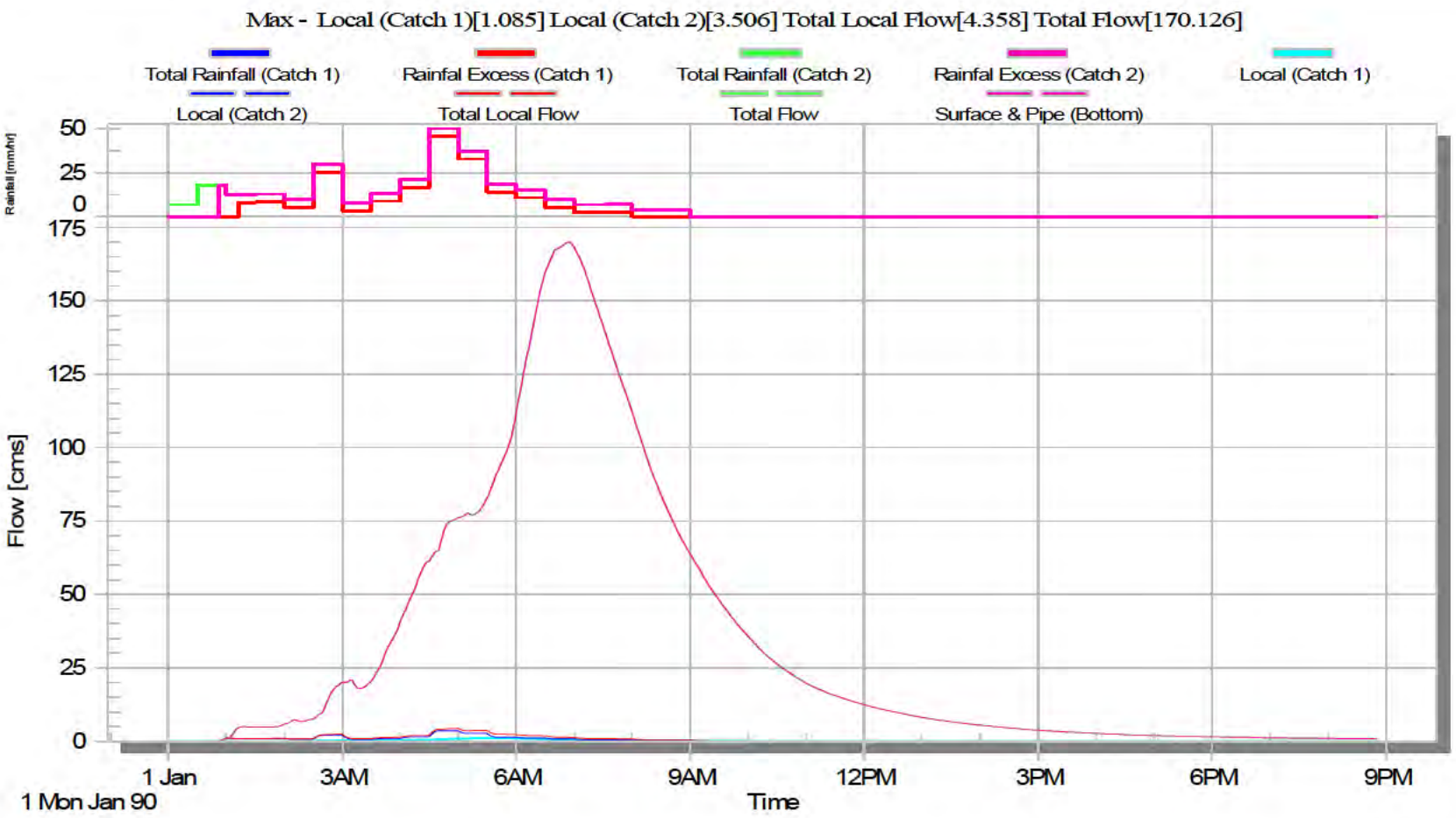
PARSONS BRINCKERHOFF

20yr ARI - Ash Street



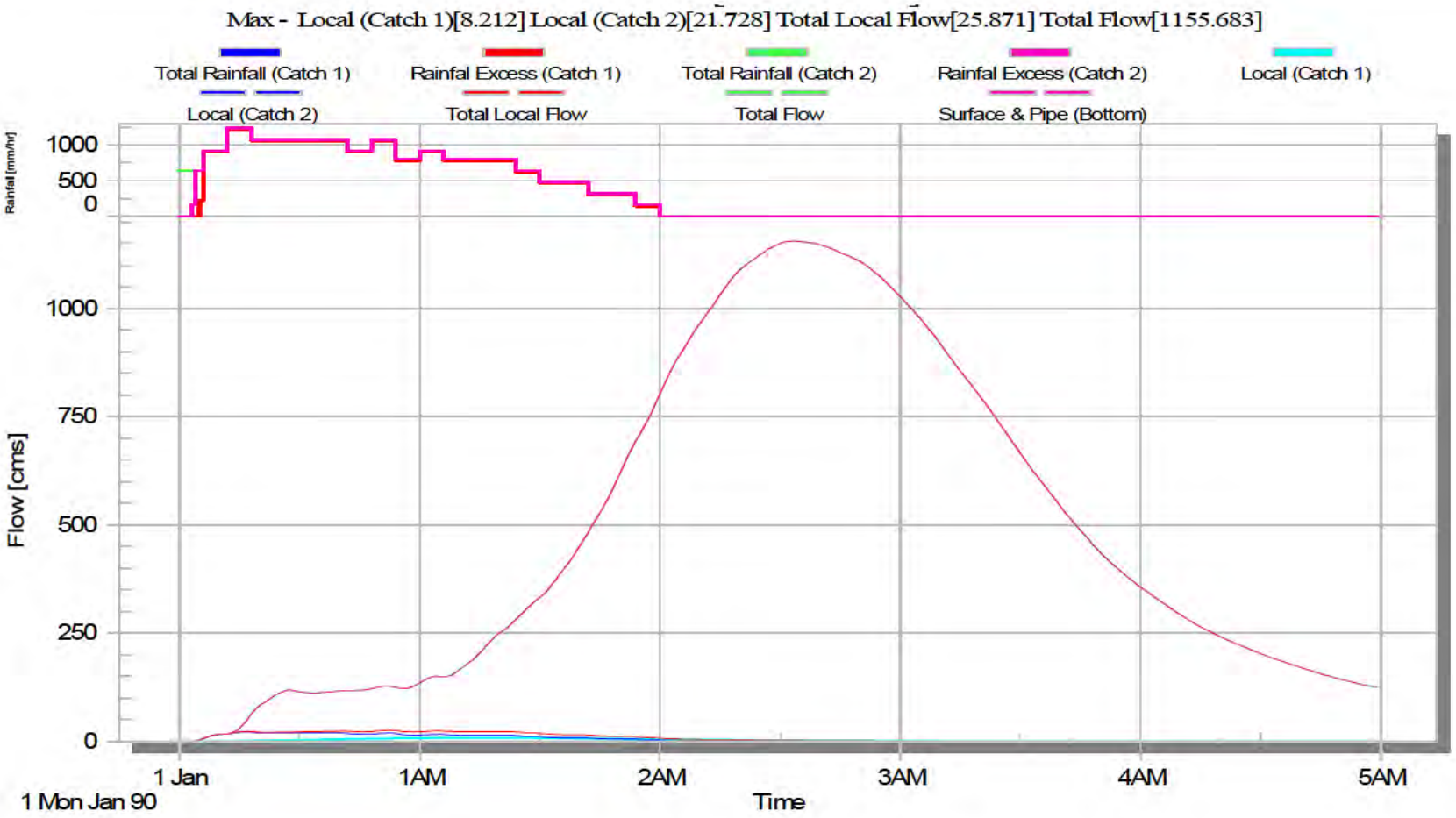
PARSONS BRINCKERHOFF

100yr ARI - Ash Street



PARSONS BRINCKERHOFF

PMF - Ash Street



Appendix H

Summary of HEC-RAS Results – Existing Situation

PARSONS BRINCKERHOFF

North Bellbird Flooding and Stormwater Assessment	Project No.	2122527A
	Client Ref.	
HEC-RAS Model Results	Date:	27/03/2006

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
1-38.06	5yr	75.4	72.00	75.02	3.02	1.96	38.6	14.9	0.39
1-38.06	10yr	92.3	72.00	75.80	3.80	1.83	50.6	16.0	0.33
1-38.06	20yr	115.3	72.00	75.97	3.97	2.16	53.3	16.3	0.38
1-38.06	100yr	161.8	72.00	76.19	4.19	2.84	56.9	16.6	0.49
1-275.69	5yr	75.4	72.00	75.68	3.68	1.00	75.2	24.1	0.18
1-275.69	10yr	92.3	72.00	76.32	4.32	1.01	91.1	25.4	0.17
1-275.69	20yr	115.3	72.00	76.65	4.65	1.16	99.6	26.0	0.19
1-275.69	100yr	161.8	72.00	77.23	5.23	1.41	115.4	30.4	0.22
1-436.04	5yr	75.4	72.00	75.97	3.97	2.68	28.2	11.3	0.54
1-436.04	10yr	92.3	72.00	76.55	4.55	2.64	35.0	12.5	0.50
1-436.04	20yr	115.3	72.00	76.91	4.91	2.91	39.7	13.3	0.54
1-436.04	100yr	161.8	72.00	77.51	5.51	3.38	48.3	15.7	0.57
1-694.76	5yr	75.4	77.00	78.67	1.67	0.92	84.1	110.9	0.27
1-694.76	10yr	92.3	77.00	78.81	1.81	0.93	99.5	113.5	0.26
1-694.76	20yr	115.3	77.00	78.98	1.98	0.94	120.0	116.8	0.24
1-694.76	100yr	161.8	77.00	79.33	2.33	0.93	175.8	203.4	0.22
1-797.79	5yr	75.4	77.00	78.86	1.86	0.49	148.9	175.0	0.13
1-797.79	10yr	92.3	77.00	78.98	1.98	0.51	170.9	177.9	0.13
1-797.79	20yr	115.3	77.00	79.15	2.15	0.53	202.6	200.5	0.13
1-797.79	100yr	161.8	77.00	79.46	2.46	0.55	273.3	243.2	0.12
1-852.2	5yr	74.8	77.00	78.90	1.90	0.61	113.8	148.2	0.19
1-852.2	10yr	91.5	77.00	79.02	2.02	0.64	132.2	156.0	0.19
1-852.2	20yr	114.4	77.00	79.18	2.18	0.67	158.5	167.4	0.18
1-852.2	100yr	160.7	77.00	79.49	2.49	0.71	215.6	197.9	0.17
1-997.47	5yr	33.1	78.00	79.23	1.23	2.70	12.3	17.1	1.01
1-997.47	10yr	40.5	78.00	79.34	1.34	2.82	14.4	18.5	0.99
1-997.47	20yr	51	78.00	79.51	1.51	2.96	17.4	20.5	0.95
1-997.47	100yr	73.6	78.00	79.78	1.78	3.19	23.6	23.7	0.91
1-1164.28	5yr	33.1	79.00	80.65	1.65	0.91	38.2	48.0	0.25
1-1164.28	10yr	40.5	79.00	80.78	1.78	0.95	44.7	54.5	0.25
1-1164.28	20yr	51	79.00	80.92	1.92	1.01	53.2	63.1	0.25
1-1164.28	100yr	73.6	79.00	81.11	2.11	1.22	73.8	133.5	0.29
1-1322.89	5yr	33.1	80.00	81.01	1.01	0.33	66.3	89.3	0.12
1-1322.89	10yr	40.5	80.00	81.11	1.11	0.36	75.9	97.8	0.12
1-1322.89	20yr	51	80.00	81.24	1.24	0.40	89.9	113.2	0.12
1-1322.89	100yr	73.6	80.00	81.45	1.45	0.46	115.6	133.0	0.13
1-1499.99	5yr	32.9	80.61	81.76	1.15	0.53	54.8	77.7	0.18
1-1499.99	10yr	40.3	80.61	81.85	1.24	0.57	61.6	80.4	0.19
1-1499.99	20yr	50.7	80.61	81.95	1.34	0.62	70.2	83.8	0.19
1-1499.99	100yr	73.2	80.61	82.14	1.53	0.75	87.2	100.0	0.22
1-1680.73	5yr	32.9	82.00	83.11	1.11	0.87	41.4	141.4	0.29
1-1680.73	10yr	40.3	82.00	83.16	1.16	0.87	48.8	149.8	0.28
1-1680.73	20yr	50.7	82.00	83.22	1.22	0.88	57.6	157.2	0.27
1-1680.73	100yr	73.2	82.00	83.32	1.32	0.92	73.9	167.5	0.27
1-1850.84	5yr	32.3	82.00	83.82	1.82	0.62	52.6	51.8	0.16
1-1850.84	10yr	39.6	82.00	83.91	1.91	0.70	58.2	66.1	0.18
1-1850.84	20yr	49.9	82.00	84.02	2.02	0.80	66.3	87.5	0.19
1-1850.84	100yr	72.1	82.00	84.19	2.19	0.94	82.7	102.3	0.22
1-2030.41	5yr	32.3	83.00	84.65	1.65	1.01	32.4	28.9	0.27
1-2030.41	10yr	39.6	83.00	84.81	1.81	1.08	37.0	31.0	0.28
1-2030.41	20yr	49.9	83.00	84.99	1.99	1.16	43.0	33.5	0.28
1-2030.41	100yr	72.1	83.00	85.20	2.20	1.17	72.5	157.3	0.27
1-2243.49	5yr	32.3	83.00	85.37	2.37	0.97	34.4	27.4	0.23
1-2243.49	10yr	39.6	83.00	85.55	2.55	1.05	39.5	30.5	0.24
1-2243.49	20yr	49.9	83.00	85.75	2.75	1.15	46.1	34.5	0.25
1-2243.49	100yr	72.1	83.00	86.04	3.04	1.37	56.7	40.7	0.28

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
1-2307.32	5yr	32.3	84.00	85.55	1.55	0.89	36.2	34.7	0.28
1-2307.32	10yr	39.6	84.00	85.72	1.72	0.93	42.7	40.6	0.28
1-2307.32	20yr	49.9	84.00	85.92	1.92	0.99	51.9	49.2	0.27
1-2307.32	100yr	72.1	84.00	86.24	2.24	1.10	69.2	64.4	0.27
1-2459.38	5yr	32.8	84.00	85.90	1.90	0.32	109.0	160.7	0.08
1-2459.38	10yr	40.4	84.00	86.05	2.05	0.33	134.5	187.7	0.08
1-2459.38	20yr	51	84.00	86.22	2.22	0.32	167.8	199.0	0.07
1-2459.38	100yr	73.6	84.00	86.50	2.50	0.32	225.6	216.9	0.07
1-2570.42	5yr	32.8	84.00	86.00	2.00	0.62	52.6	67.2	0.17
1-2570.42	10yr	40.4	84.00	86.13	2.13	0.72	72.8	165.8	0.19
1-2570.42	20yr	51	84.00	86.28	2.28	0.63	98.6	177.6	0.16
1-2570.42	100yr	73.6	84.00	86.54	2.54	0.56	147.9	199.2	0.13
1-2712.91	5yr	32.8	85.00	86.43	1.43	0.86	40.1	77.5	0.30
1-2712.91	10yr	40.4	85.00	86.52	1.52	0.89	47.7	86.2	0.30
1-2712.91	20yr	51	85.00	86.64	1.64	0.92	58.1	97.0	0.29
1-2712.91	100yr	73.6	85.00	86.84	1.84	0.96	80.5	119.6	0.28
1-2929.03	5yr	32.8	86.00	87.42	1.42	0.87	49.5	161.1	0.27
1-2929.03	10yr	40.4	86.00	87.48	1.48	0.88	59.4	175.0	0.26
1-2929.03	20yr	51	86.00	87.55	1.55	0.90	72.1	192.4	0.27
1-2929.03	100yr	73.6	86.00	87.66	1.66	0.94	92.7	195.9	0.27
1-3033.38	5yr	32.8	86.00	87.81	1.81	0.68	50.0	108.8	0.23
1-3033.38	10yr	40.4	86.00	87.88	1.88	0.72	58.2	117.1	0.23
1-3033.38	20yr	51	86.00	87.97	1.97	0.75	69.7	128.1	0.23
1-3033.38	100yr	73.6	86.00	88.08	2.08	1.01	90.5	231.2	0.29
1-3126.46	5yr	24.3	87.00	88.22	1.22	1.36	20.2	73.1	0.51
1-3126.46	10yr	30.3	87.00	88.28	1.28	1.36	25.0	83.6	0.49
1-3126.46	20yr	38.9	87.00	88.35	1.35	1.37	31.4	95.6	0.47
1-3126.46	100yr	57.8	87.00	88.55	1.55	1.14	53.2	126.9	0.35
1-3363.66	5yr	24.3	88.00	89.62	1.62	0.95	28.7	78.5	0.29
1-3363.66	10yr	30.3	88.00	89.69	1.69	0.98	34.8	98.4	0.29
1-3363.66	20yr	38.9	88.00	89.77	1.77	1.06	44.5	138.6	0.30
1-3363.66	100yr	57.8	88.00	89.89	1.89	1.11	62.7	168.2	0.30
1-3572.93	5yr	24.3	89.38	90.59	1.21	0.81	31.6	66.9	0.27
1-3572.93	10yr	30.3	89.38	90.66	1.28	0.86	36.8	73.3	0.27
1-3572.93	20yr	38.9	89.38	90.74	1.36	0.93	43.1	80.4	0.28
1-3572.93	100yr	57.8	89.38	90.89	1.51	1.05	55.6	92.7	0.30
1-3720.33	5yr	24.3	90.00	90.96	0.96	0.39	64.6	150.2	0.13
1-3720.33	10yr	30.3	90.00	91.02	1.02	0.47	76.6	246.2	0.15
1-3720.33	20yr	38.9	90.00	91.10	1.10	0.46	94.8	247.6	0.15
1-3720.33	100yr	57.8	90.00	91.23	1.23	0.46	127.8	249.9	0.14
1-3864.45	5yr	24.3	90.00	91.25	1.25	0.50	49.1	58.0	0.16
1-3864.45	10yr	30.3	90.00	91.34	1.34	0.56	54.6	61.1	0.17
1-3864.45	20yr	38.9	90.00	91.44	1.44	0.65	60.6	64.4	0.19
1-3864.45	100yr	57.8	90.00	91.60	1.60	0.83	71.5	70.5	0.23
1-3989.52	5yr	24.3	91.00	92.34	1.34	1.32	18.6	26.5	0.47
1-3989.52	10yr	30.3	91.00	92.44	1.44	1.44	21.4	29.6	0.48
1-3989.52	20yr	38.9	91.00	92.57	1.57	1.57	25.6	36.3	0.49
1-3989.52	100yr	57.8	91.00	92.80	1.80	1.73	35.9	52.4	0.49
2-1411.92	5yr	5.6	87.77	88.11	0.34	0.32	18.5	96.3	0.20
2-1411.92	10yr	6.6	87.77	88.17	0.40	0.29	23.6	103.2	0.17
2-1411.92	20yr	7.9	87.77	88.23	0.46	0.27	30.8	112.8	0.14
2-1411.92	100yr	10.3	87.77	88.38	0.61	0.23	49.3	151.7	0.10
2-1465.43	5yr	5.6	88.20	88.41	0.21	0.66	8.7	63.3	0.50
2-1465.43	10yr	6.6	88.20	88.42	0.22	0.71	9.7	65.0	0.51
2-1465.43	20yr	7.9	88.20	88.44	0.24	0.76	10.8	68.2	0.53
2-1465.43	100yr	10.3	88.20	88.47	0.27	0.84	12.7	70.8	0.55
2-1527.17	5yr	5.6	89.00	89.07	0.07	0.46	12.1	181.9	0.57
2-1527.17	10yr	6.6	89.00	89.08	0.08	0.49	13.4	183.5	0.58
2-1527.17	20yr	7.9	89.00	89.09	0.09	0.53	14.9	185.1	0.59
2-1527.17	100yr	10.3	89.00	89.10	0.10	0.58	17.9	187.7	0.59

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
2-1617.11	5yr	0.4	89.00	89.16	0.16	0.02	18.3	146.7	0.02
2-1617.11	10yr	0.5	89.00	89.17	0.17	0.02	20.0	147.8	0.02
2-1617.11	20yr	0.6	89.00	89.19	0.19	0.03	22.3	149.2	0.02
2-1617.11	100yr	0.7	89.00	89.21	0.21	0.02	26.1	151.4	0.02
2-1752.32	5yr	0.4	90.00	90.02	0.02	0.18	2.2	105.5	0.41
2-1752.32	10yr	0.5	90.00	90.02	0.02	0.21	2.3	105.9	0.46
2-1752.32	20yr	0.6	90.00	90.03	0.03	0.24	2.5	106.3	0.49
2-1752.32	100yr	0.7	90.00	90.03	0.03	0.24	3.0	107.3	0.46
2-1861.11	5yr	4.4	90.57	90.76	0.19		6.5	58.4	0.00
2-1861.11	10yr	5.1	90.57	90.77	0.20		2.2	38.4	0.00
2-1861.11	20yr	6.1	90.57	90.79	0.22		8.8	62.9	0.00
2-1861.11	100yr	7.9	90.57	90.82	0.25		10.4	68.8	0.00
2-1881.87	5yr	4.4	90.89	91.06	0.17	0.54	9.1	115.5	0.52
2-1881.87	10yr	5.1	90.89	91.07	0.18	0.55	10.3	117.5	0.50
2-1881.87	20yr	6.1	90.89	91.08	0.19	0.63	10.7	117.9	0.57
2-1881.87	100yr	7.9	90.89	91.10	0.21	0.65	13.2	121.0	0.54
2-1908.81	5yr	4.4	91.00	91.19	0.19	0.52	9.3	67.9	0.39
2-1908.81	10yr	5.1	91.00	91.20	0.20	0.55	10.1	70.4	0.40
2-1908.81	20yr	6.1	91.00	91.22	0.22	3.20	1.9	41.1	4.69
2-1908.81	100yr	7.9	91.00	91.24	0.24	0.66	13.4	79.0	0.43
2-1995.11	5yr	3.6	92.01	92.14	0.13	0.52	6.5	87.2	0.60
2-1995.11	10yr	4.2	92.01	92.15	0.14	0.51	7.6	89.9	0.56
2-1995.11	20yr	5	92.01	92.16	0.15	0.53	8.7	92.4	0.56
2-1995.11	100yr	6.5	92.01	92.18	0.17	0.60	10.1	95.5	0.59
2-2109.59	5yr	3.6	93.20	93.36	0.16	0.80	5.0	49.9	0.68
2-2109.59	10yr	4.2	93.20	93.37	0.17	0.84	5.6	52.1	0.69
2-2109.59	20yr	5	93.20	93.38	0.18	0.88	6.4	54.9	0.68
2-2109.59	100yr	6.5	93.20	93.40	0.20	0.97	7.6	58.4	0.72
2-2224.07	5yr	3.6	95.00	95.06	0.06	0.50	7.3	117.4	0.63
2-2224.07	10yr	4.2	95.00	95.07	0.07	0.56	7.5	117.6	0.70
2-2224.07	20yr	5	95.00	95.07	0.07	0.57	8.8	118.2	0.67
2-2224.07	100yr	6.5	95.00	95.08	0.08	0.65	10.0	118.8	0.71
2-2337.05	5yr	2.5	96.00	96.27	0.27	1.23	2.0	14.4	1.04
2-2337.05	10yr	2.9	96.00	96.28	0.28	1.20	2.4	16.5	1.00
2-2337.05	20yr	3.5	96.00	96.31	0.31	1.22	2.9	18.8	0.99
2-2337.05	100yr	4.6	96.00	96.35	0.35	1.18	3.9	28.2	1.01
2-2408.72	5yr	2.5	97.00	97.38	0.38	1.14	2.2	11.8	0.84
2-2408.72	10yr	2.9	97.00	97.40	0.40	1.18	2.5	12.6	0.85
2-2408.72	20yr	3.5	97.00	97.45	0.45	1.10	3.2	18.8	0.85
2-2408.72	100yr	4.6	97.00	97.48	0.48	1.21	3.8	19.1	0.86
2-2491.72	5yr	2.5	98.00	98.25	0.25	1.10	2.3	9.9	0.73
2-2491.72	10yr	2.9	98.00	98.28	0.28	1.15	2.5	10.0	0.73
2-2491.72	20yr	3.5	98.00	98.31	0.31	1.23	2.9	10.2	0.74
2-2491.72	100yr	4.6	98.00	98.37	0.37	1.34	3.4	10.6	0.75
2-2587.99	5yr	2.5	99.00	99.23	0.23	2.05	1.2	11.0	1.96
2-2587.99	10yr	2.9	99.00	99.25	0.25	1.93	1.5	11.2	1.68
2-2587.99	20yr	3.5	99.00	99.28	0.28	1.14	3.1	12.1	0.72
2-2587.99	100yr	4.6	99.00	99.32	0.32	1.26	3.7	12.5	0.74
2-2652.62	5yr	2.5	99.96	100.27	0.31	1.21	2.1	10.6	0.88
2-2652.62	10yr	2.9	99.96	100.29	0.33	1.26	2.3	11.5	0.90
2-2652.62	20yr	3.5	99.96	100.33	0.37	1.25	2.8	13.8	0.89
2-2652.62	100yr	4.6	99.96	100.38	0.42	1.29	3.6	16.0	0.87
3-205.82	5yr	2.1	90.53	90.69	0.16	0.31	7.2	94.4	0.31
3-205.82	10yr	2.3	90.53	90.69	0.16	0.32	8.0	111.6	0.30
3-205.82	20yr	2.9	90.53	90.71	0.18	0.35	9.4	118.1	0.31
3-205.82	100yr	3.6	90.53	90.72	0.19	0.38	10.7	120.6	0.33
3-441	5yr	2.1	93.72	93.89	0.17	0.63	4.3	99.5	0.62
3-441	10yr	2.3	93.72	93.89	0.17	0.65	4.5	100.4	0.63
3-441	20yr	2.9	93.72	93.90	0.18	0.70	5.4	103.1	0.65
3-441	100yr	3.6	93.72	93.91	0.19	0.67	7.0	108.5	0.59

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
3-529.43	5yr	2.1	94.97	95.09	0.12	0.49	5.2	108.0	0.57
3-529.43	10yr	2.3	94.97	95.09	0.12	0.53	5.2	108.0	0.60
3-529.43	20yr	2.9	94.97	95.10	0.13	0.55	6.2	108.3	0.60
3-529.43	100yr	3.6	94.97	95.11	0.14	0.54	7.4	109.7	0.56
3-667.93	5yr	2.1	96.56	96.74	0.18	0.65	3.6	38.3	0.58
3-667.93	10yr	2.3	96.56	96.74	0.18	0.70	3.6	38.6	0.62
3-667.93	20yr	2.9	96.56	96.76	0.20	0.75	4.3	41.3	0.64
3-667.93	100yr	3.6	96.56	96.77	0.21	0.81	5.0	44.1	0.65
3-854.72	5yr	2.1	98.58	98.75	0.17	0.53	4.0	41.3	0.54
3-854.72	10yr	2.3	98.58	98.75	0.17	0.54	4.3	42.9	0.54
3-854.72	20yr	2.9	98.58	98.77	0.19	0.58	5.0	46.1	0.56
3-854.72	100yr	3.6	98.58	98.79	0.21	0.61	5.9	50.2	0.56
3-975.79	5yr	1.5	100.00	100.06	0.06	0.39	3.9	72.5	0.53
3-975.79	10yr	1.7	100.00	100.06	0.06	0.41	4.2	72.6	0.55
3-975.79	20yr	2.1	100.00	100.07	0.07	0.44	4.8	73.1	0.55
3-975.79	100yr	2.7	100.00	100.08	0.08	0.49	5.6	73.6	0.56
3-1087.72	5yr	1.5	100.79	100.93	0.14	0.48	3.2	32.0	0.48
3-1087.72	10yr	1.7	100.79	100.93	0.14	0.52	3.3	32.2	0.53
3-1087.72	20yr	2.1	100.79	100.95	0.16	0.55	3.9	34.1	0.51
3-1087.72	100yr	2.7	100.79	100.97	0.18	0.60	4.5	36.2	0.53
3-1197.64	5yr	0.8	102.78	102.90	0.12	0.49	1.9	46.2	0.65
3-1197.64	10yr	0.9	102.78	102.90	0.12	0.45	2.2	50.2	0.59
3-1197.64	20yr	1.1	102.78	102.91	0.13	0.46	2.6	50.7	0.58
3-1197.64	100yr	1.4	102.78	102.92	0.14	0.49	3.1	51.5	0.57
3-1320.49	5yr	0.8	104.00	104.17	0.17	0.58	1.4	12.6	0.56
3-1320.49	10yr	0.9	104.00	104.18	0.18	0.59	1.5	13.2	0.56
3-1320.49	20yr	1.1	104.00	104.19	0.19	0.61	1.8	14.2	0.55
3-1320.49	100yr	1.4	104.00	104.22	0.22	3.05	0.5	8.0	4.07
3-1525.58	5yr	0.8	108.52	108.69	0.17	0.74	1.1	11.2	0.76
3-1525.58	10yr	0.9	108.52	108.69	0.17	0.78	1.2	11.5	0.78
3-1525.58	20yr	1.1	108.52	108.71	0.19	0.86	1.3	12.3	0.86
3-1525.58	100yr	1.4	108.52	108.73	0.21	0.83	1.7	14.1	0.76
3-1627.79	5yr	0.8	110.91	110.99	0.08	0.51	1.6	27.3	0.67
3-1627.79	10yr	0.9	110.91	110.99	0.08	0.56	1.6	27.3	0.75
3-1627.79	20yr	1.1	110.91	111.00	0.09	0.60	1.8	28.2	0.74
3-1627.79	100yr	1.4	110.91	111.01	0.10	0.67	2.1	29.0	0.79
3-1755.58	5yr	0.8	113.45	113.59	0.14	0.73	1.1	13.6	0.82
3-1755.58	10yr	0.9	113.45	113.60	0.15	0.72	1.3	14.4	0.77
3-1755.58	20yr	1.1	113.45	113.61	0.16	2.02	0.5	10.6	2.84
3-1755.58	100yr	1.4	113.45	113.63	0.18	2.08	0.7	11.4	2.74
3-1860.86	5yr	0.8	116.71	116.88	0.17	0.81	1.0	12.1	0.91
3-1860.86	10yr	0.9	116.71	116.89	0.18	0.83	1.1	12.7	0.91
3-1860.86	20yr	1.1	116.71	116.90	0.19	0.87	1.3	13.8	0.91
3-1860.86	100yr	1.4	116.71	116.92	0.21	0.92	1.5	15.1	0.92
3-1952.2	5yr	0.8	118.57	118.68	0.11	0.54	1.5	24.2	0.66
3-1952.2	10yr	0.9	118.57	118.69	0.12	0.55	1.7	25.1	0.65
3-1952.2	20yr	1.1	118.57	118.70	0.13	0.61	1.8	26.0	0.70
3-1952.2	100yr	1.4	118.57	118.71	0.14	0.65	2.2	28.8	0.69
4-81.49	5yr	41.5	78.00	79.79	1.79	3.20	13.0	13.5	1.00
4-81.49	10yr	50.8	78.00	79.93	1.93	3.40	15.2	14.6	0.99
4-81.49	20yr	62.9	78.00	80.37	2.37	2.50	34.0	62.5	0.62
4-81.49	100yr	86.4	78.00	80.50	2.50	2.76	43.3	64.9	0.66
4-280.24	5yr	41.5	80.01	81.48	1.47	1.77	31.0	61.1	0.55
4-280.24	10yr	50.8	80.01	81.56	1.55	1.87	36.2	65.2	0.56
4-280.24	20yr	62.9	80.01	81.65	1.64	1.98	42.0	68.7	0.57
4-280.24	100yr	86.4	80.01	81.79	1.78	2.17	51.5	70.8	0.59
4-441.75	5yr	41.5	79.00	81.97	2.97	1.43	31.7	26.2	0.34
4-441.75	10yr	50.8	79.00	82.06	3.06	1.64	37.1	71.5	0.37
4-441.75	20yr	62.9	79.00	82.18	3.18	1.80	45.6	75.5	0.40
4-441.75	100yr	86.4	79.00	82.35	3.35	2.03	59.3	81.9	0.43

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
4-563.13	5yr	41.3	80.00	82.17	2.17	1.60	26.9	24.0	0.41
4-563.13	10yr	50.6	80.00	82.30	2.30	1.78	30.3	28.0	0.44
4-563.13	20yr	62.8	80.00	82.45	2.45	1.99	34.6	32.5	0.47
4-563.13	100yr	86.1	80.00	82.66	2.66	2.35	42.0	39.5	0.53
4-824.41	5yr	41.7	81.00	82.96	1.96	1.94	23.8	23.6	0.50
4-824.41	10yr	51.2	81.00	83.14	2.14	2.05	28.0	25.4	0.50
4-824.41	20yr	63.3	81.00	83.32	2.32	2.19	32.8	27.6	0.51
4-824.41	100yr	87.1	81.00	83.60	2.60	2.46	41.0	31.1	0.53
4-895.84	5yr	38.6	81.00	83.23	2.23	1.35	29.6	25.1	0.34
4-895.84	10yr	47.4	81.00	83.40	2.40	1.48	34.6	32.0	0.35
4-895.84	20yr	58.7	81.00	83.60	2.60	1.59	41.3	37.3	0.36
4-895.84	100yr	80.8	81.00	83.91	2.91	1.75	54.0	42.4	0.37
4-1018.59	5yr	38.6	82.00	83.69	1.69	2.35	16.4	14.4	0.70
4-1018.59	10yr	47.4	82.00	83.85	1.85	2.52	18.8	15.3	0.72
4-1018.59	20yr	58.7	82.00	84.02	2.02	2.73	21.5	16.7	0.74
4-1018.59	100yr	80.8	82.00	84.28	2.28	3.13	26.8	23.6	0.78
4-1252.45	5yr	38.2	82.00	84.54	2.54	1.25	31.3	23.9	0.32
4-1252.45	10yr	46.9	82.00	84.73	2.73	1.35	36.0	25.5	0.33
4-1252.45	20yr	58.2	82.00	84.95	2.95	1.47	41.7	27.8	0.34
4-1252.45	100yr	80	82.00	85.30	3.30	1.66	52.2	32.3	0.35
4-1370.53	5yr	38.2	83.00	84.85	1.85	1.58	26.7	28.8	0.45
4-1370.53	10yr	46.9	83.00	85.03	2.03	1.63	31.8	30.2	0.43
4-1370.53	20yr	58.2	83.00	85.23	2.23	1.69	38.3	33.1	0.42
4-1370.53	100yr	80	83.00	85.57	2.57	1.79	50.1	37.8	0.41
4-1571.29	5yr	38	84.00	85.78	1.78	1.56	24.4	29.9	0.55
4-1571.29	10yr	46.8	84.00	85.91	1.91	1.63	28.7	33.1	0.56
4-1571.29	20yr	58	84.00	86.05	2.05	1.74	33.3	35.6	0.57
4-1571.29	100yr	79.8	84.00	86.27	2.27	1.93	41.8	40.6	0.57
4-1693.24	5yr	38	84.00	86.22	2.22	1.47	27.0	28.0	0.43
4-1693.24	10yr	46.8	84.00	86.35	2.35	1.60	30.7	28.8	0.45
4-1693.24	20yr	58	84.00	86.49	2.49	1.76	34.8	29.7	0.47
4-1693.24	100yr	79.8	84.00	86.72	2.72	2.03	41.7	31.0	0.50
4-2085.73	5yr	37.9	85.00	87.70	2.70	2.24	20.3	24.7	0.55
4-2085.73	10yr	46.6	85.00	87.86	2.86	2.34	24.5	27.9	0.55
4-2085.73	20yr	57.8	85.00	88.03	3.03	2.45	29.6	30.9	0.55
4-2085.73	100yr	79.6	85.00	88.29	3.29	2.61	37.8	31.9	0.55
4-2191.41	5yr	37.9	86.36	88.35	1.99	2.27	17.0	15.9	0.65
4-2191.41	10yr	46.6	86.36	88.51	2.15	2.44	19.6	17.4	0.66
4-2191.41	20yr	57.8	86.36	88.69	2.33	2.64	22.9	18.9	0.68
4-2191.41	100yr	79.6	86.36	88.98	2.62	2.96	28.9	21.5	0.69
4-2298.16	5yr	37.9	87.00	88.96	1.96	1.71	22.2	22.1	0.55
4-2298.16	10yr	46.6	87.00	89.13	2.13	1.78	26.2	23.9	0.54
4-2298.16	20yr	57.8	87.00	89.33	2.33	1.86	31.1	25.8	0.54
4-2298.16	100yr	79.6	87.00	89.65	2.65	2.01	39.9	28.8	0.52
4-2458.74	5yr	37.9	88.00	89.58	1.58	1.17	32.5	33.8	0.38
4-2458.74	10yr	46.6	88.00	89.73	1.73	1.23	38.0	35.6	0.38
4-2458.74	20yr	57.8	88.00	89.91	1.91	1.29	44.6	37.3	0.38
4-2458.74	100yr	79.6	88.00	90.20	2.20	1.43	55.7	39.6	0.38
4-2738.35	5yr	37.9	89.00	91.00	2.00	2.03	18.7	18.0	0.64
4-2738.35	10yr	46.6	89.00	91.15	2.15	2.16	21.6	19.5	0.65
4-2738.35	20yr	57.8	89.00	91.33	2.33	2.30	25.2	21.3	0.67
4-2738.35	100yr	79.6	89.00	91.61	2.61	2.52	31.6	24.2	0.70
4-2927.1	5yr	37.9	90.00	91.99	1.99	1.65	23.5	23.3	0.48
4-2927.1	10yr	46.6	90.00	92.14	2.14	1.77	27.1	24.4	0.49
4-2927.1	20yr	57.8	90.00	92.31	2.31	1.92	31.4	25.6	0.50
4-2927.1	100yr	79.6	90.00	92.59	2.59	2.16	38.9	27.5	0.52
4-3126.11	5yr	37.7	91.00	92.89	1.89	2.00	19.0	17.8	0.59
4-3126.11	10yr	46.4	91.00	93.04	2.04	2.18	21.8	19.0	0.60
4-3126.11	20yr	57.5	91.00	93.21	2.21	2.37	25.1	20.2	0.62
4-3126.11	100yr	79.2	91.00	93.49	2.49	2.69	31.1	22.2	0.64

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
4-3363.8	5yr	37.7	92.07	94.08	2.01	2.00	21.1	23.3	0.55
4-3363.8	10yr	46.4	92.07	94.24	2.17	2.11	24.8	24.6	0.55
4-3363.8	20yr	57.5	92.07	94.42	2.35	2.24	29.3	26.1	0.55
4-3363.8	100yr	79.2	92.07	94.72	2.65	2.44	37.4	28.7	0.55
4-3521.91	5yr	37.7	93.00	94.89	1.89	1.76	21.5	21.0	0.55
4-3521.91	10yr	46.4	93.00	95.04	2.04	1.89	24.6	23.4	0.57
4-3521.91	20yr	57.5	93.00	95.19	2.19	2.05	28.5	28.4	0.59
4-3521.91	100yr	79.2	93.00	95.42	2.42	2.30	36.4	36.3	0.60
4-3744.06	5yr	37.2	95.00	96.22	1.22	1.78	22.1	30.5	0.60
4-3744.06	10yr	45.7	95.00	96.32	1.32	1.91	25.3	31.2	0.61
4-3744.06	20yr	56.7	95.00	96.44	1.44	2.06	29.2	32.0	0.62
4-3744.06	100yr	78.1	95.00	96.65	1.65	2.31	36.1	33.4	0.64
4-3831.17	5yr	37.2	95.00	96.63	1.63	0.96	40.7	35.1	0.26
4-3831.17	10yr	45.7	95.00	96.76	1.76	1.05	45.5	35.9	0.27
4-3831.17	20yr	56.7	95.00	96.92	1.92	1.16	51.2	36.6	0.29
4-3831.17	100yr	78.1	95.00	97.18	2.18	1.35	60.9	38.3	0.31
4-3997.61	5yr	37.2	97.00	98.12	1.12	2.23	16.7	19.5	0.77
4-3997.61	10yr	45.7	97.00	98.25	1.25	2.38	19.2	20.2	0.78
4-3997.61	20yr	56.7	97.00	98.40	1.40	2.56	22.2	20.9	0.79
4-3997.61	100yr	78.1	97.00	98.65	1.65	2.82	27.7	22.2	0.81
4-4250.83	5yr	24.3	98.00	99.55	1.55	0.84	33.5	94.9	0.33
4-4250.83	10yr	30	98.00	99.63	1.63	0.86	41.2	100.3	0.32
4-4250.83	20yr	37.3	98.00	99.73	1.73	0.84	52.2	109.5	0.30
4-4250.83	100yr	51.6	98.00	99.91	1.91	0.82	74.5	132.4	0.27
4-4352.51	5yr	24.3	99.00	100.21	1.21	0.73	38.4	89.4	0.26
4-4352.51	10yr	30	99.00	100.26	1.26	0.81	43.0	90.2	0.28
4-4352.51	20yr	37.3	99.00	100.32	1.32	0.90	48.2	91.0	0.30
4-4352.51	100yr	51.6	99.00	100.41	1.41	1.05	56.8	92.4	0.34
4-4478.68	5yr	23.4	100.00	100.89	0.89	2.52	9.3	14.7	1.01
4-4478.68	10yr	28.9	100.00	101.12	1.12	2.04	16.7	46.8	0.72
4-4478.68	20yr	36	100.00	101.18	1.18	2.17	20.1	47.6	0.73
4-4478.68	100yr	49.8	100.00	101.31	1.31	2.44	25.2	48.9	0.78
4-4744.42	5yr	23.4	102.00	103.28	1.28	1.55	15.1	28.2	0.67
4-4744.42	10yr	28.9	102.00	103.37	1.37	1.63	17.8	30.5	0.68
4-4744.42	20yr	36	102.00	103.47	1.47	1.71	21.0	33.1	0.69
4-4744.42	100yr	49.8	102.00	103.64	1.64	1.85	27.0	39.7	0.70
4-4904.1	5yr	22.4	103.00	104.18	1.18	1.17	19.5	34.5	0.44
4-4904.1	10yr	27.7	103.00	104.27	1.27	1.27	22.9	40.2	0.45
4-4904.1	20yr	34.5	103.00	104.37	1.37	1.36	27.1	42.6	0.46
4-4904.1	100yr	47.8	103.00	104.54	1.54	1.53	34.2	46.0	0.47
4-5093.69	5yr	22.4	104.52	105.50	0.98	1.23	17.9	38.2	0.57
4-5093.69	10yr	27.7	104.52	105.58	1.06	1.31	20.8	40.5	0.58
4-5093.69	20yr	34.5	104.52	105.66	1.14	1.42	24.0	41.8	0.59
4-5093.69	100yr	47.8	104.52	105.79	1.27	1.61	29.9	43.9	0.60
4-5251.51	5yr	22.4	105.00	106.65	1.65	1.58	14.2	22.0	0.63
4-5251.51	10yr	27.7	105.00	106.76	1.76	1.67	16.6	24.2	0.64
4-5251.51	20yr	34.5	105.00	106.88	1.88	1.75	19.7	27.6	0.66
4-5251.51	100yr	47.8	105.00	107.10	2.10	1.71	30.3	63.3	0.63
4-5339.28	5yr	22.4	106.00	107.52	1.52	2.12	10.6	17.1	0.86
4-5339.28	10yr	27.7	106.00	107.64	1.64	2.18	12.7	19.4	0.86
4-5339.28	20yr	34.5	106.00	107.74	1.74	2.31	15.3	32.4	0.85
4-5339.28	100yr	47.8	106.00	107.96	1.96	2.33	23.6	49.8	0.77
4-5445.31	5yr	22.4	107.00	108.40	1.40	4.07	5.5	9.8	1.73
4-5445.31	10yr	27.7	107.00	107.94	0.94	1.91	14.5	15.3	0.63
4-5445.31	20yr	34.5	107.00	108.70	1.70	2.03	17.0	16.5	0.64
4-5445.31	100yr	47.8	107.00	108.93	1.93	2.27	21.1	18.1	0.66
4-5711.52	5yr	17.2	109.44	110.15	0.71	2.16	9.1	32.0	1.06
4-5711.52	10yr	21.2	109.44	110.36	0.92	3.49	6.7	26.4	1.91
4-5711.52	20yr	26.3	109.44	110.17	0.73	3.21	9.4	32.4	1.56
4-5711.52	100yr	36.2	109.44	110.29	0.85	3.01	15.4	55.3	1.29

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
4-5735.28	5yr	17.2	110.00	110.66	0.66	2.14	8.4	23.1	0.99
4-5735.28	10yr	21.2	110.00	110.72	0.72	2.31	9.8	25.0	1.01
4-5735.28	20yr	26.3	110.00	110.78	0.78	2.49	11.5	27.0	1.03
4-5735.28	100yr	36.2	110.00	110.89	0.89	2.77	14.4	30.0	1.06
5-77.53	5yr	3.1	83.00	83.41	0.41	0.56	5.5	14.7	0.29
5-77.53	10yr	3.8	83.00	83.58	0.58	0.47	8.1	15.7	0.21
5-77.53	20yr	4.6	83.00	83.77	0.77	0.41	11.2	16.7	0.16
5-77.53	100yr	6.3	83.00	84.08	1.08	0.37	18.2	39.0	0.12
5-147.05	5yr	3.1	84.00	84.39	0.39	1.13	2.7	13.6	0.80
5-147.05	10yr	3.8	84.00	84.44	0.44	1.14	3.3	15.8	0.79
5-147.05	20yr	4.6	84.00	84.46	0.46	1.23	3.8	16.8	0.83
5-147.05	100yr	6.3	84.00	84.53	0.53	1.24	5.1	18.8	0.77
5-232.47	5yr	3.1	85.97	86.09	0.12	0.60	5.2	63.1	0.67
5-232.47	10yr	3.8	85.97	86.10	0.13	0.63	6.0	65.8	0.67
5-232.47	20yr	4.6	85.97	86.11	0.14	0.68	6.8	68.0	0.68
5-232.47	100yr	6.3	85.97	86.13	0.16	0.77	8.3	83.4	0.72
5-317.61	5yr	3.1	86.33	86.55	0.22	0.60	5.4	31.3	0.44
5-317.61	10yr	3.8	86.33	86.57	0.24	0.65	6.1	32.1	0.45
5-317.61	20yr	4.6	86.33	86.59	0.26	0.71	6.7	32.8	0.47
5-317.61	100yr	6.3	86.33	86.63	0.30	0.83	8.0	34.2	0.50
6-164.27	5yr	11	99.00	100.03	1.03	0.95	11.6	18.0	0.38
6-164.27	10yr	13.5	99.00	100.15	1.15	0.99	13.7	18.9	0.37
6-164.27	20yr	16.6	99.00	100.31	1.31	0.96	17.3	23.3	0.35
6-164.27	100yr	22.8	99.00	100.55	1.55	0.99	23.1	25.6	0.33
6-313.94	5yr	10.8	102.00	103.20	1.20	1.40	7.7	12.0	0.56
6-313.94	10yr	13.2	102.00	103.30	1.30	1.47	9.0	13.0	0.57
6-313.94	20yr	16.3	102.00	103.41	1.41	1.56	10.4	14.0	0.58
6-313.94	100yr	22.4	102.00	103.59	1.59	1.70	13.2	15.7	0.59
6-548.04	5yr	10.8	105.00	105.89	0.89	1.02	10.6	15.5	0.39
6-548.04	10yr	13.2	105.00	106.00	1.00	1.08	12.2	16.4	0.40
6-548.04	20yr	16.3	105.00	106.12	1.12	1.15	14.2	17.2	0.40
6-548.04	100yr	22.4	105.00	106.32	1.32	1.25	17.9	18.7	0.41
6-712.85	5yr	10.8	106.40	107.87	1.47	1.28	8.4	10.0	0.45
6-712.85	10yr	13.2	106.40	107.99	1.59	1.35	9.8	10.8	0.45
6-712.85	20yr	16.3	106.40	108.14	1.74	1.43	11.4	11.6	0.46
6-712.85	100yr	22.4	106.40	108.38	1.98	1.56	14.3	13.0	0.48
6-860.78	5yr	8.1	108.00	109.40	1.40	0.86	9.4	12.0	0.31
6-860.78	10yr	10	108.00	109.54	1.54	0.91	11.1	12.9	0.31
6-860.78	20yr	12.4	108.00	109.68	1.68	0.95	13.1	14.1	0.31
6-860.78	100yr	17.3	108.00	109.94	1.94	1.03	16.8	15.9	0.32
6-928.69	5yr	8.1	109.00	109.99	0.99	0.94	8.6	12.8	0.37
6-928.69	10yr	10	109.00	110.11	1.11	0.99	10.1	13.4	0.36
6-928.69	20yr	12.4	109.00	110.24	1.24	1.04	11.9	14.0	0.36
6-928.69	100yr	17.3	109.00	110.47	1.47	1.14	15.2	15.1	0.36
6-1048.29	5yr	7	110.63	111.64	1.01	1.13	6.2	9.0	0.44
6-1048.29	10yr	8.7	110.63	111.75	1.12	1.21	7.2	9.6	0.44
6-1048.29	20yr	10.8	110.63	111.87	1.24	1.28	8.4	10.3	0.45
6-1048.29	100yr	15.1	110.63	112.08	1.45	1.41	10.7	11.5	0.47
6-1147.59	5yr	7	113.46	114.46	1.00	1.43	4.9	8.9	0.62
6-1147.59	10yr	8.7	113.46	114.55	1.09	1.50	5.8	9.7	0.62
6-1147.59	20yr	10.8	113.46	114.65	1.19	1.59	6.8	10.5	0.63
6-1147.59	100yr	15.1	113.46	114.83	1.37	1.73	8.8	11.8	0.64
6-1288.99	5yr	7	117.00	117.78	0.78	1.21	5.8	11.3	0.54
6-1288.99	10yr	8.7	117.00	117.87	0.87	1.28	6.8	12.1	0.55
6-1288.99	20yr	10.8	117.00	117.96	0.96	1.35	8.0	13.1	0.55
6-1288.99	100yr	15.1	117.00	118.13	1.13	1.47	10.3	14.7	0.56
6-1381.18	5yr	7	117.00	118.44	1.44	0.70	10.0	11.7	0.24
6-1381.18	10yr	8.7	117.00	118.56	1.56	0.76	11.4	12.5	0.25
6-1381.18	20yr	10.8	117.00	118.69	1.69	0.82	13.1	13.3	0.26
6-1381.18	100yr	15.1	117.00	118.92	1.92	0.93	16.3	14.8	0.28

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
6-1614.63	5yr	7	120.00	121.05	1.05	1.12	6.3	8.2	0.41
6-1614.63	10yr	8.7	120.00	121.17	1.17	1.19	7.3	8.7	0.41
6-1614.63	20yr	10.8	120.00	121.31	1.31	1.26	8.6	9.3	0.42
6-1614.63	100yr	15.1	120.00	121.55	1.55	1.38	11.0	10.4	0.43
6-1771.08	5yr	7	123.00	123.80	0.80	1.05	6.7	12.3	0.46
6-1771.08	10yr	8.7	123.00	123.89	0.89	1.12	7.8	12.9	0.46
6-1771.08	20yr	10.8	123.00	123.99	0.99	1.19	9.1	13.7	0.47
6-1771.08	100yr	15.1	123.00	124.16	1.16	1.30	11.6	15.0	0.47
6-1872.78	5yr	7	124.00	124.89	0.89	0.89	7.8	11.9	0.35
6-1872.78	10yr	8.7	124.00	125.00	1.00	0.95	9.1	12.6	0.36
6-1872.78	20yr	10.8	124.00	125.12	1.12	1.01	10.7	13.5	0.36
6-1872.78	100yr	15.1	124.00	125.31	1.31	1.12	13.5	14.9	0.38
7-29.59	5yr	2.5	110.41	111.04	0.63	1.68	1.5	5.3	1.01
7-29.59	10yr	3	110.41	111.09	0.68	1.73	1.7	5.9	1.02
7-29.59	20yr	3.6	110.41	111.14	0.73	1.76	2.1	6.5	1.00
7-29.59	100yr	4.8	110.41	111.22	0.81	1.89	2.5	7.2	1.02
7-78.45	5yr	2.5	112.00	112.43	0.43	1.05	2.4	8.3	0.62
7-78.45	10yr	3	112.00	112.47	0.47	1.09	2.8	8.8	0.62
7-78.45	20yr	3.6	112.00	112.52	0.52	1.14	3.2	9.5	0.63
7-78.45	100yr	4.8	112.00	112.59	0.59	1.21	4.0	10.5	0.63
7-131.93	5yr	2.3	112.00	112.78	0.78	0.45	5.1	11.0	0.21
7-131.93	10yr	2.8	112.00	112.84	0.84	0.48	5.8	11.7	0.22
7-131.93	20yr	3.3	112.00	112.89	0.89	0.51	6.5	12.3	0.23
7-131.93	100yr	4.4	112.00	113.00	1.00	0.57	7.8	13.5	0.24
7-176.09	5yr	2.3	112.00	112.87	0.87	0.32	7.1	14.7	0.15
7-176.09	10yr	2.8	112.00	112.93	0.93	0.35	8.1	15.6	0.15
7-176.09	20yr	3.3	112.00	112.99	0.99	0.37	9.0	16.6	0.15
7-176.09	100yr	4.4	112.00	113.10	1.10	0.41	11.0	18.7	0.16
7-236.99	5yr	2.3	112.07	113.00	0.93	0.51	4.5	9.2	0.24
7-236.99	10yr	2.8	112.07	113.07	1.00	0.55	5.1	9.8	0.24
7-236.99	20yr	3.3	112.07	113.13	1.06	0.57	5.8	10.4	0.25
7-236.99	100yr	4.4	112.07	113.25	1.18	0.63	7.0	11.5	0.26
7-268.83	5yr	2.3	113.00	113.45	0.45	1.05	2.2	6.8	0.59
7-268.83	10yr	2.8	113.00	113.50	0.50	1.09	2.6	7.2	0.58
7-268.83	20yr	3.3	113.00	113.54	0.54	1.15	2.9	7.5	0.59
7-268.83	100yr	4.4	113.00	113.63	0.63	1.24	3.5	8.2	0.61
7-309.37	5yr	2.3	115.68	116.02	0.34	0.82	3.2	58.9	0.72
7-309.37	10yr	2.8	115.68	116.03	0.35	0.83	3.9	59.7	0.70
7-309.37	20yr	3.3	115.68	116.04	0.36	0.86	4.3	60.2	0.71
7-309.37	100yr	4.4	115.68	116.05	0.37	0.92	5.2	61.1	0.73
7-367.88	5yr	1.8	116.00	116.26	0.26	0.28	6.4	33.1	0.19
7-367.88	10yr	2.2	116.00	116.28	0.28	0.31	7.3	34.7	0.19
7-367.88	20yr	2.6	116.00	116.30	0.30	0.33	8.1	35.9	0.20
7-367.88	100yr	3.4	116.00	116.34	0.34	0.37	9.5	38.1	0.21
7-451.2	5yr	1.8	116.00	116.48	0.48	0.42	4.3	11.5	0.22
7-451.2	10yr	2.2	116.00	116.52	0.52	0.46	4.8	11.9	0.23
7-451.2	20yr	2.6	116.00	116.56	0.56	0.50	5.2	12.3	0.24
7-451.2	100yr	3.4	116.00	116.62	0.62	0.56	6.1	13.0	0.26
7-576.7	5yr	1.8	118.63	118.83	0.20	0.42	4.3	42.2	0.42
7-576.7	10yr	2.2	118.63	118.84	0.21	0.45	4.9	43.7	0.42
7-576.7	20yr	2.6	118.63	118.86	0.23	0.48	5.4	44.7	0.44
7-576.7	100yr	3.4	118.63	118.88	0.25	0.52	6.5	46.6	0.45
7-628.12	5yr	1.8	119.00	119.20	0.20	0.33	5.4	28.6	0.24
7-628.12	10yr	2.2	119.00	119.23	0.23	0.36	6.2	29.0	0.25
7-628.12	20yr	2.6	119.00	119.25	0.25	0.38	6.8	29.4	0.25
7-628.12	100yr	3.4	119.00	119.29	0.29	0.42	8.1	30.1	0.26
7-668.29	5yr	1.8	119.00	119.32	0.32	0.29	6.2	21.1	0.17
7-668.29	10yr	2.2	119.00	119.35	0.35	0.32	6.9	21.5	0.18
7-668.29	20yr	2.6	119.00	119.38	0.38	0.35	7.5	21.7	0.19
7-668.29	100yr	3.4	119.00	119.43	0.43	0.40	8.6	22.2	0.20

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
7-697.21	5yr	1.8	119.00	119.36	0.36	0.20	9.0	27.7	0.11
7-697.21	10yr	2.2	119.00	119.39	0.39	0.22	10.0	28.2	0.12
7-697.21	20yr	2.6	119.00	119.42	0.42	0.24	10.9	28.7	0.12
7-697.21	100yr	3.4	119.00	119.48	0.48	0.27	12.5	29.6	0.13
8-66.83	5yr	1.3	100.74	100.94	0.20	1.02	1.3	12.0	1.01
8-66.83	10yr	1.5	100.74	100.95	0.21	1.04	1.4	13.0	1.00
8-66.83	20yr	1.9	100.74	100.97	0.23	1.10	1.7	13.9	1.00
8-66.83	100yr	2.6	100.74	101.00	0.26	1.21	2.2	14.3	0.99
8-152.5	5yr	1.3	104.00	104.08	0.08	0.78	1.7	22.5	0.91
8-152.5	10yr	1.5	104.00	104.08	0.08	0.82	1.8	22.6	0.92
8-152.5	20yr	1.9	104.00	104.10	0.10	0.78	2.4	22.8	0.76
8-152.5	100yr	2.6	104.00	104.12	0.12	0.99	2.6	22.9	0.93
8-280.45	5yr	1.3	104.00	104.56	0.56	0.56	2.3	8.3	0.34
8-280.45	10yr	1.5	104.00	104.59	0.59	0.58	2.6	8.8	0.34
8-280.45	20yr	1.9	104.00	104.64	0.64	0.61	3.1	9.6	0.35
8-280.45	100yr	2.6	104.00	104.72	0.72	0.66	3.9	10.9	0.35
8-358.91	5yr	1.3	106.00	106.12	0.12	0.54	2.4	20.2	0.51
8-358.91	10yr	1.5	106.00	106.13	0.13	0.57	2.6	20.3	0.51
8-358.91	20yr	1.9	106.00	106.15	0.15	0.63	3.0	20.5	0.52
8-358.91	100yr	2.6	106.00	106.19	0.19	0.70	3.7	20.7	0.53
8-460.05	5yr	1.3	107.00	107.48	0.48	0.84	1.6	6.2	0.53
8-460.05	10yr	1.5	107.00	107.50	0.50	0.87	1.7	6.6	0.54
8-460.05	20yr	1.9	107.00	107.55	0.55	0.92	2.1	7.2	0.55
8-460.05	100yr	2.6	107.00	107.63	0.63	0.99	2.6	8.1	0.55
8-561.83	5yr	1.3	109.27	109.60	0.33	0.61	2.1	13.2	0.49
8-561.83	10yr	1.5	109.27	109.62	0.35	0.64	2.4	14.0	0.49
8-561.83	20yr	1.9	109.27	109.65	0.38	0.68	2.8	15.1	0.50
8-561.83	100yr	2.6	109.27	109.70	0.43	0.74	3.5	16.1	0.51
8-665.91	5yr	1.3	111.55	111.70	0.15	2.42	0.5	6.1	2.61
8-665.91	10yr	1.5	111.55	111.71	0.16	2.47	0.6	6.3	2.54
8-665.91	20yr	1.9	111.55	111.73	0.18	2.45	0.8	6.8	2.31
8-665.91	100yr	2.6	111.55	111.76	0.21	2.60	1.0	7.3	2.25
8-701.2	5yr	1.3	116.00	116.08	0.08	0.65	1.9	19.5	0.66
8-701.2	10yr	1.5	116.00	116.09	0.09	0.74	1.9	19.5	0.75
8-701.2	20yr	1.9	116.00	116.11	0.11	0.89	2.0	19.7	0.88
8-701.2	100yr	2.6	116.00	116.13	0.13	0.98	2.5	20.3	0.88
8-746.32	5yr	1.3	116.00	116.17	0.17	0.06	23.5	142.6	0.04
8-746.32	10yr	1.5	116.00	116.18	0.18	0.06	25.2	143.1	0.05
8-746.32	20yr	1.9	116.00	116.21	0.21	0.07	28.8	144.4	0.05
8-746.32	100yr	2.6	116.00	116.25	0.25	0.08	34.4	146.5	0.05
8-780.43	5yr	1.3	116.00	116.18	0.18	0.10	10.7	70.2	0.08
8-780.43	10yr	1.5	116.00	116.19	0.19	0.10	11.6	76.1	0.08
8-780.43	20yr	1.9	116.00	116.22	0.22	0.11	13.5	77.5	0.09
8-780.43	100yr	2.6	116.00	116.25	0.25	0.13	16.6	79.5	0.09
8-807.74	5yr	1.3	116.00	116.22	0.22	0.35	3.7	18.6	0.25
8-807.74	10yr	1.5	116.00	116.24	0.24	0.38	4.0	18.8	0.26
8-807.74	20yr	1.9	116.00	116.26	0.26	0.42	4.5	19.3	0.28
8-807.74	100yr	2.6	116.00	116.30	0.30	0.49	5.3	20.0	0.31
8-840.88	5yr	1.3	116.37	116.65	0.28	0.83	1.6	10.2	0.67
8-840.88	10yr	1.5	116.37	116.66	0.29	0.89	1.7	10.5	0.71
8-840.88	20yr	1.9	116.37	116.69	0.32	0.91	2.1	11.4	0.67
8-840.88	100yr	2.6	116.37	116.74	0.37	1.01	2.6	12.5	0.71
8-924.19	5yr	0.3	119.25	119.39	0.14	0.80	0.4	5.8	1.00
8-924.19	10yr	0.4	119.25	119.40	0.15	0.92	0.4	6.1	1.10
8-924.19	20yr	0.5	119.25	119.42	0.17	0.80	0.6	7.4	0.88
8-924.19	100yr	0.7	119.25	119.44	0.19	1.02	0.7	7.8	1.10
8-979.99	5yr	0.3	121.86	121.97	0.11	0.77	0.4	5.0	0.87
8-979.99	10yr	0.4	121.86	121.99	0.13	0.96	0.4	5.1	1.06
8-979.99	20yr	0.5	121.86	122.00	0.14	0.88	0.6	5.7	0.90
8-979.99	100yr	0.7	121.86	122.03	0.17	1.04	0.7	6.1	1.00

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
8-1020.11	5yr	0.3	123.37	123.56	0.19	0.78	0.4	4.0	0.80
8-1020.11	10yr	0.4	123.37	123.58	0.21	2.23	0.2	2.7	2.74
8-1020.11	20yr	0.5	123.37	123.60	0.23	0.92	0.5	4.8	0.87
8-1020.11	100yr	0.7	123.37	123.63	0.26	1.48	0.5	4.4	1.44
8-1066.74	5yr	0.3	125.68	125.80	0.12	0.75	0.4	5.2	0.85
8-1066.74	10yr	0.4	125.68	125.78	0.10	0.79	0.5	6.1	0.88
8-1066.74	20yr	0.5	125.68	125.84	0.16	0.90	0.6	6.7	0.99
8-1066.74	100yr	0.7	125.68	125.83	0.15	2.98	0.2	4.2	3.99
8-1110.65	5yr	0.3	128.03	128.19	0.16	0.81	0.4	4.9	0.93
8-1110.65	10yr	0.4	128.03	128.21	0.18	0.97	0.4	5.1	1.09
8-1110.65	20yr	0.5	128.03	128.23	0.20	0.92	0.5	6.0	0.98
8-1110.65	100yr	0.7	128.03	128.25	0.22	0.99	0.7	7.1	1.00
8-1155.8	5yr	0.3	130.31	130.50	0.19	1.87	0.2	1.6	1.89
8-1155.8	10yr	0.4	130.31	130.52	0.21	1.67	0.2	2.0	1.56
8-1155.8	20yr	0.5	130.31	130.54	0.23	1.87	0.3	2.2	1.73
8-1155.8	100yr	0.7	130.31	130.58	0.27	2.05	0.3	2.6	1.81
8-1193.32	5yr	0.3	134.46	134.56	0.10	0.67	0.5	7.2	0.86
8-1193.32	10yr	0.4	134.46	134.58	0.12	0.89	0.5	7.2	1.14
8-1193.32	20yr	0.5	134.46	134.59	0.13	0.86	0.6	8.3	1.04
8-1193.32	100yr	0.7	134.46	134.61	0.15	0.90	0.8	9.7	1.01
8-1217.88	5yr	0.3	136.00	136.02	0.02	0.43	0.7	23.6	0.81
8-1217.88	10yr	0.4	136.00	136.03	0.03	0.58	0.7	23.6	1.09
8-1217.88	20yr	0.5	136.00	136.04	0.04	0.60	0.8	23.6	1.01
8-1217.88	100yr	0.7	136.00	136.05	0.05	0.66	1.1	23.7	1.00
8-1241.95	5yr	0.3	137.09	137.29	0.20	1.08	0.3	2.8	1.09
8-1241.95	10yr	0.4	137.09	137.32	0.23	1.07	0.4	3.2	1.00
8-1241.95	20yr	0.5	137.09	137.34	0.25	1.04	0.5	3.6	0.90
8-1241.95	100yr	0.7	137.09	137.38	0.29	1.23	0.6	3.8	1.01
9-47.85	5yr	0.3	118.63	118.77	0.14	0.84	0.4	5.7	1.06
9-47.85	10yr	0.4	118.63	118.79	0.16	0.82	0.5	7.0	0.99
9-47.85	20yr	0.5	118.63	118.80	0.17	0.88	0.6	7.2	1.00
9-47.85	100yr	0.7	118.63	118.82	0.19	0.96	0.7	7.8	1.01
9-93.97	5yr	0.3	121.00	121.14	0.14	0.95	0.3	5.6	1.28
9-93.97	10yr	0.4	121.00	121.15	0.15	0.66	0.6	13.1	0.98
9-93.97	20yr	0.5	121.00	121.16	0.16	0.81	0.6	13.3	1.19
9-93.97	100yr	0.7	121.00	121.18	0.18	0.71	1.0	15.9	0.90
9-118.83	5yr	0.3	123.00	123.08	0.08	0.74	0.4	5.1	0.84
9-118.83	10yr	0.4	123.00	123.09	0.09	0.95	0.4	5.1	1.07
9-118.83	20yr	0.5	123.00	123.11	0.11	0.97	0.5	5.3	1.00
9-118.83	100yr	0.7	123.00	123.13	0.13	1.07	0.7	5.6	1.00
9-145.72	5yr	0.3	123.00	123.17	0.17	0.11	2.6	16.6	0.09
9-145.72	10yr	0.4	123.00	123.19	0.19	0.13	3.1	16.9	0.10
9-145.72	20yr	0.5	123.00	123.22	0.22	0.14	3.5	17.1	0.10
9-145.72	100yr	0.7	123.00	123.26	0.26	0.17	4.2	17.5	0.11
9-172.34	5yr	0.3	123.00	123.18	0.18	1.06	0.3	2.3	0.97
9-172.34	10yr	0.4	123.00	123.21	0.21	1.16	0.3	2.5	1.00
9-172.34	20yr	0.5	123.00	123.24	0.24	1.22	0.4	2.7	1.00
9-172.34	100yr	0.7	123.00	123.28	0.28	1.30	0.5	3.1	1.00
9-192.74	5yr	0.3	123.84	124.00	0.16	1.55	0.2	2.0	1.60
9-192.74	10yr	0.4	123.84	124.02	0.18	1.73	0.2	2.2	1.69
9-192.74	20yr	0.5	123.84	124.04	0.20	1.76	0.3	2.3	1.60
9-192.74	100yr	0.7	123.84	124.07	0.23	1.91	0.4	2.6	1.61
9-223.4	5yr	0.3	127.10	127.29	0.19		0.2	2.1	0.00
9-223.4	10yr	0.4	127.10	127.31	0.21		0.3	2.4	0.00
9-223.4	20yr	0.5	127.10	127.33	0.23		0.3	2.5	0.00
9-223.4	100yr	0.7	127.10	127.36	0.26		0.4	2.9	0.00
9-259.87	5yr	0.3	129.67	129.77	0.10		0.2	3.5	0.00
9-259.87	10yr	0.4	129.67	129.79	0.12		0.2	3.5	0.00
9-259.87	20yr	0.5	129.67	129.80	0.13		0.3	4.0	0.00
9-259.87	100yr	0.7	129.67	129.82	0.15		0.4	4.4	0.00

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
9-308.1	5yr	0.3	133.72	133.77	0.05	59.41	0.0	1.4	315.89
9-308.1	10yr	0.4	133.72	133.78	0.06	0.75	0.5	17.4	1.28
9-308.1	20yr	0.5	133.72	133.79	0.07	0.63	0.8	25.2	0.95
9-308.1	100yr	0.7	133.72	133.79	0.07	0.72	1.0	25.8	1.01
9-356.04	5yr	0.3	136.96	137.03	0.07	1.67	0.2	8.6	3.70
9-356.04	10yr	0.4	136.96	137.03	0.07	0.57	0.7	15.8	0.86
9-356.04	20yr	0.5	136.96	137.04	0.08	0.74	0.7	15.7	1.13
9-356.04	100yr	0.7	136.96	137.05	0.09	0.75	0.9	16.4	1.00
9-376.45	5yr	0.3	138.24	138.35	0.11	0.64	0.5	8.6	0.73
9-376.45	10yr	0.4	138.24	138.37	0.13	0.62	0.6	10.5	0.68
9-376.45	20yr	0.5	138.24	138.38	0.14	0.76	0.6	10.5	0.83
9-376.45	100yr	0.7	138.24	138.40	0.16	0.75	0.9	14.8	0.78
9-394.62	5yr	0.3	139.00	139.04	0.04	0.44	0.7	17.2	0.72
9-394.62	10yr	0.4	139.00	139.05	0.05	0.48	0.8	17.3	0.70
9-394.62	20yr	0.5	139.00	139.05	0.05	0.58	0.9	17.3	0.84
9-394.62	100yr	0.7	139.00	139.06	0.06	0.62	1.1	17.5	0.77
9-421.74	5yr	0.3	141.08	141.20	0.12	1.90	0.2	3.8	2.97
9-421.74	10yr	0.4	141.08	141.22	0.14	3.23	0.1	3.4	5.39
9-421.74	20yr	0.5	141.08	141.23	0.15	0.97	0.5	6.0	1.05
9-421.74	100yr	0.7	141.08	141.26	0.18	1.04	0.7	6.7	1.05
9-447.9	5yr	0.3	143.15	143.23	0.08	0.77	0.4	6.7	1.03
9-447.9	10yr	0.4	143.15	143.24	0.09	0.89	0.5	7.0	1.12
9-447.9	20yr	0.5	143.15	143.26	0.11	0.86	0.6	8.3	1.04
9-447.9	100yr	0.7	143.15	143.28	0.13	0.82	0.9	9.7	0.88
10-81.92	5yr	0.4	104.28	104.42	0.14	0.71	0.6	7.4	0.83
10-81.92	10yr	0.5	104.28	104.43	0.15	0.93	0.5	7.2	1.08
10-81.92	20yr	0.6	104.28	104.45	0.17	0.86	0.7	9.2	1.01
10-81.92	100yr	0.8	104.28	104.52	0.24	0.52	1.5	13.0	0.48
10-163.45	5yr	0.4	106.00	106.15	0.15	0.65	0.6	6.6	0.68
10-163.45	10yr	0.5	106.00	106.17	0.17	0.71	0.7	7.0	0.71
10-163.45	20yr	0.6	106.00	106.19	0.19	0.73	0.8	7.6	0.71
10-163.45	100yr	0.8	106.00	106.22	0.22	0.74	1.1	8.5	0.66
10-229.21	5yr	0.4	107.58	107.75	0.17	0.67	0.6	6.1	0.68
10-229.21	10yr	0.5	107.58	107.77	0.19	0.70	0.7	6.6	0.68
10-229.21	20yr	0.6	107.58	107.78	0.20	0.72	0.8	7.0	0.67
10-229.21	100yr	0.8	107.58	107.80	0.22	0.82	1.0	7.5	0.72
10-269.79	5yr	0.4	108.41	108.63	0.22	3.48	0.1	2.5	5.15
10-269.79	10yr	0.5	108.41	108.64	0.23	2.03	0.3	3.7	2.53
10-269.79	20yr	0.6	108.41	108.66	0.25	0.64	0.9	9.1	0.63
10-269.79	100yr	0.8	108.41	108.68	0.27	0.68	1.2	9.9	0.63
10-312.46	5yr	0.4	110.41	110.55	0.14	0.72	0.6	8.0	0.88
10-312.46	10yr	0.5	110.41	110.56	0.15	0.85	0.6	8.1	1.00
10-312.46	20yr	0.6	110.41	110.57	0.16	0.74	0.8	10.5	0.86
10-312.46	100yr	0.8	110.41	110.59	0.18	0.83	1.0	11.1	0.90
10-355.67	5yr	0.4	111.00	111.08	0.08	0.39	1.0	13.1	0.44
10-355.67	10yr	0.5	111.00	111.09	0.09	0.43	1.2	13.3	0.47
10-355.67	20yr	0.6	111.00	111.10	0.10	0.47	1.3	13.4	0.48
10-355.67	100yr	0.8	111.00	111.12	0.12	0.51	1.6	13.8	0.48
10-400.3	5yr	0.4	111.29	111.49	0.20	0.54	0.7	5.7	0.48
10-400.3	10yr	0.5	111.29	111.51	0.22	0.59	0.9	6.0	0.50
10-400.3	20yr	0.6	111.29	111.53	0.24	0.63	1.0	6.1	0.51
10-400.3	100yr	0.8	111.29	111.56	0.27	0.70	1.1	6.4	0.53
10-483.65	5yr	0.2	113.00	113.22	0.22	0.78	0.3	1.6	0.62
10-483.65	10yr	0.3	113.00	113.27	0.27	0.88	0.3	1.8	0.64
10-483.65	20yr	0.3	113.00	113.27	0.27	0.88	0.3	1.8	0.64
10-483.65	100yr	0.4	113.00	113.31	0.31	0.96	0.4	1.9	0.66
10-550.28	5yr	0.2	119.67	119.77	0.10	0.80	0.3	5.0	1.15
10-550.28	10yr	0.3	119.67	119.79	0.12	0.79	0.4	6.1	1.01
10-550.28	20yr	0.3	119.67	119.79	0.12	0.79	0.4	6.1	1.01
10-550.28	100yr	0.4	119.67	119.80	0.13	0.93	0.4	6.5	1.14

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
10-581.24	5yr	0.2	119.00	119.80	0.80	0.01	23.7	34.9	0.00
10-581.24	10yr	0.3	119.00	119.82	0.82	0.01	24.5	35.2	0.00
10-581.24	20yr	0.3	119.00	119.82	0.82	0.01	24.5	35.2	0.00
10-581.24	100yr	0.4	119.00	119.84	0.84	0.02	25.3	35.5	0.01
10-620.97	5yr	0.2	122.30	122.40	0.10	0.53	0.4	9.7	0.86
10-620.97	10yr	0.3	122.30	122.41	0.11	0.82	0.4	9.7	1.34
10-620.97	20yr	0.3	122.30	122.41	0.11	0.82	0.4	9.7	1.34
10-620.97	100yr	0.4	122.30	122.42	0.12	0.71	0.6	11.3	1.01
10-640.61	5yr	0.2	123.00	123.01	0.01	0.33	0.6	40.6	0.87
10-640.61	10yr	0.3	123.00	123.02	0.02	0.50	0.6	40.6	1.31
10-640.61	20yr	0.3	123.00	123.02	0.02	0.50	0.6	40.6	1.31
10-640.61	100yr	0.4	123.00	123.02	0.02	0.52	0.8	40.7	1.22
10-664.21	5yr	0.2	123.54	123.66	0.12	0.85	0.2	3.9	1.11
10-664.21	10yr	0.3	123.54	123.68	0.14	0.88	0.3	4.8	1.04
10-664.21	20yr	0.3	123.54	123.68	0.14	0.88	0.3	4.8	1.04
10-664.21	100yr	0.4	123.54	123.70	0.16	0.89	0.5	5.7	1.01
11-29.23	5yr	5.4	109.22	110.04	0.82	2.12	2.6	5.7	1.01
11-29.23	10yr	6.7	109.22	110.12	0.90	2.19	3.1	6.4	1.01
11-29.23	20yr	8.5	109.22	110.22	1.00	2.28	3.7	7.2	1.01
11-29.23	100yr	11.9	109.22	110.38	1.16	2.42	4.9	8.5	1.01
11-93.39	5yr	5.4	111.33	111.77	0.44	1.33	4.1	13.8	0.79
11-93.39	10yr	6.7	111.33	111.81	0.48	1.42	4.7	14.5	0.79
11-93.39	20yr	8.5	111.33	111.87	0.54	1.52	5.6	15.5	0.81
11-93.39	100yr	11.9	111.33	111.98	0.65	1.63	7.3	17.7	0.81
11-224.02	5yr	4.6	114.14	114.58	0.44	1.18	3.9	14.7	0.74
11-224.02	10yr	5.8	114.14	114.62	0.48	1.28	4.5	15.7	0.76
11-224.02	20yr	7.4	114.14	114.68	0.54	1.32	5.6	18.0	0.76
11-224.02	100yr	10.4	114.14	114.77	0.63	1.41	7.4	21.8	0.77
11-326.04	5yr	4.6	115.97	116.24	0.27	0.97	4.7	19.5	0.63
11-326.04	10yr	5.8	115.97	116.28	0.31	1.06	5.5	19.8	0.64
11-326.04	20yr	7.4	115.97	116.32	0.35	1.14	6.5	20.2	0.65
11-326.04	100yr	10.4	115.97	116.40	0.43	1.31	7.9	20.8	0.68
11-440.01	5yr	4.6	117.43	117.97	0.54	0.84	5.5	16.4	0.47
11-440.01	10yr	5.8	117.43	118.03	0.60	0.87	6.7	19.1	0.47
11-440.01	20yr	7.4	117.43	118.09	0.66	0.95	7.8	19.8	0.48
11-440.01	100yr	10.4	117.43	118.19	0.76	1.06	9.8	21.0	0.49
11-516.89	5yr	4.6	118.50	119.00	0.50	0.81	5.7	15.4	0.43
11-516.89	10yr	5.8	118.50	119.05	0.55	0.88	6.6	15.8	0.44
11-516.89	20yr	7.4	118.50	119.12	0.62	0.97	7.7	16.2	0.45
11-516.89	100yr	10.4	118.50	119.24	0.74	1.09	9.6	16.9	0.46
11-619.52	5yr	4.6	121.00	121.43	0.43	1.01	4.6	14.9	0.58
11-619.52	10yr	5.8	121.00	121.48	0.48	1.08	5.4	15.3	0.58
11-619.52	20yr	7.4	121.00	121.54	0.54	1.18	6.3	15.7	0.60
11-619.52	100yr	10.4	121.00	121.64	0.64	1.33	7.8	16.6	0.62
12-725.22	5yr	3.3	89.78	89.79	0.01	0.03	5.2	59.2	0.21
12-725.22	10yr	4	89.78	89.79	0.01	0.04	6.7	67.2	0.22
12-725.22	20yr	5.1	89.78	89.80	0.02	0.05	7.7	71.9	0.23
12-725.22	100yr	7	89.78	89.82	0.04	0.12	9.9	80.4	0.29
12-655.98	5yr	3.3	88.81	88.87	0.06	0.16	6.0	63.3	0.31
12-655.98	10yr	4	88.81	88.87	0.06	0.19	6.5	64.4	0.34
12-655.98	20yr	5.1	88.81	88.89	0.08	0.22	7.7	67.1	0.35
12-655.98	100yr	7	88.81	88.92	0.11	0.26	9.5	71.0	0.36
12-580.44	5yr	3.3	87.70	87.86	0.16	0.25	5.6	36.0	0.28
12-580.44	10yr	4	87.70	87.88	0.18	0.30	6.5	37.6	0.29
12-580.44	20yr	5.1	87.70	87.91	0.21	0.36	7.7	39.6	0.31
12-580.44	100yr	7	87.70	87.96	0.26	0.43	9.6	42.1	0.32
12-477.35	5yr	3.3	87.00	87.16	0.16	0.16	14.7	97.2	0.13
12-477.35	10yr	4	87.00	87.17	0.17	0.18	16.1	100.2	0.14
12-477.35	20yr	5.1	87.00	87.20	0.20	0.20	18.3	110.8	0.15
12-477.35	100yr	7	87.00	87.22	0.22	0.25	21.6	118.4	0.17

Cross Section	ARI	Flow	Min Channel Elevation	Water Surface Elev	Max Depth	Average Channel Velocity	Flow Area	Top Flow Width	Channel Froude Number
		(m^3/s)	(m)	(m)	(m)	(m/s)	(m^2)	(m)	
12-434.73	5yr	3.3	87.00	87.06	0.06	0.28	8.3	146.9	0.37
12-434.73	10yr	4	87.00	87.07	0.07	0.29	9.5	147.3	0.36
12-434.73	20yr	5.1	87.00	87.07	0.07	0.33	10.9	147.7	0.38
12-434.73	100yr	7	87.00	87.09	0.09	0.36	13.3	148.5	0.39
12-333.13	5yr	9.2	85.00	85.55	0.55	0.49	18.3	48.1	0.21
12-333.13	10yr	11.3	85.00	85.60	0.60	0.54	20.6	50.6	0.22
12-333.13	20yr	14.2	85.00	85.65	0.65	0.60	23.4	53.5	0.24
12-333.13	100yr	19.6	85.00	85.74	0.74	0.69	28.1	58.2	0.26
12-247.44	5yr	9.2	85.00	85.16	0.16	0.43	15.7	105.6	0.34
12-247.44	10yr	11.3	85.00	85.18	0.18	0.47	17.8	105.9	0.35
12-247.44	20yr	14.2	85.00	85.21	0.21	0.51	20.5	106.3	0.36
12-247.44	100yr	19.6	85.00	85.25	0.25	0.57	25.0	107.0	0.36
12-120.07	5yr	9.2	84.00	84.17	0.17	0.70	9.8	59.6	0.54
12-120.07	10yr	11.3	84.00	84.20	0.20	0.73	11.5	60.6	0.52
12-120.07	20yr	14.2	84.00	84.22	0.22	0.82	12.8	61.3	0.56
12-120.07	100yr	19.6	84.00	84.27	0.27	0.92	16.0	63.1	0.56

Appendix I

Developed Hydrographs at Westcott Street and Ash Street

PB PARSONS BRINCKERHOFF

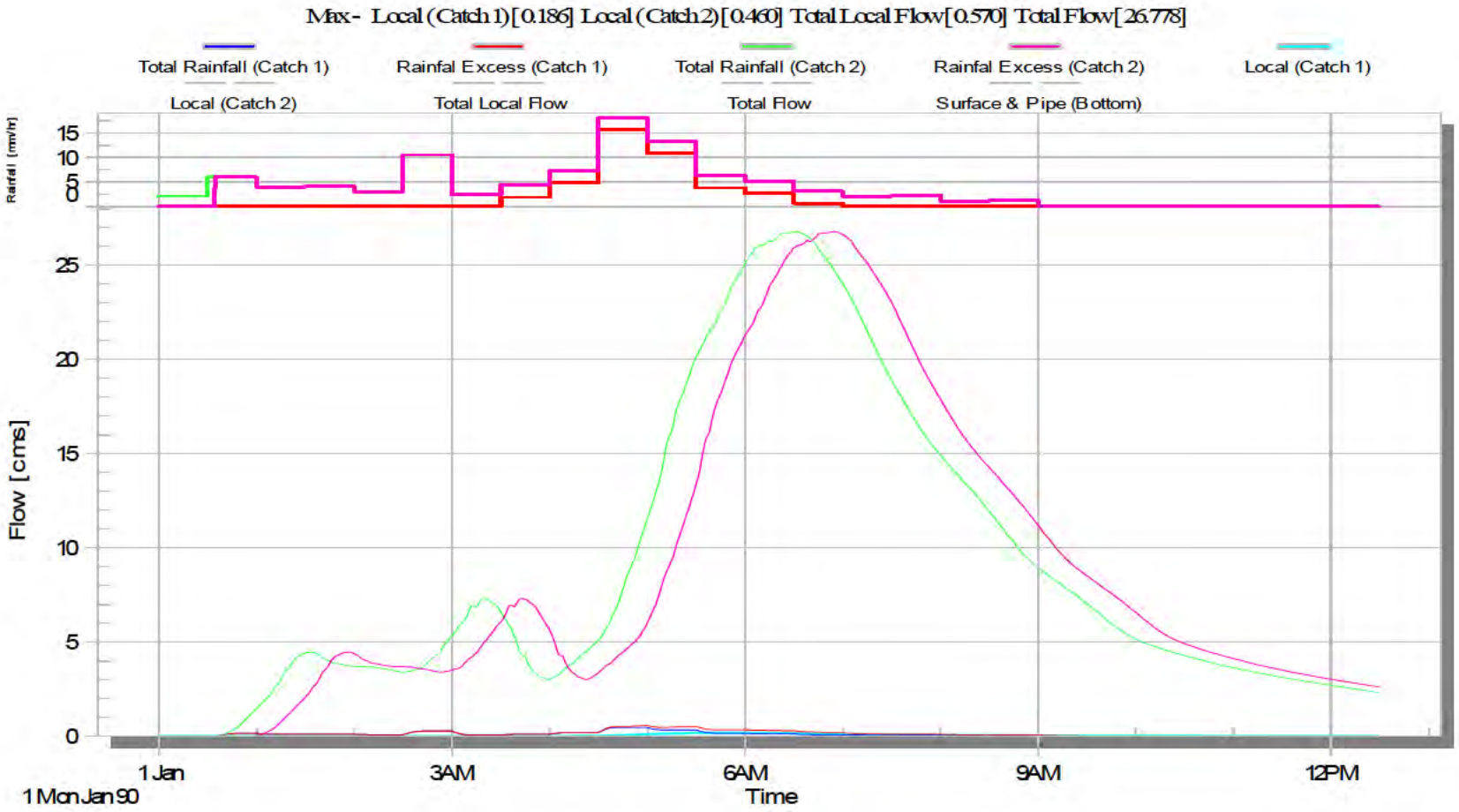
North Bellbird Flooding and Stormwater

Project No. 2122527A
Client Ref. 0

Developed Hydrographs at Westcott and Ash Street

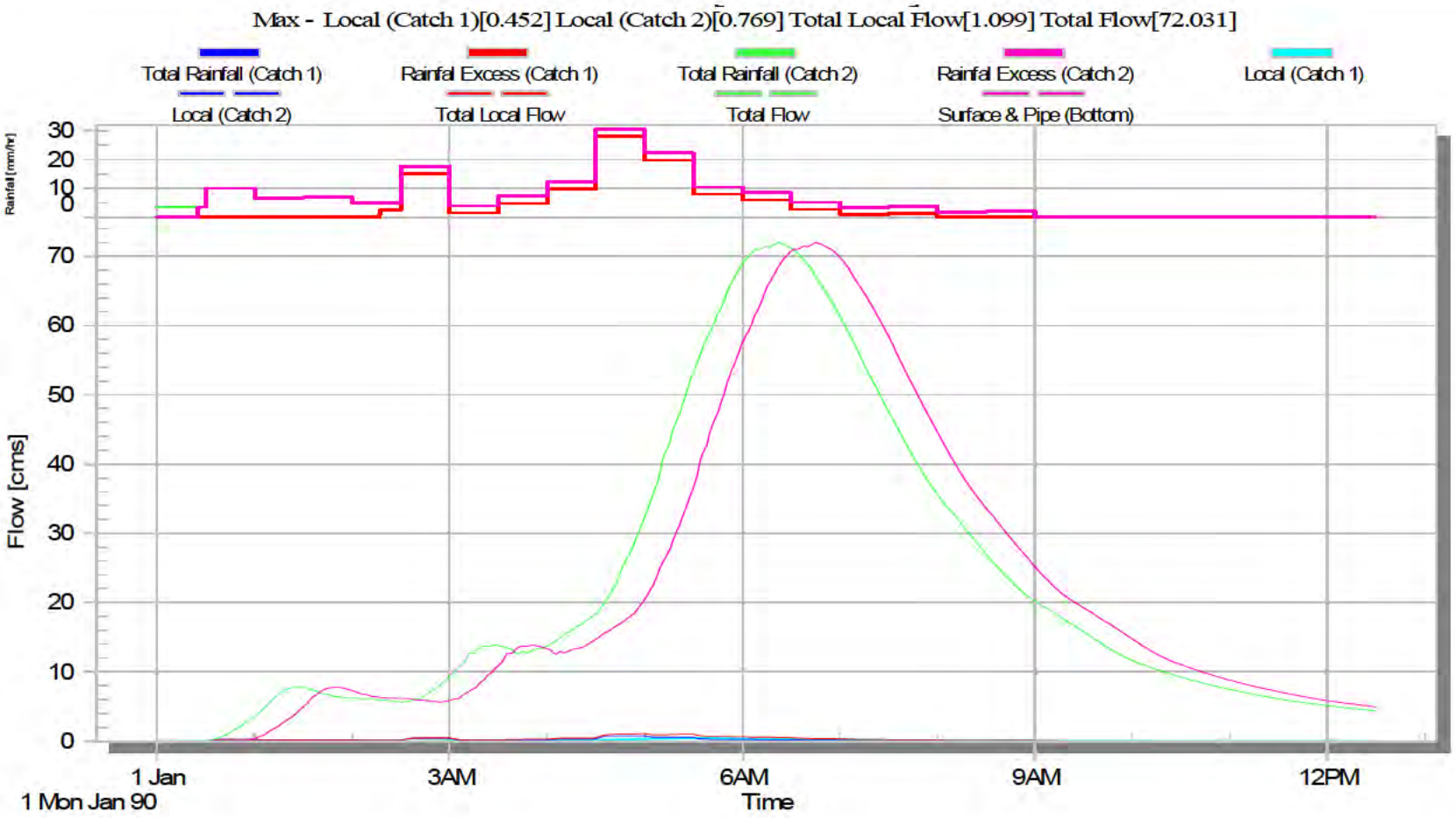
Date: 29-Mar-06

1yr ARI - Westcott Street



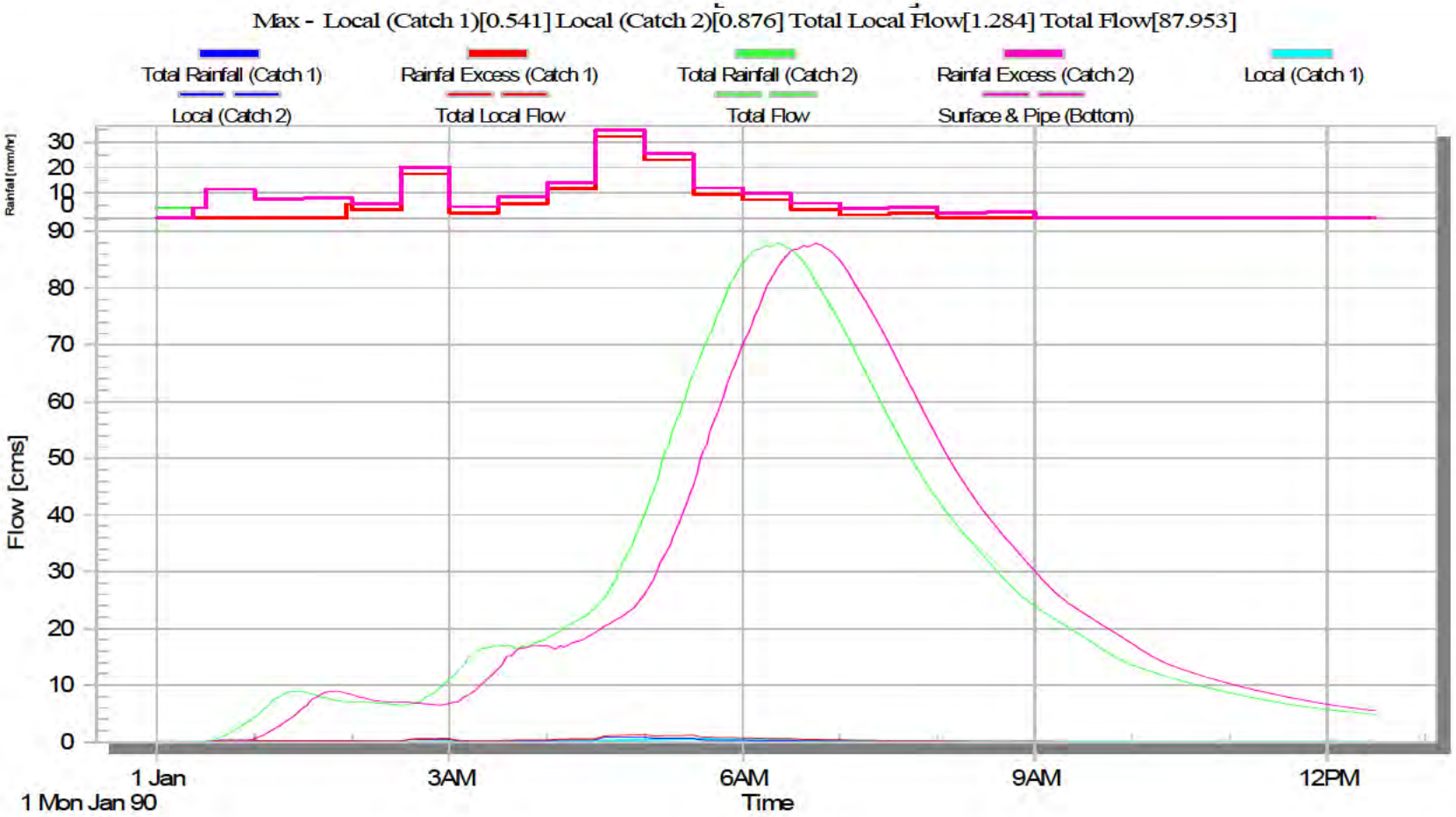
PARSONS BRINCKERHOFF

5yr ARI - Westcott Street



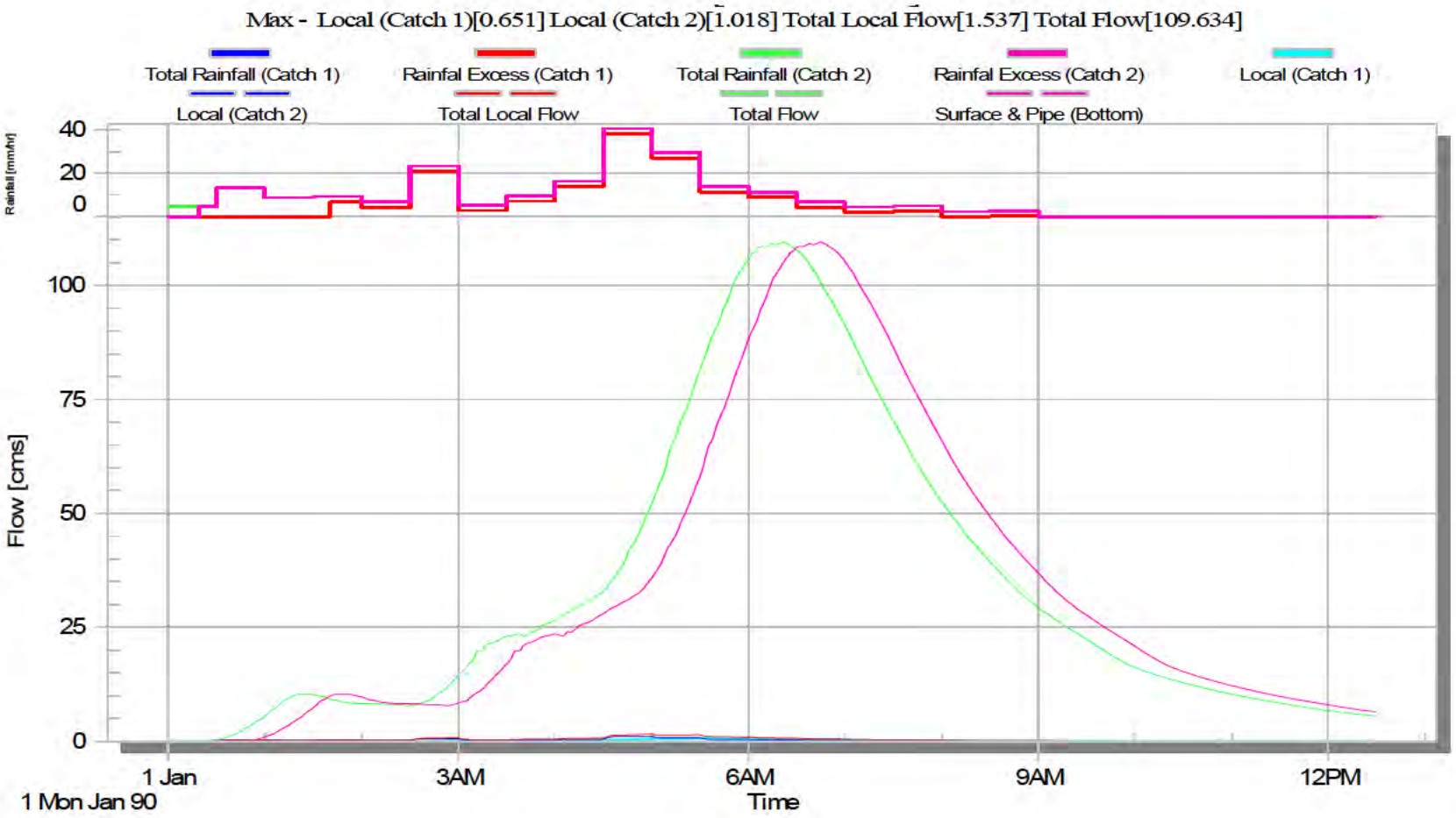
PB PARSONS BRINCKERHOFF

10yr ARI - Westcott Street



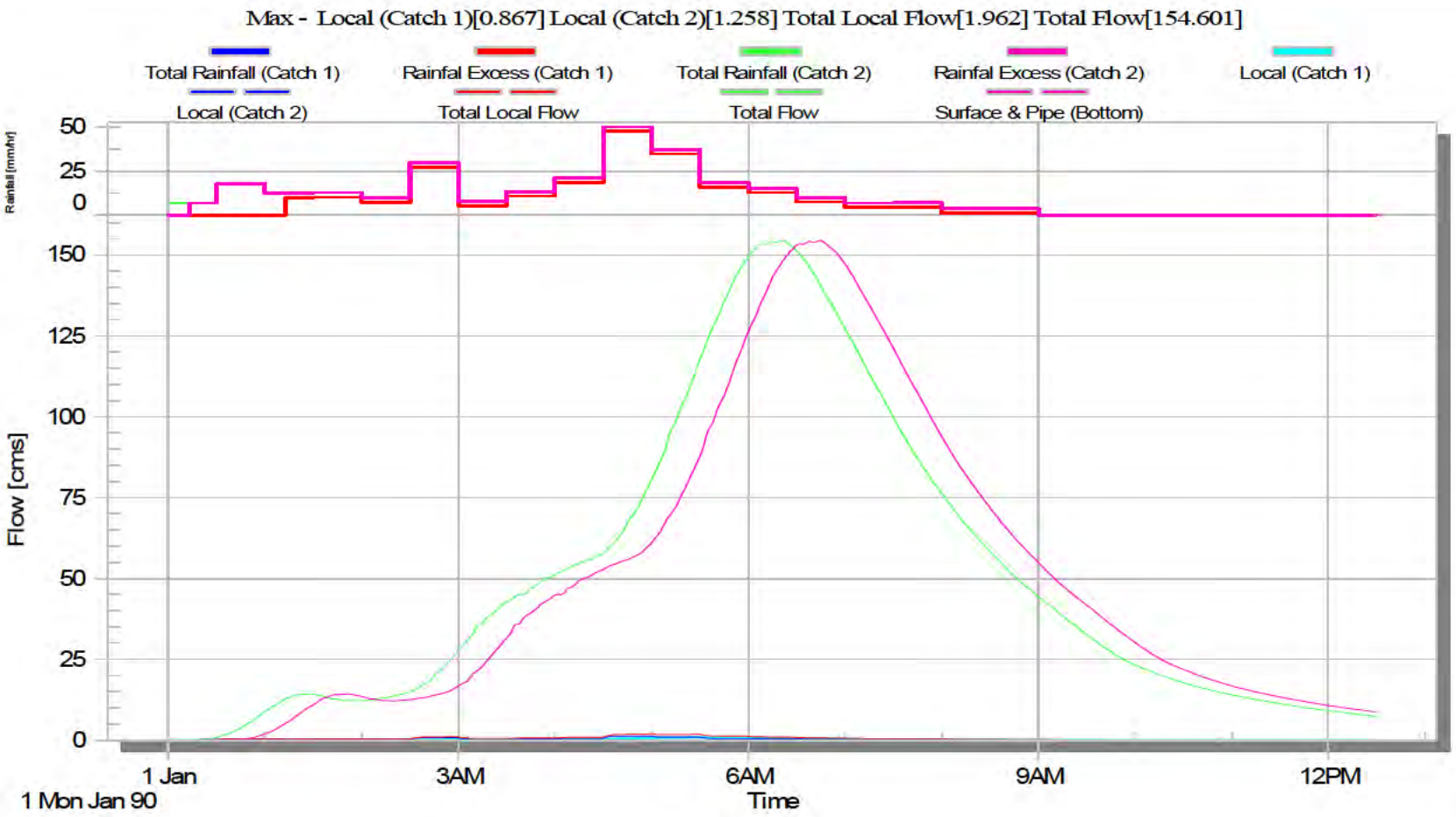
PARSONS BRINCKERHOFF

20yr ARI - Westcott Street



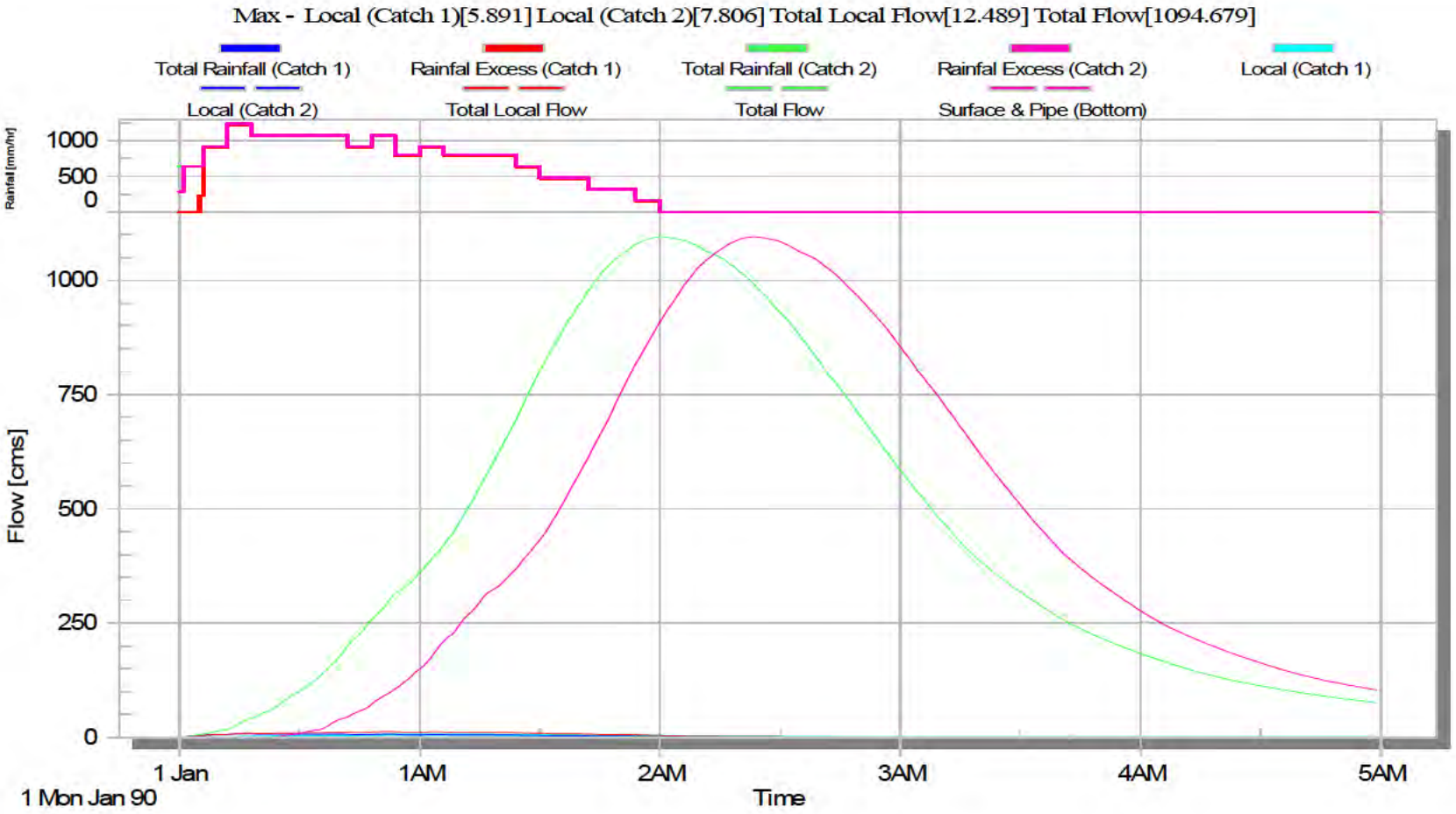
PARSONS BRINCKERHOFF

100yr ARI - Westcott Street



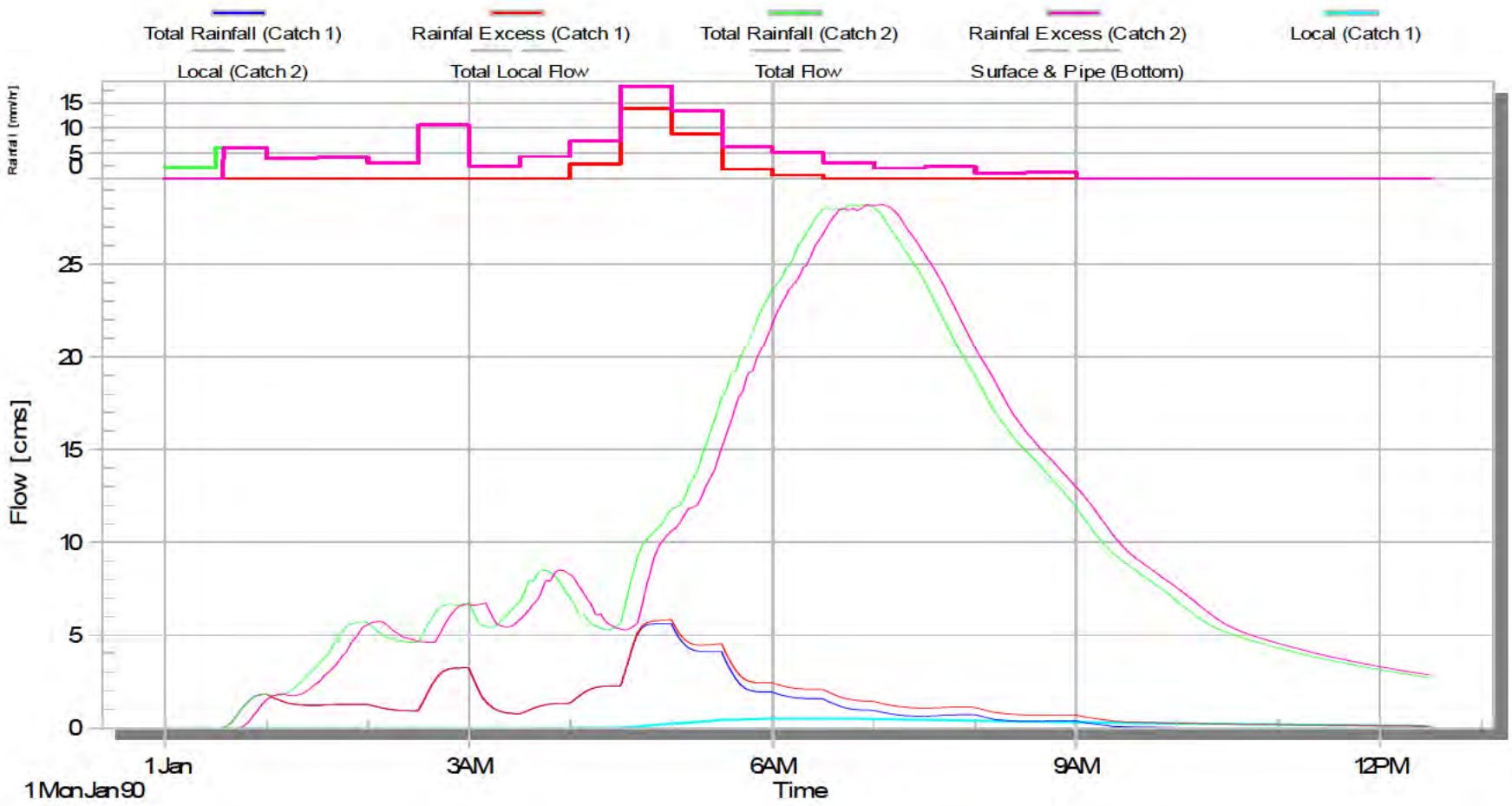
PB PARSONS BRINCKERHOFF

PMF - Westcott Street



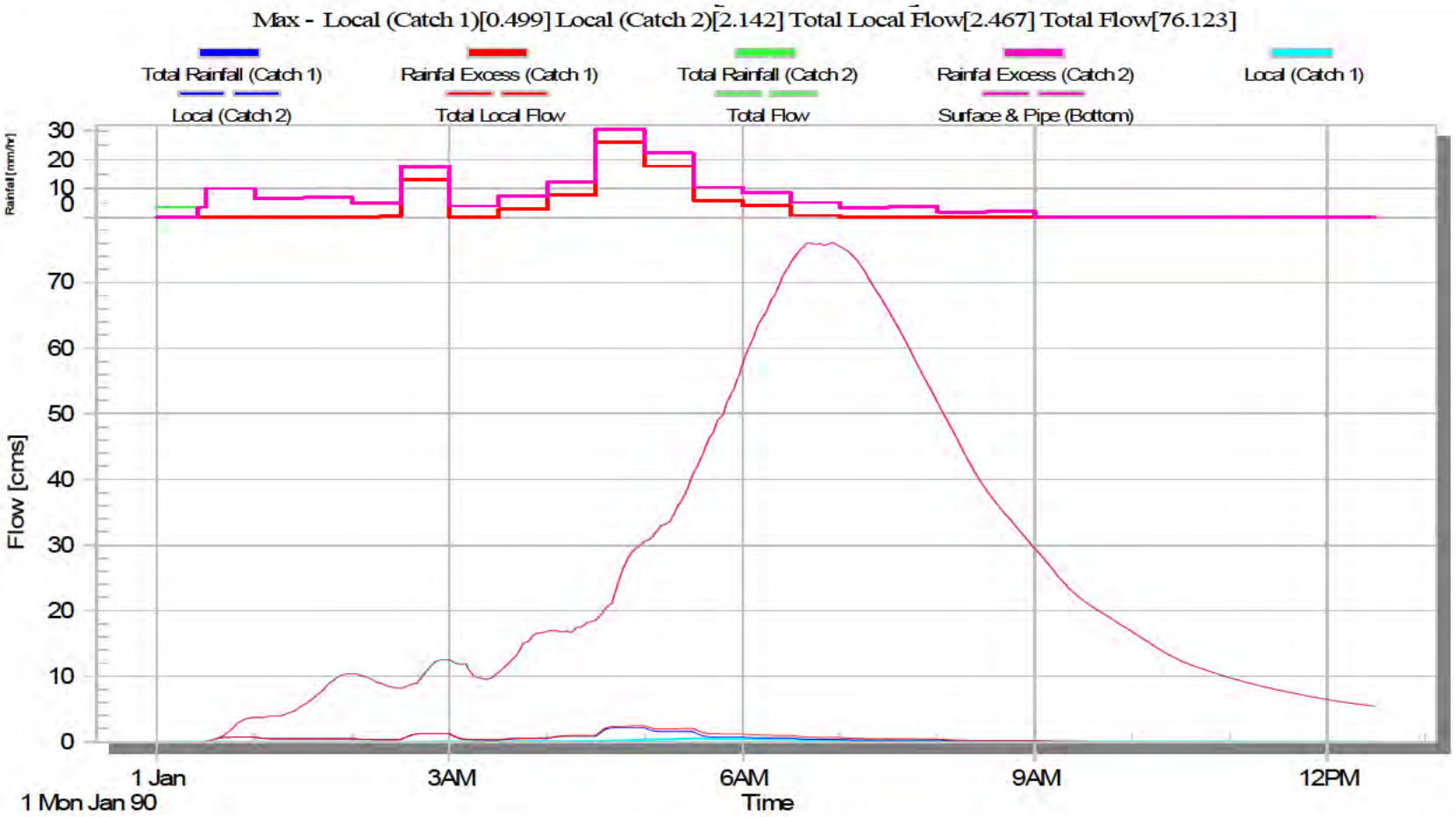
PB PARSONS BRINCKERHOFF

1yr ARI - Ash Street



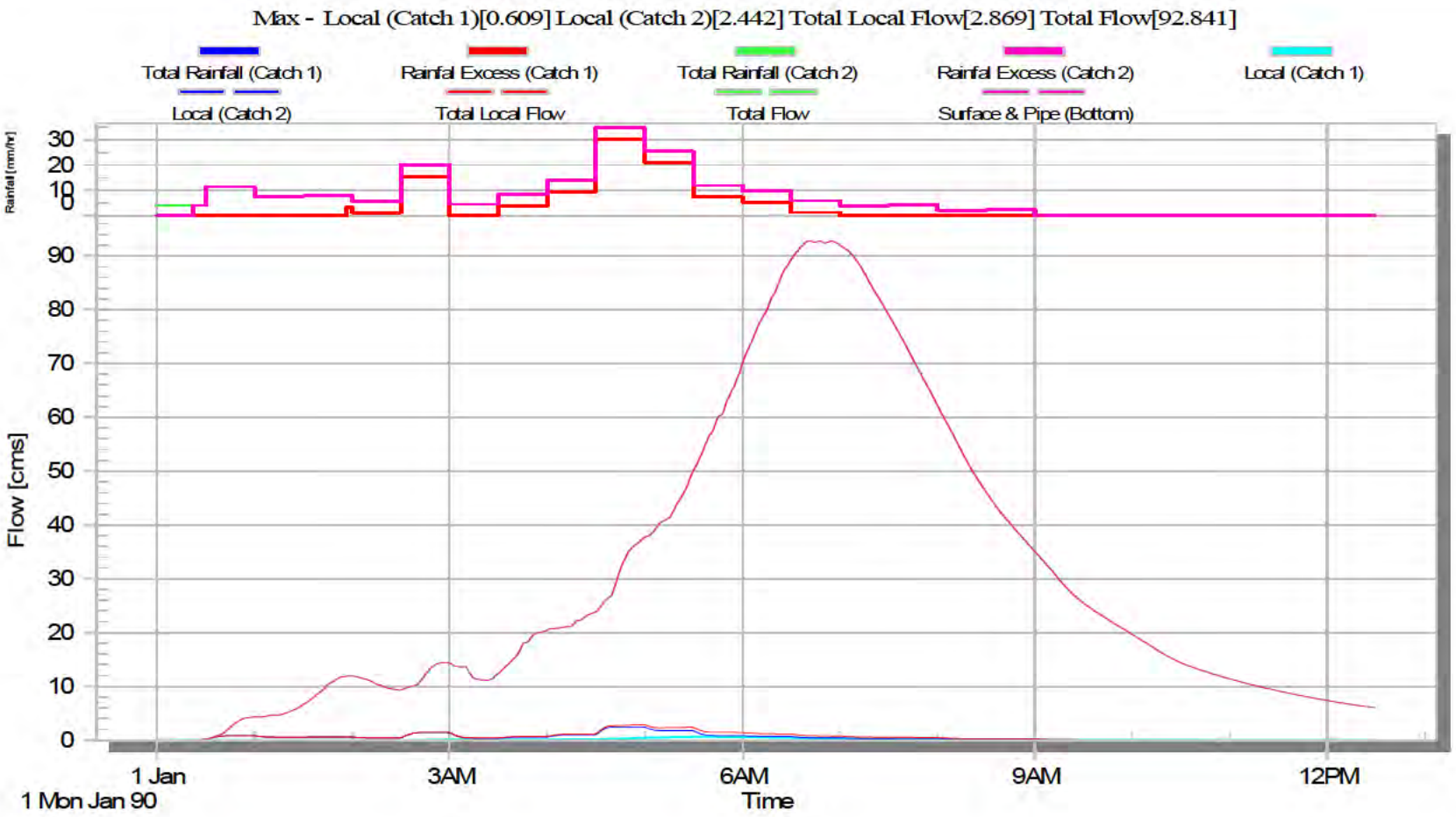
PARSONS BRINCKERHOFF

5yr ARI - Ash Street



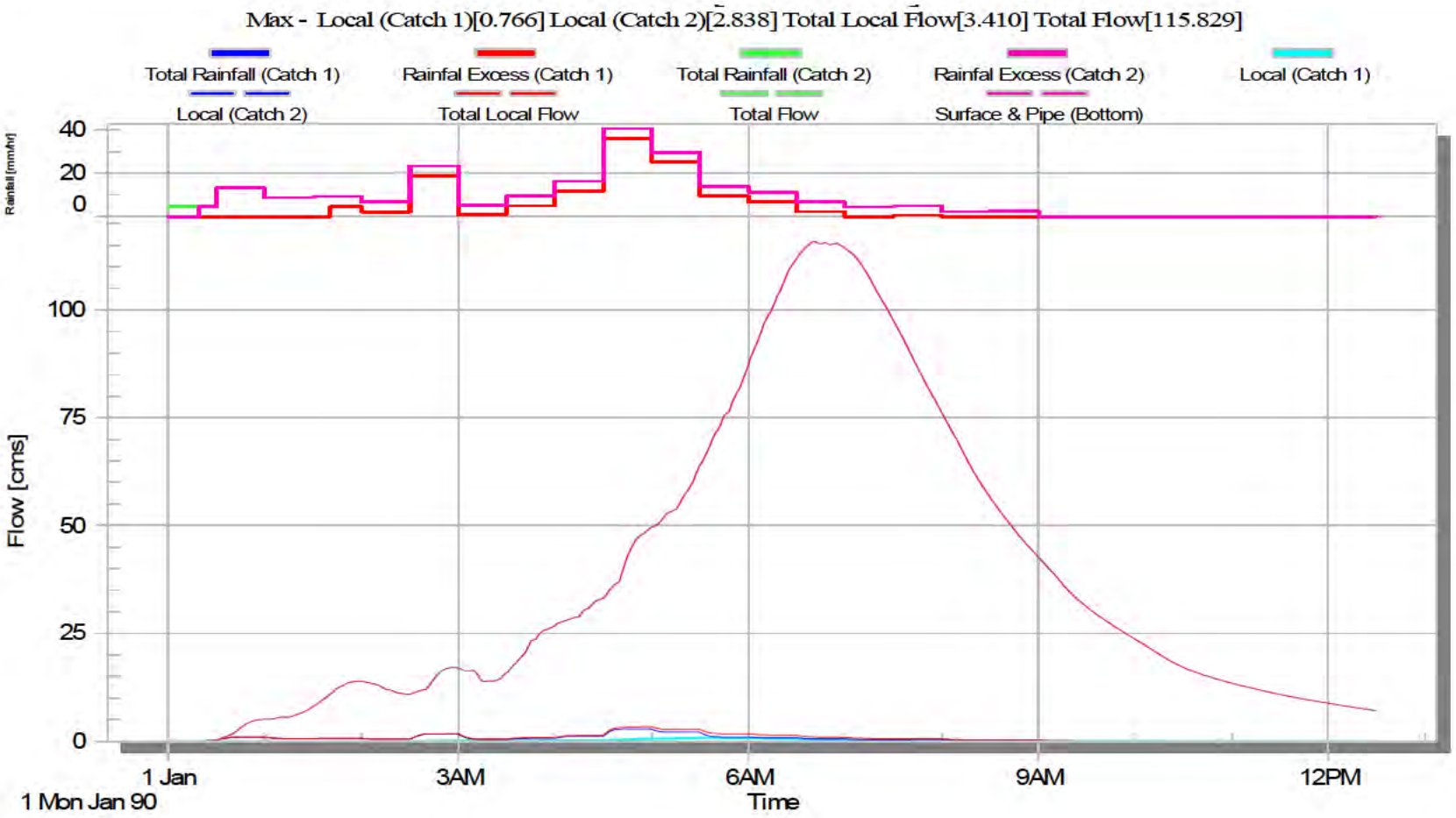
PARSONS BRINCKERHOFF

10yr ARI - Ash Street



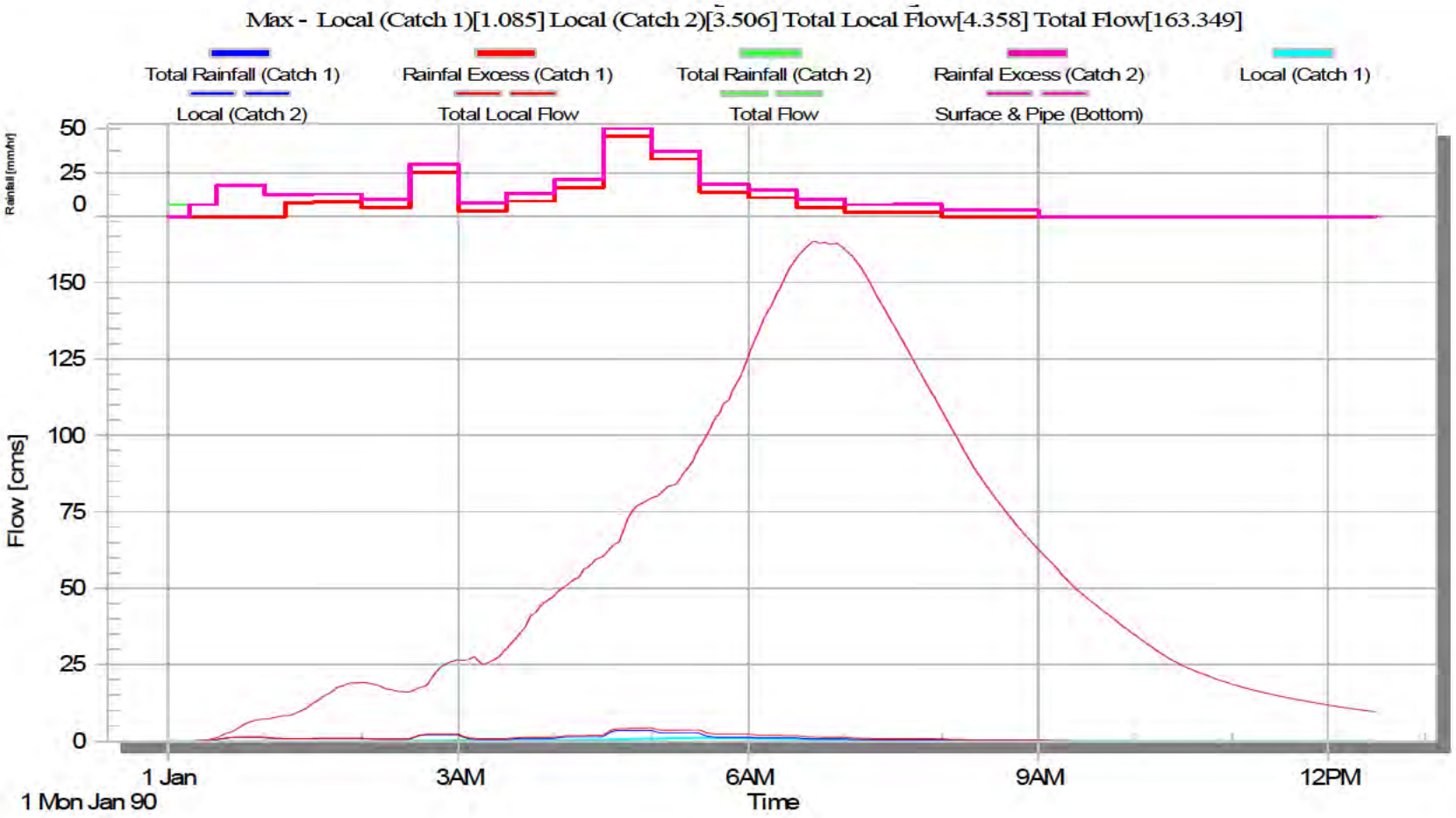
PARSONS BRINCKERHOFF

20yr ARI - Ash Street



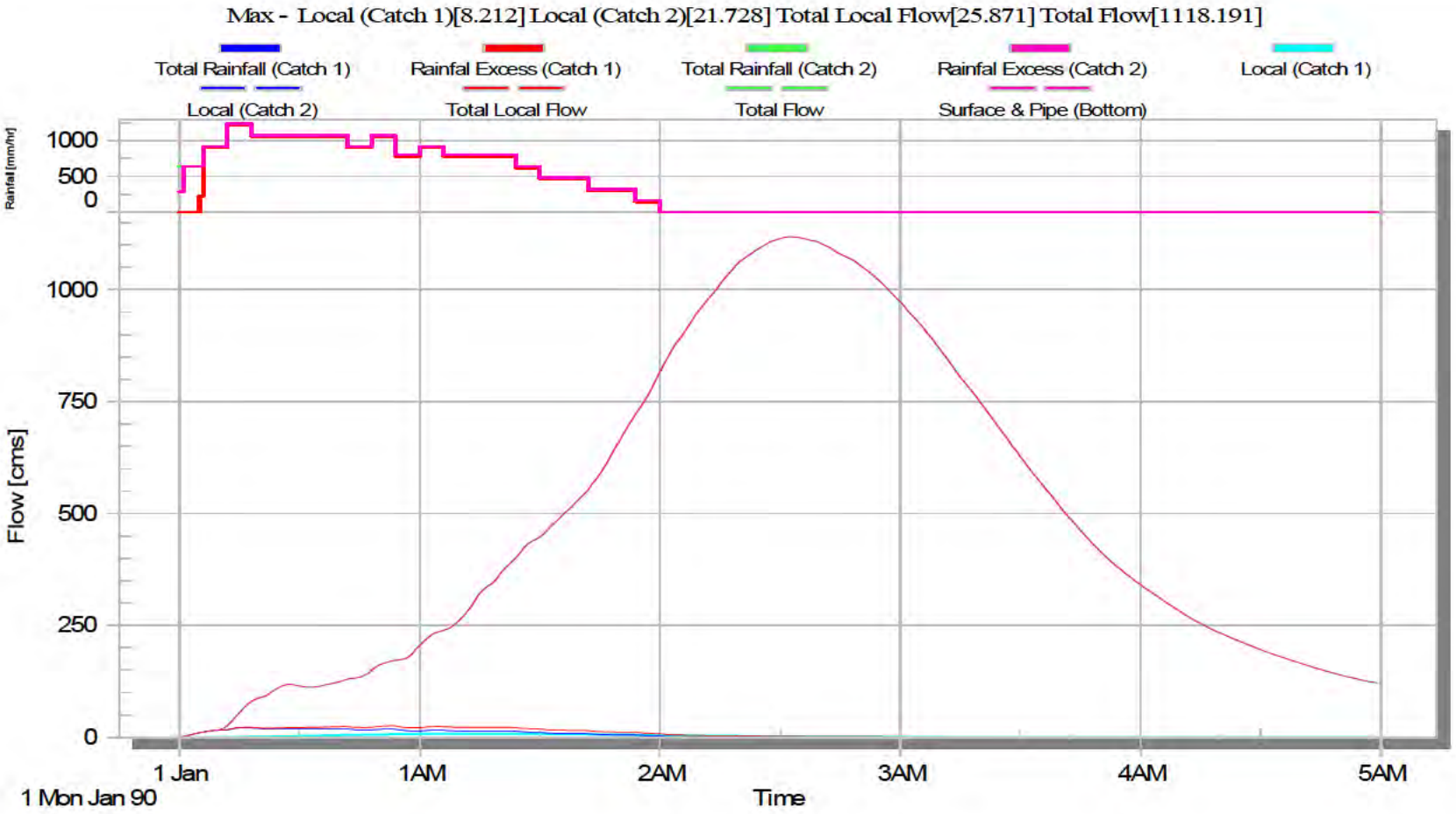
PARSONS BRINCKERHOFF

100yr ARI - Ash Street



PARSONS BRINCKERHOFF

PMF - Ash Street



Appendix J

Results from Channel Roughness Sensitivity Analysis

PARSONS BRINCKERHOFF

North Bellbird Flooding and Stormwater Assessment				Project No.	2122527A
				Client Ref.	
Manning Roughness Sensitivity Analysis Results				Date:	27/03/2006
		20% Increase Manning n		20% Decrease Manning n	
Cross Section	Max Depth (Standard Scenario)	Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)
1-38.06	3.02	3.37	12%	2.65	-12%
1-38.06	3.80	3.8	0%	3.8	0%
1-38.06	3.97	3.97	0%	3.97	0%
1-38.06	4.19	4.19	0%	4.19	0%
1-275.69	3.68	4.01	9%	3.33	-10%
1-275.69	4.32	4.46	3%	4.19	-3%
1-275.69	4.65	4.82	4%	4.49	-3%
1-275.69	5.23	5.46	4%	5.01	-4%
1-436.04	3.97	4.38	10%	3.5	-12%
1-436.04	4.55	4.82	6%	4.26	-6%
1-436.04	4.91	5.23	7%	4.56	-7%
1-436.04	5.51	5.88	7%	5.08	-8%
1-694.76	1.67	1.76	5%	1.58	-5%
1-694.76	1.81	1.91	6%	1.71	-6%
1-694.76	1.98	2.12	7%	1.86	-6%
1-694.76	2.33	2.48	6%	2.17	-7%
1-797.79	1.86	1.94	4%	1.77	-5%
1-797.79	1.98	2.08	5%	1.88	-5%
1-797.79	2.15	2.27	6%	2.03	-6%
1-797.79	2.46	2.6	6%	2.32	-6%
1-852.2	1.90	1.99	5%	1.8	-5%
1-852.2	2.02	2.12	5%	1.91	-5%
1-852.2	2.18	2.31	6%	2.06	-6%
1-852.2	2.49	2.63	6%	2.34	-6%
1-997.47	1.23	1.23	0%	1.23	0%
1-997.47	1.34	1.34	0%	1.34	0%
1-997.47	1.51	1.51	0%	1.51	0%
1-997.47	1.78	1.78	0%	1.78	0%
1-1164.28	1.65	1.76	7%	1.53	-7%
1-1164.28	1.78	1.89	6%	1.65	-7%
1-1164.28	1.92	2.02	5%	1.8	-6%
1-1164.28	2.11	2.19	4%	2	-5%
1-1322.89	1.01	1.1	9%	0.91	-10%
1-1322.89	1.11	1.21	9%	1.01	-9%
1-1322.89	1.24	1.35	9%	1.13	-9%
1-1322.89	1.45	1.54	6%	1.34	-8%
1-1499.99	1.15	1.23	7%	1.07	-7%
1-1499.99	1.24	1.32	6%	1.15	-7%
1-1499.99	1.34	1.43	7%	1.25	-7%
1-1499.99	1.53	1.62	6%	1.42	-7%
1-1680.73	1.11	1.15	4%	1.04	-6%
1-1680.73	1.16	1.2	3%	1.1	-5%
1-1680.73	1.22	1.26	3%	1.16	-5%
1-1680.73	1.32	1.37	4%	1.25	-5%
1-1850.84	1.82	1.9	4%	1.71	-6%
1-1850.84	1.91	2	5%	1.81	-5%
1-1850.84	2.02	2.11	4%	1.92	-5%
1-1850.84	2.19	2.28	4%	2.09	-5%
1-2030.41	1.65	1.79	8%	1.49	-10%
1-2030.41	1.81	1.95	8%	1.64	-9%
1-2030.41	1.99	2.11	6%	1.81	-9%
1-2030.41	2.20	2.27	3%	2.1	-5%
1-2243.49	2.37	2.53	7%	2.19	-8%
1-2243.49	2.55	2.71	6%	2.36	-7%
1-2243.49	2.75	2.9	5%	2.55	-7%
1-2243.49	3.04	3.18	5%	2.87	-6%

Cross Section	Max Depth (Standard Scenario)	20% Increase Manning n		20% Decrease Manning n	
		Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)
1-2307.32	1.55	1.7	10%	1.37	-12%
1-2307.32	1.72	1.88	9%	1.53	-11%
1-2307.32	1.92	2.08	8%	1.73	-10%
1-2307.32	2.24	2.39	7%	2.06	-8%
1-2459.38	1.90	2.02	6%	1.77	-7%
1-2459.38	2.05	2.17	6%	1.91	-7%
1-2459.38	2.22	2.34	5%	2.08	-6%
1-2459.38	2.50	2.62	5%	2.36	-6%
1-2570.42	2.00	2.11	5%	1.88	-6%
1-2570.42	2.13	2.23	5%	2	-6%
1-2570.42	2.28	2.39	5%	2.14	-6%
1-2570.42	2.54	2.66	5%	2.4	-6%
1-2712.91	1.43	1.51	6%	1.35	-6%
1-2712.91	1.52	1.61	6%	1.43	-6%
1-2712.91	1.64	1.74	6%	1.53	-7%
1-2712.91	1.84	1.97	7%	1.72	-7%
1-2929.03	1.42	1.47	4%	1.36	-4%
1-2929.03	1.48	1.54	4%	1.42	-4%
1-2929.03	1.55	1.6	3%	1.49	-4%
1-2929.03	1.66	1.71	3%	1.59	-4%
1-3033.38	1.81	1.87	3%	1.74	-4%
1-3033.38	1.88	1.94	3%	1.8	-4%
1-3033.38	1.97	2.03	3%	1.89	-4%
1-3033.38	2.08	2.13	2%	2.02	-3%
1-3126.46	1.22	1.28	5%	1.16	-5%
1-3126.46	1.28	1.34	5%	1.21	-5%
1-3126.46	1.35	1.49	10%	1.26	-7%
1-3126.46	1.55	1.6	3%	1.48	-5%
1-3363.66	1.62	1.68	4%	1.55	-4%
1-3363.66	1.69	1.75	4%	1.62	-4%
1-3363.66	1.77	1.83	3%	1.7	-4%
1-3363.66	1.89	1.94	3%	1.83	-3%
1-3572.93	1.21	1.27	5%	1.14	-6%
1-3572.93	1.28	1.34	5%	1.21	-5%
1-3572.93	1.36	1.43	5%	1.29	-5%
1-3572.93	1.51	1.58	5%	1.42	-6%
1-3720.33	0.96	1.01	5%	0.9	-6%
1-3720.33	1.02	1.07	5%	0.96	-6%
1-3720.33	1.10	1.15	5%	1.03	-6%
1-3720.33	1.23	1.29	5%	1.16	-6%
1-3864.45	1.25	1.33	6%	1.16	-7%
1-3864.45	1.34	1.41	5%	1.25	-7%
1-3864.45	1.44	1.51	5%	1.36	-6%
1-3864.45	1.60	1.69	6%	1.51	-6%
1-3989.52	1.34	1.42	6%	1.23	-8%
1-3989.52	1.44	1.53	6%	1.33	-8%
1-3989.52	1.57	1.67	6%	1.45	-8%
1-3989.52	1.80	1.91	6%	1.66	-8%
2-1411.92	0.34	0.39	15%	0.3	-12%
2-1411.92	0.40	0.44	10%	0.34	-15%
2-1411.92	0.46	0.55	20%	0.4	-13%
2-1411.92	0.61	0.65	7%	0.56	-8%
2-1465.43	0.21	0.23	10%	0.19	-10%
2-1465.43	0.22	0.24	9%	0.2	-9%
2-1465.43	0.24	0.26	8%	0.22	-8%
2-1465.43	0.27	0.3	11%	0.24	-11%
2-1527.17	0.07	0.08	14%	0.06	-14%
2-1527.17	0.08	0.09	13%	0.07	-13%
2-1527.17	0.09	0.1	11%	0.08	-11%
2-1527.17	0.10	0.11	10%	0.09	-10%

Cross Section	Max Depth (Standard Scenario)	20% Increase Manning n		20% Decrease Manning n	
		Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)
2-1617.11	0.16	0.18	13%	0.15	-6%
2-1617.11	0.17	0.19	12%	0.16	-6%
2-1617.11	0.19	0.2	5%	0.17	-11%
2-1617.11	0.21	0.22	5%	0.19	-10%
2-1752.32	0.02	0.02	0%	0.02	0%
2-1752.32	0.02	0.03	50%	0.02	0%
2-1752.32	0.03	0.03	0%	0.02	-33%
2-1752.32	0.03	0.03	0%	0.03	0%
2-1861.11	0.19	0.2	5%	0.14	-26%
2-1861.11	0.20	0.22	10%	0.19	-5%
2-1861.11	0.22	0.24	9%	0.2	-9%
2-1861.11	0.25	0.27	8%	0.23	-8%
2-1881.87	0.17	0.19	12%	0.16	-6%
2-1881.87	0.18	0.2	11%	0.17	-6%
2-1881.87	0.19	0.21	11%	0.18	-5%
2-1881.87	0.21	0.23	10%	0.19	-10%
2-1908.81	0.19	0.2	5%	0.17	-11%
2-1908.81	0.20	0.22	10%	0.18	-10%
2-1908.81	0.22	0.23	5%	0.2	-9%
2-1908.81	0.24	0.26	8%	0.22	-8%
2-1995.11	0.13	0.14	8%	0.12	-8%
2-1995.11	0.14	0.15	7%	0.13	-7%
2-1995.11	0.15	0.16	7%	0.14	-7%
2-1995.11	0.17	0.18	6%	0.15	-12%
2-2109.59	0.16	0.17	6%	0.12	-25%
2-2109.59	0.17	0.18	6%	0.15	-12%
2-2109.59	0.18	0.19	6%	0.16	-11%
2-2109.59	0.20	0.22	10%	0.18	-10%
2-2224.07	0.06	0.07	17%	0.05	-17%
2-2224.07	0.07	0.07	0%	0.06	-14%
2-2224.07	0.07	0.08	14%	0.06	-14%
2-2224.07	0.08	0.09	13%	0.07	-13%
2-2337.05	0.27	0.27	0%	0.24	-11%
2-2337.05	0.28	0.28	0%	0.28	0%
2-2337.05	0.31	0.31	0%	0.31	0%
2-2337.05	0.35	0.35	0%	0.35	0%
2-2408.72	0.38	0.4	5%	0.35	-8%
2-2408.72	0.40	0.45	12%	0.37	-8%
2-2408.72	0.45	0.47	4%	0.4	-11%
2-2408.72	0.48	0.5	4%	0.46	-4%
2-2491.72	0.25	0.28	12%	0.22	-12%
2-2491.72	0.28	0.31	11%	0.24	-14%
2-2491.72	0.31	0.35	13%	0.27	-13%
2-2491.72	0.37	0.41	11%	0.32	-14%
2-2587.99	0.23	0.25	9%	0.2	-13%
2-2587.99	0.25	0.28	12%	0.22	-12%
2-2587.99	0.28	0.31	11%	0.2	-29%
2-2587.99	0.32	0.36	13%	0.24	-25%
2-2652.62	0.31	0.34	10%	0.29	-6%
2-2652.62	0.33	0.37	12%	0.31	-6%
2-2652.62	0.37	0.4	8%	0.34	-8%
2-2652.62	0.42	0.45	7%	0.39	-7%
3-205.82	0.16	0.17	6%	0.15	-6%
3-205.82	0.16	0.17	6%	0.15	-6%
3-205.82	0.18	0.19	6%	0.16	-11%
3-205.82	0.19	0.2	5%	0.18	-5%
3-441	0.17	0.18	6%	0.16	-6%
3-441	0.17	0.18	6%	0.14	-18%
3-441	0.18	0.19	6%	0.17	-6%
3-441	0.19	0.2	5%	0.18	-5%

Cross Section	Max Depth (Standard Scenario)	20% Increase Manning n		20% Decrease Manning n	
		Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)
3-529.43	0.12	0.13	8%	0.11	-8%
3-529.43	0.12	0.13	8%	0.11	-8%
3-529.43	0.13	0.14	8%	0.12	-8%
3-529.43	0.14	0.15	7%	0.13	-7%
3-667.93	0.18	0.19	6%	0.16	-11%
3-667.93	0.18	0.19	6%	0.17	-6%
3-667.93	0.20	0.21	5%	0.18	-10%
3-667.93	0.21	0.23	10%	0.2	-5%
3-854.72	0.17	0.18	6%	0.15	-12%
3-854.72	0.17	0.19	12%	0.16	-6%
3-854.72	0.19	0.21	11%	0.17	-11%
3-854.72	0.21	0.22	5%	0.19	-10%
3-975.79	0.06	0.06	0%	0.05	-17%
3-975.79	0.06	0.07	17%	0.05	-17%
3-975.79	0.07	0.08	14%	0.06	-14%
3-975.79	0.08	0.09	13%	0.07	-13%
3-1087.72	0.14	0.15	7%	0.12	-14%
3-1087.72	0.14	0.16	14%	0.13	-7%
3-1087.72	0.16	0.18	12%	0.14	-12%
3-1087.72	0.18	0.2	11%	0.16	-11%
3-1197.64	0.12	0.12	0%	0.11	-8%
3-1197.64	0.12	0.13	8%	0.12	0%
3-1197.64	0.13	0.13	0%	0.12	-8%
3-1197.64	0.14	0.14	0%	0.13	-7%
3-1320.49	0.17	0.18	6%	0.15	-12%
3-1320.49	0.18	0.19	6%	0.16	-11%
3-1320.49	0.19	0.21	11%	0.17	-11%
3-1320.49	0.22	0.24	9%	0.2	-9%
3-1525.58	0.17	0.18	6%	0.15	-12%
3-1525.58	0.17	0.19	12%	0.16	-6%
3-1525.58	0.19	0.2	5%	0.17	-11%
3-1525.58	0.21	0.22	5%	0.19	-10%
3-1627.79	0.08	0.08	0%	0.07	-12%
3-1627.79	0.08	0.09	13%	0.07	-12%
3-1627.79	0.09	0.1	11%	0.08	-11%
3-1627.79	0.10	0.11	10%	0.09	-10%
3-1755.58	0.14	0.15	7%	0.13	-7%
3-1755.58	0.15	0.16	7%	0.14	-7%
3-1755.58	0.16	0.17	6%	0.15	-6%
3-1755.58	0.18	0.19	6%	0.15	-17%
3-1860.86	0.17	0.18	6%	0.16	-6%
3-1860.86	0.18	0.19	6%	0.17	-6%
3-1860.86	0.19	0.2	5%	0.18	-5%
3-1860.86	0.21	0.22	5%	0.2	-5%
3-1952.2	0.11	0.12	9%	0.1	-9%
3-1952.2	0.12	0.12	0%	0.11	-8%
3-1952.2	0.13	0.13	0%	0.12	-8%
3-1952.2	0.14	0.15	7%	0.13	-7%
4-81.49	1.79	1.79	0%	1.79	0%
4-81.49	1.93	1.93	0%	1.93	0%
4-81.49	2.37	2.37	0%	2.22	-6%
4-81.49	2.50	2.52	1%	2.4	-4%
4-280.24	1.47	1.54	5%	1.4	-5%
4-280.24	1.55	1.62	5%	1.48	-5%
4-280.24	1.64	1.71	4%	1.56	-5%
4-280.24	1.78	1.86	4%	1.69	-5%
4-441.75	2.97	3.05	3%	2.87	-3%
4-441.75	3.06	3.16	3%	2.97	-3%
4-441.75	3.18	3.28	3%	3.07	-3%
4-441.75	3.35	3.46	3%	3.24	-3%

Cross Section	Max Depth (Standard Scenario)	20% Increase Manning n		20% Decrease Manning n	
		Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)
4-563.13	2.17	2.29	6%	2.03	-6%
4-563.13	2.30	2.43	6%	2.16	-6%
4-563.13	2.45	2.58	5%	2.29	-7%
4-563.13	2.66	2.79	5%	2.49	-6%
4-824.41	1.96	2.12	8%	1.79	-9%
4-824.41	2.14	2.29	7%	1.95	-9%
4-824.41	2.32	2.47	6%	2.13	-8%
4-824.41	2.60	2.77	7%	2.4	-8%
4-895.84	2.23	2.36	6%	2.1	-6%
4-895.84	2.40	2.54	6%	2.27	-5%
4-895.84	2.60	2.73	5%	2.45	-6%
4-895.84	2.91	3.05	5%	2.76	-5%
4-1018.59	1.69	1.85	9%	1.49	-12%
4-1018.59	1.85	2.01	9%	1.65	-11%
4-1018.59	2.02	2.19	8%	1.81	-10%
4-1018.59	2.28	2.48	9%	2.06	-10%
4-1252.45	2.54	2.68	6%	2.39	-6%
4-1252.45	2.73	2.87	5%	2.57	-6%
4-1252.45	2.95	3.1	5%	2.78	-6%
4-1252.45	3.30	3.46	5%	3.13	-5%
4-1370.53	1.85	1.99	8%	1.71	-8%
4-1370.53	2.03	2.17	7%	1.87	-8%
4-1370.53	2.23	2.39	7%	2.06	-8%
4-1370.53	2.57	2.74	7%	2.39	-7%
4-1571.29	1.78	1.89	6%	1.63	-8%
4-1571.29	1.91	2.03	6%	1.77	-7%
4-1571.29	2.05	2.17	6%	1.91	-7%
4-1571.29	2.27	2.41	6%	2.12	-7%
4-1693.24	2.22	2.33	5%	2.09	-6%
4-1693.24	2.35	2.47	5%	2.21	-6%
4-1693.24	2.49	2.62	5%	2.34	-6%
4-1693.24	2.72	2.87	6%	2.55	-6%
4-2085.73	2.70	2.84	5%	2.52	-7%
4-2085.73	2.86	3	5%	2.68	-6%
4-2085.73	3.03	3.18	5%	2.86	-6%
4-2085.73	3.29	3.44	5%	2.82	-14%
4-2191.41	1.99	2.12	7%	1.84	-8%
4-2191.41	2.15	2.29	7%	2	-7%
4-2191.41	2.33	2.47	6%	2.17	-7%
4-2191.41	2.62	2.76	5%	2.44	-7%
4-2298.16	1.96	2.09	7%	1.8	-8%
4-2298.16	2.13	2.27	7%	1.97	-8%
4-2298.16	2.33	2.47	6%	2.16	-7%
4-2298.16	2.65	2.8	6%	2.48	-6%
4-2458.74	1.58	1.7	8%	1.44	-9%
4-2458.74	1.73	1.86	8%	1.59	-8%
4-2458.74	1.91	2.05	7%	1.76	-8%
4-2458.74	2.20	2.35	7%	2.04	-7%
4-2738.35	2.00	2.14	7%	1.83	-9%
4-2738.35	2.15	2.31	7%	1.98	-8%
4-2738.35	2.33	2.49	7%	2.14	-8%
4-2738.35	2.61	2.77	6%	2.4	-8%
4-2927.1	1.99	2.11	6%	1.84	-8%
4-2927.1	2.14	2.27	6%	1.98	-7%
4-2927.1	2.31	2.45	6%	2.14	-7%
4-2927.1	2.59	2.75	6%	2.4	-7%
4-3126.11	1.89	2.02	7%	1.74	-8%
4-3126.11	2.04	2.18	7%	1.88	-8%
4-3126.11	2.21	2.37	7%	2.03	-8%
4-3126.11	2.49	2.68	8%	2.28	-8%

Cross Section	Max Depth (Standard Scenario)	20% Increase Manning n		20% Decrease Manning n	
		Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)
4-3363.8	2.01	2.14	6%	1.86	-7%
4-3363.8	2.17	2.31	6%	2.01	-7%
4-3363.8	2.35	2.5	6%	2.18	-7%
4-3363.8	2.65	2.82	6%	2.46	-7%
4-3521.91	1.89	2.01	6%	1.75	-7%
4-3521.91	2.04	2.16	6%	1.9	-7%
4-3521.91	2.19	2.31	5%	2.04	-7%
4-3521.91	2.42	2.58	7%	2.27	-6%
4-3744.06	1.22	1.31	7%	1.12	-8%
4-3744.06	1.32	1.42	8%	1.21	-8%
4-3744.06	1.44	1.56	8%	1.32	-8%
4-3744.06	1.65	1.79	8%	1.51	-8%
4-3831.17	1.63	1.71	5%	1.55	-5%
4-3831.17	1.76	1.85	5%	1.68	-5%
4-3831.17	1.92	2.02	5%	1.83	-5%
4-3831.17	2.18	2.28	5%	2.09	-4%
4-3997.61	1.12	1.23	10%	1	-11%
4-3997.61	1.25	1.37	10%	1.12	-10%
4-3997.61	1.40	1.53	9%	1.26	-10%
4-3997.61	1.65	1.81	10%	1.5	-9%
4-4250.83	1.55	1.61	4%	1.49	-4%
4-4250.83	1.63	1.69	4%	1.57	-4%
4-4250.83	1.73	1.8	4%	1.66	-4%
4-4250.83	1.91	1.99	4%	1.84	-4%
4-4352.51	1.21	1.23	2%	1.2	-1%
4-4352.51	1.26	1.28	2%	1.25	-1%
4-4352.51	1.32	1.34	2%	1.31	-1%
4-4352.51	1.41	1.44	2%	1.4	-1%
4-4478.68	0.89	0.89	0%	0.89	0%
4-4478.68	1.12	1.12	0%	1.12	0%
4-4478.68	1.18	1.2	2%	1.11	-6%
4-4478.68	1.31	1.31	0%	1.22	-7%
4-4744.42	1.28	1.35	5%	1.19	-7%
4-4744.42	1.37	1.45	6%	1.27	-7%
4-4744.42	1.47	1.56	6%	1.36	-7%
4-4744.42	1.64	1.75	7%	1.52	-7%
4-4904.1	1.18	1.26	7%	1.1	-7%
4-4904.1	1.27	1.35	6%	1.19	-6%
4-4904.1	1.37	1.45	6%	1.28	-7%
4-4904.1	1.54	1.63	6%	1.44	-6%
4-5093.69	0.98	1.05	7%	0.91	-7%
4-5093.69	1.06	1.12	6%	0.98	-8%
4-5093.69	1.14	1.21	6%	1.06	-7%
4-5093.69	1.27	1.36	7%	1.18	-7%
4-5251.51	1.65	1.75	6%	1.55	-6%
4-5251.51	1.76	1.86	6%	1.65	-6%
4-5251.51	1.88	2.01	7%	1.76	-6%
4-5251.51	2.10	2.17	3%	1.94	-8%
4-5339.28	1.52	1.62	7%	1.44	-5%
4-5339.28	1.64	1.73	5%	1.55	-5%
4-5339.28	1.74	1.84	6%	1.65	-5%
4-5339.28	1.96	2.04	4%	1.85	-6%
4-5445.31	1.40	1.52	9%	1.27	-9%
4-5445.31	0.94	1.67	78%	1.4	49%
4-5445.31	1.70	1.82	7%	1.54	-9%
4-5445.31	1.93	2.04	6%	1.78	-8%
4-5711.52	0.71	0.91	28%	0.67	-6%
4-5711.52	0.92	0.97	5%	0.72	-22%
4-5711.52	0.73	1.05	44%	0.73	0%
4-5711.52	0.85	1.22	44%	0.82	-4%

Cross Section	Max Depth (Standard Scenario)	20% Increase Manning n		20% Decrease Manning n	
		Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)
4-5735.28	0.66	0.74	12%	0.61	-8%
4-5735.28	0.72	0.79	10%	0.66	-8%
4-5735.28	0.78	0.91	17%	0.72	-8%
4-5735.28	0.89	0.95	7%	0.81	-9%
5-77.53	0.41	0.5	22%	0.32	-22%
5-77.53	0.58	0.68	17%	0.48	-17%
5-77.53	0.77	0.87	13%	0.67	-13%
5-77.53	1.08	1.19	10%	0.98	-9%
5-147.05	0.39	0.42	8%	0.35	-10%
5-147.05	0.44	0.46	5%	0.39	-11%
5-147.05	0.46	0.49	7%	0.4	-13%
5-147.05	0.53	0.55	4%	0.45	-15%
5-232.47	0.12	0.13	8%	0.11	-8%
5-232.47	0.13	0.14	8%	0.12	-8%
5-232.47	0.14	0.15	7%	0.13	-7%
5-232.47	0.16	0.17	6%	0.15	-6%
5-317.61	0.22	0.24	9%	0.2	-9%
5-317.61	0.24	0.26	8%	0.22	-8%
5-317.61	0.26	0.29	12%	0.24	-8%
5-317.61	0.30	0.33	10%	0.27	-10%
6-164.27	1.03	1.11	8%	0.96	-7%
6-164.27	1.15	1.26	10%	1.07	-7%
6-164.27	1.31	1.39	6%	1.19	-9%
6-164.27	1.55	1.65	6%	1.43	-8%
6-313.94	1.20	1.29	8%	1.1	-8%
6-313.94	1.30	1.39	7%	1.19	-8%
6-313.94	1.41	1.51	7%	1.29	-9%
6-313.94	1.59	1.7	7%	1.46	-8%
6-548.04	0.89	0.99	11%	0.79	-11%
6-548.04	1.00	1.1	10%	0.88	-12%
6-548.04	1.12	1.23	10%	0.99	-12%
6-548.04	1.32	1.45	10%	1.17	-11%
6-712.85	1.47	1.58	7%	1.33	-10%
6-712.85	1.59	1.72	8%	1.45	-9%
6-712.85	1.74	1.87	7%	1.58	-9%
6-712.85	1.98	2.13	8%	1.8	-9%
6-860.78	1.40	1.51	8%	1.28	-9%
6-860.78	1.54	1.66	8%	1.4	-9%
6-860.78	1.68	1.81	8%	1.54	-8%
6-860.78	1.94	2.08	7%	1.77	-9%
6-928.69	0.99	1.09	10%	0.88	-11%
6-928.69	1.11	1.22	10%	0.99	-11%
6-928.69	1.24	1.36	10%	1.11	-10%
6-928.69	1.47	1.61	10%	1.31	-11%
6-1048.29	1.01	1.1	9%	0.91	-10%
6-1048.29	1.12	1.22	9%	1.01	-10%
6-1048.29	1.24	1.35	9%	1.12	-10%
6-1048.29	1.45	1.58	9%	1.31	-10%
6-1147.59	1.00	1.08	8%	0.91	-9%
6-1147.59	1.09	1.18	8%	1	-8%
6-1147.59	1.19	1.28	8%	1.09	-8%
6-1147.59	1.37	1.47	7%	1.25	-9%
6-1288.99	0.78	0.85	9%	0.7	-10%
6-1288.99	0.87	0.95	9%	0.78	-10%
6-1288.99	0.96	1.05	9%	0.86	-10%
6-1288.99	1.13	1.22	8%	1.02	-10%
6-1381.18	1.44	1.54	7%	1.33	-8%
6-1381.18	1.56	1.67	7%	1.44	-8%
6-1381.18	1.69	1.81	7%	1.56	-8%
6-1381.18	1.92	2.04	6%	1.77	-8%

Cross Section	Max Depth (Standard Scenario)	20% Increase Manning n		20% Decrease Manning n	
		Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)
6-1614.63	1.05	1.15	10%	0.93	-11%
6-1614.63	1.17	1.29	10%	1.04	-11%
6-1614.63	1.31	1.44	10%	1.17	-11%
6-1614.63	1.55	1.7	10%	1.39	-10%
6-1771.08	0.80	0.87	9%	0.72	-10%
6-1771.08	0.89	0.97	9%	0.8	-10%
6-1771.08	0.99	1.08	9%	0.89	-10%
6-1771.08	1.16	1.27	9%	1.04	-10%
6-1872.78	0.89	0.98	10%	0.79	-11%
6-1872.78	1.00	1.1	10%	0.89	-11%
6-1872.78	1.12	1.22	9%	1	-11%
6-1872.78	1.31	1.43	9%	1.18	-10%
7-29.59	0.63	0.63	0%	0.63	0%
7-29.59	0.68	0.68	0%	0.68	0%
7-29.59	0.73	0.73	0%	0.73	0%
7-29.59	0.81	0.81	0%	0.81	0%
7-78.45	0.43	0.47	9%	0.38	-12%
7-78.45	0.47	0.52	11%	0.42	-11%
7-78.45	0.52	0.56	8%	0.46	-12%
7-78.45	0.59	0.65	10%	0.53	-10%
7-131.93	0.78	0.83	6%	0.72	-8%
7-131.93	0.84	0.89	6%	0.78	-7%
7-131.93	0.89	0.95	7%	0.83	-7%
7-131.93	1.00	1.06	6%	0.93	-7%
7-176.09	0.87	0.92	6%	0.8	-8%
7-176.09	0.93	0.99	6%	0.87	-6%
7-176.09	0.99	1.05	6%	0.92	-7%
7-176.09	1.10	1.17	6%	1.02	-7%
7-236.99	0.93	0.99	6%	0.86	-8%
7-236.99	1.00	1.07	7%	0.92	-8%
7-236.99	1.06	1.13	7%	0.98	-8%
7-236.99	1.18	1.25	6%	1.09	-8%
7-268.83	0.45	0.49	9%	0.4	-11%
7-268.83	0.50	0.55	10%	0.44	-12%
7-268.83	0.54	0.6	11%	0.48	-11%
7-268.83	0.63	0.7	11%	0.56	-11%
7-309.37	0.34	0.34	0%	0.34	0%
7-309.37	0.35	0.35	0%	0.35	0%
7-309.37	0.36	0.36	0%	0.36	0%
7-309.37	0.37	0.38	3%	0.37	0%
7-367.88	0.26	0.28	8%	0.23	-12%
7-367.88	0.28	0.31	11%	0.25	-11%
7-367.88	0.30	0.33	10%	0.27	-10%
7-367.88	0.34	0.37	9%	0.31	-9%
7-451.2	0.48	0.51	6%	0.43	-10%
7-451.2	0.52	0.56	8%	0.47	-10%
7-451.2	0.56	0.6	7%	0.5	-11%
7-451.2	0.62	0.67	8%	0.57	-8%
7-576.7	0.20	0.21	5%	0.18	-10%
7-576.7	0.21	0.23	10%	0.2	-5%
7-576.7	0.23	0.24	4%	0.21	-9%
7-576.7	0.25	0.27	8%	0.23	-8%
7-628.12	0.20	0.22	10%	0.18	-10%
7-628.12	0.23	0.25	9%	0.2	-13%
7-628.12	0.25	0.28	12%	0.22	-12%
7-628.12	0.29	0.32	10%	0.26	-10%
7-668.29	0.32	0.34	6%	0.28	-12%
7-668.29	0.35	0.38	9%	0.31	-11%
7-668.29	0.38	0.41	8%	0.34	-11%
7-668.29	0.43	0.46	7%	0.38	-12%

Cross Section	Max Depth (Standard Scenario)	20% Increase Manning n		20% Decrease Manning n	
		Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)
7-697.21	0.36	0.39	8%	0.32	-11%
7-697.21	0.39	0.43	10%	0.35	-10%
7-697.21	0.42	0.46	10%	0.38	-10%
7-697.21	0.48	0.52	8%	0.43	-10%
8-66.83	0.20	0.2	0%	0.2	0%
8-66.83	0.21	0.21	0%	0.21	0%
8-66.83	0.23	0.23	0%	0.23	0%
8-66.83	0.26	0.26	0%	0.26	0%
8-152.5	0.08	0.08	0%	0.07	-13%
8-152.5	0.08	0.09	13%	0.08	0%
8-152.5	0.10	0.11	10%	0.09	-10%
8-152.5	0.12	0.13	8%	0.11	-8%
8-280.45	0.56	0.6	7%	0.51	-9%
8-280.45	0.59	0.63	7%	0.54	-8%
8-280.45	0.64	0.69	8%	0.59	-8%
8-280.45	0.72	0.77	7%	0.66	-8%
8-358.91	0.12	0.14	17%	0.11	-8%
8-358.91	0.13	0.15	15%	0.12	-8%
8-358.91	0.15	0.17	13%	0.13	-13%
8-358.91	0.19	0.21	11%	0.16	-16%
8-460.05	0.48	0.51	6%	0.43	-10%
8-460.05	0.50	0.54	8%	0.46	-8%
8-460.05	0.55	0.59	7%	0.51	-7%
8-460.05	0.63	0.67	6%	0.57	-10%
8-561.83	0.33	0.36	9%	0.31	-6%
8-561.83	0.35	0.37	6%	0.32	-9%
8-561.83	0.38	0.41	8%	0.35	-8%
8-561.83	0.43	0.45	5%	0.39	-9%
8-665.91	0.15	0.29	93%	0.14	-7%
8-665.91	0.16	0.19	19%	0.15	-6%
8-665.91	0.18	0.2	11%	0.17	-6%
8-665.91	0.21	0.24	14%	0.2	-5%
8-701.2	0.08	0.08	0%	0.08	0%
8-701.2	0.09	0.09	0%	0.09	0%
8-701.2	0.11	0.11	0%	0.11	0%
8-701.2	0.13	0.13	0%	0.13	0%
8-746.32	0.17	0.18	6%	0.16	-6%
8-746.32	0.18	0.19	6%	0.17	-6%
8-746.32	0.21	0.22	5%	0.2	-5%
8-746.32	0.25	0.26	4%	0.23	-8%
8-780.43	0.18	0.19	6%	0.17	-6%
8-780.43	0.19	0.2	5%	0.18	-5%
8-780.43	0.22	0.23	5%	0.2	-9%
8-780.43	0.25	0.27	8%	0.24	-4%
8-807.74	0.22	0.24	9%	0.2	-9%
8-807.74	0.24	0.26	8%	0.22	-8%
8-807.74	0.26	0.28	8%	0.24	-8%
8-807.74	0.30	0.33	10%	0.28	-7%
8-840.88	0.28	0.3	7%	0.24	-14%
8-840.88	0.29	0.32	10%	0.26	-10%
8-840.88	0.32	0.35	9%	0.29	-9%
8-840.88	0.37	0.4	8%	0.33	-11%
8-924.19	0.14	0.14	0%	0.14	0%
8-924.19	0.15	0.15	0%	0.15	0%
8-924.19	0.17	0.17	0%	0.17	0%
8-924.19	0.19	0.19	0%	0.19	0%
8-979.99	0.11	0.11	0%	0.11	0%
8-979.99	0.13	0.13	0%	0.12	-8%
8-979.99	0.14	0.15	7%	0.14	0%
8-979.99	0.17	0.17	0%	0.16	-6%

Cross Section	Max Depth (Standard Scenario)	20% Increase Manning n		20% Decrease Manning n	
		Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)
8-1020.11	0.19	0.2	5%	0.16	-16%
8-1020.11	0.21	0.23	10%	0.18	-14%
8-1020.11	0.23	0.25	9%	0.2	-13%
8-1020.11	0.26	0.28	8%	0.22	-15%
8-1066.74	0.12	0.14	17%	0.11	-8%
8-1066.74	0.10	0.16	60%	0.13	30%
8-1066.74	0.16	0.18	12%	0.14	-13%
8-1066.74	0.15	0.2	33%	0.16	7%
8-1110.65	0.16	0.16	0%	0.15	-6%
8-1110.65	0.18	0.18	0%	0.16	-11%
8-1110.65	0.20	0.2	0%	0.17	-15%
8-1110.65	0.22	0.23	5%	0.2	-9%
8-1155.8	0.19	0.21	11%	0.17	-11%
8-1155.8	0.21	0.24	14%	0.19	-10%
8-1155.8	0.23	0.26	13%	0.21	-9%
8-1155.8	0.27	0.3	11%	0.24	-11%
8-1193.32	0.10	0.1	0%	0.09	-10%
8-1193.32	0.12	0.12	0%	0.11	-8%
8-1193.32	0.13	0.13	0%	0.13	0%
8-1193.32	0.15	0.15	0%	0.15	0%
8-1217.88	0.02	0.03	50%	0.02	0%
8-1217.88	0.03	0.03	0%	0.03	0%
8-1217.88	0.04	0.04	0%	0.04	0%
8-1217.88	0.05	0.05	0%	0.05	0%
8-1241.95	0.20	0.2	0%	0.2	0%
8-1241.95	0.23	0.23	0%	0.23	0%
8-1241.95	0.25	0.25	0%	0.25	0%
8-1241.95	0.29	0.29	0%	0.29	0%
9-47.85	0.14	0.14	0%	0.13	-7%
9-47.85	0.16	0.16	0%	0.15	-6%
9-47.85	0.17	0.17	0%	0.16	-6%
9-47.85	0.19	0.19	0%	0.18	-5%
9-93.97	0.14	0.14	0%	0.13	-7%
9-93.97	0.15	0.16	7%	0.15	0%
9-93.97	0.16	0.17	6%	0.13	-19%
9-93.97	0.18	0.18	0%	0.17	-6%
9-118.83	0.08	0.08	0%	0.08	0%
9-118.83	0.09	0.09	0%	0.09	0%
9-118.83	0.11	0.11	0%	0.11	0%
9-118.83	0.13	0.13	0%	0.13	0%
9-145.72	0.17	0.18	6%	0.16	-6%
9-145.72	0.19	0.21	11%	0.18	-5%
9-145.72	0.22	0.23	5%	0.2	-9%
9-145.72	0.26	0.27	4%	0.24	-8%
9-172.34	0.18	0.21	17%	0.16	-11%
9-172.34	0.21	0.24	14%	0.19	-10%
9-172.34	0.24	0.26	8%	0.21	-13%
9-172.34	0.28	0.3	7%	0.24	-14%
9-192.74	0.16	0.17	6%	0.15	-6%
9-192.74	0.18	0.19	6%	0.17	-6%
9-192.74	0.20	0.22	10%	0.19	-5%
9-192.74	0.23	0.24	4%	0.21	-9%
9-223.4	0.19	0.21	11%	0.17	-11%
9-223.4	0.21	0.23	10%	0.19	-10%
9-223.4	0.23	0.24	4%	0.21	-9%
9-223.4	0.26	0.29	12%	0.23	-12%
9-259.87	0.10	0.12	20%	0.1	0%
9-259.87	0.12	0.13	8%	0.11	-8%
9-259.87	0.13	0.14	8%	0.12	-8%
9-259.87	0.15	0.16	7%	0.14	-7%

Cross Section	Max Depth (Standard Scenario)	20% Increase Manning n		20% Decrease Manning n	
		Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)
9-308.1	0.05	0.06	20%	0.05	0%
9-308.1	0.06	0.07	17%	0.06	0%
9-308.1	0.07	0.07	0%	0.07	0%
9-308.1	0.07	0.08	14%	0.07	0%
9-356.04	0.07	0.07	0%	0.07	0%
9-356.04	0.07	0.08	14%	0.07	0%
9-356.04	0.08	0.08	0%	0.08	0%
9-356.04	0.09	0.09	0%	0.09	0%
9-376.45	0.11	0.11	0%	0.11	0%
9-376.45	0.13	0.13	0%	0.12	-8%
9-376.45	0.14	0.14	0%	0.13	-7%
9-376.45	0.16	0.16	0%	0.14	-13%
9-394.62	0.04	0.04	0%	0.04	0%
9-394.62	0.05	0.05	0%	0.04	-20%
9-394.62	0.05	0.06	20%	0.05	0%
9-394.62	0.06	0.07	17%	0.06	0%
9-421.74	0.12	0.13	8%	0.12	0%
9-421.74	0.14	0.14	0%	0.14	0%
9-421.74	0.15	0.16	7%	0.15	0%
9-421.74	0.18	0.18	0%	0.17	-6%
9-447.9	0.08	0.09	13%	0.08	0%
9-447.9	0.09	0.1	11%	0.09	0%
9-447.9	0.11	0.11	0%	0.11	0%
9-447.9	0.13	0.13	0%	0.13	0%
10-81.92	0.14	0.14	0%	0.14	0%
10-81.92	0.15	0.15	0%	0.15	0%
10-81.92	0.17	0.17	0%	0.17	0%
10-81.92	0.24	0.27	13%	0.2	-17%
10-163.45	0.15	0.17	13%	0.14	-7%
10-163.45	0.17	0.19	12%	0.16	-6%
10-163.45	0.19	0.2	5%	0.17	-11%
10-163.45	0.22	0.24	9%	0.19	-14%
10-229.21	0.17	0.18	6%	0.15	-12%
10-229.21	0.19	0.2	5%	0.17	-11%
10-229.21	0.20	0.21	5%	0.18	-10%
10-229.21	0.22	0.24	9%	0.21	-5%
10-269.79	0.22	0.23	5%	0.2	-9%
10-269.79	0.23	0.25	9%	0.22	-4%
10-269.79	0.25	0.26	4%	0.23	-8%
10-269.79	0.27	0.29	7%	0.25	-7%
10-312.46	0.14	0.14	0%	0.14	0%
10-312.46	0.15	0.15	0%	0.15	0%
10-312.46	0.16	0.16	0%	0.16	0%
10-312.46	0.18	0.19	6%	0.18	0%
10-355.67	0.08	0.09	13%	0.07	-13%
10-355.67	0.09	0.1	11%	0.08	-11%
10-355.67	0.10	0.12	20%	0.09	-10%
10-355.67	0.12	0.14	17%	0.11	-8%
10-400.3	0.20	0.22	10%	0.18	-10%
10-400.3	0.22	0.24	9%	0.2	-9%
10-400.3	0.24	0.26	8%	0.22	-8%
10-400.3	0.27	0.29	7%	0.24	-11%
10-483.65	0.22	0.24	9%	0.11	-50%
10-483.65	0.27	0.3	11%	0.14	-48%
10-483.65	0.27	0.3	11%	0.14	-48%
10-483.65	0.31	0.34	10%	0.17	-45%
10-550.28	0.10	0.1	0%	0.1	0%
10-550.28	0.12	0.12	0%	0.12	0%
10-550.28	0.12	0.12	0%	0.12	0%
10-550.28	0.13	0.13	0%	0.13	0%

Cross Section	Max Depth (Standard Scenario)	20% Increase Manning n		20% Decrease Manning n	
		Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)
10-581.24	0.80	0.8	0%	0.8	0%
10-581.24	0.82	0.82	0%	0.82	0%
10-581.24	0.82	0.82	0%	0.82	0%
10-581.24	0.84	0.84	0%	0.84	0%
10-620.97	0.10	0.1	0%	0.1	0%
10-620.97	0.11	0.11	0%	0.11	0%
10-620.97	0.11	0.11	0%	0.11	0%
10-620.97	0.12	0.12	0%	0.12	0%
10-640.61	0.01	0.01	0%	0.01	0%
10-640.61	0.02	0.02	0%	0.02	0%
10-640.61	0.02	0.02	0%	0.02	0%
10-640.61	0.02	0.02	0%	0.02	0%
10-664.21	0.12	0.12	0%	0.12	0%
10-664.21	0.14	0.14	0%	0.14	0%
10-664.21	0.14	0.14	0%	0.14	0%
10-664.21	0.16	0.16	0%	0.16	0%
11-29.23	0.82	0.82	0%	0.79	-4%
11-29.23	0.90	0.9	0%	0.88	-2%
11-29.23	1.00	1	0%	0.98	-2%
11-29.23	1.16	1.16	0%	1.13	-3%
11-93.39	0.44	0.47	7%	0.39	-11%
11-93.39	0.48	0.52	8%	0.44	-8%
11-93.39	0.54	0.59	9%	0.49	-9%
11-93.39	0.65	0.7	8%	0.58	-11%
11-224.02	0.44	0.47	7%	0.4	-9%
11-224.02	0.48	0.53	10%	0.44	-8%
11-224.02	0.54	0.58	7%	0.48	-11%
11-224.02	0.63	0.68	8%	0.57	-10%
11-326.04	0.27	0.3	11%	0.24	-11%
11-326.04	0.31	0.34	10%	0.27	-13%
11-326.04	0.35	0.39	11%	0.31	-11%
11-326.04	0.43	0.48	12%	0.38	-12%
11-440.01	0.54	0.59	9%	0.49	-9%
11-440.01	0.60	0.65	8%	0.54	-10%
11-440.01	0.66	0.71	8%	0.61	-8%
11-440.01	0.76	0.82	8%	0.69	-9%
11-516.89	0.50	0.54	8%	0.44	-12%
11-516.89	0.55	0.6	9%	0.5	-9%
11-516.89	0.62	0.68	10%	0.56	-10%
11-516.89	0.74	0.81	9%	0.66	-11%
11-619.52	0.43	0.47	9%	0.39	-9%
11-619.52	0.48	0.53	10%	0.43	-10%
11-619.52	0.54	0.59	9%	0.49	-9%
11-619.52	0.64	0.7	9%	0.57	-11%

Cross Section	Max Depth (Standard Scenario)	20% Increase Manning n		20% Decrease Manning n	
		Max Depth	Relative Change in Max Depth	Max Depth	Relative Change in Max Depth
	(m)	(m)	(%)	(m)	(%)

Appendix K

MUSIC Model Data

PARSONS BRINCKERHOFF

North Bellbird Flooding and Stormwater Assessment

Project No. 2122527A
Client Ref.

MUSIC Model Subcatchment Data

Date: 19-May-06

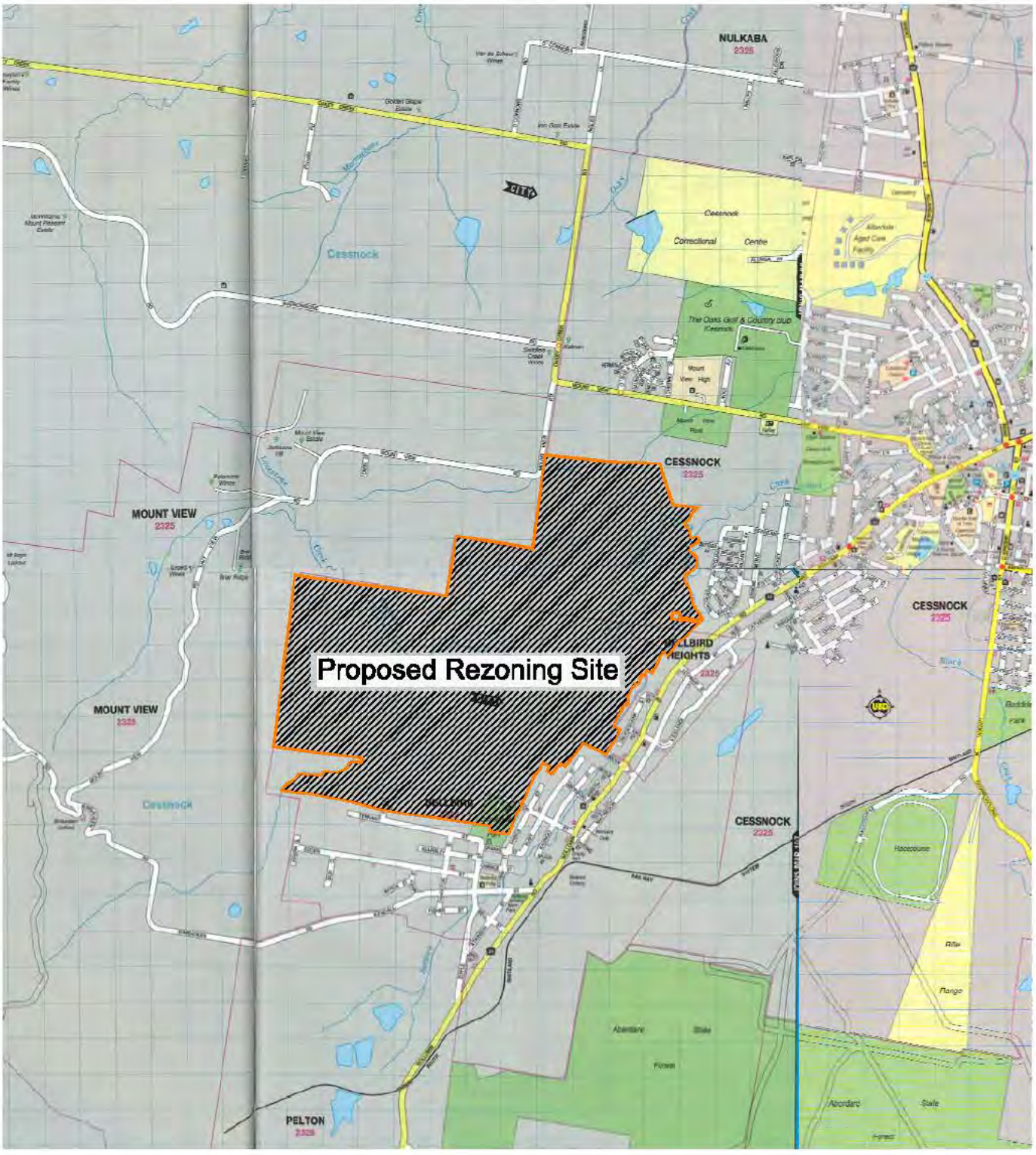
WQ Subcatchment	Area (ha)	2% of Area (ha)	% Imperv Existing	% Imperv Developed
1	57.8	1.16	0	50
2	44.5	0.89	0	50
3	38.7	0.77	0	50
4	29.3	0.59	0	50
5	30.1	0.60	0	50
6	9.5	0.19	0	50
7	23.1	0.46	0	50
8	12.3	0.25	0	50
9	19.9	0.40	0	50
10	18.8	0.38	0	50
11	7.4	0.15	0	50

Client: Johnson Property Group
Project: North Bellbird Investigation Area
Flooding and Stormwater Assessment
Location: Cessnock, NSW

PARSONS BRINCKERHOFF

0 1000 2000 m

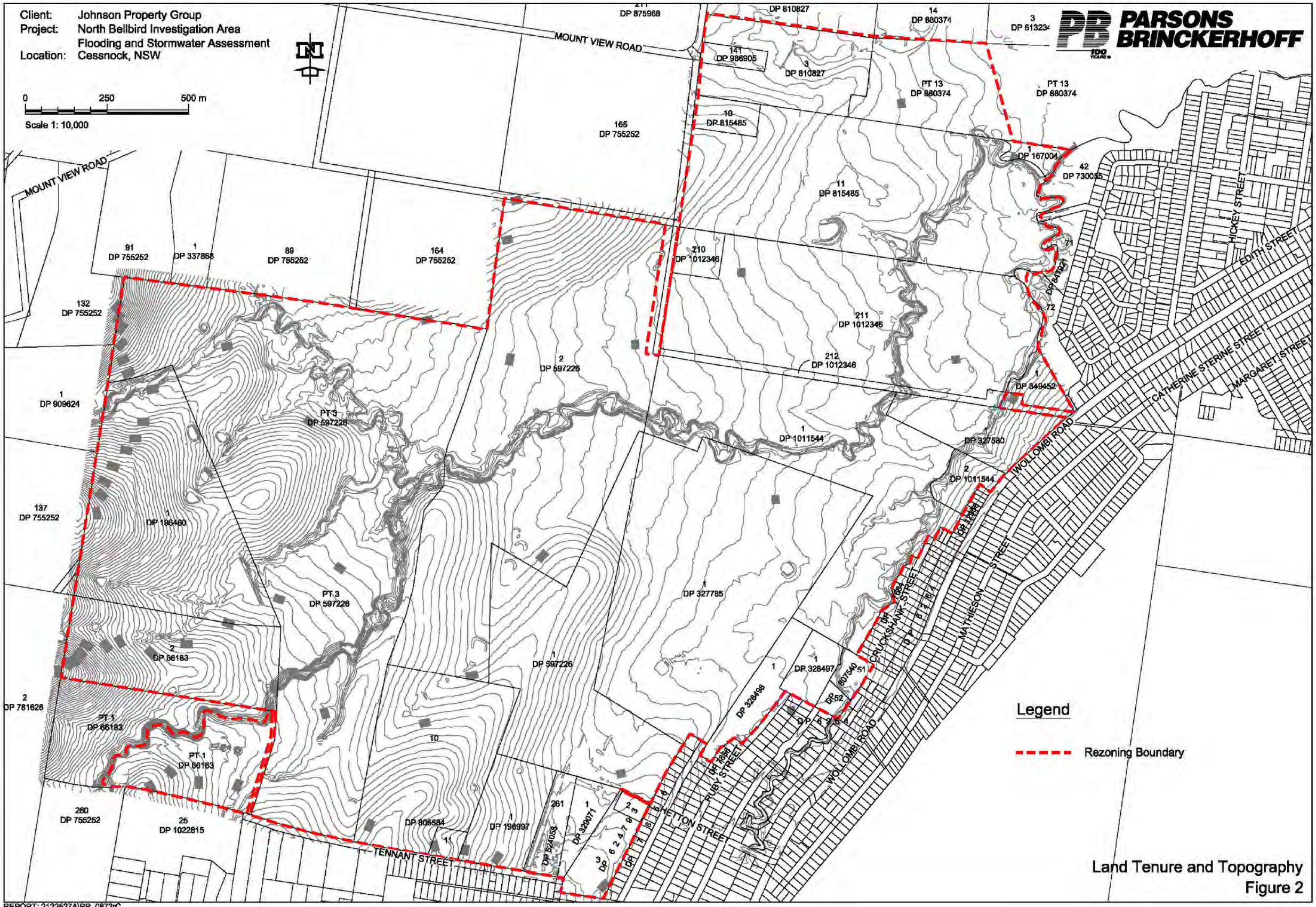
Scale 1: 40,000



Locality Plan
Figure 1

Map reproduced with permission of UBD. Copyright Universal Publishers Pty Ltd, DG 10/03.

REPORT: 2122527A\PR_0872rC
CAD REFERENCE: J:\A502CL-NCL\21225XX\PROJ\2122527A\9_Drafting\PR_0872rC\FIGURE 1.dwg



Land Tenure and Topography
Figure 2

REPORT: 2122527A\PR_0872rC
CAD REFERENCE: J:\A502CL-NCL\21225XX\PROJ\2122527A\9_Drafting\PR_0872rC\FIGURE 2.dwg

Client: Johnson Property Group
Project: North Bellbird Investigation Area
Flooding and Stormwater Assessment
Location: Cessnock, NSW

250 0 250 500 750 1000 1250 m
Scale 1: 25,000

PB PARSONS BRINCKERHOFF

MARROWBONE ROAD
OAKLEY CREEK
ALLANDALE ROAD
MAITLAND ROAD
VINCENT STREET
WOLLOMBI ROAD
MOUNT VIEW ROAD
Limestone Creek
Bellbird Creek
Black Creek

REFER TO FIGURE 4

UNK 1
UNK 2
UNK 3
UNK 4
UNK 5
UNK 6
UNK 7
UNK 8
BEL 1
BEL 2
BEL 3
BEL 4
BEL 5
BEL 6
BEL 7
BEL 8
BEL 23
BEL 24
BEL 25
LIM 1
LIM 4
LIM 8
LIM 9

Legend

- BEL 1 — XP-RAFTS node
- XP-RAFTS link
- Rezoning Boundary
- Subcatchment boundary
- Road
- Storage node

Bellbird Creek Subcatchment Layout
Figure 3

REPORT: 2122527A\PR_0872rC
CAD REFERENCE: J:\A502CL-NCL\21225XX\PROJ\2122527A\9_Drafting\PR_0872rC\FIGURE 3.dwg

Client: Johnson Property Group
Project: North Bellbird Investigation Area
Flooding and Stormwater Assessment
Location: Cessnock, NSW

PB PARSONS BRINCKERHOFF

0 250 500 m

Scale 1: 10,000

LIM 8
LIM 10
LIM 11
LIM 23
LIM 26
LIM 25
BEL 23
BEL 22
LIM 24
BEL 21
LIM 22
BEL 20
LIM 9
LIM 13
LIM 21
LIM 12
LIM 18
LIM 19
LIM 20
LIM 16
LIM 15
LIM 17
BEL 18
BEL 19
LIM 7
BEL 15
BEL 16
BEL 17
LIM 14
LIM 6
BEL 14
BEL 13
BEL 11
BEL 12
LIM 5
LIM 3
BEL 10
BEL 7
LIM 2
BEL 9
LIM 4
LIM 1
BEL 8

Legend

BEL 1 XP-RAFTS node

XP-RAFTS link

Rezoning Boundary

Subcatchment boundary

Local Development Subcatchment Layout
Figure 4

REPORT: 2122527A\PR_0872rC
CAD REFERENCE: J:\A502CL-NCL\21225XX\PROJ\2122527A\9_Drafting\PR_0872rC\FIGURE 4.dwg

Client: Johnson Property Group
Project: North Bellbird Investigation Area
Flooding and Stormwater Assessment
Location: Cessnock, NSW

0 250 500 m

Scale 1: 10,000

PB PARSONS BRINCKERHOFF

LEGEND:

1-852.20 HEC-RAS Cross Sections (100 Year Model)

Rezoning Boundary

Loaction of HEC-RAS Cross Sections 100 Year
Figure 5

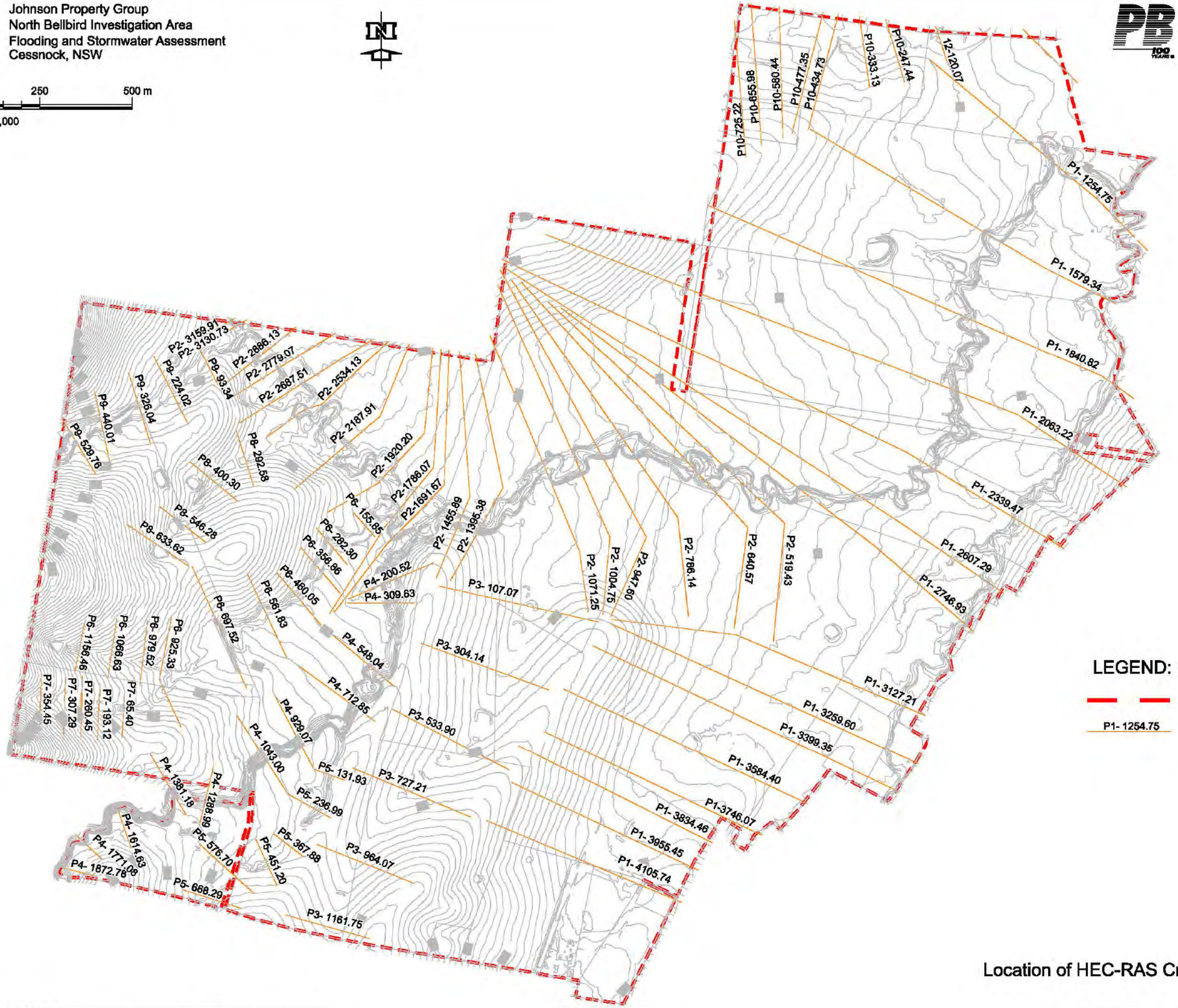
REPORT: 2122527A\PR_0872rC
CAD REFERENCE: J:\A502CL-NCL\21225XX\PROJ\2122527A\9_Drafting\PR_0872rC\FIGURE 5.dwg

Client: Johnson Property Group
Project: North Bellbird Investigation Area
Flooding and Stormwater Assessment
Location: Cessnock, NSW

0 250 500 m

Scale 1: 10,000

PARSONS BRINCKERHOFF



LEGEND:

Rezoning Boundary

P1- 1254.75 — HECRAS Cross Section (PMF Model)

Location of HEC-RAS Cross Sections - PMF Model
Figure 6

REPORT: 2122527A\PR_0872rC
CAD REFERENCE: J:\A502CL-NCL\21225XX\PROJ\2122527A\9_Drafting\PR_0872rC\FIGURE 6.dwg

Client: Johnson Property Group
Project: North Ellalong Investigation Area
Flooding and Stormwater Assessment
Location: Cessnock, NSW

0 200 800 m

Scale 1: 10,000

PB PARSONS BRINCKERHOFF

FIGURE 8

FIGURE 11

FIGURE 10

FIGURE 9

LEGEND:

- 1 year Flood Envelope
- 5 year Flood Envelope
- 10 year Flood Envelope
- 20 year Flood Envelope
- 100 year Flood Envelope
- PMF Flood Envelope
- Rezoning Boundary

Existing Flood Envelopes Site Plan
Figure 7

REPORT: F:\2265\7\RPR_0072.C
CAD REFERENCE: J:\AD\SOL\nCL\2122\0029\RO\21226072\A9_Drafting\RPR_0072\FIGURE 7.dwg

Client: Johnson Property Group
Project: North Ballbird Investigation Area
Flooding and Stormwater Assessment
Location: Cessnock, NSW

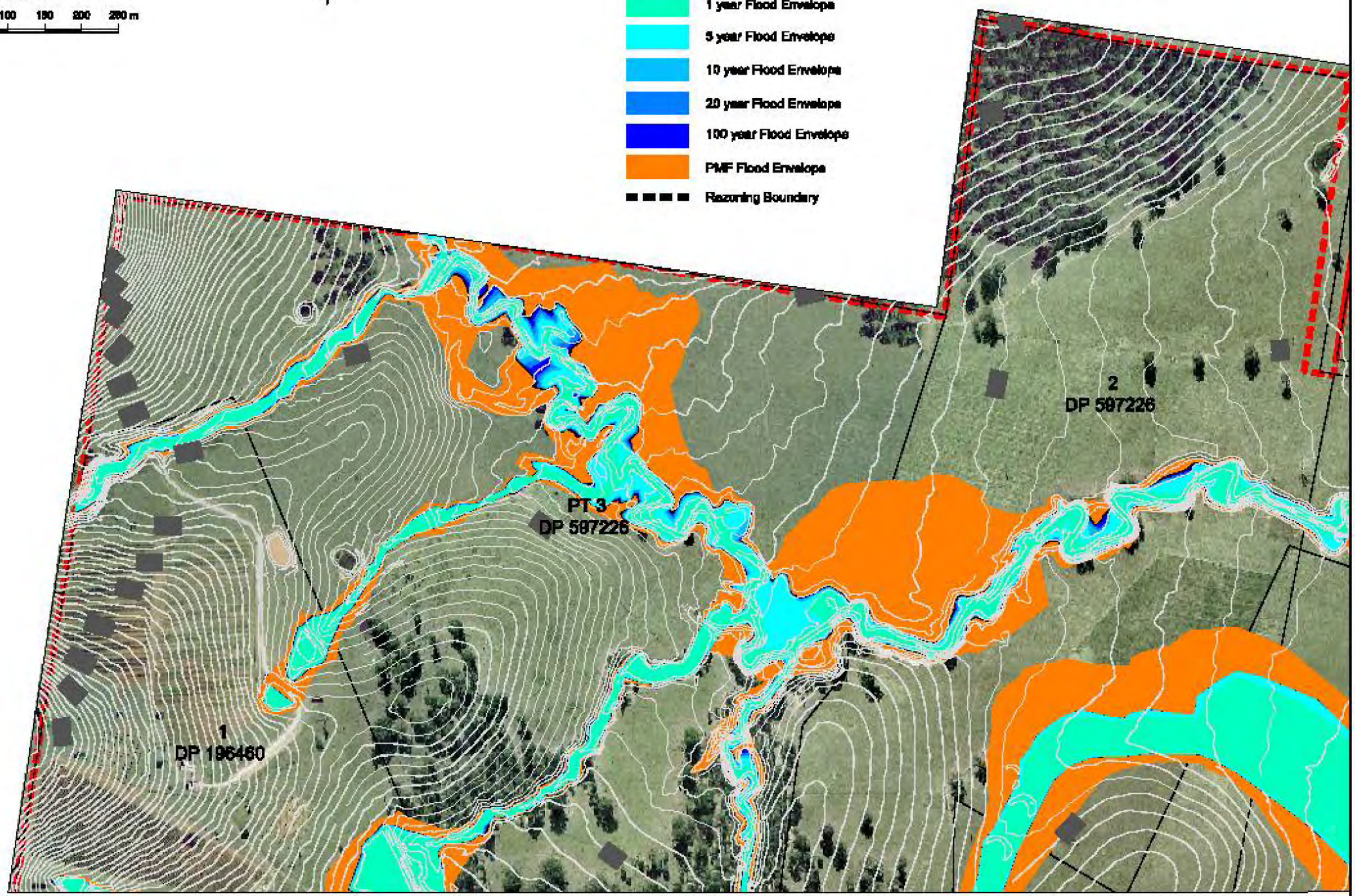
80 0 60 100 150 200 250 m

Scale 1: 5000

PARSONS BRINCKERHOFF

LEGEND:

- 1 year Flood Envelope
- 5 year Flood Envelope
- 10 year Flood Envelope
- 20 year Flood Envelope
- 100 year Flood Envelope
- PMF Flood Envelope
- Rezoning Boundary



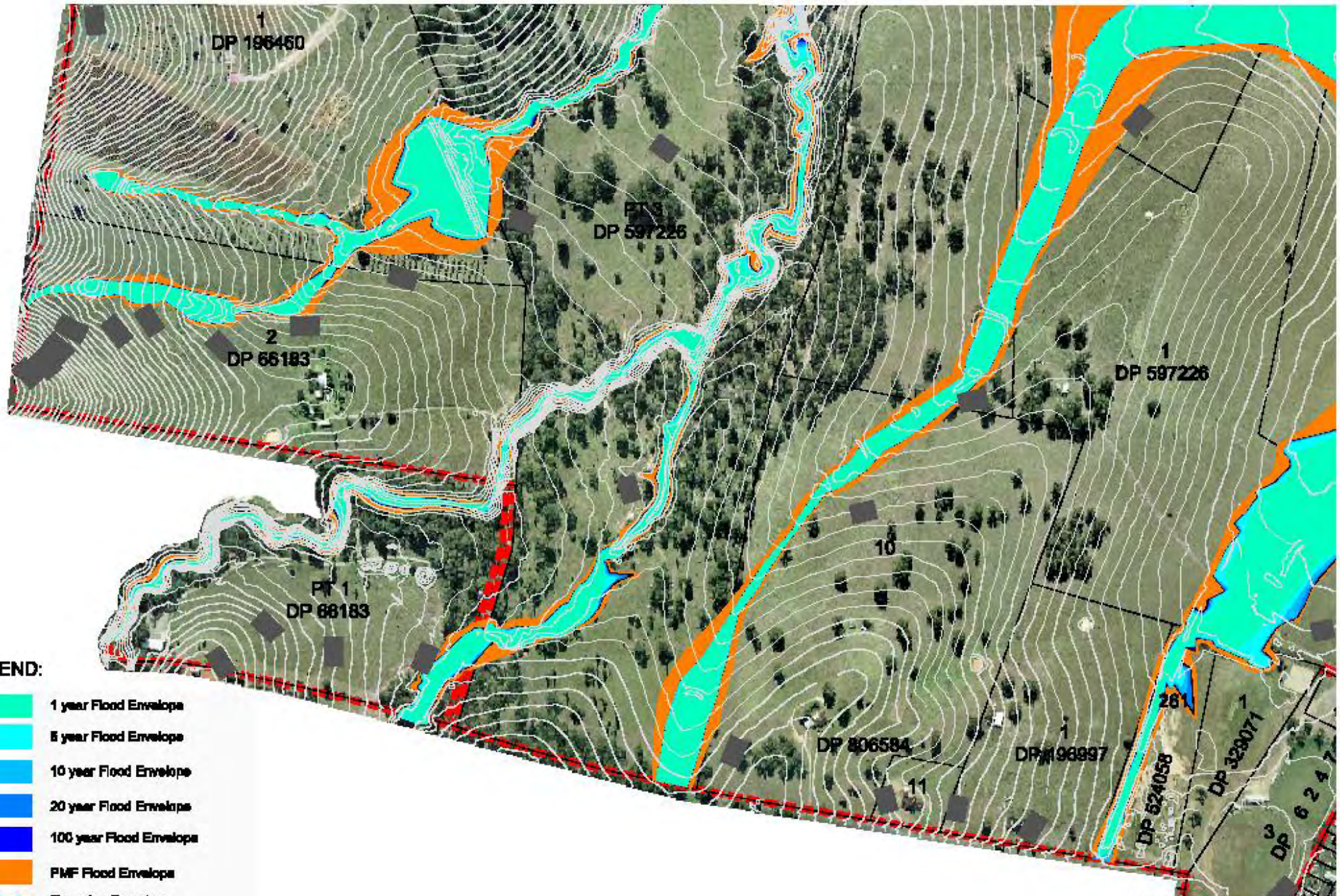
Estimated Flood Envelope Sheet 1
Figure 8

REPORT: 218887/PR_[illegible]
CAD REFERENCE: J:\AS\CL-WCL\218\218887\GIS_Drafting\PR_[illegible]\FIGURE 8.dwg

Client: Johnson Property Group
Project: North Ballbird Investigation Area
Flooding and Stormwater Assessment
Location: Cessnock, NSW

50 0 50 100 150 200 250 m
Scale 1: 5000

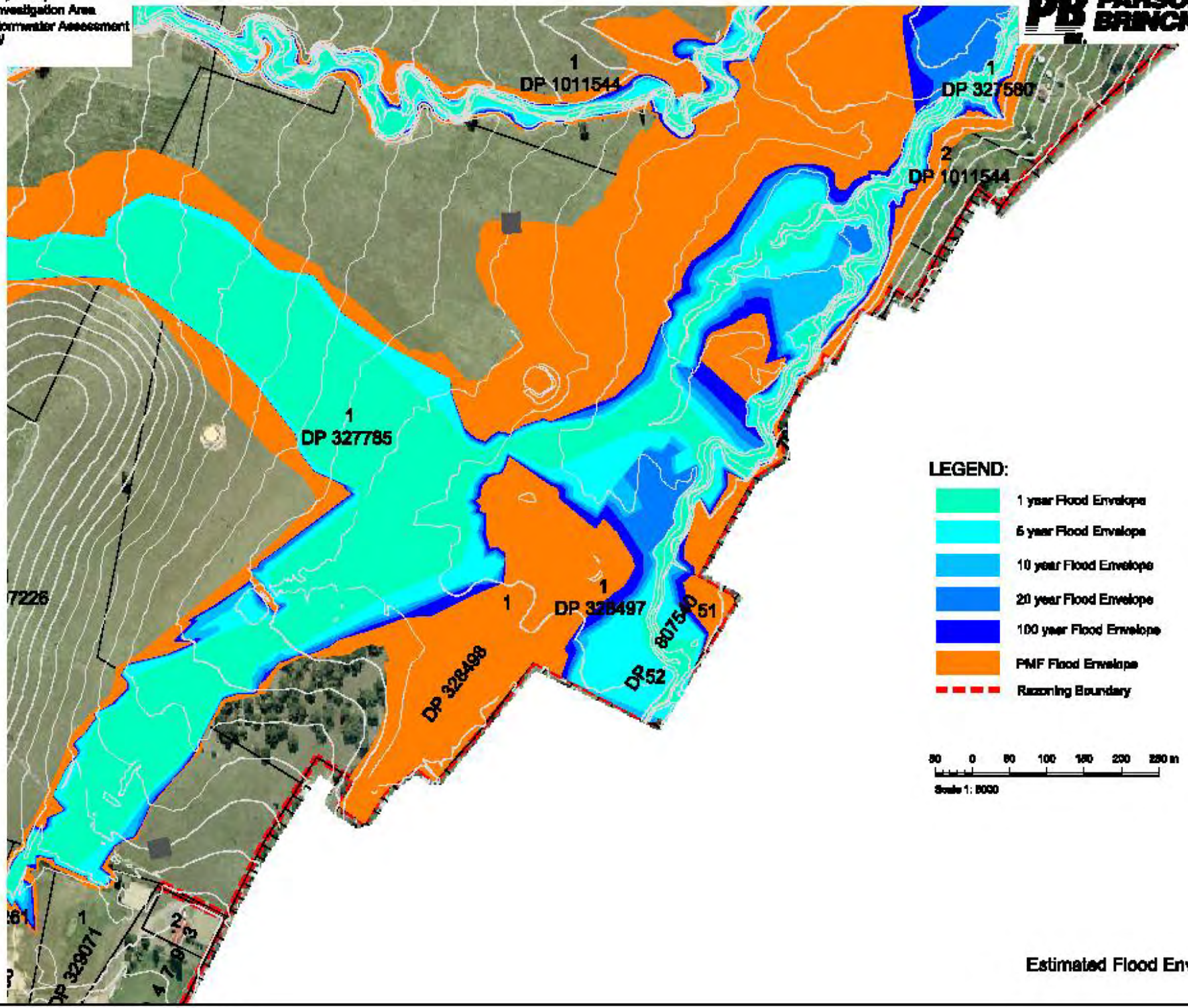
PARSONS BRINCKERHOFF



Estimated Flood Envelope Sheet 2
Figure 9

REPORT: 2122527/APR_5072rC
CAD REFERENCE: J:\A502CL-NCL\2122527\PROJ\2122527A9_Drafting\PR_5072rC\FIGURE 9.dwg

Client: Johnson Property Group
Project: North Ballbird Investigation Area
Flooding and Stormwater Assessment
Location: Cessnock, NSW



Estimated Flood Envelope Sheet 3
Figure 10

REPORT: 2122527A/PR_5072C
CAD REFERENCE: J:\AS\SCL-NCL\2122527A\PROJ\2122527A9_Drafting\PR_5072C\FIGURE 10.dwg

Client: Johnson Property Group
Project: North Belbird Investigation Area
Flooding and Stormwater Assessment
Location: Cessnock, NSW

PARSONS BRINCKERHOFF

50 0 50 100 150 200 250 m
Scale 1: 5000

N

LEGEND:

- 1 year Flood Envelope
- 5 year Flood Envelope
- 10 year Flood Envelope
- 20 year Flood Envelope
- 100 year Flood Envelope
- PMF Flood Envelope
- Rezoning Boundary

141
DP 866605

3
DP 810827

PT 13
DP 880374

10
DP 815485

1
DP 167004

11
DP 815485

210
DP 1012346

211
DP 1012346

212
DP 1012346

6

1
DP 1011544

1
DP 349452

1
DP 327580

Estimated Flood Envelope Sheet 4
Figure 11

REPORT: 21[illegible]/R_[illegible]
CAD REFERENCE: J:\V[illegible]\FIGURE 11.dwg

Client: Johnson Property Group
Project: North Bellbird Investigation Area
Flooding and Stormwater Assessment
Location: Cessnock, NSW

0 250 500 m

Scale 1: 10,000

PB PARSONS BRINCKERHOFF

THIS AREA IS DEVELOPABLE SUBJECT TO CAREFUL PLANNING DUE TO PROXIMITY TO FLOOD ENVELOPES

FURTHER FLOODING ANALYSIS REQUIRED TO DETERMINE EXTENT OF ALLOWABLE FILL

PROVIDE ENGINEERED DRAINAGE LINE

FURTHER FLOODING ANALYSIS REQUIRED TO DETERMINE EXTENT OF ALLOWABLE FILL

PROVIDE ENGINEERED DRAINAGE LINE

#1 #2 #3 #4 #5 #6 #7 #8 #9 #10 #11

LEGEND:

- Nominal Development Area
- Possible Developable Area Following Further Analysis / Design
- #1 Potential Detention Basin/WQCP Location
- Engineered Drainage Line
- 100 year Flood Envelope

Nominal Development Areas and Location of Detention Basins/ WQCP's
Figure 12

REPORT: 2122527A\PR_0872rC
CAD REFERENCE: J:\A502CL-NCL\21225XX\PROJ\2122527A\9_Drafting\PR_0872rC\FIGURE 12.dwg

JOHNSON PROPERTY GROUP

PROPOSED REZONING STUDY
NORTH BELLBIRD, NSW

PRELIMINARY GEOTECHNICAL &
CONTAMINATION ASSESSMENT

REPORT G25058/1-Dr2 JULY 2006

Network Geotechnics Pty Ltd

ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
Telephone 4351 6200
Facsimile 4351 6300
Email: gosnetgeo@bigpond.com

G25058/1-Dr2 VdS: TC
7th July 2006

Johnson Property Group
PO Box 1196
CASTLE HILL NSW 2154

Attention: Mr Paul Hedge

Dear Sir

Re: Proposed Rezoning Study, Bellbird North, NSW: Preliminary Geotechnical & Contamination Assessment.

Please find enclosed our report on preliminary geotechnical and contamination site assessments undertaken for the above project. This report supercedes any previous reports issued under G25058/1-D and should be read in conjunction with the attached General Notes.

The report presents the results of field and laboratory testing and describes surface, subsurface and geotechnical conditions. Report recommendations cover preliminary contamination site assessment and other geotechnical issues considered relevant. The extent of the investigation was designed to satisfy constraint analysis required for the purpose of rezoning.

This investigation includes the findings of the investigation carried out during April -July 2005 and reported in our Interim Report G25058/1-B of 25th August 2005 and the findings of the investigation carried out during March- April 2006 on the three additional parcels of land added to the study (Interim Report G25058/1-C dated 17 March 2006).

Please do not hesitate to contact Mr Vipul de Silva or the undersigned if you have any queries or require further assistance.

For and on behalf of
Network Geotechnics Pty Ltd

R J King *(BE) Civil*
Principal Geotechnical Engineer

EXECUTIVE SUMMARY

Network Geotechnics Pty Ltd (NG) was commissioned by Insite Planning and Engineering Pty Ltd on behalf of Johnson Property Group and land owners of the North Bellbird Investigation Area, to carry out a preliminary geotechnical and contamination assessment for rezoning submission.

The scope of the investigation was limited to identifying major constraints affecting the proposed rezoning.

The North Bellbird Investigation Area has been assessed with respect to its capacity to sustain a mix of development and conservation including:

- A mix of residential environments provided through sequential staging.
- A commercial and retial precinct including mixed use development capable of serving the needs of the North Bellbird community.
- Social and community infrastructure including schools, community and recreational facilities including open space.
- Infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails.
- Conservation of quality remnant vegetation; and
- Rehabilitation of degraded riparian corridors to provide habitat linkages.

North Bellbird Investigation Area covers about 496ha.

NG commission included the following scope of works:

- Review of historical land title records, aerial photographs, groundwater bore data to aid assessment of potential contaminants.
- Limited walkover assessment of areas of interest identified in the desk study.
- Drilling/excavation of about 20 boreholes/test pits across the site.
- Soil and surface water sampling for preliminary contamination assessment.
- Preliminary assessment of soil salinity.
- Assessment for the presence of acid sulphate soils
- Prepare a report identifying any constraints for the proposed development.

The site is located west of Mount View foothills on gently undulating terrain underlain by Dalwood Group Rutherford Formation comprising siltstone, marl and minor sandstone. Subsurface profile comprised residual Clayey Sand and Sandy Clay overlying Sandstone over the south and the southwest. The north east area of the site comprised colluvial and alluvial Sandy Clay.

Geotechnical investigation carried out did not reveal any constraints affecting rezoning of the area.

Review of historical records and preliminary contamination testing of soil and water samples indicated that the investigation area is free from major site contamination apart from localised hydrocarbon contamination in one of the farm dams. This area may need further investigation during the development application process.

Some of the soil samples located close to creeks were found to be moderately to highly saline. Further investigation of soil salinity would be required during the development application process for developments within 50-100m from creek lines.

The investigation did not reveal presence of acid sulphate soils within the site.

Lots 211 and 212 in DP1012346, Lots 1 and 2 in DP101544 and Lot 1 in DP327580 were excluded from this study and were the subject of a previous study. Lots 2 and 3 in DP624793 and Lot 1 in DP329071 was not included in the current commission. The latter three lots have existing urban development and would be subject for further studies if the current land use is to be altered.

In conclusion the investigations did not reveal any geotechnical or site contamination constraints which would preclude urban development within the North Bellbird Investigation Area.

TABLE OF CONTENTS

		PAGE
	EXECUTIVE SUMMARY	
1.0	**INTRODUCTION**	6
2.0	**THE SITE**	7
2.1	Site Location	7
2.2	Site History	8
2.3	Aerial Photographs	9
3.0	**FIELDWORK**	10
4.0	**LABORATORY TESTING**	11
4.1	Contamination	11
4.2	Salinity	12
4.3	Acid Sulphate Testing	12
4.4	Classification Testing	12
5.0	**ASSESSMENT CRITERIA**	12
6.0	**INVESTIGATION RESULTS**	15
6.1	Surface	15
6.2	Subsurface	16
7.0	**SITE CHARACTERISATION**	16
8.0	**GEOTECHNICAL APPRAISAL**	19
8.1	Slope Instability	19
8.2	Effluent Disposal	20
8.3	Site Filling	20
8.4	Stormwater	20
8.5	Salinity	20
9.0	**CONTAMINATION ISSUES**	21
10.0	**ACID SULPHATE ASSESSMENT**	21
11.00	**ACCESS ROADS**	22
12.00	**MINE SUBSIDENCE**	22
13.00	**CONCLUSION**	22

GENERAL NOTES

Landslide Risk Management – AGS Subcommittee Appendix J – Some Guidelines for Hillside Construction

Appendix A Test Pit and Borehole Logs

Appendix B Laboratory Test Results Engineering Properties

Appendix C Laboratory test Results- Contamination Testing

Appendix D Historical Aerial Photographs: Summary of Observation

Appendix E Information from Mine Subsidence Board

Appendix F Extract of European Heritage Report

DRAWING No. G25058/1-3 Locality Plan

DRAWING No. G25058/1-1R Site Plan and Test Location

1.0 INTRODUCTION

Network Geotechnics Pty Ltd has undertaken a preliminary geotechnical and contamination site assessment for the proposed rezoning of about 496ha of land located at North Bellbird, NSW. The investigation was carried out as a component of a rezoning submission to be lodged with Cessnock City Council (CCC) to assist in preparation of Local Environment Plan (LEP). This report should be read in conjunction with the attached General Notes.

The proposed future urban development is understood to comprise the following:

- A mix of residential environments provided through sequential staging.
- A commercial and retial precinct including mixed use development capable of serving the needs of the North Bellbird community.
- Social and community infrastructure including schools, community and recreational facilities including open space.
- Infrastructure capable of servicing the needs of the community, including road access, public transport, integrated cycle and pedestrian linkages, all reticulated service infrastructure, and fire trails.
- Conservation of quality remnant vegetation; and
- Rehabilitation of degraded riparian corridors to provide habitat linkages.

The aim of the investigation was to provide sufficient information for rezoning submission. The following aspects were targeted in this study:

- Geotechnical issues affecting the suitability of land for subdivision, in particular slope instability of moderately steep sloping land.
- A site contamination assessment including compilation of site history based on land title search and examination of aerial photographs, preliminary sampling and testing and preparation of a report identifying constraints affecting the proposed rezoning.
- Preliminary appraisal of soil salinity.
- Preliminary assessment of acid sulphate potential of site soils, particularly in the low lying areas.

The study was commissioned by Insite Planning on behalf of Johnson Property Group Pty Ltd on 6 April 2005. At that time the study comprised 21 allotments covering about 400ha. An interim report G25058/1-B was issued in August 2005 based on studies carried out during April to July last year.

In February 2006 the commission was extended to cover three more allotments covering an area of about 100ha. The investigation for the additional land was carried out during March- April 2006. An Interim Report was issued on 17th March 2006.

This current report combines the findings of the two previous interim reports.

2.0 THE SITE

2.1 Site Location

The site is located to the west of Wollombi Road, Bellbird between Tennant Street, Bellbird to the south, Bellbird Creek to the east, and rural holdings bordering Mount View Road to the north and west. The area is at present of rural character and includes 23 parcels of land covering about 496ha. The site contains the following properties:

Lot No	DP Number	Area ha
Lot1	DP 66183	20.33
Part Lot3	DP 597226	93.7
Lot10	DP 806584	19.4
Lot1	DP 196997	6.7
Lot 261	DP 524058	2.7
Lot 1	DP 597226	28.4
Lot 1	DP 327785	47.8
Lot 2	DP 597226	66.0
Lot 1	DP 328498	4.2
Lot 1	DP 328497	2.5
Part Lot 51	DP 807540	1.5
Lot 52	DP 807540	0.6
Lot 1	DP 349452	1.9
Lot 210	DP 1012346	2.0
Lot 11	DP 815485	41.8
Lot 10	DP 815485	2.0
Lot 3	DP 810827	11.5
Part Lot 13	DP 880374	41.5
Lot 1	DP 167004	1.4
Lot 141	DP 986905	1.2
Lot 11	DP 806564	0.8
Lot 3	DP 597726(North)	50.0
Lot 2	DP 66183	16.0
Lot 1	DP 196460	35.0

Note: Lots 211 and 212 in DP1012346, Lots 1 and 2 in DP1011544 and Lot 1 in DP327580 were excluded from this study and were the subject of a previous study by Coffey (Report N08037/0-1-AC dated 11/1/2002). This report concluded that there are no impediments for development of the land for the proposed use apart from areas along the watercourses. Lots 2 and 3 in DP624793 and Lot 1 in DP329071 was not included in the current commission. The latter three lots have existing urban development and would be subject for further studies if the current land use is to be altered.

Access to the site is from Mount View Road, Mount View in the north, Tennant Street, Bellbird in the south and Victoria Street, Bellbird North in the east. Buttaba Avenue, Cruckshank Street and Hetton Street in the east abut the site.

A locality plan is included in Drawing No G25058/1-3 and a site plan is included in Drawing No G25058/1-1R attached.

2.2 Site History

Historical land titles held in the Department of Land Information were purchased and inspected to assess the potential for former site contamination activities. Title records show that the various parcels of land was held by vine growers, farmers, graziers, butchers, businessmen and tradesmen over the years. Based on the historical title records the following activities may have some potential for site contamination:

- Lot 1 in DP66183 was owned by a vine grower from 1915-1949.
- Lot 1, Lot 2 and Part Lot 3 in DP597226 comprising in excess of 100ha were at some stages owned by a family whose occupation is listed as butchers. It is understood that a slaughter house was located close to southern boundary of Lot 1 DP597226. A tannery associated with the slaughter house understood to be located in the south eastern corner of Lot 2 DP597226.
- Lot 1 DP196997 was owned at some stage by a person described as a broiler farmer. It is understood that a large chicken shed was located south of Tennant Street.
- Lot 1 DP167004 was once owned by a person listed as a dog breeder.

A summary of items of concern identified from title records are shown on Table 2.1 below. Title records are held in NG office for reference if required.

Table 2.1 Summary of Title Information

Lot/DP	Area (ha)	Main Finding
Part Lot 1 DP66183	20.33 (total)	1915-1949 owned by vine grower. 1949-1986 owned by miner and farmer.
Part 3 DP597226	93.71 (total)	1923 - present, owned by graziers/butchers. Mainly McDonald family.
Part 1 DP597226	6.33	A butcher was listed as owner from 1941 - ?
Lot 10 DP806564	19.4	Graziers were listed as owners.
Lot 1 DP196997	6.736	Broiler farmer owned the property from 1970-73.
Lot 1 DP327785	47.84	Similar history to Part 3 DP597226 above.
Lot 2 DP597226	65.97	Similar history to Part 3 DP597226 above.
Lot 1 DP328498	4.19	Similar history to Part 3 DP597226 above.
Lot 1 DP328497	2.464	Owned by miners/fitters etc.

Lot 51 & 52 DP807540	1.486 north 0.6239 south	-
Lot 1 DP349452	1.897	-
Lot 200 DP1012346	2.0	Owned by graziers, farmers.
Lot 10/11 DP815485	41.76 2.0	-
Lot 3 DP810827	11.45	-
Lot 13 DP880374	41.54	-
Lot 1 DP176004	1.576	Dog breeder owned from 1947-1958.

2.3 Aerial Photographs

Nine aerial photographs were purchased from the Land Information Centre of the Department of Infrastructure Planning and Natural Resources and inspected to assess the activities which may have been carried out on the site. The observations are given in Table 2.2 below.

Table 2.2 Observations from Aerial Photographs

Date	Scale	Description
26/9/04	Approx 1:25000	Several large sheds south of Tennant Street opposite Pt 3 DP597226. Disturbed land in Lot 261 DP524058. Several houses along Tennant Street. Several dams. A dwelling on Lot 11 DP806564.
24/8/94	Approx 1:25000	Lot 261 DP524058 under construction (playground). Some farming activity in the central area on both sides of the creek.
24/4/84	Approx 1:40000	A larger area appeared to be covered by farming activities. Residence in Lot 11 DP806564 was present. A number of dams appeared to be dry. A small shed was visible in SE corner of Lot 2 DP597226.
3/5/78	Approx 1:16000	Southern area of Pt 3 DP597226 appeared to be disturbed.
27/5/75	Approx 1:40000	Several sheds visible in all areas of the site. Farming was more widespread.

-/3/61	Approx 1:40000	Two lots of sheds in the area suspected to contain the slaughter house were visible. Several tracks were present leading to sheds.
1/4/52	Approx 1:40000	Some soil disturbance. Land clearing in the middle, west of the creek.

Detailed description of observations made for each parcel of land is included in Appendix D.

Based on the above information and the site history contained in land titles it is assessed that there are no indications of recent onsite activities which could lead to site contamination. Although the site may have previously been used mainly as a grazing area similar to present land use, there were dams, sheds, dwellings and a previous slaughter house present which could have a potential for site contamination.

3.0 FIELDWORK

Fieldwork for the investigation was initially carried out on 28/6/05 and 20/7/05 and comprised a walk over assessment and excavation of 7 machine test pits (TP2, TP3, TP5, TP9, TP12, TP13 & TP14) to depths ranging from about 1.2m to 1.5m. The test pit locations were set out in the field using a hand held GPS and pace measurements in relation to the existing features shown on the plan provided. Fieldwork was supervised and test pits were logged and sampled by a Senior Geotechnical Engineer from this Company.

In addition, water samples were collected from dams located in Lot 2 DP66183 (WS1) and Lot 1 DP196460 (WS2, WS3 and WS4). A field duplicate sample (a duplicate of WS3) was also collected.

Water samples were analysed for Total Petroleum Hydrocarbon (TPH), Benzene, Toluene, Ethyl benzene and Xylene (BTEX), Organochlorine and Organophosphate Pesticides (OC/OP) and heavy metals.

Fieldwork for the study related to additional three sites commissioned in February 2006 was carried out from 9/03/06 to 15/03/06 and included drilling of 12 boreholes, logging and soil sampling. Water samples were collected from existing dams.

During the field work for the additional three lots, further investigations were carried out in an area included within the initial commission for which access was not available during April-July 2005. These included shallow Boreholes BH7, BH8 and BH11 in Lot 1 DP327785 and surface sampling SS1 to SS3 and SAL1 to SAL3. A summary of borehole information and testing carried out are included in Table 3.1 below:

Table 3.1 Summary of Test Pit and Borehole Information

Lot and DP No	Test Pit No	Depth (m)	Depth to Rock(m)	Laboratory Testing
Lot11 DP 815485	TP2 TP3	1.2 1.3	>1.2 >1.3	Salinity, Metals, OC/OP/PCB Salinity, Metals
Lot13 DP880374	TP5	1.2	>1.2	Atterberg Limits, Salinity, Metals

Lot 2 DP597226	TP9	1.2	0.8	Atterberg Limits, Salinity, Metals, OC/OP/PCB
	TP12	1.2	>1.2	Salinity, Metals, OC/PCB/PAH/TPH/BTEX
Pt3 DP597226	TP13	1.25	>1.25	Atterberg Limits, Salinity, Metals
Lot 1 DP66183	TP14	1.3	>1.3	Salinity, Metals, OC/OP/PCB
Lot 2 DP66183	BH101	1.5	1.1	Salinity, Atterberg Limits, Emerson Class No, Metals, OC/OP
	BH102	1.5	>1.5	Salinity, Metals, OC/OP
	BH103	1.5	0.75	Salinity, Metals, OC/OP
	ES07	-	-	OC/OP, Asbestos
Lot 1 DP196480	BH104	1.5	1.3	Atterberg Limits, Emerson, Salinity, Metals, OC/OP
	BH105	1.5	1.2	Salinity, Metals, OC/OP
	BH106	1.5	>1.5	Salinity, Metals, OC/OP
	BH107	1.5	>1.5	Acid Sulphate, Salinity, Metals, OC/OP
Pt3 DP57726 (North)	BH108	1.5	>1.5	Atterberg Limits, Emerson, Salinity, Metals, OC/OP
	BH109	1.5	>1.5	Acid Sulphate, Salinity, Metals, OC/OP
	BH110	1.5	>1.5	Atterberg Limits, Emerson, Acid Sulphate, Salinity, Metals, OC/OP
	BH111	1.5	>1.5	Acid Sulphate, Salinity, Metals, OC/OP
	BH112	1.5	>1.5	Salinity, Metals, OC/OP
Lot 1 DP597226	SS1			Metals, OC/OP/PCB
	SS2			Metals, OC/OP/PCB
	SS3			Metals, OC/OP/PCB
	BH10			Salinity, Metals, OC/OP/PCB
Lot 1 DP327285	BH7			Salinity, Metals, OC/OP/PCB
	BH8			Salinity, Metals, OC/OP/PCB
	BH11			Salinity, Metals, OC/OP/PCB
Lot 1 DP807540	SAL1			ASS Salinity
Lot 51 DP807540	SAL2			ASS Salinity
Lot 1 DP328497	SAL3			ASS Salinity

Approximate test locations are shown on the attached Drawing No. G25058/1-1R and engineering logs of boreholes and test pits are presented in Appendix A.

4.0 LABORATORY TESTING

4.1 Contamination

Laboratory tests included analytical tests on discrete and composite soil samples and 7 water soil samples to determine concentrations of heavy metals, Total Petroleum Hydrocarbon (TPH), Benzene, Toluene, Ethyl Benzene, Xylene (BTEX) organochlorine pesticides (OCP) organophosphorus pesticides (OPP) and Polychlorinated Biphenyl (PCB) carried out at Australian Laboratory Services (ALS), Sydney. The test results along with Chain of Custody documents are included in Appendix C. The results are discussed in Section 7.0.

4.2 Salinity

Salinity tests were carried out on 10 soil samples during April-July 2005 and 27 soil samples in March-April 2006. The tests included:

- Electrical conductivity tests on 1:5 (by man) soil water suspension using a TD Scan 4 meter.

- Textural soil classification tests based on ASL547 in order to determine the multiplication factor for conversion of electrical conductivity on 1:5 soil-water mix to equivalent electrical conductivity of pore water when saturated ECe.

  The results are included in Appendix B.

4.3 Acid Sulphate Testing

Acid sulphate screening tests were carried out on 14 soil samples. pH tests were carried out on soil-water suspensions and soil pre-treated with hydrogen peroxide (H_2O_2). Results indicated that pH in water were more than 4 pH units and pH in H_2O_2 was more than 3.0 except in one sample where pH=2.6. This sample appeared to contain organic matter. Further laboratory acid sulphate testing was not conducted as the screening test results indicated negative results.

Test results are included in Appendix B.

4.4 Classification Tests

Laboratory classification tests included Atterberg Limits and Emerson Class Number. The results are included in Appendix B.

5.0 ASSESSMENT CRITERIA

The assessment of potentially contaminated land involves the evaluation of potential human health hazards and environmental impacts. The receptors (or potential receptors) of concern may be within the site being assessed, or outside the site boundaries due to potential off-site migration of contaminants.

The following assessment criteria were used for assessment of the soils:

- The Health-Based Investigation Levels (HBIL) summarised in the following Table 5.1, which are extracted from Schedule B (7a) of the NEPM and Guidelines or the NSW Site Auditor Scheme, 1998, are used for assessing the risk to human health.

- BTEX (Benzene, Toluene, Ethyl Benzene and Xylenes) and Total Petroleum Hydrocarbons (TPH), threshold Levels were extracted from the NSW EPA *Guidelines for Assessing Service Station Sites, 1994* and summarised in the following Table 5.2.

- The Provisional Phytotoxicity-Based Investigation Levels (PPBIL) summarised in the following Table 5.1, which are extracted from the *Guidelines for the NSW Site Auditor Scheme, 1998,* are adopted for use as screening guidance for assessing the potential phytotoxicity effects on plant species.

The abovementioned levels are presented on the following Tables 5.1 and 5.2.

Table 5.1 SOIL (mg/kg)

	Health Based Investigation Levels[a] (HBIL)				Column 5
Setting[b]	Column 1	Column 2	Column 3	Column 4	
Substance	Residential with gardens/accessible soil (home-grown produce contributing less than 10% fruit and vegetable intake; no poultry) including children's day care centres, pre-schools, primary schools, townhouses and villas (NEHF A)	Residential with minimal access to soil including high-rise apartments and flats (NEHF D)	Parks, recreational open space playing fields including secondary schools (NEHF E)	Commercial or Industrial (NEHF F)	Provisional Phytotoxicity Based Investigation Levels* for sandy loams of pH 6-8 (PPBIL)
METALS/METALLOIDS					
Arsenic (total	100	400	200	500	20
Berylium	20	80	40	100	-
Boron	3000	12000	6000	15000	-
Cadmium	20	80	40	100	3
Chromium (III)[c]	12%	48%	24%	60%	400
Chromium (VI)	100	400	200	500	1
Cobalt	100	400	200	500	-
Copper	1000	4000	2000	5000	100
Lead	300	1200	600	1500	600
Manganese	1500	6000	3000	7500	-
Methyl Mercury	10	40	20	50	-
Mercury (Inorganic)	15	60	30	75	1[f]
Nickel	600	2400	600	3000	60
Vanadium	-	-	-	-	50
Zinc	7000	28000	14000	35000	200
ORGANICS					
Aldrin + dildrin	10	40	20	50	-
Chlordane	50	200	100	250	-
DDD + DDE + DDT	200	800	400	1000	-
Heptachlor	10	40	20	50	-
Polycyclic Aromatic Hydrocarbons (PAH) Total	20	80	40	100	-
Benzo(a)pyrene	1	4	2	5	-
Phenol[d]	8500	34000	17000	42500	70
Polychlorinated Biphenyls (PCB) Total	10	40	20	50	-
Petroleum Hydrocarbon					
>C16-C35 Aromatics	90	360	180	450	-
>C16-C35 Aliphatics	5600	22400	11200	28000	-
>C35 Aliphatics	56000	224000	112000	280000	-
OTHER					
Cyanides (complex)	500	2000	1000	2500	-
Cyanides (free)	250	1000	500	1250	-

Notes:

a. The limitations of Health-Based Soil Investigation Levels are discussed in P Imray & A Langley, 1999, *Health-Based Soil Investigation Levels,* National Environmental Health Forum (NEHF) Monographs, Soil Series No. 1, 3rd Edition.
b. See exposure settings detailed in R Taylor & A Langley, 1999. *Exposure Scenarios and Exposure Settings.* NEHF Monographs, Soil Series No. 2, 3rd Edition.
c. Soil discolouration may occur at these concentrations.
d. Odours may occur at lower concentrations.
e. The Provisional Phytotoxicity-Based Investigation Levels proposed in this document are single number criteria. Their use has significant limitations because phytotoxicity depends on soil and species parameters in ways that are not fully understood. The provisional phytotoxicity-based investigation levels, intended for use as screening guidance, may be assumed to apply to sandy loam soils, or soils of a closely similar texture and at a pH of between 6 and 8.
f. Total Mercury.

Table 5.2 SOIL (mg/kg)

NSW EPA Service Station Guidelines (1994)

TPH (C6-C9)	TPH (C10-C40	Benzene	Toluene	Ethyl Benzene	Xylenes (Total)
65	1000	1	1.4	3.1	14
Environmental Quality Objectives in the Netherlands (1994) Intervention Values					
Heptachlor Epoxide	Methoxychlor	Aldrin + Dieldrin + Endrin		Endosulfan	Fluorides (Total)
5	5	4		5	2000

Test results for surface water samples collected from this site was analysed against the Australian Water Quality Guidelines for the Protection of Aquatic Ecosystems Fresh Water related to the protection of 95% of species (ANZECC/ARMCANZ 2000). Where these guidelines are not considered appropriate due to higher background levels and site specific features or the guidelines are not available, new trigger values were derived based on risk assessment. Assessment criteria adopted for assessment of surface water is shown on Table 5.3 below:

Table 5.3 Site Assessment Criteria For Surface Water

Parameter	**Groundwater GIL (µg/L)**		**Project Laboratory PQL**
	Freshwater Aquatic Ecosystems[a]	**Australian Drinking Water Guidelines[f]**	**Water (µg/L)**
Aluminium	<5	200[i]	10
Arsenic	50	7	1
Cadmium	0.2	2	0.2-1
Chromium[g]	10	1000	1
Chromium VI	-	50	
Copper	2	2000/1000[i]	1
Iron	1000	300[i]	100
Lead	1	10	1
Mercury (inorganic)	0.1 (total)	1	0.5-0.1
Nickel	15	20	1-5
Zinc	5	300[i]	1
TPH C_6C_9 fraction	325[b]	-	20
TPH $C_{10}C_{36}$ fraction		-	50-100 (indiv)
Benzene	300	1	1
Toluene	300	800/25[i]	2
Ethyl Benzene	140	300/3[i]	2
Total Xylenes	380[d]	600/20[i]	2
PAHs (total)	3	-	2-4 (indiv)
Benzo(a)pyrene	-	0.01	2
Organochlorine Pesticides (OCPs)		-	0.5-2[c] (indiv)
Dieldrin	0.002[g]	0.3	
Aldrin	0.01[g]	0.3	
Endrin	0.003[g]	-	

Parameter	Groundwater GIL (µg/L)		Project Laboratory PQL
	Freshwater Aquatic Ecosystems[a]	Australian Drinking Water Guidelines[f]	Water (µg/L)
Chlordane	0.004[g]	1.0	
Endosulfan	0.01[g]	-	
Methoxychlor	0.04[g]	-	
Heptachlor	0.01[g]	0.3	
DDE	0.014[g]	-	
DDT	0.001[g]	20.0	
DDD	-	-	
Organophosphate Pesticides (OPPs)	0.001 - 1[g]	-	0.5 - 2[c]
Chlorinated Hydrocarbons	1-10[h]	3-4 (indiv)	1-10 (indiv)
Phenols	50	-	1
PCBs	0.001	-	1
Phenoxy Acid Herbicides	0.05[h]	-	0.05 (indiv)

Footnotes:

a) NEPC (1999) NEPM Schedule B(1), Groundwater Investigation Levels for Fresh Water Aquatic Ecosystems.
b) Dutch (Intervention Value + Target Value)/2 Ministry of Housing Spatial Planning and Environment 1992.
c) Laboratory detection limit in laboratories cannot reliably achieve the ANZECC Levels for pesticides.
d) NSW EPA (1994) "guidelines for Assessing Service Station Sites".
e) Valence State not distinguished, expected as Cr (III).
f) NHMRC/ARMCANZ (1996) "Australian Drinking Water Guidelines".
g) Due to low guideline values below routine laboratory detection limits, the laboratory detection limit used for screening purposes.
h) Laboratory detection limit used for screening purposes.
i) Value based on aesthetic considerations.
j) ANZECC (1992) Australian Water Quality Guidelines for Fresh and Marine Waters.
NT = Not Tested
- = Not Available

The site is proposed for mixed development, including residential, commercial and recreational uses. Consequently, the issues of concern for contamination (if present) within the site are considered to be the risk of harm to human health and environmental impacts.

6.0 INVESTIGATION RESULTS

6.1 Surface

The site is located east of Mount View foot hills and is bound by Bellbird Creek to the east. There are several creeks associated with Bellbird Creek and Limestone Creek traversing across the site, generally in a north and north-east direction.

The south western area of the site is generally undulating with an overall north east facing slope of about 3˚-5˚ and locally up to 10˚. The balance of the site is mainly flat or gently sloping, with slopes less than about 2˚. A number of farm dams and several rural residences were present on the site. The current land use appears to be cattle grazing. There were no signs of intensive farming.

Lot 2 DP66183 and Lot 1 DP196460 are located on the western border of the study area and occupies about 51ha of east facing 4˚ to 6˚ slope locally increasing to about 8˚ to 10˚ along the western boundary. Two east flowing tributaries of Limestone Creek intersect the area. A series of farm dams were located on both properties. Lot 2 DP66183 is mainly grassland. Lot 1 DP195460 appeared to be a hobby farm with some areas containing wineries and olive plantations and the rest grass covered. Pt 3 DP597226 covers about 50ha and is generally flat. Limestone Creek flows across the site in south-easterly direction. An east flowing tributary of Limestone Creek runs along the boundary between Lot 1 DP196460 and Pt 3 DP597226. Creek banks are 2-3m deep at some locations. Terrain along the creek lines appeared to be hummocky possibly indicating episodes of erosion and deposition.

Vegetation at the site is mainly grass, with generally only scattered gum trees. The steeper areas of the site within the south-western corner contain relatively dense gum trees.

6.2 Subsurface

Geological maps of the area indicate most the site to be underlain by Dalwood Group Rutherford Formation, mainly comprising siltstone, marl and minor sandstone. The area close to the eastern boundary is shown to be underlain by Dalwood Group Farley Formation comprising Silty Sandstone. The area containing Wollombi Road is shown to be underlain by Greta Coal Measure comprising Siltstone, Conglomerate, Sandstone and Coal. This formation is outside the study area.

Test pits located south of Limestone Creek indicated residual Clayey SAND and Sandy CLAY underlain by fine grained sandstone at shallow depths. Test pits in the area north of Limestone Creek encountered a deeper sandy CLAY profile. Rock was not encountered at these test pits. Geological maps for the area shows the existence of a geological fault approximately along Limestone Creek. Inspection of creek banks indicated up to about 3-4m deep clay on the northern bank of the creek and sandstone/siltstone rock exposed at 1-2m depths on the southern bank.

Boreholes located in Lot 2 DP66183 (BH101 and BH103) recorded Silty Sand slopewash and medium plasticity clay and sandy clay overlying sandstone bedrock. BH102 recorded similar profile but rock was not encountered with 1.5m depth limit of drilling. BH104 and BH105 located in the southern half of Lot 1 DP 196460 also recorded a similar profile to BH101 and BH103. BH107 in Lot 1 DP196460, BH110 and BH111 in DP597226 located on or adjacent to Limestone Creek recorded alluvial soils to the full depth of the investigation.

Groundwater table was not encountered in any of the boreholes at the time of investigation. However depth to groundwater and seepage could change as a result of variation in rainfall, drainage and other factors.

7.0 SITE CHARACTERISATION

The site is characterised by undulating land in the south-west and relatively flat terrain in the balance of the site. Some of the land adjacent to Bellbird Creek comprises relatively broad floodplain. Limestone Creek has steep banks. Soils in most of the site investigated comprised low to medium plasticity clays. It is considered unlikely that there will be major limitation from geotechnical and contamination aspects that would affect the proposed development.

Lots 1 and 2 DP66183

Lot 1 and 2 DP66183 covers an area of about 32ha located in the south-west corner of the project. A tributary of Limestone Creek flows across Lot 1. Both banks of the creek were heavily vegetated with tall timber. A homestead called "Derby Lodge" is located in Lot 2, which also contains a farm dam. The lodge is located on an east trending low ridge. Ground slopes range from 3˚-7˚ generally to the north-east and to the south-east on either side of the ridge. Creek banks were found to be steep, in excess of 70˚ and about 3-5m deep at locations.

There was some evidence of horticulture/vineyards within the area in the past. The present land use appears to be cattle grazing. Boreholes TP14, BH101, BH102 and BH103 were drilled in this area. Subsurface conditions encountered in the boreholes comprised Sandy Silt Slopewash overlying residual Sandy clay of low to medium plasticity. Emerson Class number of Sandy Clay at 0.5 -0.7m depth in BH101 was 1 indicating high potential for soil erosion. BH103 encountered extremely weathered sandstone at about 0.8m depth. Eastern side of the creek exposed about 3-4m high residual clay bank.

Moderately saline to highly saline soils were encountered in BH102 and TP14 respectively. Both these test locations were within 30m from creek/drainage lines.

Four near surface soil samples were tested for heavy metals, OC/OP pesticides and PCB. Test results were less than National Environmental Health Forum Health based investigation Levels for residential areas with accessible gardens, exposure A (NEHF HIL A).

A water sample from a farm dam located in Lot 2 was tested for metals, OC/OP pesticides, TPH, and BTEX. Water quality test results were less than ANZECC 2000 investigation guidelines for fresh water aquatic systems. OC/OP and BTEX were below the laboratory detection levels. A minor concentration of TPH C_{15}-C_{36} (270ug/l) was recorded in the dam water sample tested. There are no ANZECC investigation guidelines for TPH. However a limit of 325ug/l is sometimes used by contaminated site auditors for assessment of freshwater quality.

Lot 1 DP196460

Lot1 DP 196460 occupies about 35ha of 5^0-8^0 North East facing slope. A deep drainage swale is located along the northern boundary. Two drainage gullies runs across the site in an north- easterly direction towards limestone creek. Three farm dams are located on these drainage gullies. A farm house is located in the middle of the property.

Boreholes BH104, BH105, BH 106 and BH 107 were drilled in this site. Subsurface profile was found to be similar to that in Lot1 and Lot2 DP 66183 described above. Extremely weathered Sandstone was encountered in BH104 and BH 105 at 1.3m and 1.2m depths respectively. A soil sample from BH 104 at 0.3-0.5m depth recorded a liquid limit of 50% and Emerson Class No 6.

Aerial photographs indicated that the site has been used for vineyard/horticulture for more than 50 years. The site was found to be extensively cleared in the 1951 photograph.

Water samples WS2, WS3 and WS4 did not contain metals above investigation guidelines except zinc which recorded concentrations of 0.024 to 0.052mg/l.

These concentrations are considered to represent background levels for the area and are considerably less than acceptable criteria for drinking water.

Sample WS3 was tested for OC/OP pesticides. The results were less than the laboratory detection level.

All three samples were tested for BTEX and TPH C6-C9 and the results were less than laboratory detection level. WS2 and WS3 were tested for TPH C_{10}-C_{36}. WS3 results were less than laboratory detection level. WS2 recorded TPH C_{15}-C_{36} of 380ug/l which is slightly higher than the acceptable investigation level.

Lot 3 DP 597226

Lot 3 DP 597226 occupies about 93ha of 2^0-5^0 generally north facing slope. Limestone creek flows within the northern portion of the site in a south –easterly direction. Creek banks were found to be steep and heavily eroded at some sections, possibly due to cattle traffic. The southern portion is heavily timbered and the rest was covered with grass. A small farm dam is located near the southern boundary adjacent to Tennant Street.

Test Pit TP13 and boreholes BH108, BH109, BH110, BH111 and BH112 were located in this site. All boreholes and the test pit exposed Sandy CLAY/ Sandy SILT top soil overlying residual Sandy CLAY/ Clayey SAND of medium to high plasticity. Liquid Limit of residual clay ranged from 44% to 65%. One sample from BH 110 recorded an Emerson Class Number of 3 indicating potential for erosion.

Samples from TP13, BH109 and BH 112 found to be moderately saline while all other samples were either non-saline or slightly saline. It is considered that there are no limitations for developments within non/slightly saline soils.

Historical aerial photographs indicated the southern area of the site to have been disturbed during late 1970s. A cattle holding yard is located near Tennant Street. The northern area appeared to have been used as a wine yard or an orchard, but only grass pastureland at present.

Anecdotal evidence suggests that there was a large chicken shed just south of Tennant Street adjacent to the site. Storm water from this site would have flown to the subject property in the past.

Soil samples tested (7 samples) did not record heavy metal or OC/OP pesticide above NEHF HIL A levels.

A water sample from the dam did not record metals and OP/OC pesticides above NEHF HIL A.

Lot 1 and Lot 2 DP 597726

These two lots occupy about 94ha of 2^0-5^0 north east facing slope. The site is characterised by two north east trending ridges located in the south. Four farm dams and two sheds were found to be located within the area.

Most of the site is covered with grass with isolated trees.

Test pits TP 9 and TP 12 were located within this area. Subsurface profile was found to comprise Silty SAND/ Clayey SAND slope wash overlying Sandy CLAY of high plasticity. A sample from TP 9 recorded a liquid limit of 66%.

A soil sample from TP 12 recorded moderate salinity.

Aerial photographs indicated the site would have been mainly used as a cattle farm. Anecdotal evidence suggests that a slaughter house was located in the south west corner of Lot 1. A house was said to have been located close to the western boundary of lot 2. Two sheds, understood to have been used for drying and storing hide are located at the dog leg north west corner of Lot 2.

Near surface samples from TP9, TP10 and three samples from the area assumed to be from former slaughter house were tested for metals and OC/OP Pesticides. All tests recorded concentrations below NEHF HIL A. Soil samples from TP 12 and ES16 (from the area containing hide drying sheds) were tested for metals, OC pesticides, PCB, TPH and BTEX recorded concentrations below NEHF HIL A.

A water sample from a dam near TP12 recorded TPH concentrations of in excess of 5000ug/l.

Lot1 DP 327785 and other smaller allotments to the east

These lots occupy about 60ha of relatively flat land. Bellbird Creek flows northwards along the eastern boundary of the site. Historical aerial photographs indicated that the area remained as grazing land/cattle farm.
Subsurface profile is expected to comprise topsoil/slope-wash overlying residual sandy clay of high plasticity.

Surface soil samples tested for heavy metal, OC/OP pesticides did not record contamination above NEHF HIL A.

One soil sample near the creek recorded high salinity.

Lot 11 DP 815485 and smaller lots to the North

These lots occupy about 60ha of 1^0 to 2^0 east facing slope. The area is located adjacent to the urban residential developments located to the north. Several rural residences and a few sheds were located within this area.

Test Pits TP2, TP3 and TP5 were located in this area. Subsurface profile comprised Sandy CLAY top soil overlying alluvial Sandy CLAY of low to medium plasticity to the full depth (1.5m) of investigation.

Two highly saline and one moderately saline soil samples were recorded in this area.

Samples tested for metals and OP/OC Pesticides recorded contamination below NEHF HIL A.

8.0 GEOTECHNICAL APPRAISAL

8.1 Slope Instability

Slope instability is assessed to not be a major concern within most of the site. Any local areas with slopes exceeding 12.5% would require construction carried out in accordance with good hillside engineering practices as outlined by Australian Geomechanics Appendix J attached. Such areas may only be found in the south-west corner particularly in Lot 1 DP1966460 and Lot 2 DP66183.

8.2 Effluent Disposal

It is understood that the proposed lots will be provided with a reticulated sewerage system. There are assessed to be no geotechnical constraints affecting the construction of sewer lines.

8.3 Site Filling

Site filling may be required in some areas close to creek lines to bring site levels above local flood levels. It is assessed that there would be no geotechnical impediments against such filling. Foundation soils are assessed to be competent to receive fill loading without unacceptable settlement. Such filled sites would be suitable for proposed developments provided site filling is carried out in accordance with AS3798 (1998) "Guidelines for Earthworks for Commercial and Residential Developments".

8.4 Stormwater

Disposal of stormwater may be carried out by conventional means. Excess stormwater runoff generated by urban development work may be directed to detention basins. Sizing of detention basins may be based on absorption rate of 30mm/d/m^2 for preliminary assessment.

8.5 Salinity

Discussions with DIPNR indicate that there are currently no salinity maps available for this area. Electrical conductivity tests on 1:5 soil water mixture were carried out on 39 soil samples distributed across the site. Salinity rating of samples tested are given below:

Non-Saline (EC_e <2 ds/m)	19 samples
Slightly Saline (EC_e 2-4 ds/m)	9 samples
Moderately Saline (EC_e 4-8 ds/m)	6 samples
Highly Saline (EC_e >8 ds/m)	5 samples

Moderately saline and highly saline samples were located generally close to creeks.

Soils close to creek lines may be moderately saline (ECe 4-8 ds/m). Such soils may generate salts when disturbed which may cause problems in road pavements, brickwork and concrete in buildings. Developments within areas with moderate to high saline soils should be carried out with regard to salinity management practices currently being implemented in Western Sydney. Further investigation should be carried out to delineate areas of possible moderate to high salinity, prior to construction commencing on site, preferably in conjunction with development applications. Based on our professional experience, areas within 50m to 100m of creek lines underlain by shale/siltstone may contain saline soils in the upper soil horizons.

9.0 CONTAMINATION ISSUES

Our historical search and site inspection along with targeted soil and water testing did not reveal site contamination levels that would limit the development of any of the sites. One water sample obtained from the creek near Tennant Street (sample No 6) contained heavy metal concentration slightly above ANZEC investigation levels for protection of freshwater aquatic systems. This sample was obtained at the upstream entry point to the site and hence would more reflect contamination entering the site rather than on-site contamination. It may also be due to site disturbance at the park located just outside the site boundary. Sample 5 collected from creek at Lot 11 DP815485 located at the downstream end of the creek did not record heavy metal contamination. However the recorded contaminant concentrations were only marginally higher and may be due to chemical composition of natural soils. Further testing will need be carried out in conjunction with detailed planning, prior to development application to assess any contamination potential of surface water.

It is understood that a slaughter house was located in the south-west corner Lot 1 DP597226 bordering Lot 2 DP597226. Preliminary soil samples collected from this area did not record soil contamination when tested for heavy metals, total petroleum hydrocarbon (TPH), polycylic aromatic hydrocarbon (PAH) or organochlorine pesticides. A water sample (Sample Dam 12) collected from a dam in Lot 2 DP597226 contained Total Petroleum Hydrocarbon (TPH) C_{10}-C_{36} fraction <5510 ug/l. ANZECC guidelines does not provide an investigation level for hydrocarbon. However a TPH concentration of 325/ug/l is considered the threshold above which further investigation will be required. This may represent a localised elevated contamination and should be subjected to further investigation in conjunction with detailed planning prior to the Development Application process for the proposed subdivision. It is assessed that remediation of such contamination levels could be achieved during construction. The area targeted for the investigation should be the area which contained the slaughter house and drying and storing hide (area about 50m from either side of dog leg south-west boundary between Lot 1 and 2 in DP597226).

Based on the information collected from review of title records and aerial photographs, preliminary sampling and testing, and limited walkover assessment, it is considered that past and present site usage present a minimal risk to soil and groundwater contamination. It is considered likely that extent of any contamination resulting from past activities would be localised and could be managed during the normal earthworks construction of any future subdivisions.

We assess that the investigations described in this report sufficiently characterise the site in relation to potential site contamination for the proposed re-zoning submission. It is assessed that no further investigations, apart from the area which contained the slaughter house, would be required prior to any development application. There is assessed to be a need for further sampling and testing to assess any local contamination hot spots. Such testing should best be carried out during construction when areas are stripped and structures are demolished.

The following lists the potential sites which would require further sampling and testing during construction. The list below is indicative only and may need to be revised as more areas are exposed.

- Test all dam water and sediments for hydrocarbon and pesticides in all farm dams.

- Soil testing for heavy metals, pesticides and hydrocarbon around existing sheds, cattleyards, and farm houses.

- Testing of soils as above in any buried waste pits which may be uncovered during construction.

- Assess presence of asbestos containing materials in any of the structures to be demolished.

It is recommended that a generic Remedial Action Plan incorporating the above requirements be developed covering all allotments prior to subdivision applications.

Past and present site features, excluding farm dams, which may require further sampling and testing are shown on Figure 4.1 of European Heritage Assessment by Stedinger (Report May 2006), a copy of which is included in Appendix F.

10.0 ACID SULPHATE ASSESSMENT

Fourteen samples close to the creeks were tested to assess acid sulphate potential. The tests recorded negative results.

Acid sulphate soils are generally found in low lying marine deposits. Soils in the study area are derived by weathering of sandstone/siltstone and to some extent transportation from adjacent hills. There is no evidence to suggest the presence of acid sulphate soils. Several soil samples collected from boreholes adjacent to creeks were tested and the results indicate that the site soils would not generate acid upon exposure.

Based on topography, limited test results and visual assessment of subsurface soils, it is considered unlikely that Acid Sulphate soils are present in the area.

11.0 ACCESS ROADS

Construction of access roads would not require major earthworks given the relatively mild slopes. Earthworks for roads (and lot filling) should be carried out with a view to managing soil salinity if present.

Subgrade CBR values of 3-8% may be expected giving pavement thickness in the range 250mm-500mm for minor roads.

12.0 MINE SUBSIDENCE

An enquiry with the Mine Subsidence Board (Singleton) indicates that the site is not within a proclaimed mine district and is not subject to any building restrictions imposed by the Mine Subsidence Board. A letter from Mine Subsidence Board is included in Appendix E.

13.0 CONCLUSION

This investigation did not reveal any geotechnical or environmental constraints that will inhibit the proposed development. Further subsurface geotechnical/contamination investigations involving drilling/test pitting would be required to enable subdivision design and approval.

For and on behalf of
Network Geotechnics Pty Ltd

Reviewed by

V W de Silva *B.Sc.Eng. MIE Aust, CPEng*
Senior Geotechnical Engineer

R J King *BE (Civil)*
Principal Geotechnical Engineer

Network Geotechnics Pty Ltd

GENERAL NOTES

GENERAL

Geotechnical reports present the results of investigations carried out for a specific project and usually for a specific phase of the project (e.g. preliminary design). The report may not be relevant for other phases of the project (e.g. construction), or where project details change.

SOIL AND ROCK DESCRIPTIONS

Soil and rock descriptions are based on AS 1726 – 1993, using visual and tactile assessment except at discrete locations where field and / or laboratory tests have been carried out. Refer to the terms and symbols sheet for definitions.

GROUNDWATER

The water levels indicated on the logs are taken at the time of measurement and depending on material permeability may not reflect the actual groundwater level at those specific locations. Also, groundwater levels can vary with time due to seasonal or tidal fluctuations and construction activities.

INTERPRETATION OF RESULTS

The discussion and recommendations in the accompanying report are based on extrapolation / interpolation from data obtained at discrete locations. The actual interface between the materials may be far more gradual or abrupt than indicated. Also, actual conditions in areas not sampled may differ from those predicted.

CHANGE IN CONDITIONS

Subsurface conditions can change with time and can vary between test locations. Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations can also affect subsurface conditions.

REPRODUCTION OF REPORTS

This report is the subject of copyright and shall not be reproduced either totally or in part without the express permission of this firm. Where information from the accompanying report is to be included in contract documents or engineering specification for the project, the entire report should be included in order to minimise the likelihood of misinterpretation from logs.

FURTHER ADVICE

Network Geotechnics would be pleased to further discuss how any of the above issues could affect your specific project. We would also be pleased to provide further advice or assistance including:

- assessment of suitability of designs and construction techniques;
- contract documentation and specification;
- construction control testing (earthworks, pavement materials, concrete);
- construction advice (foundation assessments, excavation support).

APPENDIX J

SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

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

APPENDIX A

- **SUMMARY ENGINEERING LOGS (JULY 2005)**

  TP2, TP3, TP4, TP5, TP12, TP13, TP4

- **ENGINEERING LOGS (MARCH 2006)**

  BH101 to BH112

SUMMARY ENGINEERING LOGS

Insight Planning
North Bellbird School Rezoning, Bellbird

Logged by: V De Silva Date: 19/7/05 Equipment: Daewoo Excavator 5.5t 480m

Location	Depth (m)	Description
TP2 AMG Co-ord: 343364E 6365484N	0.0 – 0.15	**TOPSOIL:** (CL) Sandy CLAY, low plasticity, dark grey, M>Wp, firm
	0.15 – 0.8	**ALLUVIUM:** (CL) Sandy CLAY, low plasticity, grey-brown, M>Wp, stiff
	0.8 – 1.2	**ALLUVIUM:** (CH) Sandy CLAY, high plasticity, red-brown mottled grey, M≈Wp, very stiff
		TP2 terminated at 1.2m depth ~ no groundwater encountered
TP3 AMG Co-ord: 343903E 6365290N	0.0 – 0.2	**TOPSOIL:** (CL) Sandy CLAY, low plasticity, dark grey, M>Wp, firm
	0.2 – 1.3	**ALLUVIAL:** (CL) Sandy CLAY, low plasticity, brown, M>Wp, stiff
		TP3 terminated at 1.3m depth ~ no groundwater encountered
TP5 AGS Co-ord: 343763E 6365823N	0.0 – 0.25	**TOPSOIL:** (CL) Silty CLAY, low plasticity, dark grey, M>Wp, firm
	0.25 – 1.2	**ALLUVIAL:** (CI) CLAY, medium plasticity, pale brown, M>Wp, stiff to very stiff
		TP5 terminated at 1.2m depth ~ no groundwater encountered
TP9 AMG Co-ord: 342048E 6364323N	0.0 – 0.3	**SLOPEWASH:** (SC) Clayey SAND, fine to medium grained, brown, moist, medium dense
	0.3 – 0.8	**RESIDUAL:** (CI) Sandy CLAY, medium plasticity, red-brown, fine sand, M<Wp, very stiff
	0.8 – 1.2	**ROCK:** SANDSTONE, red-brown, fine grained, extremely weathered
		TP9 terminated at 1.2m depth ~ no groundwater encountered
TP12 342191E 6364021N	0.0 – 0.3	**SLOPEWASH:** (SM) Silty SAND, fine grained, brown, moist, medium dense
	0.3 – 1.2	**RESIDUAL:** (SC) Clayey SAND, fine grained, brown, moist, dense
		TP12 terminated at 1.2m depth ~ no groundwater encountered

Summary Engineering Logs (cont)

Location	Depth (m)	Description
TP13 AMG Co-ord: 341813E 6364022N	0.0 – 0.35	**TOPSOIL:** (CL) Sandy CLAY, low plasticity, dark grey, M>Wp, firm
	0.35 – 0.9	**RESIDUAL:** (CI) Sandy CLAY, low plasticity, brown, fine sand, M>Wp, very stiff
	0.9 – 1.25	**RESIDUAL:** (CL) Sandy CLAY, low plasticity, brown mottled white/grey, M<Wp, very stiff to hard TP13 terminated at 1.25m depth ~ no groundwater encountered
TP14 AMG Co-ord: 341456E 6363613N	0.0 – 0.35	**SLOPEWASH:** (ML) Sandy SILT, low plasticity, grey, M<Wp, hard
	0.35 – 1.3	**RESIDUAL:** (CL) Sandy CLAY, low plasticity, pale brown, fine sand, M<Wp, hard TP14 terminated at 1.3m depth ~ no groundwater encountered
EXP15A (creek bank) West Lot 2 DP597226	0.0 – 3.0	**ALLUVIUM:** (CL) Sandy CLAY, low plasticity, red brown, fine grained sand, M>Wp
EXP 15B (creek bank) South East Lot 2 DP597226	0.0 - 1.5	**RESIDUAL:** (SC) Clayey SAND, fine to medium grained, red brown, some fine to coarse grained gravel
	1.5 – 3.0	**ROCK:** SANDSTONE fine to coarse grained, red brown, distinctly weathered, low rock strength
HA16 AMG Co-ord: 342374E 6364321N	0.0 – 0.2	**RESIDUAL:** (CL) Sandy CLAY, low plasticity, red brown-brown, fine grained sand HA16 terminated at 0.2m depth ` no groundwater encountered

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G25058/1
Hole No:	**BH101**
Sheet:	PAGE 1 / 1
Started:	10/03/06
Finished:	10/03/06
Logged:	TS
Checked:	VDS
RL Surface:	-
Datum:	-

Client: INSITE PLANNING SERVICES

Project: NORTH BELLBIRD REZONING

Location: BELLBIRD NORTH, CESSNOCK
GPS (341188E 6363977N)

Equipment Type: SKID STEER DRILL RIG

Borehole Diameter: -mm (I D.)100mm (O.D.) Inclination: deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADT	None Encountered.	ES1				SM	Silty SAND fine to medium grained, dark brown, low plasticity fines	M	-	SLOPEWASH
						CL	CLAY medium plasticity, red-brown some grey mottling	>Wp		RESIDUAL
		D								ES2 at 0.5 - 0.7 depth
						CL	Silty Sandy CLAY low to medium plasticity, red/orange-brown mottled grey, fine sand	<Wp		-
		D		1.0						
							Extremely weathered SANDSTONE, fine grained, pale orange-grey	-		ROCK
				2.0			BH101 Terminated at 1.5 m			

BOREHOLE LOG G25058-1.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 25/7/06

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G25058/1
Hole No:	**BH102**
Sheet:	PAGE 1 / 1
Started:	10/03/06
Finished:	10/03/06
Logged:	TS
Checked:	VDS
RL Surface:	-
Datum:	-

Client: INSITE PLANNING SERVICES

Project: NORTH BELLBIRD REZONING

Location: BELLBIRD NORTH, CESSNOCK
GPS (341300E 6364130N)

Equipment Type: SKID STEER DRILL RIG

Borehole Diameter: -mm (I D.)100mm (O.D.) Inclination: deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADT	None Encountered.	ES3				SM	Silty SAND fine to medium grined, dark brown, low plasticity fines	M	-	SLOPEWASH
		D				CL	Silty CLAY medium plasticity, orange-brown mottled grey	>Wp		RESIDUAL ES4 at 0 5 - 0.6 depth
		D		1 0		CL	Silty CLAY medium plasticity, red-brown some grey mottling			
				2 0			BH102 Terminated at 1.5 m			

BOREHOLE LOG G25058-1.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 25/7/06

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G25058/1
Hole No:	**BH103**
Sheet:	PAGE 1 / 1
Started:	10/03/06
Finished:	10/03/06
Logged:	TS
Checked:	VDS
RL Surface:	-
Datum:	-

Client: INSITE PLANNING SERVICES

Project: NORTH BELLBIRD REZONING

Location: BELLBIRD NORTH, CESSNOCK
GPS (341502E 6363987N)

Equipment Type: SKID STEER DRILL RIG

Borehole Diameter: -mm (I D.)100mm (O.D.) Inclination: deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADT	None Encountered.	ES5				SM	Silty SAND fine to medium grained, dark brown, low plasticity fines	M	-	SLOPEWASH ES5 sample at 0.1 - 0.2 depth
		D					Sandy CLAY medium plasticity, red-brown mottled grey, fine to medium sand, trace well rounded pebbles 0.25-0.40m	<Wp		RESIDUAL ES6 sample at 0 6 - 0.7 depth
		ES6								
		D		1 0			Extremely weathered SANDSTONE, red-brown/grey red-brown	M/D		ROCK
				2 0			BH103 Terminated at 1.5 m			

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G25058/1
Hole No:	**BH104**
Sheet:	PAGE 1 / 1
Started:	10/03/06
Finished:	10/03/06
Logged:	TS
Checked:	VDS
RL Surface:	-
Datum:	-

Client: INSITE PLANNING SERVICES

Project: NORTH BELLBIRD REZONING

Location: BELLBIRD NORTH, CESSNOCK
GPS (341407E 6364262N)

Equipment Type: SKID STEER DRILL RIG

Borehole Diameter: -mm (I D.)100mm (O.D.) Inclination: deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADT	None Encountered.					ML	Sandy SILT low plasticity, pale orange-grey, fine sand	<Wp	-	SLOPEWASH
		ES8								
						CL	Silty CLAY medium plasticity, grey-brown mottled red	<Wp		RESIDUAL
		D								
		ES9								
				1 0			Silty Sandy CLAY medium plasticity, pale grey mottled red, fine to medium sand			
		D								
							Extremely weathered SANDSTONE, pale red/yellow-brown	-		ROCK
							BH104 Terminated at 1.5 m			
				2 0						

BOREHOLE LOG G25058-1.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 25/7/06

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G25058/1
Hole No:	**BH105**
Sheet:	PAGE 1 / 1
Started:	10/03/06
Finished:	10/03/06
Logged:	TS
Checked:	VDS
RL Surface:	-
Datum:	-

Client: INSITE PLANNING SERVICES

Project: NORTH BELLBIRD REZONING

Location: BELLBIRD NORTH, CESSNOCK
GPS (341427E 6364482N)

Equipment Type: SKID STEER DRILL RIG

Borehole Diameter: -mm (I D.)100mm (O.D.) Inclination: deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADT	None Encountered.	ES10				ML	Sandy SILT low to medium plasticity, grey-brown, fine sand	<Wp	-	SLOPEWASH
						CL	Sandy CLAY medium plasticity, red-brown mottled grey, increasing grey mottling below 0.7m depth	<Wp		RESIDUAL
		D								ES11 at 0.5 - 0 6 depth
		D		1 0						
							Extremely weathered SANDSTONE	D		ROCK
							BH105 Terminated at 1.5 m			
				2 0						

BOREHOLE LOG G25058-1.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 25/7/06

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G25058/1
Hole No:	**BH106**
Sheet:	PAGE 1 / 1
Started:	10/03/06
Finished:	10/03/06
Logged:	TS
Checked:	VDS
RL Surface:	-
Datum:	-

Client: INSITE PLANNING SERVICES

Project: NORTH BELLBIRD REZONING

Location: BELLBIRD NORTH, CESSNOCK
GPS (341278E 6364427N)

Equipment Type: SKID STEER DRILL RIG

Borehole Diameter: -mm (I D.)100mm (O.D.) Inclination: deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADT	None Encountered.					ML	Sandy SILT low to medium plasticity, grey-brown, fine sand	-	-	SLOPEWASH
		ES12				CL/CH	CLAY medium to high plasticity, red-brown mottled grey	<Wp		RESIDUAL
		D								
		ES13				CL	Silty CLAY medium plasticity, yellow grey-brown mottled red	<Wp		
		D		1.0						
							BH106 Terminated at 1.5 m			
				2.0						

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G25058/1
Hole No:	**BH107**
Sheet:	PAGE 1 / 1
Started:	10/03/06
Finished:	10/03/06
Logged:	TS
Checked:	VDS
RL Surface:	-
Datum:	-

Client: INSITE PLANNING SERVICES

Project: NORTH BELLBIRD REZONING

Location: BELLBIRD NORTH, CESSNOCK
GPS (341170E 6364843N)

Equipment Type: SKID STEER DRILL RIG

Borehole Diameter: -mm (I D.)100mm (O.D.) Inclination: deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADT	None Encountered.	ES14				CL	Silty Sandy CLAY medium plasticity, dark brown, fine to medium sand	>Wp	-	ALLUVIUM
		D								
		ES!5								
		D		1 0						
							BH107 Terminated at 1.5 m			
				2 0						

BOREHOLE LOG G25058-1.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 25/7/06

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G25058/1
Hole No:	**BH108**
Sheet:	PAGE 1 / 1
Started:	10/03/06
Finished:	10/03/06
Logged:	TS
Checked:	VDS
RL Surface:	-
Datum:	-

Client: INSITE PLANNING SERVICES

Project: NORTH BELLBIRD REZONING

Location: BELLBIRD NORTH, CESSNOCK
GPS (341280E 6365043N)

Equipment Type: SKID STEER DRILL RIG

Borehole Diameter: -mm (I D.)100mm (O.D.) Inclination: deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADT	None Encountered.	ES16				ML	Sandy SILT low plasticity, grey-brown, fine to medium sand	M	-	TOPSOIL
						CL/CH	CLAY medium to high plasticity, red-brown some grey mottling increasing with depth	<Wp		RESIDUAL
		D								
		ES17								
				1 0						
		D								
							BH108 Terminated at 1.5 m			
				2 0						

BOREHOLE LOG G25058-1.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 25/7/06

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G25058/1
Hole No:	**BH109**
Sheet:	PAGE 1 / 1
Started:	10/03/06
Finished:	10/03/06
Logged:	TS
Checked:	VDS
RL Surface:	-
Datum:	-

Client: INSITE PLANNING SERVICES

Project: NORTH BELLBIRD REZONING

Location: BELLBIRD NORTH, CESSNOCK
GPS (341644E 6365026N)

Equipment Type: SKID STEER DRILL RIG

Borehole Diameter: -mm (I D.)100mm (O.D.) Inclination: deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADT	None Encountered.	ES18				ML	Sandy SILT low plasticity, brown, fine to medium sand	D/M	-	SLOPEWASH
		D				CL	Sandy CLAY medium plasticity, brown, fine to medium sand	<Wp		RESIDUAL
		ES19				CL/SC	Sandy CLAY/Clayey SAND medium plasticity, brown, fine to medium sand	<Wp		
		D		1 0						
				2 0			BH109 Terminated at 1.5 m			

BOREHOLE LOG G25058-1.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 25/7/06

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G25058/1
Hole No:	**BH110**
Sheet:	PAGE 1 / 1
Started:	10/03/06
Finished:	10/03/06
Logged:	TS
Checked:	VDS
RL Surface:	-
Datum:	-

Client: INSITE PLANNING SERVICES

Project: NORTH BELLBIRD REZONING

Location: BELLBIRD NORTH, CESSNOCK
GPS

Equipment Type: SKID STEER DRILL RIG

Borehole Diameter: -mm (I D.)100mm (O.D.) Inclination: deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADT	None Encountered.	ES20				SC	Clayey SAND fine to medium grained, red-brown, low to medium plasticity fines	D to D/M	-	ALLUVIUM
		D								
		ES21								
		D		1.0						
							BH110 Terminated at 1.5 m			
				2.0						

BOREHOLE LOG G25058-1.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 25/7/06

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G25058/1
Hole No:	**BH111**
Sheet:	PAGE 1 / 1
Started:	10/03/06
Finished:	10/03/06
Logged:	TS
Checked:	VDS
RL Surface:	-
Datum:	-

Client: INSITE PLANNING SERVICES

Project: NORTH BELLBIRD REZONING

Location: BELLBIRD NORTH, CESSNOCK
GPS (341041E 6364601N)

Equipment Type: SKID STEER DRILL RIG

Borehole Diameter: -mm (I D.)100mm (O.D.) Inclination: deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADT	None Encountered.	ES22				SM	Silty SAND fine to medium grained, brown, low plasticity fines	D/M	-	TOPSOIL
						SC	Clayey SAND fine to medium grained, red-brown, low to medium plasticity fines	D/M		ALLUVIUM E23 at 0.5 - 0.6 depth
		D								
				10						
		D								
							Gravelly SAND medium sand, red-brown, medium gravel, trace clay			
							BH111 Terminated at 1.5 m			
				20						

BOREHOLE LOG G25058-1.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 25/7/06

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

BOREHOLE LOG

Network Geotechnics Pty Ltd
ACN 069 211 561
6/6 Morton Close
TUGGERAH NSW 2259
02 4351 6200
02 4351 6300

Job No:	G25058/1
Hole No:	**BH112**
Sheet:	PAGE 1 / 1
Started:	10/03/06
Finished:	10/03/06
Logged:	TS
Checked:	VDS
RL Surface:	-
Datum:	-

Client: INSITE PLANNING SERVICES

Project: NORTH BELLBIRD REZONING

Location: BELLBIRD NORTH, CESSNOCK
GPS (342156E 6364995N)

Equipment Type: SKID STEER DRILL RIG

Borehole Diameter: -mm (I D.)100mm (O.D.) Inclination: deg Bearing:

method	water	samples, tests etc	DCP Blows per 150 mm	depth (m)	graphic log	USCS symbol	Material Description	Moisture condition	Consistency/ relative density	comments / notes, structure, and additional observations
ADT	None Encountered.	ES24				ML/SM	Sandy SILT/Silty SAND fine to medium grained, grey-brown, low plasticity fines	D to <Wp	-	TOPSOIL
		D				CL/CH	Sandy CLAY medium to high plasticity, brown becoming red-brown at 0.7m depth, fine to medium sand	<Wp		RESIDUAL
		ES25								
		D		1 0						
				2 0			BH112 Terminated at 1.5 m			

BOREHOLE LOG G25058-1.GPJ NETWORK GEOTECHNICS PTY LTD.GDT 25/7/06

Refer To Explanation Sheets For Description Of Terms And Symbols Used.

Network Geotechnics Pty Ltd

TERMS AND SYMBOLS

SOIL DESCRIPTIONS

Moisture Condition

D	Dry
M	Moist
W	Wet
Wp	Plastic Limit
Wl	Liquid Limit
MC	Moisture Content

Consistency		Qu (kPa)
VS	Very Soft	<25
S	Soft	25 – 50
F	Firm	50 – 100
St	Stiff	100 – 200
VSt	Very Stiff	200 – 400
H	Hard	>400
Fb	Friable	

Density Index		I_D (%)
VL	Very Loose	< 15
L	Loose	15 – 35
MD	Medium Dense	35 – 65
D	Dense	65 – 85
VD	Very Dense	> 85

ROCK DESCRIPTIONS

Weathering

Rs	Residual Soil
XW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
DW	Distinctly Weathered
SW	Slightly Weathered
FR	Fresh

(DW covers both HW & MW)

Strength		Is (50) MPa
EL	Extremely Low	< 0.03
VL	Very Low	0.03 – 0.1
L	Low	0.1 – 0.3
M	Medium	0.3 – 1
H	High	1 – 3
VH	Very High	3 – 10
EH	Extremely High	> 10

Structure	Spacing
Thinly Laminated	< 6mm
Laminated	6 – 20mm
Very thinly bedded	20 – 60mm
Thinly bedded	60 – 200mm
Medium bedded	0.2 – 0.6m
Thickly bedded	0.6 – 2.0m
Very thickly bedded	> 2.0m

NOTE: Soil And rock descriptions are based on AS 1726 - 1993

Natural Fractures

Type		Shape	
JT	Joint	pl	Planar
BP	Bedding plane	cu	Curved
SM	Seam	un	Undulose
FZ	Fractured zone	st	Stepped
SZ	Shear zone	ir	Irregular
VN	Vein		

Infill or Coating		Roughness	
Cn	Clean	pol	Polished
Cl	Clay	slk	Slickensided
Ca	Calcite	smo	Smooth
Fe	Iron oxide	rou	Rough
Mi	Micaceous	vro	Very rough
Qz	Quartz		

EXCAVATION/DRILLING METHOD AND CASING

BH	Backhoe/excavator bucket
NE	Natural exposure
HE	Hand excavation
AS	Auger Screwing *
AD	Auger Drilling *
R	Roller/Tricone
W	Washbore

** denotes bit shown by suffix*

B	Blank Bit
V	"V" Shaped Bit
T	Tungsten Carbide Bit

NMLC	NMLC Core Drilling
NQ/HQ	Wireline Core Drilling

C	Casing
M	Mud

SAMPLES/TESTS

B	Bulk sample
D	Disturbed sample
U50	Thin-walled tube sample (50mm diameter)
PP	Pocket penetrometer (kPa)
N*	SPT (blows per 300mm)
	**denotes sample taken*
Nc	SPT with solid cone
R	SPT refusal

VANE SHEAR TESTS

s_u	Vane shear strength Peak/residual (kPa) and Vane size (mm)

WATER MEASUREMENTS

▼	Water level
▲–	Water inflow
–▲	Water outflow

APPENDIX B

LABORATORY TEST RESULTS

- **Atterberg Limits – (7 tests)**
- **Emerson Class Number (4 tests)**
- **Textural Classification & Electrical Conductivity (39 tests)**
- **Acid Sulphate Screening Tests**
  Ph in H_2O and H_2O_2 (15 tests)

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

ACN 069 211 561
6/6 Morton Close
Tuggerah NSW 2259 AUSTRALIA
Telephone 61 2 43 516200
Facsimile 61 2 43 516300
Email gosnetgeo@bigpond.com

TEST REPORT

Client:	Insight Planning	**Job No:**	G25058/1	**Sheet:**	1 of 1
Project:	North Bellbird Rezoning Study	**Tested By:**	SW	**Date:**	29/07/2005
Location:	Bellbird	**Checked By:**	SW		

Sample Description:	*(CI) CLAY, medium plasticity, pale brown*	Sample Procedure:	AS1289 1.1-2001 AS1289 1.2.1-1998
Sample Number:	TP5 (0.2 to 0.8m)	Sample History:	Oven Dried
Date Sampled:	19/07/2005	Preparation Method:	Dry Sieved
		Shrinkage Mould Length (mm)	254

ATTERBERG LIMITS & LINEAR SHRINKAGE

TEST PROCEDURE		TEST RESULTS
AS1289 3.1.2-1995 Liquid Limit (W_L)	%	40
AS1289 3.2.1-1995 Plastic Limit (W_P)	%	11
AS1289 3.3.1-1995 Plasticity Index (I_P)	%	29
AS1289 3.4.1-1995 Linear Shrinkage(L_S)	%	10.5

REMARKS:

THE TESTS, CALIBRATIONS OR MEASUREMENTS COVERED BY THIS DOCUMENT HAVE BEEN PERFORMED IN ACCORDANCE WITH NATA REQUIREMENTS WHICH INCLUDE THE REQUIREMENTS OF ISO/IEC 17025 AND ARE TRACEABLE TO NATIONAL STANDARDS OF MEASUREMENTS. THIS DOCUMENT SHALL NOT BE REPRODUCED, EXCEPT IN FULL.
NATA ACCREDITED LABORATORY NUMBER: 1916

APPROVED SIGNATORY
S J WAUGH

DATE 5.9.05

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

ACN 069 211 561
6/6 Morton Close
Tuggerah NSW 2259 AUSTRALIA
Telephone 61 2 43 516200
Facsimile 61 2 43 516300
Email gosnetgeo@bigpond.com

TEST REPORT

Client:	Insight Planning	**Job No:**	G25058/1	**Sheet:**	1 of 1
Project:	North Bellbird Rezoning Study	**Tested By:**	SW	**Date:**	29/07/2005
Location:	Bellbird	**Checked By:**	SW		

Sample Description:	*(CI) Sandy CLAY, medium plasticity, red-brown, fine sand*	Sample Procedure:	AS1289 1.1-2001 AS1289 1.2.1-1998
Sample Number:	**TP9 (0.3 to 0.5m)**	Sample History:	Oven Dried
Date Sampled:	**19/07/2005**	Preparation Method:	Dry Sieved
		Shrinkage Mould Length (mm)	254

ATTERBERG LIMITS & LINEAR SHRINKAGE

TEST PROCEDURE		TEST RESULTS
AS1289 3.1.2-1995 Liquid Limit (W_L)	%	66
AS1289 3.2.1-1995 Plastic Limit (W_P)	%	18
AS1289 3.3.1-1995 Plasticity Index (I_P)	%	48
AS1289 3.4.1-1995 Linear Shrinkage(L_S)	%	16.0

REMARKS:

THE TESTS, CALIBRATIONS OR MEASUREMENTS COVERED BY THIS DOCUMENT HAVE BEEN PERFORMED IN ACCORDANCE WITH NATA REQUIREMENTS WHICH INCLUDE THE REQUIREMENTS OF ISO/IEC 17025 AND ARE TRACEABLE TO NATIONAL STANDARDS OF MEASUREMENTS. THIS DOCUMENT SHALL NOT BE REPRODUCED, EXCEPT IN FULL.
NATA ACCREDITED LABORATORY NUMBER: 1318

APPROVED SIGNATORY
S J WAUGH

DATE 29-7-05

(Document No. R12.3)

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

ACN 069 211 561
6/6 Morton Close
Tuggerah NSW 2259 AUSTRALIA
Telephone 61 2 43 516200
Facsimile 61 2 43 516300
Email gosnetgeo@bigpond.com

TEST REPORT

Client:	Insight Planning	**Job No:**	G25058/1	**Sheet:**	1 of 1
Project:	North Bellbird Rezoning Study	**Tested By:**	SW	**Date:**	29/07/2005
Location:	Bellbird	**Checked By:**	SW		

Sample Description:	***(CL) Sandy CLAY, low plasticity, brown, fine sand***	Sample Procedure:	AS1289 1.1-2001 AS1289 1.2.1-1998
Sample Number:	**TP13 (0.35 to 0.5m)**	Sample History:	Oven Dried
Date Sampled:	**19/07/2005**	Preparation Method:	Dry Sieved
		Shrinkage Mould Length (mm)	253

ATTERBERG LIMITS & LINEAR SHRINKAGE

TEST PROCEDURE		TEST RESULTS
AS1289 3.1.2-1995 Liquid Limit (W_L)	%	49
AS1289 3.2.1-1995 Plastic Limit (W_P)	%	13
AS1289 3.3.1-1995 Plasticity Index (I_P)	%	36
AS1289 3.4.1-1995 Linear Shrinkage(L_S)	%	14.5

REMARKS:

THE TESTS, CALIBRATIONS OR MEASUREMENTS COVERED BY THIS DOCUMENT HAVE BEEN PERFORMED IN ACCORDANCE WITH NATA REQUIREMENTS WHICH INCLUDE THE REQUIREMENTS OF ISO/IEC 17025 AND ARE TRACEABLE TO NATIONAL STANDARDS OF MEASUREMENTS. THIS DOCUMENT SHALL NOT BE REPRODUCED, EXCEPT IN FULL.
NATA ACCREDITED LABORATORY NUMBER: 1318

APPROVED SIGNATORY
S J WAUGH

DATE 5.9.05

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

ACN 009 271 561
Unit 1/140 Industrial Road
Oak Flats NSW 2529 AUSTRALIA
Telephone 61 2 4257 4458
Facsimile 61 2 4257 4463
Email wolnetgeo@bigpond.com

TEST REPORT

Client:	Insite Planning	**Job No:**	G25058/1	**Sheet:**	1 of 1
Principal:	Johnson Property Group Pty Ltd				
Project:	North Bellbird Rezoning	**Tested By:**	JM	**Date:**	20.3.06
Location:	North Bellbird, Cessnock	**Checked By:**	JD	**Date:**	21.3.06

Sample Description:	*CLAY, medium plasticity, red brown some grey mottling*	Sample Procuedure:	AS1289.1.2.1-1998 (6.5.3 Power Auger Drilling)
Sample Number:	BH101 (0.5m to 0.7m depth)	Sample History:	oven dried
Date Sampled:	10.3.06	Preparation Method:	dry sieved
Client Number:	-	Shrinkage Mould Length (mm)	-

ATTERBERG LIMITS & LINEAR SHRINKAGE

TEST PROCEDURE		TEST RESULTS
Liquid Limit (W_L) AS1289 3.1.1-1995	%	46
Plastic Limit (W_P) AS1289 3.2.1-1995	%	19
Plasticity Index (I_P) AS1289 3.3.1-1995	%	27
Linear Shrinkage(L_S) AS1289 3.4.1-1995	%	-

REMARKS:

NATA ACCREDITED FOR TECHNICAL COMPETENCE

THE TESTS, CALIBRATIONS OR MEASUREMENTS COVERED BY THIS DOCUMENT HAVE BEEN PERFORMED IN ACCORDANCE WITH NATA REQUIREMENTS WHICH INCLUDE THE REQUIREMENTS OF ISO/IEC 17025 AND ARE TRACEABLE TO NATIONAL STANDARDS OF MEASUREMENTS. THIS DOCUMENT SHALL NOT BE REPRODUCED, EXCEPT IN FULL.
NATA ACCREDITED LABORATORY NUMBER: 1316

APPROVED SIGNATORY
J.L. Davies

23.3.06
DATE

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

ACN 069 271 561
Unit 1/140 Industrial Road
Oak Flats NSW 2529 AUSTRALIA
Telephone 61 2 4257 4458
Facsimile 61 2 4257 4463
Email wolnetgeo@bigpond.com

TEST REPORT

Client:	Insite Planning	**Job No:**	G25068/1	**Sheet:**	1 of 1
Principal:	Johnson Property Group Pty Ltd				
Project:	North Bellbird Rezoning	**Tested By:**	JM	**Date:**	20.3.06
Location:	North Bellbird, Cessnock	**Checked By:**	JD	**Date:**	21.3.06

Sample Description:	*Silty CLAY, medium plasticity, grey brown mottled red*	Sample Procuedure:	AS1289.1.2.1-1998 (6.5.3 Power Auger Drilling)
Sample Number:	BH104 (0.3m to 0.5m depth)	Sample History:	oven dried
Date Sampled:	10.3.06	Preparation Method:	dry sieved
Client Number:	-	Shrinkage Mould Length (mm)	-

ATTERBERG LIMITS & LINEAR SHRINKAGE

TEST PROCEDURE		TEST RESULTS
Liquid Limit (W_L) AS1289 3.1.1-1995	%	50
Plastic Limit (W_P) AS1289 3.2.1-1995	%	20
Plasticity Index (I_P) AS1289 3.3.1-1995	%	30
Linear Shrinkage(L_S) AS1289 3.4.1-1995	%	-

REMARKS:

NATA ACCREDITED FOR TECHNICAL COMPETENCE

THE TESTS, CALIBRATIONS OR MEASUREMENTS COVERED BY THIS DOCUMENT HAVE BEEN PERFORMED IN ACCORDANCE WITH NATA REQUIREMENTS WHICH INCLUDE THE REQUIREMENTS OF ISO/IEC 17025 AND ARE TRACEABLE TO NATIONAL STANDARDS OF MEASUREMENTS. THIS DOCUMENT SHALL NOT BE REPRODUCED, EXCEPT IN FULL.
NATA ACCREDITED LABORATORY NUMBER: 1318

APPROVED SIGNATORY
J.L. Davies

23.3.06
DATE

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

Unit 1/140 Industrial Road
Oak Flats NSW 2529 AUSTRALIA
Telephone 61 2 4257 4458
Facsimile 61 2 4257 4463
Email wolnetgeo@bigpond.com

TEST REPORT

Client:	Insite Planning	**Job No:**	G25058/1	**Sheet:**	1 of 1
Principal:	Johnson Property Group Pty Ltd				
Project:	North Bellbird Rezoning	**Tested By:**	JM	**Date:**	20.3.06
Location:	North Bellbird, Cessnock	**Checked By:**	JD	**Date:**	21.3.06

Sample Description:	*CLAY, high plasticity, red brown some grey mottling*	Sample Procuedure:	AS1289.1.2.1-1998 (6.5.3 Power Auger Drilling)
Sample Number:	BH108 (1.0m to 1.2m depth)	Sample History:	oven dried
Date Sampled:	10.3.06	Preparation Method:	dry sieved
Client Number:	-	Shrinkage Mould Length (mm)	-

ATTERBERG LIMITS & LINEAR SHRINKAGE

TEST PROCEDURE		TEST RESULTS
Liquid Limit (W_L) AS1289 3.1.1-1995	%	65
Plastic Limit (W_P) AS1289 3.2.1-1995	%	25
Plasticity Index (I_P) AS1289 3.3.1-1995	%	40
Linear Shrinkage(L_S) AS1289 3.4.1-1995	%	-

REMARKS:

NATA ACCREDITED FOR TECHNICAL COMPETENCE

THE TESTS, CALIBRATIONS OR MEASUREMENTS COVERED BY THIS DOCUMENT HAVE BEEN PERFORMED IN ACCORDANCE WITH NATA REQUIREMENTS WHICH INCLUDE THE REQUIREMENTS OF ISO/IEC 17025 AND ARE TRACEABLE TO NATIONAL STANDARDS OF MEASUREMENTS. THIS DOCUMENT SHALL NOT BE REPRODUCED, EXCEPT IN FULL.
NATA ACCREDITED LABORATORY NUMBER: 1818

APPROVED SIGNATORY
J.L. Davies

23.3.06
DATE

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

ACN 089 211 561
Unit 1/140 Industrial Road
Oak Flats NSW 2529 AUSTRALIA
Telephone 61 2 4257 4458
Facsimile 61 2 4257 4463
Email wolnetgeo@bigpond.com

TEST REPORT

Client:	Insite Planning	**Job No:**	G25058/1	**Sheet:**	1 of 1
Principal:	Johnson Property Group Pty Ltd				
Project:	North Bellbird Rezoning	**Tested By:**	JM	**Date:**	20.3.06
Location:	North Bellbird, Cessnock	**Checked By:**	JD	**Date:**	21.3.06

Sample Description:	*Clayey SAND, fine to medium grained, red brown, low plasticity fines*	Sample Procuedure:	AS1289.1.2.1-1998 (6.5.3 Power Auger Drilling)
Sample Number:	BH110 (0.3m to 0.5m depth)	Sample History:	oven dried
Date Sampled:	10.3.06	Preparation Method:	dry sieved
Client Number:	-	Shrinkage Mould Length (mm)	-

ATTERBERG LIMITS & LINEAR SHRINKAGE

TEST PROCEDURE		TEST RESULTS
Liquid Limit (W_L) AS1289 3.1.1-1995	%	44
Plastic Limit (W_P) AS1289 3.2.1-1995	%	22
Plasticity Index (I_P) AS1289 3.3.1-1995	%	22
Linear Shrinkage(L_S) AS1289 3.4.1-1995	%	-

REMARKS:

NATA ACCREDITED FOR TECHNICAL COMPETENCE

THE TESTS, CALIBRATIONS OR MEASUREMENTS COVERED BY THIS DOCUMENT HAVE BEEN PERFORMED IN ACCORDANCE WITH NATA REQUIREMENTS WHICH INCLUDE THE REQUIREMENTS OF ISO/IEC 17025 AND ARE TRACEABLE TO NATIONAL STANDARDS OF MEASUREMENTS. THIS DOCUMENT SHALL NOT BE REPRODUCED, EXCEPT IN FULL.
NATA ACCREDITED LABORATORY NUMBER: 1318

APPROVED SIGNATORY
J.L. Davies

23.3.06
DATE

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

Unit 1/140 Industrial Road
Oak Flats NSW 2529 AUSTRALIA
Telephone 61 2 4257 4458
Facsimile 61 2 4257 4463
Email wolnetgeo@bigpond.com

TEST REPORT

Client:	Insite Planning	**Job No:**	G25058/1	**Sheet:**	1 of 1
Principal:	Johnson Property Group Pty Ltd				
Project:	North Bellbird Rezoning	**Tested By:**	JM	**Date:**	21.3.06
Location:	North Bellbird, Cessnock	**Checked By:**	JD	**Date:**	21.3.06

Sample Description:	*CLAY, medium plasticity, red brown some grey mottling*	Sample Procedure:	AS1289.1.2.1-1998 (6.6.3 Power Auger Drilling)
Sample Number:	BH101 (0.5m to 0.7m depth)		
Date Sampled by Client:	10.3.06		
Client Number:	-		

EMERSON CRUMB - AS1289 3.8.1 (1997)

TEST PROCEDURE	TEST RESULTS
Emerson Class No	Class 1

REMARKS:

APPROVED SIGNATORY
J.L. Davies

23-3-06
DATE

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

ACN 003 211 031
Unit 1/140 Industrial Road
Oak Flats NSW 2529 AUSTRALIA
Telephone 61 2 4257 4458
Facsimile 61 2 4257 4463
Email wolnetgeo@bigpond.com

TEST REPORT

Client:	Insite Planning	**Job No:**	G25058/1	**Sheet:**	1 of 1
Principal:	Johnson Property Group Pty Ltd				
Project:	North Bellbird Rezoning	**Tested By:**	JM	**Date:**	21.3.06
Location:	North Bellbird, Cessnock	**Checked By:**	JD	**Date:**	21.3.06

Sample Description:	*Silty CLAY, medium plasticity, grey brown mottled red*	Sample Procedure:	AS1289.1.2.1-1998 (6.5.3 Power Auger Drilling)
Sample Number:	BH104 (0.3m to 0.5m depth)		
Date Sampled by Client:	10.3.06		
Client Number:	-		

EMERSON CRUMB - AS1289 3.8.1 (1997)

TEST PROCEDURE	TEST RESULTS
Emerson Class No	Class 6

REMARKS:

APPROVED SIGNATORY J.L. Davies

23-06
DATE

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

Unit 1/140 Industrial Road
Oak Flats NSW 2529 AUSTRALIA
Telephone 61 2 4257 4458
Facsimile 61 2 4257 4463
Email wolnetgeo@bigpond.com

TEST REPORT

Client:	Insite Planning	**Job No:**	G25058/1	**Sheet:**	1 of 1
Principal:	Johnson Property Group Pty Ltd				
Project:	North Bellbird Rezoning	**Tested By:**	JM	**Date:**	21.3.06
Location:	North Bellbird, Cessnock	**Checked By:**	JD	**Date:**	21.3.06

Sample Description:	*CLAY, high plasticity, red brown some grey mottling*	Sample Procedure:	AS1289.1.2.1-1998 (6.5.3 Power Auger Drilling)
Sample Number:	BH108 (1.0m to 1.2m depth)		
Date Sampled by Client:	10.3.06		
Client Number:	-		

EMERSON CRUMB - AS1289 3.8.1 (1997)

TEST PROCEDURE	TEST RESULTS
Emerson Class No	Class 6

REMARKS:

APPROVED SIGNATORY
J.L. Davies

23-5-06
DATE

Network Geotechnics Pty Ltd
Geotechnical Engineering, Consulting & Testing Services

ACN 069 211 561
Unit 1/140 Industrial Road
Oak Flats NSW 2529 AUSTRALIA
Telephone 61 2 4257 4459
Facsimile 61 2 4257 4463
Email wolnetgeo@bigpond.com

TEST REPORT

Client:	Insite Planning	**Job No:**	G25058/1	**Sheet:**	1 of 1
Principal:	Johnson Property Group Pty Ltd				
Project:	North Bellbird Rezoning	**Tested By:**	JM	**Date:**	21.3.06
Location:	North Bellbird, Cessnock	**Checked By:**	JD	**Date:**	21.3.06

Sample Description:	*Clayey SAND, fine to medium grained, red brown, low plasticity fines*	Sample Procedure:	AS1289.1.2.1-1998 (6.5.3 Power Auger Drilling)
Sample Number:	BH110 (0.3m to 0.5m depth)		
Date Sampled by Client:	10.3.06		
Client Number:	-		

EMERSON CRUMB - AS1289 3.8.1 (1997)

TEST PROCEDURE	TEST RESULTS
Emerson Class No	Class 3

REMARKS:

APPROVED SIGNATORY
J.L. Davies

23.3.06
DATE

INSITE PLANNING
NORTH BELLBIRD REZONING STUDY

Electrical Conductivity (Ec), Textural Classification and Acid Sulphate Screening Test Results (cont)

Job No: G25058/1
Sampled: 10-15 March 2006
Tested by: TS
Checked by: VdS
Date: 21/03/06

Location	Depth (m)		Textural Classification	Factor	EC	ECe	Salinity Rating		*pH 4.5
	From	To						pH in H_2O	pH in H_2O_2
BH101	0.5	0.7	light medium clay	8	0.3	2.4	SS		
	0.8	1.0	light medium clay	8	0.2	1.6	NS		
BH102	0.3	0.5	light medium clay	8	0.4	3.2	SS		
	0.9	1.1	light medium clay	8	0.6	4.8	MS		
BH103	0.4	0.6	light medium clay	8	0.1	0.8	NS		
	0.8	1.0	light medium clay	8	0.1	0.8	NS		
BH104	0.3	0.5	light medium clay	8	0.4	3.2	SS		
	1.1	1.3	medium clay	7	0.3	2.1	SS		
BH105	0.4	0.6	light medium clay	8	0.1	0.8	NS		
	1.0	1.2	light medium clay	8	0.2	1.6	NS		
BH106	0.3	0.5	light medium clay	8	0.3	2.4	SS		
	1.1	1.3	medium clay	7	0.2	1.4	NS		
BH107	0.4	0.6	sandy loam	10	0.9	9.0	HS	5.6	6.2
	1.0	1.2	sandy loam	10	0.3	3.0	SS	6.0	5.6
BH108	0.4	0.6	light medium clay	8	0.2	1.6	NS		
	1.0	1.2	light medium clay	8	0.4	3.2	SS		

INSITE PLANNING
NORTH BELLBIRD REZONING STUDY

Electrical Conductivity (Ec), Textural Classification and Acid Sulphate Screening Test Results

Job No: G25058/1
Sampled: 10-15 March 2006
Tested by: TS
Checked by: VdS
Date: 21/03/06

BH109	0.3	0.5	clay loam	9	0.1	0.9	NS	5.6	4.6
	0.9	1.1	clay loam	9	0.5	4.5	MS	5.6	5.4
BH110	0.3	0.5	clay loam	9	0.1	0.9	NS	6.1	5.1
	0.9	1.1	sandy clay	9	0.1	0.9	NS	6.1	6.2
BH111	0.4	0.6	sandy clay	9	0.1	0.9	NS	5.1	5.3
	1.1	1.3	sandy clay	9	0.1	0.9	NS	5.4	5.5
BH112	0.3	0.5	light medium clay	8	0.4	3.2	SS		
	0.8	1.0	light medium clay	8	0.5	4.0	MS		
SAL1			silt loam	10	0.0	0.0	NS	7.8	4.9
SAL2			silt loam	10	0.1	1.0	NS	7.1	5.8
SAL3			sandy clay	9	1.7	15.3	HS	6.4	2.6

INSITE PLANNING
North Bellbird Rezoning Study
Salinity and Textural Classifications

Job No: G25058/1
Tested by: TS
Checked: VdS
Date: 26/07/05

Location	Depth (m)	Textural Classification	Factor	EC	ECe	Salinity Rating
TP 2	0.3-0.5	sandy clay	9	0.9	8.1	High
TP 2	0.8-1.2	silty clay	9	1.1	9.9	High
TP3	0.3-0.5	sandy clay loam	10	0	0	None
TP3	0.8-1.0	silty clay	9	0.1	0.9	None
TP5	0.2-0.8	silty clay	9	0.5	4.5	Moderate
TP9	0.3-0.5	light medium clay	8	0.1	0.8	None
TP9	0.8-1.2	sandy clay	9	0.2	1.8	None
TP12	0.8-1.2	sandy clay	9	0.7	6.3	Moderate
TP13	0.35-0.5	silty clay	9	0.1	0.9	None
TP13	0.9-1.2	sandy clay	10	0.4	4	Moderate
TP14	0.0-0.5	silty clay	9	0.4	3.6	Slight
TP14	0.5-1.0	silty clay	9	0.9	8.1	High

INSITE PLANNING
North Bellbird Rezoning Study
Acid Sulphate Screening Tests

Job No: G25058/1
Tested by: TS
Checked: VdS
Date: 26/07/05

Location	Depth	Ph in H_2O	Ph in H_2O_2
TP3	0.3-0.5	8.0	4.9
TP2	0.3-0.5	5.4	4.1
TP5	0.2-0.5	5.7	4.9

Note:

1. Ph measured in 1:5 soil water mixture using a TDS Scan 4 meter.
2. Ph in H_2O >3 and Ph in H_2O_2 >3 would not be regarded as actual acid sulphate soils or potential acid sulphate soils.

APPENDIX C

CONTAMINATION TEST RESULTS

- **Sampled on 19/7/2005 Chain of Custody 019653**

  - **Soil: Metal 8 discrete samples**
    TPH/BTEX, PAH 2 discrete samples

  - **Water: Metals 3 tests**
    OC/OP/PCB 2 tests
    TPH/BTEX, PAH 1 test

- **Sampled on 10/03/2006 Chain of Custody 008305**

  - **Soil: Metals 6 composites (18 discrete)**
    OC/OP/PCB 4 composite (12 discrete) and 1 discrete

  - **Asbestos: 1 discrete**

- **Sampled on 14/03/2006 Chain of Custody 008307**

  - **Soil: Metals 1 discrete 3 composites (each 3 discrete)**
    OC/OP/PCB 2 discrete 3 composites (each 3 discrete)
    includes one field duplicate ES37 duplicate of ES34

  - **Water: Metals 5 tests**
    TPH/BTEX 3 tests
    OC/OP/PCB 4 tests
    (include one duplicate of WS3)

ALS Environmental

CERTIFICATE OF ANALYSIS

Client	:	**NETWORK GEOTECHNICS PTY LTD**	**Laboratory**	:	ALS Environmental Sydney	**Page**	: **1 of 14**
Contact	:	MR VIPUL DE SILVA	**Contact**	:	Greg Vogel		
Address	:	6/6 MORTON CLOSE TUGGERAH NSW AUSTRALIA 2259	**Address**	:	277-289 Woodpark Road Smithfield NSW Australia 2164	**Work order**	: **ES0506034**
Project	:	G25058/1	**Quote number**	:	SY/405/02	**Date received**	: 20 Jul 2005
Order number	:	- Not provided -				**Date issued**	: 31 Jul 2005
C-O-C number	:	019653					
Site	:	- Not provided -					
E-mail	:	gosnetgeo@bigpond.com	**E-mail**	:	Greg.Vogel@alsenviro.com	**No. of samples**	
Telephone	:	02 4351 6200	**Telephone**	:	61-2-87848555	**Received**	: 13
Facsimile	:	02 4351 6300	**Facsimile**	:	61-2-87848500	**Analysed**	: 12

This final report for the ALSE work order reference ES0506034 supersedes any previous reports with this reference.
Results apply to the samples as submitted. All pages of this report have been checked and approved for release.
This report contains the following information:

- Analytical results for samples submitted
- Surrogate control limits

Work order specific comments

Insufficient samples 13 and 12-Dam has been provided for standard analysisof EP068. Where applicable LOR values have been adjusted accordingly.

ALSE - Excellence in Analytical Testing

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory - 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

This document has been digitally signed by those names that appear on this report and are the authorised signatories. Digital signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Daniel Um	Organics - NATA 10911 (Sydney)
Peter Dickenson	Inorganics - NATA 10911 (Sydney)

ALS Environmental

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits).
Abbreviations: ***CAS number*** = *Chemical Abstract Services number*, ***LOR*** = *Limit of Reporting*. ***# Indicates a raised LOR, * Indicates failed Surrogate Recoveries.***
When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes.

Analytical Results

				Client Sample ID :	2	3	5	9	12
				Sample Matrix Type / Description :	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL
				Sample Date / Time :	19 Jul 2005 15:00	19 Jul 2005 15:00	19 Jul 2005 15:00	19 Jul 2005 15 00	19 Jul 2005 15:00
				Laboratory Sample ID :	ES0506034-004	ES0506034-005	ES0506034-006	ES0506034-007	ES0506034-008
Analyte	*CAS number*	*LOR*	*Units*						
EA055: Moisture Content									
Moisture Content (dried @ 103°C)		1.0	%		17.9	17.1	17.2	6.7	5.3
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		10	<5	<5	<5	<5
Barium	7440-39-3	10	mg/kg		140	50	40	20	----
Beryllium	7440-41-7	1	mg/kg		<1	<1	<1	<1	----
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		24	16	10	11	7
Cobalt	7440-48-4	2	mg/kg		2	11	<2	2	----
Copper	7440-50-8	5	mg/kg		6	6	<5	<5	<5
Lead	7439-92-1	5	mg/kg		18	12	7	7	8
Manganese	7439-96-5	5	mg/kg		71	680	13	11	----
Nickel	7440-02-0	2	mg/kg		3	6	3	3	2
Vanadium	7440-62-2	5	mg/kg		144	41	39	20	----
Zinc	7440-66-6	5	mg/kg		12	20	<5	9	8
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	<0.1	<0.1	<0.1
EP066: Polychlorinated Biphenyls (PCB)									
Total Polychlorinated biphenyls		0.10	mg/kg		<0.10	----	----	<0.10	<0.10
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.05	mg/kg		<0.05	----	----	<0.05	<0.05
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg		<0.05	----	----	<0.05	<0.05
beta-BHC	319-85-7	0.05	mg/kg		<0.05	----	----	<0.05	<0.05
gamma-BHC	58-89-9	0.05	mg/kg		<0.05	----	----	<0.05	<0.05
delta-BHC	319-86-8	0.05	mg/kg		<0.05	----	----	<0.05	<0.05
Heptachlor	76-44-8	0.05	mg/kg		<0.05	----	----	<0.05	<0.05
Aldrin	309-00-2	0.05	mg/kg		<0.05	----	----	<0.05	<0.05
Heptachlor epoxide	1024 57 3	0 05	mg/kg		0 05			0 05	0 05
trans-Chlordane	5103-74-2	0.05	mg/kg		<0.05	----	----	<0.05	<0.05
alpha-Endosulfan	959-98-8	0.05	mg/kg		<0.05	----	----	<0.05	<0.05
cis-Chlordane	5103-71-9	0.05	mg/kg		<0.05	----	----	<0.05	<0.05
Dieldrin	60-57-1	0.05	mg/kg		<0.05	----	----	<0.05	<0.05
4,4'-DDE	72-55-9	0.05	mg/kg		<0.05	----	----	<0.05	<0.05

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: 2	3	5	9	12
Sample Matrix Type / Description				SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL
Sample Date / Time				19 Jul 2005 15:00	19 Jul 2005 15:00	19 Jul 2005 15:00	19 Jul 2005 15 00	19 Jul 2005 15:00
Laboratory Sample ID				ES0506034-004	ES0506034-005	ES0506034-006	ES0506034-007	ES0506034-008
EP068A: Organochlorine Pesticides (OC)								
Endrin	72-20-8	0.05	mg/kg	<0.05	----	----	<0.05	<0.05
beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	----	----	<0.05	<0.05
4,4'-DDD	72-54-8	0.05	mg/kg	<0.05	----	----	<0.05	<0.05
Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	----	----	<0.05	<0.05
Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	----	----	<0.05	<0.05
4,4'-DDT	50-29-3	0.2	mg/kg	<0.2	----	----	<0.2	----
4,4'-DDT	50-29-3	0.2	mg/kg	----	----	----	----	<0.2
Endrin ketone	53494 70 5	0 05	mg/kg	0 05			0 05	0 05
Methoxychlor	72-43-5	0.2	mg/kg	<0.2	----	----	<0.2	----
Methoxychlor	72-43-5	0.2	mg/kg	----	----	----	----	<0.2
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.05	mg/kg	<0.05	----	----	<0.05	----
Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	----	----	<0.05	----
Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	----	----	<0.2	----
Dimethoate	60-51-5	0.05	mg/kg	<0.05	----	----	<0.05	----
Diazinon	333-41-5	0.05	mg/kg	<0.05	----	----	<0.05	----
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	----	----	<0.05	----
Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	----	----	<0.2	----
Malathion	121-75-5	0.05	mg/kg	<0.05	----	----	<0.05	----
Fenthion	55-38-9	0.05	mg/kg	<0.05	----	----	<0.05	----
Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	----	----	<0.05	----
Parathion	56-38-2	0.2	mg/kg	<0.2	----	----	<0.2	----
Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	----	----	<0.05	----
Chlorfenvinphos	470 90 6	0 05	mg/kg	0 05			0 05	
Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	----	----	<0.05	----
Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	----	----	<0.05	----
Prothiofos	34643-46-4	0.05	mg/kg	<0.05	----	----	<0.05	----
Ethion	563-12-2	0.05	mg/kg	<0.05	----	----	<0.05	----
Carbophenothion	786-19-6	0.05	mg/kg	<0.05	----	----	<0.05	----
Methyl Azinphos	86-50-0	0.05	mg/kg	<0.05	----	----	<0.05	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	0.5	mg/kg	----	----	----	----	<0.5
Acenaphthylene	208-96-8	0.5	mg/kg	----	----	----	----	<0.5
Acenaphthene	83-32-9	0.5	mg/kg	----	----	----	----	<0.5
Fluorene	86-73-7	0.5	mg/kg	----	----	----	----	<0.5
Phenanthrene	85-01-8	0.5	mg/kg	----	----	----	----	<0.5

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: 2	3	5	9	12
Sample Matrix Type / Description				SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL
Sample Date / Time				19 Jul 2005 15:00	19 Jul 2005 15:00	19 Jul 2005 15:00	19 Jul 2005 15 00	19 Jul 2005 15:00
Laboratory Sample ID				ES0506034-004	ES0506034-005	ES0506034-006	ES0506034-007	ES0506034-008
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Anthracene	120-12-7	0.5	mg/kg	----	----	----	----	<0.5
Fluoranthene	206-44-0	0.5	mg/kg	----	----	----	----	<0.5
Pyrene	129-00-0	0.5	mg/kg	----	----	----	----	<0.5
Benz(a)anthracene	56-55-3	0.5	mg/kg	----	----	----	----	<0.5
Chrysene	218-01-9	0.5	mg/kg	----	----	----	----	<0.5
Benzo(b)fluoranthene	205-99-2	0.5	mg/kg	----	----	----	----	<0.5
Benzo(k)fluoranthene	207-08-9	0.5	mg/kg	----	----	----	----	<0.5
Benzo(a)pyrene	50 32 8	0 5	mg/kg					0 5
Indeno(1,2,3,cd)pyrene	193-39-5	0.5	mg/kg	----	----	----	----	<0.5
Dibenz(a,h)anthracene	53-70-3	0.5	mg/kg	----	----	----	----	<0.5
Benzo(g,h,i)perylene	191-24-2	0.5	mg/kg	----	----	----	----	<0.5
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction		2	mg/kg	----	----	----	----	<2
C10 - C14 Fraction		50	mg/kg	----	----	----	----	<50
C15 - C28 Fraction		100	mg/kg	----	----	----	----	<100
C29 - C36 Fraction		100	mg/kg	----	----	----	----	<100
EP080: BTEX								
Benzene	71-43-2	0.2	mg/kg	----	----	----	----	<0.2
Toluene	108-88-3	0.2	mg/kg	----	----	----	----	<0.2
Ethylbenzene	100 41 4	0 2	mg/kg					0 2
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg	----	----	----	----	<0.2
ortho-Xylene	95-47-6	0.2	mg/kg	----	----	----	----	<0.2
EP066S: PCB Surrogate								
Decachlorobiphenyl	2051-24-3	0.1	%	60.8	----	----	65.2	66.1
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE		0.1	%	108	----	----	88.8	102
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78 48 8	0 1	%	105			98 5	108
EP075(SIM)S: Phenolic Compound Surrogates								
2-Fluorophenol	367-12-4	0.1	%	----	----	----	----	92.0
Phenol-d6	13127-88-3	0.1	%	----	----	----	----	78.0
2-Chlorophenol-D4	93951-73-6	0.1	%	----	----	----	----	84.7
2,4,6-Tribromophenol	118-79-6	0.1	%	----	----	----	----	115
EP075(SIM)T PAH Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	----	----	----	----	98.0
Anthracene-d10	1719-06-8	0.1	%	----	----	----	----	106

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: 2	3	5	9	12
Sample Matrix Type / Description				SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL
Sample Date / Time				19 Jul 2005 15:00	19 Jul 2005 15:00	19 Jul 2005 15:00	19 Jul 2005 15 00	19 Jul 2005 15:00
Laboratory Sample ID				ES0506034-004	ES0506034-005	ES0506034-006	ES0506034-007	ES0506034-008
EP075(SIM)T: PAH Surrogates								
4-Terphenyl-d14	1718-51-0	0.1	%	----	----	----	----	96.8
EP080S: TPH(V)/BTEX Surrogates								
1,2-Dichloroethane-D4	17060-07-0	0.1	%	----	----	----	----	97.2
Toluene D8	2037 26-5	0 1	%					109
4-Bromofluorobenzene	460-00-4	0.1	%	----	----	----	----	100

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: 13	14	16		
Sample Matrix Type / Description				SOIL / SOIL	SOIL / SOIL	SOIL / SOIL		
Sample Date / Time				19 Jul 2005 15:00	19 Jul 2005 15:00	19 Jul 2005 15:00		
Laboratory Sample ID				ES0506034-009	ES0506034-010	ES0506034-011		
EA055: Moisture Content								
Moisture Content (dried @ 103°C)		1.0	%	17.7	4.6	9.7		
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	10	<5	9		
Barium	7440 39-3	10	mg/kg	80	20			
Beryllium	7440-41-7	1	mg/kg	1	<1	----		
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1		
Chromium	7440-47-3	2	mg/kg	19	7	19		
Cobalt	7440-48-4	2	mg/kg	5	<2	----		
Copper	7440-50-8	5	mg/kg	<5	<5	6		
Lead	7439-92-1	5	mg/kg	16	9	15		
Manganese	7439-96-5	5	mg/kg	59	20	----		
Nickel	7440-02-0	2	mg/kg	7	<2	7		
Vanadium	7440-62-2	5	mg/kg	71	42	----		
Zinc	7440-66-6	5	mg/kg	16	7	178		
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1		
EP066: Polychlorinated Biphenyls (PCB)								
Total Polychlorinated biphenyls		0.10	mg/kg	----	<0.10	<0.10		
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	----	<0.05	<0.05		
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	----	<0.05	<0.05		
beta-BHC	319-85-7	0.05	mg/kg	----	<0.05	<0.05		
gamma-BHC	58-89-9	0.05	mg/kg	----	<0.05	<0.05		
delta-BHC	319-86-8	0.05	mg/kg	----	<0.05	<0.05		
Heptachlor	76-44-8	0.05	mg/kg	----	<0.05	<0.05		
Aldrin	309-00-2	0.05	mg/kg	----	<0.05	<0.05		
Heptachlor epoxide	1024-57-3	0.05	mg/kg	----	<0.05	<0.05		
trans-Chlordane	5103-74-2	0.05	mg/kg	----	<0.05	<0.05		
alpha-Endosulfan	959-98-8	0.05	mg/kg	----	<0.05	<0.05		
cis-Chlordane	5103-71-9	0.05	mg/kg	----	<0.05	<0.05		
Dieldrin	60-57-1	0.05	mg/kg	----	<0.05	<0.05		
4,4' DDE	72 55 9	0 05	mg/kg		0 05	0 05		
Endrin	72-20-8	0.05	mg/kg	----	<0.05	<0.05		
beta-Endosulfan	33213-65-9	0.05	mg/kg	----	<0.05	<0.05		
4,4'-DDD	72-54-8	0.05	mg/kg	----	<0.05	<0.05		
Endrin aldehyde	7421-93-4	0.05	mg/kg	----	<0.05	<0.05		

ALS Environmental

Analytical Results

				Client Sample ID :	13	14	16		
				Sample Matrix Type / Description :	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL		
				Sample Date / Time :	19 Jul 2005 15:00	19 Jul 2005 15:00	19 Jul 2005 15:00		
				Laboratory Sample ID :	ES0506034-009	ES0506034-010	ES0506034-011		
Analyte	*CAS number*	*LOR*	*Units*						
EP068A: Organochlorine Pesticides (OC)									
Endosulfan sulfate	1031-07-8	0.05	mg/kg	----	<0.05	<0.05			
4,4'-DDT	50-29-3	0.2	mg/kg	----	<0.2	----			
4,4'-DDT	50-29-3	0.2	mg/kg	----	----	<0.2			
Endrin ketone	53494-70-5	0.05	mg/kg	----	<0.05	<0.05			
Methoxychlor	72-43-5	0.2	mg/kg	----	<0.2	----			
Methoxychlor	72-43-5	0.2	mg/kg	----	----	<0.2			
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.05	mg/kg	----	<0.05	----			
Demeton-S-methyl	919-86-8	0.05	mg/kg	----	<0.05	----			
Monocrotophos	6923-22-4	0.2	mg/kg	----	<0.2	----			
Dimethoate	60-51-5	0.05	mg/kg	----	<0.05	----			
Diazinon	333-41-5	0.05	mg/kg	----	<0.05	----			
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	----	<0.05	----			
Parathion-methyl	298-00-0	0.2	mg/kg	----	<0.2	----			
Malathion	121-75-5	0.05	mg/kg	----	<0.05	----			
Fenthion	55-38-9	0.05	mg/kg	----	<0.05	----			
Chlorpyrifos	2921-88-2	0.05	mg/kg	----	<0.05	----			
Parathion	56-38-2	0.2	mg/kg	----	<0.2	----			
Pirimphos-ethyl	23505-41-1	0.05	mg/kg	----	<0.05	----			
Chlorfenvinphos	470-90-6	0.05	mg/kg	----	<0.05	----			
Bromophos-ethyl	4824-78-6	0.05	mg/kg	----	<0.05	----			
Fenamiphos	22224-92-6	0.05	mg/kg	----	<0.05	----			
Prothiofos	34643-46-4	0.05	mg/kg	----	<0.05	----			
Ethion	563 12 2	0 05	mg/kg		0 05				
Carbophenothion	786-19-6	0.05	mg/kg	----	<0.05	----			
Methyl Azinphos	86-50-0	0.05	mg/kg	----	<0.05	----			
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	0.5	mg/kg	----	----	<0.5			
Acenaphthylene	208-96-8	0.5	mg/kg	----	----	<0.5			
Acenaphthene	83-32-9	0.5	mg/kg	----	----	<0.5			
Fluorene	86-73-7	0.5	mg/kg	----	----	<0.5			
Phenanthrene	85-01-8	0.5	mg/kg	----	----	<0.5			
Anthracene	120-12-7	0.5	mg/kg	----	----	<0.5			
Fluoranthene	206-44-0	0.5	mg/kg	----	----	<0.5			
Pyrene	129-00-0	0.5	mg/kg	----	----	<0.5			
Benz(a)anthracene	56-55-3	0.5	mg/kg	----	----	<0.5			

ALS Environmental

Analytical Results

				Client Sample ID :	13	14	16		
				Sample Matrix Type / Description :	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL		
				Sample Date / Time :	19 Jul 2005 15:00	19 Jul 2005 15:00	19 Jul 2005 15:00		
				Laboratory Sample ID :	ES0506034-009	ES0506034-010	ES0506034-011		
Analyte	*CAS number*	*LOR*	*Units*						
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Chrysene	218-01-9	0.5	mg/kg		----	----	<0.5		
Benzo(b)fluoranthene	205-99-2	0.5	mg/kg		----	----	<0.5		
Benzo(k)fluoranthene	207-08-9	0.5	mg/kg		----	----	<0.5		
Benzo(a)pyrene	50-32-8	0.5	mg/kg		----	----	<0.5		
Indeno(1,2,3,cd)pyrene	193-39-5	0.5	mg/kg		----	----	<0.5		
Dibenz(a,h)anthracene	53-70-3	0.5	mg/kg		----	----	<0.5		
Benzo(g,h,i)perylene	191-24-2	0.5	mg/kg		----	----	<0.5		
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction		2	mg/kg		----	----	<2		
C10 - C14 Fraction		50	mg/kg		----	----	<50		
C15 - C28 Fraction		100	mg/kg		----	----	<100		
C29 - C36 Fraction		100	mg/kg		----	----	<100		
EP080: BTEX									
Benzene	71-43-2	0.2	mg/kg		----	----	<0.2		
Toluene	108-88-3	0.2	mg/kg		----	----	<0.2		
Ethylbenzene	100-41-4	0.2	mg/kg		----	----	<0.2		
meta- & para-Xylene	108-38-3 106-42-3	0.2	mg/kg		----	----	<0.2		
ortho-Xylene	95-47-6	0.2	mg/kg		----	----	<0.2		
EP066S: PCB Surrogate									
Decachlorobiphenyl	2051-24-3	0.1	%		----	71.8	59.4		
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE		0.1	%		----	81.5	70.1		
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.1	%		----	94.1	81.5		
EP075(SIM)S: Phenolic Compound Surrogates									
2-Fluorophenol	367-12-4	0.1	%		----	----	108		
Phenol-d6	13127-88-3	0.1	%		----	----	92.1		
2-Chlorophenol-D4	93951-73-6	0.1	%		----	----	86.4		
2,4,6-Tribromophenol	118-79-6	0.1	%		----	----	118		
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	0.1	%		----	----	97.9		
Anthracene-d10	1719-06-8	0.1	%		----	----	102		
4-Terphenyl-d14	1718-51-0	0.1	%		----	----	98.5		
EP080S: TPH(V)/BTEX Surrogates									
1,2-Dichloroethane-D4	17060-07-0	0.1	%		----	----	90.2		
Toluene D8	2037 26-5	0 1	%				86 5		

ALS Environmental

Analytical Results

				Client Sample ID :	13	14	16		
				Sample Matrix Type / Description :	SOIL / SOIL	SOIL / SOIL	SOIL / SOIL		
				Sample Date / Time :	19 Jul 2005 15:00	19 Jul 2005 15:00	19 Jul 2005 15:00		
				Laboratory Sample ID :					
Analyte	*CAS number*	*LOR*	*Units*		ES0506034-009	ES0506034-010	ES0506034-011		
EP080S: TPH(V)/BTEX Surrogates									
4-Bromofluorobenzene	460-00-4	0.1	%		----	----	85.0		

ALS Environmental

Analytical Results

				Client Sample ID :	13-DAM	12-DAM	6-TENNAN RD	S-LOT 11 CREEK	
				Sample Matrix Type / Description :	WATER / WATER	ATER / WATER	ATER / WATER	WATER / WATER	
				Sample Date / Time :	19 Jul 2005 11:30	19 Jul 2005 13:00	28 Jun 2005 11:30	28 Jun 2005 11:30	
				Laboratory Sample ID :	ES0506034-001	ES0506034-002	ES0506034-012	ES0506034-013	
Analyte	*CAS number*	*LOR*	*Units*						
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		----	----	<0.001	<0.001	
Beryllium	7440-41-7	0.001	mg/L		----	----	<0.001	<0.001	
Barium	7440-39-3	0.001	mg/L		----	----	0.153	0.015	
Cadmium	7440-43-9	0.0001	mg/L		----	----	0.0003	<0.0001	
Chromium	7440-47-3	0.001	mg/L		----	----	0.003	<0.001	
Cobalt	7440-48-4	0.001	mg/L		----	----	0.003	<0.001	
Copper	7440-50-8	0.001	mg/L		----	----	0.007	<0.001	
Lead	7439 92 1	0 001	mg/L				0 009	0 001	
Manganese	7439-96-5	0.001	mg/L		----	----	0.092	0.053	
Nickel	7440-02-0	0.001	mg/L		----	----	0.006	0.002	
Vanadium	7440-62-2	0.05	mg/L		----	----	<0.05	<0.05	
Zinc	7440-66-6	0.005	mg/L		----	----	0.134	0.008	
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		0.001	0.001	----	----	
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	
Barium	7440-39-3	0.001	mg/L		0.018	----	----	----	
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	----	----	
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	----	----	
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	----	----	
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	
Manganese	7439-96-5	0.001	mg/L		0.010	----	----	----	
Nickel	7440-02-0	0.001	mg/L		0.001	<0.001	----	----	
Vanadium	7440 62 2	0 01	mg/L		0 01				
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	----	----	
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		----	----	<0.0001	<0.0001	
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	
EP066: Polychlorinated Biphenyls (PCB)									
Total Polychlorinated biphenyls		1	µg/L		# <2	# <2	----	----	
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.5	µg/L		# <1.0	# <1.2	----	----	
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L		# <1.0	# <1.2	----	----	
beta-BHC	319-85-7	0.5	µg/L		# <1.0	# <1.2	----	----	
gamma-BHC	58-89-9	0.5	µg/L		# <1.0	# <1.2	----	----	

ALS Environmental

Analytical Results

				Client Sample ID :	13-DAM	12-DAM	6-TENNAN RD	S-LOT 11 CREEK	
				Sample Matrix Type / Description :	WATER / WATER	ATER / WATER	ATER / WATER	WATER / WATER	
				Sample Date / Time :	19 Jul 2005 11:30	19 Jul 2005 13:00	28 Jun 2005 11:30	28 Jun 2005 11:30	
				Laboratory Sample ID :	ES0506034-001	ES0506034-002	ES0506034-012	ES0506034-013	
Analyte	*CAS number*	*LOR*	*Units*						
EP068A: Organochlorine Pesticides (OC)									
delta-BHC	319-86-8	0.5	µg/L		# <1.0	# <1.2	----	----	
Heptachlor	76-44-8	0.5	µg/L		# <1.0	# <1.2	----	----	
Aldrin	309-00-2	0.5	µg/L		# <1.0	# <1.2	----	----	
Heptachlor epoxide	1024-57-3	0.5	µg/L		# <1.0	# <1.2	----	----	
trans-Chlordane	5103-74-2	0.5	µg/L		# <1.0	# <1.2	----	----	
alpha-Endosulfan	959-98-8	0.5	µg/L		# <1.0	# <1.2	----	----	
cis-Chlordane	5103-71-9	0.5	µg/L		# <1.0	# <1.2	----	----	
Dieldrin	60 57 1	0 5	µg/L		# 1 0	# 1 2			
4,4'-DDE	72-55-9	0.5	µg/L		# <1.0	# <1.2	----	----	
Endrin	72-20-8	0.5	µg/L		# <1.0	# <1.2	----	----	
beta-Endosulfan	33213-65-9	0.5	µg/L		# <1.0	# <1.2	----	----	
4,4'-DDD	72-54-8	0.5	µg/L		# <1.0	# <1.2	----	----	
Endrin aldehyde	7421-93-4	0.5	µg/L		# <1.0	# <1.2	----	----	
Endosulfan sulfate	1031-07-8	0.5	µg/L		# <1.0	# <1.2	----	----	
4,4'-DDT	50-29-3	2	µg/L		<2	<2	----	----	
Endrin ketone	53494-70-5	0.5	µg/L		# <1.0	# <1.2	----	----	
Methoxychlor	72-43-5	2	µg/L		<2	<2	----	----	
EP068B Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		# <1.0	----	----	----	
Demeton-S-methyl	919-86-8	0.5	µg/L		# <1.0	----	----	----	
Monocrotophos	6923-22-4	2	µg/L		<2	----	----	----	
Dimethoate	60-51-5	0.5	µg/L		# <1.0	----	----	----	
Diazinon	333-41-5	0.5	µg/L		# <1.0	----	----	----	
Chlorpyrifos methyl	5598 13-0	0 5	µg/L		# 1 0				
Parathion-methyl	298-00-0	2	µg/L		<2	----	----	----	
Malathion	121-75-5	0.5	µg/L		# <1.0	----	----	----	
Fenthion	55-38-9	0.5	µg/L		# <1.0	----	----	----	
Chlorpyrifos	2921-88-2	0.5	µg/L		# <1.0	----	----	----	
Parathion	56-38-2	2	µg/L		<2	----	----	----	
Pirimphos-ethyl	23505-41-1	0.5	µg/L		# <1.0	----	----	----	
Chlorfenvinphos	470-90-6	0.5	µg/L		# <1.0	----	----	----	
Bromophos-ethyl	4824-78-6	0.5	µg/L		# <1.0	----	----	----	
Fenamiphos	22224-92-6	0.5	µg/L		# <1.0	----	----	----	
Prothiofos	34643-46-4	0.5	µg/L		# <1.0	----	----	----	
Ethion	563-12-2	0.5	µg/L		# <1.0	----	----	----	
Carbophenothion	786-19-6	0.5	µg/L		# <1.0	----	----	----	

ALS Environmental

Analytical Results

				Client Sample ID :	13-DAM	12-DAM	6-TENNAN RD	S-LOT 11 CREEK	
				Sample Matrix Type / Description :	WATER / WATER	ATER / WATER	ATER / WATER	WATER / WATER	
				Sample Date / Time :	19 Jul 2005 11:30	19 Jul 2005 13:00	28 Jun 2005 11:30	28 Jun 2005 11:30	
				Laboratory Sample ID :	ES0506034-001	ES0506034-002	ES0506034-012	ES0506034-013	
Analyte	*CAS number*	*LOR*	*Units*						
EP068B: Organophosphorus Pesticides (OP)									
Methyl Azinphos	86-50-0	0.5	µg/L		# <1.0	----	----	----	
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		----	<1.0	----	----	
Acenaphthylene	208 96 8	1 0	µg/L			1 0			
Acenaphthene	83-32-9	1.0	µg/L		----	<1.0	----	----	
Fluorene	86-73-7	1.0	µg/L		----	<1.0	----	----	
Phenanthrene	85-01-8	1.0	µg/L		----	<1.0	----	----	
Anthracene	120-12-7	1.0	µg/L		----	<1.0	----	----	
Fluoranthene	206-44-0	1.0	µg/L		----	<1.0	----	----	
Pyrene	129-00-0	1.0	µg/L		----	<1.0	----	----	
Benz(a)anthracene	56-55-3	1.0	µg/L		----	<1.0	----	----	
Chrysene	218-01-9	1.0	µg/L		----	<1.0	----	----	
Benzo(b)fluoranthene	205-99-2	1.0	µg/L		----	<1.0	----	----	
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		----	<1.0	----	----	
Benzo(a)pyrene	50-32-8	0.5	µg/L		----	<0.5	----	----	
Indeno(1,2,3,cd)pyrene	193-39-5	1.0	µg/L		----	<1.0	----	----	
Dibenz(a,h)anthracene	53-70-3	1.0	µg/L		----	<1.0	----	----	
Benzo(g,h,i)perylene	191-24-2	1.0	µg/L		----	<1.0	----	----	
EP080/071: Total Petroleum Hydrocarbons									
C6 C9 Fraction		20	µg/L			20			
C10 - C14 Fraction		50	µg/L		----	950	----	----	
C15 - C28 Fraction		100	µg/L		----	4500	----	----	
C29 - C36 Fraction		50	µg/L		----	# <60	----	----	
EP080: BTEX									
Benzene	71-43-2	1	µg/L		----	<1	----	----	
Toluene	108-88-3	2	µg/L		----	<2	----	----	
Ethylbenzene	100-41-4	2	µg/L		----	<2	----	----	
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		----	<2	----	----	
ortho-Xylene	95-47-6	2	µg/L		----	<2	----	----	
EP066S: PCB Surrogate									
Decachlorobiphenyl	2051-24-3	0.1	%		80.4	60.7	----	----	
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE		0.1	%		65.8	89.3	----	----	
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.1	%		68.6	59.8	----	----	

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: 13-DAM Sample Matrix Type / Description: WATER / WATER Sample Date / Time: 19 Jul 2005 11:30 Laboratory Sample ID: ES0506034-001	12-DAM ATER / WATER 19 Jul 2005 13:00 ES0506034-002	6-TENNAN RD ATER / WATER 28 Jun 2005 11:30 ES0506034-012	S-LOT 11 CREEK WATER / WATER 28 Jun 2005 11:30 ES0506034-013	
EP075(SIM)S: Phenolic Compound Surrogates								
2-Fluorophenol	367-12-4	0.1	%	----	50.6	----	----	
Phenol-d6	13127-88-3	0.1	%	----	24.1	----	----	
2-Chlorophenol-D4	93951-73-6	0.1	%	----	44.1	----	----	
2,4,6-Tribromophenol	118-79-6	0.1	%	----	41.7	----	----	
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	----	49.4	----	----	
Anthracene-d10	1719-06-8	0.1	%	----	41.6	----	----	
4-Terphenyl-d14	1718-51-0	0.1	%	----	44.4	----	----	
EP080S: TPH(V)/BTEX Surrogates								
1,2-Dichloroethane-D4	17060-07-0	0.1	%	----	98.8	----	----	
Toluene-D8	2037-26-5	0.1	%	----	97.7	----	----	
4-Bromofluorobenzene	460-00-4	0.1	%	----	98.7	----	----	

ALS Environmental

Surrogate Control Limits

The analytical procedures used by ALS Environmental are based on established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house procedure are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

Matrix Type: WATER — ***Surrogate Control Limits***

Method name	*Analyte name*	*Lower Limit*	*Upper Limit*
EP066: Polychlorinated Biphenyls (PCB)			
EP066S: PCB Surrogate	Decachlorobiphenyl	10	164
EP068: Pesticides			
EP068S: Organochlorine Pesticide Surrogate	Dibromo-DDE	10	136
EP068T: Organophosphorus Pesticide Surrogate	DEF	10	136
EP075(SIM): PAH/Phenols (GC/MS - SIM)			
EP075(SIM)S: Phenolic Compound Surrogates	2-Fluorophenol	21	100
	Phenol-d6	10	94
	2-Chlorophenol-D4	23	134
	2,4,6-Tribromophenol	10	123
EP075(SIM)T: PAH Surrogates	2-Fluorobiphenyl	43	116
	Anthracene-d10	27	133
	4 Terphenyl d14	33	141
EP080: TPH Volatiles/BTEX			
EP080S: TPH(V)/BTEX Surrogates	1,2-Dichloroethane-D4	80	120
	Toluene-D8	88	110
	4-Bromofluorobenzene	86	115

Matrix Type: SOIL — ***Surrogate Control Limits***

Method name	*Analyte name*	*Lower Limit*	*Upper Limit*
EP066: Polychlorinated Biphenyls (PCB)			
EP066S: PCB Surrogate	Decachlorobiphenyl	10	164
EP068: Pesticides by GCMS			
EP068S: Organochlorine Pesticide Surrogate	Dibromo-DDE	10	136
EP068T: Organophosphorus Pesticide Surrogate	DEF	10	136
EP075(SIM): PAH/Phenols (SIM)			
EP075(SIM)S: Phenolic Compound Surrogates	2-Fluorophenol	25	121
	Phenol-d6	24	113
	2-Chlorophenol-D4	23	134
	2,4,6-Tribromophenol	19	122
EP075(SIM)T: PAH Surrogates	2-Fluorobiphenyl	30	115
	Anthracene-d10	27	133
	4-Terphenyl-d14	18	137
EP080: TPH Volatiles/BTEX			
EP080S: TPH(V)/BTEX Surrogates	1,2-Dichloroethane-D4	80	120
	Toluene-D8	81	117
	4 Bromofluorobenzene	74	121

ALS Environmental

INTERPRETIVE QUALITY CONTROL REPORT

Client	:	**NETWORK GEOTECHNICS PTY LTD**	**Laboratory**	:	ALS Environmental Sydney	**Page**	: **1 of 9**
Contact		MR VIPUL DE SILVA	**Contact**		Greg Vogel		
Address	:	6/6 MORTON CLOSE TUGGERAH NSW AUSTRALIA 2259	**Address**	:	277 289 Woodpark Road Smithfield NSW Australia 2164	**Work order**	: **ES0506034**
						Amendment No	
Project	:	G25058/1	**Quote number**	:	SY/405/02	**Date received**	: 20 Jul 2005
Order number	:	- Not provided -				**Date issued**	: 31 Jul 2005
C-O-C number	:	019653					
Site	:	Not provided					
E-mail	:	gosnetgeo@bigpond com	**E-mail**	:	Greg Vogel@alsenviro com	**No. of samples**	
Telephone	:	02 4351 6200	**Telephone**	:	61-2-87848555	**Received**	: 13
Facsimile	:	02 4351 6300	**Facsimile**	:	61 2 87848500	**Analysed**	: 12

This Interpretive Quality Control Report was issued on 31 Jul 2005 for the ALS work order reference ES0506034 and supersedes any previous reports with this reference.
This report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Type Frequency Compliance
- Summary of all Quality Control Outliers
- Brief Method Summaries

ALS Environmental

Interpretive Quality Control Report - Analysis Holding Time

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extrac ion or analysis and preclude subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the sample aliquot was taken. Elapsed time to analysis represents time from sampling where no extraction / digestion is involved or time from extraction / digestion where this is present. For composite samples, sampling date/time is taken as that of he oldest sample contributing to that composite. Sample date/time for laboratory produced leaches are taken from the comple ion date/time of the leaching process. Outliers for holding time are based on USEPA SW846, APHA, AS and NEPM (1999). Failed outliers, refer to the 'Summary of Outliers'.

Matrix Type: SOIL

Analysis Holding Time and Preservation

Method / Container / Client Sample ID(s)		Date Sampled	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EA055-103: Moisture Content								
Soil Glass Jar - Unpreserved								
2,	3,	**19 Jul 2005**	---	---	---	**25 Jul 2005**	26 Jul 2005	Pass
5,	9,							
12,	13,							
14,	16							
EG005T: Total Metals by ICP-AES								
Soil Glass Jar - Unpreserved								
2,	3,	**19 Jul 2005**	**25 Jul 2005**	15 Jan 2006	Pass	**26 Jul 2005**	15 Jan 2006	Pass
5,	9,							
12,	13,							
14,	16							
EG035T: Total Mercury by FIMS								
Soil Glass Jar - Unpreserved								
2,	3,	**19 Jul 2005**	**25 Jul 2005**	16 Aug 2005	Pass	**26 Jul 2005**	16 Aug 2005	Pass
5,	9,							
12,	13,							
14,	16							
EP066: Polychlorinated Biphenyls (PCB)								
Soil Glass Jar - Unpreserved								
2,	9,	**19 Jul 2005**	**22 Jul 2005**	2 Aug 2005	Pass	**25 Jul 2005**	31 Aug 2005	Pass
12,	14,							
16								
EP068: Pesticides by GCMS								
Soil Glass Jar - Unpreserved								
2,	9,	**19 Jul 2005**	**22 Jul 2005**	2 Aug 2005	Pass	**25 Jul 2005**	31 Aug 2005	Pass
12,	14,							
16								
EP071: TPH - Semivolatile Fraction								
Soil Glass Jar - Unpreserved								
12,	16	**19 Jul 2005**	**25 Jul 2005**	2 Aug 2005	Pass	**26 Jul 2005**	3 Sep 2005	Pass
EP075(SIM): PAH/Phenols (SIM)								
Soil Glass Jar - Unpreserved								
12,	16	**19 Jul 2005**	**25 Jul 2005**	2 Aug 2005	Pass	**26 Jul 2005**	3 Sep 2005	Pass
EP080: TPH Volatiles/BTEX								
Soil Glass Jar - Unpreserved								
12,	16	**19 Jul 2005**	**21 Jul 2005**	2 Aug 2005	Pass	**22 Jul 2005**	2 Aug 2005	Pass

Matrix Type: WATER

Analysis Holding Time and Preservation

Method / Container / Client Sample ID(s)		Date Sampled	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EG020A-F: Dissolved Metals by ICP-MS - Suite A								
Clear Plastic Bottle - Nitric Acid; Filtered								
6-TENNAN RD,	S-LOT 11 CREEK	**28 Jun 2005**	**----**	----	----	**23 Jul 2005**	25 Dec 2005	Pass
EG020A-T: Total Metals by ICP-MS - Suite A								
Clear Plastic Bottle - Nitric Acid; Unfiltered								
13-DAM,	12-DAM	**19 Jul 2005**	----	15 Jan 2006		**22 Jul 2005**	15 Jan 2006	Pass
EG035F: Dissolved Mercury by FIMS								
Clear Plastic Bottle - Nitric Acid; Filtered								
6-TENNAN RD,	S-LOT 11 CREEK	**28 Jun 2005**	----	----	----	**27 Jul 2005**	26 Jul 2005	**Fail by 1 day**
EG035T: Total Mercury by FIMS								
Clear Plastic Bottle - Nitric Acid; Unfiltered								
13-DAM,	12-DAM	**19 Jul 2005**	----	----	----	**22 Jul 2005**	16 Aug 2005	Pass
EP066: Polychlorinated Biphenyls (PCB)								
Amber Glass Bottle - Unpreserved								
13-DAM,	12-DAM	**19 Jul 2005**	**22 Jul 2005**	26 Jul 2005	Pass	**29 Jul 2005**	31 Aug 2005	Pass
EP068: Pesticides								
Amber Glass Bottle - Unpreserved								
13-DAM,	12-DAM	**19 Jul 2005**	**22 Jul 2005**	26 Jul 2005	Pass	**29 Jul 2005**	31 Aug 2005	Pass
EP071: TPH - Semivolatile Fraction								
Amber Glass Bottle - Unpreserved								
12-DAM		**19 Jul 2005**	**22 Jul 2005**	26 Jul 2005	Pass	**25 Jul 2005**	31 Aug 2005	Pass
EP075(SIM): PAH/Phenols (GC/MS - SIM)								
Amber Glass Bottle - Unpreserved								
12-DAM		**19 Jul 2005**	**22 Jul 2005**	26 Jul 2005	Pass	**26 Jul 2005**	31 Aug 2005	Pass
EP080: TPH Volatiles/BTEX								
Amber VOC Vial - HCl								
12-DAM		**19 Jul 2005**	**----**	----	----	**21 Jul 2005**	2 Aug 2005	Pass

ALS Environmental

Interpretive Quality Control Report - Frequency of Quality Control Samples

The following report summarises the frequency of laboratory QC samples analysed within he analytical lot(s) in which this work order was processed. Actual rate should be greater than or equal to the expected rate.

Matrix Type: SOIL

Frequency of Quality Control Samples

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
EA055-103: Moisture Content	3	29	10.3	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG005T: Total Metals by ICP-AES	4	40	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	3	29	10.3	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	2	11	18.2	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	2	11	18.2	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP071: TPH - Semivolatile Fraction	1	10	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP075(SIM): PAH/Phenols (SIM)	1	8	12.5	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	2	19	10.5	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Laboratory Control Samples (LCS)					
EG005T: Total Metals by ICP-AES	2	40	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	2	29	6.9	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	1	11	9.1	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	1	11	9.1	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP071: TPH - Semivolatile Fraction	1	10	10.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP075(SIM): PAH/Phenols (SIM)	1	8	12.5	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	1	19	5.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Method Blanks (MB)					
EG005T: Total Metals by ICP-AES	2	40	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	2	29	6.9	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	1	11	9.1	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	1	11	9.1	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP071: TPH - Semivolatile Fraction	1	10	10.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP075(SIM): PAH/Phenols (SIM)	1	8	12.5	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	1	19	5.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Matrix Spikes (MS)					
EG005T: Total Metals by ICP-AES	2	40	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	2	29	6.9	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	1	11	9.1	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	1	11	9.1	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP071: TPH - Semivolatile Fraction	1	10	10.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP075(SIM): PAH/Phenols (SIM)	1	8	12.5	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	1	19	5.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement

Matrix Type: WATER

Frequency of Quality Control Samples

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
EG020A-F: Dissolved Metals by ICP-MS - Suite A	2	12	16.7	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG020A-T: Total Metals by ICP-MS - Suite A	2	20	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	4	25.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	3	20	15.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	1	2	50.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides	1	2	50.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP071: TPH - Semivolatile Fraction	1	5	20.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP075(SIM): PAH/Phenols (GC/MS - SIM)	1	6	16.7	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	2	12	16.7	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Laboratory Control Samples (LCS)					
EG020A-F: Dissolved Metals by ICP-MS - Suite A	1	12	8.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG020A-T: Total Metals by ICP-MS - Suite A	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	4	25.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	2	20	10.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	1	2	50.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides	1	2	50.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP071: TPH - Semivolatile Fraction	1	5	20.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP075(SIM): PAH/Phenols (GC/MS - SIM)	1	6	16.7	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	1	12	8.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Method Blanks (MB)					
EG020A-F: Dissolved Metals by ICP-MS - Suite A	1	12	8.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG020A-T: Total Metals by ICP-MS - Suite A	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	4	25.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	2	20	10.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	1	2	50.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides	1	2	50.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP071: TPH - Semivolatile Fraction	1	5	20.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP075(SIM): PAH/Phenols (GC/MS - SIM)	1	6	16.7	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	1	12	8.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Matrix Spikes (MS)					
EG020A-F: Dissolved Metals by ICP-MS - Suite A	1	12	8.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG020A-T: Total Metals by ICP-MS - Suite A	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	4	25 0	5 0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T Total Mercury by FIM	2	20	10.0	5.0	NEPM 1999 chedule B(3) and AL E QC 3 requirement
EP066: Polychlorinated Biphenyls (PCB)	1	2	50.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides	1	2	50.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP071: TPH - Semivolatile Fraction	1	5	20 0	5 0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP075(IM) PAH/Phenols (GC/M IM)	1	6	16.7	5.0	NEPM 1999 chedule B(3) and AL E QC 3 requirement
EP080: TPH Volatiles/BTEX	1	12	8.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement

Interpretive Quality Control Report - Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged on the 'Quality Control Report'. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot.

Non-surrogates

Matrix Type: SOIL

Summary of Outliers - Quality Control Samples

ALS QC Lot	Matrix Type	Laboratory Sample ID	Client Sample ID	Analyte	Data	Limits	Comment
Laboratory Duplicates (DUP)							
EP068A: Organochlorine Pesticides (OC)	SOIL	ES0506039-001	Anonymous	Dieldrin	26.1 %	0-20 %	RPD exceeds LOR based limits
Laboratory Control Samples (LCS)							
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons	SOIL	102655-008	----	Phenanthrene	126 %	85-113 %	Recovery greater than upper control limit
				Benzo(g,h,i)perylene	64.1 %	76-109 %	Recovery less than lower control limit
Matrix Spikes (MS)							
EG005T: Total Metals by ICP-AES	SOIL	ES0506034-007	9	Beryllium	ND	----	Matrix Spike Recovery not determined due to sample matrix interference.
				Cobalt	0.08 %	70-130 %	Recovery less than lower data quality objective
EP068A: Organochlorine Pesticides (OC)	SOIL	ES0506039-001	Anonymous	Dieldrin	ND	----	MS recovery not determined, background level greater than or equal to 4x spike level.
				4,4'-DDT	ND	----	MS recovery not determined, background level greater than or equal to 4x spike level.

Matrix Type: WATER

Summary of Outliers - Quality Control Samples

ALS QC Lot	Matrix Type	Laboratory Sample ID	Client Sample ID	Analyte	Data	Limits	Comment
Laboratory Control Samples (LCS)							
EP068A: Organochlorine Pesticides (OC)	WATER	101491-030	----	beta-Endosulfan	109 %	76.8-107 %	Recovery greater than upper control limit
EP068B: Organophosphorus Pesticides (OP)	WATER	101491-030	----	Monocrotophos	48.3 %	3.29-37.7 %	Recovery greater than upper control limit

- **For all matrices, no method blank result outliers occur.**

Surrogates

- **For all matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time

The following report highlights outliers within his 'Interpretive Quality Control Report - Analysis Holding Time'.

Matrix Type: WATER

Summary of Outliers - Analysis Holding times and Preservation

Method / Container / Client Sample D(s)	Date Sampled	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EG020A-T: Total Metals by ICP-MS - Suite A							
Clear Plastic Bottle - Nitric Acid; Unfiltered							
13-DAM, 12-DAM	**19 Jul 2005**	---	15 Jan 2006		**22 Jul 2005**	15 Jan 2006	Pass

Matrix Type: WATER

Summary of Outliers - Analysis Holding times and Preservation

Method / Container / Client Sample D(s)	Date Sampled	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered							
6-TENNAN RD, S-LOT 11 CREEK	**28 Jun 2005**	---	---	---	**27 Jul 2005**	26 Jul 2005	**Fail by 1 day**

Outliers : Frequency of Quality Control Samples

The following report highlights outliers within this 'Interpretive Quality Control Report - Frequency of Quality Control Samples'.

- **No frequency outliers occur.**

Method Reference Summary

The analytical procedures used by ALS Environmental are based on established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house procedure are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

Matrix Type: SOIL ***Method Reference Summary***

Preparation Methods

EN69 : Hot Block Digest for metals in soils sediments and sludges - USEPA 200.2 Mod. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bu ked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (1999) Schedule B(3) (Method 202)

ORG16 : Methanolic Extraction of Soils for Purge and Trap - (USEPA SW 846 - 5030A) 5g of solid is shaken with surrogate and 10mL methanol prior to analysis by Purge and Trap - GC/MS.

ORG17A : Tumbler Extraction of Solids (Option A - Concentrating) - In-house, Mechanical agitation (tumbler). 20g of sample, Na2SO4 and surrogate are extracted with 150mL 1:1 DCM/Acetone by end over end tumble. The solvent is decanted, dehydrated and concentrated (by KD) to the desired volume for analysis.

ORG17B : Tumbler Extraction of Solids (Option B - Non-concentrating) - In-house, Mechanical agitation (tumbler). 10g of sample, Na2SO4 and surrogate are extracted with 20mL 1:1 DCM/Acetone by end over end tumble. The solvent is transferred directly to a GC vial for analysis.

Analytical Methods

EA055-103 : Moisture Content - A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (1999) Schedule B(3) (Method 102)

EG005T : Total Metals by ICP-AES - (APHA 20th ed., 3120; USEPA SW 846 - 6010) (ICPAES) Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (1999) Schedule B(3)

EG035T : Total Mercury by FIMS - AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion A bromate/bromide reagent is used to oxidise any organic mercury compounds in the extract Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve.

EP066 : Polychlorinated Biphenyls (PCB) - (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point cal bration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 504)

EP068 : Pesticides by GCMS - (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This technique is compliant with NEPM (1999) Schedule B(3) (Method 504,505)

EP071 : TPH - Semivolatile Fraction - (USEPA SW 846 - 8015A) Sample extracts are analysed by Capillary GC/FID and quantified against alkane standards over the range C10 - C36. This method is compliant with NEPM (1999) Schedule B(3) (Method 506.1)

EP075(SIM) : PAH/Phenols (SIM) - (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS in Selective Ion Mode (SIM) and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 502 and 507)

EP080 : TPH Volatiles/BTEX - (USEPA SW 846 - 8260B) Extracts are analysed by Purge and Trap, Capillary GC/MS. Quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 501)

Matrix Type: WATER ***Method Reference Summary***

Preparation Methods

Matrix Type: WATER

Method Reference Summary

Preparation Methods

EN25 : Digestion for Total Recoverable Metals - USEPA SW846-3005 Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

ORG14 : Separatory Funnel Extraction of Liquids - USEPA SW 846 - 3510B 500 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2). ALS default excludes sediment which may be resident in the container.

Analytical Methods

EG020A-F : Dissolved Metals by ICP-MS - Suite A - (APHA 20th ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

EG020A-T : Total Metals by ICP-MS - Suite A - (APHA 20th ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

EG035F : Dissolved Mercury by FIMS - AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EG035T : Total Mercury by FIMS - AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EP066 : Polychlorinated Biphenyls (PCB) - USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EP068 : Pesticides - USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point cal bration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EP071 : TPH - Semivolatile Fraction - USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-A kane standards. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EP075(SIM) : PAH/Phenols (GC/MS - SIM) - USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point cal bration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EP080 : TPH Volatiles/BTEX - USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

ALS Environmental

QUALITY CONTROL REPORT

Client	:	**NETWORK GEOTECHNICS PTY LTD**	**Laboratory**	: ALS Environmental Sydney	**Page**	:	**1 of 28**
Contact	:	MR VIPUL DE SILVA	**Contact**	: Greg Vogel			
Address	:	6/6 MORTON CLOSE TUGGERAH NSW AUSTRALIA 2259	**Address**	: 277-289 Woodpark Road Smithfield NSW Australia 2164	**Work order**	:	**ES0506034**
					Amendment No.	:	
Project	:	G25058/1	**Quote number**	: SY/405/02	**Date received**	:	20 Jul 2005
Order number	:	- Not provided -			**Date issued**	:	31 Jul 2005
C-O-C number	:	019653					
Site	:	- Not provided -					
E-mail	:	gosnetgeo@bigpond.com	**E-mail**	: Greg.Vogel@alsenviro.com	**No. of samples**		
Telephone	:	02 4351 6200	**Telephone**	: 61-2-87848555	**Received**	:	13
Facsimile	:	02 4351 6300	**Facsimile**	: 61-2-87848500	**Analysed**	:	12

This final report for the ALSE work order reference ES0506034 supersedes any previous reports with this reference.

Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- Laboratory Duplicates (DUP); Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Samples (LCS); Recovery and Acceptance Limits
- Matrix Spikes (MS); Recovery and Acceptance Limits

Work order specific comments

Insufficient samples 13 and 12-Dam has been provided for standard analysisof EP068. Where applicable LOR values have been adjusted accordingly.

ALSE - Excellence in Analytical Testing

NATA

WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory - 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IED 17025

This document has been digitally signed by those names that appear on this report and are the authorised signatories. Digital signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Daniel Um	Organics - NATA 10911 (Sydney)
Peter Dickenson	norganics - NATA 10911 (Sydney)

Quality Control Report - Laboratory Duplicates (DUP)

The quality control term **Laboratory Duplicate** refers to an intralaboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
- Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** = *Limit of Reporting,* ***RPD*** = *Relative Percent Difference.*
* Indicates failed QC. The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:- Result < 10 times LOR, no limit - Result between 10 and 20 times LOR, 0% - 50% - Result > 20 times LOR, 0% - 20%

Matrix Type: SOIL ***Laboratory Duplicates (DUP) Report***

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EA055: Moisture Content						
EA055: Moisture Content - (QC Lot: 95332)				%	%	%
ES0506026-007	Anonymous	Moisture Content (dried @ 103°C)	1.0 %	20.0	20.8	3.9
ES0506026-016	Anonymous	Moisture Content (dried @ 103°C)	1.0 %	1.8	1.6	16.6
EA055: Moisture Content - (QC Lot: 95333)				%	%	%
ES0506034-011	16	Moisture Content (dried @ 103°C)	1.0 %	9.7	9.9	1.9
EG005T: Total Metals by ICP-AES						
EG005T: Total Metals by ICP-AES - (QC Lot: 95296)				mg/kg	mg/kg	%
ES0506026-004	Anonymous	Arsenic	5 mg/kg	6	6	0.0
		Barium	10 mg/kg	130	130	0.0
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	2 mg/kg	10	10	0.0
		Cobalt	2 mg/kg	<2	<2	0.0
		Copper	5 mg/kg	17	16	0.0
		Lead	5 mg/kg	13	12	0.0
		Manganese	5 mg/kg	16	7	78.5
		Nickel	2 mg/kg	<2	<2	0.0
		Vanadium	5 mg/kg	37	38	3.6
		Zinc	5 mg/kg	8	7	14.1
ES0506026-014	Anonymous	Arsenic	5 mg/kg	7	7	0.0
		Barium	10 mg/kg	40	60	30.2
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	2 mg/kg	13	14	10.4
		Cobalt	2 mg/kg	<2	<2	0.0
		Copper	5 mg/kg	24	25	5.0
		Lead	5 mg/kg	15	17	10.5
		Manganese	5 mg/kg	8	6	20.3
		Nickel	2 mg/kg	<2	<2	0.0

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EG005T: Total Metals by ICP-AES - continued						
EG005T: Total Metals by ICP-AES - (QC Lot: 95296) - continued				mg/kg	mg/kg	%
ES0506026-014	Anonymous	Vanadium	5 mg/kg	40	43	6.9
		Zinc	5 mg/kg	9	9	0.0
EG005T: Total Metals by ICP-AES - (QC Lot: 95298)				mg/kg	mg/kg	%
ES0506034-007	9	Arsenic	5 mg/kg	<5	<5	0.0
		Barium	10 mg/kg	20	20	0.0
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	2 mg/kg	11	9	20.1
		Cobalt	2 mg/kg	2	2	0.0
		Copper	5 mg/kg	<5	<5	0.0
		Lead	5 mg/kg	7	6	23.2
		Manganese	5 mg/kg	11	11	0.0
		Nickel	2 mg/kg	3	3	0.0
		Vanadium	5 mg/kg	20	18	11.4
		Zinc	5 mg/kg	9	9	0.0
ES0506063-006	Anonymous	Arsenic	5 mg/kg	<5	<5	0.0
		Barium	10 mg/kg	<10	<10	0.0
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	2 mg/kg	3	3	0.0
		Cobalt	2 mg/kg	<2	<2	0.0
		Copper	5 mg/kg	<5	<5	0.0
		Lead	5 mg/kg	6	<5	24.4
		Manganese	5 mg/kg	5	<5	0.0
		Nickel	2 mg/kg	<2	<2	0.0
		Vanadium	5 mg/kg	<5	<5	0.0
		Zinc	5 mg/kg	<5	<5	0.0
EG035T: Total Mercury by FIMS						
EG035T: Total Mercury by FIMS - (QC Lot: 95297)				mg/kg	mg/kg	%
ES0506026-004	Anonymous	Mercury	0.1 mg/kg	<0.1	<0.1	0.0
ES0506026-014	Anonymous	Mercury	0.1 mg/kg	<0.1	<0.1	0.0
EG035T: Total Mercury by FIMS - (QC Lot: 95299)				mg/kg	mg/kg	%

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EG035T: Total Mercury by FIMS - continued						
EG035T: Total Mercury by FIMS - (QC Lot: 95299) - continued				mg/kg	mg/kg	%
ES0506034-007	9	Mercury	0.1 mg/kg	<0.1	<0.1	0.0
EP066: Polychlorinated Biphenyls (PCB)						
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 94716)				mg/kg	mg/kg	%
ES0506039-001	Anonymous	Total Polychlorinated biphenyls	0.10 mg/kg	<0.10	<0.10	0.0
EP068A: Organochlorine Pesticides (OC)						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 94717)				mg/kg	mg/kg	%
ES0506039-001	Anonymous	alpha-BHC	0.05 mg/kg	<0.25	<0.25	0.0
		alpha-BHC	0.05 mg/kg	<0.25	<0.25	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.25	<0.25	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.25	<0.25	0.0
		beta-BHC	0.05 mg/kg	<0.25	<0.25	0.0
		beta-BHC	0.05 mg/kg	<0.25	<0.25	0.0
		gamma-BHC	0.05 mg/kg	<0.25	<0.25	0.0
		gamma-BHC	0.05 mg/kg	<0.25	<0.25	0.0
		delta-BHC	0.05 mg/kg	<0.25	<0.25	0.0
		delta-BHC	0.05 mg/kg	<0.25	<0.25	0.0
		Heptachlor	0.05 mg/kg	<0.25	<0.25	0.0
		Heptachlor	0.05 mg/kg	<0.25	<0.25	0.0
		Aldrin	0.05 mg/kg	<0.25	<0.25	0.0
		Aldrin	0.05 mg/kg	<0.25	<0.25	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.25	<0.25	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.25	<0.25	0.0
		trans-Chlordane	0.05 mg/kg	<0.25	<0.25	0.0
		trans-Chlordane	0.05 mg/kg	<0.25	<0.25	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.25	<0.25	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.25	<0.25	0.0
		cis-Chlordane	0.05 mg/kg	<0.25	<0.25	0.0
		cis-Chlordane	0.05 mg/kg	<0.25	<0.25	0.0
		Dieldrin	0.05 mg/kg	3.75	4.87	26.1
		Dieldrin	0.05 mg/kg	3.75	4.87	26.1
		4,4'-DDE	0.05 mg/kg	1.92	2.06	7.3
		4,4'-DDE	0.05 mg/kg	1.92	2.06	7.3

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 94717) - continued				mg/kg	mg/kg	%
ES0506039-001	Anonymous	Endrin	0.05 mg/kg	<0.25	<0.25	0.0
		Endrin	0.05 mg/kg	<0.25	<0.25	0.0
		beta-Endosulfan	0.05 mg/kg	<0.25	<0.25	0.0
		beta-Endosulfan	0.05 mg/kg	<0.25	<0.25	0.0
		4,4'-DDD	0.05 mg/kg	5.29	5.40	2.2
		4,4'-DDD	0.05 mg/kg	5.29	5.40	2.2
		Endrin aldehyde	0.05 mg/kg	<0.25	<0.25	0.0
		Endrin aldehyde	0.05 mg/kg	<0.25	<0.25	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.25	<0.25	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.25	<0.25	0.0
		4,4'-DDT	0.2 mg/kg	18.8	19.7	4.7
		4,4'-DDT	0.2 mg/kg	18.8	19.7	4.7
		Endrin ketone	0.05 mg/kg	<0.25	<0.25	0.0
		Endrin ketone	0.05 mg/kg	<0.25	<0.25	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 94717)				mg/kg	mg/kg	%
ES0506039-001	Anonymous	Dichlorvos	0.05 mg/kg	<0.25	<0.25	0.0
		Dichlorvos	0.05 mg/kg	<0.25	<0.25	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.25	<0.25	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.25	<0.25	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.25	<0.25	0.0
		Dimethoate	0.05 mg/kg	<0.25	<0.25	0.0
		Diazinon	0.05 mg/kg	<0.25	<0.25	0.0
		Diazinon	0.05 mg/kg	<0.25	<0.25	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.25	<0.25	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.25	<0.25	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 94717) - continued				mg/kg	mg/kg	%
ES0506039-001	Anonymous	Malathion	0.05 mg/kg	<0.25	<0.25	0.0
		Malathion	0.05 mg/kg	<0.25	<0.25	0.0
		Fenthion	0.05 mg/kg	<0.25	<0.25	0.0
		Fenthion	0.05 mg/kg	<0.25	<0.25	0.0
		Chlorpyrifos	0.05 mg/kg	<0.25	<0.25	0.0
		Chlorpyrifos	0.05 mg/kg	<0.25	<0.25	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.25	<0.25	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.25	<0.25	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.25	<0.25	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.25	<0.25	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.25	<0.25	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.25	<0.25	0.0
		Fenamiphos	0.05 mg/kg	<0.25	<0.25	0.0
		Fenamiphos	0.05 mg/kg	<0.25	<0.25	0.0
		Prothiofos	0.05 mg/kg	<0.25	<0.25	0.0
		Prothiofos	0.05 mg/kg	<0.25	<0.25	0.0
		Ethion	0.05 mg/kg	<0.25	<0.25	0.0
		Ethion	0.05 mg/kg	<0.25	<0.25	0.0
		Carbophenothion	0.05 mg/kg	<0.25	<0.25	0.0
		Carbophenothion	0.05 mg/kg	<0.25	<0.25	0.0
		Methyl Azinphos	0.05 mg/kg	<0.25	<0.25	0.0
		Methyl Azinphos	0.05 mg/kg	<0.25	<0.25	0.0
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons						
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - (QC Lot: 95083)				mg/kg	mg/kg	%
ES0506063-005	Anonymous	Naphthalene	0.5 mg/kg	<0.5	<0.5	0.0
		Acenaphthylene	0.5 mg/kg	<0.5	<0.5	0.0
		Acenaphthene	0.5 mg/kg	<0.5	<0.5	0.0
		Fluorene	0.5 mg/kg	<0.5	<0.5	0.0
		Phenanthrene	0.5 mg/kg	<0.5	<0.5	0.0
		Anthracene	0.5 mg/kg	<0.5	<0.5	0.0

ALS Environmental

Matrix Type: SOIL — *Laboratory Duplicates (DUP) Report*

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - continued						
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - (QC Lot: 95083) - continued				mg/kg	mg/kg	%
ES0506063-005	Anonymous	Fluoranthene	0.5 mg/kg	<0.5	<0.5	0.0
		Pyrene	0.5 mg/kg	<0.5	<0.5	0.0
		Benz(a)anthracene	0.5 mg/kg	<0.5	<0.5	0.0
		Chrysene	0.5 mg/kg	<0.5	<0.5	0.0
		Benzo(b)fluoranthene	0.5 mg/kg	<0.5	<0.5	0.0
		Benzo(k)fluoranthene	0.5 mg/kg	<0.5	<0.5	0.0
		Benzo(a)pyrene	0.5 mg/kg	<0.5	<0.5	0.0
		Indeno(1,2,3,cd)pyrene	0.5 mg/kg	<0.5	<0.5	0.0
		Dibenz(a,h)anthracene	0.5 mg/kg	<0.5	<0.5	0.0
		Benzo(g,h,i)perylene	0.5 mg/kg	<0.5	<0.5	0.0
EP080/071: Total Petroleum Hydrocarbons						
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 94297)				mg/kg	mg/kg	%
ES0506036-001	Anonymous	C6 - C9 Fraction	2 mg/kg	<2	<2	0.0
ES0506036-008	Anonymous	C6 - C9 Fraction	2 mg/kg	<2	<2	0.0
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 95082)				mg/kg	mg/kg	%
ES0506063-005	Anonymous	C10 - C14 Fraction	50 mg/kg	<50	<50	0.0
		C15 - C28 Fraction	100 mg/kg	<100	<100	0.0
		C29 - C36 Fraction	100 mg/kg	<100	<100	0.0
EP080: BTEX						
EP080: BTEX - (QC Lot: 94297)				mg/kg	mg/kg	%
ES0506036-001	Anonymous	Benzene	0.2 mg/kg	<0.2	<0.2	0.0
		Toluene	0.2 mg/kg	<0.2	<0.2	0.0
		Ethylbenzene	0.2 mg/kg	<0.2	<0.2	0.0
		meta- & para-Xylene	0.2 mg/kg	<0.2	<0.2	0.0
		ortho-Xylene	0.2 mg/kg	<0.2	<0.2	0.0
ES0506036-008	Anonymous	Benzene	0.2 mg/kg	<0.2	<0.2	0.0
		Toluene	0.2 mg/kg	<0.2	<0.2	0.0
		Ethylbenzene	0.2 mg/kg	<0.2	<0.2	0.0
		meta- & para-Xylene	0.2 mg/kg	<0.2	<0.2	0.0
		ortho-Xylene	0.2 mg/kg	<0.2	<0.2	0.0

Matrix Type: WATER — *Laboratory Duplicates (DUP) Report*

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD

ALS Environmental

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EG020F: Dissolved Metals by ICP-MS						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 94943)				mg/L	mg/L	%
ES0505997-005	Anonymous	Arsenic	0.001 mg/L	<0.001	<0.001	0.0
		Beryllium	0.001 mg/L	<0.001	<0.001	0.0
		Barium	0.001 mg/L	0.017	0.017	0.0
		Cadmium	0.0001 mg/L	<0 0001	<0.0001	0.0
		Chromium	0.001 mg/L	<0.001	<0.001	0.0
		Cobalt	0.001 mg/L	0.035	0.034	4.8
		Copper	0.001 mg/L	0.002	0.002	0.0
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Manganese	0.001 mg/L	0.562	0.548	2.6
		Nickel	0.001 mg/L	0.011	0.010	0.0
		Vanadium	0.01 mg/L	<0.01	<0.01	0.0
		Zinc	0.005 mg/L	0.028	0.028	0.0
ES0506081-012	Anonymous	Arsenic	0.001 mg/L	<0.001	<0.001	0.0
		Beryllium	0.001 mg/L	<0.001	<0.001	0.0
		Barium	0.001 mg/L	<0.001	<0.001	0.0
		Cadmium	0.0001 mg/L	<0 0001	<0.0001	0.0
		Chromium	0.001 mg/L	<0.001	<0.001	0.0
		Cobalt	0.001 mg/L	<0.001	<0.001	0.0
		Copper	0.001 mg/L	<0.001	<0.001	0.0
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Manganese	0.001 mg/L	<0.001	<0.001	0.0
		Nickel	0.001 mg/L	<0.001	<0.001	0.0
		Vanadium	0.01 mg/L	<0.01	<0.01	0.0
		Zinc	0.005 mg/L	<0.005	<0.005	0.0
EG020T: Total Metals by ICP-MS						
EG020T: Total Metals by ICP-MS - (QC Lot: 94411)				mg/L	mg/L	%
ES0506027-038	Anonymous	Arsenic	0.001 mg/L	<0.001	<0.001	0.0
		Beryllium	0.001 mg/L	<0.001	<0.001	0.0
		Barium	0.001 mg/L	0.008	0.009	15.3
		Cadmium	0.0001 mg/L	<0 0001	<0.0001	0.0
		Chromium	0.001 mg/L	<0.001	<0.001	0.0
		Cobalt	0.001 mg/L	<0.001	<0.001	0.0

ALS Environmental

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EG020T: Total Metals by ICP-MS - continued						
EG020T: Total Metals by ICP-MS - (QC Lot: 94411) - continued				mg/L	mg/L	%
ES0506027-038	Anonymous	Copper	0.001 mg/L	0.001	0.002	0.0
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Manganese	0.001 mg/L	0.014	0.016	9.8
		Nickel	0.001 mg/L	<0.001	0.001	0.0
		Vanadium	0.01 mg/L	<0.01	<0.01	0.0
		Zinc	0.005 mg/L	0.010	0.016	43.8
ES0506032-007	Anonymous	Arsenic	0.001 mg/L	<0.001	<0.001	0.0
		Beryllium	0.001 mg/L	<0.001	<0.001	0.0
		Barium	0.001 mg/L	0.002	0.002	0.0
		Cadmium	0.0001 mg/L	<0 0001	<0.0001	0.0
		Chromium	0.001 mg/L	<0.001	<0.001	0.0
		Cobalt	0.001 mg/L	<0.001	<0.001	0.0
		Copper	0.001 mg/L	<0.001	<0.001	0.0
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Manganese	0.001 mg/L	0.015	0.014	0.0
		Nickel	0.001 mg/L	<0.001	<0.001	0.0
		Vanadium	0.01 mg/L	<0.01	<0.01	0.0
		Zinc	0.005 mg/L	0.009	<0.005	56.5
EG035F: Dissolved Mercury by FIMS						
EG035F: Dissolved Mercury by FIMS - (QC Lot: 96109)				mg/L	mg/L	%
ES0506026-001	Anonymous	Mercury	0.0001 mg/L	<0 0001	<0.0001	0.0
EG035T: Total Mercury by FIMS						
EG035T: Total Mercury by FIMS - (QC Lot: 94702)				mg/L	mg/L	%
ES0505985-007	Anonymous	Mercury	0.0001 mg/L	<0 0001	<0.0001	0.0
ES0506028-001	Anonymous	Mercury	0.0001 mg/L	0.0001	0.0001	0.0
EG035T: Total Mercury by FIMS - (QC Lot: 96110)				mg/L	mg/L	%
ES0506034-013	S-LOT 11 CREEK	Mercury	0.0001 mg/L	<0 0001	<0.0001	0.0
EP080/071: Total Petroleum Hydrocarbons						
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 94008)				µg/L	µg/L	%
ES0506024-001	Anonymous	C6 - C9 Fraction	20 µg/L	<20	<20	0.0
ES0506034-002	12-DAM	C6 - C9 Fraction	20 µg/L	<20	<20	0.0
EP080: BTEX						

ALS Environmental

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EP080: BTEX - continued						
EP080: BTEX - (QC Lot: 94008)				µg/L	µg/L	%
ES0506024-001	Anonymous	Benzene	1 µg/L	<1	<1	0.0
		Toluene	2 µg/L	<2	<2	0.0
		Ethylbenzene	2 µg/L	<2	<2	0.0
		meta- & para-Xylene	2 µg/L	<2	<2	0.0
		ortho-Xylene	2 µg/L	<2	<2	0.0
ES0506034-002	12-DAM	Benzene	1 µg/L	<1	<1	0.0
		Toluene	2 µg/L	<2	<2	0.0
		Ethylbenzene	2 µg/L	<2	<2	0.0
		meta- & para-Xylene	2 µg/L	<2	<2	0.0
		ortho-Xylene	2 µg/L	<2	<2	0.0

Quality Control Report - Method Blank (MB) and Laboratory Control Samples (LCS)

The quality control term **Method / Laboratory Blank** refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term **Laboratory Control Sample (LCS)** refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of actual laboratory data. Abbreviations: LOR = Limit of reporting.

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

		Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
Analyte name	LOR			LCS	Low	High
EG005T: Total Metals by ICP-AES						
EG005T: Total Metals by ICP-AES - (QC Lot: 95296)		mg/kg	mg/kg	%	%	%
Arsenic	5 mg/kg	----	13.1	102	70	130
	5 mg/kg	<5	----	----	----	----
Barium	10 mg/kg	<10	----	----	----	----
Beryllium	1 mg/kg	<1	----	----	----	----
Cadmium	1 mg/kg	----	2.76	104	70	130
	1 mg/kg	<1	----	----	----	----
Chromium	2 mg/kg	----	60.9	101	70	130
	2 mg/kg	<2	----	----	----	----
Cobalt	2 mg/kg	<2	----	----	----	----
Copper	5 mg/kg	----	54.7	98.5	70	130
	5 mg/kg	<5	----	----	----	----
Lead	5 mg/kg	----	55.2	97.1	70	130
	5 mg/kg	<5	----	----	----	----
Manganese	5 mg/kg	<5	----	----	----	----
Nickel	2 mg/kg	----	54.8	101	70	130
	2 mg/kg	<2	----	----	----	----
Vanadium	5 mg/kg	<5	----	----	----	----
Zinc	5 mg/kg	----	104	96.0	70	130
	5 mg/kg	<5	----	----	----	----
EG005T: Total Metals by ICP-AES - (QC Lot: 95298)		mg/kg	mg/kg	%	%	%
Arsenic	5 mg/kg	----	13.1	110	70	130
	5 mg/kg	<5	----	----	----	----
Barium	10 mg/kg	<10	----	----	----	----
Beryllium	1 mg/kg	<1	----	----	----	----
Cadmium	1 mg/kg	----	2.76	109	70	130
	1 mg/kg	<1	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EG005T: Total Metals by ICP-AES - continued						
EG005T: Total Metals by ICP-AES - (QC Lot: 95298) - continued		mg/kg	mg/kg	%	%	%
Chromium	2 mg/kg	----	60.9	105	70	130
	2 mg/kg	<2		----	----	----
Cobalt	2 mg/kg	<2		----	----	----
Copper	5 mg/kg	----	54.7	103	70	130
	5 mg/kg	<5	----	----	----	----
Lead	5 mg/kg	----	55.2	99.9	70	130
	5 mg/kg	<5		----	----	----
Manganese	5 mg/kg	<5		----	----	----
Nickel	2 mg/kg	----	54.8	104	70	130
	2 mg/kg	<2	----	----	----	----
Vanadium	5 mg/kg	<5	----	----	----	----
Zinc	5 mg/kg	----	104	98.6	70	130
	5 mg/kg	<5		----	----	----
EG035T: Total Mercury by FIMS						
EG035T: Total Mercury by FIMS - (QC Lot: 95297)		mg/kg	mg/kg	%	%	%
Mercury	0.1 mg/kg	----	1.4	99.1	70	130
	0.1 mg/kg	<0.1	----	----	----	----
EG035T: Total Mercury by FIMS - (QC Lot: 95299)		mg/kg	mg/kg	%	%	%
Mercury	0.1 mg/kg	----	1.4	81.6	70	130
	0.1 mg/kg	<0.1	----	----	----	----
EP066: Polychlorinated Biphenyls (PCB)						
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 94716)		mg/kg	mg/kg	%	%	%
Total Polychlorinated biphenyls	0.1 mg/kg	----	0.5	101	66	121
	0.10 mg/kg	<0.10	----	----	----	----
EP068A: Organochlorine Pesticides (OC)						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 94717)		mg/kg	mg/kg	%	%	%
4,4'-DDD	0.05 mg/kg	----	0.25	101	72.4	109
	0.05 mg/kg	<0.05	----	----	----	----

ALS Environmental

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 94717) - continued		mg/kg	mg/kg	%	%	%
4,4'-DDE	0.05 mg/kg	----	0.25	91.2	73.6	107
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDT	0.2 mg/kg	----	0.25	79.2	62.1	125
	0.2 mg/kg	<0.2	----	----	----	----
Aldrin	0.05 mg/kg	----	0.25	89.0	73.3	108
	0.05 mg/kg	<0.05	----	----	----	----
alpha-BHC	0.05 mg/kg	----	0.25	90.6	77.5	109
	0.05 mg/kg	<0.05	----	----	----	----
alpha-Endosulfan	0.05 mg/kg	----	0.25	86.6	71.5	112
	0.05 mg/kg	<0.05	----	----	----	----
beta-BHC	0.05 mg/kg	----	0.25	82.4	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----
beta-Endosulfan	0.05 mg/kg	----	0.25	102	73.8	112
	0.05 mg/kg	<0.05	----	----	----	----
cis-Chlordane	0.05 mg/kg	----	0.25	96.0	70.8	111
	0.05 mg/kg	<0.05	----	----	----	----
delta-BHC	0.05 mg/kg	----	0.25	93.2	67.1	113
	0.05 mg/kg	<0.05	----	----	----	----
Dieldrin	0.05 mg/kg	----	0.25	94.0	72.7	109
	0.05 mg/kg	<0.05	----	----	----	----
Endosulfan sulfate	0.05 mg/kg	----	0.25	92.6	68.5	115
	0.05 mg/kg	<0.05	----	----	----	----
Endrin	0.05 mg/kg	----	0.25	78.8	65.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Endrin aldehyde	0.05 mg/kg	----	0.25	103	72.2	114
	0.05 mg/kg	<0.05	----	----	----	----
Endrin ketone	0.05 mg/kg	----	0.25	99.0	71.1	114
	0.05 mg/kg	<0.05	----	----	----	----
gamma-BHC	0.05 mg/kg	----	0.25	97.2	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 94717) - continued		mg/kg	mg/kg	%	%	%
Heptachlor	0.05 mg/kg	----	0.25	89.4	74.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor epoxide	0.05 mg/kg	----	0.25	102	74	108
	0.05 mg/kg	<0.05	----	----	----	----
Hexachlorobenzene (HCB)	0.05 mg/kg	----	0.25	89.2	69.6	108
	0.05 mg/kg	<0.05	----	----	----	----
Methoxychlor	0.2 mg/kg	----	0.25	89.0	56.8	137
	0.2 mg/kg	<0.2	----	----	----	----
trans-Chlordane	0.05 mg/kg	----	0.25	99.4	74.6	108
	0.05 mg/kg	<0.05	----	----	----	----
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 94717)		mg/kg	mg/kg	%	%	%
Methyl Azinphos	0.05 mg/kg	----	0.25	100	33.1	144
	0.05 mg/kg	<0.05	----	----	----	----
Bromophos-ethyl	0.05 mg/kg	----	0.25	97.6	66.5	112
	0.05 mg/kg	<0.05	----	----	----	----
Carbophenothion	0.05 mg/kg	----	0.25	103	67.8	108
	0.05 mg/kg	<0.05	----	----	----	----
Chlorfenvinphos	0.05 mg/kg	----	0.25	86.6	54.5	132
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos	0.05 mg/kg	----	0.25	91.0	75	109
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos-methyl	0.05 mg/kg	----	0.25	96.4	72.2	107
	0.05 mg/kg	<0.05	----	----	----	----
Demeton-S-methyl	0.05 mg/kg	----	0.25	104	57.7	123
	0.05 mg/kg	<0.05	----	----	----	----
Diazinon	0.05 mg/kg	----	0.25	91.6	72.9	108
	0.05 mg/kg	<0.05	----	----	----	----
Dichlorvos	0.05 mg/kg	----	0.25	99.8	64	117
	0.05 mg/kg	<0.05	----	----	----	----

ALS Environmental

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 94717) - continued		mg/kg	mg/kg	%	%	%
Dimethoate	0.05 mg/kg	----	0.25	82.6	60.7	117
	0.05 mg/kg	<0.05	----	----	----	----
Ethion	0.05 mg/kg	----	0.25	80.2	58.9	116
	0.05 mg/kg	<0.05	----	----	----	----
Fenamiphos	0.05 mg/kg	----	0.25	83.8	48.8	118
	0.05 mg/kg	<0.05	----	----	----	----
Fenthion	0.05 mg/kg	----	0.25	95.6	72.5	107
	0.05 mg/kg	<0.05	----	----	----	----
Malathion	0.05 mg/kg	----	0.25	99.4	61.6	121
	0.05 mg/kg	<0.05	----	----	----	----
Monocrotophos	0.2 mg/kg	----	0.25	100	46.9	125
	0.2 mg/kg	<0.2	----	----	----	----
Para hion	0.2 mg/kg	----	0.25	96.0	65.2	116
	0.2 mg/kg	<0.2	----	----	----	----
Para hion-methyl	0.2 mg/kg	----	0.25	85.2	68	109
	0.2 mg/kg	<0.2	----	----	----	----
Pirimphos-ethyl	0.05 mg/kg	----	0.25	97.6	66.3	118
	0.05 mg/kg	<0.05	----	----	----	----
Prothiofos	0.05 mg/kg	----	0.25	99.0	73	111
	0.05 mg/kg	<0.05	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons						
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - (QC Lot: 95083)		mg/kg	mg/kg	%	%	%
Acenaphthene	0.5 mg/kg	----	4	98.7	87	105
	0.5 mg/kg	<0.5	----	----	----	----
Acenaphthylene	0.5 mg/kg	----	4	95.2	85	107
	0.5 mg/kg	<0.5	----	----	----	----
Anthracene	0.5 mg/kg	----	4	102	88	107
	0.5 mg/kg	<0.5	----	----	----	----
Benz(a)anthracene	0.5 mg/kg	----	4	90.8	85	100
	0.5 mg/kg	<0.5	----	----	----	----

ALS Environmental

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - continued						
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - (QC Lot: 95083) - continued		mg/kg	mg/kg	%	%	%
Benzo(a)pyrene	0.5 mg/kg	----	4	98.8	83	108
	0.5 mg/kg	<0.5	----	----	----	----
Benzo(b)fluoranthene	0.5 mg/kg	----	4	92.6	68	112
	0.5 mg/kg	<0.5	----	----	----	----
Benzo(g,h,i)perylene	0.5 mg/kg	----	4	64.1	76	109
	0.5 mg/kg	<0.5	----	----	----	----
Benzo(k)fluoranthene	0.5 mg/kg	----	4	83.3	70	129
	0.5 mg/kg	<0.5	----	----	----	----
Chrysene	0.5 mg/kg	----	4	87.7	84	111
	0.5 mg/kg	<0.5	----	----	----	----
Dibenz(a,h)anthracene	0.5 mg/kg	----	4	80.2	77	107
	0.5 mg/kg	<0.5	----	----	----	----
Fluoranthene	0.5 mg/kg	----	4	99.2	87	105
	0.5 mg/kg	<0.5	----	----	----	----
Fluorene	0.5 mg/kg	----	4	96.8	85	105
	0.5 mg/kg	<0.5	----	----	----	----
Indeno(1,2,3,cd)pyrene	0.5 mg/kg	----	4	79.8	76	110
	0.5 mg/kg	<0.5	----	----	----	----
Naphthalene	0.5 mg/kg	----	4	100	87	103
	0.5 mg/kg	<0.5	----	----	----	----
Phenanthrene	0.5 mg/kg	----	4	126	85	113
	0.5 mg/kg	<0.5	----	----	----	----
Pyrene	0.5 mg/kg	----	4	98.4	75	105
	0.5 mg/kg	<0.5	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons						
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 94297)		mg/kg	mg/kg	%	%	%
C6 - C9 Fraction	2 mg/kg	----	26	101	80	119
	2 mg/kg	<2	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 95082)		mg/kg	mg/kg	%	%	%

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP080/071: Total Petroleum Hydrocarbons - continued						
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 95082) - continued		mg/kg	mg/kg	%	%	%
C10 - C14 Fraction	50 mg/kg	----	200	101	79	112
	50 mg/kg	<50	----	----	----	----
C15 - C28 Fraction	100 mg/kg	----	200	104	84	108
	100 mg/kg	<100	----	----	----	----
C29 - C36 Fraction	100 mg/kg	----	200	83.7	76	117
	100 mg/kg	<100	----	----	----	----
EP080: BTEX						
EP080: BTEX - (QC Lot: 94297)		mg/kg	mg/kg	%	%	%
Benzene	0.2 mg/kg	----	1	96.6	80	118
	0.2 mg/kg	<0.2	----	----	----	----
Ethylbenzene	0.2 mg/kg	----	1	98.5	80	120
	0.2 mg/kg	<0.2	----	----	----	----
meta- & para-Xylene	0.2 mg/kg	----	1	98.6	79	119
	0.2 mg/kg	<0.2	----	----	----	----
ortho-Xylene	0.2 mg/kg	----	1	100	80	119
	0.2 mg/kg	<0.2	----	----	----	----
Toluene	0.2 mg/kg	----	1	99.3	81	119
	0.2 mg/kg	<0.2	----	----	----	----

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EG020F: Dissolved Metals by ICP-MS						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 94943)		mg/L	mg/L	%	%	%
Arsenic	0.001 mg/L	----	0.1	91.9	70	130
	0.001 mg/L	<0.001	----	----	----	----
Barium	0.001 mg/L	----	0.1	93.4	70	130
	0.001 mg/L	<0.001	----	----	----	----
Beryllium	0.001 mg/L	----	0.1	95.7	70	130
	0.001 mg/L	<0.001	----	----	----	----

ALS Environmental

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EG020F: Dissolved Metals by ICP-MS - continued						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 94943) - continued		mg/L	mg/L	%	%	%
Cadmium	0.0001 mg/L	----	0.1	99.3	70	130
	0.0001 mg/L	<0.0001	----	----	----	----
Chromium	0.001 mg/L	----	0.1	93.3	70	130
	0.001 mg/L	<0.001	----	----	----	----
Cobalt	0.001 mg/L	----	0.1	95.0	70	130
	0.001 mg/L	<0.001	----	----	----	----
Copper	0.001 mg/L	----	0.1	98.9	70	130
	0.001 mg/L	<0.001	----	----	----	----
Lead	0.001 mg/L	----	0.1	106	70	130
	0.001 mg/L	<0.001	----	----	----	----
Manganese	0.001 mg/L	----	0.1	107	70	130
	0.001 mg/L	<0.001	----	----	----	----
Nickel	0.001 mg/L	----	0.1	99.9	70	130
	0.001 mg/L	<0.001	----	----	----	----
Vanadium	0.01 mg/L	----	0.1	105	70	130
	0.01 mg/L	<0.01	----	----	----	----
Zinc	0.005 mg/L	----	0.1	100	70	130
	0.005 mg/L	<0.005	----	----	----	----
EG020T: Total Metals by ICP-MS						
EG020T: Total Metals by ICP-MS - (QC Lot: 94411)		mg/L	mg/L	%	%	%
Arsenic	0.001 mg/L	----	0.1	92.4	70	130
	0.001 mg/L	<0.001	----	----	----	----
Barium	0.001 mg/L	----	0.1	94.9	70	130
	0.001 mg/L	<0.001	----	----	----	----
Beryllium	0.001 mg/L	----	0.1	101	70	130
	0.001 mg/L	<0.001	----	----	----	----
Cadmium	0.0001 mg/L	----	0.1	102	70	130
	0.0001 mg/L	<0.0001	----	----	----	----
Chromium	0.001 mg/L	----	0.1	91.0	70	130
	0.001 mg/L	<0.001	----	----	----	----

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EG020T: Total Metals by ICP-MS - continued						
EG020T: Total Metals by ICP-MS - (QC Lot: 94411) - continued		mg/L	mg/L	%	%	%
Cobalt	0.001 mg/L	----	0.1	96.0	70	130
	0.001 mg/L	<0.001		----	----	----
Copper	0.001 mg/L	----	0.1	97.3	70	130
	0.001 mg/L	<0.001	----	----	----	----
Lead	0.001 mg/L	----	0.1	105	70	130
	0.001 mg/L	<0.001		----	----	----
Manganese	0.001 mg/L	----	0.1	108	70	130
	0.001 mg/L	<0.001	----	----	----	----
Nickel	0.001 mg/L	----	0.1	104	70	130
	0.001 mg/L	<0.001		----	----	----
Vanadium	0.01 mg/L	----	0.1	101	70	130
	0.01 mg/L	<0.01	----	----	----	----
Zinc	0.005 mg/L	----	0.1	92.9	70	130
	0.005 mg/L	<0.005		----	----	----
EG035F: Dissolved Mercury by FIMS						
EG035F: Dissolved Mercury by FIMS - (QC Lot: 96109)		mg/L	mg/L	%	%	%
Mercury	0.0001 mg/L	----	0.010	102	70	130
	0.0001 mg/L	<0.0001	----	----	----	----
EG035T: Total Mercury by FIMS						
EG035T: Total Mercury by FIMS - (QC Lot: 94702)		mg/L	mg/L	%	%	%
Mercury	0.0001 mg/L	----	0.010	99.4	70	130
	0.0001 mg/L	<0.0001	----	----	----	----
EG035T: Total Mercury by FIMS - (QC Lot: 96110)		mg/L	mg/L	%	%	%
Mercury	0.0001 mg/L	----	0.010	80.6	70	130
	0.0001 mg/L	<0.0001	----	----	----	----
EP066: Polychlorinated Biphenyls (PCB)						
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 93918)		µg/L	µg/L	%	%	%
Total Polychlorinated biphenyls	1 µg/L	----	10	88.5	75	115
	1 µg/L	<1	----	----	----	----

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC)						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 93919)		µg/L	µg/L	%	%	%
4,4'-DDD	0.5 µg/L	----	5	94.0	70.9	110
	0.5 µg/L	<0.5	----	----	----	----
4,4'-DDE	0.5 µg/L	----	5	87.1	72.4	110
	0.5 µg/L	<0.5	----	----	----	----
4,4'-DDT	2.0 µg/L	----	5	88.5	57	123
	2 µg/L	<2	----	----	----	----
Aldrin	0.5 µg/L	----	5	87.5	77.7	106
	0.5 µg/L	<0.5	----	----	----	----
alpha-BHC	0.5 µg/L	----	5	82.5	77.7	106
	0.5 µg/L	<0.5	----	----	----	----
alpha-Endosulfan	0.5 µg/L	----	5	85.9	77.8	108
	0.5 µg/L	<0.5	----	----	----	----
beta-BHC	0.5 µg/L	----	5	86.3	74.3	111
	0.5 µg/L	<0.5	----	----	----	----
beta-Endosulfan	0.5 µg/L	----	5	109	76.8	107
	0.5 µg/L	<0.5	----	----	----	----
cis-Chlordane	0.5 µg/L	----	5	76.3	75.1	106
	0.5 µg/L	<0.5	----	----	----	----
delta-BHC	0.5 µg/L	----	5	81.7	71.7	106
	0.5 µg/L	<0.5	----	----	----	----
Dieldrin	0.5 µg/L	----	5	87.0	82.3	105
	0.5 µg/L	<0.5	----	----	----	----
Endosulfan sulfate	0.5 µg/L	----	5	81.4	77.5	106
	0.5 µg/L	<0.5	----	----	----	----
Endrin	0.5 µg/L	----	5	80.2	79.4	106
	0.5 µg/L	<0.5	----	----	----	----
Endrin aldehyde	0.5 µg/L	----	5	80.8	76.8	108
	0.5 µg/L	<0.5	----	----	----	----
Endrin ketone	0.5 µg/L	----	5	79.0	74.1	107
	0.5 µg/L	<0.5	----	----	----	----

ALS Environmental

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 93919) - continued		µg/L	µg/L	%	%	%
gamma-BHC	0.5 µg/L	----	5	85.8	74.3	111
	0.5 µg/L	<0.5	----	----	----	----
Heptachlor	0.5 µg/L	----	5	92.5	80.4	103
	0.5 µg/L	<0.5	----	----	----	----
Heptachlor epoxide	0.5 µg/L	----	5	77.5	76.1	107
	0.5 µg/L	<0.5	----	----	----	----
Hexachlorobenzene (HCB)	0.5 µg/L	----	5	82.6	57.3	119
	0.5 µg/L	<0.5	----	----	----	----
Methoxychlor	2.0 µg/L	----	5	94.3	34.3	139
	2 µg/L	<2	----	----	----	----
trans-Chlordane	0.5 µg/L	----	5	86.4	76.8	105
	0.5 µg/L	<0.5	----	----	----	----
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 93919)		µg/L	µg/L	%	%	%
Methyl Azinphos	0.5 µg/L	----	5	84.0	54.8	127
	0.5 µg/L	<0.5	----	----	----	----
Bromophos-ethyl	0.5 µg/L	----	5	94.1	63.4	128
	0.5 µg/L	<0.5	----	----	----	----
Carbophenothion	0.5 µg/L	----	5	98.5	78.1	101
	0.5 µg/L	<0.5	----	----	----	----
Chlorfenvinphos	0.5 µg/L	----	5	91.1	78.7	106
	0.5 µg/L	<0.5	----	----	----	----
Chlorpyrifos	0.5 µg/L	----	5	81.7	79.5	104
	0.5 µg/L	<0.5	----	----	----	----
Chlorpyrifos-methyl	0.5 µg/L	----	5	82.6	76.6	106
	0.5 µg/L	<0.5	----	----	----	----
Demeton-S-methyl	0.5 µg/L	----	5	91.7	60.3	115
	0.5 µg/L	<0.5	----	----	----	----
Diazinon	0.5 µg/L	----	5	92.5	78.1	104
	0.5 µg/L	<0.5	----	----	----	----

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 93919) - continued		µg/L	µg/L	%	%	%
Dichlorvos	0.5 µg/L	----	5	84.2	70.4	110
	0.5 µg/L	<0.5	----	----	----	----
Dimethoate	0.5 µg/L	----	5	89.0	67.5	108
	0.5 µg/L	<0.5	----	----	----	----
Ethion	0.5 µg/L	----	5	84.3	57.6	123
	0.5 µg/L	<0.5	----	----	----	----
Fenamiphos	0.5 µg/L	----	5	76.8	66	109
	0.5 µg/L	<0.5	----	----	----	----
Fenthion	0.5 µg/L	----	5	86.9	65.6	117
	0.5 µg/L	<0.5	----	----	----	----
Malathion	0.5 µg/L	----	5	79.3	77.6	106
	0.5 µg/L	<0.5	----	----	----	----
Monocrotophos	0.5 µg/L	----	5	48.3	3.29	37.7
	2 µg/L	<2	----	----	----	----
Para hion	2.0 µg/L	----	5	82.4	79	100
	2 µg/L	<2	----	----	----	----
Para hion-methyl	2.0 µg/L	----	5	98.7	71.8	110
	2 µg/L	<2	----	----	----	----
Pirimphos-ethyl	0.5 µg/L	----	5	93.7	70.7	108
	0.5 µg/L	<0.5	----	----	----	----
Prothiofos	0.5 µg/L	----	5	82.0	74.8	104
	0.5 µg/L	<0.5	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons						
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - (QC Lot: 93915)		µg/L	µg/L	%	%	%
Acenaphthene	0.2 µg/L	----	2	79.3	74	111
	0.5 µg/L	<0.5	----	----	----	----
Acenaphthylene	0.2 µg/L	----	2	83.8	77	110
	0.5 µg/L	<0.5	----	----	----	----
Anthracene	0.2 µg/L	----	2	82.0	77	107
	0.5 µg/L	<0.5	----	----	----	----

ALS Environmental

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - continued						
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - (QC Lot: 93915) - continued		µg/L	µg/L	%	%	%
Benz(a)anthracene	0.2 µg/L	----	2	82.1	78	107
	0.5 µg/L	<0.5	----	----	----	----
Benzo(a)pyrene	0.2 µg/L	----	2	88.2	73	112
	0.5 µg/L	<0.5	----	----	----	----
Benzo(b)fluoranthene	0.2 µg/L	----	2	81.7	55	118
	0.5 µg/L	<0.5	----	----	----	----
Benzo(g,h,i)perylene	0.2 µg/L	----	2	95.0	66	107
	0.5 µg/L	<0.5	----	----	----	----
Benzo(k)fluoranthene	0.2 µg/L	----	2	87.5	67	114
	0.5 µg/L	<0.5	----	----	----	----
Chrysene	0.2 µg/L	----	2	81.7	76	109
	0.5 µg/L	<0.5	----	----	----	----
Dibenz(a,h)anthracene	0.2 µg/L	----	2	91.4	66	109
	0.5 µg/L	<0.5	----	----	----	----
Fluoranthene	0.2 µg/L	----	2	78.7	70	113
	0.5 µg/L	<0.5	----	----	----	----
Fluorene	0.2 µg/L	----	2	83.8	73	110
	0.5 µg/L	<0.5	----	----	----	----
Indeno(1,2,3,cd)pyrene	0.2 µg/L	----	2	89.0	68	109
	0.5 µg/L	<0.5	----	----	----	----
Naphthalene	0.2 µg/L	----	2	79.7	72	111
	0.5 µg/L	<0.5	----	----	----	----
Phenanthrene	0.2 µg/L	----	2	79.4	75	112
	0.5 µg/L	<0.5	----	----	----	----
Pyrene	0.2 µg/L	----	2	84.7	65	109
	0.5 µg/L	<0.5	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons						
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 93914)		µg/L	µg/L	%	%	%
C10 - C14 Fraction	50 µg/L	----	200	85.1	75	134
	50 µg/L	<50	----	----	----	----

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP080/071: Total Petroleum Hydrocarbons - continued						
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 93914) - continued		µg/L	µg/L	%	%	%
C15 - C28 Fraction	100 µg/L	----	200	98.1	87	132
	100 µg/L	<100	----	----	----	----
C29 - C36 Fraction	50 µg/L	----	200	106	80	126
	50 µg/L	<50	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 94008)		µg/L	µg/L	%	%	%
C6 - C9 Fraction	20 µg/L	----	260	104	80	120
	20 µg/L	<20	----	----	----	----
EP080: BTEX						
EP080: BTEX - (QC Lot: 94008)		µg/L	µg/L	%	%	%
Benzene	1 µg/L	----	10	97.6	78	125
	1 µg/L	<1	----	----	----	----
Ethylbenzene	2 µg/L	----	10	95.7	73	118
	2 µg/L	<2	----	----	----	----
meta- & para-Xylene	2 µg/L	----	10	95.6	78	117
	2 µg/L	<2	----	----	----	----
ortho-Xylene	2 µg/L	----	10	96.6	75	119
	2 µg/L	<2	----	----	----	----
Toluene	2 µg/L	----	10	105	74	126
	2 µg/L	<2	----	----	----	----

Quality Control Report - Matrix Spikes (MS)

The quality control term **Matrix Spike (MS)** refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQO's). 'Ideal' recovery ranges stated may be waived in the event of sample matrix interferences. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** *= Limit of Reporting,* ***RPD*** *= Relative Percent Difference.*

* Indicates failed QC

Matrix Type: SOIL

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	Laboratory Sample ID	Client Sample ID	LOR	Spike Concentration		MS	Low	High
EG005T: Total Metals by ICP-AES								
EG005T: Total Metals by ICP-AES - (QC Lot: 95296)				mg/kg	mg/kg	%	%	%
Arsenic	ES0506026-004	Anonymous	5 mg/kg	50	6	96.5	70	130
Cadmium			1 mg/kg	50	<1	104	70	130
Chromium			2 mg/kg	50	10	104	70	130
Copper			5 mg/kg	250	17	105	70	130
Lead			5 mg/kg	250	13	104	70	130
Nickel			2 mg/kg	50	<2	106	70	130
Zinc			5 mg/kg	250	8	97.2	70	130
EG005T: Total Metals by ICP-AES - (QC Lot: 95298)				mg/kg	mg/kg	%	%	%
Arsenic	ES0506034-007	9	5 mg/kg	50	<5	112	70	130
Beryllium			1 mg/kg	50	<1	* Not Determined	70	130
Cadmium			1 mg/kg	50	<1	105	70	130
Chromium			2 mg/kg	50	11	104	70	130
Cobalt			2 mg/kg	50	2	0.08	70	130
Copper			5 mg/kg	250	<5	102	70	130
Lead			5 mg/kg	250	7	105	70	130
Nickel			2 mg/kg	50	3	107	70	130
Zinc			5 mg/kg	250	9	93.3	70	130
EG035T: Total Mercury by FIMS								
EG035T: Total Mercury by FIMS - (QC Lot: 95297)				mg/kg	mg/kg	%	%	%
Mercury	ES0506026-004	Anonymous	0.1 mg/kg	5	<0.1	101	70	130
EG035T: Total Mercury by FIMS - (QC Lot: 95299)				mg/kg	mg/kg	%	%	%
Mercury	ES0506034-007	9	0.1 mg/kg	5	<0.1	95.3	70	130
EP066: Polychlorinated Biphenyls (PCB)								
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 94716)				mg/kg	mg/kg	%	%	%

Matrix Type: SOIL

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EP066: Polychlorinated Biphenyls (PCB) - continued								
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 94716) - continued				mg/kg	mg/kg	%	%	%
Total Polychlorinated biphenyls	ES0506039-001	Anonymous	0.1 mg/kg	0.5	<0.10	91.0	70	130
EP068A: Organochlorine Pesticides (OC)								
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 94717)				mg/kg	mg/kg	%	%	%
gamma-BHC	ES0506039-001	Anonymous	0.05 mg/kg	0.25	<0.25	109	75.65	110.44
Heptachlor			0.05 mg/kg	0.25	<0.25	78.2	72.2	106.71
Aldrin			0.05 mg/kg	0.25	<0.25	93.8	77.54	107.0
Dieldrin			0.05 mg/kg	0.25	3.75	* Not Determined	76.37	109.7
Endrin			0.05 mg/kg	1	<0.25	85.5	68.51	119.47
4,4'-DDT			0.2 mg/kg	1	18.8	* Not Determined	67.12	118.10
EP068B: Organophosphorus Pesticides (OP)								
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 94717)				mg/kg	mg/kg	%	%	%
Diazinon	ES0506039-001	Anonymous	0.05 mg/kg	0.25	<0.25	78.6	75.85	107.06
Chlorpyrifos-methyl			0.05 mg/kg	0.25	<0.25	82.4	74.84	107.91
Pirimphos-ethyl			0.05 mg/kg	0.25	<0.25	88.6	67.98	109.42
Bromophos-ethyl			0.05 mg/kg	0.25	<0.25	82.6	74.94	107.37
Prothiofos			0.05 mg/kg	0.25	<0.25	91.0	75.45	106.05
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - (QC Lot: 95083)				mg/kg	mg/kg	%	%	%
Acenaphthene	ES0506034-008	12	0.5 mg/kg	10	<0.5	88.9	70	130
Pyrene			0.5 mg/kg	10	<0.5	82.4	70	130
EP080/071: Total Petroleum Hydrocarbons								
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 94297)				mg/kg	mg/kg	%	%	%
C6 - C9 Fraction	ES0506036-008	Anonymous	2 mg/kg	26	<2	73.3	70	130
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 95082)				mg/kg	mg/kg	%	%	%
C10 - C14 Fraction	ES0506034-008	12	50 mg/kg	700	<50	109	70	130
C15 - C28 Fraction			100 mg/kg	3400	<100	123	70	130
C29 - C36 Fraction			100 mg/kg	3600	<100	105	70	130
EP080: BTEX								

Matrix Type: SOIL

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EP080: BTEX - continued								
EP080: BTEX - (QC Lot: 94297)				mg/kg	mg/kg	%	%	%
Benzene	ES0506036-008	Anonymous	0.2 mg/kg	2.5	<0.2	72.0	70	130
Toluene			0.2 mg/kg	2.5	<0.2	71.8	70	130
Ethylbenzene			0.2 mg/kg	2.5	<0.2	72.2	70	130
meta- & para-Xylene			0.2 mg/kg	2.5	<0.2	72.4	70	130
ortho-Xylene			0.2 mg/kg	2.5	<0.2	75.1	70	130

Matrix Type: WATER

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EG020F: Dissolved Metals by ICP-MS								
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 94943)				mg/L	mg/L	%	%	%
Arsenic	ES0505997-005	Anonymous	0.001 mg/L	0.2	<0.001	110	70	130
Beryllium			0.001 mg/L	0.2	<0.001	108	70	130
Barium			0.001 mg/L	0.2	0.017	106	70	130
Cadmium			0.0001 mg/L	0.05	<0.0001	108	70	130
Chromium			0.001 mg/L	0.2	<0.001	103	70	130
Cobalt			0.001 mg/L	0.2	0.035	105	70	130
Copper			0.001 mg/L	0.2	0.002	109	70	130
Lead			0.001 mg/L	0.2	<0.001	103	70	130
Manganese			0.001 mg/L	0.2	0.562	98.5	70	130
Nickel			0.001 mg/L	0.2	0.011	113	70	130
Vanadium			0.01 mg/L	0.2	<0.01	113	70	130
Zinc			0.005 mg/L	0.2	0.028	114	70	130
EG020T: Total Metals by ICP-MS								
EG020T: Total Metals by ICP-MS - (QC Lot: 94411)				mg/L	mg/L	%	%	%
Arsenic	ES0506027-040	Anonymous	0.001 mg/L	1	<0.001	115	70	130
Beryllium			0.001 mg/L	1	<0.001	110	70	130
Barium			0.001 mg/L	1	0.009	109	70	130
Cadmium			0.0001 mg/L	0.25	<0.0001	113	70	130
Chromium			0.001 mg/L	1	0.002	102	70	130

Matrix Type: WATER

Matrix Spike (MS) Report

Analyte name	Laboratory Sample ID	Client Sample ID	LOR	Spike Concentration	Actual Results: Sample Result	Actual Results: Spike Recovery MS	Recovery Limits: Static Limits Low	Recovery Limits: Static Limits High
EG020T: Total Metals by ICP-MS - continued								
EG020T: Total Metals by ICP-MS - (QC Lot: 94411) - continued				mg/L	mg/L	%	%	%
Cobalt	ES0506027-040	Anonymous	0.001 mg/L	1	<0.001	108	70	130
Copper			0.001 mg/L	1	<0.001	106	70	130
Lead			0.001 mg/L	1	<0.001	114	70	130
Manganese			0.001 mg/L	1	0.004	114	70	130
Nickel			0.001 mg/L	1	<0.001	116	70	130
Vanadium			0.01 mg/L	1	<0.01	112	70	130
Zinc			0.005 mg/L	1	0.022	106	70	130
EG035F: Dissolved Mercury by FIMS								
EG035F: Dissolved Mercury by FIMS - (QC Lot: 96109)				mg/L	mg/L	%	%	%
Mercury	ES0506026-001	Anonymous	0.0001 mg/L	0.0100	<0.0001	96.0	70	130
EG035T: Total Mercury by FIMS								
EG035T: Total Mercury by FIMS - (QC Lot: 94702)				mg/L	mg/L	%	%	%
Mercury	ES0505985-007	Anonymous	0.0001 mg/L	0.010	<0.0001	90.1	70	130
EG035T: Total Mercury by FIMS - (QC Lot: 96110)				mg/L	mg/L	%	%	%
Mercury	ES0506034-013	S-LOT 11 CREEK	0.0001 mg/L	0.010	<0.0001	96.1	70	130
EP080/071: Total Petroleum Hydrocarbons								
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 94008)				µg/L	µg/L	%	%	%
C6 - C9 Fraction	ES0506034-002	12-DAM	20 µg/L	250	<20	120	80	120
EP080: BTEX								
EP080: BTEX - (QC Lot: 94008)				µg/L	µg/L	%	%	%
Benzene	ES0506034-002	12-DAM	1 µg/L	25	<1	106	80	120
Toluene			2 µg/L	25	<2	95.7	80	120
Ethylbenzene			2 µg/L	25	<2	96.6	80	120
meta- & para-Xylene			2 µg/L	25	<2	93.7	80	120
ortho-Xylene			2 µg/L	25	<2	96.6	80	120

CHAIN OF CUSTODY DOCUMENTATION

019653

Australian Laboratory Services Pty Ltd
32 Shand Street
STAFFORD QLD 4053
TEL: (07) 3243 7222
FAX: (07) 3243 7218

CLIENT: Networks Geotechnics
POSTAL ADDRESS: 6/6 Morton close Tuggerah 2259
SEND REPORT TO: V. de Silva SEND INVOICE TO: V. de Silva.
DATA NEEDED BY: 27/07/05 REPORT NEEDED BY: —
PROJECT ID: G25058/1 QUOTE NO.:
P.O. NO.: COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LABORATORY BATCH NO.:
SAMPLERS:
PHONE: FAX: E-MAIL:
REPORT FORMAT: HARD: ☐ FAX: ☐ DISK: ☐ BULLETIN BOARD: ☐ E-MAIL: ☐
QC LEVEL: QCS1: ☐ QCS2: ☐ QCS3: ☐ QCS4: ☐

FOR LAB USE ONLY
COOLER SEAL
Yes ..... No .....
Broken ..... Intact .....
COOLER TEMP: deg. C

| SAMPLE DATA | | | | *CONTAINER DATA | | | ANALYSIS REQUIRED | | | |

Network Geotechnics

From: ALSE Sydney Aus [alse.sydney.aus@als.com.au]
Sent: Wednesday, 22 March 2006 5:46 PM
To: gosnetgeo@bigpond.com
Subject: Your Reference : G25058 1. Deliverables(Including Invoice) for ALSE Workorder : ES0603007



ES0603007_C ANA.PDF (55 KB) ES0603007_E G_SOIL-1.csv (1 ES0603007_Q INA.PDF (47 KB) ES0603007_Q KINA.PDF (130 KB) ES0603007_PI INVOICE_E5586 c.pdf (345 KB) es0603007_co

This e-mail has been automatically generated.

-- PLEASE DO NOT REPLY --

ALS acknowledges the risks associated with supplying electronic media reports based on client requirements. This type of format has the ability to embed viruses within the code and, as such, ALS has introduced a three tier layer of protection throughout their company resources. However, ALS cannot guarantee any attachment is virus free and will not be held liable for any disruption to business. It is highly recommended that all attachments received are scanned prior to opening.

****
This e-mail and any file transmitted with it are confidential and intended solely for the use of the individual or entity to whom they are addressed. If you received this e-mail in error, please notify the email Administrator at MailAdmin@als.com.au. This footnote also confirms that this message has been swept
to the best of our current abilities for the presence of computer viruses. You should NOT take this as any guarantee or warrant that such material is Virus free, and should apply Virus detection techniques appropriate to your security requirements BEFORE using any material attached to this message. Occasionally electronic communications are monitored and stored in secure databases by Campbell Brothers Ltd IT department to support operational and security activities. We respect the privacy right of all individuals and are committed to comply at all times with the Privacy Amendment (Private Sector) Act 2000. Further information can be obtained by viewing the CBL Privacy Policy by clicking here http://www.campbell.com.au/CBL_Privacy_Policy.pdf
****

ALS Environmental

CERTIFICATE OF ANALYSIS

Client	: NETWORK GEOTECHNICS PTY LTD	*Laboratory*	: ALS Environmental Sydney	*Page*	: 1 of 7
Contact	: MR VIPUL DE SILVA	*Contact*	: Greg Vogel	*Work Order*	: ES0603007
Address	: UNIT 14, 25 STODDART ROAD PROSPECT NSW AUSTRALIA 2148	*Address*	: 277-289 Woodpark Road Smithfield NSW Australia 2164		
E-mail	: gosnetgeo@bigpond.com	*E-mail*	: Greg.Vogel@alsenviro.com		
Telephone	: 02 9688 1764	*Telephone*	: 61-2-87848555		
Facsimile	: 02 9688 1765	*Facsimile*	: 61-2-87848500		
Project	: G25058 1	*Quote number*	: SY/405/02	*Date received*	: 14 Mar 2006
Order number	: Not provided			*Date issued*	: 22 Mar 2006
C-O-C number	: 008303 008305			*No. of samples*	- *Received* : 31
Site	- Not provided -				*Analysed* 7

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

This document has been digitally signed by those names that appear on this report and are the authorised signatories. Digital signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	*Position*	*Department*
Peter Dickenson	Senior Spectroscopist	Inorganics - NATA 825 (10911 - Sydney)
Rassem Ayoubi	Senior Organic Chemist	Organics - NATA 825 (10911 - Sydney)

ALS Environmental

Comments

This report for the ALSE reference ES0603007 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- **Analytical results for samples submitted**

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

- **Surrogate control limits**

The analytical procedures used by ALS Environmental are based on established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house procedure are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: COMPOSITE 1 Sample Matrix Type / Description: SOIL Sample Date / Time: 9 Mar 2006 11:00 Laboratory Sample ID: ES0603007-001	Client Sample ID: COMPOSITE 2 Sample Matrix Type / Description: SOIL Sample Date / Time: 9 Mar 2006 11:00 Laboratory Sample ID: ES0603007-002	Client Sample ID: COMPOSITE 3 Sample Matrix Type / Description: SOIL Sample Date / Time: 9 Mar 2006 11 00 Laboratory Sample ID: ES0603007-003	Client Sample ID: COMPOSITE 4 Sample Matrix Type / Description: SOIL Sample Date / Time: 9 Mar 2006 11:00 Laboratory Sample ID: ES0603007-004	Client Sample ID: COMPOSITE 5 Sample Matrix Type / Description: SOIL Sample Date / Time: 10 Mar 2006 11:00 Laboratory Sample ID: ES0603007-005
EA055: Moisture Content								
Moisture Content (dried @ 103°C)		1.0	%	14.9	18.7	7.0	12.2	16.6
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	5	9	<5	7	6
Barium	7440-39-3	10	mg/kg	40	40	70	200	110
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	12	27	12	20	35
Cobalt	7440-48-4	2	mg/kg	4	<2	2	<2	17
Copper	7440-50-8	5	mg/kg	<5	<5	<5	<5	9
Lead	7439-92-1	5	mg/kg	9	15	10	14	14
Manganese	7439-96-5	5	mg/kg	59	9	26	<5	931
Nickel	7440-02-0	2	mg/kg	4	4	3	<2	20
Vanadium	7440-62-2	5	mg/kg	33	62	29	44	72
Zinc	7440-66-6	5	mg/kg	10	18	9	9	37
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EP066: Polychlorinated Biphenyls (PCB)								
Total Polychlorinated biphenyls		0 10	mg/kg	<0.10	---	<0.10	---	<0.10
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
beta-BHC	319-85-7	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
gamma-BHC	58-89-9	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
delta-BHC	319-86-8	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
Heptachlor	76-44-8	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
Aldrin	309-00-2	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
Dieldrin	60-57-1	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
4.4'-DDE	72-55-9	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
Endrin	72-20-8	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
4.4'-DDD	72-54-8	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	---	<0.05	---	<0.05
Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	---	<0.05	---	<0.05

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: COMPOSITE 1 Sample Matrix Type / Description: SOIL Sample Date / Time: 9 Mar 2006 11:00 Laboratory Sample ID: ES0603007-001	Client Sample ID: COMPOSITE 2 Sample Matrix Type / Description: SOIL Sample Date / Time: 9 Mar 2006 11:00 Laboratory Sample ID: ES0603007-002	Client Sample ID: COMPOSITE 3 Sample Matrix Type / Description: SOIL Sample Date / Time: 9 Mar 2006 11 00 Laboratory Sample ID: ES0603007-003	Client Sample ID: COMPOSITE 4 Sample Matrix Type / Description: SOIL Sample Date / Time: 9 Mar 2006 11:00 Laboratory Sample ID: ES0603007-004	Client Sample ID: COMPOSITE 5 Sample Matrix Type / Description: SOIL Sample Date / Time: 10 Mar 2006 11:00 Laboratory Sample ID: ES0603007-005
EP068A: Organochlorine Pesticides (OC)								
4.4'-DDT	50-29-3	0.2	mg/kg	<0.2	----	<0.2	----	<0.2
Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Methoxychlor	72-43-5	0.2	mg/kg	<0.2	----	<0.2	----	<0.2
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	----	<0.2	----	<0.2
Dimethoate	60-51-5	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Diazinon	333-41-5	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	----	<0.2	----	<0.2
Malathion	121-75-5	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Fenthion	55-38-9	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Parathion	56-38-2	0.2	mg/kg	<0.2	----	<0.2	----	<0.2
Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Prothiofos	34643-46-4	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Ethion	563-12-2	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Carbophenothion	786-19-6	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
Azinphos Methyl	86-50-0	0.05	mg/kg	<0.05	----	<0.05	----	<0.05
EP066S: PCB Surrogate								
Decachlorobiphenyl	2051-24-3	0.1	%	58.2	----	50.8	----	48.8
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE		0.1	%	61.4	----	58.7	----	57.2
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.1	%	91.9	----	91.2	----	75.5

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID : COMPOSITE 6 Sample Matrix Type / Description : SOIL Sample Date / Time : 10 Mar 2006 11:00 Laboratory Sample ID : ES0603007-006	Client Sample ID : ES7 0.0-0.1 Sample Matrix Type / Description : SOIL Sample Date / Time : 10 Mar 2006 9:00 Laboratory Sample ID : ES0603007-031			
EA055: Moisture Content								
Moisture Content (dried @ 103°C)		1.0	%	13.2	16.2			
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	<5	----			
Barium	7440-39-3	10	mg/kg	80	----			
Beryllium	7440-41-7	1	mg/kg	<1	----			
Cadmium	7440-43-9	1	mg/kg	<1	----			
Chromium	7440-47-3	2	mg/kg	24	----			
Cobalt	7440-48-4	2	mg/kg	14	----			
Copper	7440-50-8	5	mg/kg	11	----			
Lead	7439-92-1	5	mg/kg	18	----			
Manganese	7439-96-5	5	mg/kg	1010	----			
Nickel	7440-02-0	2	mg/kg	13	----			
Vanadium	7440-62-2	5	mg/kg	62	----			
Zinc	7440-66-6	5	mg/kg	48	----			
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	----			
EP066: Polychlorinated Biphenyls (PCB)								
Total Polychlorinated biphenyls		0 10	mg/kg	<0.10	----			
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05			
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05			
beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05			
gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05			
delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05			
Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05			
Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05			
Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05			
trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05			
alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05			
cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05			
Dieldrin	60-57-1	0.05	mg/kg	<0.05	0.06			
4.4'-DDE	72-55-9	0.05	mg/kg	<0.05	<0.05			
Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05			
beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05			
4.4'-DDD	72-54-8	0.05	mg/kg	<0.05	<0.05			
Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05			
Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05			

ALS Environmental

Analytical Results

				Client Sample ID :	COMPOSITE 6	ES7 0.0-0.1			
				Sample Matrix Type / Description	SOIL	SOIL			
				Sample Date / Time :	10 Mar 2006 11:00	10 Mar 2006 9:00			
				Laboratory Sample ID :					
Analyte	CAS number	LOR	Units		ES0603007-006	ES0603007-031			
EP068A: Organochlorine Pesticides (OC)									
4.4'-DDT	50-29-3	0.2	mg/kg		<0.2	<0.2			
Endrin ketone	53494-70-5	0.05	mg/kg		<0.05	<0.05			
Methoxychlor	72-43-5	0.2	mg/kg		<0.2	<0.2			
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.05	mg/kg		<0.05	<0.05			
Demeton-S-methyl	919-86-8	0.05	mg/kg		<0.05	<0.05			
Monocrotophos	6923-22-4	0.2	mg/kg		<0.2	<0.2			
Dimethoate	60-51-5	0.05	mg/kg		<0.05	<0.05			
Diazinon	333-41-5	0.05	mg/kg		<0.05	<0.05			
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg		<0.05	<0.05			
Parathion-methyl	298-00-0	0.2	mg/kg		<0.2	<0.2			
Malathion	121-75-5	0.05	mg/kg		<0.05	<0.05			
Fenthion	55-38-9	0.05	mg/kg		<0.05	<0.05			
Chlorpyrifos	2921-88-2	0.05	mg/kg		<0.05	<0.05			
Parathion	56-38-2	0.2	mg/kg		<0.2	<0.2			
Pirimphos-ethyl	23505-41-1	0.05	mg/kg		<0.05	<0.05			
Chlorfenvinphos	470-90-6	0.05	mg/kg		<0.05	<0.05			
Bromophos-ethyl	4824-78-6	0.05	mg/kg		<0.05	<0.05			
Fenamiphos	22224-92-6	0.05	mg/kg		<0.05	<0.05			
Prothiofos	34643-46-4	0.05	mg/kg		<0.05	<0.05			
Ethion	563-12-2	0.05	mg/kg		<0.05	<0.05			
Carbophenothion	786-19-6	0.05	mg/kg		<0.05	<0.05			
Azinphos Methyl	86-50-0	0.05	mg/kg		<0.05	<0.05			
EP066S: PCB Surrogate									
Decachlorobiphenyl	2051-24-3	0.1	%		37.8	----			
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE		0.1	%		63.1	88.2			
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.1	%		105	107			

ALS Environmental

Surrogate Control Limits

Matrix Type: SOIL - Surrogate Control Limits ***Surrogate Control Limits***

Method name	*Analyte name*	*Lower Limit*	*Upper Limit*
EP066: Polychlorinated Biphenyls (PCB)			
EP066S: PCB Surrogate	Decachlorobiphenyl	10	164
EP068: Pesticides by GCMS			
EP068S: Organochlorine Pesticide Surrogate	Dibromo-DDE	10	136
EP068T: Organophosphorus Pesticide Surrogate	DEF	10	136

ALS Environmental

INTERPRETIVE QUALITY CONTROL REPORT

Client	:	**NETWORK GEOTECHNICS PTY LTD**	**Laboratory**	:	ALS Environmental Sydney	**Page**	: **1 of 5**
Contact		MR VIPUL DE SILVA	**Contact**		Greg Vogel		
Address	:	UNIT 14, 25 STODDART ROAD PROSPECT NSW AUSTRALIA 2148	**Address**	:	277 289 Woodpark Road Smithfield NSW Australia 2164	**Work order**	: **ES0603007**
						Amendment No	
Project	:	G25058 1	**Quote number**	:	SY/405/02	**Date received**	: 14 Mar 2006
Order number	:	- Not provided -				**Date issued**	: 22 Mar 2006
C-O-C number	:	008303 008305					
Site	:	Not provided					
E-mail	:	gosnetgeo@bigpond com	**E-mail**	:	Greg Vogel@alsenviro com	**No. of samples**	
Telephone	:	02 9688 1764	**Telephone**	:	61-2-87848555	**Received**	: 31
Facsimile	:	02 9688 1765	**Facsimile**	:	61 2 87848500	**Analysed**	: 7

This Interpretive Quality Control Report was issued on 22 Mar 2006 for the ALS work order reference ES0603007 and supersedes any previous reports with this reference.
This report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Type Frequency Compliance
- Summary of all Quality Control Outliers
- Brief Method Summaries

Interpretive Quality Control Report - Analysis Holding Time

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extrac ion or analysis and preclude subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the sample aliquot was taken. Elapsed time to analysis represents time from sampling where no extraction / digestion is involved or time from extraction / digestion where this is present. For composite samples, sampling date/time is taken as that of he oldest sample contributing to that composite. Sample date/time for laboratory produced leaches are taken from the comple ion date/time of the leaching process. Outliers for holding time are based on USEPA SW846, APHA, AS and NEPM (1999). Failed outliers, refer to the 'Summary of Outliers'.

Matrix Type: SOIL

Analysis Holding Time and Preservation

Method / Container / Client Sample ID(s)		Date Sampled	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EA055-103: Moisture Content								
Soil Glass Jar - Unpreserved								
COMPOSITE 1,	COMPOSITE 2,	**9 Mar 2006**	---	---	---	**21 Mar 2006**	16 Mar 2006	**Fail by 5 days**
COMPOSITE 3,	COMPOSITE 4							
Soil Glass Jar - Unpreserved								
ES7 0.0-0.1		**10 Mar 2006**	---	---	---	**20 Mar 2006**	17 Mar 2006	**Fail by 3 days**
Soil Glass Jar - Unpreserved								
COMPOSITE 5,	COMPOSITE 6	**10 Mar 2006**	---	---	---	**21 Mar 2006**	17 Mar 2006	**Fail by 4 days**
EG005T: Total Metals by ICP-AES								
Soil Glass Jar - Unpreserved								
COMPOSITE 1,	COMPOSITE 2,	**9 Mar 2006**	**21 Mar 2006**	5 Sep 2006	Pass	**21 Mar 2006**	5 Sep 2006	Pass
COMPOSITE 3,	COMPOSITE 4							
Soil Glass Jar - Unpreserved								
COMPOSITE 5,	COMPOSITE 6	**10 Mar 2006**	**21 Mar 2006**	6 Sep 2006	Pass	**21 Mar 2006**	6 Sep 2006	Pass
EG035T: Total Mercury by FIMS								
Soil Glass Jar - Unpreserved								
COMPOSITE 1,	COMPOSITE 2,	**9 Mar 2006**	**21 Mar 2006**	6 Apr 2006	Pass	**21 Mar 2006**	6 Apr 2006	Pass
COMPOSITE 3,	COMPOSITE 4							
Soil Glass Jar - Unpreserved								
COMPOSITE 5,	COMPOSITE 6	**10 Mar 2006**	**21 Mar 2006**	7 Apr 2006	Pass	**21 Mar 2006**	7 Apr 2006	Pass
EP066: Polychlorinated Biphenyls (PCB)								
Soil Glass Jar - Unpreserved								
COMPOSITE 1,	COMPOSITE 3	**9 Mar 2006**	**22 Mar 2006**	23 Mar 2006	Pass	**22 Mar 2006**	1 May 2006	Pass
Soil Glass Jar - Unpreserved								
COMPOSITE 5,	COMPOSITE 6	**10 Mar 2006**	**22 Mar 2006**	24 Mar 2006	Pass	**22 Mar 2006**	1 May 2006	Pass
EP068: Pesticides by GCMS								
Soil Glass Jar - Unpreserved								
COMPOSITE 1,	COMPOSITE 3	**9 Mar 2006**	**22 Mar 2006**	23 Mar 2006	Pass	**22 Mar 2006**	1 May 2006	Pass
Soil Glass Jar - Unpreserved								
ES7 0.0-0.1		**10 Mar 2006**	**17 Mar 2006**	24 Mar 2006	Pass	**20 Mar 2006**	26 Apr 2006	Pass
Soil Glass Jar - Unpreserved								
COMPOSITE 5,	COMPOSITE 6	**10 Mar 2006**	**22 Mar 2006**	24 Mar 2006	Pass	**22 Mar 2006**	1 May 2006	Pass

ALS Environmental

Interpretive Quality Control Report - Frequency of Quality Control Samples

The following report summarises the frequency of laboratory QC samples analysed within he analytical lot(s) in which this work order was processed. Actual rate should be greater than or equal to the expected rate.

Matrix Type: SOIL

Frequency of Quality Control Samples

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
EA055-103: Moisture Content	3	26	**11.5**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG005T: Total Metals by ICP-AES	1	6	**16.7**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	1	6	**16.7**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	1	4	**25.0**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	3	19	**15.8**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Laboratory Control Samples (LCS)					
EG005T: Total Metals by ICP-AES	1	6	**16.7**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	1	6	**16.7**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	1	4	**25.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	2	19	**10.5**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Method Blanks (MB)					
EG005T: Total Metals by ICP-AES	1	6	**16.7**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	1	6	**16.7**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	1	4	**25.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	2	19	**10.5**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Matrix Spikes (MS)					
EG005T: Total Metals by ICP-AES	1	6	**16 7**	**5 0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T Total Mercury by FIM	1	6	**16.7**	**5.0**	NEPM 1999 chedule B(3) and AL E QC 3 requirement
EP066: Polychlorinated Biphenyls (PCB)	1	4	**25.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	2	19	**10.5**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement

Interpretive Quality Control Report - Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged on the 'Quality Control Report'. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot.

Non-surrogates

Matrix Type: SOIL

Summary of Outliers - Quality Control Samples

ALS QC Lot	Matrix Type	Laboratory Sample ID	Client Sample ID	Analyte	Data	Limits	Comment
Laboratory Control Samples (LCS)							
EP068A: Organochlorine Pesticides (OC)	SOIL	204725-002	----	beta-Endosulfan	121 %	73.8-112 %	Recovery greater than upper control limit
Matrix Spikes (MS)							
EP068B: Organophosphorus Pesticides (OP)	SOIL	ES0603007-005	COMPOSITE 5	Chlorpyrifos-methyl	68.2 %	74 84-107.	Recovery less than lower data quality objective

- **For all matrices, no RPD recovery outliers occur for the duplicate analysis.**
- **For all matrices, no method blank result outliers occur.**

Surrogates

- **For all matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time

The following report highlights outliers within his 'Interpretive Quality Control Report - Analysis Holding Time'.

- **No holding time outliers occur.**

Outliers : Frequency of Quality Control Samples

The following report highlights outliers within this 'Interpretive Quality Control Report - Frequency of Quality Control Samples'.

- **No frequency outliers occur.**

Method Reference Summary

The analytical procedures used by ALS Environmental are based on established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house procedure are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

Matrix Type: SOIL ***Method Reference Summary***

Preparation Methods

EN69 : Hot Block Digest for metals in soils sediments and sludges - USEPA 200.2 Mod. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bu ked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (1999) Schedule B(3) (Method 202)

ORG17A : Tumbler Extraction of Solids (Option A - Concentrating) - In-house, Mechanical agitation (tumbler). 20g of sample, Na2SO4 and surrogate are extracted with 150mL 1:1 DCM/Acetone by end over end tumble. The solvent is decanted, dehydrated and concentrated (by KD) to the desired volume for analysis.

Analytical Methods

ASB-SOL : Asbestos - Count (Solid) - Asbestos Count on solid matrices conducted by Subcontracting Laboratory

EA055-103 : Moisture Content - A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (1999) Schedule B(3) (Method 102)

EG005T : Total Metals by ICP-AES - (APHA 20th ed., 3120; USEPA SW 846 - 6010) (ICPAES) Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (1999) Schedule B(3)

EG035T : Total Mercury by FIMS - AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion A bromate/bromide reagent is used to oxidise any organic mercury compounds in the extract Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve.

EP066 : Polychlorinated Biphenyls (PCB) - (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point cal bration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 504)

EP068 : Pesticides by GCMS - (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This technique is compliant with NEPM (1999) Schedule B(3) (Method 504,505)

ALS Environmental

QUALITY CONTROL REPORT

Client	:	**NETWORK GEOTECHNICS PTY LTD**	**Laboratory**	: ALS Environmental Sydney	**Page**	:	**1 of 16**
Contact	:	MR VIPUL DE SILVA	**Contact**	: Greg Vogel			
Address	:	UNIT 14, 25 STODDART ROAD PROSPECT NSW AUSTRALIA 2148	**Address**	: 277-289 Woodpark Road Smithfield NSW Australia 2164	**Work order**	:	**ES0603007**
					Amendment No.	:	
Project	:	G25058 1	**Quote number**	: SY/405/02	**Date received**	:	14 Mar 2006
Order number	:	- Not provided -			**Date issued**	:	22 Mar 2006
C-O-C number	:	008303 - 008305					
Site	:	- Not provided -					
E-mail	:	gosnetgeo@bigpond.com	**E-mail**	: Greg.Vogel@alsenviro.com	**No. of samples**		
Telephone	:	02 9688 1764	**Telephone**	: 61-2-87848555	**Received**	:	31
Facsimile	:	02 9688 1765	**Facsimile**	: 61-2-87848500	**Analysed**	:	7

This final report for the ALSE work order reference ES0603007 supersedes any previous reports with this reference.
Results apply to the samples as submitted. All pages of this report have been checked and approved for release.
This report contains the following information:

- Laboratory Duplicates (DUP); Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Samples (LCS); Recovery and Acceptance Limits
- Matrix Spikes (MS); Recovery and Acceptance Limits

ALSE - Excellence in Analytical Testing

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory - 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IED 17025

This document has been digitally signed by those names that appear on this report and are the authorised signatories. Digital signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Peter Dickenson	norganics - NATA 825 (10911 - Sydney)
Rassem Ayoubi	Organics - NATA 825 (10911 - Sydney)

Quality Control Report - Laboratory Duplicates (DUP)

The quality control term **Laboratory Duplicate** refers to an intralaboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
- Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** = *Limit of Reporting,* ***RPD*** = *Relative Percent Difference.*
* Indicates failed QC. The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:- Result < 10 times LOR, no limit - Result between 10 and 20 times LOR, 0% - 50% - Result > 20 times LOR, 0% - 20%

Matrix Type: SOIL ***Laboratory Duplicates (DUP) Report***

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EA055: Moisture Content						
EA055: Moisture Content - (QC Lot: 188371)				%	%	%
ES0603007-031	ES7 0.0-0.1	Moisture Content (dried @ 103°C)	1.0 %	16.2	16.3	0.0
ES0603047-009	Anonymous	Moisture Content (dried @ 103°C)	1.0 %	3.1	3.1	0.0
EA055: Moisture Content - (QC Lot: 188556)				%	%	%
ES0603007-001	COMPOSITE 1	Moisture Content (dried @ 103°C)	1.0 %	14.9	14.8	0.7
EG005T: Total Metals by ICP-AES						
EG005T: Total Metals by ICP-AES - (QC Lot: 188560)				mg/kg	mg/kg	%
ES0603007-001	COMPOSITE 1	Arsenic	5 mg/kg	5	6	21.2
		Barium	10 mg/kg	40	40	0.0
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	2 mg/kg	12	15	23.4
		Cobalt	2 mg/kg	4	4	0.0
		Copper	5 mg/kg	<5	<5	0.0
		Lead	5 mg/kg	9	12	24.6
		Manganese	5 mg/kg	59	64	7.2
		Nickel	2 mg/kg	4	6	29.3
		Vanadium	5 mg/kg	33	37	11.9
		Zinc	5 mg/kg	10	14	30.8
EG035T: Total Mercury by FIMS						
EG035T: Total Mercury by FIMS - (QC Lot: 188559)				mg/kg	mg/kg	%
ES0603007-001	COMPOSITE 1	Mercury	0.1 mg/kg	<0.1	<0.1	0.0
EP066 Polychlorinated Biphenyls (PCB)						
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 188583)				mg/kg	mg/kg	%
ES0603007-005	COMPOSITE 5	Total Polychlorinated biphenyls	0.10 mg/kg	<0.10	<0.10	0.0
EP068A: Organochlorine Pesticides (OC)						

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 185576)				mg/kg	mg/kg	%
ES0603017-019	Anonymous	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
ES0603017-027	Anonymous	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 185576) - continued				mg/kg	mg/kg	%
ES0603017-027	Anonymous	trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDE	0.05 mg/kg	0.34	0.23	39.6
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDD	0.05 mg/kg	0.09	0.08	17.6
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188582)				mg/kg	mg/kg	%
ES0603007-005	COMPOSITE 5	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188582) - continued				mg/kg	mg/kg	%
ES0603007-005	COMPOSITE 5	4,4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 185576)				mg/kg	mg/kg	%
ES0603017-019	Anonymous	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Methyl Azinphos	0.05 mg/kg	<0.05	<0.05	0.0
ES0603017-027	Anonymous	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 185576) - continued				mg/kg	mg/kg	%
ES0603017-027	Anonymous	Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Methyl Azinphos	0.05 mg/kg	<0.05	<0.05	0.0
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188582)				mg/kg	mg/kg	%
ES0603007-005	COMPOSITE 5	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188582) - continued				mg/kg	mg/kg	%
ES0603007-005	COMPOSITE 5	Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Methyl Azinphos	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Quality Control Report - Method Blank (MB) and Laboratory Control Samples (LCS)

The quality control term **Method / Laboratory Blank** refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term **Laboratory Control Sample (LCS)** refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of actual laboratory data. Abbreviations: LOR = Limit of reporting.

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

		Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
Analyte name	LOR			LCS	Low	High
EG005T: Total Metals by ICP-AES						
EG005T: Total Metals by ICP-AES - (QC Lot: 188560)		mg/kg	mg/kg	%	%	%
Arsenic	5 mg/kg	----	13.1	112	70	130
	5 mg/kg	<5	----	----	----	----
Barium	10 mg/kg	<10	----	----	----	----
Beryllium	1 mg/kg	<1	----	----	----	----
Cadmium	1 mg/kg	----	2.76	94.7	70	130
	1 mg/kg	<1	----	----	----	----
Chromium	2 mg/kg	----	60.9	104	70	130
	2 mg/kg	<2	----	----	----	----
Cobalt	2 mg/kg	<2	----	----	----	----
Copper	5 mg/kg	----	54.7	99.0	70	130
	5 mg/kg	<5	----	----	----	----
Lead	5 mg/kg	----	55.2	98.8	70	130
	5 mg/kg	<5	----	----	----	----
Manganese	5 mg/kg	<5	----	----	----	----
Nickel	2 mg/kg	----	54.8	104	70	130
	2 mg/kg	<2	----	----	----	----
Vanadium	5 mg/kg	<5	----	----	----	----
Zinc	5 mg/kg	----	104	95.5	70	130
	5 mg/kg	<5	----	----	----	----
EG035T: Total Mercury by FIMS						
EG035T: Total Mercury by FIMS - (QC Lot: 188559)		mg/kg	mg/kg	%	%	%
Mercury	0.1 mg/kg	----	1.4	101	70	130
	0.1 mg/kg	<0.1	----	----	----	----
EP066: Polychlorinated Biphenyls (PCB)						
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 188583)		mg/kg	mg/kg	%	%	%

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
				LCS	Low	High
EP066: Polychlorinated Biphenyls (PCB) - continued						
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 188583) - continued		mg/kg	mg/kg	%	%	%
Total Polychlorinated biphenyls	0.1 mg/kg	----	0.5	98.5	66	121
	0.10 mg/kg	<0.10	----	----	----	----
EP068A: Organochlorine Pesticides (OC)						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 185576)		mg/kg	mg/kg	%	%	%
4,4'-DDD	0.05 mg/kg	----	0.25	98.0	72.4	109
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDE	0.05 mg/kg	----	0.25	96.4	73.6	107
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDT	0.2 mg/kg	----	0.25	100	62.1	125
	0.2 mg/kg	<0.2	----	----	----	----
Aldrin	0.05 mg/kg	----	0.25	106	73.3	108
	0.05 mg/kg	<0.05	----	----	----	----
alpha-BHC	0.05 mg/kg	----	0.25	93.0	77.5	109
	0.05 mg/kg	<0.05	----	----	----	----
alpha-Endosulfan	0.05 mg/kg	----	0.25	97.2	71.5	112
	0.05 mg/kg	<0.05	----	----	----	----
beta-BHC	0.05 mg/kg	----	0.25	94.0	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----
beta-Endosulfan	0.05 mg/kg	----	0.25	99.4	73.8	112
	0.05 mg/kg	<0.05	----	----	----	----
cis-Chlordane	0.05 mg/kg	----	0.25	101	70.8	111
	0.05 mg/kg	<0.05	----	----	----	----
delta-BHC	0.05 mg/kg	----	0.25	98.4	67.1	113
	0.05 mg/kg	<0.05	----	----	----	----
Dieldrin	0.05 mg/kg	----	0.25	99.4	72.7	109
	0.05 mg/kg	<0.05	----	----	----	----
Endosulfan sulfate	0.05 mg/kg	----	0.25	106	68.5	115
	0.05 mg/kg	<0.05	----	----	----	----
Endrin	0.05 mg/kg	----	0.25	105	65.8	107
	0.05 mg/kg	<0.05	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 185576) - continued		mg/kg	mg/kg	%	%	%
Endrin aldehyde	0.05 mg/kg	----	0.25	94.0	72.2	114
	0.05 mg/kg	<0.05	----	----	----	----
Endrin ketone	0.05 mg/kg	----	0.25	98.8	71.1	114
	0.05 mg/kg	<0.05	----	----	----	----
gamma-BHC	0.05 mg/kg	----	0.25	93.8	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor	0.05 mg/kg	----	0.25	100	74.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor epoxide	0.05 mg/kg	----	0.25	98.8	74	108
	0.05 mg/kg	<0.05	----	----	----	----
Hexachlorobenzene (HCB)	0.05 mg/kg	----	0.25	92.2	69.6	108
	0.05 mg/kg	<0.05	----	----	----	----
Methoxychlor	0.2 mg/kg	----	0.25	101	56.8	137
	0.2 mg/kg	<0.2	----	----	----	----
trans-Chlordane	0.05 mg/kg	----	0.25	92.6	74.6	108
	0.05 mg/kg	<0.05	----	----	----	----
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188582)		mg/kg	mg/kg	%	%	%
4,4'-DDD	0.05 mg/kg	----	0.25	81.2	72.4	109
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDE	0.05 mg/kg	----	0.25	91.8	73.6	107
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDT	0.2 mg/kg	----	0.25	84.8	62.1	125
	0.2 mg/kg	<0.2	----	----	----	----
Aldrin	0.05 mg/kg	----	0.25	79.6	73.3	108
	0.05 mg/kg	<0.05	----	----	----	----
alpha-BHC	0.05 mg/kg	<0.05	----	----	----	----
	0.05 mg/kg	----	0.25	79.6	77.5	109
alpha-Endosulfan	0.05 mg/kg	----	0.25	82.8	71.5	112
	0.05 mg/kg	<0.05	----	----	----	----

ALS Environmental

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188582) - continued		mg/kg	mg/kg	%	%	%
beta-BHC	0.05 mg/kg	<0.05	----	----	----	----
	0.05 mg/kg	----	0.25	87.0	73.1	110
beta-Endosulfan	0.05 mg/kg	----	0.25	121	73.8	112
	0.05 mg/kg	<0.05	----	----	----	----
cis-Chlordane	0.05 mg/kg	----	0.25	78.6	70.8	111
	0.05 mg/kg	<0.05	----	----	----	----
delta-BHC	0.05 mg/kg	----	0.25	75.0	67.1	113
	0.05 mg/kg	<0.05	----	----	----	----
Dieldrin	0.05 mg/kg	----	0.25	81.6	72.7	109
	0.05 mg/kg	<0.05	----	----	----	----
Endosulfan sulfate	0.05 mg/kg	----	0.25	85.0	68.5	115
	0.05 mg/kg	<0.05	----	----	----	----
Endrin	0.05 mg/kg	----	0.25	83.4	65.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Endrin aldehyde	0.05 mg/kg	----	0.25	81.0	72.2	114
	0.05 mg/kg	<0.05	----	----	----	----
Endrin ketone	0.05 mg/kg	----	0.25	103	71.1	114
	0.05 mg/kg	<0.05	----	----	----	----
gamma-BHC	0.05 mg/kg	----	0.25	84.6	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor	0.05 mg/kg	----	0.25	91.4	74.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor epoxide	0.05 mg/kg	----	0.25	77.4	74	108
	0.05 mg/kg	<0.05	----	----	----	----
Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	----	----	----	----
	0.05 mg/kg	----	0.25	88.8	69.6	108
Methoxychlor	0.2 mg/kg	----	0.25	84.4	56.8	137
	0.2 mg/kg	<0.2	----	----	----	----
trans-Chlordane	0.05 mg/kg	----	0.25	81.4	74.6	108
	0.05 mg/kg	<0.05	----	----	----	----

ALS Environmental

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 185576)		mg/kg	mg/kg	%	%	%
Methyl Azinphos	0.05 mg/kg	----	0.25	103	33.1	144
	0.05 mg/kg	<0.05	----	----	----	----
Bromophos-ethyl	0.05 mg/kg	----	0.25	99.4	66.5	112
	0.05 mg/kg	<0.05	----	----	----	----
Carbophenothion	0.05 mg/kg	----	0.25	94.0	67.8	108
	0.05 mg/kg	<0.05	----	----	----	----
Chlorfenvinphos	0.05 mg/kg	----	0.25	92.6	54.5	132
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos	0.05 mg/kg	----	0.25	98.2	75	109
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos-methyl	0.05 mg/kg	----	0.25	99.0	72.2	107
	0.05 mg/kg	<0.05	----	----	----	----
Demeton-S-methyl	0.05 mg/kg	----	0.25	87.6	57.7	123
	0.05 mg/kg	<0.05	----	----	----	----
Diazinon	0.05 mg/kg	----	0.25	93.8	72.9	108
	0.05 mg/kg	<0.05	----	----	----	----
Dichlorvos	0.05 mg/kg	----	0.25	77.0	64	117
	0.05 mg/kg	<0.05	----	----	----	----
Dimethoate	0.05 mg/kg	----	0.25	105	60.7	117
	0.05 mg/kg	<0.05	----	----	----	----
Ethion	0.05 mg/kg	----	0.25	102	58.9	116
	0.05 mg/kg	<0.05	----	----	----	----
Fenamiphos	0.05 mg/kg	----	0.25	87.4	48.8	118
	0.05 mg/kg	<0.05	----	----	----	----
Fenthion	0.05 mg/kg	----	0.25	97.6	72.5	107
	0.05 mg/kg	<0.05	----	----	----	----
Malathion	0.05 mg/kg	----	0.25	106	61.6	121
	0.05 mg/kg	<0.05	----	----	----	----
Monocrotophos	0.2 mg/kg	----	0.25	93.6	46.9	125
	0.2 mg/kg	<0.2	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 185576) - continued		mg/kg	mg/kg	%	%	%
Para hion	0.2 mg/kg	----	0.25	110	65.2	116
	0.2 mg/kg	<0.2	----	----	----	----
Para hion-methyl	0.2 mg/kg	----	0.25	104	68	109
	0.2 mg/kg	<0.2	----	----	----	----
Pirimphos-ethyl	0.05 mg/kg	----	0.25	98.8	66.3	118
	0.05 mg/kg	<0.05	----	----	----	----
Prothiofos	0.05 mg/kg	----	0.25	98.2	73	111
	0.05 mg/kg	<0.05	----	----	----	----
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188582)		mg/kg	mg/kg	%	%	%
Methyl Azinphos	0.05 mg/kg	----	0.25	70.4	33.1	144
	0.05 mg/kg	<0.05	----	----	----	----
Bromophos-ethyl	0.05 mg/kg	----	0.25	82.8	66.5	112
	0.05 mg/kg	<0.05	----	----	----	----
Carbophenothion	0.05 mg/kg	----	0.25	85.0	67.8	108
	0.05 mg/kg	<0.05	----	----	----	----
Chlorfenvinphos	0.05 mg/kg	----	0.25	81.4	54.5	132
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos	0.05 mg/kg	----	0.25	75.4	75	109
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos-methyl	0.05 mg/kg	----	0.25	80.2	72.2	107
	0.05 mg/kg	<0.05	----	----	----	----
Demeton-S-methyl	0.05 mg/kg	----	0.25	75.6	57.7	123
	0.05 mg/kg	<0.05	----	----	----	----
Diazinon	0.05 mg/kg	----	0.25	83.8	72.9	108
	0.05 mg/kg	<0.05	----	----	----	----
Dichlorvos	0.05 mg/kg	----	0.25	77.0	64	117
	0.05 mg/kg	<0.05	----	----	----	----
Dimethoate	0.05 mg/kg	----	0.25	93.8	60.7	117
	0.05 mg/kg	<0.05	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188582) - continued		mg/kg	mg/kg	%	%	%
Ethion	0.05 mg/kg	----	0.25	81.0	58.9	116
	0.05 mg/kg	<0.05	----	----	----	----
Fenamiphos	0.05 mg/kg	----	0.25	77.0	48.8	118
	0.05 mg/kg	<0.05	----	----	----	----
Fenthion	0.05 mg/kg	----	0.25	82.8	72.5	107
	0.05 mg/kg	<0.05	----	----	----	----
Malathion	0.05 mg/kg	----	0.25	79.6	61.6	121
	0.05 mg/kg	<0.05	----	----	----	----
Monocrotophos	0.2 mg/kg	----	0.25	64.2	46.9	125
	0.2 mg/kg	<0.2	----	----	----	----
Para hion	0.2 mg/kg	----	0.25	97.0	65.2	116
	0.2 mg/kg	<0.2	----	----	----	----
Para hion-methyl	0.2 mg/kg	----	0.25	91.4	68	109
	0.2 mg/kg	<0.2	----	----	----	----
Pirimphos-ethyl	0.05 mg/kg	----	0.25	79.4	66.3	118
	0.05 mg/kg	<0.05	----	----	----	----
Prothiofos	0.05 mg/kg	----	0.25	81.6	73	111
	0.05 mg/kg	<0.05	----	----	----	----

Quality Control Report - Matrix Spikes (MS)

The quality control term **Matrix Spike (MS)** refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQO's). 'Ideal' recovery ranges stated may be waived in the event of sample matrix interferences. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** *= Limit of Reporting,* ***RPD*** *= Relative Percent Difference.*

* Indicates failed QC

Matrix Type: SOIL

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	Laboratory Sample ID	Client Sample ID	LOR	Spike Concentration		MS	Low	High
EG005T: Total Metals by ICP-AES								
EG005T: Total Metals by ICP-AES - (QC Lot: 188560)				mg/kg	mg/kg	%	%	%
Arsenic	ES0603007-001	COMPOSITE 1	5 mg/kg	50	5	106	70	130
Cadmium			1 mg/kg	50	<1	106	70	130
Chromium			2 mg/kg	50	12	104	70	130
Copper			5 mg/kg	250	<5	107	70	130
Lead			5 mg/kg	250	9	103	70	130
Nickel			2 mg/kg	50	4	107	70	130
Zinc			5 mg/kg	250	10	101	70	130
EG035T: Total Mercury by FIMS								
EG035T: Total Mercury by FIMS - (QC Lot: 188559)				mg/kg	mg/kg	%	%	%
Mercury	ES0603007-001	COMPOSITE 1	0.1 mg/kg	5	<0.1	114	70	130
EP066: Polychlorinated Biphenyls (PCB)								
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 188583)				mg/kg	mg/kg	%	%	%
Total Polychlorinated biphenyls	ES0603007-005	COMPOSITE 5	0.1 mg/kg	0.5	<0.10	87.8	70	130
EP068A: Organochlorine Pesticides (OC)								
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 185576)				mg/kg	mg/kg	%	%	%
gamma-BHC	ES0603017-027	Anonymous	0.05 mg/kg	0.25	<0.05	104	75.65	110.44
Heptachlor			0.05 mg/kg	0.25	<0.05	88.4	72.2	106.71
Aldrin			0.05 mg/kg	0.25	<0.05	85.2	77.54	107.0
Dieldrin			0.05 mg/kg	0.25	<0.05	94.6	76.37	109.7
Endrin			0.05 mg/kg	1	<0.05	82.5	68.51	119.47
4,4'-DDT			0.20 mg/kg	1	<0.2	97.5	67.12	118.10
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188582)				mg/kg	mg/kg	%	%	%
gamma-BHC	ES0603007-005	COMPOSITE 5	0.05 mg/kg	0.25	<0.05	97.0	75.65	110.44

Matrix Type: SOIL

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EP068A: Organochlorine Pesticides (OC) - continued								
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188582) - continued				mg/kg	mg/kg	%	%	%
Heptachlor	ES0603007-005	COMPOSITE 5	0.05 mg/kg	0.25	<0.05	102	72.2	106.71
Aldrin			0.05 mg/kg	0.25	<0.05	82.0	77.54	107.0
Dieldrin			0.05 mg/kg	0.25	<0.05	84.2	76.37	109.7
Endrin			0.05 mg/kg	1	<0.05	84.5	68.51	119.47
4,4'-DDT			0.2 mg/kg	1	<0.2	117	67.12	118.10
EP068B: Organophosphorus Pesticides (OP)								
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 185576)				mg/kg	mg/kg	%	%	%
Diazinon	ES0603017-027	Anonymous	0.05 mg/kg	0.25	<0.05	104	75.85	107.06
Chlorpyrifos-methyl			0.05 mg/kg	0.25	<0.05	77.6	74.84	107.91
Pirimphos-ethyl			0.05 mg/kg	0.25	<0.05	80.8	67.98	109.42
Bromophos-ethyl			0.05 mg/kg	0.25	<0.05	79.2	74.94	107.37
Prothiofos			0.05 mg/kg	0.25	<0.05	94.6	75.45	106.05
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188582)				mg/kg	mg/kg	%	%	%
Diazinon	ES0603007-005	COMPOSITE 5	0.05 mg/kg	0.25	<0.05	97.0	75.85	107.06
Chlorpyrifos-methyl			0.05 mg/kg	0.25	<0.05	68.2	74.84	107.91
Pirimphos-ethyl			0.05 mg/kg	0.25	<0.05	87.0	67.98	109.42
Bromophos-ethyl			0.05 mg/kg	0.25	<0.05	81.8	74.94	107.37
Prothiofos			0.05 mg/kg	0.25	<0.05	84.2	75.45	106.05

CHAIN OF CUSTODY DOCUMENTATION

008303

Australian Laboratory Services Pty ltd
Unit 28, METRO CENTRE
38-46 South St
RYDALMERE NSW 2116
TEL: (02) 9841 9500
FAX: (02) 9841 9530

CLIENT: Network Geotechnics
POSTAL ADDRESS: 6/6 Morton Close TUGGERAH
SEND REPORT TO: VIPUL da SILVA SEND INVOICE TO:
DATA NEEDED BY: ASAP REPORT NEEDED BY: ASAP.
PROJECT ID: G25058/1 QUOTE NO.:
P.O. NO.: COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LABORATORY BATCH NO.:
SAMPLERS: TS
PHONE: 43 516 200 FAX: 43 516 300
REPORT FORMAT: HARD _____ FAX: _____ DISK: _____ BULLETIN BOARD: _____
QC LEVEL: QCS1 _____ QCS2 _____ QCS3 _____ QCS4 _____

LABORATORY USE ONLY
CUSTODY SEAL Yes / No
Intact
COOLER TEMP: deg. C

ANALYSIS REQUIRED

SAMPLE DATA				*CONTAINER DATA				
	SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	pH	NOTES
1	BH1 ES1 0.0-0.1	SOIL	10/3	AM	J	1		
2	ES2 0.5-0.6							
3	BH2 ES3 0.1-0.2							
4	ES4 0.5-0.6							
5	BH3 ES5 0.1-0.2							
6	ES6 0.6-0.7							
7	BH4 ES8 0.1-0.2							
8	ES9 0.5-0.6			PM				
9	BH5 ES10 0.1-0.2							
10	ES11 0.5-0.6							
11	BH6 ES12 0.1-0.2							
12	ES13 0.6-0.7							
13	BH7 ES14 0.1-0.2							
14	ES15 0.7-0.8							

S3 S13

ALS Environmental
Sydney
Work Order
ES0603007
Report Version: WOLabel 1.01
Telephone : 61-2-87848555

CONTRACT WORK
BACTO ASSET
ASBESTOS
1 X PULP BAG

RELINQUISHED BY		RECEIVED BY		
NAME: Tim Smith	DATE: 13/3/06	NAME:	DATE: 14-03-06	METHOD OF SHIPMENT
OF: NETWORK	TIME: pm	OF: JESSIE DAVID	TIME: 12:20pm	CONSIGNMENT NOTE NO.
NAME:	DATE:	NAME:	DATE:	TRANSPORT CO. NAME.
OF:	TIME:	OF:	TIME:	

*Container Type and Preservative Codes: **P** = Natural Plastic; **N** = Nitric Acid Preserved; **C** = Sodium Hydroxide Preserved; **J** = Solvent Washed Acid Rinsed Jar; **S** = Solvent Washed Acid Rinsed Glass Bottle; **VC** = Hydrochloric Acid Preserved Vial; **VS** = Sulphuric Acid Preserved Vial; **BS** = Sulphuric Acid Preserved Glass Bottle; **Z** = Zinc Acetate Preserved Bottle; **E** = EDTA Preserved Bottle; **ST** = Sterile Bottle; **O** = Other.

AUSTRALIAN LABORATORY SERVICES P/L

CHAIN OF CUSTODY DOCUMENTATION

008304

Australian Laboratory Services Pty ltd
Unit 28, METRO CENTRE
38-46 South St
RYDALMERE NSW 2116
TEL: (02) 9841 9500
FAX: (02) 9841 9530

CLIENT: Network Geotechnics
POSTAL ADDRESS: 6/6 Morton Close TUGGERAH
SEND REPORT TO: VIPUL da SILVA SEND INVOICE TO:
DATA NEEDED BY: ASAP REPORT NEEDED BY: ASAP
PROJECT ID: G25058/1 QUOTE NO.:
P.O. NO.: COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LABORATORY BATCH NO.:
SAMPLERS: TJ
PHONE: 43 516 200 FAX: 43 516 300
REPORT FORMAT: HARD ____ FAX: ____ DISK: ____ BULLETIN BOARD: ____
QC LEVEL: QCS1 ____ QCS2 ____ QCS3 ____ QCS4 ____

FOR LAB USE ONLY
ENDER SEAL
No
Intact
COOLER TEMP: deg. C

ANALYSIS REQUIRED

	SAMPLE DATA				*CONTAINER DATA			S3	S13	NOTES
	SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	pH			
21	BH8 ES16 0.0-0.1	SOIL	10/3	PM	J	1				
22	ES17 0.7-0.8	↓	↓	↓	↓	↓				
23	BH9 ES18 0.1-0.2	↓	↓	↓	↓	↓				
24	ES19 0.6-0.7	↓	↓	↓	↓	↓				
25	BH10 ES20 0.0-0.1	↓	↓	↓	↓	↓				
26	ES21 0.8-0.9	↓	↓	↓	↓	↓				
27	BH11 ES22 0.0-0.1	↓	↓	↓	↓	↓				
28	ES23 0.5-0.6	↓	↓	↓	↓	↓				
29	BH12 ES24 0.1-0.2	↓	↓	↓	↓	↓				
30	ES25 0.5-0.6	↓	↓	↓	↓	↓				
1	Composite 1	SOIL	10/3							
	ES1 + ES3 + ES5	↓	↓					/	/	
2	Composite 2	↓	↓							
	ES2 + ES4 + ES6	↓	↓					/		

RELINQUISHED BY		RECEIVED BY		METHOD OF SHIPMENT
NAME: Tim Smith OF: NETWORK	DATE: 13/5/06 TIME: pm	NAME: JESSIED OF: ALS	DATE: 14-12-06 TIME: 12:20pm	CONSIGNMENT NOTE NO.
NAME: OF:	DATE: TIME:	NAME: OF:	DATE: TIME:	TRANSPORT CO. NAME.

*Container Type and Preservative Codes: **P** = Natural Plastic; **N** = Nitric Acid Preserved; **C** = Sodium Hydroxide Preserved; **J** = Solvent Washed Acid Rinsed Jar; **S** = Solvent Washed Acid Rinsed Glass Bottle; **VC** = Hydrochloric Acid Preserved Vial; **VS** = Sulphuric Acid Preserved Vial; **BS** = Sulphuric Acid Preserved Glass Bottle; **Z** = Zinc Acetate Preserved Bottle; **E** = EDTA Preserved Bottle; **ST** = Sterile Bottle; **O** = Other.

AUSTRALIAN LABORATORY SERVICES P/L

CHAIN OF CUSTODY DOCUMENTATION

008305

Australian Laboratory Services Pty ltd
Unit 28, METRO CENTRE
38-46 South St
RYDALMERE NSW 2116
TEL: (02) 9841 9500
FAX: (02) 9841 9530

CLIENT: NETWORK GEOTECHNICS
POSTAL ADDRESS: 6/6 Morton Close TUGGERAH
SEND REPORT TO: VIPUL da SILVA SEND INVOICE TO:
DATA NEEDED BY: ASAP REPORT NEEDED BY: ASAP
PROJECT ID: G25058/1 QUOTE NO.:
P.O. NO.: COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LABORATORY BATCH NO.:
SAMPLERS: TS
PHONE: 43 576 200 FAX: 43 576 300
REPORT FORMAT: HARD _____ FAX: _____ DISK: _____ BULLETIN BOARD: _____
QC LEVEL: QCS1 _____ QCS2 _____ QCS3 _____ QCS4 _____

ANALYSIS REQUIRED

LAB USE ONLY
No.
Intact
COOLER TEMP: deg. C

	SAMPLE DATA				*CONTAINER DATA			S3	S13	Asbestos	Pesticides	NOTES
	SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	pH					
(3)	Composite 3	Soil	10/3		J	1		/	/			
	ES8 + ES10 + ES12											
(4)	Composite 4							/				
	ES9 + ES11 + ES13											
(5)	Composite 5							/	/			
	ES14 + ES16 + ES18											
(6)	Composite 6							/	/			
	ES20 + ES22 + ES24											
(31)	ES7 0.0-0.1	Soil	10/3	AM	J	1				/	/	

RELINQUISHED BY		RECEIVED BY		
NAME: Tim Smith	DATE: 13/3/06	NAME: JESSIE	DATE: 14-03-06	METHOD OF SHIPMENT
OF: NETWORK	TIME: PM.	OF: ALS	TIME: 12:20 pm	CONSIGNMENT NOTE NO.
NAME:	DATE:	NAME:	DATE:	TRANSPORT CO. NAME.
OF:	TIME:	OF:	TIME:	

*Container Type and Preservative Codes: **P** = Natural Plastic; **N** = Nitric Acid Preserved; **C** = Sodium Hydroxide Preserved; **J** = Solvent Washed Acid Rinsed Jar; **S** = Solvent Washed Acid Rinsed Glass Bottle; **VC** = Hydrochloric Acid Preserved Vial; **VS** = Sulphuric Acid Preserved Vial; **BS** = Sulphuric Acid Preserved Glass Bottle; **Z** = Zinc Acetate Preserved Bottle; **E** = EDTA Preserved Bottle; **ST** = Sterile Bottle; **O** = Other.

AUSTRALIAN LABORATORY SERVICES P/L

Network Geotechnics

From: ALSE Sydney Aus [alse.sydney.aus@als.com.au]
Sent: Wednesday, 22 March 2006 5:51 PM
To: gosnetgeo@bigpond.com
Subject: Your Reference : G25058 1. Deliverables for ALSE Workorder : ES0603007

ES0603007_Assos.pdf (38 KB) es0603007_coc.pdf (345 KB)

This e-mail has been automatically generated.

-- PLEASE DO NOT REPLY --

ALS acknowledges the risks associated with supplying electronic media reports based on client requirements. This type of format has the ability to embed viruses within the code and, as such, ALS has introduced a three tier layer of protection throughout their company resources. However, ALS cannot guarantee any attachment is virus free and will not be held liable for any disruption to business. It is highly recommended that all attachments received are scanned prior to opening.

****
This e-mail and any file transmitted with it are confidential and intended solely for the use of the individual or entity to whom they are addressed. If you received this e-mail in error, please notify the email Administrator at MailAdmin@als.com.au. This footnote also confirms that this message has been swept
to the best of our current abilities for the presence of computer viruses. You should NOT take this as any guarantee or warrant that such material is Virus free, and should apply Virus detection techniques appropriate to your security requirements BEFORE using any material attached to this message. Occasionally electronic communications are monitored and stored in secure databases by Campbell Brothers Ltd IT department to support operational and security activities. We respect the privacy right of all individuals and are committed to comply at all times with the Privacy Amendment (Private Sector) Act 2000. Further information can be obtained by viewing the CBL Privacy Policy by clicking here http://www.campbell.com.au/CBL_Privacy_Policy.pdf
****

AUSTRALIAN SAFER ENVIRONMENT & TECHNOLOGY PTY LTD

ABN 36 088 095 112

Our ref : ASET 7986/ 11054 / 1 - 1
Your ref:ES0603007
NATA Accreditation No: 14484

17 March 2006

Australian Laboratory Services Pty. Ltd.
277 Woodpark Road
Smithfield
NSW 2164

Attn:Mr Greg Vogel,
Fax No:02 – 8784 8500

Dear Greg,
Asbestos Identification
This report presents the results of one sample, forwarded by Australian Laboratory Services Pty. Ltd. on 15 March 2006, for analysis for asbestos.

1.Introduction: One sample forwarded was examined and analysed for the presence of asbestos.

2. Methods : The sample was examined under a Stereo Microscope and selected fibres were analysed by Polarized Light Microscopy in conjunction with dispersion Staining method **(Safer Environment Method 1.)**

3. Results : **Sample No. 1. ASET 7986 / 11054 / 1. ES0603007 - 1.**
Approx dimensions 5.5 cm x 3.0 cm x 2.0 cm
The sample consisted of mixture of clayish sandy soil, stones, plant matter and fragments of plaster.
No asbestos detected.

Analysed and reported by,

NATA Accredited Laboratory Number: 14484

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to Australian national standards of measurement. This document shall not be reproduced, except in full.

Mahen De Silva . BSc. MSc. Grad Dip (Occ Hyg)
Occupational Hygienist / Approved Signatory.

ALS Environmental

CERTIFICATE OF ANALYSIS

Client	: NETWORK GEOTECHNICS PTY LTD	*Laboratory*	: ALS Environmental Sydney	*Page*	: 1 of 7
Contact	: MR VIPUL DE SILVA	*Contact*	: Greg Vogel	*Work Order*	: ES0603097
Address	: UNIT 14, 25 STODDART ROAD PROSPECT NSW AUSTRALIA 2148	*Address*	: 277-289 Woodpark Road Smithfield NSW Australia 2164		
E-mail	: gosnetgeo@bigpond.com	*E-mail*	: Greg.Vogel@alsenviro.com		
Telephone	: 02 9688 1764	*Telephone*	: 61-2-87848555		
Facsimile	: 02 9688 1765	*Facsimile*	: 61-2-87848500		
Project	: G25058/1	*Quote number*	: SY/405/02	*Date received*	: 15 Mar 2006
Order number	: Not provided			*Date issued*	: 27 Mar 2006
C-O-C number	: 008306 008307			*No. of samples*	- *Received* : 20
Site	- Not provided -				*Analysed* 10

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

This document has been digitally signed by those names that appear on this report and are the authorised signatories. Digital signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	*Position*	*Department*
Daniel Um	Senior Organic Chemist	Organics - NATA 825 (10911 - Sydney)
Peter Dickenson	Senior Spectroscopist	Inorganics - NATA 825 (10911 - Sydney)

ALS Environmental

Comments

This report for the ALSE reference ES0603097 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- **Analytical results for samples submitted**

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

- **Surrogate control limits**

The analytical procedures used by ALS Environmental are based on established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house procedure are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

Specific comments for Work Order **ES0603097**

EP068: Insufficient samples have been provided for standard analysis. Where applicable LOR values have been adjusted accordingly.

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: 34_SS1_0.0_0.1	ES37	COMP 7	COMP 8	COMP 9
Sample Matrix Type / Description				SOIL	SOIL	SOIL	SOIL	SOIL
Sample Date / Time				14 Mar 2006 15:00	14 Mar 2006 15:00	14 Mar 2006 11 00	14 Mar 2006 11:00	14 Mar 2006 11:00
Laboratory Sample ID				ES0603097-001	ES0603097-007	ES0603097-008	ES0603097-009	ES0603097-010
EA055: Moisture Content								
Moisture Content (dried @ 103°C)		1.0	%	9.9	9.0	8.8	8.9	8.7
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	9	9	<5	<5	5
Barium	7440-39-3	10	mg/kg	240	210	50	50	60
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	1
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	22	18	16	16	13
Cobalt	7440-48-4	2	mg/kg	3	3	10	10	9
Copper	7440-50-8	5	mg/kg	10	9	5	<5	7
Lead	7439-92-1	5	mg/kg	85	67	10	8	31
Manganese	7439-96-5	5	mg/kg	184	80	446	342	230
Nickel	7440-02-0	2	mg/kg	6	6	7	6	10
Vanadium	7440-62-2	5	mg/kg	37	40	43	42	26
Zinc	7440-66-6	5	mg/kg	197	195	21	14	68
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EP066: Polychlorinated Biphenyls (PCB)								
Total Polychlorinated biphenyls		0 10	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
trans-Chlordane	5103-74-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
alpha-Endosulfan	959-98-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
cis-Chlordane	5103-71-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Dieldrin	60-57-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
4.4'-DDE	72-55-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Endrin	72-20-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
beta-Endosulfan	33213-65-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
4.4'-DDD	72-54-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Endrin aldehyde	7421-93-4	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Endosulfan sulfate	1031-07-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: 34_SS1_0.0_0.1 Sample Matrix Type / Description: SOIL Sample Date / Time: 14 Mar 2006 15:00 Laboratory Sample ID: ES0603097-001	ES37 SOIL 14 Mar 2006 15:00 ES0603097-007	COMP 7 SOIL 14 Mar 2006 11 00 ES0603097-008	COMP 8 SOIL 14 Mar 2006 11:00 ES0603097-009	COMP 9 SOIL 14 Mar 2006 11:00 ES0603097-010
EP068A: Organochlorine Pesticides (OC)								
4.4'-DDT	50-29-3	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin ketone	53494-70-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Methoxychlor	72-43-5	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Demeton-S-methyl	919-86-8	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Monocrotophos	6923-22-4	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Dimethoate	60-51-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Diazinon	333-41-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Parathion-methyl	298-00-0	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Malathion	121-75-5	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Fenthion	55-38-9	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorpyrifos	2921-88-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Parathion	56-38-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Pirimphos-ethyl	23505-41-1	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorfenvinphos	470-90-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Bromophos-ethyl	4824-78-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Fenamiphos	22224-92-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Prothiofos	34643-46-4	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Ethion	563-12-2	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Carbophenothion	786-19-6	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
Azinphos Methyl	86-50-0	0.05	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05
EP066S: PCB Surrogate								
Decachlorobiphenyl	2051-24-3	0.1	%	56.5	67.6	71.0	67.0	87.0
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE		0.1	%	44.3	49.0	74.6	75.3	96.7
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.1	%	66.5	72.5	93.0	84.9	77.9

ALS Environmental

Analytical Results

				WS1	WS2	WS3	WS4	DUPLICATE
Client Sample ID :				WS1	WS2	WS3	WS4	DUPLICATE
Sample Matrix Type / Description				WATER	WATER	WATER	WATER	WATER
Sample Date / Time :				14 Mar 2006 13:30	14 Mar 2006 13:45	14 Mar 2006 14:10	14 Mar 2006 14:30	14 Mar 2006 14:10
Laboratory Sample ID :				ES0603097-002	ES0603097-003	ES0603097-004	ES0603097-005	ES0603097-006
Analyte	*CAS number*	*LOR*	*Units*					
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.001	<0.001	<0.001	0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.0001	0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.001	0.002	0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.001	0.002	0.001
Zinc	7440-66-6	0.005	mg/L	0.063	0.024	0.028	0.052	0.032
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.9	----	<0.9	----	<0.9
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.9	----	<0.9	----	<0.9
beta-BHC	319-85-7	0.5	µg/L	<0.9	----	<0.9	----	<0.9
gamma-BHC	58-89-9	0.5	µg/L	<0.9	----	<0.9	----	<0.9
delta-BHC	319-86-8	0.5	µg/L	<0.9	----	<0.9	----	<0.9
Heptachlor	76-44-8	0.5	µg/L	<0.9	----	<0.9	----	<0.9
Aldrin	309-00-2	0.5	µg/L	<0.9	----	<0.9	----	<0.9
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.9	----	<0.9	----	<0.9
trans-Chlordane	5103-74-2	0.5	µg/L	<0.9	----	<0.9	----	<0.9
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.9	----	<0.9	----	<0.9
cis-Chlordane	5103-71-9	0.5	µg/L	<0.9	----	<0.9	----	<0.9
Dieldrin	60-57-1	0.5	µg/L	<0.9	----	<0.9	----	<0.9
4.4'-DDE	72-55-9	0.5	µg/L	<0.9	----	<0.9	----	<0.9
Endrin	72-20-8	0.5	µg/L	<0.9	----	<0.9	----	<0.9
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.9	----	<0.9	----	<0.9
4.4'-DDD	72-54-8	0.5	µg/L	<0.9	----	<0.9	----	<0.9
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.9	----	<0.9	----	<0.9
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.9	----	<0.9	----	<0.9
4.4'-DDT	50-29-3	2	µg/L	<2	----	<2	----	<2
Endrin ketone	53494-70-5	0.5	µg/L	<0.9	----	<0.9	----	<0.9
Methoxychlor	72-43-5	2	µg/L	<2	----	<2	----	<2
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.9	----	<0.9	----	<0.9
Demeton-S-methyl	919 86 8	0 5	µg/L	<0.9	----	<0.9	----	<0.9
Monocrotophos	6923-22-4	2	µg/L	<2	----	<2	----	<2
Dimethoate	60 51 5	0 5	µg/L	<0.9	----	<0.9	----	<0.9
Diazinon	333-41-5	0.5	µg/L	<0.9	----	<0.9	----	<0.9

ALS Environmental

Analytical Results

				Client Sample ID :	WS1	WS2	WS3	WS4	DUPLICATE
				Sample Matrix Type / Description	WATER	WATER	WATER	WATER	WATER
				Sample Date / Time :	14 Mar 2006 13:30	14 Mar 2006 13:45	14 Mar 2006 14:10	14 Mar 2006 14:30	14 Mar 2006 14:10
				Laboratory Sample ID :					
Analyte	*CAS number*	*LOR*	*Units*		ES0603097-002	ES0603097-003	ES0603097-004	ES0603097-005	ES0603097-006
EP068B: Organophosphorus Pesticides (OP)									
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		<0.9	----	<0.9	----	<0.9
Parathion-methyl	298-00-0	2	µg/L		<2	----	<2	----	<2
Malathion	121-75-5	0.5	µg/L		<0.9	----	<0.9	----	<0.9
Fenthion	55-38-9	0.5	µg/L		<0.9	----	<0.9	----	<0.9
Chlorpyrifos	2921-88-2	0.5	µg/L		<0.9	----	<0.9	----	<0.9
Parathion	56-38-2	2	µg/L		<2	----	<2	----	<2
Pirimphos-ethyl	23505-41-1	0.5	µg/L		<0.9	----	<0.9	----	<0.9
Chlorfenvinphos	470-90-6	0.5	µg/L		<0.9	----	<0.9	----	<0.9
Bromophos-ethyl	4824-78-6	0.5	µg/L		<0.9	----	<0.9	----	<0.9
Fenamiphos	22224-92-6	0.5	µg/L		<0.9	----	<0.9	----	<0.9
Prothiofos	34643-46-4	0.5	µg/L		<0.9	----	<0.9	----	<0.9
Ethion	563-12-2	0.5	µg/L		<0.9	----	<0.9	----	<0.9
Carbophenothion	786-19-6	0.5	µg/L		<0.9	----	<0.9	----	<0.9
Azinphos Methyl	86-50-0	0.5	µg/L		<0.9	----	<0.9	----	<0.9
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction		20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction		50	µg/L		<50	<50	<50	----	<50
C15 - C28 Fraction		100	µg/L		200	300	<100	----	<100
C29 - C36 Fraction		50	µg/L		70	80	<50	----	<50
EP080: BTEX									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE		0.1	%		112	----	103	----	109
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.1	%		125		103		120
EP080S TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.1	%		92.9	99.9	102	103	96.2
Toluene-D8	2037-26-5	0.1	%		101	101	103	109	101
4-Bromofluorobenzene	460-00-4	0.1	%		88.6	93.4	92.0	92.2	89.1

ALS Environmental

INTERPRETIVE QUALITY CONTROL REPORT

Client	:	**NETWORK GEOTECHNICS PTY LTD**	**Laboratory**	:	ALS Environmental Sydney	**Page**	: **1 of 8**
Contact		MR VIPUL DE SILVA	**Contact**		Greg Vogel		
Address	:	UNIT 14, 25 STODDART ROAD PROSPECT NSW AUSTRALIA 2148	**Address**	:	277 289 Woodpark Road Smithfield NSW Australia 2164	**Work order**	: **ES0603097**
						Amendment No	
Project	:	G25058/1	**Quote number**	:	SY/405/02	**Date received**	: 15 Mar 2006
Order number	:	- Not provided -				**Date issued**	: 27 Mar 2006
C-O-C number	:	008306 008307					
Site	:	Not provided					
E-mail	:	gosnetgeo@bigpond com	**E-mail**	:	Greg Vogel@alsenviro com	**No. of samples**	
Telephone	:	02 9688 1764	**Telephone**	:	61-2-87848555	**Received**	: 20
Facsimile	:	02 9688 1765	**Facsimile**	:	61 2 87848500	**Analysed**	: 10

This Interpretive Quality Control Report was issued on 27 Mar 2006 for the ALS work order reference ES0603097 and supersedes any previous reports with this reference.
This report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Type Frequency Compliance
- Summary of all Quality Control Outliers
- Brief Method Summaries

Interpretive Quality Control Report - Analysis Holding Time

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extrac ion or analysis and preclude subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the sample aliquot was taken. Elapsed time to analysis represents time from sampling where no extraction / digestion is involved or time from extraction / digestion where this is present. For composite samples, sampling date/time is taken as that of he oldest sample contributing to that composite. Sample date/time for laboratory produced leaches are taken from the comple ion date/time of the leaching process. Outliers for holding time are based on USEPA SW846, APHA, AS and NEPM (1999). Failed outliers, refer to the 'Summary of Outliers'.

Matrix Type: SOIL ***Analysis Holding Time and Preservation***

Method / Container / Client Sample ID(s)	Date Sampled	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EG005T: Total Metals by ICP-AES							
Soil Glass Jar - Unpreserved 34_SS1_0.0_0.1, ES37	**14 Mar 2006**	**20 Mar 2006**	10 Sep 2006	Pass	**21 Mar 2006**	10 Sep 2006	Pass
Soil Glass Jar - Unpreserved COMP 7, COMP 8, COMP 9	**14 Mar 2006**	**22 Mar 2006**	10 Sep 2006	Pass	**22 Mar 2006**	10 Sep 2006	Pass
EG035T: Total Mercury by FIMS							
Soil Glass Jar - Unpreserved 34_SS1_0.0_0.1, ES37	**14 Mar 2006**	**20 Mar 2006**	11 Apr 2006	Pass	**21 Mar 2006**	11 Apr 2006	Pass
Soil Glass Jar - Unpreserved COMP 7, COMP 8, COMP 9	**14 Mar 2006**	**22 Mar 2006**	11 Apr 2006	Pass	**22 Mar 2006**	11 Apr 2006	Pass
EP066: Polychlorinated Biphenyls (PCB)							
Soil Glass Jar - Unpreserved 34_SS1_0.0_0.1, ES37	**14 Mar 2006**	**18 Mar 2006**	28 Mar 2006	Pass	**20 Mar 2006**	27 Apr 2006	Pass
Soil Glass Jar - Unpreserved COMP 7, COMP 8, COMP 9	**14 Mar 2006**	**24 Mar 2006**	28 Mar 2006	Pass	**24 Mar 2006**	3 May 2006	Pass
EP068: Pesticides by GCMS							
Soil Glass Jar - Unpreserved 34_SS1_0.0_0.1, ES37	**14 Mar 2006**	**18 Mar 2006**	28 Mar 2006	Pass	**20 Mar 2006**	27 Apr 2006	Pass
Soil Glass Jar - Unpreserved COMP 7, COMP 8, COMP 9	**14 Mar 2006**	**24 Mar 2006**	28 Mar 2006	Pass	**24 Mar 2006**	3 May 2006	Pass

Matrix Type: WATER ***Analysis Holding Time and Preservation***

Method / Container / Client Sample ID(s)	Date Sampled	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EG020A-F: Dissolved Metals by ICP-MS - Suite A							
Clear Plastic Bottle - Nitric Acid; Filtered S1, WS2, WS3, WS4, DUPLICATE	**14 Mar 2006**	**----**	----	----	**18 Mar 2006**	10 Sep 2006	Pass
EP068: Pesticides							
Amber Glass Bottle Unpreserved S1, WS3, DUPLICATE	**14 Mar 2006**	**18 Mar 2006**	21 Mar 2006	Pass	**20 Mar 2006**	27 Apr 2006	Pass

ALS Environmental

Matrix Type: WATER

Analysis Holding Time and Preservation

Method / Container / Client Sample ID(s)	Date Sampled	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EP071: TPH - Semivolatile Fraction							
Amber Glass Bottle - Unpreserved S1, WS2, WS3, DUPLICATE	**14 Mar 2006**	**18 Mar 2006**	21 Mar 2006	Pass	**20 Mar 2006**	27 Apr 2006	Pass
EP080: TPH Volatiles/BTEX							
Amber VOC Vial - HCl S1, WS2, WS3, WS4, DUPLICATE	**14 Mar 2006**	**----**	----	----	**26 Mar 2006**	28 Mar 2006	Pass

Interpretive Quality Control Report - Frequency of Quality Control Samples

The following report summarises the frequency of laboratory QC samples analysed within he analytical lot(s) in which this work order was processed. Actual rate should be greater than or equal to the expected rate.

Matrix Type: SOIL

Frequency of Quality Control Samples

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
EA055-103: Moisture Content	2	20	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG005T: Total Metals by ICP-AES	4	40	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	4	36	11.1	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	2	5	40.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	3	22	13.6	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Laboratory Control Samples (LCS)					
EG005T: Total Metals by ICP-AES	2	40	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	2	36	5.6	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	2	5	40.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	2	22	9.1	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Method Blanks (MB)					
EG005T: Total Metals by ICP-AES	2	40	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	2	36	5.6	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	2	5	40.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	2	22	9.1	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Matrix Spikes (MS)					
EG005T: Total Metals by ICP-AES	2	40	5 0	5 0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T Total Mercury by FIM	2	36	5.6	5.0	NEPM 1999 chedule B(3) and AL E QC 3 requirement
EP066: Polychlorinated Biphenyls (PCB)	2	5	40.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	2	22	9.1	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement

Matrix Type: WATER

Frequency of Quality Control Samples

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
EG020A-F: Dissolved Metals by ICP-MS - Suite A	2	20	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	2	20	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	2	20	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Laboratory Control Samples (LCS)					
EG020A-F: Dissolved Metals by ICP-MS - Suite A	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides	1	3	33.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP071: TPH - Semivolatile Fraction	1	4	25.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement

ALS Environmental

Matrix Type: WATER

Frequency of Quality Control Samples

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Method Blanks (MB)					
EG020A-F: Dissolved Metals by ICP-MS - Suite A	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides	1	3	33.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP071: TPH - Semivolatile Fraction	1	4	25.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Matrix Spikes (MS)					
EG020A-F: Dissolved Metals by ICP-MS - Suite A	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement

Interpretive Quality Control Report - Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged on the 'Quality Control Report'. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot.

Laboratory Control Samples (LCS)							
EP068A: Organochlorine Pesticides (OC)	SOIL	204726-002	----	Heptachlor epoxide	72.6 %	74-108 %	Recovery less than lower control limit
EP068B: Organophosphorus Pesticides (OP)	SOIL	204726-002	----	Demeton-S-methyl	43.4 %	57.7-123 %	Recovery less than lower control limit
Matrix Spikes (MS)							
EP068A: Organochlorine Pesticides (OC)	SOIL	ES0603097-008	COMP 7	gamma-BHC	120 %	75.65-110.	Recovery greater than upper data quality objective
Laboratory Control Samples (LCS)							
EP068A: Organochlorine Pesticides (OC)	WATER	202870-014	----	beta-Endosulfan	76.0 %	76.8-107 %	Recovery less than lower control limit
EP068B: Organophosphorus Pesticides (OP)	WATER	202870-014	----	Monocrotophos	66.8 %	3.29-37.7 %	Recovery greater than upper control limit

Outliers : Analysis Holding Time

The following report highlights outliers within his 'Interpretive Quality Control Report - Analysis Holding Time'.

- **No holding time outliers occur.**

Outliers : Frequency of Quality Control Samples

The following report highlights outliers within this 'Interpretive Quality Control Report - Frequency of Quality Control Samples'.

- **No frequency outliers occur.**

Method Reference Summary

The analytical procedures used by ALS Environmental are based on established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house procedure are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

Matrix Type: SOIL ***Method Reference Summary***

Preparation Methods

EN69 : Hot Block Digest for metals in soils sediments and sludges - USEPA 200.2 Mod. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bu ked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (1999) Schedule B(3) (Method 202)

ORG17A : Tumbler Extraction of Solids (Option A - Concentrating) - In-house, Mechanical agitation (tumbler). 20g of sample, Na2SO4 and surrogate are extracted with 150mL 1:1 DCM/Acetone by end over end tumble. The solvent is decanted, dehydrated and concentrated (by KD) to the desired volume for analysis.

Analytical Methods

EA055-103 : Moisture Content - A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (1999) Schedule B(3) (Method 102)

EG005T : Total Metals by ICP-AES - (APHA 20th ed., 3120; USEPA SW 846 - 6010) (ICPAES) Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (1999) Schedule B(3)

EG035T : Total Mercury by FIMS - AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion A bromate/bromide reagent is used to oxidise any organic mercury compounds in the extract Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve.

EP066 : Polychlorinated Biphenyls (PCB) - (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point cal bration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 504)

EP068 : Pesticides by GCMS - (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This technique is compliant with NEPM (1999) Schedule B(3) (Method 504,505)

Matrix Type: WATER ***Method Reference Summary***

Preparation Methods

ORG14 : Separatory Funnel Extraction of Liquids - USEPA SW 846 - 3510B 500 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2). ALS default excludes sediment which may be resident in the container.

Analytical Methods

EG020A-F : Dissolved Metals by ICP-MS - Suite A - (APHA 20th ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

EG035F : Dissolved Mercury by FIMS - AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Matrix Type: WATER

Method Reference Summary

Analytical Methods

EP068 : Pesticides - USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point cal bration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EP071 : TPH - Semivolatile Fraction - USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-A kane standards. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EP080 : TPH Volatiles/BTEX - USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

ALS Environmental

INTERPRETIVE QUALITY CONTROL REPORT

Client	:	**NETWORK GEOTECHNICS PTY LTD**	**Laboratory**	:	ALS Environmental Sydney	**Page**	: **1 of 8**
Contact		MR VIPUL DE SILVA	**Contact**		Greg Vogel		
Address	:	UNIT 14, 25 STODDART ROAD PROSPECT NSW AUSTRALIA 2148	**Address**	:	277 289 Woodpark Road Smithfield NSW Australia 2164	**Work order**	: **ES0603097**
						Amendment No	
Project	:	G25058/1	**Quote number**	:	SY/405/02	**Date received**	: 15 Mar 2006
Order number	:	- Not provided -				**Date issued**	: 27 Mar 2006
C-O-C number	:	008306 008307					
Site	:	Not provided					
E-mail	:	gosnetgeo@bigpond com	**E-mail**	:	Greg Vogel@alsenviro com	**No. of samples**	
Telephone	:	02 9688 1764	**Telephone**	:	61-2-87848555	**Received**	: 20
Facsimile	:	02 9688 1765	**Facsimile**	:	61 2 87848500	**Analysed**	: 10

This Interpretive Quality Control Report was issued on 27 Mar 2006 for the ALS work order reference ES0603097 and supersedes any previous reports with this reference.
This report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Type Frequency Compliance
- Summary of all Quality Control Outliers
- Brief Method Summaries

Interpretive Quality Control Report - Analysis Holding Time

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extrac ion or analysis and preclude subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the sample aliquot was taken. Elapsed time to analysis represents time from sampling where no extraction / digestion is involved or time from extraction / digestion where this is present. For composite samples, sampling date/time is taken as that of he oldest sample contributing to that composite. Sample date/time for laboratory produced leaches are taken from the comple ion date/time of the leaching process. Outliers for holding time are based on USEPA SW846, APHA, AS and NEPM (1999). Failed outliers, refer to the 'Summary of Outliers'.

Matrix Type: SOIL ***Analysis Holding Time and Preservation***

Method / Container / Client Sample ID(s)	Date Sampled	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EG005T: Total Metals by ICP-AES							
Soil Glass Jar - Unpreserved 34_SS1_0.0_0.1, ES37	**14 Mar 2006**	**20 Mar 2006**	10 Sep 2006	Pass	**21 Mar 2006**	10 Sep 2006	Pass
Soil Glass Jar - Unpreserved COMP 7, COMP 8, COMP 9	**14 Mar 2006**	**22 Mar 2006**	10 Sep 2006	Pass	**22 Mar 2006**	10 Sep 2006	Pass
EG035T: Total Mercury by FIMS							
Soil Glass Jar - Unpreserved 34_SS1_0.0_0.1, ES37	**14 Mar 2006**	**20 Mar 2006**	11 Apr 2006	Pass	**21 Mar 2006**	11 Apr 2006	Pass
Soil Glass Jar - Unpreserved COMP 7, COMP 8, COMP 9	**14 Mar 2006**	**22 Mar 2006**	11 Apr 2006	Pass	**22 Mar 2006**	11 Apr 2006	Pass
EP066: Polychlorinated Biphenyls (PCB)							
Soil Glass Jar - Unpreserved 34_SS1_0.0_0.1, ES37	**14 Mar 2006**	**18 Mar 2006**	28 Mar 2006	Pass	**20 Mar 2006**	27 Apr 2006	Pass
Soil Glass Jar - Unpreserved COMP 7, COMP 8, COMP 9	**14 Mar 2006**	**24 Mar 2006**	28 Mar 2006	Pass	**24 Mar 2006**	3 May 2006	Pass
EP068: Pesticides by GCMS							
Soil Glass Jar - Unpreserved 34_SS1_0.0_0.1, ES37	**14 Mar 2006**	**18 Mar 2006**	28 Mar 2006	Pass	**20 Mar 2006**	27 Apr 2006	Pass
Soil Glass Jar - Unpreserved COMP 7, COMP 8, COMP 9	**14 Mar 2006**	**24 Mar 2006**	28 Mar 2006	Pass	**24 Mar 2006**	3 May 2006	Pass

Matrix Type: WATER ***Analysis Holding Time and Preservation***

Method / Container / Client Sample ID(s)	Date Sampled	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EG020A-F: Dissolved Metals by ICP-MS - Suite A							
Clear Plastic Bottle - Nitric Acid; Filtered S1, WS2, WS3, WS4, DUPLICATE	**14 Mar 2006**	**----**	----	----	**18 Mar 2006**	10 Sep 2006	Pass
EP068: Pesticides							
Amber Glass Bottle Unpreserved S1, WS3, DUPLICATE	**14 Mar 2006**	**18 Mar 2006**	21 Mar 2006	Pass	**20 Mar 2006**	27 Apr 2006	Pass

ALS Environmental

Matrix Type: WATER

Analysis Holding Time and Preservation

Method / Container / Client Sample ID(s)	Date Sampled	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EP071: TPH - Semivolatile Fraction							
Amber Glass Bottle - Unpreserved S1, WS2, WS3, DUPLICATE	**14 Mar 2006**	**18 Mar 2006**	21 Mar 2006	Pass	**20 Mar 2006**	27 Apr 2006	Pass
EP080: TPH Volatiles/BTEX							
Amber VOC Vial - HCl S1, WS2, WS3, WS4, DUPLICATE	**14 Mar 2006**	**----**	----	----	**26 Mar 2006**	28 Mar 2006	Pass

Interpretive Quality Control Report - Frequency of Quality Control Samples

The following report summarises the frequency of laboratory QC samples analysed within he analytical lot(s) in which this work order was processed. Actual rate should be greater than or equal to the expected rate.

Matrix Type: SOIL

Frequency of Quality Control Samples

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
EA055-103: Moisture Content	2	20	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG005T: Total Metals by ICP-AES	4	40	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	4	36	11.1	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	2	5	40.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	3	22	13.6	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Laboratory Control Samples (LCS)					
EG005T: Total Metals by ICP-AES	2	40	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	2	36	5.6	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	2	5	40.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	2	22	9.1	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Method Blanks (MB)					
EG005T: Total Metals by ICP-AES	2	40	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T: Total Mercury by FIMS	2	36	5.6	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP066: Polychlorinated Biphenyls (PCB)	2	5	40.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	2	22	9.1	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Matrix Spikes (MS)					
EG005T: Total Metals by ICP-AES	2	40	5 0	5 0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035T Total Mercury by FIM	2	36	5.6	5.0	NEPM 1999 chedule B(3) and AL E QC 3 requirement
EP066: Polychlorinated Biphenyls (PCB)	2	5	40.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides by GCMS	2	22	9.1	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement

Matrix Type: WATER

Frequency of Quality Control Samples

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
EG020A-F: Dissolved Metals by ICP-MS - Suite A	2	20	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	2	20	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	2	20	10.0	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Laboratory Control Samples (LCS)					
EG020A-F: Dissolved Metals by ICP-MS - Suite A	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides	1	3	33.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP071: TPH - Semivolatile Fraction	1	4	25.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement

ALS Environmental

Matrix Type: WATER

Frequency of Quality Control Samples

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Method Blanks (MB)					
EG020A-F: Dissolved Metals by ICP-MS - Suite A	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP068: Pesticides	1	3	33.3	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP071: TPH - Semivolatile Fraction	1	4	25.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Matrix Spikes (MS)					
EG020A-F: Dissolved Metals by ICP-MS - Suite A	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EP080: TPH Volatiles/BTEX	1	20	5.0	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement

Interpretive Quality Control Report - Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged on the 'Quality Control Report'. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot.

Laboratory Control Samples (LCS)							
EP068A: Organochlorine Pesticides (OC)	SOIL	204726-002	----	Heptachlor epoxide	72.6 %	74-108 %	Recovery less than lower control limit
EP068B: Organophosphorus Pesticides (OP)	SOIL	204726-002	----	Demeton-S-methyl	43.4 %	57.7-123 %	Recovery less than lower control limit
Matrix Spikes (MS)							
EP068A: Organochlorine Pesticides (OC)	SOIL	ES0603097-008	COMP 7	gamma-BHC	120 %	75.65-110.	Recovery greater than upper data quality objective
Laboratory Control Samples (LCS)							
EP068A: Organochlorine Pesticides (OC)	WATER	202870-014	----	beta-Endosulfan	76.0 %	76.8-107 %	Recovery less than lower control limit
EP068B: Organophosphorus Pesticides (OP)	WATER	202870-014	----	Monocrotophos	66.8 %	3.29-37.7 %	Recovery greater than upper control limit

Outliers : Analysis Holding Time

The following report highlights outliers within his 'Interpretive Quality Control Report - Analysis Holding Time'.

- **No holding time outliers occur.**

Outliers : Frequency of Quality Control Samples

The following report highlights outliers within this 'Interpretive Quality Control Report - Frequency of Quality Control Samples'.

- **No frequency outliers occur.**

Method Reference Summary

The analytical procedures used by ALS Environmental are based on established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house procedure are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

Matrix Type: SOIL ***Method Reference Summary***

Preparation Methods

EN69 : Hot Block Digest for metals in soils sediments and sludges - USEPA 200.2 Mod. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bu ked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (1999) Schedule B(3) (Method 202)

ORG17A : Tumbler Extraction of Solids (Option A - Concentrating) - In-house, Mechanical agitation (tumbler). 20g of sample, Na2SO4 and surrogate are extracted with 150mL 1:1 DCM/Acetone by end over end tumble. The solvent is decanted, dehydrated and concentrated (by KD) to the desired volume for analysis.

Analytical Methods

EA055-103 : Moisture Content - A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (1999) Schedule B(3) (Method 102)

EG005T : Total Metals by ICP-AES - (APHA 20th ed., 3120; USEPA SW 846 - 6010) (ICPAES) Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (1999) Schedule B(3)

EG035T : Total Mercury by FIMS - AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion A bromate/bromide reagent is used to oxidise any organic mercury compounds in the extract Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve.

EP066 : Polychlorinated Biphenyls (PCB) - (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point cal bration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 504)

EP068 : Pesticides by GCMS - (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This technique is compliant with NEPM (1999) Schedule B(3) (Method 504,505)

Matrix Type: WATER ***Method Reference Summary***

Preparation Methods

ORG14 : Separatory Funnel Extraction of Liquids - USEPA SW 846 - 3510B 500 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2). ALS default excludes sediment which may be resident in the container.

Analytical Methods

EG020A-F : Dissolved Metals by ICP-MS - Suite A - (APHA 20th ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

EG035F : Dissolved Mercury by FIMS - AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Matrix Type: WATER

Method Reference Summary

Analytical Methods

EP068 : Pesticides - USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point cal bration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EP071 : TPH - Semivolatile Fraction - USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-A kane standards. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EP080 : TPH Volatiles/BTEX - USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

ALS Environmental

QUALITY CONTROL REPORT

Client	:	**NETWORK GEOTECHNICS PTY LTD**	**Laboratory**	: ALS Environmental Sydney	**Page**	:	**1 of 24**
Contact	:	MR VIPUL DE SILVA	**Contact**	: Greg Vogel			
Address	:	UNIT 14, 25 STODDART ROAD PROSPECT NSW AUSTRALIA 2148	**Address**	: 277-289 Woodpark Road Smithfield NSW Australia 2164	**Work order**	:	**ES0603097**
					Amendment No.	:	
Project	:	G25058/1	**Quote number**	: SY/405/02	**Date received**	:	15 Mar 2006
Order number	:	- Not provided -			**Date issued**	:	27 Mar 2006
C-O-C number	:	008306-008307					
Site	:	- Not provided -					
E-mail	:	gosnetgeo@bigpond.com	**E-mail**	: Greg.Vogel@alsenviro.com	**No. of samples**		
Telephone	:	02 9688 1764	**Telephone**	: 61-2-87848555	**Received**	:	20
Facsimile	:	02 9688 1765	**Facsimile**	: 61-2-87848500	**Analysed**	:	10

This final report for the ALSE work order reference ES0603097 supersedes any previous reports with this reference.

Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- Laboratory Duplicates (DUP); Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Samples (LCS); Recovery and Acceptance Limits
- Matrix Spikes (MS); Recovery and Acceptance Limits

Work order specific comments

EP068: Insufficient samples have been provided for standard analysis. Where applicable LOR values have been adjusted accordingly.

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory - 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IED 17025

This document has been digitally signed by those names that appear on this report and are the authorised signatories. Digital signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Daniel Um	Organics - NATA 825 (10911 - Sydney)
Peter Dickenson	norganics - NATA 825 (10911 - Sydney)

Quality Control Report - Laboratory Duplicates (DUP)

The quality control term **Laboratory Duplicate** refers to an intralaboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
- Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** = *Limit of Reporting,* ***RPD*** = *Relative Percent Difference.*
* Indicates failed QC. The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:- Result < 10 times LOR, no limit - Result between 10 and 20 times LOR, 0% - 50% - Result > 20 times LOR, 0% - 20%

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EA055: Moisture Content						
EA055: Moisture Content - (QC Lot: 188604)				%	%	%
ES0603073-009	Anonymous	Moisture Content (dried @ 103°C)	1.0 %	7.2	6.9	4.1
ES0603097-008	COMP 7	Moisture Content (dried @ 103°C)	1.0 %	8.8	8.8	0.0
EG005T: Total Metals by ICP-AES						
EG005T: Total Metals by ICP-AES - (QC Lot: 188051)				mg/kg	mg/kg	%
ES0603103-014	Anonymous	Arsenic	5 mg/kg	<5	<5	0.0
		Barium	10 mg/kg	30	30	0.0
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	2 mg/kg	15	15	0.0
		Cobalt	2 mg/kg	9	7	19.4
		Copper	5 mg/kg	239	218	9.4
		Lead	5 mg/kg	<5	6	0.0
		Manganese	5 mg/kg	335	286	15.6
		Nickel	2 mg/kg	5	5	0.0
		Vanadium	5 mg/kg	38	37	3.3
		Zinc	5 mg/kg	27	27	0.0
ES0603103-024	Anonymous	Arsenic	5 mg/kg	<5	6	0.0
		Barium	10 mg/kg	40	40	0.0
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	2 mg/kg	17	18	0.0
		Cobalt	2 mg/kg	9	9	0.0
		Copper	5 mg/kg	222	260	15.7
		Lead	5 mg/kg	5	5	0.0
		Manganese	5 mg/kg	347	354	2.1

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EG005T: Total Metals by ICP-AES - continued						
EG005T: Total Metals by ICP-AES - (QC Lot: 188051) - continued				mg/kg	mg/kg	%
ES0603103-024	Anonymous	Nickel	2 mg/kg	7	7	0.0
		Vanadium	5 mg/kg	43	46	7.4
		Zinc	5 mg/kg	31	28	9.5
EG005T: Total Metals by ICP-AES - (QC Lot: 188667)				mg/kg	mg/kg	%
ES0603097-008	COMP 7	Arsenic	5 mg/kg	<5	<5	0.0
		Barium	10 mg/kg	50	60	0.0
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	2 mg/kg	16	19	18.2
		Cobalt	2 mg/kg	10	11	0.0
		Copper	5 mg/kg	5	6	0.0
		Lead	5 mg/kg	10	10	0.0
		Manganese	5 mg/kg	446	500	11.5
		Nickel	2 mg/kg	7	8	15.8
		Vanadium	5 mg/kg	43	49	14.7
		Zinc	5 mg/kg	21	22	5.9
ES0603195-054	Anonymous	Arsenic	5 mg/kg	23	13	57.1
		Barium	10 mg/kg	80	90	0.0
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	2	3	0.0
		Chromium	2 mg/kg	3	2	48.1
		Cobalt	2 mg/kg	<2	<2	0.0
		Copper	5 mg/kg	13	14	0.0
		Lead	5 mg/kg	149	152	1.8
		Manganese	5 mg/kg	39	41	5.9
		Nickel	2 mg/kg	3	3	0.0
		Vanadium	5 mg/kg	25	8	99.7
		Zinc	5 mg/kg	247	274	10.4
EG035T: Total Mercury by FIMS						

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EG035T: Total Mercury by FIMS - continued						
EG035T: Total Mercury by FIMS - (QC Lot: 188052)				mg/kg	mg/kg	%
ES0603103-014	Anonymous	Mercury	0.1 mg/kg	<0.1	0.1	0.0
ES0603103-024	Anonymous	Mercury	0.1 mg/kg	<0.1	<0.1	0.0
EG035T: Total Mercury by FIMS - (QC Lot: 188668)				mg/kg	mg/kg	%
ES0603097-008	COMP 7	Mercury	0.1 mg/kg	<0.1	<0.1	0.0
ES0603239-001	Anonymous	Mercury	0.1 mg/kg	<0.1	<0.1	0.0
EP066: Polychlorinated Biphenyls (PCB)						
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 186608)				mg/kg	mg/kg	%
ES0603097-001	34_SS1_0.0_0.1	Total Polychlorinated biphenyls	0.10 mg/kg	<0.10	<0.10	0.0
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 188585)				mg/kg	mg/kg	%
ES0603097-008	COMP 7	Total Polychlorinated biphenyls	0.10 mg/kg	<0.10	<0.10	0.0
EP068A: Organochlorine Pesticides (OC)						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186607)				mg/kg	mg/kg	%
ES0603097-001	34_SS1_0.0_0.1	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186607) - continued				mg/kg	mg/kg	%
ES0603097-001	34_SS1_0.0_0.1	Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
ES0603102-009	Anonymous	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188584)				mg/kg	mg/kg	%
ES0603097-008	COMP 7	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188584) - continued				mg/kg	mg/kg	%
ES0603097-008	COMP 7	gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186607)				mg/kg	mg/kg	%
ES0603097-001	34_SS1_0.0_0.1	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186607) - continued				mg/kg	mg/kg	%
ES0603097-001	34_SS1_0.0_0.1	Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Methyl Azinphos	0.05 mg/kg	<0.05	<0.05	0.0
ES0603102-009	Anonymous	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Methyl Azinphos	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Matrix Type: SOIL — *Laboratory Duplicates (DUP) Report*

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188584)				mg/kg	mg/kg	%
ES0603097-008	COMP 7	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Methyl Azinphos	0.05 mg/kg	<0.05	<0.05	0.0

Matrix Type: WATER — *Laboratory Duplicates (DUP) Report*

Lab rat ry Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Dupli ate Result	RPD
EG020F: Dissolved Metals by ICP-MS						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 187484)				mg/L	mg/L	%
ES0603097-002	WS1	Arsenic	0.001 mg/L	0.001	0.001	0.0
		Cadmium	0.0001 mg/L	<0 0001	<0.0001	0.0
		Chromium	0.001 mg/L	<0.001	<0.001	0.0
		Copper	0.001 mg/L	<0.001	<0.001	0.0
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Nickel	0.001 mg/L	<0.001	<0.001	0.0

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EG020F: Dissolved Metals by ICP-MS - continued						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 187484) - continued				mg/L	mg/L	%
ES0603097-002	WS1	Zinc	0.005 mg/L	0.063	0.059	5.4
ES0603141-004	Anonymous	Arsenic	0.001 mg/L	0.002	0.003	0.0
		Cadmium	0.0001 mg/L	<0 0001	<0.0001	0.0
		Chromium	0.001 mg/L	<0.001	0.001	0.0
		Copper	0.001 mg/L	0.004	0.002	58.4
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Nickel	0.001 mg/L	0.026	0.026	0.0
		Zinc	0.005 mg/L	0.018	0.016	13.8
EG035F: Dissolved Mercury by FIMS						
EG035F: Dissolved Mercury by FIMS - (QC Lot: 186960)				mg/L	mg/L	%
ES0603081-002	Anonymous	Mercury	0.0001 mg/L	<0 0001	<0.0001	0.0
ES0603081-004	Anonymous	Mercury	0.0001 mg/L	<0 0001	<0.0001	0.0
EP080/071: Total Petroleum Hydrocarbons						
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 190974)				µg/L	µg/L	%
ES0603246-003	Anonymous	C6 - C9 Fraction	20 µg/L	3860	3610	6.7
ES0603247-008	Anonymous	C6 - C9 Fraction	20 µg/L	<20	<20	0.0
EP080: BTEX						
EP080: BTEX - (QC Lot: 190974)				µg/L	µg/L	%
E 0603246 003	Anonymous	Benzene	1 µg/L	540	528	2 2
		Toluene	2 µg/L	928	911	1.9
		Ethylbenzene	2 µg/L	333	319	4.3
		meta- & para-Xylene	2 µg/L	598	574	4.1
		ortho Xylene	2 µg/L	191	182	4 6
ES0603247-008	Anonymous	Benzene	1 µg/L	<1	<1	0.0
		Toluene	2 µg/L	<2	<2	0.0
		Ethylbenzene	2 µg/L	<2	<2	0.0
		meta & para Xylene	2 µg/L	2	2	0 0
		ortho-Xylene	2 µg/L	<2	<2	0.0

ALS Environmental

Quality Control Report - Method Blank (MB) and Laboratory Control Samples (LCS)

The quality control term **Method / Laboratory Blank** refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term **Laboratory Control Sample (LCS)** refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of actual laboratory data. Abbreviations: LOR = Limit of reporting.

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

		Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
Analyte name	LOR			LCS	Low	High
EG005T: Total Metals by ICP-AES						
EG005T: Total Metals by ICP-AES - (QC Lot: 188051)		mg/kg	mg/kg	%	%	%
Arsenic	5 mg/kg	----	13.1	92.8	70	130
	5 mg/kg	<5	----	----	----	----
Barium	10 mg/kg	<10	----	----	----	----
Beryllium	1 mg/kg	<1	----	----	----	----
Cadmium	1 mg/kg	<1	----	----	----	----
	1 mg/kg	----	2.76	88.2	70	130
Chromium	2 mg/kg	----	60.9	95.0	70	130
	2 mg/kg	<2	----	----	----	----
Cobalt	2 mg/kg	<2	----	----	----	----
Copper	5 mg/kg	----	54.7	92.0	70	130
	5 mg/kg	<5	----	----	----	----
Lead	5 mg/kg	----	55.2	92.0	70	130
	5 mg/kg	<5	----	----	----	----
Manganese	5 mg/kg	<5	----	----	----	----
Nickel	2 mg/kg	----	54.8	96.8	70	130
	2 mg/kg	<2	----	----	----	----
Vanadium	5 mg/kg	<5	----	----	----	----
Zinc	5 mg/kg	----	104	88.7	70	130
	5 mg/kg	<5	----	----	----	----
EG005T: Total Metals by ICP-AES - (QC Lot: 188667)		mg/kg	mg/kg	%	%	%
Arsenic	5 mg/kg	----	13.1	103	70	130
	5 mg/kg	<5	----	----	----	----
Barium	10 mg/kg	<10	----	----	----	----
Beryllium	1 mg/kg	<1	----	----	----	----
Cadmium	1 mg/kg	----	2.76	97.2	70	130
	1 mg/kg	<1	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EG005T: Total Metals by ICP-AES - continued						
EG005T: Total Metals by ICP-AES - (QC Lot: 188667) - continued		mg/kg	mg/kg	%	%	%
Chromium	2 mg/kg	----	60.9	105	70	130
	2 mg/kg	<2	----	----	----	----
Cobalt	2 mg/kg	<2	----	----	----	----
Copper	5 mg/kg	----	54.7	102	70	130
	5 mg/kg	<5	----	----	----	----
Lead	5 mg/kg	----	55.2	99.0	70	130
	5 mg/kg	<5	----	----	----	----
Manganese	5 mg/kg	<5	----	----	----	----
Nickel	2 mg/kg	----	54.8	107	70	130
	2 mg/kg	<2	----	----	----	----
Vanadium	5 mg/kg	<5	----	----	----	----
Zinc	5 mg/kg	----	104	98.1	70	130
	5 mg/kg	<5	----	----	----	----
EG035T: Total Mercury by FIMS						
EG035T: Total Mercury by FIMS - (QC Lot: 188052)		mg/kg	mg/kg	%	%	%
Mercury	0.1 mg/kg	----	1.4	93.4	70	130
	0 1 mg/kg	0 1	----			
EG035T: Total Mercury by FIMS - (QC Lot: 188668)		mg/kg	mg/kg	%	%	%
Mercury	0.1 mg/kg	----	1.4	98.1	70	130
	0.1 mg/kg	<0.1	----	----	----	----
EP066: Polychlorinated Biphenyls (PCB)						
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 186608)		mg/kg	mg/kg	%	%	%
Total Polychlorinated biphenyls	0.1 mg/kg	----	0.5	89.3	66	121
	0.10 mg/kg	<0.10	----	----	----	----
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 188585)		mg/kg	mg/kg	%	%	%
Total Polychlorinated biphenyls	0.1 mg/kg	----	0.5	87.5	66	121
	0.10 mg/kg	<0.10	----	----	----	----
EP068A: Organochlorine Pesticides (OC)						

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186607)		mg/kg	mg/kg	%	%	%
4,4'-DDD	0.05 mg/kg	----	0.25	76.2	72.4	109
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDE	0.05 mg/kg	----	0.25	90.4	73.6	107
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDT	0.2 mg/kg	----	0.25	104	62.1	125
	0.2 mg/kg	<0.2	----	----	----	----
Aldrin	0.05 mg/kg	----	0.25	87.8	73.3	108
	0.05 mg/kg	<0.05	----	----	----	----
alpha-BHC	0.05 mg/kg	----	0.25	89.6	77.5	109
	0.05 mg/kg	<0.05	----	----	----	----
alpha-Endosulfan	0.05 mg/kg	----	0.25	78.2	71.5	112
	0.05 mg/kg	<0.05	----	----	----	----
beta-BHC	0.05 mg/kg	----	0.25	93.0	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----
beta-Endosulfan	0.05 mg/kg	----	0.25	81.8	73.8	112
	0.05 mg/kg	<0.05	----	----	----	----
cis-Chlordane	0.05 mg/kg	----	0.25	83.4	70.8	111
	0.05 mg/kg	<0.05	----	----	----	----
delta-BHC	0.05 mg/kg	----	0.25	88.6	67.1	113
	0.05 mg/kg	<0.05	----	----	----	----
Dieldrin	0.05 mg/kg	----	0.25	82.4	72.7	109
	0.05 mg/kg	<0.05	----	----	----	----
Endosulfan sulfate	0.05 mg/kg	----	0.25	77.6	68.5	115
	0.05 mg/kg	<0.05	----	----	----	----
Endrin	0.05 mg/kg	----	0.25	98.0	65.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Endrin aldehyde	0.05 mg/kg	----	0.25	81.8	72.2	114
	0.05 mg/kg	<0.05	----	----	----	----
Endrin ketone	0.05 mg/kg	----	0.25	74.4	71.1	114
	0.05 mg/kg	<0.05	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186607) - continued		mg/kg	mg/kg	%	%	%
gamma-BHC	0.05 mg/kg	----	0.25	90.4	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor	0.05 mg/kg	----	0.25	106	74.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor epoxide	0.05 mg/kg	----	0.25	84.6	74	108
	0.05 mg/kg	<0.05	----	----	----	----
Hexachlorobenzene (HCB)	0.05 mg/kg	----	0.25	94.4	69.6	108
	0.05 mg/kg	<0.05	----	----	----	----
Methoxychlor	0.2 mg/kg	----	0.25	90.4	56.8	137
	0.2 mg/kg	<0.2	----	----	----	----
trans-Chlordane	0.05 mg/kg	----	0.25	88.8	74.6	108
	0.05 mg/kg	<0.05	----	----	----	----
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188584)		mg/kg	mg/kg	%	%	%
4,4'-DDD	0.05 mg/kg	----	0.25	96.0	72.4	109
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDE	0.05 mg/kg	----	0.25	93.8	73.6	107
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDT	0.2 mg/kg	----	0.25	92.6	62.1	125
	0.2 mg/kg	<0.2	----	----	----	----
Aldrin	0.05 mg/kg	----	0.25	84.4	73.3	108
	0.05 mg/kg	<0.05	----	----	----	----
alpha-BHC	0.05 mg/kg	----	0.25	80.8	77.5	109
	0.05 mg/kg	<0.05	----	----	----	----
alpha-Endosulfan	0.05 mg/kg	----	0.25	78.6	71.5	112
	0.05 mg/kg	<0.05	----	----	----	----
beta-BHC	0.05 mg/kg	----	0.25	86.2	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----
beta-Endosulfan	0.05 mg/kg	----	0.25	98.0	73.8	112
	0.05 mg/kg	<0.05	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188584) - continued		mg/kg	mg/kg	%	%	%
cis-Chlordane	0.05 mg/kg	----	0.25	87.2	70.8	111
	0.05 mg/kg	<0.05	----	----	----	----
delta-BHC	0.05 mg/kg	----	0.25	104	67.1	113
	0.05 mg/kg	<0.05	----	----	----	----
Dieldrin	0.05 mg/kg	----	0.25	91.4	72.7	109
	0.05 mg/kg	<0.05	----	----	----	----
Endosulfan sulfate	0.05 mg/kg	----	0.25	97.0	68.5	115
	0.05 mg/kg	<0.05	----	----	----	----
Endrin	0.05 mg/kg	----	0.25	91.2	65.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Endrin aldehyde	0.05 mg/kg	----	0.25	88.6	72.2	114
	0.05 mg/kg	<0.05	----	----	----	----
Endrin ketone	0.05 mg/kg	----	0.25	82.0	71.1	114
	0.05 mg/kg	<0.05	----	----	----	----
gamma-BHC	0.05 mg/kg	----	0.25	85.4	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor	0.05 mg/kg	----	0.25	98.4	74.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor epoxide	0.05 mg/kg	----	0.25	72.6	74	108
	0.05 mg/kg	<0.05	----	----	----	----
Hexachlorobenzene (HCB)	0.05 mg/kg	----	0.25	80.6	69.6	108
	0.05 mg/kg	<0.05	----	----	----	----
Methoxychlor	0.2 mg/kg	----	0.25	83.8	56.8	137
	0.2 mg/kg	<0.2	----	----	----	----
trans-Chlordane	0.05 mg/kg	----	0.25	87.2	74.6	108
	0.05 mg/kg	<0.05	----	----	----	----
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186607)		mg/kg	mg/kg	%	%	%
Methyl Azinphos	0.05 mg/kg	----	0.25	92.2	33.1	144
	0.05 mg/kg	<0.05	----	----	----	----

ALS Environmental

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186607) - continued		mg/kg	mg/kg	%	%	%
Bromophos-ethyl	0.05 mg/kg	----	0.25	85.0	66.5	112
	0.05 mg/kg	<0.05	----	----	----	----
Carbophenothion	0.05 mg/kg	----	0.25	84.6	67.8	108
	0.05 mg/kg	<0.05	----	----	----	----
Chlorfenvinphos	0.05 mg/kg	----	0.25	88.8	54.5	132
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos	0.05 mg/kg	----	0.25	88.0	75	109
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos-methyl	0.05 mg/kg	----	0.25	89.0	72.2	107
	0.05 mg/kg	<0.05	----	----	----	----
Demeton-S-methyl	0.05 mg/kg	----	0.25	88.6	57.7	123
	0.05 mg/kg	<0.05	----	----	----	----
Diazinon	0.05 mg/kg	----	0.25	90.8	72.9	108
	0.05 mg/kg	<0.05	----	----	----	----
Dichlorvos	0.05 mg/kg	----	0.25	97.4	64	117
	0.05 mg/kg	<0.05	----	----	----	----
Dimethoate	0.05 mg/kg	----	0.25	102	60.7	117
	0.05 mg/kg	<0.05	----	----	----	----
Ethion	0.05 mg/kg	----	0.25	76.2	58.9	116
	0.05 mg/kg	<0.05	----	----	----	----
Fenamiphos	0.05 mg/kg	----	0.25	83.4	48.8	118
	0.05 mg/kg	<0.05	----	----	----	----
Fenthion	0.05 mg/kg	----	0.25	86.8	72.5	107
	0.05 mg/kg	<0.05	----	----	----	----
Malathion	0.05 mg/kg	----	0.25	87.8	61.6	121
	0.05 mg/kg	<0.05	----	----	----	----
Monocrotophos	0.2 mg/kg	----	0.25	103	46.9	125
	0.2 mg/kg	<0.2	----	----	----	----
Para hion	0.2 mg/kg	----	0.25	88.6	65.2	116
	0.2 mg/kg	<0.2	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186607) - continued		mg/kg	mg/kg	%	%	%
Para hion-methyl	0.2 mg/kg	----	0.25	106	68	109
	0.2 mg/kg	<0.2	----	----	----	----
Pirimphos-ethyl	0.05 mg/kg	----	0.25	97.4	66.3	118
	0.05 mg/kg	<0.05	----	----	----	----
Prothiofos	0.05 mg/kg	----	0.25	82.4	73	111
	0.05 mg/kg	<0.05	----	----	----	----
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188584)		mg/kg	mg/kg	%	%	%
Methyl Azinphos	0.05 mg/kg	----	0.25	59.8	33.1	144
	0.05 mg/kg	<0.05	----	----	----	----
Bromophos-ethyl	0.05 mg/kg	----	0.25	89.4	66.5	112
	0.05 mg/kg	<0.05	----	----	----	----
Carbophenothion	0.05 mg/kg	----	0.25	88.6	67.8	108
	0.05 mg/kg	<0.05	----	----	----	----
Chlorfenvinphos	0.05 mg/kg	----	0.25	94.2	54.5	132
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos	0.05 mg/kg	----	0.25	98.2	75	109
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos-methyl	0.05 mg/kg	----	0.25	95.2	72.2	107
	0.05 mg/kg	<0.05	----	----	----	----
Demeton-S-methyl	0.05 mg/kg	----	0.25	43.4	57.7	123
	0.05 mg/kg	<0.05	----	----	----	----
Diazinon	0.05 mg/kg	----	0.25	79.2	72.9	108
	0.05 mg/kg	<0.05	----	----	----	----
Dichlorvos	0.05 mg/kg	----	0.25	75.2	64	117
	0.05 mg/kg	<0.05	----	----	----	----
Dimethoate	0.05 mg/kg	----	0.25	85.6	60.7	117
	0.05 mg/kg	<0.05	----	----	----	----
Ethion	0.05 mg/kg	----	0.25	93.2	58.9	116
	0.05 mg/kg	<0.05	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188584) - continued		mg/kg	mg/kg	%	%	%
Fenamiphos	0.05 mg/kg	----	0.25	77.2	48.8	118
	0.05 mg/kg	<0.05	----	----	----	----
Fenthion	0.05 mg/kg	----	0.25	84.4	72.5	107
	0.05 mg/kg	<0.05	----	----	----	----
Malathion	0.05 mg/kg	----	0.25	92.4	61.6	121
	0.05 mg/kg	<0.05	----	----	----	----
Monocrotophos	0.2 mg/kg	----	0.25	57.0	46.9	125
	0.2 mg/kg	<0.2	----	----	----	----
Para hion	0.2 mg/kg	----	0.25	93.0	65.2	116
	0.2 mg/kg	<0.2	----	----	----	----
Para hion-methyl	0.2 mg/kg	----	0.25	104	68	109
	0.2 mg/kg	<0.2	----	----	----	----
Pirimphos-ethyl	0.05 mg/kg	----	0.25	87.8	66.3	118
	0.05 mg/kg	<0.05	----	----	----	----
Prothiofos	0.05 mg/kg	----	0.25	89.6	73	111
	0.05 mg/kg	<0.05	----	----	----	----

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EG020F: Dissolved Metals by ICP-MS						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 187484)		mg/L	mg/L	%	%	%
Arsenic	0.001 mg/L	----	0.1	99.0	70	130
	0.001 mg/L	<0.001	----	----	----	----
Cadmium	0.0001 mg/L	----	0.1	102	70	130
	0.0001 mg/L	<0.0001	----	----	----	----
Chromium	0.001 mg/L	----	0.1	106	70	130
	0.001 mg/L	<0.001	----	----	----	----
Copper	0.001 mg/L	----	0.1	101	70	130
	0.001 mg/L	<0.001	----	----	----	----

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EG020F: Dissolved Metals by ICP-MS - continued						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 187484) - continued		mg/L	mg/L	%	%	%
Lead	0.001 mg/L	----	0.1	102	70	130
	0.001 mg/L	<0.001	----	----	----	----
Nickel	0.001 mg/L	----	0.1	97.0	70	130
	0.001 mg/L	<0.001	----	----	----	----
Zinc	0.005 mg/L	----	0.1	102	70	130
	0.005 mg/L	<0.005	----	----	----	----
EG035F: Dissolved Mercury by FIMS						
EG035F: Dissolved Mercury by FIMS - (QC Lot: 186960)		mg/L	mg/L	%	%	%
Mercury	0.0001 mg/L	----	0.010	100	70	130
	0.0001 mg/L	<0.0001	----	----	----	----
EP068A: Organochlorine Pesticides (OC)						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186600)		µg/L	µg/L	%	%	%
4,4'-DDD	0.5 µg/L	----	5	86.4	70.9	110
	0.5 µg/L	<0.5	----	----	----	----
4,4'-DDE	0.5 µg/L	----	5	89.2	72.4	110
	0.5 µg/L	<0.5	----	----	----	----
4,4'-DDT	2.0 µg/L	----	5	84.6	57	123
	2 µg/L	<2	----	----	----	----
Aldrin	0.5 µg/L	----	5	86.4	77.7	106
	0.5 µg/L	<0.5	----	----	----	----
alpha-BHC	0.5 µg/L	----	5	85.0	77.7	106
	0.5 µg/L	<0.5	----	----	----	----
alpha-Endosulfan	0.5 µg/L	----	5	88.0	77.8	108
	0.5 µg/L	<0.5	----	----	----	----
beta-BHC	0.5 µg/L	----	5	85.8	74.3	111
	0.5 µg/L	<0.5	----	----	----	----
beta-Endosulfan	0.5 µg/L	----	5	76.0	76.8	107
	0.5 µg/L	<0.5	----	----	----	----

ALS Environmental

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186600) - continued		µg/L	µg/L	%	%	%
cis-Chlordane	0.5 µg/L	----	5	89.2	75.1	106
	0.5 µg/L	<0.5	----	----	----	----
delta-BHC	0.5 µg/L	----	5	87.8	71.7	106
	0.5 µg/L	<0.5	----	----	----	----
Dieldrin	0.5 µg/L	----	5	87.0	82.3	105
	0.5 µg/L	<0.5	----	----	----	----
Endosulfan sulfate	0.5 µg/L	----	5	85.2	77.5	106
	0.5 µg/L	<0.5	----	----	----	----
Endrin	0.5 µg/L	----	5	87.2	79.4	106
	0.5 µg/L	<0.5	----	----	----	----
Endrin aldehyde	0.5 µg/L	----	5	85.0	76.8	108
	0.5 µg/L	<0.5	----	----	----	----
Endrin ketone	0.5 µg/L	----	5	83.6	74.1	107
	0.5 µg/L	<0.5	----	----	----	----
gamma-BHC	0.5 µg/L	----	5	84.6	74.3	111
	0.5 µg/L	<0.5	----	----	----	----
Heptachlor	0.5 µg/L	----	5	89.6	80.4	103
	0.5 µg/L	<0.5	----	----	----	----
Heptachlor epoxide	0.5 µg/L	----	5	86.4	76.1	107
	0.5 µg/L	<0.5	----	----	----	----
Hexachlorobenzene (HCB)	0.5 µg/L	----	5	90.4	57.3	119
	0.5 µg/L	<0.5	----	----	----	----
Methoxychlor	2.0 µg/L	----	5	95.2	34.3	139
	2 µg/L	<2	----	----	----	----
trans-Chlordane	0.5 µg/L	----	5	98.2	76.8	105
	0.5 µg/L	<0.5	----	----	----	----
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186600)		µg/L	µg/L	%	%	%
Methyl Azinphos	0.5 µg/L	----	5	96.0	54.8	127
	0.5 µg/L	<0.5	----	----	----	----

ALS Environmental

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186600) - continued		µg/L	µg/L	%	%	%
Bromophos-ethyl	0.5 µg/L	----	5	86.8	63.4	128
	0.5 µg/L	<0.5	----	----	----	----
Carbophenothion	0.5 µg/L	----	5	86.2	78.1	101
	0.5 µg/L	<0.5	----	----	----	----
Chlorfenvinphos	0.5 µg/L	----	5	84.6	78.7	106
	0.5 µg/L	<0.5	----	----	----	----
Chlorpyrifos	0.5 µg/L	----	5	88.6	79.5	104
	0.5 µg/L	<0.5	----	----	----	----
Chlorpyrifos-methyl	0.5 µg/L	----	5	89.0	76.6	106
	0.5 µg/L	<0.5	----	----	----	----
Demeton-S-methyl	0.5 µg/L	----	5	82.2	60.3	115
	0.5 µg/L	<0.5	----	----	----	----
Diazinon	0.5 µg/L	----	5	87.4	78.1	104
	0.5 µg/L	<0.5	----	----	----	----
Dichlorvos	0.5 µg/L	----	5	105	70.4	110
	0.5 µg/L	<0.5	----	----	----	----
Dimethoate	0.5 µg/L	----	5	81.4	67.5	108
	0.5 µg/L	<0.5	----	----	----	----
Ethion	0.5 µg/L	----	5	85.2	57.6	123
	0.5 µg/L	<0.5	----	----	----	----
Fenamiphos	0.5 µg/L	----	5	87.6	66	109
	0.5 µg/L	<0.5	----	----	----	----
Fenthion	0.5 µg/L	----	5	87.6	65.6	117
	0.5 µg/L	<0.5	----	----	----	----
Malathion	0.5 µg/L	----	5	83.8	77.6	106
	0.5 µg/L	<0.5	----	----	----	----
Monocrotophos	0.5 µg/L	----	5	66.8	3.29	37.7
	2 µg/L	<2	----	----	----	----
Para hion	2.0 µg/L	----	5	94.4	79	100
	2 µg/L	<2	----	----	----	----

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186600) - continued		µg/L	µg/L	%	%	%
Para hion-methyl	2.0 µg/L	----	5	94.4	71.8	110
	2 µg/L	<2	----	----	----	----
Pirimphos-ethyl	0.5 µg/L	----	5	88.2	70.7	108
	0.5 µg/L	<0.5	----	----	----	----
Prothiofos	0.5 µg/L	----	5	87.0	74.8	104
	0.5 µg/L	<0.5	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons						
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 186601)		µg/L	µg/L	%	%	%
C10 - C14 Fraction	50 µg/L	----	200	80.7	75	134
	50 µg/L	<50	----	----	----	----
C15 - C28 Fraction	100 µg/L	----	200	105	87	132
	100 µg/L	<100	----	----	----	----
C29 - C36 Fraction	50 µg/L	----	200	89.7	80	126
	50 µg/L	<50	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 190974)		µg/L	µg/L	%	%	%
C6 - C9 Fraction	20 µg/L	----	260	84.6	80	120
	20 µg/L	<20	----	----	----	----
EP080: BTEX						
EP080: BTEX - (QC Lot: 190974)		µg/L	µg/L	%	%	%
Benzene	1 µg/L	----	10	104	78	125
	1 µg/L	<1	----	----	----	----
Ethylbenzene	2 µg/L	----	10	104	73	118
	2 µg/L	<2	----	----	----	----
meta- & para-Xylene	2 µg/L	----	10	105	78	117
	2 µg/L	<2	----	----	----	----
ortho-Xylene	2 µg/L	----	10	104	75	119
	2 µg/L	<2	----	----	----	----
Toluene	2 µg/L	----	10	107	74	126
	2 µg/L	<2	----	----	----	----

Quality Control Report - Matrix Spikes (MS)

The quality control term **Matrix Spike (MS)** refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQO's). 'Ideal' recovery ranges stated may be waived in the event of sample matrix interferences. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** *= Limit of Reporting,* ***RPD*** *= Relative Percent Difference.*

* Indicates failed QC

Matrix Type: SOIL

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	Laboratory Sample ID	Client Sample ID	LOR	Spike Concentration		MS	Low	High
EG005T: Total Metals by ICP-AES								
EG005T: Total Metals by ICP-AES - (QC Lot: 188051)				mg/kg	mg/kg	%	%	%
Arsenic	ES0603103-014	Anonymous	5 mg/kg	50	<5	105	70	130
Cadmium			1 mg/kg	50	<1	92.7	70	130
Chromium			2 mg/kg	50	15	92.6	70	130
Copper			5 mg/kg	250	239	98.0	70	130
Lead			5 mg/kg	250	<5	91.9	70	130
Nickel			2 mg/kg	50	5	94.7	70	130
Zinc			5 mg/kg	250	27	86.3	70	130
EG005T: Total Metals by ICP-AES - (QC Lot: 188667)				mg/kg	mg/kg	%	%	%
Arsenic	ES0603097-008	COMP 7	5 mg/kg	50	<5	108	70	130
Cadmium			1 mg/kg	50	<1	105	70	130
Chromium			2 mg/kg	50	16	106	70	130
Copper			5 mg/kg	250	5	103	70	130
Lead			5 mg/kg	250	10	102	70	130
Nickel			2 mg/kg	50	7	110	70	130
Zinc			5 mg/kg	250	21	101	70	130
EG035T: Total Mercury by FIMS								
EG035T: Total Mercury by FIMS - (QC Lot: 188052)				mg/kg	mg/kg	%	%	%
Mercury	ES0603103-014	Anonymous	0.1 mg/kg	5	<0.1	107	70	130
EG035T: Total Mercury by FIMS - (QC Lot: 188668)				mg/kg	mg/kg	%	%	%
Mercury	ES0603097-008	COMP 7	0.1 mg/kg	5	<0.1	109	70	130
EP066: Polychlorinated Biphenyls (PCB)								
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 186608)				mg/kg	mg/kg	%	%	%
Total Polychlorinated biphenyls	ES0603097-001	34_SS1_0.0_0.1	0.1 mg/kg	0.5	<0.10	103	70	130

Matrix Type: SOIL

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EP066: Polychlorinated Biphenyls (PCB) - continued								
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 188585)				mg/kg	mg/kg	%	%	%
Total Polychlorinated biphenyls	ES0603097-008	COMP 7	0.1 mg/kg	0.5	<0.10	91.7	70	130
EP068A: Organochlorine Pesticides (OC)								
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186607)				mg/kg	mg/kg	%	%	%
gamma-BHC	ES0603097-001	34_SS1_0.0_0.1	0.05 mg/kg	0.25	<0.05	104	75.65	110.44
Heptachlor			0.05 mg/kg	0.25	<0.05	94.2	72.2	106.71
Aldrin			0.05 mg/kg	0.25	<0.05	82.4	77.54	107.0
Dieldrin			0.05 mg/kg	0.25	<0.05	98.0	76.37	109.7
Endrin			0.05 mg/kg	1	<0.05	82.0	68.51	119.47
4,4'-DDT			0.2 mg/kg	1	<0.2	110	67.12	118.10
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188584)				mg/kg	mg/kg	%	%	%
gamma-BHC	ES0603097-008	COMP 7	0.05 mg/kg	0.25	<0.05	120	75.65	110.44
Heptachlor			0.05 mg/kg	0.25	<0.05	121	72.2	106.71
Aldrin			0.05 mg/kg	0.25	<0.05	89.2	77.54	107.0
Dieldrin			0.05 mg/kg	0.25	<0.05	85.6	76.37	109.7
Endrin			0.05 mg/kg	1	<0.05	115	68.51	119.47
4,4'-DDT			0.2 mg/kg	1	<0.2	115	67.12	118.10
EP068B: Organophosphorus Pesticides (OP)								
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186607)				mg/kg	mg/kg	%	%	%
Diazinon	ES0603097-001	34_SS1_0.0_0.1	0.05 mg/kg	0.25	<0.05	92.6	75.85	107.06
Chlorpyrifos-methyl			0.05 mg/kg	0.25	<0.05	82.4	74.84	107.91
Pirimphos-ethyl			0.05 mg/kg	0.25	<0.05	81.4	67.98	109.42
Bromophos-ethyl			0.05 mg/kg	0.25	<0.05	77.4	74.94	107.37
Prothiofos			0.05 mg/kg	0.25	<0.05	99.2	75.45	106.05
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188584)				mg/kg	mg/kg	%	%	%
Diazinon	ES0603097-008	COMP 7	0.05 mg/kg	0.25	<0.05	83.8	75.85	107.06
Chlorpyrifos-methyl			0.05 mg/kg	0.25	<0.05	100	74.84	107.91
Pirimphos-ethyl			0.05 mg/kg	0.25	<0.05	93.8	67.98	109.42
Bromophos-ethyl			0.05 mg/kg	0.25	<0.05	85.6	74.94	107.37

Matrix Type: SOIL

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EP068B: Organophosphorus Pesticides (OP) - continued								
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188584) - continued				mg/kg	mg/kg	%	%	%
Prothiofos	ES0603097-008	COMP 7	0.05 mg/kg	0.25	<0.05	94.6	75.45	106.05

Matrix Type: WATER

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EG020F: Dissolved Metals by ICP-MS								
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 187484)				mg/L	mg/L	%	%	%
Arsenic	ES0603097-002	WS1	0.001 mg/L	0.2	0.001	99.3	70	130
Cadmium			0.0001 mg/L	0.05	<0.0001	104	70	130
Chromium			0.001 mg/L	0.2	<0.001	99.8	70	130
Copper			0.001 mg/L	0.2	<0.001	102	70	130
Lead			0.001 mg/L	0.2	<0.001	96.2	70	130
Nickel			0.001 mg/L	0.2	<0.001	96.3	70	130
Zinc			0.005 mg/L	0.2	0.063	101	70	130
EG035F: Dissolved Mercury by FIMS								
EG035F: Dissolved Mercury by FIMS - (QC Lot: 186960)				mg/L	mg/L	%	%	%
Mercury	ES0603081-002	Anonymous	0.0001 mg/L	0.0100	<0.0001	95.8	70	130
EP080/071: Total Petroleum Hydrocarbons								
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 190974)				µg/L	µg/L	%	%	%
C6 - C9 Fraction	ES0603247-008	Anonymous	20 µg/L	250	<20	89.3	80	120
EP080: BTEX								
EP080: BTEX - (QC Lot: 190974)				µg/L	µg/L	%	%	%
Benzene	ES0603247-008	Anonymous	1 µg/L	25	<1	109	80	120
Toluene			2 µg/L	25	<2	96.5	80	120
Ethylbenzene			2 µg/L	25	<2	110	80	120
meta- & para-Xylene			2 µg/L	25	<2	109	80	120
ortho-Xylene			2 µg/L	25	<2	109	80	120

ALS Environmental

QUALITY CONTROL REPORT

Client	:	**NETWORK GEOTECHNICS PTY LTD**	**Laboratory**	: ALS Environmental Sydney	**Page**	:	**1 of 24**
Contact	:	MR VIPUL DE SILVA	**Contact**	: Greg Vogel			
Address	:	UNIT 14, 25 STODDART ROAD PROSPECT NSW AUSTRALIA 2148	**Address**	: 277-289 Woodpark Road Smithfield NSW Australia 2164	**Work order**	:	**ES0603097**
					Amendment No.	:	
Project	:	G25058/1	**Quote number**	: SY/405/02	**Date received**	:	15 Mar 2006
Order number	:	- Not provided -			**Date issued**	:	27 Mar 2006
C-O-C number	:	008306-008307					
Site	:	- Not provided -					
E-mail	:	gosnetgeo@bigpond.com	**E-mail**	: Greg.Vogel@alsenviro.com	**No. of samples**		
Telephone	:	02 9688 1764	**Telephone**	: 61-2-87848555	**Received**	:	20
Facsimile	:	02 9688 1765	**Facsimile**	: 61-2-87848500	**Analysed**	:	10

This final report for the ALSE work order reference ES0603097 supersedes any previous reports with this reference.

Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- Laboratory Duplicates (DUP); Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Samples (LCS); Recovery and Acceptance Limits
- Matrix Spikes (MS); Recovery and Acceptance Limits

Work order specific comments

EP068: Insufficient samples have been provided for standard analysis. Where applicable LOR values have been adjusted accordingly.

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory - 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IED 17025

This document has been digitally signed by those names that appear on this report and are the authorised signatories. Digital signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Daniel Um	Organics - NATA 825 (10911 - Sydney)
Peter Dickenson	norganics - NATA 825 (10911 - Sydney)

Quality Control Report - Laboratory Duplicates (DUP)

The quality control term **Laboratory Duplicate** refers to an intralaboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
- Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** = *Limit of Reporting,* ***RPD*** = *Relative Percent Difference.*
* Indicates failed QC. The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:- Result < 10 times LOR, no limit - Result between 10 and 20 times LOR, 0% - 50% - Result > 20 times LOR, 0% - 20%

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EA055: Moisture Content						
EA055: Moisture Content - (QC Lot: 188604)				%	%	%
ES0603073-009	Anonymous	Moisture Content (dried @ 103°C)	1.0 %	7.2	6.9	4.1
ES0603097-008	COMP 7	Moisture Content (dried @ 103°C)	1.0 %	8.8	8.8	0.0
EG005T: Total Metals by ICP-AES						
EG005T: Total Metals by ICP-AES - (QC Lot: 188051)				mg/kg	mg/kg	%
ES0603103-014	Anonymous	Arsenic	5 mg/kg	<5	<5	0.0
		Barium	10 mg/kg	30	30	0.0
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	2 mg/kg	15	15	0.0
		Cobalt	2 mg/kg	9	7	19.4
		Copper	5 mg/kg	239	218	9.4
		Lead	5 mg/kg	<5	6	0.0
		Manganese	5 mg/kg	335	286	15.6
		Nickel	2 mg/kg	5	5	0.0
		Vanadium	5 mg/kg	38	37	3.3
		Zinc	5 mg/kg	27	27	0.0
ES0603103-024	Anonymous	Arsenic	5 mg/kg	<5	6	0.0
		Barium	10 mg/kg	40	40	0.0
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	2 mg/kg	17	18	0.0
		Cobalt	2 mg/kg	9	9	0.0
		Copper	5 mg/kg	222	260	15.7
		Lead	5 mg/kg	5	5	0.0
		Manganese	5 mg/kg	347	354	2.1

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EG005T: Total Metals by ICP-AES - continued						
EG005T: Total Metals by ICP-AES - (QC Lot: 188051) - continued				mg/kg	mg/kg	%
ES0603103-024	Anonymous	Nickel	2 mg/kg	7	7	0.0
		Vanadium	5 mg/kg	43	46	7.4
		Zinc	5 mg/kg	31	28	9.5
EG005T: Total Metals by ICP-AES - (QC Lot: 188667)				mg/kg	mg/kg	%
ES0603097-008	COMP 7	Arsenic	5 mg/kg	<5	<5	0.0
		Barium	10 mg/kg	50	60	0.0
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	<1	<1	0.0
		Chromium	2 mg/kg	16	19	18.2
		Cobalt	2 mg/kg	10	11	0.0
		Copper	5 mg/kg	5	6	0.0
		Lead	5 mg/kg	10	10	0.0
		Manganese	5 mg/kg	446	500	11.5
		Nickel	2 mg/kg	7	8	15.8
		Vanadium	5 mg/kg	43	49	14.7
		Zinc	5 mg/kg	21	22	5.9
ES0603195-054	Anonymous	Arsenic	5 mg/kg	23	13	57.1
		Barium	10 mg/kg	80	90	0.0
		Beryllium	1 mg/kg	<1	<1	0.0
		Cadmium	1 mg/kg	2	3	0.0
		Chromium	2 mg/kg	3	2	48.1
		Cobalt	2 mg/kg	<2	<2	0.0
		Copper	5 mg/kg	13	14	0.0
		Lead	5 mg/kg	149	152	1.8
		Manganese	5 mg/kg	39	41	5.9
		Nickel	2 mg/kg	3	3	0.0
		Vanadium	5 mg/kg	25	8	99.7
		Zinc	5 mg/kg	247	274	10.4
EG035T: Total Mercury by FIMS						

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EG035T: Total Mercury by FIMS - continued						
EG035T: Total Mercury by FIMS - (QC Lot: 188052)				mg/kg	mg/kg	%
ES0603103-014	Anonymous	Mercury	0.1 mg/kg	<0.1	0.1	0.0
ES0603103-024	Anonymous	Mercury	0.1 mg/kg	<0.1	<0.1	0.0
EG035T: Total Mercury by FIMS - (QC Lot: 188668)				mg/kg	mg/kg	%
ES0603097-008	COMP 7	Mercury	0.1 mg/kg	<0.1	<0.1	0.0
ES0603239-001	Anonymous	Mercury	0.1 mg/kg	<0.1	<0.1	0.0
EP066: Polychlorinated Biphenyls (PCB)						
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 186608)				mg/kg	mg/kg	%
ES0603097-001	34_SS1_0.0_0.1	Total Polychlorinated biphenyls	0.10 mg/kg	<0.10	<0.10	0.0
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 188585)				mg/kg	mg/kg	%
ES0603097-008	COMP 7	Total Polychlorinated biphenyls	0.10 mg/kg	<0.10	<0.10	0.0
EP068A: Organochlorine Pesticides (OC)						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186607)				mg/kg	mg/kg	%
ES0603097-001	34_SS1_0.0_0.1	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186607) - continued				mg/kg	mg/kg	%
ES0603097-001	34_SS1_0.0_0.1	Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
ES0603102-009	Anonymous	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188584)				mg/kg	mg/kg	%
ES0603097-008	COMP 7	alpha-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Hexachlorobenzene (HCB)	0.05 mg/kg	<0.05	<0.05	0.0
		beta-BHC	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188584) - continued				mg/kg	mg/kg	%
ES0603097-008	COMP 7	gamma-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		delta-BHC	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor	0.05 mg/kg	<0.05	<0.05	0.0
		Aldrin	0.05 mg/kg	<0.05	<0.05	0.0
		Heptachlor epoxide	0.05 mg/kg	<0.05	<0.05	0.0
		trans-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		alpha-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		cis-Chlordane	0.05 mg/kg	<0.05	<0.05	0.0
		Dieldrin	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDE	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin	0.05 mg/kg	<0.05	<0.05	0.0
		beta-Endosulfan	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDD	0.05 mg/kg	<0.05	<0.05	0.0
		Endrin aldehyde	0.05 mg/kg	<0.05	<0.05	0.0
		Endosulfan sulfate	0.05 mg/kg	<0.05	<0.05	0.0
		4,4'-DDT	0.2 mg/kg	<0.2	<0.2	0.0
		Endrin ketone	0.05 mg/kg	<0.05	<0.05	0.0
		Methoxychlor	0.2 mg/kg	<0.2	<0.2	0.0
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186607)				mg/kg	mg/kg	%
ES0603097-001	34_SS1_0.0_0.1	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186607) - continued				mg/kg	mg/kg	%
ES0603097-001	34_SS1_0.0_0.1	Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Methyl Azinphos	0.05 mg/kg	<0.05	<0.05	0.0
ES0603102-009	Anonymous	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Methyl Azinphos	0.05 mg/kg	<0.05	<0.05	0.0

ALS Environmental

Matrix Type: SOIL — *Laboratory Duplicates (DUP) Report*

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188584)				mg/kg	mg/kg	%
ES0603097-008	COMP 7	Dichlorvos	0.05 mg/kg	<0.05	<0.05	0.0
		Demeton-S-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Monocrotophos	0.2 mg/kg	<0.2	<0.2	0.0
		Dimethoate	0.05 mg/kg	<0.05	<0.05	0.0
		Diazinon	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos-methyl	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion-methyl	0.2 mg/kg	<0.2	<0.2	0.0
		Malathion	0.05 mg/kg	<0.05	<0.05	0.0
		Fenthion	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorpyrifos	0.05 mg/kg	<0.05	<0.05	0.0
		Parathion	0.2 mg/kg	<0.2	<0.2	0.0
		Pirimphos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Chlorfenvinphos	0.05 mg/kg	<0.05	<0.05	0.0
		Bromophos-ethyl	0.05 mg/kg	<0.05	<0.05	0.0
		Fenamiphos	0.05 mg/kg	<0.05	<0.05	0.0
		Prothiofos	0.05 mg/kg	<0.05	<0.05	0.0
		Ethion	0.05 mg/kg	<0.05	<0.05	0.0
		Carbophenothion	0.05 mg/kg	<0.05	<0.05	0.0
		Methyl Azinphos	0.05 mg/kg	<0.05	<0.05	0.0

Matrix Type: WATER — *Laboratory Duplicates (DUP) Report*

Lab rat ry Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Dupli ate Result	RPD
EG020F: Dissolved Metals by ICP-MS						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 187484)				mg/L	mg/L	%
ES0603097-002	WS1	Arsenic	0.001 mg/L	0.001	0.001	0.0
		Cadmium	0.0001 mg/L	<0 0001	<0.0001	0.0
		Chromium	0.001 mg/L	<0.001	<0.001	0.0
		Copper	0.001 mg/L	<0.001	<0.001	0.0
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Nickel	0.001 mg/L	<0.001	<0.001	0.0

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EG020F: Dissolved Metals by ICP-MS - continued						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 187484) - continued				mg/L	mg/L	%
ES0603097-002	WS1	Zinc	0.005 mg/L	0.063	0.059	5.4
ES0603141-004	Anonymous	Arsenic	0.001 mg/L	0.002	0.003	0.0
		Cadmium	0.0001 mg/L	<0 0001	<0.0001	0.0
		Chromium	0.001 mg/L	<0.001	0.001	0.0
		Copper	0.001 mg/L	0.004	0.002	58.4
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Nickel	0.001 mg/L	0.026	0.026	0.0
		Zinc	0.005 mg/L	0.018	0.016	13.8
EG035F: Dissolved Mercury by FIMS						
EG035F: Dissolved Mercury by FIMS - (QC Lot: 186960)				mg/L	mg/L	%
ES0603081-002	Anonymous	Mercury	0.0001 mg/L	<0 0001	<0.0001	0.0
ES0603081-004	Anonymous	Mercury	0.0001 mg/L	<0 0001	<0.0001	0.0
EP080/071: Total Petroleum Hydrocarbons						
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 190974)				µg/L	µg/L	%
ES0603246-003	Anonymous	C6 - C9 Fraction	20 µg/L	3860	3610	6.7
ES0603247-008	Anonymous	C6 - C9 Fraction	20 µg/L	<20	<20	0.0
EP080: BTEX						
EP080: BTEX - (QC Lot: 190974)				µg/L	µg/L	%
E 0603246 003	Anonymous	Benzene	1 µg/L	540	528	2 2
		Toluene	2 µg/L	928	911	1.9
		Ethylbenzene	2 µg/L	333	319	4.3
		meta- & para-Xylene	2 µg/L	598	574	4.1
		ortho Xylene	2 µg/L	191	182	4 6
ES0603247-008	Anonymous	Benzene	1 µg/L	<1	<1	0.0
		Toluene	2 µg/L	<2	<2	0.0
		Ethylbenzene	2 µg/L	<2	<2	0.0
		meta & para Xylene	2 µg/L	2	2	0 0
		ortho-Xylene	2 µg/L	<2	<2	0.0

ALS Environmental

Quality Control Report - Method Blank (MB) and Laboratory Control Samples (LCS)

The quality control term **Method / Laboratory Blank** refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term **Laboratory Control Sample (LCS)** refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of actual laboratory data. Abbreviations: LOR = Limit of reporting.

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

		Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
Analyte name	LOR			LCS	Low	High
EG005T: Total Metals by ICP-AES						
EG005T: Total Metals by ICP-AES - (QC Lot: 188051)		mg/kg	mg/kg	%	%	%
Arsenic	5 mg/kg	----	13.1	92.8	70	130
	5 mg/kg	<5	----	----	----	----
Barium	10 mg/kg	<10	----	----	----	----
Beryllium	1 mg/kg	<1	----	----	----	----
Cadmium	1 mg/kg	<1	----	----	----	----
	1 mg/kg	----	2.76	88.2	70	130
Chromium	2 mg/kg	----	60.9	95.0	70	130
	2 mg/kg	<2	----	----	----	----
Cobalt	2 mg/kg	<2	----	----	----	----
Copper	5 mg/kg	----	54.7	92.0	70	130
	5 mg/kg	<5	----	----	----	----
Lead	5 mg/kg	----	55.2	92.0	70	130
	5 mg/kg	<5	----	----	----	----
Manganese	5 mg/kg	<5	----	----	----	----
Nickel	2 mg/kg	----	54.8	96.8	70	130
	2 mg/kg	<2	----	----	----	----
Vanadium	5 mg/kg	<5	----	----	----	----
Zinc	5 mg/kg	----	104	88.7	70	130
	5 mg/kg	<5	----	----	----	----
EG005T: Total Metals by ICP-AES - (QC Lot: 188667)		mg/kg	mg/kg	%	%	%
Arsenic	5 mg/kg	----	13.1	103	70	130
	5 mg/kg	<5	----	----	----	----
Barium	10 mg/kg	<10	----	----	----	----
Beryllium	1 mg/kg	<1	----	----	----	----
Cadmium	1 mg/kg	----	2.76	97.2	70	130
	1 mg/kg	<1	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EG005T: Total Metals by ICP-AES - continued						
EG005T: Total Metals by ICP-AES - (QC Lot: 188667) - continued		mg/kg	mg/kg	%	%	%
Chromium	2 mg/kg	----	60.9	105	70	130
	2 mg/kg	<2	----	----	----	----
Cobalt	2 mg/kg	<2	----	----	----	----
Copper	5 mg/kg	----	54.7	102	70	130
	5 mg/kg	<5	----	----	----	----
Lead	5 mg/kg	----	55.2	99.0	70	130
	5 mg/kg	<5	----	----	----	----
Manganese	5 mg/kg	<5	----	----	----	----
Nickel	2 mg/kg	----	54.8	107	70	130
	2 mg/kg	<2	----	----	----	----
Vanadium	5 mg/kg	<5	----	----	----	----
Zinc	5 mg/kg	----	104	98.1	70	130
	5 mg/kg	<5	----	----	----	----
EG035T: Total Mercury by FIMS						
EG035T: Total Mercury by FIMS - (QC Lot: 188052)		mg/kg	mg/kg	%	%	%
Mercury	0.1 mg/kg	----	1.4	93.4	70	130
	0 1 mg/kg	0 1	----			
EG035T: Total Mercury by FIMS - (QC Lot: 188668)		mg/kg	mg/kg	%	%	%
Mercury	0.1 mg/kg	----	1.4	98.1	70	130
	0.1 mg/kg	<0.1	----	----	----	----
EP066: Polychlorinated Biphenyls (PCB)						
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 186608)		mg/kg	mg/kg	%	%	%
Total Polychlorinated biphenyls	0.1 mg/kg	----	0.5	89.3	66	121
	0.10 mg/kg	<0.10	----	----	----	----
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 188585)		mg/kg	mg/kg	%	%	%
Total Polychlorinated biphenyls	0.1 mg/kg	----	0.5	87.5	66	121
	0.10 mg/kg	<0.10	----	----	----	----
EP068A: Organochlorine Pesticides (OC)						

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186607)		mg/kg	mg/kg	%	%	%
4,4'-DDD	0.05 mg/kg	----	0.25	76.2	72.4	109
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDE	0.05 mg/kg	----	0.25	90.4	73.6	107
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDT	0.2 mg/kg	----	0.25	104	62.1	125
	0.2 mg/kg	<0.2	----	----	----	----
Aldrin	0.05 mg/kg	----	0.25	87.8	73.3	108
	0.05 mg/kg	<0.05	----	----	----	----
alpha-BHC	0.05 mg/kg	----	0.25	89.6	77.5	109
	0.05 mg/kg	<0.05	----	----	----	----
alpha-Endosulfan	0.05 mg/kg	----	0.25	78.2	71.5	112
	0.05 mg/kg	<0.05	----	----	----	----
beta-BHC	0.05 mg/kg	----	0.25	93.0	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----
beta-Endosulfan	0.05 mg/kg	----	0.25	81.8	73.8	112
	0.05 mg/kg	<0.05	----	----	----	----
cis-Chlordane	0.05 mg/kg	----	0.25	83.4	70.8	111
	0.05 mg/kg	<0.05	----	----	----	----
delta-BHC	0.05 mg/kg	----	0.25	88.6	67.1	113
	0.05 mg/kg	<0.05	----	----	----	----
Dieldrin	0.05 mg/kg	----	0.25	82.4	72.7	109
	0.05 mg/kg	<0.05	----	----	----	----
Endosulfan sulfate	0.05 mg/kg	----	0.25	77.6	68.5	115
	0.05 mg/kg	<0.05	----	----	----	----
Endrin	0.05 mg/kg	----	0.25	98.0	65.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Endrin aldehyde	0.05 mg/kg	----	0.25	81.8	72.2	114
	0.05 mg/kg	<0.05	----	----	----	----
Endrin ketone	0.05 mg/kg	----	0.25	74.4	71.1	114
	0.05 mg/kg	<0.05	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186607) - continued		mg/kg	mg/kg	%	%	%
gamma-BHC	0.05 mg/kg	----	0.25	90.4	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor	0.05 mg/kg	----	0.25	106	74.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor epoxide	0.05 mg/kg	----	0.25	84.6	74	108
	0.05 mg/kg	<0.05	----	----	----	----
Hexachlorobenzene (HCB)	0.05 mg/kg	----	0.25	94.4	69.6	108
	0.05 mg/kg	<0.05	----	----	----	----
Methoxychlor	0.2 mg/kg	----	0.25	90.4	56.8	137
	0.2 mg/kg	<0.2	----	----	----	----
trans-Chlordane	0.05 mg/kg	----	0.25	88.8	74.6	108
	0.05 mg/kg	<0.05	----	----	----	----
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188584)		mg/kg	mg/kg	%	%	%
4,4'-DDD	0.05 mg/kg	----	0.25	96.0	72.4	109
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDE	0.05 mg/kg	----	0.25	93.8	73.6	107
	0.05 mg/kg	<0.05	----	----	----	----
4,4'-DDT	0.2 mg/kg	----	0.25	92.6	62.1	125
	0.2 mg/kg	<0.2	----	----	----	----
Aldrin	0.05 mg/kg	----	0.25	84.4	73.3	108
	0.05 mg/kg	<0.05	----	----	----	----
alpha-BHC	0.05 mg/kg	----	0.25	80.8	77.5	109
	0.05 mg/kg	<0.05	----	----	----	----
alpha-Endosulfan	0.05 mg/kg	----	0.25	78.6	71.5	112
	0.05 mg/kg	<0.05	----	----	----	----
beta-BHC	0.05 mg/kg	----	0.25	86.2	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----
beta-Endosulfan	0.05 mg/kg	----	0.25	98.0	73.8	112
	0.05 mg/kg	<0.05	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188584) - continued		mg/kg	mg/kg	%	%	%
cis-Chlordane	0.05 mg/kg	----	0.25	87.2	70.8	111
	0.05 mg/kg	<0.05	----	----	----	----
delta-BHC	0.05 mg/kg	----	0.25	104	67.1	113
	0.05 mg/kg	<0.05	----	----	----	----
Dieldrin	0.05 mg/kg	----	0.25	91.4	72.7	109
	0.05 mg/kg	<0.05	----	----	----	----
Endosulfan sulfate	0.05 mg/kg	----	0.25	97.0	68.5	115
	0.05 mg/kg	<0.05	----	----	----	----
Endrin	0.05 mg/kg	----	0.25	91.2	65.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Endrin aldehyde	0.05 mg/kg	----	0.25	88.6	72.2	114
	0.05 mg/kg	<0.05	----	----	----	----
Endrin ketone	0.05 mg/kg	----	0.25	82.0	71.1	114
	0.05 mg/kg	<0.05	----	----	----	----
gamma-BHC	0.05 mg/kg	----	0.25	85.4	73.1	110
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor	0.05 mg/kg	----	0.25	98.4	74.8	107
	0.05 mg/kg	<0.05	----	----	----	----
Heptachlor epoxide	0.05 mg/kg	----	0.25	72.6	74	108
	0.05 mg/kg	<0.05	----	----	----	----
Hexachlorobenzene (HCB)	0.05 mg/kg	----	0.25	80.6	69.6	108
	0.05 mg/kg	<0.05	----	----	----	----
Methoxychlor	0.2 mg/kg	----	0.25	83.8	56.8	137
	0.2 mg/kg	<0.2	----	----	----	----
trans-Chlordane	0.05 mg/kg	----	0.25	87.2	74.6	108
	0.05 mg/kg	<0.05	----	----	----	----
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186607)		mg/kg	mg/kg	%	%	%
Methyl Azinphos	0.05 mg/kg	----	0.25	92.2	33.1	144
	0.05 mg/kg	<0.05	----	----	----	----

ALS Environmental

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186607) - continued		mg/kg	mg/kg	%	%	%
Bromophos-ethyl	0.05 mg/kg	----	0.25	85.0	66.5	112
	0.05 mg/kg	<0.05	----	----	----	----
Carbophenothion	0.05 mg/kg	----	0.25	84.6	67.8	108
	0.05 mg/kg	<0.05	----	----	----	----
Chlorfenvinphos	0.05 mg/kg	----	0.25	88.8	54.5	132
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos	0.05 mg/kg	----	0.25	88.0	75	109
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos-methyl	0.05 mg/kg	----	0.25	89.0	72.2	107
	0.05 mg/kg	<0.05	----	----	----	----
Demeton-S-methyl	0.05 mg/kg	----	0.25	88.6	57.7	123
	0.05 mg/kg	<0.05	----	----	----	----
Diazinon	0.05 mg/kg	----	0.25	90.8	72.9	108
	0.05 mg/kg	<0.05	----	----	----	----
Dichlorvos	0.05 mg/kg	----	0.25	97.4	64	117
	0.05 mg/kg	<0.05	----	----	----	----
Dimethoate	0.05 mg/kg	----	0.25	102	60.7	117
	0.05 mg/kg	<0.05	----	----	----	----
Ethion	0.05 mg/kg	----	0.25	76.2	58.9	116
	0.05 mg/kg	<0.05	----	----	----	----
Fenamiphos	0.05 mg/kg	----	0.25	83.4	48.8	118
	0.05 mg/kg	<0.05	----	----	----	----
Fenthion	0.05 mg/kg	----	0.25	86.8	72.5	107
	0.05 mg/kg	<0.05	----	----	----	----
Malathion	0.05 mg/kg	----	0.25	87.8	61.6	121
	0.05 mg/kg	<0.05	----	----	----	----
Monocrotophos	0.2 mg/kg	----	0.25	103	46.9	125
	0.2 mg/kg	<0.2	----	----	----	----
Para hion	0.2 mg/kg	----	0.25	88.6	65.2	116
	0.2 mg/kg	<0.2	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186607) - continued		mg/kg	mg/kg	%	%	%
Para hion-methyl	0.2 mg/kg	----	0.25	106	68	109
	0.2 mg/kg	<0.2	----	----	----	----
Pirimphos-ethyl	0.05 mg/kg	----	0.25	97.4	66.3	118
	0.05 mg/kg	<0.05	----	----	----	----
Prothiofos	0.05 mg/kg	----	0.25	82.4	73	111
	0.05 mg/kg	<0.05	----	----	----	----
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188584)		mg/kg	mg/kg	%	%	%
Methyl Azinphos	0.05 mg/kg	----	0.25	59.8	33.1	144
	0.05 mg/kg	<0.05	----	----	----	----
Bromophos-ethyl	0.05 mg/kg	----	0.25	89.4	66.5	112
	0.05 mg/kg	<0.05	----	----	----	----
Carbophenothion	0.05 mg/kg	----	0.25	88.6	67.8	108
	0.05 mg/kg	<0.05	----	----	----	----
Chlorfenvinphos	0.05 mg/kg	----	0.25	94.2	54.5	132
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos	0.05 mg/kg	----	0.25	98.2	75	109
	0.05 mg/kg	<0.05	----	----	----	----
Chlorpyrifos-methyl	0.05 mg/kg	----	0.25	95.2	72.2	107
	0.05 mg/kg	<0.05	----	----	----	----
Demeton-S-methyl	0.05 mg/kg	----	0.25	43.4	57.7	123
	0.05 mg/kg	<0.05	----	----	----	----
Diazinon	0.05 mg/kg	----	0.25	79.2	72.9	108
	0.05 mg/kg	<0.05	----	----	----	----
Dichlorvos	0.05 mg/kg	----	0.25	75.2	64	117
	0.05 mg/kg	<0.05	----	----	----	----
Dimethoate	0.05 mg/kg	----	0.25	85.6	60.7	117
	0.05 mg/kg	<0.05	----	----	----	----
Ethion	0.05 mg/kg	----	0.25	93.2	58.9	116
	0.05 mg/kg	<0.05	----	----	----	----

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188584) - continued		mg/kg	mg/kg	%	%	%
Fenamiphos	0.05 mg/kg	----	0.25	77.2	48.8	118
	0.05 mg/kg	<0.05	----	----	----	----
Fenthion	0.05 mg/kg	----	0.25	84.4	72.5	107
	0.05 mg/kg	<0.05	----	----	----	----
Malathion	0.05 mg/kg	----	0.25	92.4	61.6	121
	0.05 mg/kg	<0.05	----	----	----	----
Monocrotophos	0.2 mg/kg	----	0.25	57.0	46.9	125
	0.2 mg/kg	<0.2	----	----	----	----
Para hion	0.2 mg/kg	----	0.25	93.0	65.2	116
	0.2 mg/kg	<0.2	----	----	----	----
Para hion-methyl	0.2 mg/kg	----	0.25	104	68	109
	0.2 mg/kg	<0.2	----	----	----	----
Pirimphos-ethyl	0.05 mg/kg	----	0.25	87.8	66.3	118
	0.05 mg/kg	<0.05	----	----	----	----
Prothiofos	0.05 mg/kg	----	0.25	89.6	73	111
	0.05 mg/kg	<0.05	----	----	----	----

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EG020F: Dissolved Metals by ICP-MS						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 187484)		mg/L	mg/L	%	%	%
Arsenic	0.001 mg/L	----	0.1	99.0	70	130
	0.001 mg/L	<0.001	----	----	----	----
Cadmium	0.0001 mg/L	----	0.1	102	70	130
	0.0001 mg/L	<0.0001	----	----	----	----
Chromium	0.001 mg/L	----	0.1	106	70	130
	0.001 mg/L	<0.001	----	----	----	----
Copper	0.001 mg/L	----	0.1	101	70	130
	0.001 mg/L	<0.001	----	----	----	----

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EG020F: Dissolved Metals by ICP-MS - continued						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 187484) - continued		mg/L	mg/L	%	%	%
Lead	0.001 mg/L	----	0.1	102	70	130
	0.001 mg/L	<0.001	----	----	----	----
Nickel	0.001 mg/L	----	0.1	97.0	70	130
	0.001 mg/L	<0.001	----	----	----	----
Zinc	0.005 mg/L	----	0.1	102	70	130
	0.005 mg/L	<0.005	----	----	----	----
EG035F: Dissolved Mercury by FIMS						
EG035F: Dissolved Mercury by FIMS - (QC Lot: 186960)		mg/L	mg/L	%	%	%
Mercury	0.0001 mg/L	----	0.010	100	70	130
	0.0001 mg/L	<0.0001	----	----	----	----
EP068A: Organochlorine Pesticides (OC)						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186600)		µg/L	µg/L	%	%	%
4,4'-DDD	0.5 µg/L	----	5	86.4	70.9	110
	0.5 µg/L	<0.5	----	----	----	----
4,4'-DDE	0.5 µg/L	----	5	89.2	72.4	110
	0.5 µg/L	<0.5	----	----	----	----
4,4'-DDT	2.0 µg/L	----	5	84.6	57	123
	2 µg/L	<2	----	----	----	----
Aldrin	0.5 µg/L	----	5	86.4	77.7	106
	0.5 µg/L	<0.5	----	----	----	----
alpha-BHC	0.5 µg/L	----	5	85.0	77.7	106
	0.5 µg/L	<0.5	----	----	----	----
alpha-Endosulfan	0.5 µg/L	----	5	88.0	77.8	108
	0.5 µg/L	<0.5	----	----	----	----
beta-BHC	0.5 µg/L	----	5	85.8	74.3	111
	0.5 µg/L	<0.5	----	----	----	----
beta-Endosulfan	0.5 µg/L	----	5	76.0	76.8	107
	0.5 µg/L	<0.5	----	----	----	----

ALS Environmental

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068A: Organochlorine Pesticides (OC) - continued						
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186600) - continued		µg/L	µg/L	%	%	%
cis-Chlordane	0.5 µg/L	----	5	89.2	75.1	106
	0.5 µg/L	<0.5	----	----	----	----
delta-BHC	0.5 µg/L	----	5	87.8	71.7	106
	0.5 µg/L	<0.5	----	----	----	----
Dieldrin	0.5 µg/L	----	5	87.0	82.3	105
	0.5 µg/L	<0.5	----	----	----	----
Endosulfan sulfate	0.5 µg/L	----	5	85.2	77.5	106
	0.5 µg/L	<0.5	----	----	----	----
Endrin	0.5 µg/L	----	5	87.2	79.4	106
	0.5 µg/L	<0.5	----	----	----	----
Endrin aldehyde	0.5 µg/L	----	5	85.0	76.8	108
	0.5 µg/L	<0.5	----	----	----	----
Endrin ketone	0.5 µg/L	----	5	83.6	74.1	107
	0.5 µg/L	<0.5	----	----	----	----
gamma-BHC	0.5 µg/L	----	5	84.6	74.3	111
	0.5 µg/L	<0.5	----	----	----	----
Heptachlor	0.5 µg/L	----	5	89.6	80.4	103
	0.5 µg/L	<0.5	----	----	----	----
Heptachlor epoxide	0.5 µg/L	----	5	86.4	76.1	107
	0.5 µg/L	<0.5	----	----	----	----
Hexachlorobenzene (HCB)	0.5 µg/L	----	5	90.4	57.3	119
	0.5 µg/L	<0.5	----	----	----	----
Methoxychlor	2.0 µg/L	----	5	95.2	34.3	139
	2 µg/L	<2	----	----	----	----
trans-Chlordane	0.5 µg/L	----	5	98.2	76.8	105
	0.5 µg/L	<0.5	----	----	----	----
EP068B: Organophosphorus Pesticides (OP)						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186600)		µg/L	µg/L	%	%	%
Methyl Azinphos	0.5 µg/L	----	5	96.0	54.8	127
	0.5 µg/L	<0.5	----	----	----	----

ALS Environmental

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186600) - continued		µg/L	µg/L	%	%	%
Bromophos-ethyl	0.5 µg/L	----	5	86.8	63.4	128
	0.5 µg/L	<0.5	----	----	----	----
Carbophenothion	0.5 µg/L	----	5	86.2	78.1	101
	0.5 µg/L	<0.5	----	----	----	----
Chlorfenvinphos	0.5 µg/L	----	5	84.6	78.7	106
	0.5 µg/L	<0.5	----	----	----	----
Chlorpyrifos	0.5 µg/L	----	5	88.6	79.5	104
	0.5 µg/L	<0.5	----	----	----	----
Chlorpyrifos-methyl	0.5 µg/L	----	5	89.0	76.6	106
	0.5 µg/L	<0.5	----	----	----	----
Demeton-S-methyl	0.5 µg/L	----	5	82.2	60.3	115
	0.5 µg/L	<0.5	----	----	----	----
Diazinon	0.5 µg/L	----	5	87.4	78.1	104
	0.5 µg/L	<0.5	----	----	----	----
Dichlorvos	0.5 µg/L	----	5	105	70.4	110
	0.5 µg/L	<0.5	----	----	----	----
Dimethoate	0.5 µg/L	----	5	81.4	67.5	108
	0.5 µg/L	<0.5	----	----	----	----
Ethion	0.5 µg/L	----	5	85.2	57.6	123
	0.5 µg/L	<0.5	----	----	----	----
Fenamiphos	0.5 µg/L	----	5	87.6	66	109
	0.5 µg/L	<0.5	----	----	----	----
Fenthion	0.5 µg/L	----	5	87.6	65.6	117
	0.5 µg/L	<0.5	----	----	----	----
Malathion	0.5 µg/L	----	5	83.8	77.6	106
	0.5 µg/L	<0.5	----	----	----	----
Monocrotophos	0.5 µg/L	----	5	66.8	3.29	37.7
	2 µg/L	<2	----	----	----	----
Para hion	2.0 µg/L	----	5	94.4	79	100
	2 µg/L	<2	----	----	----	----

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	LOR	Method blank result	Actual Results: Spike concentration	Actual Results: Spike Recovery LCS	Recovery Limits: Dynamic Recovery Limits Low	Recovery Limits: Dynamic Recovery Limits High
EP068B: Organophosphorus Pesticides (OP) - continued						
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186600) - continued		µg/L	µg/L	%	%	%
Para hion-methyl	2.0 µg/L	----	5	94.4	71.8	110
	2 µg/L	<2	----	----	----	----
Pirimphos-ethyl	0.5 µg/L	----	5	88.2	70.7	108
	0.5 µg/L	<0.5	----	----	----	----
Prothiofos	0.5 µg/L	----	5	87.0	74.8	104
	0.5 µg/L	<0.5	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons						
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 186601)		µg/L	µg/L	%	%	%
C10 - C14 Fraction	50 µg/L	----	200	80.7	75	134
	50 µg/L	<50	----	----	----	----
C15 - C28 Fraction	100 µg/L	----	200	105	87	132
	100 µg/L	<100	----	----	----	----
C29 - C36 Fraction	50 µg/L	----	200	89.7	80	126
	50 µg/L	<50	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 190974)		µg/L	µg/L	%	%	%
C6 - C9 Fraction	20 µg/L	----	260	84.6	80	120
	20 µg/L	<20	----	----	----	----
EP080: BTEX						
EP080: BTEX - (QC Lot: 190974)		µg/L	µg/L	%	%	%
Benzene	1 µg/L	----	10	104	78	125
	1 µg/L	<1	----	----	----	----
Ethylbenzene	2 µg/L	----	10	104	73	118
	2 µg/L	<2	----	----	----	----
meta- & para-Xylene	2 µg/L	----	10	105	78	117
	2 µg/L	<2	----	----	----	----
ortho-Xylene	2 µg/L	----	10	104	75	119
	2 µg/L	<2	----	----	----	----
Toluene	2 µg/L	----	10	107	74	126
	2 µg/L	<2	----	----	----	----

Quality Control Report - Matrix Spikes (MS)

The quality control term **Matrix Spike (MS)** refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQO's). 'Ideal' recovery ranges stated may be waived in the event of sample matrix interferences. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** *= Limit of Reporting,* ***RPD*** *= Relative Percent Difference.*

* Indicates failed QC

Matrix Type: SOIL

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	Laboratory Sample ID	Client Sample ID	LOR	Spike Concentration		MS	Low	High
EG005T: Total Metals by ICP-AES								
EG005T: Total Metals by ICP-AES - (QC Lot: 188051)				mg/kg	mg/kg	%	%	%
Arsenic	ES0603103-014	Anonymous	5 mg/kg	50	<5	105	70	130
Cadmium			1 mg/kg	50	<1	92.7	70	130
Chromium			2 mg/kg	50	15	92.6	70	130
Copper			5 mg/kg	250	239	98.0	70	130
Lead			5 mg/kg	250	<5	91.9	70	130
Nickel			2 mg/kg	50	5	94.7	70	130
Zinc			5 mg/kg	250	27	86.3	70	130
EG005T: Total Metals by ICP-AES - (QC Lot: 188667)				mg/kg	mg/kg	%	%	%
Arsenic	ES0603097-008	COMP 7	5 mg/kg	50	<5	108	70	130
Cadmium			1 mg/kg	50	<1	105	70	130
Chromium			2 mg/kg	50	16	106	70	130
Copper			5 mg/kg	250	5	103	70	130
Lead			5 mg/kg	250	10	102	70	130
Nickel			2 mg/kg	50	7	110	70	130
Zinc			5 mg/kg	250	21	101	70	130
EG035T: Total Mercury by FIMS								
EG035T: Total Mercury by FIMS - (QC Lot: 188052)				mg/kg	mg/kg	%	%	%
Mercury	ES0603103-014	Anonymous	0.1 mg/kg	5	<0.1	107	70	130
EG035T: Total Mercury by FIMS - (QC Lot: 188668)				mg/kg	mg/kg	%	%	%
Mercury	ES0603097-008	COMP 7	0.1 mg/kg	5	<0.1	109	70	130
EP066: Polychlorinated Biphenyls (PCB)								
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 186608)				mg/kg	mg/kg	%	%	%
Total Polychlorinated biphenyls	ES0603097-001	34_SS1_0.0_0.1	0.1 mg/kg	0.5	<0.10	103	70	130

Matrix Type: SOIL

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EP066: Polychlorinated Biphenyls (PCB) - continued								
EP066: Polychlorinated Biphenyls (PCB) - (QC Lot: 188585)				mg/kg	mg/kg	%	%	%
Total Polychlorinated biphenyls	ES0603097-008	COMP 7	0.1 mg/kg	0.5	<0.10	91.7	70	130
EP068A: Organochlorine Pesticides (OC)								
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 186607)				mg/kg	mg/kg	%	%	%
gamma-BHC	ES0603097-001	34_SS1_0.0_0.1	0.05 mg/kg	0.25	<0.05	104	75.65	110.44
Heptachlor			0.05 mg/kg	0.25	<0.05	94.2	72.2	106.71
Aldrin			0.05 mg/kg	0.25	<0.05	82.4	77.54	107.0
Dieldrin			0.05 mg/kg	0.25	<0.05	98.0	76.37	109.7
Endrin			0.05 mg/kg	1	<0.05	82.0	68.51	119.47
4,4'-DDT			0.2 mg/kg	1	<0.2	110	67.12	118.10
EP068A: Organochlorine Pesticides (OC) - (QC Lot: 188584)				mg/kg	mg/kg	%	%	%
gamma-BHC	ES0603097-008	COMP 7	0.05 mg/kg	0.25	<0.05	120	75.65	110.44
Heptachlor			0.05 mg/kg	0.25	<0.05	121	72.2	106.71
Aldrin			0.05 mg/kg	0.25	<0.05	89.2	77.54	107.0
Dieldrin			0.05 mg/kg	0.25	<0.05	85.6	76.37	109.7
Endrin			0.05 mg/kg	1	<0.05	115	68.51	119.47
4,4'-DDT			0.2 mg/kg	1	<0.2	115	67.12	118.10
EP068B: Organophosphorus Pesticides (OP)								
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 186607)				mg/kg	mg/kg	%	%	%
Diazinon	ES0603097-001	34_SS1_0.0_0.1	0.05 mg/kg	0.25	<0.05	92.6	75.85	107.06
Chlorpyrifos-methyl			0.05 mg/kg	0.25	<0.05	82.4	74.84	107.91
Pirimphos-ethyl			0.05 mg/kg	0.25	<0.05	81.4	67.98	109.42
Bromophos-ethyl			0.05 mg/kg	0.25	<0.05	77.4	74.94	107.37
Prothiofos			0.05 mg/kg	0.25	<0.05	99.2	75.45	106.05
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188584)				mg/kg	mg/kg	%	%	%
Diazinon	ES0603097-008	COMP 7	0.05 mg/kg	0.25	<0.05	83.8	75.85	107.06
Chlorpyrifos-methyl			0.05 mg/kg	0.25	<0.05	100	74.84	107.91
Pirimphos-ethyl			0.05 mg/kg	0.25	<0.05	93.8	67.98	109.42
Bromophos-ethyl			0.05 mg/kg	0.25	<0.05	85.6	74.94	107.37

Matrix Type: SOIL

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EP068B: Organophosphorus Pesticides (OP) - continued								
EP068B: Organophosphorus Pesticides (OP) - (QC Lot: 188584) - continued				mg/kg	mg/kg	%	%	%
Prothiofos	ES0603097-008	COMP 7	0.05 mg/kg	0.25	<0.05	94.6	75.45	106.05

Matrix Type: WATER

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*		*MS*	*Low*	*High*
EG020F: Dissolved Metals by ICP-MS								
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 187484)				mg/L	mg/L	%	%	%
Arsenic	ES0603097-002	WS1	0.001 mg/L	0.2	0.001	99.3	70	130
Cadmium			0.0001 mg/L	0.05	<0.0001	104	70	130
Chromium			0.001 mg/L	0.2	<0.001	99.8	70	130
Copper			0.001 mg/L	0.2	<0.001	102	70	130
Lead			0.001 mg/L	0.2	<0.001	96.2	70	130
Nickel			0.001 mg/L	0.2	<0.001	96.3	70	130
Zinc			0.005 mg/L	0.2	0.063	101	70	130
EG035F: Dissolved Mercury by FIMS								
EG035F: Dissolved Mercury by FIMS - (QC Lot: 186960)				mg/L	mg/L	%	%	%
Mercury	ES0603081-002	Anonymous	0.0001 mg/L	0.0100	<0.0001	95.8	70	130
EP080/071: Total Petroleum Hydrocarbons								
EP080/071: Total Petroleum Hydrocarbons - (QC Lot: 190974)				µg/L	µg/L	%	%	%
C6 - C9 Fraction	ES0603247-008	Anonymous	20 µg/L	250	<20	89.3	80	120
EP080: BTEX								
EP080: BTEX - (QC Lot: 190974)				µg/L	µg/L	%	%	%
Benzene	ES0603247-008	Anonymous	1 µg/L	25	<1	109	80	120
Toluene			2 µg/L	25	<2	96.5	80	120
Ethylbenzene			2 µg/L	25	<2	110	80	120
meta- & para-Xylene			2 µg/L	25	<2	109	80	120
ortho-Xylene			2 µg/L	25	<2	109	80	120

CHAIN OF CUSTODY DOCUMENTATION

008306

Australian Laboratory Services Pty ltd
Unit 28, METRO CENTRE
38 - 46 South St
RYDALMERE NSW 2116
TEL: (02) 9841 9500
FAX: (02) 9841 9530

CLIENT: Network Geotechnics P/L
POSTAL ADDRESS: 6/6 Horton Cl. Tuggerah 2259
SEND REPORT TO: V. de Silva SEND INVOICE TO: V de Silva
DATA NEEDED BY: ASAP REPORT NEEDED BY: —
PROJECT ID: G25058/1 QUOTE NO.: S4/405/02
P.O. NO.: COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LABORATORY BATCH NO.:
SAMPLERS: TS
PHONE: 43516200 FAX: 43516300
REPORT FORMAT: HARD FAX: DISK: BULLETIN BOARD:
QC LEVEL: QCS1 QCS2 QCS3 QCS4

FOR LAB USE ONLY
COOLER SEAL
Yes No
Broken Intact
COOLER TEMP: deg. C

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	pH	S2	S13	W5	W12	W3	NOTES
4	ES 26 BH11 0_0.1	S	14/3	PM									
12	27 BH11 0.2_0.3	S	"	"									
13	28 BH8 0.0_0.1	S	"	"									
14	29 BH8 0.2_0.3	S	"	"									
15	30 BH7 0.0_0.1	S	"	"									
16	31 ~~30~~ BH7 0.2_0.3	S	"	"									
17	32 ~~31~~ BH10 0.0_0.1	S	"	"									
18	33 BH10 0.2_0.3	S	"	"									
1	34 ~~BH~~ SS1 0.0_0.1	S	"	"				/	/				
19	35 SS2 0.0_0.1	S	"	"									
20	36 SS3 0.0_0.1	S	"	"									
2	WS1	W	14/3/06	1:30	N, VC, S	4			/				
3	WS2	W	14/3/06	1.45	N, VC, S	4			/				
4	WS3	W	14/3/06	2.10	N, VC, S	4			/				
5	WS4	W	14/3/06	2.30	N, VC	3				/			

ALS Environmental
Sydney
Work Order
ES0603097
Report Version: WOLabel 1.01
Telephone : 61-2-87848555

RELINQUISHED BY		RECEIVED BY		
NAME: T. Smith	DATE: 14/3/06	NAME: Sonya Stephens	DATE: 15/3/06	METHOD OF SHIPMENT
OF: Network Geotech	TIME: 6.00pm	OF: AS.	TIME: 11.10am	CONSIGNMENT NOTE NO.
NAME: V. de Silva	DATE: 15/3	NAME:	DATE:	TRANSPORT CO. NAME.
OF: N.G	TIME: 10.00	OF:	TIME:	

*Container Type and Preservative Codes: **P** = Natural Plastic; **N** = Nitric Acid Preserved; **C** = Sodium Hydroxide Preserved; **J** = Solvent Washed Acid Rinsed Jar; **S** = Solvent Washed Acid Rinsed Glass Bottle; **VC** = Hydrochloric Acid Preserved Vial; **VS** = Sulphuric Acid Preserved Vial; **BS** = Sulphuric Acid Preserved Glass Bottle; **Z** = Zinc Acetate Preserved Bottle; **E** = EDTA Preserved Bottle; **ST** = Sterile Bottle; **O** = Other.

CHAIN OF CUSTODY DOCUMENTATION

Sheet 2/2 008307

Australian Laboratory Services Pty ltd
Unit 28, METRO CENTRE
38-46 South St
RYDALMERE NSW 2116
TEL: (02) 9841 9500
FAX: (02) 9841 9530

CLIENT: Network Geotechnics P/L
POSTAL ADDRESS: 6/6 Morton Cl. Tuy
SEND REPORT TO: V. de Silva SEND INVOICE TO: V. de Silva
DATA NEEDED BY: NSNP REPORT NEEDED BY: NSNP
PROJECT ID: G25058/1 QUOTE NO.:
P.O. NO.: COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LABORATORY BATCH NO.:
SAMPLERS: T.S
PHONE: 43516200 FAX: 43516300
REPORT FORMAT: (HARD) FAX: _____ DISK: _____ BULLETIN BOARD: _____
QC LEVEL: QCS1 _____ QCS2 _____ QCS3 _____ QCS4 _____

FOR LAB USE ONLY
COOLER SEAL
Yes ..... No .....
Broken ..... Intact .....
COOLER TEMP: ..... deg. C

ANALYSIS REQUIRED

SAMPLE DATA				*CONTAINER DATA				NOTES
SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	pH	S3 S13 W5 W12 N3	
(6) Duplicate	W	14/3	PM	N, VC, S	4			
(7) ES37	S	14/3	PM					
(8) Comp 7 (ES26 + ES28 + ES30)								
(9) Comp 8 (ES27 + ES29 + ES31)								
(10) Comp 9 (ES32 + ES35 + ES36)								

RELINQUISHED BY		RECEIVED BY		METHOD OF SHIPMENT
NAME: T. Smith	DATE: 14/3/06	NAME: Joe Stephens	DATE: 15/3/6	
OF: NG	TIME: 1800	OF: ALS	TIME: 11-10am	CONSIGNMENT NOTE NO.
NAME: V de Silva	DATE: 15/3/06	NAME:	DATE:	
OF: NG	TIME: 1000	OF:	TIME:	TRANSPORT CO. NAME.

*Container Type and Preservative Codes: **P** = Natural Plastic; **N** = Nitric Acid Preserved; **C** = Sodium Hydroxide Preserved; **J** = Solvent Washed Acid Rinsed Jar; **S** = Solvent Washed Acid Rinsed Glass Bottle; **VC** = Hydrochloric Acid Preserved Vial; **VS** = Sulphuric Acid Preserved Vial; **BS** = Sulphuric Acid Preserved Glass Bottle; **Z** = Zinc Acetate Preserved Bottle; **E** = EDTA Preserved Bottle; **ST** = Sterile Bottle; **O** = Other.

APPENDIX D

OBSERVATIONS FROM AERIAL PHOTOGRAPHS

Observations from Aerial Photographs

Lot 1 DP66183

26/09/04	Heavy timber north and west of creek. A track runs along the edge of timber to a shed or a house. The rest of the land covered with grass.
23/07/00	Similar to 2004.
24/08/94	Similar to 2004.
27/04/84	Appeared similar to 2004, but no shed or a track.
3/05/78	Less tree cover appeared. Mainly grass cover.
March 1961	Same as 1978.
1/04/51	Same as 1978.

Lot 2 DP66183

26/09/04 1:25,000 colour	A farm house and a shed in the middle. A small farm dam north of the house. The rest of the area covered with grass.
23/07/00 1:25,000 colour	Same as 2004.
24/08/94 1:25,000 colour	Same as 2004.
27/04/84 1:40,000 black & white	The farm house visible – no dam.
03/05/78 1:16,000 black & white	A farm house present. Orchard or horticultural work evident.
March 1961	Same as 1978.
1/04/51	Same as 1978.

Observations from Aerial Photographs (cont)

Lot 1 DP196460

26/09/04	Most of the area cleared. Some vineyards/orchards. A small farm house in the middle. Four farm dams, water appeared brown.
23/07/00	Same as 2004.
24/08/94	Only the farm house was present. No vineyards/orchards. Land covered mostly with grass. A small shed was locate don the north west corner.
27/04/84	A small shed/house at the location of the farm house. Some bare patches. Otherwise grass covered.
3/05/78	Extensively cleared. Less grass more bare patches. Vineyards or orchards. A farm house in the middle. No dams.
1/04/51	Same as 1961.

Lot 3 DP597226

26/09/04	Heavy timber in the south with patchy grassland. Two small dam close to the north-west boundary.
23/07/00	Same as 2004.
24/08/94	One dam only, closes to the north-west boundary otherwise no change.
27/04/84	Less tree cover – mostly grass no dams.
03/05/78	Extensive clearing and land disturbance in the southern area. Evidence of orchard/vineyards activities north west of the creek.
March 1961	The southern area covered with trees and grass. No land disturbance visible. No orchards visible. Generally covered with grass/timber.
1/04/51	Same as 1961.

Observations from Aerial Photographs (cont)

Lot 2 DP597226

26/09/04	No significant man made interventions visible. Bands of the creek appeared heavily eroded. Two sheds and two dams visible in the south east corner.
23/7/00	Same as 2004.
24/08/94	Same as 2004.
27/04/84	Same as 2004. Appeared like a dairy/cattle farm with well defined grass areas.
03/05/78	Same as 1984.
March 1961	Same as 1984
01/04/51	Same as 1984.

Lot 1 DP597226

26/09/04	Mainly grassland. A farm dam near the northern boundary with Lot 2. A small shed or a clearing visible at the centre.
23/07/04	Same as 2004.
24/08/94	Same as 2004.
27/04/84	No change.
03/05/78	Same as 2004.
March 1961	No change.
01/04/51	Same as 2004.

Lot 10 DP806584, Lot 11 DP806584, and Lot 1 DP196997

26/09/04	A farm house in the middle of Lot 10 DP806594. A residence in Lot 11 DP806584 and Lot 1 DP196997. A shed in Lot 1 DP196997.
23/07/00	Same as 2004.
24/08/94	Farm house in Lot 10. A shed (?) and a residence in Lot 1 DP196997.
27/04/84	No structures/residences visible. Grass cover and scattered trees.
03/05/78	Same as 1984.
March 1961	Mostly grass cover.
01/04/61	Same as 1961.

ATTACHMENT

Part Lot 1	DP 66183
Part Lot 3	DP 597226
Lot 10	DP 806564
Lot 1	DP 196997
Lot 261	DP 524058
Lot 1	DP 597226
Lot 1	DP 327785
Lot 2	DP 597226
Lot 1	DP 328498
Lot 1	DP 328497
Lot 51	DP 807540
Lot 52	DP 807540
Lot 1	DP 349452
Lot 210	DP 1012346
Lot 11	DP 815485
Lot 10	DP 815485
Lot 3	DP 810827
Lot 13	DP 880374
Lot 1	DP 167004
Lot 141	DP 986905
Lot 11	DP 806564

APPENDIX F

ITEMS REFERRED IN FIGURE 4.1 EUROPEAN HERITAGE REPORT

1 & 2	***Brick & Tile Homes***
3	***Shed***
4	***Shed***
5	***Cattle Yard***
6	***Bowling Club***
7	***Soccer Club***
8	***Two storey brick residence***
9	***Single storey brick residence***
10	***Colorbond Garage***
11	***Vehicle Shed***
12	***Residence (hardiplank)***
13	***Residence (hardiplank)***
14	***Cottage***
15	***Slaughter house***
16	***Residence***
17	***Weatherboard Cottage***
18	***Residence***
19	***Fibro Cottage with Iron Roof***
20	***Shed***

NORTH BELLBIRD REZONING

PROJECT: REZONING SUBMISSION

PLAN: SERVICES AND LAND FEATURES PLAN.

CLIENT: JOHNSON PROPERTY GROUP PTY LTD

SURDEVEL SURVEYORS

INSITE Planning and Engineering

PLAN DATE: 20/09/2006

SCALE: 1:5,000 (A1)

SHEET 1 OF 1 SHEETS

FILE NAME: S:\Planning\Jobs\1449\SURV1A

PLAN No: SURV1A

Nissan Huts

O'Neill's Hotel

New Development

Cruckshank Street

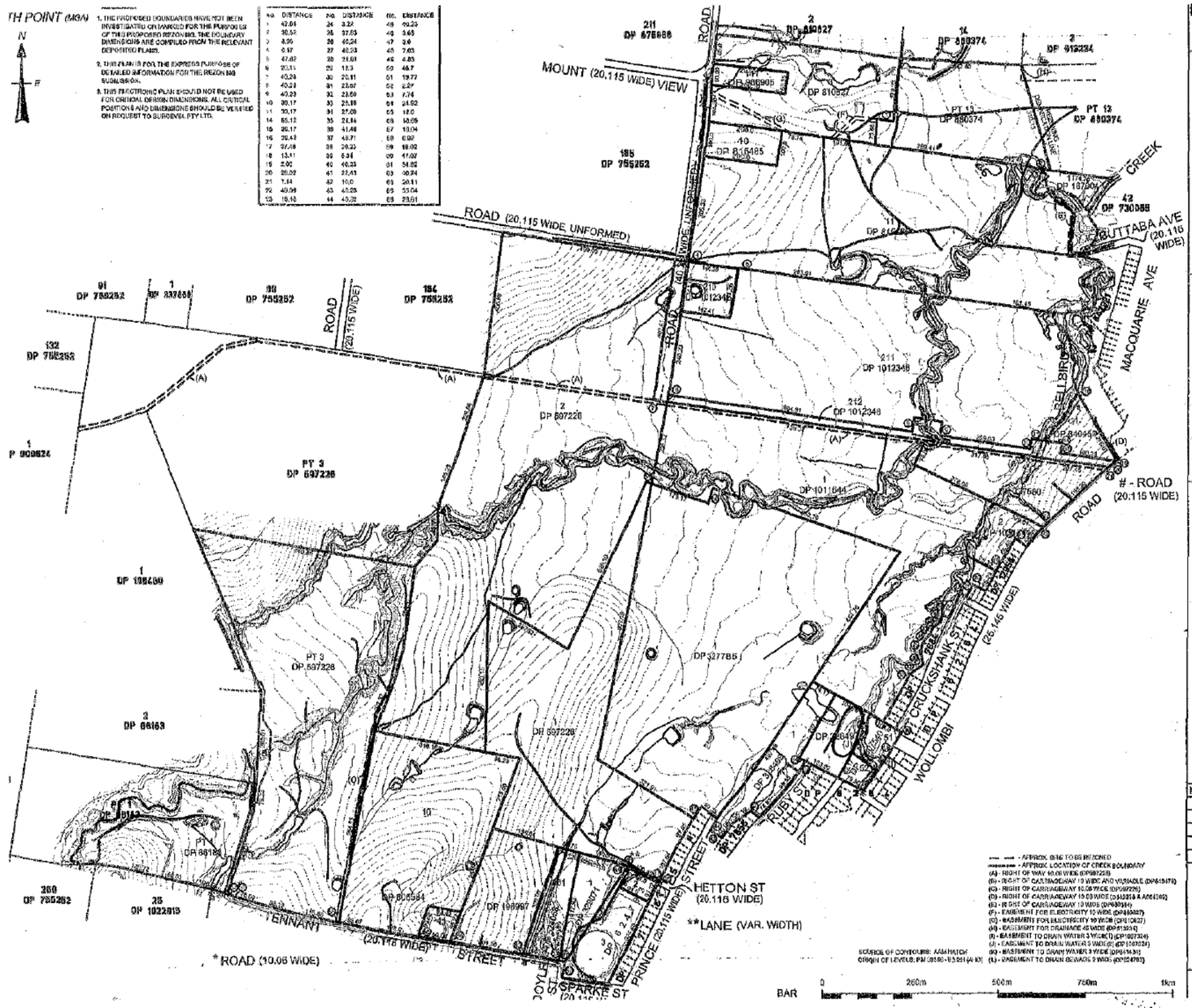
Wollombi Road

Mt View Vineyards

New Development

Bellbird Colliery

Document No. R21.0



No.	DISTANCE	No.	DISTANCE	No.	DISTANCE
1	42.01	24	3.22	46	20.23
2	30.52	25	37.63	46	3.63
3	8.95	26	40.24	47	3.6
4	0.17	27	40.33	48	7.63
5	47.62	28	21.61	49	4.83
6	20.11	29	18.3	50	46.7
7	40.23	30	20.11	51	19.77
8	40.23	31	23.67	52	2.27
9	40.23	32	23.69	53	7.74
10	30.17	33	25.16	54	24.52
11	30.17	34	27.09	55	12.0
14	65.12	35	21.84	56	10.65
15	20.17	36	41.48	57	10.04
16	20.43	37	48.71	58	6.02
17	27.48	38	20.23	59	18.02
18	13.11	39	6.31	60	41.07
19	2.92	40	40.33	61	34.62
20	26.02	41	21.43	62	40.24
21	7.44	42	10.0	63	20.11
22	40.09	43	40.23	64	33.04
23	15.48	44	40.22	65	23.61

1. THE PROPOSED BOUNDARIES HAVE NOT BEEN INVESTIGATED OR MARKED FOR THE PURPOSES OF THIS PROPOSED REZONING. THE BOUNDARY DIMENSIONS ARE COMPILED FROM THE RELEVANT DEPOSITED PLANS.
2. THIS PLAN IS FOR THE EXPRESS PURPOSE OF DETAILED INFORMATION FOR THE REZONING SUBMISSION.
3. THIS ELECTRONIC PLAN SHOULD NOT BE USED FOR CRITICAL DESIGN DIMENSIONS. ALL CRITICAL POSITION AND DIMENSIONS SHOULD BE VERIFIED ON REQUEST TO SURDEVEL PTY LTD.

NORTH BELLBIRD REZONING

PROJECT:
REZONING SUBMISSION

PLAN:
LAND INFORMATION FOR NORTH BELLBIRD REZONING INCLUDING CADASTRE & DTM.

CLIENT:
JOHNSON PROPERTY GROUP PTY LTD

SURDEVEL SURVEYORS
45 JOSEPHSON STREET, SWANSEA
P.O. BOX 300 SWANSEA NSW 2281
PH (02) 49719899 FAX (02) 49719822

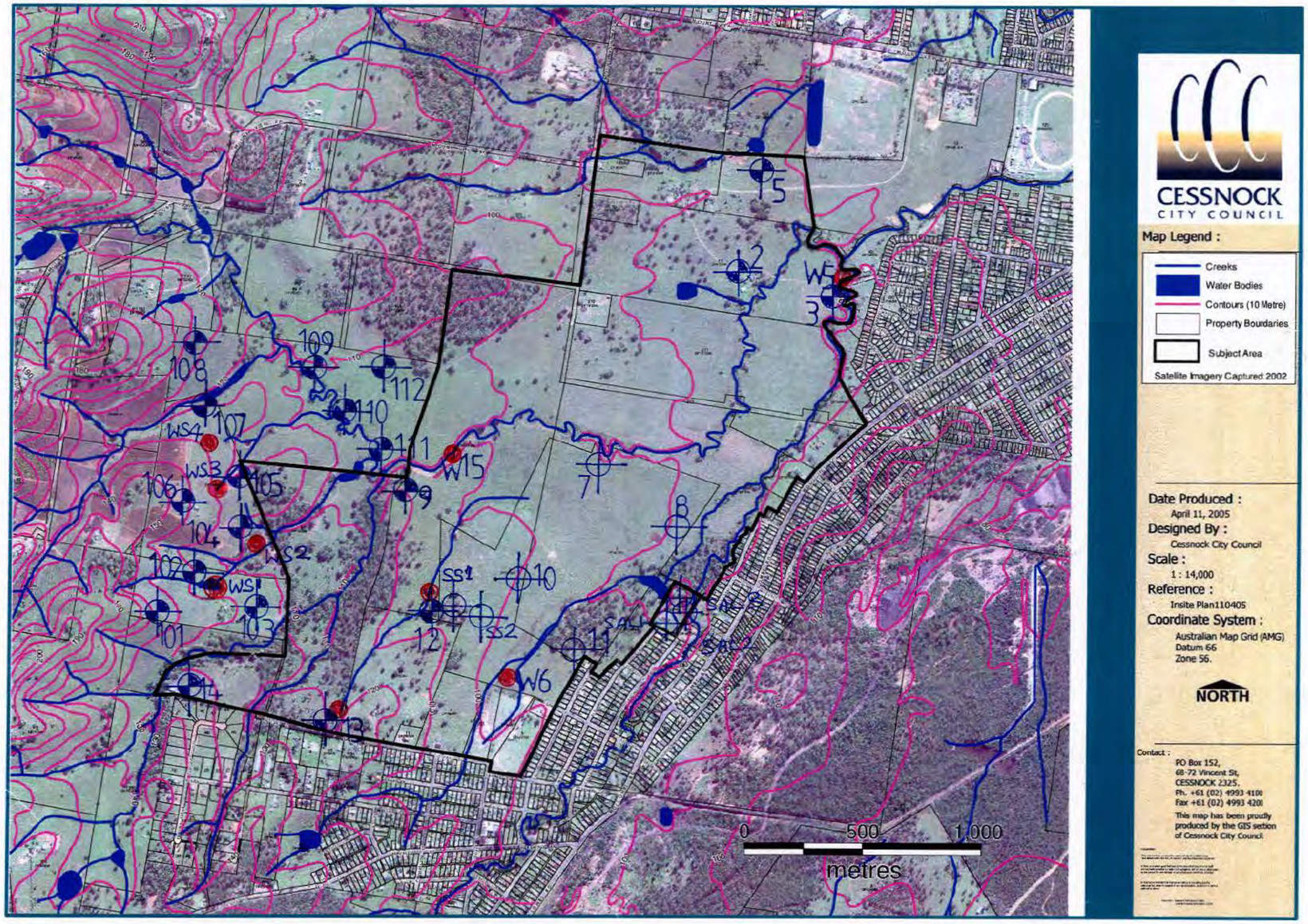
SURVEY JOB No.: 1448

SITE DESCRIPTION
PT1/86183, PT3/597226, 10/806564, 1/190997, 261/624058, 1/597226, 1/327765, 2/697228, 1/322498, 51/807540, 62/807540, 1/349452, 210/1012346, 11/815485, 10/815485, 3/810927, 13/880374, 1/167004, 141/986005, 11/806574, 1/328497

No.	AMENDMENTS	DATE

PLAN DATE: 23/05/2005
SCALE: 1 : 5,000 (A1)
SHEET 1 OF 1 SHEETS
FILE NAME: S:\Rezoning\Bellbird\1448MGA+DTM
PLAN No.: SURV2
AMEND No.:

LEGEND	Network Geotechnics Pty Ltd	Scale: NTS	Client: INSITE PLANNING
	6/6 Morton Close TUGGERAH NSW 2259 Tel: (02) 4351 6200 Fax: (02) 4351 6300 Email: gosnetgeo@bigpond.com	Plot size: A4	Project: REZONING STUDY
		Drawing: VdS	Location: NORTH BELLBIRD
		Drawing No: G25058/1-3	**LOCALITY PLAN**



	LEGEND
⊕	Approximate Borehole Location
●	Approximate Water Sample Location
⊕	Approximate Location of Surface Samples
	SITE PLAN BASED ON SURDEVEL PLAN NO SUR/2
	JOB NO 1448

Network Geotechnics Pty Ltd
6/6 Morton Close TUGGERAH NSW 2259
Tel: (02) 4351 6200 Fax: (02) 4351 6300
Email: gosnetgeo@bigpond.com

Scale:	NTS
Plot size:	A4
Drawing:	VdS
Drawing No:	G25058/1-1R

Client: INSITE PLANNING
Project: REZONING STUDY
Location: NORTH BELLBIRD

SITE PLAN

Observations from Aerial Photographs (cont)

Lot 1 DP327785, Lot 1 DP328498, Lot 1 DP28497, and Lot 51 DP807540, Lot 52 DP807540

26/09/04	Heavy timber along the creek. Rest is mainly grassland. A clearing (probably a dried up dam) in the middle of Lot 1 DP328885.
23/07/00	Similar to 2004.
24/08/04	Similar to 2004.
27/04/84	Same as 2004.
03/05/78	Same as 2004.
March 1961	Some farming activity (probably cattle) visible.
01/04/51	Same as 1961.

Lot 211 DP1012346, Lot 201 DP1012346, Lot 11 DP815485, Lot 12 DP815485

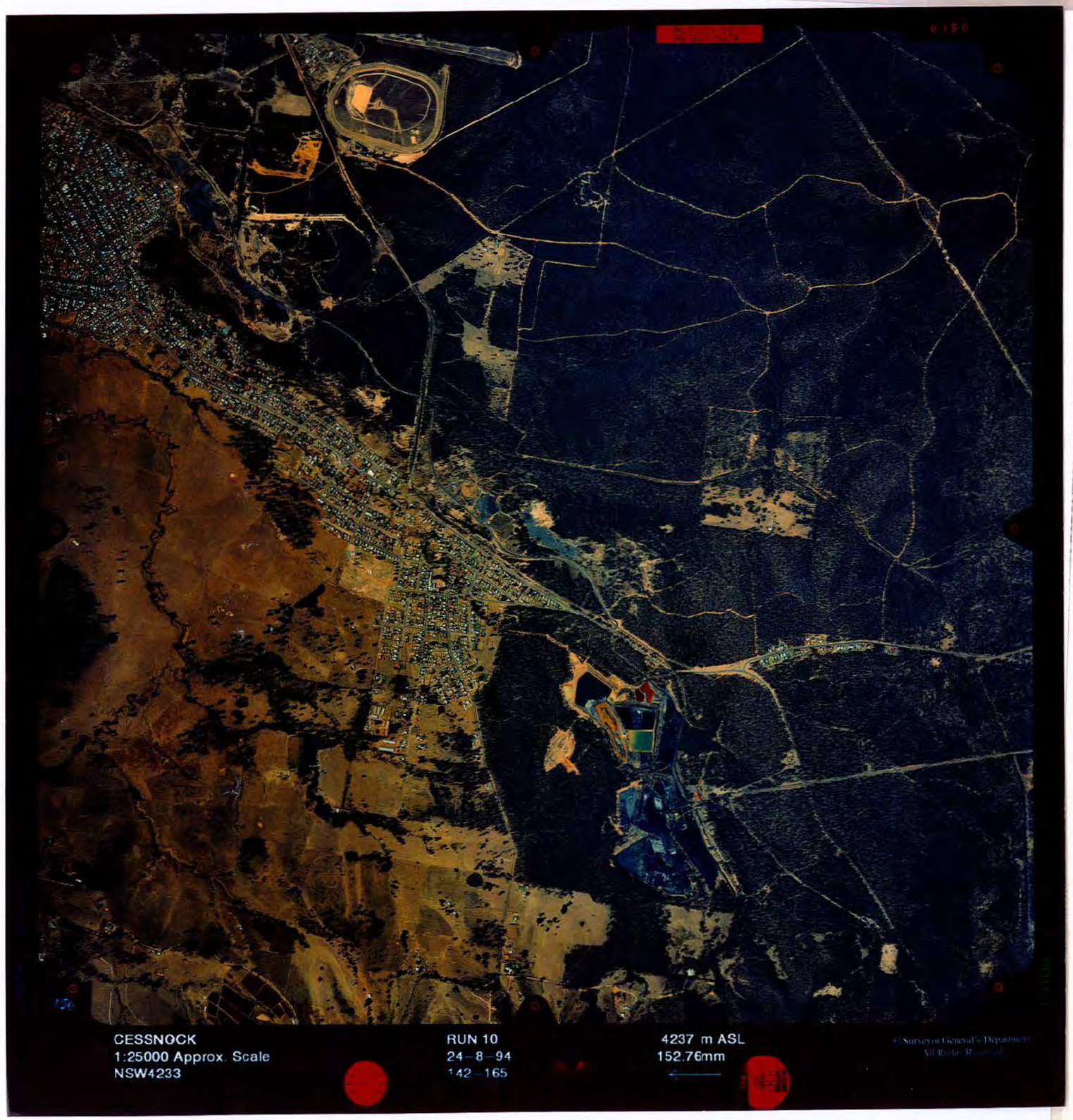
26/09/04	Residences in Lot 210 DP1012346 and Lot 11 DP815485. Several access tracks a large/shed/house in Lot 11.
23/07/00	Similar to 2004.
24/08/04	Similar to 2004.
27/04/84	A farm house in Lot 11 only. Otherwise similar to 2004.
03/05/78	More sheds and structures than 1984.
March 1961	Some sheds. No houses.
01/04/51	Same as 1961. Some land disturbance between the two creeks.


0152
CESSNOCK
1:25000 Approx. Scale
NSW4514 (M2226)
RUN 10
23-07-00
142-166
152.76 mm
© Land and Property Information
All Rights Reserved

2000 1/2


WILD 15/4 UAG-S
Na 13217 152.75
0182
CESSNOCK
1:25000 Approx. Scale
NSW4514 (M2226)
RUN 9
23-07-00
167-191
152.76 mm

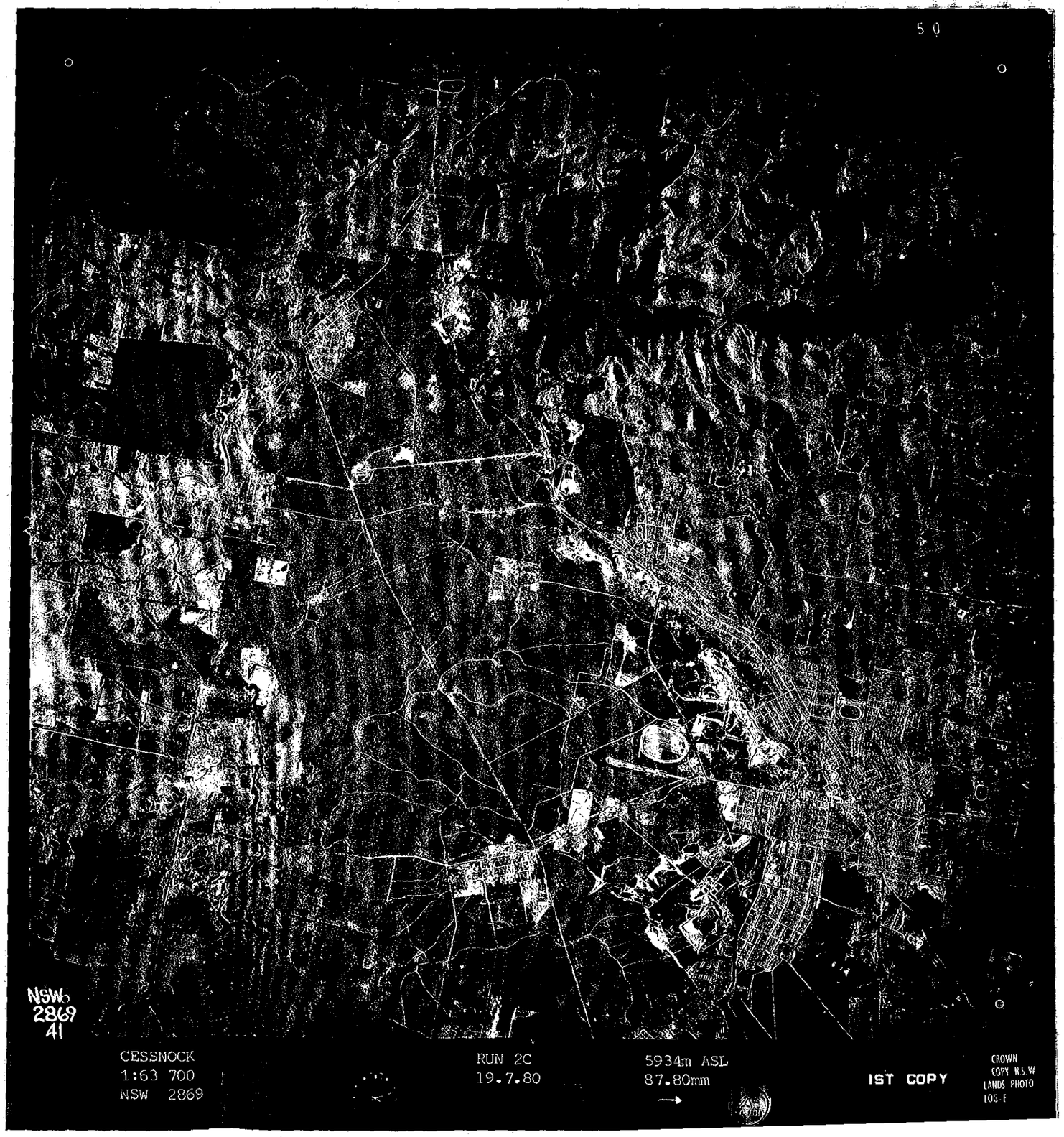
2000 2/2


CESSNOCK
1:25000 Approx. Scale
NSW4233
RUN 10
24–8–94
142–165
4237 m ASL
152.76mm
N

1994

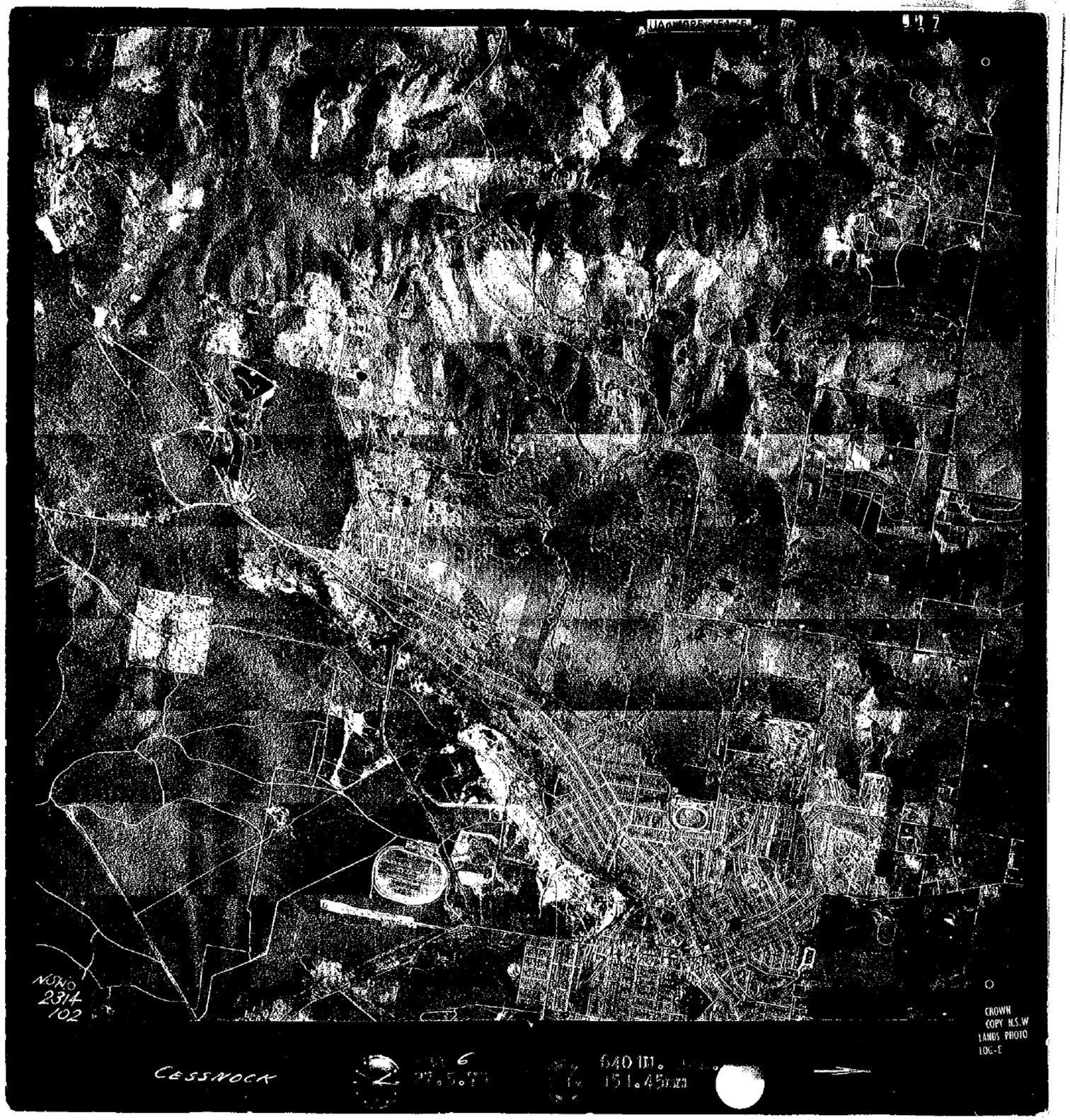


1984 →


50
NSW
2869
41
CESSNOCK
1:63 700
NSW 2869
RUN 2C
19.7.80
5934m ASL
87.80mm
IST COPY
CROWN
COPY N.S.W
LANDS PHOTO
LOG-F


NSW
2711
213
CROWN
COPY N.S.W
LANDS PHOTO
NEWCASTLE I.S.G. (CESSNOCK)
1:16 000 (MISC. 967)
NSW 2711
RUN 4
3.5.78
2605m ASL
151.45mm
IST COPY

← 1978


NSNO
2314
102
CESSNOCK
640 ft.
151.45mm
CROWN
COPY N.S.W
LANDS PHOTO
LOG-E

1975 ⟶

APPENDIX E

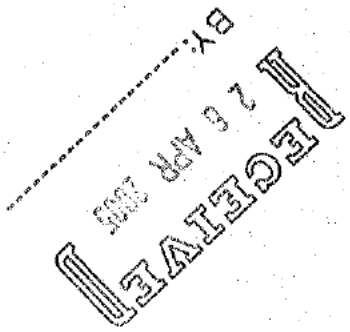
INFORMATION FROM MINE SUBSIDENCE BOARD

In reply please send to: Singleton

Our reference: FN05-00150O3 GM:SA

Your reference: GARY PEAKE

Contact: Garry Moore (02) 6572 4344



NETWORK GEOTECHNICS P/L
6/6 MORTON CLOSE
TUGGERAH 2259

21 April 2005

Dear Sir or Madam

ENQUIRY NO: TENQ05-00413O3
BELLBIRD NORTH, PROPOSED REZONING AT CESSNOCK
(see attachment)

This property is not within a proclaimed Mine Subsidence District and is not subject to any building restrictions imposed by the Mine Subsidence Board.

The provisions of the Mine Subsidence Compensation Act cover any improvement erected on this land.

The subject properties are not undermined by any recorded workings.

Yours faithfully

Garry Moore
District Manager

MINE SUBSIDENCE BOARD

HEAD OFFICE:
PO Box 488G
Newcastle 2300
Telephone: (02) 4908 4395
Facsimile: (02) 4929 1032

NEWCASTLE:
NSW Government Offices
117 Bull Street
Newcastle West 2302
PO Box 488G
Newcastle 2300
Telephone: (02) 4908 4300
Facsimile: (02) 4929 1032
DX 4322 Newcastle West

SPEERS POINT:
143 Main Road
Speers Point 2284
PO Box 9 Boolaroo 2284
Telephone: (02) 4950 8088
Facsimile: (02) 4950 8101
DX 7820 Newcastle

WYONG:
Suite 3 Feldwin Court
30 Holy Street
Wyong 2259
PO Box 157 Wyong 2259
Telephone: (02) 4352 1646
Facsimile: (02) 4352 1757
DX 7317 Wyong

SINGLETON:
Coal Services Building
1 Civic Avenue
Singleton 2330
PO Box 524 Singleton 2330
Telephone: (02) 6572 4344
Facsimile: (02) 6572 4504

PICTON:
100 Argyle Street
Picton 2571
PO Box 40 Picton 2571
Telephone: (02) 4677 1967
Facsimile: (02) 4677 2040
DX 26053 Picton

EMAIL:
mail@minesub.nsw.gov.au

WEBSITE:
www.minesub.nsw.gov.au

Quality System
Quality Endorsed Company
ISO 9001:2000
Lic 12871
Standards Australia

Legend

- Village Centre
- Medium Density
- Conventional Lots 450 - 800m²
- Rural Transition Zone (Lifestyle Lots) - 2000 - 5000m² Restrictions on vegetation removal. Building locations subject to Voluntary Management Agreements with DEC
- Vegetation to be retained within Rural Transition Lots
- Vineyard Zone
- School Site
- Riparian Zone including open space, drainage and water quality
- Active Open Space



Johnson Property Group
Creating living communities

North Bellbird
Johnson Property Group
Structure Plan

Job No. 05002 20 07 06

SCALE 1:10000

0 100 250 500

1:10 000 @ A3

Andrews.Neil
ARCHITECTURE • PLANNING • LANDSCAPE • ENVIRONMENT • URBAN DESIGN

Legend

- Village Centre
- Medium Density
- Conventional Lots 450 - 800m²
- Rural Transition Zone (Lifestyle Lots) - 2000 - 5000m² Restrictions on vegetation removal. Building locations subject to Voluntary Management Agreements with DEC
- Vegetation to be retained within Rural Transition Lots
- Vineyard Zone
- School Site
- Riparian Zone including open space, drainage and water quality
- Active Open Space



Johnson Property Group
Creating living communities

North Bellbird
Johnson Property Group
Structure Plan

Job No. 05002 20 07 06

SCALE 1:10000

0 100 250 500

1:10 000 @ A3

Andrews.Neil
ARCHITECTURE • PLANNING • LANDSCAPE • ENVIRONMENT • URBAN DESIGN