AGENDA
PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
11 DECEMBER 2017

MEMBERSHIP: Councillors J Diffey, V Etheridge, D Grant, D Gumley, A Jones, S Lawrence, G Mohr, K Parker, J Ryan and B Shields

The meeting is scheduled to commence at 5.30pm.

PDEC17/11 REPORT OF THE PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE - MEETING 20 NOVEMBER 2017 (ID17/2166)
The Committee had before it the report of the Planning, Development and Environment Committee meeting held 20 November 2017.

PDEC17/12 BUILDING SUMMARY - NOVEMBER 2017 (ID17/2171)
The Committee had before it the report dated 5 December 2017 from the Director Planning and Environment regarding Building Summary - November 2017.

PDEC17/13 PREPARATION OF A NEW COMPREHENSIVE LEP FOR THE DUBBO REGIONAL LGA (ID17/2082)
The Committee had before it the report dated 5 December 2017 from the Manager Strategic Planning Services regarding Preparation of a new Comprehensive LEP for the Dubbo Regional LGA.
PDEC17/14  PLANNING PROPOSAL - (R16-3) - AMENDMENT TO DUBBO LEP 2011
PROPERTY: 4L CAMP ROAD, DUBBO
APPLICANT: DOHERTY SMITH AND ASSOCIATES
OWNER: MRS L K BENDER (ID17/2083)

The Committee had before it the report dated 5 December 2017 from the Manager Strategic Planning Services regarding Planning Proposal - (R16-3) - Amendment to Dubbo LEP 2011 Property: 4L Camp Road, Dubbo

PDEC17/15  PROPOSED NEW POLICY - COUNCIL'S RESPONSE TO SICK AND INJURED ANIMALS NOT IN COUNCIL'S CARE (ID17/2177)

The Committee had before it the report dated 5 December 2017 from the Manager Environmental Control regarding Proposed New Policy - Council's Response to Sick and Injured Animals not in Council's Care.
The Committee had before it the report of the Planning, Development and Environment Committee meeting held 20 November 2017.

RECOMMENDATION

That the report of the Planning, Development and Environment Committee meeting held on 20 November 2017, be adopted.
PRESENT: Councillors J Diffey, V Etheridge, D Grant, A Jones, S Lawrence, G Mohr, K Parker, J Ryan and B Shields.

ALSO IN ATTENDANCE:
The General Manager, the Director Corporate Services, the Manager Governance and Risk, the Team Leader Governance, the Communications Coordinator, the Director Infrastructure and Operations, the Manager Infrastructure Strategy, the Manager Transport and Emergency, Manager Infrastructure Delivery, Manager Water Supply and Sewerage, Infrastructure Strategy Contractor, the Director Planning and Environment, the Manager Building and Development Services, the Statutory Planning Services Team Leader, the Manager Strategic Planning Services, Senior Strategic Planner, the Director Community and Recreation and the Manager Social Services.

Councillor S Lawrence assumed chairmanship of the meeting.

The proceedings of the meeting commenced at 5.54pm.

PDEC17/3 REPORT OF THE PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE - MEETING 16 OCTOBER 2017 (ID17/1971)
The Committee had before it the report of the Planning, Development and Environment Committee meeting held 16 October 2017.

Moved by Councillor J Diffey and seconded by Councillor D Grant

MOTION

The Committee recommends that the report of the Planning, Development and Environment Committee meeting held on 16 October 2017 be adopted. CARRIED
PDEC17/4 BUILDING SUMMARY - OCTOBER 2017 (ID17/1989)
The Committee had before it the report dated 14 November 2017 from the Director Planning and Environment regarding Building Summary - October 2017.

Moved by Councillor G Mohr and seconded by Councillor D Grant

MOTION

The Committee recommends that the information contained in the report of the Director Planning and Environment dated 14 November 2017 be noted.

CARRIED

PDEC17/5 PLANNING PROPOSAL R17-4 - ADDITIONAL PERMITTED USE (DWELLING HOUSE), WARRIE ROAD, DUBBO
APPLICANT: GEOLYSE PTY LTD
OWNER: A J JOYCE-BRANDON AND R M BRANDON (ID17/1803)
The Committee had before it the report dated 14 November 2017 from the Manager Strategic Planning Services regarding Planning Proposal R17-4 - Additional Permitted Use ( Dwelling House), Warrie Road, Dubbo.

Moved by Councillor A Jones and seconded by Councillor V Etheridge

MOTION

The Committee recommends:
1. That Council supports the Planning Proposal to include a dwelling house as a permissible development activity ancillary to intensive livestock agriculture on the combined area of Lot 147 and Lot 148 DP 754331, Warrie Road, Dubbo.
2. That Council supports a minimum 28 day public exhibition period for the Planning Proposal.
3. That Council resolves to use its delegation under Section 59 of the Environmental Planning and Assessment Act, 1979 to draft the amendments to the Dubbo Local Environmental Plan 2011.
4. That following completion of the public exhibition period, a further report be provided to Council detailing the results of the public exhibition for further consideration of the Planning Proposal.

CARRIED
The Committee had before it the report dated 14 November 2017 from the Manager Strategic Planning Services regarding Planning Proposal (R16-5) - Southlakes Estate, Dubbo. The Committee reports having met with Mr Steve Guy, MAAS Group Family Properties, regarding this matter.

Moved by Councillor B Shields and seconded by Councillor J Diffey

MOTION

The Committee recommends:

1. That the Planning Proposal, as exhibited, to undertake the following amendments to the Dubbo Local Environmental Plan 2011 be adopted by Council:
   - That part of the subject land be rezoned from R2 Low Density Residential to R1 General Residential, B1 Neighbour Centre and the existing RE1 Public Recreation zone be reconfigured;
   - That minimum lot sizes be changed from existing 600 m² and 4000 m² to a range of no minimum lot sizes, 450 m², 600 m², 800 m² and 2000 m²;
   - That land situated to the south of the indicative location of the Southern Distributor be zoned RU2 Rural Landscape;
   - That the area of land proposed to be zoned B1 Neighbourhood Centre be subject to a suitable provision in the Dubbo Local Environmental Plan 2011 that limits the total retail floor space of any centre to 5,000 m²; and
   - That the additional use of Recreational Facility (Indoor) be permitted on the subject area of the land proposed to be zoned B1 Neighbourhood Centre under the provisions of the Dubbo Local Environmental Plan 2011.

2. That Council request the Department of Planning and Environment to prepare the draft amendment to the Dubbo Local Environmental Plan 2011 and provide Council with an Opinion that the Plan be made.

3. That following receipt of an Opinion from the Department that the Plan be made, that the General Manager request gazettal of the Plan.

4. That those who made a submission be thanked and advised of Council’s determination in this matter.

CARRIED
PDEC17/7 DEVELOPER CONTRIBUTIONS AND ASSOCIATED ISSUES - SOUTHLAKES ESTATE, SOUTH-EAST DUBBO (ID17/1970)

The Committee had before it the report dated 16 November 2017 from the Manager Strategic Planning Services regarding Developer Contributions and Associated Issues - Southlakes Estate, South-East Dubbo. The Committee reports having met with Mr Steve Guy, MAAS Group Family Properties, regarding this matter.

Moved by Councillor G Mohr and seconded by Councillor J Diffey

MOTION

The Committee recommends:

1. That it be noted that in respect of the Southlakes Estate, the Keswick on the Park Estate and the Magnolia Grove Estate, Council has not overcharged Section 94 Developer Contributions for any development application pursuant to the following Section 94 Developer Contributions Plans:
   - Section 94 Contributions Plan for Open Space and Recreation Facilities, 1998 (former Section 94 Plan);
   - Section 94 Contributions Plan for Open Space and Recreation Facilities, 2016; and

2. That Council proceed to enter into a Works-In-Kind Agreement for the first 950 lots included in Stage 2 of the Southlakes Estate (Hillview Land) with Maas Group Family Properties for the provision of Open Space and Recreation Facilities in accordance with the following:
   - Embellishment of the Council-owned land situated within the Stage 2 Southlakes Estate area to the value of $2 million;
   - Embellishment of the Council-owned land to be undertaken in compliance with the Furniture and Equipment Standard of the Community and Recreation Division;
   - Payment of a City-wide contribution of $1,436.78 per lot; and

3. That Council enter into a Maintenance Agreement with the proponent for the ongoing maintenance of open space within Stage 2 (including Lot 2 DP 880413) of the Southlakes Estate by the developer for a period of 10 years in conjunction with any future development application(s) for subdivision in Stage 2 in accordance with the Dubbo Development Control Plan 2013.

4. That following receipt of the consultancy assessment from Cardno Pty Ltd in respect of trunk stormwater drainage requirements in Catchment 3.1 under the provisions of the Section 94 Contributions Plan Urban Stormwater Drainage Headworks, a further report be provided to Council in February 2018 including the following:
   - Details of trunk stormwater infrastructure delivered;
   - Infrastructure required to be delivered and infrastructure costs; and
   - Further consideration as to whether amendment of the Section 94 Contributions Plan is required or any other mechanism, both in respect of development in the catchment and Stage 2 including Lot 2 DP 880413 of the Southlakes Estate.
5. That Council not enter into a Voluntary Planning Agreement in accordance with the request to enter into a Voluntary Planning Agreement as provided by GLN Planning Pty Ltd, dated 3 November 2016 and provided here in Appendix 4.

6. That Council commence the acquisition of 52,116.77m² of Lot 36 DP 1233637 for the purpose of the future development of the Southern Distributor Road under the provisions of the Land Acquisition (Just Terms Compensation) Act, 1991, with a further report forwarded to Council in due course.

7. That Council undertake a land swap with Maas Group Family Properties to exchange 3.152 hectares of Council owned land for approximately 5.817 hectares of land owned by Maas Group Family Properties as shown here in Appendix 8.

8. That the land swap included in item 7 be at no cost to Council (ie a direct swap of land with no monetary compensation).

9. That the land swap included in item 7 not be formalised until the Minister for Planning has gazetted the Planning Proposal for the Southlakes Estate (R16/5).

10. That consideration of a Works-In-Kind Agreement for the provision of sewer and water infrastructure be deferred pending completion and adoption of the complete Structure Plan for Southlakes Estate including Lot 2 DP 880413.

11. That Council not accede to the request to enter into a Voluntary Planning Agreement (VPA) in respect of road infrastructure for Stage 2 including Lot 2 DP 880413 of the Southlakes Estate.

12. That any necessary documentation to facilitate the land swap be executed under the Common Seal of Council.

CARRIED

PDEC17/8

DEVELOPMENT APPLICATION D17-415 - REGISTERED CLUB (ALTERATIONS AND ADDITIONS)
PROPERTY: 82 WHYLANDRA STREET, DUBBO
APPLICANT: CLUB DUBBO
OWNER: WEST DUBBO BOWLING CLUB LTD (ID17/1911)

The Committee had before it the report dated 14 November 2017 from the Senior Strategic Planner regarding Development Application D17-415 - Registered Club (Alterations and Additions). The Committee reports having met with Ms Alicia Rich regarding this matter.

Moved by Councillor D Grant and seconded by Councillor A Jones

MOTION

The Committee recommends:

1. That Development Application D17-415 for alterations and additions to a registered club at Lot 229 DP 753233, 82 Whylandra Street, Dubbo, be granted approval subject to the conditions of consent included as Appendix 1 to the report of the Senior Strategic Planner dated 14 November 2017.

2. That Council accede to the request for the reduction in the Section 94 contribution for Urban Roads from $138,769.64 to $65,303.36 based on the traffic analysis prepared by Stanbury Traffic Planning and dated August 2017 as submitted with Development Application D17-415.
3. That those who made submissions in this matter be advised of Council’s determination.

CARRIED

Councillor B Shields declared a non-pecuniary, significant interest in the matter now before the Committee and left the room and was out of sight during Committee’s consideration. The reason for such interest is that Councillor B Shields is a former employee of Club Dubbo and was employed by Club Dubbo in the past 12 months.

PDEC17/9 DEVELOPMENT APPLICATION D2017-462 - TWO (2) LOT SUBDIVISION, MULTI DWELLING HOUSING AND FOUR (4) LOT STRATA SUBDIVISION
PROPERTY: 197 WINGEWARRA STREET, DUBBO
APPLICANT: MR R STEVENSON
OWNER: RACEBAIL PTY LTD (ID17/1982)
The Committee had before it the report dated 15 November 2017 from the Statutory Planning Services Team Leader regarding Development Application D2017-462 - Two (2) Lot Subdivision, Multi Dwelling Housing and Four (4) Lot Strata Subdivision.

Moved by Councillor G Mohr and seconded by Councillor V Etheridge

MOTION

The Committee recommends that Development Application D2017-462 for a two (2) lot subdivision, multi dwelling housing (four (4) terrace dwellings) and four (4) lot strata subdivision at Lot 1 Sec 40 DP 758361, 197 Wingewarra Street, Dubbo, be refused for the following reasons:

1. The proposed development does not represent the orderly development of land. (Section 5(a) Environmental Planning and Assessment Act, 1979).

2. The proposed strata subdivision fails to meet the minimum lot size requirements as stated in Dubbo Local Environmental Plan 2011, Clause 4.1. The request to vary the development standard in Clause 4.6 cannot be supported due to the proposal’s failure against subclauses (3) and (4) and a number of requirements in Dubbo Development Control Plan 2013, Chapter 2.1 Residential Development and Subdivision. (Section 79C(1)(a)(i) Environmental Planning and Assessment Act, 1979).

3. The subject development requires an exemption to the minimum lot size standard in accordance with Clause 4.6 (4) of the Dubbo Local Environmental Plan. The subject application is contrary to Clause 4.6 on the basis that Council is not satisfied the proposal meets the requirements of Clause 4.6. (Section 79C(1)(a)(i) Environmental Planning and Assessment Act, 1979).

4. The proposed driveways of terraces 1 and 2 are located within three (3) metres of the existing power pole, contrary to the requirements of Essential Energy. (Section 79C(1)(a)(i) Environmental Planning and Assessment Act, 1979).

5. Proposed Lot 12 (being 528 m² in area) is below the minimum lot size of 700 m² as required for multi dwelling housing development, in accordance with Dubbo Development Control Plan 2013. (Section 79C(1)(a)(iii) Environmental Planning and Assessment Act, 1979).
6. The private open space areas proposed for the four (4) terrace dwellings fail to achieve the minimum required hours of direct sunlight in accordance with Dubbo Development Control Plan 2013. (Section 79C(1)(a)(iii) Environmental Planning and Assessment Act, 1979).

7. The private open space areas of the existing dwelling, together with terraces 2 and 3 fail to meet the minimum area requirements specified in the Dubbo Development Control Plan 2013. (Section 79C(1)(a)(iii) Environmental Planning and Assessment Act, 1979).

8. The vehicle access arrangements for the four (4) terrace dwellings does not permit vehicles to enter and leave in a forward direction, nor is there any provision for the required visitor car parking space onsite, as required in Dubbo Development Control Plan 2013. (Section 79C(1)(a)(iii) Environmental Planning and Assessment Act, 1979).

9. The proposed four (4) terrace dwellings’ driveways to Fitzroy Street are located such that they are deemed dangerous to the road network, the travelling public and the future occupants of the terraces, and in contravention of Dubbo Development Control Plan 2013 (Section 79C(1)(a)(iii) Environmental Planning and Assessment Act, 1979).

10. The existing dwelling’s proposed driveway to Wingewarra Street is located such that it is deemed dangerous to the road network, the travelling public and the adjoining occupant at 199 Wingewarra Street, as required in Dubbo Development Control Plan 2013 (Section 79C(1)(a)(iii) Environmental Planning and Assessment Act, 1979).

11. The proposed development (Stages 2 and 3) is deemed unsuitable for the subject site based on the areas of non-compliance with the Development Control Plan identified as it constitutes an over-development of the site. (Section 79C(1)(c) Environmental Planning and Assessment Act, 1979).

11. The proposed development is not deemed to be in the public interest, given the numerous non-compliances of the proposal together with the potential detrimental impacts on the road network and the property to the south (184 Fitzroy Street). (Section 79C(1)(e) Environmental Planning and Assessment Act, 1979).

CARRIED

Councillor D Grant declared a pecuniary, significant interest in the matter now before the Committee and left the room and was out of sight during Committee’s consideration. The reason for such interest is that Councillor D Grant is an employee of Elders Insurance who have business dealings with the proponent of the application.

PDEC17/10 LEAVE OF ABSENCE
A request for leave of absence was received from Councillor D Gumley who was absent from the meeting due to the personal reasons.

Moved by Councillor A Jones and seconded by Councillor V Etheridge

MOTION

That such request for leave of absence be accepted and Councillor D Gumley be granted leave of absence from this meeting.

CARRIED
The meeting closed at 6.21pm.

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CHAIRMAN
REPORT: Building Summary - November 2017

AUTHOR: Director Planning and Environment
REPORT DATE: 5 December 2017
TRIM REFERENCE: ID17/2171

EXECUTIVE SUMMARY

Information has been prepared on the statistics of the number of dwellings and residential flat buildings approved in the Dubbo Regional Council Local Government Area and statistics for approved Development Applications for the information of Council.

Appendix 1 includes data relating to the former Dubbo LGA prior to the current financial year and the combined housing figures for Dubbo Regional Council for the current financial year. Appendices 2 and 3 also include the retrospective figures for the combined LGA.

All development applications, construction certificates and complying development certificates can be tracked online at https://planning.dubbo.nsw.gov.au/Home/Disclaimer

ORGANISATIONAL VALUES

Customer Focused: Council aims to provide high quality and timely building and development services. This reporting provides ongoing monitoring of building activity in the Local Government Area (LGA).
Integrity: This report provides transparent statistics regarding development activity in the LGA.
One Team: This report demonstrates Council’s commitment to work as one to ensure the growth of the LGA.

FINANCIAL IMPLICATIONS

There are no financial implications arising from this report.

POLICY IMPLICATIONS

There are no policy implications arising from this report.
RECOMMENDATION

That the information contained in this report of the Director Planning and Environment dated 5 December 2017 be noted.

Melissa Watkins
Director Planning and Environment
REPORT

Provided for information are the latest statistics (as at the time of production of this report) for Development Applications for Dubbo Regional Council.

1. Residential Building Summary

Dwellings and other residential developments approved during November 2017 were as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwellings</td>
<td>16</td>
</tr>
<tr>
<td>Other residential development</td>
<td>9</td>
</tr>
<tr>
<td>(No. of units)</td>
<td>(16)</td>
</tr>
</tbody>
</table>

For consistency with land use definitions included in the Dubbo Local Environmental Plan 2011, residential development has been separated into ‘Dwellings’ and ‘Other residential development’. ‘Other residential development’ includes dual occupancies, secondary dwellings, multi-unit and seniors living housing.

These figures include Development Applications approved by private certifying authorities (Complying Development Certificates).

A summary of residential approvals for the former Dubbo City Council area since 2010-2011 is included in Appendix 1 however, it should be noted that the figures from July 2017 onwards include the approvals within the former Wellington Local Government Area as well as a consequence of the commencement of the merged application system.

2. Approved Development Applications

The total number of approved Development Applications (including Complying Development Certificates) for November 2017 and a comparison with figures 12 months prior and the total for the respective financial years, are as follows:

<table>
<thead>
<tr>
<th>Period</th>
<th>No. of applications</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 November 2017 – 30 November 2017</td>
<td>69</td>
<td>$13,444,963</td>
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<tr>
<td>1 July 2017 – 30 November 2017</td>
<td>345</td>
<td>$81,154,507</td>
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<td>1 November 2016 – 30 November 2016</td>
<td>70</td>
<td>$22,298,738</td>
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<tr>
<td>1 July 2016 – 30 November 2016</td>
<td>366</td>
<td>$83,474,531</td>
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</table>

A summary breakdown of the figures is included in Appendices 2-3.
3. **Online Application Tracking**

All development applications, construction certificates and complying development certificates are tracked online and can be accessed at any time. A link is available on Councillor iPads for assistance ([https://planning.dubbo.nsw.gov.au/Home/Disclaimer](https://planning.dubbo.nsw.gov.au/Home/Disclaimer))

What information is available?

- All development applications, construction certificates and complying development certificates submitted from 1 November 2015 will provide access to submitted plans and supporting documents as well as tracking details of the progress of the application;
- More limited information is provided for applications submitted from 1 January 2001 to 31 October 2015; and
- Occupation certificates (where issued) are provided from 2010.

What information is not available?

- Application forms;
- Floor plans for residential dwellings;
- Documentation associated with privately certified applications; and
- Internal reports.

Councillors are welcome to contact me should they require further information in respect of outstanding Development Applications emanating from the online tracking system.

The information included in this report is provided for notation.

**Appendices:**

1. Building Summary
2. Approved Development Applications - November 2017
3. Approved Development Applications - November 2016
4. Approved Development Applications - 1 July 2017 to 30 November 2017
5. Approved Development Applications - 1 July 2016 to 30 November 2016
### Statistical Information on Dwellings and Multi Unit Housing

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<th>Year</th>
<th>Jul</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
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* (Includes private certifiers and redefined land use categories based on LEP definitions)
# Approved Development & Complying Development Applications

by Dubbo Regional Council and Private Certifiers-Period 1/11/2017 - 30/11/2017

<table>
<thead>
<tr>
<th>Development Type</th>
<th>Number of Applications</th>
<th>Est. $</th>
<th>New Developments</th>
<th>Est. $</th>
<th>Amendments &amp; Alteration</th>
<th>Est. $</th>
<th>New Lots</th>
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Total Number of Applications for this period: 69

*** Note: There may be more than one Development Type per Development Application. Statistics include applications by Private Certifiers

--------- End of Report -------

F:\Authority\crystal\Applications\Approved Statistics LGA V1.0.rpt
## Approved Development & Complying Development Applications
by Dubbo Regional Council and Private Certifiers - Period 1/11/2016 - 30/11/2016

<table>
<thead>
<tr>
<th>Development Type</th>
<th>Number of Applications</th>
<th>Est. $</th>
<th>New Developments</th>
<th>Est. $</th>
<th>Amendments and Alteration</th>
<th>Est. $</th>
<th>New Lots</th>
<th>New Lots</th>
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<tbody>
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**Total Number of Applications for this period: 70**

*** Note: There may be more than one Development Type per Development Application
Statistics include applications by Private Certifiers

--- End of Report ---
### Approved Development & Complying Development Applications

by Dubbo Regional Council and Private Certifiers - Period 1/07/2017 - 30/11/2017

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<th>New Developments</th>
<th>Est. $</th>
<th>Additions and Alterations</th>
<th>Est. $</th>
<th>New Developments</th>
<th>New Lots</th>
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**Total Number of Applications for this period: 345**

***Note: There may be more than one Development Type per Development Application. Statistics include applications by Private Certifiers***

________ End of Report ________
### Approved Development & Complying Development Applications
by Dubbo Regional Council and Private Certifiers-Period 1/07/2016 - 30/11/2016

<table>
<thead>
<tr>
<th>Development Type</th>
<th>Number of Applications</th>
<th>Est. $</th>
<th>New Developments</th>
<th>Est. $</th>
<th>Addition and Alteration</th>
<th>Est. $</th>
<th>New Lots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwelling - single</td>
<td>110</td>
<td>31,810,251</td>
<td>87</td>
<td>29,202,166</td>
<td>23</td>
<td>2,608,085</td>
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<tr>
<td>Dwelling- Transportable/Relocatable</td>
<td>1</td>
<td>198,884</td>
<td>1</td>
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<tr>
<td>Dwelling - Secondary/Dual Occ Dwelling</td>
<td>11</td>
<td>2,390,900</td>
<td>11</td>
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<tr>
<td>Dwelling - Dual Occupancy, one storey</td>
<td>23</td>
<td>6,425,400</td>
<td>21</td>
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<tr>
<td>Medium Density Res - one/two storeys</td>
<td>2</td>
<td>675,000</td>
<td>2</td>
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<tr>
<td>Medium Density Res - Seniors Living SEPI</td>
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<td>Garage/Carport/Roofted Outbuildings</td>
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<td>108</td>
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<td>Fences/Unroofed Structures</td>
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<td>Swimming Pool</td>
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<td>883,363</td>
<td>35</td>
<td>859,263</td>
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<td>Office Building</td>
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<td>Retail Building</td>
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<tr>
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<tr>
<td>Factory/Production Building</td>
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<td>3,130,000</td>
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<tr>
<td>Warehouse/storage</td>
<td>9</td>
<td>3,881,000</td>
<td>7</td>
<td>3,551,000</td>
<td>2</td>
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<td>Carpark</td>
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<td>Infrastructure - Transport, Utilities</td>
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<td>Health Care Facility - Hospital</td>
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<tr>
<td>Health Care Facility - Other</td>
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<td>Signs/Advertising Structure</td>
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<td>Demolition</td>
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<td>Home Industry</td>
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## Approved Development & Complying Development Applications
by Dubbo Regional Council and Private Certifiers - Period 1/7/2016 - 30/11/2016

<table>
<thead>
<tr>
<th>Development Type</th>
<th>Number of Applications</th>
<th>Est. $</th>
<th>New Developments</th>
<th>Est. $</th>
<th>Additions and Alterations</th>
<th>Est. $</th>
<th>New Dwellings</th>
<th>New Lots</th>
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<tr>
<td>Child Care - Centre Based</td>
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<td>1,530,000</td>
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<tr>
<td>Change of Use - Commercial</td>
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<td>196,000</td>
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<td>Agricultural Development</td>
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<td>Subdivision - Residential</td>
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<td>Subdivision - Commercial</td>
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<td>Subdivision - Industrial</td>
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<td></td>
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<tr>
<td>Subdivision - Rural</td>
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<td>8</td>
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<tr>
<td>Subdivision - Other</td>
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<td>Miscellaneous</td>
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<td>7,045,378</td>
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<tr>
<td><strong>Totals for Development Types</strong></td>
<td><strong>391</strong></td>
<td><strong>83,474,531</strong></td>
<td><strong>3</strong></td>
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</tr>
</tbody>
</table>

**Total Number of Applications for this period:** 366

***Note: There may be more than one Development Type per Development Application. Statistics include applications by Private Certifiers.***

--- End of Report ---
EXECUTIVE SUMMARY

Following the amalgamation of the former Wellington Council and Dubbo City Council on 11 May 2016, Dubbo Regional Council has operated with two (2) separate Local Environmental Plans (LEPs).

The Wellington Local Environmental Plan 2012 (Wellington LEP) commenced operation on 23 November 2012 and applies to land situated in the former Wellington Local Government Area. The Dubbo Local Environmental Plan 2011 (Dubbo LEP) commenced operation on 11 November 2011 and applies to land situated in the former Dubbo Local Government Area (LGA).

Following the amalgamation and in accordance with the requirements of the NSW Department of Premier and Cabinet, Council is required to prepare a new Comprehensive LEP for the new LGA. This process will bring the planning controls for the new LGA into one main document which will ultimately aid the development industry and residents in understanding the planning controls that apply to land.

Preparation of a new Comprehensive LEP is a significant strategic planning project. Given the significance of the project and the importance to the continued development of the new LGA, it is proposed to undertake development of the new Plan across a number of stages. These include the following:

1. Operational reviews of the Dubbo LEP and the Wellington LEP (currently underway);
2. Preparation of a new Comprehensive LEP as a compilation of two (2) current LEPs; and
3. Preparation of land use strategies for the former Wellington LGA and a review of existing land use strategies in respect of the former Dubbo LGA.

Preparatory works have now commenced towards the preparation of a combined LEP. This process effectively includes combining both LEPs into one document, inclusive of all provisions that are applicable in both former local government areas.
Preparation of the new LEP will not result in any changes to land use zones or other specific provisions unless the change is considered to be an administrative error or omission. Any changes proposed to be undertaken, which would ordinarily require a land use strategy to be in place or are outside of a Council adopted land use strategy, are not considered appropriate for inclusion in this LEP.

Following preparation of the combined Comprehensive LEP, staff will commence the development of a number of land use strategies for the former Wellington LGA and undertake a review of current Strategies that are applicable to the former Dubbo LGA.

The following land use strategies are proposed to be prepared for land within the former Wellington LGA:

- Rural Areas Development Strategy;
- Wellington Town Strategy; and
- Villages Strategy.

A further report, including project planning for the preparation of land use strategies for the former Wellington LGA and a review of land use strategies for the former Dubbo LGA will be provided to Council for consideration at its April 2018 meetings.

This report recommends that Council adopt a three stage program for preparation of a new Comprehensive LEP and that a further report be provided to Council at its March 2018 meeting, including a Planning Proposal and draft Comprehensive LEP for the new LGA in accordance with stage 2 of the program.

**ORGANISATIONAL VALUES**

**Customer Focused:** Preparation of a new Comprehensive LEP is one of the core strategic projects a Council can undertake. Given the importance of the Plan and its role in guiding the sustainable development of a new LGA, the community will have an important role in guiding the future direction of the new Comprehensive LEP.

**Integrity:** A new Comprehensive LEP will be required to be prepared in accordance with the requirements of the Environmental Planning and Assessment Act, 1979 and the NSW Department of Planning and Environment’s document, A Guide to Preparing Planning Proposals.

**One Team:** Council staff have been involved in the assessment of the Planning Proposal in accordance with relevant legislation and Dubbo Regional Council policy.

**FINANCIAL IMPLICATIONS**

It is considered that there are no direct financial implications arising from this report. Financial implications will be required to be considered by Council in future reports in respect of specific components of the three stage program to the preparation of the new Comprehensive LEP for the new Dubbo Regional LGA.
POLICY IMPLICATIONS

This report recommends that Council adopt a three stage program for the preparation of a new Comprehensive LEP for the new Dubbo Regional Local Government Area. Preparation of a new LEPlan is Council’s most important planning policy that will guide the sustainable development of the new Local Government Area.

RECOMMENDATION

1. That Council adopt a three stage program for the preparation of a new Comprehensive Local Environmental Plan for the Dubbo Regional Local Government Area as included in this report which incorporate the following components:

   Stage 1 - Operational review of the Dubbo Local Environmental Plan 2011 and the Wellington Local Environmental Plan 2012 (noting this work is currently underway);
   Stage 2 - Preparation of a new Comprehensive Local Environmental Plan as a compilation of the current provisions in the Dubbo Local Environmental Plan 2011 and the Wellington Local Environmental Plan 2012; and
   Stage 3 - Preparation of land use strategies for land within the former Wellington Local Government Area and review of existing Strategies for land situated in the former Dubbo Local Government Area.

2. That preparation of the new Comprehensive Local Environmental Plan not include any changes to land use zones and/or any other specific provisions unless the change is considered to be an administrative error or omission.

3. That any changes to planning provisions, which would ordinarily require a land use strategy to be in place or are outside of a Council adopted land use strategy, not be included in the Comprehensive Local Environmental Plan.

4. That a further report, including the draft Planning Proposal and draft Comprehensive Local Environmental Plan, be presented to Council for consideration in March 2018.

5. That a further report, including project planning for the preparation of land use strategies for the former Wellington Local Government Area and a review of land use strategies for the former Dubbo Local Government Area be provided to Council for consideration in April 2018.

Steven Jennings
Manager Strategic Planning Services
BACKGROUND

Following the amalgamation of the former Wellington Council and Dubbo City Council on 11 May 2016, Dubbo Regional Council has operated with two separate Local Environmental Plans.

The Wellington Local Environmental Plan 2012 (Wellington LEP) commenced operation on 23 November 2012 and applies to land situated in the former Wellington Local Government Area. The Dubbo Local Environmental Plan 2011 (Dubbo LEP) commenced operation on 11 November 2011 and applies to land situated in the former Dubbo Local Government Area.

Following the amalgamation and in accordance with the requirements of the NSW Department of Premier and Cabinet, Council is required to prepare a new Comprehensive Local Environmental Plan (LEP) for the new Local Government Area (LGA). This process will bring the planning controls for the new LGA into one main document, which will ultimately aid the development industry and residents in understanding the planning controls that apply to land.

REPORT

1. Introduction

(a) What is a Local Environmental Plan?

A Local Environmental Plan (LEP) is a legal document that is required to be prepared by Council and is regulated and approved by the NSW Department of Planning and Environment (DPE). Every LGA in the state is required to have an LEP in place that has been prepared in accordance with the requirements of the Standard Instrument (Principal Local Environmental Plans) Order, 2006.

An LEP has the role of regulating and guiding land use and development across whole or part of an LGA. LEPs consist of a written document and accompanying maps. The written component of a LEP generally contains the following key components:

- Overall objectives for development Council is seeking to achieve in the Plan;
- A range of land use zones and an associated land use table for each zone which provide the overall objectives for development in the zone, the land use activities permitted with or without development consent, and prohibited land use activities;
- Subdivision controls which guide the subdivision of land within certain land use zones and areas;
- Development standards for certain land use activities;
- Other clauses that guide the conservation of both indigenous and European heritage, development on flood-prone land and other clauses that guide the consideration of development in respect of land use constraints and provisions that guide the consideration of site specific issues;
• Requirements for development undertaken in defined Residential Urban Release Areas; and
• Definitions and other administrative clauses.

An LEP is also accompanied by an extensive series of maps which assist in the overall understanding of the provisions as contained in the Plan as set out below:

• Land application map;
• Land reservation acquisition maps;
• Land zoning maps;
• Minimum subdivision lot size maps;
• Heritage maps;
• Natural resource – Biodiversity map;
• Urban Release Area map;
• Natural Resource – Water map, Natural Resource – Groundwater Vulnerability map;
• Flood planning maps;
• Land reclassification maps; and
• Additional permitted use maps.

All LEPs in NSW are required to be prepared in accordance with the Standard Instrument (Local Environmental Plans) Order, 2006 or the ‘Standard instrument’. This means that all LEPs have the same structure, are prepared using the same suite of land use zones and provide a level of similarity in local provisions.

As a key component of the NSW Planning System, LEPs can be amended through the Planning Proposal process. The Wellington LEP has been amended on four occasions since adoption. The Dubbo LEP has been amended on 11 separate occasions. This component of the NSW Planning System allows LEPs to be amended to best accord with the demands of the community and the development industry.

(a) Why is a new LEP required?

The former Wellington and Dubbo City councils were amalgamated by proclamation on 12 May 2016. Following the amalgamation and in accordance with the requirements of the NSW Department of Premier and Cabinet, all amalgamated councils are required to prepare a new Comprehensive LEP.

Preparation of a new singular LEP for the Dubbo Regional Local Government Area will provide a continuity of planning controls across the LGA and will ensure residents and the development industry have access to an integrated document that will guide the sustainable development of the LGA.

Preparation of a new Comprehensive LEP is one of the core strategic projects a council can undertake. Given the importance of the Plan and its role in guiding the sustainable development of a new LGA, the community will have an important role in guiding the future direction of a new Comprehensive LEP.
A new LEP is required to be prepared in response to the State Government’s requirement for all NSW councils to prepare an LEP which conforms to the Standard Instrument (Local Environmental Plan) Order, 2006.

(b) LEP preparation process

Preparation of a new Comprehensive LEP is required to be undertaken in accordance with the Standard Instrument (Principle Local Environmental Plans) Order, 2006.

The DPE has introduced a process for the consideration of amendments to LEPs in 2009. The process for the consideration of an amendment to an LEP commences with a council’s consideration of a Planning Proposal. The Planning Proposal process is shown in Figure 1.
The role of a Planning Proposal is to explain the intended effects of a proposed LEP amendment or a Comprehensive LEP and the justification for undertaking preparation of the Plan or amendment. A council has the role of considering a Planning Proposal. If the council resolves to continue with the Planning Proposal, the draft Comprehensive LEP is required to be provided to the DPE to seek a Gateway Determination.

Figure 1. Planning Proposal Process
The Gateway Determination has the role of considering a Planning Proposal in its initial stages prior to further consideration by Council. After consideration by the Department, Council is provided with a Gateway Determination.

The Gateway Determination specifies that the Department will allow development of the Plan to proceed, any matters that require additional information, the level of public consultation required and state government agencies to be consulted. After all the additional matters have been addressed and the required consultation has been carried out, a report is provided to the council for further consideration.

Following consideration by the council, the Planning Proposal (or LEP amendment) is provided for finalisation and making to the Department and the Office of Parliamentary Counsel.

(c) The importance of land use strategies

Land use strategies are strategic plans prepared by councils in conjunction with the community which guide the future development of an LGA or specific lands within an LGA. Land use strategies form the foundation of the NSW Planning System and provide the community with the opportunity to shape the future development and the conservation of lands.

Figure 2 shows the role of land use strategies in the NSW Planning System.
Land use strategies form the basis of the NSW Planning System. LEPs have the role of articulating the future desired character of an area into guiding principles and controls. Part of this guidance may be through the zoning of land or other controls.

The role of a Development Control Plan (DCP) is to further articulate the community’s vision into guidance on built form and character. This may include such items as building setbacks and heights, open space and parkland requirements and construction standards for public infrastructure.

Land use strategies are prepared to guide development over a significant time period, which may be in excess of 20 years. This allows a strategy to provide a specific vision that council and the community can actively work toward throughout this period. Strategies are required to include a sufficient level of information, which allows the community to consider and understand the following:

- The extent of lands and development types included in a specific strategy;
- The relationship of these considerations with their local neighbourhoods;
- The need for the future development and/or conservation of lands through a robust evidence base. This may include guidance from government, demographic trends or other evidence;
- Overall constraints, including environment and other constraints;
- The likely future character the strategy will facilitate at both a local and possibly a Local Government Area scale; and
- The overall vision or guiding principles the strategy is seeking to implement.

The relative success of a land use strategy depends specifically on its implementation and acceptance by the wider community and the development industry.

2. Strategic Context

Preparation of a new Comprehensive LEP ordinarily requires sound land use strategies to be in place to ensure the community’s vision can be delivered through planning controls and associated guidance, which is included in an LEP.

The following provides information detailing the strategic context and any applicable land use strategies for the former Dubbo City and Wellington LGAs:

(b) Former Dubbo Local Government Area

(i) Dubbo Rural Areas Development Strategy

The Dubbo Rural Areas Development Strategy forms the basis for the rural land use zonings and planning controls provided in the Dubbo LEP.

The overall Strategy consists of a number of subsidiary Strategies, which are based on the location of specific precincts within the former Dubbo City LGA, as listed below:
• Benelong District Strategy;
• Coolbaggie District Strategy;
• Goonoo District Strategy;
• Macquarie District Strategy;
• Minore District Strategy;
• Southern District Strategy; and
• Talbragar District Strategy.

Each subsidiary Strategy provides development objectives in the following key areas:

• Agriculture – A more secure future for agriculture in Dubbo and expansion of its economic value;
• Transport – Safe and efficient transport links between Dubbo and other major centres, with a capacity for future expansion;
• Tourism – Expand Dubbo’s rural-based tourism industry;
• Recreation – Use the recreational potential of the rural area;
• Settlement – Direct rural settlement pressures into the rural villages and selected areas of existing fragmentation; and
• Villages – Protect village communities as effective alternatives to urban living.

The Strategy was subject to an initial review in 2003 by the former Dubbo City Council. The Strategy was also reviewed again in 2011 with preparation of the Dubbo LEP and in 2016 by Council as part of an Operational Review of the LEP.

(ii) Dubbo Urban Areas Development Strategy

The Dubbo Urban Areas Development Strategy was first adopted by the former Dubbo City Council in 1996 and was endorsed by the NSW DPE in 2011. The Strategy forms the basis for the land use zonings and planning controls provided in the Dubbo LEP.

The Strategy includes a number of subsidiary strategies and documents, as provided below:

• Residential Areas Development Strategy;
• Commercial Areas Development Strategy;
• Industrial Areas Development Strategy;
• Institutional Areas Development Strategy;
• Recreational Areas Development Strategy; and
• Future Directions and Structure Plan.

The Strategy was subject to review by the former Dubbo City Council in 2007. The Strategy was reviewed again in 2011 with preparation of the Dubbo LEP and in 2016 by Council as part of an Operational Review of the LEP.
A core aim of the Urban Areas Development Strategy is to ensure the Dubbo Central Business District (CBD) is at the centroid of Dubbo. To ensure this core aim is achieved, the Strategy facilitates the future development of approximately 7,000 residential allotments in north-west and south-west Dubbo over time. In addition, the Strategy only allows for limited residential development opportunities in south-east Dubbo.

In respect of the Commercial Areas Development Strategy, this Strategy provides a robust commercial hierarchy for Dubbo, which has the Dubbo CBD as a commercial area with regional importance that recognises its role as a service centre to Dubbo, the Orana Region and western NSW.

(a) Former Wellington Local Government Area

A number of land use strategies and background papers have been prepared over time to guide development of the former Wellington LGA. However, it is currently understood that there are no formal Council-adopted land use strategies in place.

The following provides an understanding of the strategic work that has been undertaken by the former Wellington Council.

(i) Draft Wellington Settlement Strategy

A draft Settlement Strategy was prepared for the former Wellington LGA in 2012 to specifically examine the strategic direction and future land use requirements for the following key settlements:

- Wellington;
- Geurie;
- Mumbil;
- Stuart Town; and
- Euchareena.

The draft Settlement Strategy was prepared to develop strategies to address the future growth and development of each settlement over a 20 year period and to articulate the vision of each community into future growth principles. However, the Strategy was not ultimately adopted by the former Wellington Council.

It is understood that consultation in respect of the draft Strategy was previously undertaken with the former Wellington Council however, consultation with the respective communities was not undertaken.
(ii) Draft Wellington Rural Land use Study

The former Wellington Council engaged agribusiness and environmental consultants, Booth Associates, to prepare a Rural Land Use Study specifically in respect of land zoned RU1 Primary Production and RU4 Primary Production Small Lots in October 2012. The Department of Planning and Environment provided funding to undertake preparation of the Study.

It is understood that a number of workshops were held with the community in late 2012 and early 2013. The purpose of the workshops was to raise awareness of the preparation of the Study and seek feedback from key stakeholders including farmers, real estate agents and councillors. The workshops enabled a discussion of farming systems and practices, local planning impacts on farming, and other impacts on primary production such as mining and wind farms.

The Study found that for rural land in the former Wellington LGA, the following minimum areas were required to sustain a single family unit:

- 625 ha for a mixed farm;
- 1,150 ha for a livestock farm with improved pastures; and
- 2,225 ha for a livestock farm with native pastures.

It is understood however, that the former Council sought a reduction in the minimum lot size for land zoned RU1 Primary Production from 400 hectares to 250 hectares.

The draft Study was submitted to the NSW DPE for consideration on 7 November 2013. The DPE on 10 January 2014 provided information that the proposed reduction in the minimum allotment size for the subdivision of land zoned RU1 Primary Production from 400 ha to 250 ha was not justified on economic, environmental, social or agricultural production grounds and that further strategic work would be required to adequately justify any such reduction in the minimum allotment size for subdivision.

The draft Study was not finalised.

(iii) Draft Wellington Rural Residential Land Study

Concurrently with preparation of the draft Wellington Rural Land Use Study, consultants Booth Associates also prepared the draft Wellington Rural Residential Land Study.

The purpose of this Study was to examine opportunities for rural residential development across a number of lands in the former Wellington LGA. This included an examination of lands around Wellington, Geurie and Stuart Town.
A Planning Proposal to provide additional land zoned R5 Large Lot Residential was gazetted by the Minister for Planning on 12 August 2016. This Planning Proposal zoned limited lands at Wellington, Geurie and Stuart Town R5 Large Lot Residential to allow for the development of a dwelling house on land that was previously zoned RU1 Primary Production under the provisions of the Wellington LEP.

3. Program for new Comprehensive Local Environmental Plan

Preparation of a new Comprehensive LEP for the LGA is a significant strategic planning project that is required to be undertaken in accordance with the requirements of the NSW DPE and the Department of Premier and Cabinet, following the creation of the new LGA.

Ultimately, the preparation process for a new Comprehensive LEP can take some years to progress through to fruition given the number of steps involved in the process, the processes and controls contained in legislation and the expectations of the community.

To ensure the process for the preparation of the new Comprehensive LEP can proceed, whilst ensuring Council continues to meet the expectations of the community and the development industry in the achievement of a new Comprehensive LEP, it is proposed to develop the new LEP in three key stages, as provided in Figure 3.

![Figure 3. Comprehensive LEP three stage program](image)

The three key stages are further discussed below.

Stage 1: Operational Review of the Dubbo and Wellington LEPs

Council has undertaken an operational review of both the Wellington and Dubbo LEPs. The objectives in undertaking the operational review of each LEP were to amend/address any administrative issues, errors or omissions and to provide a level of parity between the provisions of both LEPs.

Following the conclusion of the operational reviews, separate Planning Proposals were prepared by Council to undertake amendments to both LEPs.
Dubbo Local Environmental Plan 2011

The Planning Proposal in respect of the Dubbo LEP included the following proposed changes as administrative and/or other minor amendments:

- Permissible land use activities;
- Subdivision controls;
- Clause 5.4 Controls relating to permissible uses;
- Part 7 Local provisions;
- Schedule 5 Environmental heritage;
- Minor amendments to land use zoning; and
- Minor amendments to biodiversity mapping.

Council at its meeting on 26 April 2017 considered a report in respect of the Operational Review and resolved as follows:

“1. That Council support the proposed amendments contained in the Operational Review of the Dubbo Local Environmental Plan 2011.
2. That Council support a minimum 28 day public exhibition period for the Planning Proposal.
3. That Council resolve to not use its delegation under Section 59 of the Environmental Planning and Assessment Act, 1979 to draft the amendments to the Dubbo Local Environmental Plan 2011.
4. That following the completion of the public exhibition period, a further report be provided to Council detailing the results of the public exhibition and for further consideration of the Planning Proposal.
5. That a further report be provided to Council for consideration that includes a suite of proposed measures Council could consider to guide the provision of dual occupancy development across the Dubbo Regional Local Government Area.”

Public exhibition of the subject Planning Proposal recently concluded on 24 November 2017. A further report will be provided to Council at its February 2018 meetings detailing the results of the public exhibition.

Wellington Local Environmental Plan 2012

The Planning Proposal in respect of the Wellington LEP included the following proposed changes as administrative and/or other minor amendments:

- Permissible land use activities;
- Subdivision controls;
- Clause 5.4 Controls relating to permissible uses;
- Part 6 Local provisions;
- Schedule 5 Environmental heritage; and
- Minor amendments to land use zoning.
Council at its meeting on 26 April 2017 considered a report in respect of the Operational Review of the Wellington LEP and resolved as follows:

“1. That Council support the proposed amendments contained in the Operational Review of the Wellington Local Environmental Plan 2012.
2. That Council support a minimum 28 day public exhibition period for the Planning Proposal.
3. That Council resolve to not use its delegation under Section 59 of the Environmental Planning and Assessment Act, 1979 to draft the amendments to the Wellington Local Environmental Plan 2012.
4. That following the completion of the public exhibition period, a further report be provided to Council detailing the results of the public exhibition and for further consideration of the Planning Proposal.”

Council has received a Gateway Determination from the DPE. The conditions of the Determination are currently being met prior to the Planning Proposal being placed on public exhibition.

Following completion of the public exhibition process, a further report will be provided to Council for consideration.

Stage 2: Preparation of a new combined Local Environmental Plan

Preparatory works have now commenced towards the preparation of a new combined LEP. This process effectively includes combining both LEPs into one document, inclusive of all provisions that are applicable in both former local government areas.

Preparation of the combined LEP will not result in any changes to land use zones or specific provisions unless the change is considered to be an administrative error or omission. Any change proposed to be undertaken, which would ordinarily require a land use strategy to be in place or are outside of a Council adopted land use strategy, are not considered appropriate for inclusion in this LEP.

It should be noted however, that during this preparation process for the new combined LEP, proponents seeking rezoning and/or alteration of specific provisions of either the Dubbo or Wellington LEPs, will have the opportunity to lodge a site-specific Planning Proposal with Council for consideration.

A further report, including the draft Planning Proposal and draft new, combined LEP, will be presented to Council for consideration at the March 2018 meetings. The purpose of that report will be to seek Council’s consideration of the draft Planning Proposal and combined LEP prior to seeking a Gateway Determination from the DPE, which would ultimately allow Council to proceed with the Planning Proposal process for the new, Comprehensive LEP.
Stage 3: Preparation of land use strategies

Following preparation of the new Comprehensive LEP, staff will commence the development of a number of land use strategies for the former Wellington LGA and undertake a review of current Strategies that are applicable to the former Dubbo LGA.

The following land use strategies are proposed to be prepared for land within the former Wellington LGA:

- Rural Areas Development Strategy;
- Wellington Town Strategy; and
- Villages Strategy.

A further report, including project planning for the preparation of land use strategies for the former Wellington LGA and a review of land use strategies for the former Dubbo LGA will be provided to Council for consideration in April 2018.

SUMMARY

Preparation of a new Comprehensive LEP is a significant strategic planning project. Given the significance of the project and the importance to the continued development of the new LGA, it is proposed to undertake development of the new Plan across a number of stages. These include the following:

1. Operational review of the Dubbo Local Environmental Plan 2011 and the Wellington Local Environmental Plan 2012 (currently underway);
2. Preparation of a new Comprehensive Local Environmental Plan as a compilation of the two current LEPs; and
3. Preparation of land use strategies for the former Wellington Local Government Area and a review of existing land use strategies in respect of the former Dubbo Local Government Area.

This report recommends that Council adopt a three stage program for preparation of a new Comprehensive LEP and that a further report be provided to Council in March 2018, including a Planning Proposal and draft Comprehensive LEP for the new LGA in accordance with stage 2 of the program.
EXECUTIVE SUMMARY

A Planning Proposal was lodged with Council on 23 September 2016 by Doherty Smith and Associates, seeking to amend the Dubbo Local Environmental Plan 2011 (Dubbo LEP). The Planning Proposal affects Lot 8 DP 1063425, 4L Camp Road, Dubbo.

The Planning Proposal seeks to rezone the subject land from SP3 Tourist to part RU2 Rural Landscape and part E3 Environmental Management under the provisions of the Dubbo LEP. The Planning Proposal also seeks to provide a minimum allotment size for subdivision of two hectares for the area proposed to be zoned RU2 Rural Landscape and 100 hectares for the area of the land proposed to be zoned E3 Environmental Management.

The original Planning Proposal was lodged with Council on 23 September 2016 (Appendix 1). Following Council’s initial assessment of the proposal, an amended Planning Proposal was provided by the proponent on 15 May 2017 (Appendix 2). The amended Proposal included further information in respect of acoustic impacts and flora and fauna impacts. The proponent again submitted further information on 23 November 2017 which includes an amended zoning regime for the land (Appendix 3).

Assessment of the Planning Proposal, including the rezoning part of the subject land to RU2 Rural Landscape, has shown that this area of the land should be zoned RU6 Transition. Rezoning to RU6 Transition would allow for the development of tourist facilities, whilst permitting a dwelling house on each allotment of land as part of the subdivision. The Dubbo LEP does not currently include this zone. The Planning Proposal will also result in this zone being included in the LEP.

Biodiversity is a key consideration of the Planning Proposal. Following receipt of a Gateway Determination from the NSW Department of Planning and Environment (NSW DPE) the proponent will be required to undertake further consideration of flora and fauna impacts associated with future development of the land and, in particular, the area of the site proposed to be zoned E3 Environmental Management.
The Planning Proposal will facilitate future subdivision and development of the land, including the potential for the development of a dwelling house on each allotment.

It is recommended that the Planning Proposal be submitted to the NSW DPE to seek a Gateway Determination.

ORGANISATIONAL VALUES

Customer Focused: Council officers have worked with the applicant to address issues with the Planning Proposal in its early stages prior to its consideration by Council and submission to the NSW DPE.

Integrity: The Planning Proposal has been assessed against the requirements of the Environmental Planning and Assessment Act, 1979 and the NSW DPE’s document, A Guide to Preparing Planning Proposals.

One Team: Council staff have been involved in the assessment of the Planning Proposal in accordance with relevant legislation and Dubbo Regional Council policy.

FINANCIAL IMPLICATIONS

The proponent provided on lodgement of the Planning Proposal, payment of fees to Council in the amount of $25,000. These fees are to cover the ad hoc processing and assessment fees for the Planning Proposal application in accordance with Council’s adopted Revenue Policy.

POLICY IMPLICATIONS

The Planning Proposal is provided for consideration and endorsement to seek Gateway Determination from the NSW DPE. Receipt of a Gateway Determination from the Department will allow Council to, conditionally, undertake an amendment to the Dubbo LEP.
RECOMMENDATION

1. That Council endorse the amended Planning Proposal included as Appendix 2 and the further information included as Appendix 3 to the report of the Manager Strategic Planning Services dated 5 December 2017 for the following amendments to the Dubbo Local Environmental Plan 2011:
   - That the RU6 Transition zone be inserted into the Dubbo Local Environmental Plan 2011, including the Land Use Table as included in this report;
   - That part of Lot 8 DP 1063425, 4L Camp Road, Dubbo be rezoned from SP3 Tourist to RU6 Transition;
   - That part of Lot 8 DP 1063425, 4L Camp Road, Dubbo be rezoned from SP3 Tourist to E3 Environmental Management;
   - That part of Lot 8 DP 1063425, 4L Camp Road, proposed to be zoned RU6 Transition be provided with a minimum allotment size for subdivision of two (2) hectares; and
   - That part of Lot 8 DP 1063425, 4L Camp Road, Dubbo proposed to be zoned E3 Environmental Management be provided with a minimum allotment size for subdivision of 100 hectares.

2. That Council support a minimum 28 day public exhibition period for the Planning Proposal.

3. That Council not use its delegation under Section 59 of the Environmental Planning and Assessment Act, 1979 to draft the amendment to the Dubbo Local Environmental Plan 2011 as the State Government may issue a conditional Gateway Determination in respect of the Planning Proposal.

4. That following the completion of the public exhibition period, a further report be provided to Council detailing the results of the public exhibition and for further consideration of the Planning Proposal.

Steven Jennings
Manager Strategic Planning Services
BACKGROUND

The Planning Proposal was lodged on 23 September 2016 by consultants, Doherty Smith and Associates on behalf of the land owner, Mrs L K Bender. The Planning Proposal seeks to rezone the subject land from SP3 Tourist to part RU2 Rural Landscape and part E3 Environmental Management. The Planning Proposal also seeks to provide a minimum lot size for subdivision of land zoned RU2 rural Landscape of two (2) hectares and 100 hectares for land zoned E3 Environmental Management.

The intent of the Planning Proposal is to facilitate the future development of the subject land to permit a dwelling house on each allotment. In addition, the intent of the proposal is to allow for small scale tourist activities on the land, cognisant with the zoning of the Camp Road tourist precinct.

REPORT

1. Particulars of the Planning Proposal Application

Owner: Mrs L K Bender
Applicant: Doherty Smith and Associates
Subject land: Lot 8 DP 1063425, 4L Camp Road, Dubbo
Land area: Approximately 131 hectares
Current zoning: SP3 Tourist
Proposed LEP amendment: The rezoning of approximately 86 hectares of the subject land from SP3 Tourist to RU6 and the rezoning of approximately 45 hectares to E3 Environmental Management. The proposed amendment will create provision for a minimum allotment size for subdivision of land zoned RU2 Rural Landscape of two (2) hectares and 100 hectares for land zoned E3 Environmental Management
Lodgement date: 23 September 2016

2. Amendments to Local Environmental Plans

The NSW Department of Planning and Environment (NSW DPE) introduced a process for the consideration of amendments to local environmental plans in 2009. The process for the consideration of an amendment to a Local Environmental Plan commences with Council’s consideration of a Planning Proposal. The Planning Proposal process is shown in Figure 1.
PLANNING PROPOSAL PROCESS

Amendment proposed to the Dubbo Local Environmental Plan 2011

Council initially considers the proposal

Planning Proposal prepared and submitted to the NSW Government Planning and Environment

NSW Government Planning and Environment issues a Gateway Determination (allows Council to place the proposal on public display)

Planning Proposal placed on public display

Council consideration of the Planning Proposal involving all public submissions

Council resolves not to support the Planning Proposal

Notification is provided to NSW Government Planning and Environment

No further action to be taken

Council resolves to support the Planning Proposal

Legal drafting and consideration by State Government Planning and Environment (office of Parliamentary Counsel)

Plan provided for Notification (making into legislation) to State Government Planning and Environment

Amendment made into law

Figure 1. Planning Proposal process
The role of a Planning Proposal is to explain the intended effects of a proposed Local Environmental Plan amendment and the justification for undertaking the amendment. Council has the role of considering a Planning Proposal. If Council resolves to continue with the Planning Proposal, the amendment is provided to the NSW DPE to seek a Gateway Determination.

The Gateway Determination reviews and considers planning proposals in their initial stages prior to further consideration by Council. After consideration by the Department, Council is provided with a Gateway Determination for the LEP amendment.

The Gateway Determination specifies that the Department will allow the proposed amendment to proceed, any matters that require additional information, the level of public consultation required and state government agencies to be consulted. After all matters have been addressed and the required consultation has been carried out, a report is provided to Council for further consideration.

Following Council’s consideration, the Planning Proposal will be provided to the NSW DPE for finalisation of the LEP amendment.

3. Planning Proposal

The Planning Proposal has sought to rezone Lot 8 DP 1063425, 4L Camp Road, Dubbo from SP3 Tourist to part RU2 Rural Landscape and part E3 Environmental Management. The proposal also seeks to provide a minimum allotment size for subdivision of land zoned RU2 Rural Landscape of two (2) hectares and 100 hectares for land zoned E3 Environmental Management.

The original Planning Proposal was lodged with Council on 23 September 2016 (Appendix 1). The proponent lodged an amended Planning Proposal on 15 May 2017 (Appendix 2). The proponent subsequently submitted further information for the Proposal on 23 November 2017 (Appendix 3).

The proponent’s final amended Planning Proposal shows an indicative lot layout, which has extended further to the west to avoid acoustic impacts associated with the Morris Park Motor Sports Complex. This amended layout shows that a possible future development of the land could provide in the order of 28 allotments, subject to development consent from Council. Issues in respect of acoustic impacts associated with the Morris Park Motor Sports Complex are further discussed in this report.

The current land use zoning regime on the subject land is shown in Figure 2. The proposed land use zoning regime as provided by the proponent is shown in Figure 3.
Figure 2: Current Land Use Zoning Regime, Dubbo Local Environmental Plan 2011

Figure 3: The proponent’s proposed land use zoning regime
The proponent, as a component of the Planning Proposal, is also seeking to provide minimum allotment sizes for subdivision of the land. Under the provisions of the Dubbo LEP, the land does not currently have a minimum allotment size for subdivision. In respect of the area of the land proposed to be zoned RU2 Rural Landscape, the proponent is seeking to provide a minimum allotment size for subdivision of two hectares. In respect of the area proposed to be zoned E3 Environmental Management, the proponent is seeking to provide a minimum allotment size for subdivision of 100 hectares. This issue is further discussed in this report.

The proposed minimum allotment sizes for subdivision are shown in Figure 4.

![Figure 4: Proposed minimum lot sizes for subdivision, Dubbo Local Environmental Plan 2011](image)

An assessment of the overall suitability of the proposed RU2 Rural Landscape zone in this location has been undertaken as part of the Planning Proposal process. As the Dubbo LEP zones other lands RU2 Rural Landscape, which have different characteristics to the subject land, it is considered that this area of the land be zoned RU6 Transition. Issues in respect of the proposed RU6 Transition zone are further discussed in the Dubbo LEP section of this report.
4. Site Characteristics

The land the subject of the Planning Proposal is Lot 8 DP 1063425, 4L Camp Road, Dubbo. The land contains one (1) existing dwelling house which facilitates management of the existing extensive agricultural land use activities on the land.

The north-western section of the subject land contains scattered trees across an undulating landscape. The land contains a well-vegetated ridge, which effectively separates the site from the Morris Park Motor Sports Complex further to the east. The land also contains a drainage line, which traverses from south to north and is consistent with the general slope of the land.

The site is bound by Camp Road to the north and Belowrie Road to the south. The surrounding land is zoned SP3 Tourist to the north, east and north-west of the site and RU1 Primary Production to the south and south-west. Land situated on the northern side of Camp Road forms part of the overall land holding of the Taronga Western Plains Zoo.

The subject land is the largest individual land parcel within the Camp Road tourist precinct. The location of the land is shown in Figure 5.

5. Planning Considerations

This section of the report provides an analysis against the planning considerations required in the Planning Proposal process. The information below does not provide an analysis of all planning considerations associated with the Planning Proposal.

The purpose of this section is to explain any significant matters for consideration in the Planning Proposal process.
(i) Dubbo Urban Areas Development Strategy

The Dubbo Urban Areas Development Strategy (including the Dubbo Commercial Areas Development Strategy) was first adopted by the former Dubbo City Council in 1996 and was endorsed by the NSW DPE in 2011. The Strategy forms the basis for land use zonings and planning controls provided in the Dubbo LEP.

Dubbo Commercial Areas Development Strategy

Development of the Camp Road tourist precinct is included as a component of the Dubbo Commercial Areas Development Strategy. The following details the function and principles of the precinct:

“Camp Road Precinct
Action Plan for the Camp Road Precinct
Description

The Camp Road precinct south of Dubbo includes the land east of the Newell Highway to the river and down to properties fronting Camp Road. This area has been managed as rural but is now proposed to be incorporated into an extended urban LEP. As such its foremost role be to ensure the rural areas to the immediate south remain buffered from the impacts of urban encroachment.

However, when considering what land uses would be most compatible with this objective it became evident that this area, which includes the Western Plains Zoo – a major tourism investment that is arguably the most significant single attraction in Rural NSW – was not comparable with any part of the City. The current land use pattern is unique as it is dominated by tourist developments, it is in a crucial location close to the city, adjoins important transport routes and it is elevated and still partially vegetated.

These features identify the Camp Road – Zoo – Macquarie River locale as a distinct, separate precinct which already has unique tourism assets and potential for further tourism development.

The role of the Camp Road precinct is to provide a suitable environment for tourist attractions that are compatible with the Zoo and opportunities for a concentration of activities for visitors willing to extend their stay.

The objectives of the precinct are as follows:

- Capture the opportunity for Camp Road to become a focus for synergistic low density tourism development;
- Recognise, protect and enhance the distinctive character of the Camp Road precinct;
- Ensure the Camp Road precinct is developed in an environmentally sustainable manner;
Council has received numerous representations from land owners in the Camp Road precinct over time, including during the initial preparation of the Dubbo LEP. These representations have centered on the fact that the Dubbo LEP does not currently allow the development of a dwelling house on land zoned SP3 Tourist. This includes land within the Camp Road precinct. The proponent, in providing the subject Planning Proposal to Council, has sought to justify, through an examination of site constraints, location and external factors, that the controls as contained in the Dubbo LEP for this land should be altered accordingly to allow subdivision and the development of a dwelling house on each allotment.

It is considered that the Planning Proposal put forward has strategic merit in respect of compliance with the Dubbo Commercial Areas Development Strategy when considered in the context of the current controls as contained in the Dubbo LEP and former controls applying to the land. The Dubbo LEP does not currently provide a minimum allotment size for subdivision of the land. This flexibility was provided in the LEP to allow the proponents of tourism related development to adequately justify to Council the need for subdivision and the likely size of resultant allotments. The former controls applying to the land as contained in the Dubbo Local Environmental Plan 1998 – Urban Areas allowed for the development of a dwelling house ancillary to another permissible use on the land. This could include such uses as a bed and breakfast, etc.

It is considered Through these iterations of planning controls applying to the Camp Road precinct, the tourism market has not made particular use of the opportunities afforded by being within close proximity to the Taronga Western Plains Zoo and the Morris Park Motor Sports Complex.

It is considered that the introduction of a minimum allotment size for subdivision and the provision of a dwelling house on resultant allotments is unlikely to provide any significant effect to the realisation of tourism development in the precinct given the location of the land.

It is considered that the Planning Proposal is broadly consistent with the objectives of the Camp Road precinct and the direction of the Dubbo Commercial Areas Development Strategy.

(ii) Section 117 Directions

A number of Section 117 Directions are applicable to the Planning Proposal, as described in Table 1.
<table>
<thead>
<tr>
<th>Direction</th>
<th>Requirement</th>
<th>Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2 Rural zones</td>
<td>This Direction applies to the Planning Proposal as the Proposal will affect land within an existing or proposed rural zone which includes the alteration of an existing rural zone boundary.</td>
<td>The Planning Proposal is considered to be consistent with the Direction. The Proposal intends to rezone land from SP3 Tourist to RU6 Transition and E3 Environmental Management to ensure a buffer is maintained to protect the adjoining rural land.</td>
</tr>
<tr>
<td>1.5 Rural lands</td>
<td>The Direction applies to a Planning Proposal that will affect land within an existing or proposed rural zone or changes the existing minimum lot size on the land within a rural zone.</td>
<td>The Planning Proposal is considered to be consistent with the Direction. The proposal intends to rezone the land from SP3 Tourist to RU6 Transition and E3 Environmental Management to ensure a buffer is maintained to protect the adjoining rural land. In addition, it is considered that the Planning Proposal is consistent with the Rural Planning Principles as contained in State Environmental Planning Policy (Rural Lands), 2008.</td>
</tr>
<tr>
<td>2.1 Environmental protection zones</td>
<td>The Direction applies to a Planning Proposal that will affect land mapped on the Natural Resource Biodiversity Map.</td>
<td>The Planning Proposal is inconsistent with the Direction. The inconsistency is considered to be of minor significance as the portion of the land containing dense vegetation is proposed to be zoned as E3 Environmental Management.</td>
</tr>
<tr>
<td>2.3 Heritage conservation</td>
<td>The Direction applies to a Planning Proposal that may impact indigenous or European heritage.</td>
<td>The Planning Proposal is inconsistent with the Direction. The inconsistency is considered to be of minor significance as future</td>
</tr>
<tr>
<td>Direction</td>
<td>Requirement</td>
<td>Consistency</td>
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<tr>
<td>---------------------------------------</td>
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<tr>
<td>development may occur on the subject land without significantly impacting known Aboriginal heritage sites.</td>
<td></td>
<td></td>
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<tr>
<td>It is also acknowledged that Council will consult with the Office of Environment and Heritage as a component of the Planning Proposal process.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3 Home occupations</td>
<td>The Direction is applicable when any Planning Proposal is prepared.</td>
<td>The Planning Proposal is considered to be consistent with the Direction.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The Planning Proposal will create provision for future dwelling houses on the subject land which will provide opportunities for home occupations.</td>
</tr>
<tr>
<td>3.4 Integrated land use and transport</td>
<td>The Direction applies to the Planning Proposal as it seeks to rezone the subject area from SP3 tourist to RU6 Transition and E3 Environmental Management. The Proposal will create provision for the future subdivision of the land subject to development consent.</td>
<td>The Planning Proposal is inconsistent with the Direction. The inconsistency is considered to be of minor significance as the subject land is serviced by adequate road infrastructure via Camp Road and is within close proximity to the Newell Highway.</td>
</tr>
<tr>
<td>4.4 Planning for bushfire protection</td>
<td>The Direction is applicable to the Planning Proposal as a large portion of the subject land is classified as Category 1 Bushfire Prone Land.</td>
<td>It is considered that the Planning Proposal is consistent with the Direction. However, Council will be required to consult with the NSW Rural Fire Service as a component of the Planning Proposal process.</td>
</tr>
<tr>
<td>5.10 Implementation of Regional Plans</td>
<td>The Direction is applicable when a Planning Proposal is prepared.</td>
<td>The Planning Proposal is considered to be consistent.</td>
</tr>
</tbody>
</table>
Direction | Requirement | Consistency
--- | --- | ---
| | prepared. | with the Central West and Orana Regional Plan. |
| 6.1 Approval and referral requirements | The Direction is applicable when a Planning Proposal is prepared. | The Planning Proposal does not require concurrence and is considered to be consistent with the Direction. |

(iii) **State Environmental Planning Policies**

A number of State Environmental Planning Policies (SEPPs) apply to the Planning Proposal. It is considered that the Planning Proposal is consistent with the following SEPPs:

- SEPP No 55 – Remediation of Land;
- SEPP (Exempt and Complying Development Codes), 2008;
- SEPP (Infrastructure), 2007;
- SEPP (Building Sustainability Index: Basix), 2004; and
- SEPP (Rural Lands), 2008.

**State Environmental Planning Policy No 55 – Remediation of Land**

The proponent provided a preliminary contamination investigation with the Planning Proposal. The role of the preliminary contamination investigation was to assess the suitability of the site for development having regard to the agricultural activities carried out on the land over time and any other activities.

The investigation concluded that the land was suitable for development however, the proponent will be required to undertake further consideration of issues in respect of contamination at the development application stage for subdivision and resultant development of the land.

**State Environmental Planning Policy (Rural Lands), 2008**

The SEPP aims to guide the sustainable use of rural lands through the provision of specific rural planning principles. The SEPP requires a Planning Proposal to be consistent with the following rural planning principles:

- The promotion and protection of opportunities for current and potential productive and sustainable economic activities in rural areas;
- Recognition of the importance of rural lands and agriculture and the changing nature of agriculture and of trends, demands and issues in agriculture in the area, region or state;
- Recognition of the significance of rural land uses to the state and rural communities, including the social and economic benefits of rural land use and development;
- In planning for rural lands, to balance the social, economic and environmental interests of the community;
• The identification and protection of natural resources having regard to maintaining biodiversity, the protection of native vegetation, the importance of water resources and avoiding constrained land;
• The provision of opportunities for rural lifestyle, settlement and housing that contribute to the social and economic welfare of rural communities;
• The consideration of impacts on services and infrastructure and appropriate location when providing for rural housing; and
• Ensuring consistency with any applicable regional strategy of the NSW DPE or any applicable local strategy endorsed by the Director-General.

The Planning Proposal is considered to be consistent with the rural planning principles. The intent of the Planning Proposal is to rezone the subject land from SP3 Tourist to RU6 Transition and E3 Environmental Management to create provision for future subdivision and the resultant development of a dwelling and/or tourist development.

It is considered that the RU6 Transition zone will ensure rural activities south of the subject land are protected from development.

(iv) Central West and Orana Regional Plan 2036

The Central West and Orana Regional Plan 2036 was released by the Minister for Planning on 14 June 2017. The goals of the Central West and Orana Regional Plan are as follows:

“Goal 1: The most diverse regional economy in NSW;
Goal 2: A stronger, healthier environment and diverse heritage;
Goal 3: Quality freight, transport and infrastructure networks; and
Goal 4: Dynamic, vibrant and healthy communities.”

It is considered that the Planning Proposal is broadly consistent with the Central West and Orana Regional Plan 2036.

(v) Dubbo Local Environmental Plan 2011

The subject land comprises of approximately 131.9 hectares and is currently zoned SP3 Tourist. The land is not subject to a minimum allotment size for subdivision.

The Planning Proposal is seeking to facilitate future subdivision of part of the land, which was proposed to be zoned RU2 Rural Landscape into lots, two hectares and larger. However, on balance, and given that other lands in Dubbo are zoned RU2 Rural Landscape which have different and distinct characteristics, it is considered appropriate for this section of the land to be zoned RU6 Transition.

Zoning this section of the land RU6 Transition would provide further certainty for the future of the Camp Road area, whilst allowing the same uses as the SP3 Tourist zone and the development of dwelling houses, subject to development consent from Council.
The draft RU6 Transition zone land use table is provided below. The land use table details the following:

- Objectives of the zone (the text shown in red is mandated by the Standard Instrument (Local Environmental Plans) Order, 2006;
- Permitted without consent (these are development activities that can be undertaken without the need for development consent from Council);
- Permitted with consent (these are development activities that can be undertaken only with development consent from Council); and
- Prohibited (development that cannot be undertaken in the zone).

“Zone RU6 Transition

1. **Objectives of zone**

- To protect and maintain land that provides a transition between rural and other land uses of varying intensities or environmental sensitivities.
- To minimise conflict between land uses within this zone and land uses within adjoining zones.
- To provide for a variety of tourist-oriented development and related uses.
- To recognise the importance of the Taronga Western Plains Zoo as a key tourist facility with the area of the City of Dubbo.
- To ensure that development in the Camp Road precinct will not interfere with the continued operation of the Taronga Western Plains Zoo.

2. **Permitted without consent**

   Environmental protection works; Extensive agriculture; Home occupations; Roads

3. **Permitted with consent**

   Aquaculture; Cellar door premises; Correctional centre; Dwelling houses; Educational establishments; Food and drink premises; Farm buildings; Group homes; Health consulting rooms; Home-based child care; Home business; Home industries; Markets; Medical centres; Plant nurseries; Roadside stalls; Secondary dwellings; Shop top housing; Tourist and visitor accommodation; Viticulture; Waste or resource transfer stations; Water reticulation systems; Any other development not specified in item 2 or 4.

4. **Prohibited**

   Advertising structures; Agriculture; Air transport facilities; Boat building and repair facilities; Car parks; Cemeteries; Commercial premises; Correctional centres; Crematoria; Depots; Educational establishments; Electricity generating works; Exhibition homes; Exhibition villages; Flood mitigation works; Freight transport facilities; Health services facilities; Heavy industrial storage premises; Home (and other developments that are prohibited by the Standard Instrument (Local Environmental Plans) Order, 2006).
occupations (sex services): Industrial retail outlets; Industrial training facilities; Industries; Marinas; Mortuaries; Public administration buildings; Residential accommodation; Restricted premises; Rural industries; Sex services premises; Storage premises; Transport depots; Truck depots; Vehicle body repair workshops; Vehicle repair stations; Warehouse or distribution centres; Waste or resource management facilities; Wholesale supplies.”

The balance of the land, which is proposed to be zoned E3 Environmental Management and is proposed to be provided with a minimum allotment size for subdivision of 100 hectares, will contain the majority of remnant vegetation on the land. The proponent has provided information that management regimes for this land will be further considered as a component of the development assessment process. However, one such possible management regime could be facilitated through a Community Title subdivision of the land which could manage this area as Association Property.

(vii) Bushfire Prone Land

Part of the subject land is mapped as Category 1 Bushfire Prone Land, which is located in the area of the land including the vegetated ridge. The majority of this land is proposed to be zoned E3 Environmental Management to prevent provision for future residential development. The NSW Rural Fire Service’s document, Planning for Bushfire Protection, 2006 requires that any LEP amendment which changes the zoning and/or land use of bushfire prone land address the following:

“Planning Principles for Rezoning to Residential Land in Bush Fire Prone Areas
(a) Provision of a perimeter road with two way access which delineates the extent of the intended development;
(b) Provisions, at the urban bushland interface, for the establishment of adequate asset protection zones for future housing;
(c) Specifying minimum residential lot depths to accommodate asset protection zone for lots on perimeter roads;
(d) Minimising the perimeter of land, interfacing the hazard, which may be developed;
(e) Introduction of controls which avoid placing inappropriate developments in hazardous areas; and
(f) Introduction of controls on the placement of combustible materials in asset protection zones.”

It is considered that the Planning Proposal is broadly consistent with the planning principles for Rezoning Land in Bush Fire Prone Areas under the NSW Rural Fire Service’s document, Planning for Bushfire Protection, 2006. However, Council will be required to consult with the NSW Rural Fire Service as a component of the Planning Proposal process.
(viii) Site Access and Traffic

Council’s Infrastructure and Operations officers have undertaken assessment of the Planning Proposal. Vehicle access to the subject site is from the north via Camp Road. Camp Road connects to the Newell Highway approximately 3.2 kilometres to the west of the subject land and meets Obley Road approximately 400 metres to the east of the subject land.

At this stage of the Planning Proposal process, it is considered that vehicle access to the land is suitable to facilitate rezoning of the land. Vehicular access and general traffic arrangements will be required to be further considered as a component of the development assessment process.

(ix) Infrastructure

Electricity and telecommunications services are currently connected to the subject site with potential to be extended to meet future development demands. Reticulated water services are available via Camp Road and rainwater tanks will also be required to meet the Basix and Planning for Bushfire Protection requirements.

The Planning Proposal has provided the following information in respect of sewerage management on the land:

“Currently, the site utilises on-site sewage treatment, with a septic system. Lots to the east of the subject land have access to a low capacity sewer effluent line, which drains overflow from septic tanks on each site. If the land is rezoned and an application to subdivide submitted, it will be proposed that sewage be managed by bio-environmental on-site systems.”

It should be noted that there is a sewerage pump station situated adjacent to the land which may have adequate capacity to service development on the land without the need to provide for onsite effluent disposal systems. It is considered that further consideration of sewerage management options is undertaken as part of the development assessment process for any future development of the land.

(x) Flora and Fauna

The subject site is mapped as containing moderate and high levels of biodiversity. A flora and fauna report was provided with the Planning Proposal and was reviewed by Council’s Environment and Health officers.

The Planning Proposal provides the following information in respect of flora and fauna impacts:
“Impax Group were engaged to prepare a flora and fauna assessment of the subject land to determine what, if any, species of flora and fauna are likely to be impacted by subsequent development on the site. The assessment identified several threatened species which may exist upon the subject land:

1. Pine Donkey Orchid – Diuris Tricolor
2. Glossy Black-Cockatoo – Calyptorhynchus lathamii
3. Grey-Crowned Babbler – Pomatostomus Temporalis Temporalis

Of these threatened species, the likelihood of the Pine Donkey Orchid was considered low. The likelihood of the Glossy Black Cockatoo appearing at the site is considered low and no suitable sheoak feed species were observed within the site. The likelihood of the Grey Crowned Babbler appearing at the site is considered moderate, with suitable open box woodland being present on the site for habitat. The assessment concludes that the proposed development is expected to have a low potential impact upon biodiversity, threatened flora species or fauna species at the site.”

Correspondence was provided to the proponent on 11 December 2016 requesting a detailed flora and fauna assessment be provided to Council to assess the ecological value of the land proposed to be zoned E3 Environmental Management. Following Council’s request, further consultation was undertaken with the proponent in respect of the need for a detailed flora and fauna investigation and 7 Part Test of significance.

In certain circumstances, the DPE’s Guide to Preparing Planning Proposals allows for a proponent to provide a detailed flora and fauna investigation and an associated impact assessment as a condition of a Gateway Determination. This would effectively mean that if the NSW DPE issues a Gateway Determination, this work would be required to be undertaken prior to the Planning Proposal being placed on public display.

(xi) Noise

The Planning Proposal has included a noise impact assessment to determine any potential noise impacts on the subject land caused by the Morris Park Motor Sport Complex.

The Planning Proposal provides the following information:

“The noise assessment was carried out during a speedway event on 7 May 2016. This event featured Super Sedans in a NSW title race. Qualifying and racing occurred from late afternoon until approximately midnight. Approximately 25 cars were entered in the event.

The impact upon the subject land of noise from the Morris Park Motor Sport Complex is considered to be minimal. Separation distances have been provided and expected noise levels within dwellings constructed on the subject land in future can meet the requirements of SEPP (Infrastructure) 2007. The prevailing wind direction and speed is such that noise generated by any activity at Morris Park Motor Sport Complex is likely to
be directed generally away from the subject land. Motor sport events at Morris Park Motor Sport Complex are held regularly, averaging 12 events per year. Noise from motor sport events held at Morris Park Motor Sport Complex is not likely to cause health issues to occupants of proposed lots within the subject land.”

Notwithstanding the conclusions of the acoustic assessment, the proponent, as a component of the Planning Proposal, has located potential dwelling envelopes on the area of the site, which are subject to noise impacts during events at Morris Park of 55dB(A) or under. Any future dwellings on the land will be required to have specific acoustic treatments to address noise impacts associated with the Morris Park Motor Sports Complex.

It should also be noted that Council, as a component of the Planning Proposal process, will be required to undertake consultation with the NSW Environment Protection Authority (EPA) to consider the acoustic impacts associated with the Planning Proposal.

(xii) Aboriginal Archaeology

The Planning Proposal has provided information that the land contains a total of six (6) Aboriginal archaeological heritage sites. A number of these sites are associated with a drainage line which traverses the site from south to north to accord with the contours of the land.

The Planning Proposal has provided the following information in respect of impacts on Aboriginal Archaeology:

“The report by Impax Group considered the potential impacts of development on the site in relation to Aboriginal heritage items, in accordance with the NSW Due Diligence Code of Practice. The report concludes that the proposed development should be able to proceed without impacting any Aboriginal site, provided the development complies with its legal obligations under the NSW National Parks and Wildlife Act, 1974.”

In addition, as a component of the Planning Proposal process, Council will be required to undertake consultation with the Office of Environment and Heritage in respect of Aboriginal archaeology.

SUMMARY

Council is in receipt of a Planning Proposal that seeks to rezone Lot 8 DP 1063425, 4L Camp Road, Dubbo from SP3 Tourist to RU6 Transition and E3 Environmental Management. The Planning Proposal also seeks to change the minimum allotment size from no minimum lot size to a minimum allotment size for subdivision of two (2) hectares for land proposed to be zoned RU6 Transition and a minimum allotment size for subdivision of 100 hectares for land proposed to be zoned E3 Environmental Management, under the provisions of the Dubbo LEP.

The Planning Proposal will facilitate future subdivision and development of the land, including the potential for the development of a dwelling house on each allotment of land.
It is recommended that the Planning Proposal be submitted to the NSW Department of Planning and Environment to seek a Gateway Determination.

Appendices:
1. Original Planning Proposal - 4L Camp Road
2. Amended Planning Proposal
3. Planning Proposal - Further Information
APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

ITEM NO: PDEC17/14

PLANNING PROPOSAL
Lot 8 DP1063425
4L Camp Road
Dubbo
Parish of Dubbo
County of Gordon

Report prepared by

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Table of Contents

PLANNING PROPOSAL .................................................. 2
  Summary of Proposal ........................................... 2
  Objectives Of Proposal .......................................... 5
  Planning Provisions ............................................. 6
  Justification ..................................................... 8
    Background .................................................... 8
    Demand ........................................................ 9
    Land Use ...................................................... 9
    Topography and Vegetation ................................... 10
    Bushfire Prone Land .......................................... 10
    Site Access and Traffic ...................................... 13
    Connection to Services ....................................... 14
    Flora and Fauna .............................................. 15
    Groundwater Impacts ......................................... 15
    Non-Aboriginal Archaeological Heritage ................... 16
    Aboriginal Archaeological Heritage ....................... 16
    Preliminary Contamination Investigation .................. 17
    Noise: Adjoining land – Morris Park Motor Sport Complex 18
      Background ................................................... 18
      Noise Assessment ........................................... 18
      Conclusion .................................................. 19
      Recommendations .......................................... 19
    Smoke/Dust – Morris Park Motor Sport Complex ............ 20
      Background ................................................... 20
      Tyre Burnout Smoke/Dust .................................... 22
      Composition of tyre smoke .................................. 23
      Prevailing Wind Speed and Direction ...................... 27
      Separation Distance ........................................ 28
      Conclusion .................................................. 29
      Recommendations .......................................... 29
  Conclusion ....................................................... 30
  References ........................................................ 32
  Appendix A – Diagrams .......................................... 33
  Appendix B – Site Plans ........................................ 39
  Appendix C – Impax Group Report ................................ 40
  Appendix D – Noise and Sound Services Report ............. 41
  Appendix E – Documents relating to Smoke/Dust and Noise 42
  Appendix F – Wind Speed and Direction Roses ............... 43
  Appendix G – GEA Water Reticulation Analysis .............. 44
  Appendix H – Archaeological Study ........................... 45
PLANNING PROPOSAL

Summary of Proposal

This planning proposal relates to 4L Camp Road Dubbo, being Lot 8 DP1063425. The subject land is owned by Mrs Leetina Kish Bender. Mrs Bender is the applicant for this proposal.

The subject land currently has one dwelling standing upon it. The current land use is dryland agriculture, specifically grazing of stock and limited dryland cropping. The western and northern portions of the site are gently sloping with established grasses and scattered old growth eucalypt and regrowth eucalypt trees, with some invasive black pine scrub. A small watercourse flows through western portion of the land from south to north. The eastern portion of the land encompasses a small hill that is heavily vegetated with regrowth native eucalypt trees and invasive black pine scrub.

The soil on the site varies depending on the topography. The lower, more gently sloping land has heavier and more fertile soil consisting of sandy loam. Land situated on the slopes of the hill on the eastern side of the subject land is infertile light sandy loam.

The land is bounded by Camp Road and adjoining properties to the north; enclosed crown road to the west, with small agricultural holdings beyond; Crown road and Belowrie Road to the south, with small agricultural holdings beyond; Morris Park Motor Sport Complex and small tourism zoned lots to the east.

The land is currently zoned SP3, Tourist, according to the Dubbo Local Environmental Plan 2012. Adjoining land to the north, west and east is also zoned SP3. Land to the south of the subject land is zoned RU1, consisting of lots with varying sizes, with the majority less than 40 hectares. Many adjoining lots in the RU1 zone have dwellings upon them as a result of being existing holdings. Adjacent land in the RU1 zone has a prescribed Minimum Lot Size of 800 hectares. The subject land has an area of 131.9 hectares and is the largest single lot within the SP3 zoned land in private ownership. Taronga Western Plains Zoo is located on the northern side of Camp Road, and is zoned SP3 Tourist.

Permitted land uses in the SP3 zone include Aquaculture; Cellar door premises; Food and drink premises; Health consulting rooms; Markets; Medical centres; Roadside stalls; Shop top housing; Tourist and visitor accommodation; Viticulture; Waste or resource transfer stations; Water reticulation systems and any other development that is not prohibited. Prohibited land uses in the SP3 zone include Advertising structures; Agriculture; Air transport facilities; Bed and breakfast accommodation; Boat building and repair facilities; Car parks; Cemeteries; Commercial premises; Correctional centres; Crematoria; Depots; Educational establishments; Electricity generating works; Exhibition homes;
Exhibition villages; Extractive industries; Flood mitigation works; Forestry; Freight transport facilities; Health services facilities; Heavy industrial storage premises; Home-based child care; Home businesses; Home occupations; Home occupations (sex services); Industrial retail outlets; Industrial training facilities; Industries; Marinas; Mortuaries; Open cut mining; Public administration buildings; Residential accommodation; Restricted premises; Rural industries; Sewerage systems; Sex services premises; Storage premises; Transport depots; Truck depots; Vehicle body repair workshops; Vehicle repair stations; Warehouse or distribution centres; Waste or resource management facilities; Water supply systems; Wholesale supplies. According to Minimum Lot Size mapping, the subject land currently has no prescribed minimum lot size for subdivision. Current zoning and Minimum Lot Size mapping can be seen in Appendix A.

Although the subject land and many of the adjoining SP3 zoned lots are currently used as small agricultural holdings, Agriculture is not permitted within the zone. The current agricultural land use is subject to existing use rights, having been used for this purpose continuously since prior to the introduction of the current zoning for the land.

The site is located approximately 7.5km drive from the centre of Dubbo with an average drive time of between 7 and 12 minutes. The site has existing access from Camp Road which joins Obley Road to gain access to the Newell Highway.

Examples of other sites located within 7 to 12 minutes’ drive time from the centre of Dubbo include:

- Kintyre Residential Estate located approximately 3km north-west of the subject land. Zoned R2 Low Density Residential with minimum lot sizes of 4000m² and 6000m².
- Outlook Residential Estate located north of Minore Road approximately 5km west of Dubbo. Zoned R2 Large Lot Residential with minimum lot size of 600m².
- Homestead Green residential estate, located approximately 6km east of Dubbo on Buninyong Road. Zoned R2 Low Density Residential with minimum lot size 4000m².
- Whitewood Road, Mugga Downs, located approximately 6km east of Dubbo. Zoned RU2 Rural Landscape with minimum lot size 8 hectares.
- Richmond Residential Estate located north of Whitewood Road approximately 9km east of Dubbo. Zoned RU2 Rural Landscape with minimum lot size of 1.5 hectares.
- Angle Park residential estate, located east of Old Dubbo Road approximately 10km south of Dubbo. Zoned RU2 Rural Landscape with minimum lot size of 8 hectares.

The proponent is applying to have the zone for the subject land changed from SP3 Tourist with no prescribed Minimum Lot Size to a split zoning with environmentally sensitive areas zoned E3 Environmental Management and less sensitive areas zoned RU2 Rural Landscape with a 3 hectare minimum lot size.
### Street Address:
4L Camp Road Road

### Town:
Dubbo, NSW

### Postcode:
2830

### Local Government Area:
Western Plains Regional Council

### Lot/DP:
Lot 8 DP1063425

### Owner:
Mrs Leetina Kish Bender

### Current Zoning of Area:
SP3 Tourist

### Proposed Zoning Amendment:
RU2 Rural Landscape, E3 Environmental Management

### Current Minimum Lot Size:
No MLS prescribed

### Proposed Minimum Lot Size:
3 hectares

### Number of Existing Lots:
1

### Total area of site:
131.9 hectares
Objectives Of Proposal

The subject land is Lot 8 in DP1063425. This parcel is currently 131.9 hectares in size. The zoning under the Dubbo Local Environmental Plan 2012 is SP3 Tourist. There is no minimum lot size for the subject land. Under the current zoning, subject to Council approval, the land could be developed for tourism related purposes to a high density.

The proponent is applying to have the zone for the subject land changed from SP3 Tourist with no prescribed Minimum Lot Size to a split zoning. Part of the land is proposed to be zoned RU2 Rural Landscape with a 3 hectare minimum lot size, with a vegetated hill located on the eastern portion of the land proposed to be zoned E5 Environmental Management. The proposed rezoning will allow future development of the land for rural residential purposes, while protecting an existing natural feature. A layout for a potential subdivision of the subject land has been prepared which provides a total of 25 rural residential lots varying in size from 3 hectares to 7.59 hectares. The vegetated hill along the eastern boundary, has been set aside from the development to protect the vegetated hill area and to provide a buffer for the proposed residential lots from the adjacent SP3 zoned land, including the Morris Park Motor Sport Complex.

Despite the current zoning of the land being SP3 Tourist, the effective development for tourism of such a large site requires investment on a scale more suited to a corporation or government body. Further to this, the demand for tourism facilities in Dubbo is limited, meaning a tourism facility large enough to occupy the subject land is unlikely to be economically viable. It is considered extremely unlikely that the subject land could be effectively developed for tourism purposes.

An appropriate size for an agricultural holding in the Dubbo area has been determined to be 800 hectares. The subject land, at 131.9 hectares, is only 16% of the size required for a self-supporting agricultural holding. The subject land is considered to be a rural smallholding, requiring off-farm income to remain viable.

The site is not considered to be prime agricultural land. The soil type is not suitable for intensive agriculture and water for irrigation is not available. Much of the land is covered with regrowth eucalypt and invasive black pine trees. This land is marginally productive for grazing of stock, however is not suitable for commercial cropping. Land to the west of the site is more agriculturally productive and has been utilised for limited dryland cropping and grazing of stock.

The proposed rezoning of the land and application of a minimum lot size of 3 hectares for the RU2 zoned land will allow the site to be effectively developed while retaining much of the existing vegetation with minimal impact upon adjoining properties.
Planning Provisions

The subject land is currently zoned SP3 Tourist under the Dubbo LEP 2012. The objectives of the SP3 Tourist zone are as follows:

- To provide for a variety of tourist-oriented development and related uses.
- To recognise the importance of the Taronga Western Plains Zoo as a key tourist facility with the area of the City of Dubbo.
- To facilitate tourist-oriented development along major transport corridors and at key nodes throughout the City of Dubbo.
- To ensure that further tourism related development in the Cobra Street and Whylandra Street precincts will not interfere with established uses on adjoining residentially zoned land.
- To ensure that development in the Camp Road precinct will not interfere with the continued operation of the Taronga Western Plains Zoo.

It is proposed to change the zoning of the land to RU2 Rural Landscape under the Dubbo Local Environmental Plan 2012. The objectives of the RU2 Rural Landscape zone are as follows:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To maintain the rural landscape character of the land.
- To provide for a range of compatible land uses, including extensive agriculture.

The changing of zone for the subject land from SP3 Tourist to RU2 Rural Landscape will not interfere with the operation of tourist facilities on adjoining land. In particular, Taronga Western Plains Zoo will not be adversely affected and any future development on the site will be sympathetic to adjacent land uses. In addition, the use of land zoned RU2 Rural Landscape for tourism purposes, including eco-tourist facilities, is permissible with consent.

The proposed changing of zone and minimum lot size will allow the development of the subject land in such a way that potential impacts on environmentally sensitive locations are minimised and scenic quality of the area is not adversely affected. A proposed layout for the subdivision of the land sets aside a large part of the land, reserving it from the residential development, while retaining sufficient land for 25 dwelling lots. Dwelling envelopes have been provided on each lot with locations chosen to minimise impact on existing vegetation and vulnerable land forms such as water courses.

The rezoning of the subject land and the application of a minimum lot size is likely to decrease the potential future demand for public services and public facilities. Under the current zoning of SP3 Tourist, the site could be developed to a high level for tourist accommodation and facilities. Such development
generates a high demand for public services and public facilities based on the
turnover of visitors and higher potential number of accommodation units which
could be placed upon the land.

Adjoining land to the south is currently zoned RU1 Primary Production with a
minimum lot size of 800 hectares. Adjoining land to the north and east is currently
zoned SP3 Tourist with no prescribed minimum lot size. Directly adjoining lots,
with sizes are listed below:

<table>
<thead>
<tr>
<th>Lot and DP</th>
<th>Address</th>
<th>Zoning</th>
<th>Area (Approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot 6 DP249414</td>
<td>21L Camp Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>16.44 Ha</td>
</tr>
<tr>
<td>Lot 1942 DP866937</td>
<td>20L Camp Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>10 Ha</td>
</tr>
<tr>
<td>Lot 1 DP1017984</td>
<td>18L Camp Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>8.341 Ha</td>
</tr>
<tr>
<td>Lot 4 DP1033752</td>
<td>16L Camp Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>5.391 Ha</td>
</tr>
<tr>
<td>Lot 5 DP1033752</td>
<td>14L Camp Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>6.964 Ha</td>
</tr>
<tr>
<td>Lot 5 DP1082444</td>
<td>3L Camp Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>7.263 Ha</td>
</tr>
<tr>
<td>Lot 3 DP1082444</td>
<td>40R Obley Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>6.158 Ha</td>
</tr>
<tr>
<td>Lot 2 DP1082444</td>
<td>42R Obley Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>5.731 Ha</td>
</tr>
<tr>
<td>Lot 1 DP1082444</td>
<td>44R Obley Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>6.253 Ha</td>
</tr>
<tr>
<td>Lot 237 DP401652</td>
<td>48R Obley Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>14.31 Ha</td>
</tr>
<tr>
<td>Lot 205 DP753233</td>
<td>48R Obley Road, Dubbo</td>
<td>RU1 Primary Production</td>
<td>36.42 Ha</td>
</tr>
<tr>
<td>Lot 138 DP753233</td>
<td>Obley Road, Dubbo</td>
<td>RU1 Primary Production</td>
<td>18.19 Ha</td>
</tr>
<tr>
<td>Lot 162 DP753233</td>
<td>48R Obley Road, Dubbo</td>
<td>RU1 Primary Production</td>
<td>23.98 Ha</td>
</tr>
<tr>
<td>Lot 163 DP753233</td>
<td>46L Peak Hill Road, Dubbo</td>
<td>RU1 Primary Production</td>
<td>50.99 Ha</td>
</tr>
</tbody>
</table>

Of the lots above, Lot 163 DP753233 and Lot 205 DP753233 are part of larger
holdings. Lot 163 DP753233 is part of a holding with a total area of 867.6
hectares. Lot 205 DP753233 is part of a holding with a total area of 73.28
hectares.

The impact on the adjoining land of changing the zone and applying a 3 hectare
minimum lot size to the subject land is anticipated to be minimal. Sufficient
buffers between potential dwelling sites and adjoining land have been provided.
Rural-residential land uses are not incompatible with either Tourist or Primary
Production land uses. The adjoining land zoned RU1 Primary Production consists
of lots and holdings that are all less than the prescribed minimum lot size. The
existing adjoining lots zoned RU1 Primary Production are between 6% and 2% of
the prescribed minimum lot size.

The amendment to the Minimum Lot Size mapping to reflect a 3 hectare
minimum lot size on the subject land is unlikely to adversely affect adjoining land.
The proposed changes to the zone and Minimum Lot Size will result in a
satisfactory outcome for the subject land and adjoining land.
Justification

Background

The subject land is currently zoned SP3 Tourist under the Dubbo LEP 2012. The land directly west, north, and east of the subject land is also zoned SP3 Tourist. Land to the south of the subject land is zoned RU1 Primary Production under the Dubbo LEP 2012.

Lots to the west, north and east have existing dwellings and tourist facilities upon them. All of the lots in the immediate area have areas of less than 800 hectares. The layout of the land boundaries and dwellings in the area largely conforms with the objectives of the RU2 Rural Landscape zone under the Dubbo LEP 2012, providing residential housing in a rural setting.

Impacts on scenic quality and environmentally sensitive locations caused by the existing housing density are difficult to assess. Given the long-term nature of development in the area, occurring over the past 150 years, it would appear that the most obvious and noticeable change on the site would have been caused immediately following the initial occupation by European settlers. The land would have been cleared with the intention of being used for agricultural purposes, fences constructed and dwellings erected. In subsequent years, changes would have been more incremental, including updated and additional dwellings.

The subject land was first surveyed in 1906, consisting of two separate portions of land, being Portions 194 and 195 in the Parish of Dubbo, County of Gordon. At the time of the initial survey, both portion 194 and 195 were vacant, with the only improvements listed being fencing of nominal value. The two portions, 194 and 195, which were subdivided to form the subject land, were shown in separate ownership on the original plans. The land was described in some detail on the plans, with vegetated areas and topography shown diagrammatically. Copies of the original portion plans for the subject land can be seen in Appendix A.

In 1906, portions 194 and 195 had thick gum, pine and she-oak on the stony ridge, with open box and pine vegetation on the gentler slopes to the west. In general, the vegetation as annotated on the original plans of survey matches the vegetation on site today although it is apparent that some clearing of the site has taken place.

In the years between the initial occupation and the present, the land has remained largely unchanged, with minimal additional impact caused by the construction of dwellings on the lots.
Demand

Demand for rural lifestyle lots in the Dubbo area is quite high. As at 6 July 2016, only 7 vacant rural lifestyle properties in excess of 2 hectares were listed on realestate.com.au in the Dubbo and Wellington areas. Of those listed, the majority had land areas in excess of 10 hectares, which puts them in a different class to the proposed development. In close proximity to Dubbo, there are very few opportunities for rural lifestyle development, with the subject land offering short travel times to the Dubbo CBD. Future road links will increase the connectivity to and from Dubbo.

The Dubbo Zirconia Project is commencing work and is anticipated to employ over 240 people to staff their mining and processing operations. The Dubbo Zirconia Project is located at Toongi and will be accessed from Dubbo via Obley Road. It can reasonably be expected that, if the rezoning proposal and subsequent development occurs, many employees of the Dubbo Zirconia Project will find the subject land an attractive place to live. The subject land is located close to Dubbo, however will save employees of the Dubbo Zirconia Project travel time to work and offer an attractive rural-residential lifestyle.

Land Use

The subject land is currently used for dryland agriculture including grazing of stock. The land has one dwelling standing upon it with associated outbuildings. The existing dwelling is located on the north-eastern portion of the land. The agricultural capacity of the land is not sufficient for the land to be self-supporting in a financial sense. As such, the land is a “lifestyle block” allowing rural residential living in close proximity to the city of Dubbo. If the subject land were to be sold it could be expected that a new owner/s would have at least one occupant with a full-time job to supplement any income generated by agricultural pursuits on the land.

Permitted land uses in the SP3 zone include Aquaculture; Cellar door premises; Food and drink premises; Health consulting rooms; Markets; Medical centres; Roadside stalls; Shop top housing; Tourist and visitor accommodation; Viticulture; Waste or resource transfer stations; Water reticulation systems and any other development that is not prohibited. Due to the nature of tourism, most tourism developments are likely to generate traffic and waste, with potential for noise impacts and increased demand for services.

In relation to the subject land, the large area available for development means that there is potential for tourism development on a very large scale. Approximately 47 hectares of the total area of the site consists of heavily vegetated land. This leaves approximately 85 hectares available for development for tourism purposes without the requirement for clearing. Existing tourism
development in the area includes a vineyard and cellar door as well as several tourist accommodation developments.

If the site were developed for tourist accommodation purposes, it is estimated that up to 600 individual accommodation units could be placed upon the site. This figure is subject to approval and economic feasibility, however the impact of a single large tourism focused development on the subject land is likely to be significant.

Under the proposed rezoning, the future development of the land will be limited by lot size, vegetation and topography. A proposed layout for the subdivision of the subject land has been prepared, with a maximum of 25 dwelling lots. This layout provides for dwelling envelopes that have minimal impact on existing vegetation and sets aside a large area to the east of the site as a vegetated buffer. The proposal requires the construction of approximately 2200 metres of road as well as services required for rural residential development.

When considering an appropriate layout for the subdivision of the land, the total area of 131.9 hectares can yield 25 dwelling lots with a nominal size of 5 hectares each. By setting aside 25 hectares of land to provide a buffer and protect the stony vegetated ridge, a minimum lot size of 3 hectares is required in order to achieve the same yield of 25 dwelling lots. The potential impact of rural residential development on the subject land, while significant, is manageable and limited by the proposed minimum lot size.

**Topography and Vegetation**

The site is gently undulating, with an overall slope from south to north. The western and northern portions of the site are gently sloping with established grasses and scattered old growth eucalypt and regrowth eucalypt trees, with some black pine scrub. A small watercourse flows through western portion of the land from south to north. The eastern portion of the land encompasses a small hill that is heavily vegetated with regrowth native eucalypt trees and invasive black pine scrub.

The soil on the site varies depending on the topography. The lower, more gently sloping land has heavier and more fertile soil consisting of sandy loam. Land situated on the slopes of the hill on the eastern side of the subject land is infertile light sandy loam.

**Bushfire Prone Land**

The subject land is partially identified as bushfire prone. The bushfire prone land is largely limited by the hilly vegetated land to the east of the site. Where dwellings are proposed on bushfire prone land, consideration must be given to the predominant vegetation, effective slope of the land, fire weather, fire intensity...
and building classification. These factors are used to design an appropriate asset protection zone.

The vegetation on the site, as described above, most closely conforms to a vegetation class formation of Central Western Grasslands for most proposed building sites. Where sites are located near the vegetated hilly area of the site, the vegetation classification more closely conforms to a vegetation class formation of Semi-arid woodlands with Shrubby sub formation. Proposed dwelling sites have been located downslope from the vegetated hilly land which poses the greatest risk in terms of bushfire attack. The effective slope from proposed dwelling sites in the direction of the bushfire prone land has been measured using LIDAR data, with a maximum value of 9% slope or 5.6°. All upslope vegetation is considered to have an effective slope classification of [i] or 0°. When considering downslope vegetation, all proposed dwelling sites have a predominant downslope vegetation classification of Central Western Grasslands. Effective downslopes have been measured using LIDAR data, with average downslopes of 2.6°, and maximum downslopes of 3.3°. This gives an effective downslope classification of [ii] >0 to 5° downslope vegetation.

The Dubbo area falls within the Lower Central West Plains Fire Weather Area, with a Fire Danger Index (FDI) of 80.

Planning for Bushfire Protection 2006, Appendix 2, Section 2.3 (d) states:

*Grasslands of 100 metres from any boundary (subdivision) or buildings (SFPBs) do not require construction requirements in conformity with AS 3959 – 1999 or this document but requires an APZ of 10 metres for slopes <18°.*

In consideration of upslope Semi-Arid Woodland vegetation in FDI 80 areas, Table A2.5 of Planning for Bushfire Protection requires an asset protection zone of 10 metres based on a construction level of 3. For a Level 1 construction, separation distances of 18 to 50m are required to the predominant vegetation. All lots shown on the proposed site plan in Appendix B have sufficient area to provide setbacks to boundaries of at least 20 metres.

An APZ consists of two areas, an Inner Protection Area (IPA) and an Outer Protection Area (OPA). The OPA serves to reduce the potential length of the flames, filtering embers and reducing the likelihood of crown fire. The OPA should provide tree canopy cover of less than 30% and should have the understorey managed (mowed) to treat all shrubs and grasses on an annual basis in advance of the fire season. The IPA is critical and provides a defendable space and manages heat intensities at the building surface. The IPA should provide tree canopy cover of less than 15% and should be located greater than 2 metres from any part of the roofline of the dwelling. Garden beds of flammable shrubs are not to be located under trees and should be no closer than 10 metres.
from an exposed window or door. Trees should have lower limbs removed up to a height of 2 metres above the ground.

A diagram explaining asset protection zones is shown below:

If an adequate APZ is not able to be provided within the subject land, the level of construction of the dwelling will have to be increased. Bushfire mapping for the subject land can be seen below:
Site Access and Traffic

The subject land is currently accessed from Camp Road. Camp Road is a bitumen sealed two-way through road, connecting to Obley Road approximately 400 metres to the east of the subject land and to the Newell Highway approximately 3.2km to the west of the subject land.

Obley Road is a bitumen sealed two-way through road, and is in the process of being upgraded to cater for additional traffic loads anticipated to be generated by the commencement of the Dubbo Zirconia Project at Toongi. Obley Road will be constructed to cater for heavy vehicle traffic, with an expected 155 heavy vehicles per day using the road, as well as passenger vehicles accessing the Dubbo Zirconia Project and typical traffic currently using the road. The intersection of Camp Road with Obley Road provides adequate site distance in both directions, and the road has been widened to allow for merging traffic. Some upgrade of this intersection may be required if the subject land is rezoned, however until a development application is submitted with a specified number of lots it is not possible to determine whether such an upgrade is necessary.

Traffic accessing Dubbo from the subject land is anticipated to follow a route along Camp Road to Obley Road, then north to the Newell Highway. The intersection of Obley Road with the Newell Highway is currently an uncontrolled intersection with a chanellised arrangement of turning and merging lanes. This intersection arrangement is anticipated to be adequate for the potential added traffic if the subject land is rezoned and subsequently developed for rural-residential purposes.

In addition to the Camp Road access, the subject land has frontage to Belowrie Road at the southern end of the site. Belowrie Road is currently a gravel sealed two-way rural road, catering for several rural dwellings at the western end and for Morris Park Motor Sport Complex at the eastern end. Belowrie Road meets Obley Road at an uncontrolled intersection. Sight distance at this intersection is marginal to adequate, and it is doubtful whether this intersection has been designed with consideration to the levels of traffic using it to access Morris Park Motor Sport Complex. As the site is classified Bushfire Prone, a second access may be required. This will provide a second escape route from the subject land if the other access is blocked due to bush fire. The proponent would prefer to use Belowrie Road as an emergency access only, however recognises that Council may require Belowrie Road to be upgraded and opened as a trafficable road. If Belowrie Road is upgraded and used as access for the site, it is anticipated that about 20% of the land will use Belowrie Road for access.

While a final lot layout has not been determined, the proposed site plan in Appendix B, creating 25 dwelling lots, is a possible future layout. On this layout, it can be anticipated that Lots 16-18 would utilise Belowrie Road for access, while Lots 15 and 19 may use either Belowrie Road or Camp Road. All other dwelling lots would be most likely to use Camp Road for access. If the land is rezoned in
accordance with this proposal, and a development application is subsequent submitted for the subdivision of the land, the proponent will investigate more thoroughly the road layout and costs involved with upgrading Belowie Road.

Connection to Services

The subject land is currently connected to overhead electricity and underground telecommunications services. These services can be extended to service the development of the subject land in the future.

Reticulated water services currently exist at Obley Road with an extension proposed to service Camp Road. A water reticulation analysis has been undertaken to determine whether the subject land can be provided water from the existing infrastructure. Pressure and capacity for the provision of water to the subject land have been determined to be adequate. In addition, it is anticipated that most dwellings constructed on the subject land will have rainwater tanks installed. This assists home designers in meeting the requirements of BASIX as well as bushfire requirements. Planning for Bushfire Protection requires for subdivisions creating rural/lifestyle lots in excess of 1 hectare in size and with no access to reticulated water to provide a minimum of 20,000 litres static water per lot, dedicated to fire fighting. Where reticulated water supply is available, fire hydrants are to be spaced and sized in accordance with AS2419.1 – 2005. It is anticipated that all requirements in relation to water supply and firefighting provisions can be met.

Currently, the site utilises on-site sewage treatment, with a septic system. Lots to the east of the subject land have access to a low capacity sewer effluent line, which drains overflow from septic tanks on each site. If the land is rezoned and an application to subdivide submitted, it will be proposed that sewage be managed by bio-environmental on-site systems.

Currently, the site is undeveloped and rainfall runoff follows natural overland flow paths to established creeks. Due to the nature of the proposed rezoning and likely form of development on the site, proposed roads will not have kerb and guttering and a piped stormwater system. Water sensitive urban design principles including grassed swales beside roads will be adopted to direct stormwater flows to natural drainage channels. Runoff from proposed dwellings and outbuildings is anticipated to be largely captured by rainwater tanks. Runoff from hardstands and driveways within proposed lots is anticipated to be directed to road swales and then to natural drainage channels. If the rezoning is successful, a design for civil works including disposal of stormwater will be submitted with any subsequent development application for subdivision of the land.

Reticulated gas is not anticipated to be provided to the subject land.
Flora and Fauna

Impax Group were engaged to prepare a Flora and Fauna Assessment on the subject land to determine what, if any, species of flora and fauna are likely to be impacted by subsequent development on the site. The assessment identified several threatened species which may exist upon the subject land:

1. Pine Donkey Orchid – D. tricolor
2. Glossy Black-Cockatoo – Calyptorhynchus lathami
3. Grey-crowned Babbler – Pomatostomus temporalis temporalis

Of these threatened species, the likelihood of the Pine Donkey Orchid occurring at the site is considered low. The likelihood of the Glossy Black Cockatoo occurring at the site is considered low and no suitable sheoak species were observed within the site. The likelihood of the Grey Crowned Babbler occurring at the site is considered moderate, with suitable open box woodland being present on the site for habitat. The assessment concludes that the proposed development is expected to have a low potential impact upon biodiversity, threatened flora species or fauna species at the site.

Groundwater Impacts

Impax Group were engaged to prepare a Groundwater Assessment to determine whether the site is vulnerable to groundwater contamination or damage to aquifers by subsequent development on site.

The groundwater assessment found that the soil types on site are consistent with the ‘Eulomogo’ soil type on cleared areas, and the ‘Splitters Hill’ soil type on the central rocky outcrop. Eulomogo soils described as low to moderate fertility, reddish brown fine sandy clay loam underlain with mottled yellow and grey clay. Splitters Hill soils are described as moderate fertility, mainly red podzolic soils with non-calccic brown soils on the lower slopes with shallow soils on steep/rocky slopes and small areas of red-brown earths and red earths in association with red podzolic soils. The assessment indicates that there does not appear to be a significant aquifer used for beneficial purposes below the site.

The report identified likely future activities which have potential to impact upon groundwater, as follows:

1. Standard household garden water use practices resulting in an increase in the amount of water being applied at the site;
2. Rainwater run-off from additional hard stand areas resulting in an increased concentration of water being applied at the site; and
3. The installation of an onsite sewage management system resulting in an increase in the amount of water being applied at the site (in the event that the development is not connected to the Dubbo sewerage system).
The report recommended multiple mitigation measures which could be implemented to minimise the impact of any subsequent rural-residential development on the site (see Recommended Mitigation Measures, Page 12, Report by Impax Group 2016-022 RPI).

**Non-Aboriginal Archaeological Heritage**

Impax Group were engaged to prepare an assessment of non-Aboriginal Heritage items on or near the site and potential impacts of developing the land for rural-residential purposes in the future. No items of heritage value were found on the site, and no items if heritage value were expected to be impacted by subsequent development of the land for rural-residential purposes.

**Aboriginal Archaeological Heritage**

Impax Group were engaged to prepare an assessment of Aboriginal Heritage items on the site. As such, a review of an existing Aboriginal Archaeological Assessment Report was conducted and related to the current proposal. Impax Group reviewed the document titled “An Archaeological Assessment for the Proposed "Glenn Lee" Tourism Development, Camp Road, Dubbo, NSW.” This report was prepared in 1995 by Central West Archaeological and Heritage Services in December 1995. The report considered a study area which included the subject land. The report identified a total of eight open campsites, two scarred tree sites and one isolated artefact within the study area. Of the eleven identified sites, six were located within the subject land, comprising four open camp sites and two scarred tree sites.

The report by Impax Group considered the potential impacts of development on the site in relation to Aboriginal Heritage items, in accordance with the NSW Due Diligence Code of Practice. The report concludes that the proposed development should be able to proceed without impacting on any Aboriginal Sites, provided the development complies with its legal obligations under the NSW National Parks and Wildlife Act 1974.
Preliminary Contamination Investigation

Impax Group were engaged to prepare a site history and preliminary contamination investigation on the subject land. This assessment utilised historical records including title information, aerial photography and other records. Soil sampling was undertaken on site with the samples analysed for organochlorine and organophosphorus pesticides (OCPs and OPPs), priority heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, mercury and zinc), pH and electrical conductivity (EC). The study concludes that no potentially contaminating activities have been undertaken at the site. Concentrations of common contaminants of concern within soils at the study area were below the threshold concentrations for residential land use. The soil within the study area is considered suitable for the proposed development with regards to contamination.
Noise (Adjoining land – Morris Park Motor Sport Complex)

Background

Morris Park Motor Sport Complex, located to the south east of the subject land, regularly holds motorsport competitions including off-road motorcycle events, speedway events and occasionally burnout competitions. Noise generated by motorsport events at Morris Park has been raised by Western Plains Regional Council as an issue to be addressed prior to any development on the site. Noise and Sound Services, were engaged to prepare an assessment of noise from motor sports in relation to the subject land.

Noise Assessment

The noise assessment was carried out during a speedway event on 7 May 2016. This event featured Super Sedans in a NSW title race. Qualifying and racing occurred from late afternoon until approximately midnight. Approximately 25 cars were entered in the event.

The noise assessment concluded that the internal noise criteria set out in SEPP (Infrastructure) 2007, Subdivision 2, Clause 102, can be met. The report submitted by Noise and Sound Services recommended several measures to be adopted in construction of future dwellings on the subject land in order that the noise emitted by Morris Park not exceed the internal noise criteria.
Conclusion

The impact upon the subject land of noise from the Morris Park Motor Sport Complex is considered to be minimal. Separation distances have been provided and expected noise levels within dwellings constructed on the subject land in future can meet the requirements of SEPP (Infrastructure) 2007. The prevailing wind direction and speed is such that noise generated by any activity at Morris Park Motor Sport Complex is likely to be directed generally away from the subject land. Motor sport events at Morris Park Motor Sport Complex are held regularly, averaging 12 events per year. Noise from motor sport events and held at Morris Park Motor Sport Complex is not likely to cause health issues to occupants of proposed lots within the subject land.

Recommendations

Noise from motor sport events at Morris Park may be considered to be a nuisance by residents nearby. In the interests of informing potential purchasers of land that such a nuisance may exist, it is recommended that Western Plains Regional Council utilise a notation on a Section 149(5) certificate for each lot created upon the subject land. In this way potential purchasers can see prior to purchase that the site is liable to be occasionally subjected to noise from motor sports. An alternative is to require a Restriction on the use of land upon each dwelling lot, stating that each lot is liable to be occasionally subject to noise from motor sport events and specifying minimum noise levels which can be considered to be more than a nuisance.
Smoke/Dust – Morris Park Motor Sport Complex

Background

Morris Park Motor Sport Complex, located to the south east of the subject land, occasionally holds burnout competitions. Smoke from burnout competitions has been raised by Western Plains Regional Council as an issue to be addressed prior to any development on the site. Contact with various consultants and the NSW Environmental Protection Authority have provided information in relation to air quality, however specific reference to burnout completion tyre smoke and dust does not currently exist.

Levels of particulate matter with particles less than 10 μm in diameter (PM$_{10}$) is a method used to assess ambient air quality according to the National Environment Protection (Ambient Air Quality) Measure (NEPM). Fine particles with a diameter of less than 2.5 μm (PM$_{2.5}$) are also subject to reporting standards.

The current compliance standard for particles categorised as PM$_{10}$ is 50μg/m$^3$ averaged over 24 hours and the maximum concentration averaged over a year is 25μg/m$^3$. No exceedances of PM$_{10}$ concentrations greater than 50μg/m$^3$ are permitted per year under the National Environment Protection (Ambient Air Quality) Measure (as amended). The current advisory reporting standard for PM$_{2.5}$ in ambient air is 25μg/m$^3$ averaged over 24 hours and the maximum concentration averaged over a year is 8μg/m$^3$ per year. No exceedances of PM$_{2.5}$ concentrations greater than 25μg/m$^3$ are permitted under the National Environment Protection (Ambient Air Quality) Measure (as amended).

<table>
<thead>
<tr>
<th>Item</th>
<th>Pollutant</th>
<th>Averaging Period</th>
<th>Maximum Concentration Standard</th>
<th>Maximum Allowable Exceedances</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Carbon monoxide</td>
<td>8 hours</td>
<td>9.0 ppm</td>
<td>1 day a year</td>
</tr>
<tr>
<td>2</td>
<td>Nitrogen dioxide</td>
<td>1 hour</td>
<td>0.12 ppm</td>
<td>1 day a year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 year</td>
<td>0.03 ppm</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>Photochemical oxidants (as ozone)</td>
<td>1 hour</td>
<td>0.10 ppm</td>
<td>1 day a year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 hours</td>
<td>0.08 ppm</td>
<td>1 day a year</td>
</tr>
<tr>
<td>4</td>
<td>Sulfur dioxide</td>
<td>1 hour</td>
<td>0.20 ppm</td>
<td>1 day a year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 day</td>
<td>0.08 ppm</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 year</td>
<td>0.02 ppm</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>Lead</td>
<td>1 year</td>
<td>0.50 μg/m$^3$</td>
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</tr>
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<td>6</td>
<td>Particles as PM$_{10}$</td>
<td>1 day</td>
<td>50 μg/m$^3$</td>
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<tr>
<td></td>
<td></td>
<td>1 year</td>
<td>25 μg/m$^3$</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>1 year</td>
<td>8 μg/m$^3$</td>
<td>None</td>
</tr>
</tbody>
</table>

Table 1 – Standards for Pollutants (NEPM)
There are health implications related to particle emissions. Particulates with diameter greater than 10µm collect in the hairs of nose and throat and are eliminated by coughing and blowing the nose. Particulates with diameter between 10µm and 2.5µm are usually trapped in the upper respiratory system. Particles with diameter less than 2.5µm can make their way to the air sacs in the lungs (alveoli). These particles are of most concern in relation to health. The NSW Environmental Protection Authority document *Managing Particles and Improving Air Quality in NSW* states, in part:

"Unlike larger particles, these smaller particles invisible to the naked eye can be breathed deep into the lungs and even pass into the bloodstream. They also travel under the influence of wind and weather and can produce effects many kilometres from their source. Long and short-term exposure to particles is linked to an increased risk of respiratory and cardiovascular disease and of death from those diseases. Long-term exposure is most harmful and those most affected by particle pollution are the elderly, children and people with existing cardiovascular and respiratory health conditions. The evidence is clear that long-term exposure to PM2.5 has a larger health effect than short-term exposure, indicating that strategies that provide long-term reductions in fine particle pollution are likely to produce the greatest health benefit."
Tyre Burnout Smoke/Dust

Monitoring of burnout smoke has been undertaken for the Summernats car show in Canberra. Monitoring and reporting occurred during the 2010 Summernats car show from 8 January 2010 until 11 January 2010. PM$_{10}$ concentrations were measured at two locations adjacent to the site. The consultant, Robson Environmental Pty Ltd, offered the opinion that “Summernats activities appeared to have an adverse effect on both PM$_{10}$ and atmospheric metal (copper, lead and chromium) concentrations; although none of the concentrations exceeded the Australian NEPM$^2$ (TWAGO bound) of 50µg/m$^3$ for PM$_{10}$ in ambient air or 0.5µg/m$^3$ for atmospheric lead.”

Further to this, a peak in real-time PM$_{10}$ concentrations corresponded with main stage activities including the Summernats concert and fireworks. According to the report by Robson Environmental Pty Ltd, fireworks have been reported to cause increases in ambient PM$_{10}$ concentrations, as well as atmospheric concentrations of lead and copper. The report stated that fireworks at Summernats may have contributed to the increases in lead and copper concentrations detected during the course of the Summernats car show. The Robson Environmental report in relation to Summernats 2010 can be seen in Appendix E.

While the air quality monitoring undertaken by Robson Environmental for the Summernats car show in 2010 provides a valuable benchmark, it is noted that PM$_{2.5}$ particle concentrations were not monitored, and that these particles are considered to be a more significant risk to the health or persons inhaling them than PM$_{10}$ particles.
Composition of tyre smoke

A study titled Characterization of heavy metal particles embedded in tire dust was published by Adachi & Tainosho in 2004. The study found that tyre smoke and dust can contain potentially hazardous materials including heavy metals such as iron (5.5%), copper (0.1%), zinc (1.6%) and lead (0.1%), as well as asphalt materials which include aluminium (7.5%), calcium (10.1%) and silica (21.2%) (Adachi & Tainosho, 2004). According to the study, tyre dust consists of debris from tyre wear and assimilated heavy metal particles emitted from road traffic materials such as brake lining and road paint. The abstract from the study is shown below:

Abstract

Tire dust is a significant pollutant, especially as a source of zinc in the urban environment. This study characterizes the morphology and chemical composition of heavy metal particles embedded in tire dust and traffic-related materials (brake dust, yellow paint, and tire tread) as measured by a field emission scanning electron microscope equipped with an energy dispersive X-ray spectrometer (FESEM/EDX). In 60 samples of tire dust, we detected 2288 heavy metal particles, which we classified into four groups using cluster analysis according to the following typical elements: cluster 1: Fe, cluster 2: Cr/Pb, cluster 3: multiple elements (Ti, Cr, Fe, Cu, Zn, Sr, Y, Zr, Sn, Sb, Ba, La, Ce, Pb), cluster 4: ZnO. According to their morphologies and chemical compositions, the possible sources of each cluster were as follows: (1) brake dust (particles rich in Fe and with trace Cu, Sb, and Ba), (2) yellow paint (Cr/PbO4 particles), (3) brake dust (particulate Ti, Fe, Cu, Sb, Zr, and Ba) and heavy minerals (Y, Zr, La, and Ce), (4) tire tread (zinc oxide). When the chemical composition of tire dust was compared to that of tire tread, the tire dust was found to have greater concentrations of heavy metal elements as well as mineral or asphalt pavement material characterized by Al, Si, and Ca. We conclude that tire dust consists not only of the debris from tire wear but also of assimilated heavy metal particles emitted from road traffic materials such as brake lining and road paint.

A study was published in 2011 by Michael Bennett, Simon M. Christie, Angus Graham, Bryony S. Thomas, Vladimir Vishnyakov, Kevin Morris, Daniel M. Peters, Rhys Jones, and Cathy Ansell titled Composition of Smoke Generated by Landing Aircraft. This study determined that the particle size of tyre smoke generated by landing aircraft has equal numbers of particles at peaks of aerodynamic diameter ~10µm and ~50µm. The peak at 10µm was determined to be predominantly carbonaceous, while the peak at 50µm was determined to be elements typical of an asphalt concrete runway. One of the chosen measurement methodologies adopted for the study, LIDAR, was not suitable to measure particles smaller than 10µm. The study notes in the conclusion "these observations suggest that the bulk of the visible aerosol in tire smoke is too coarse to be respirable; it seems to consist largely of mechanically generated
dust from the runway surface. Mass balance considerations imply that very little of the tire rubber lost is released as fine aerosol. The conclusion goes on to note "Overall, it would appear that while tire smoke emissions can be spectacular, and may have operational implications in terms of tire wear and runway degradation, the emission of respirable PM is relatively modest. There may, however, still be health issues arising from hazardous organics (e.g., PAHs) volatilized from the rubber or of nuisance from the associated odor."

The parallel between smoke generated by landing aircraft and smoke generated by a car spinning tyres is that tyre composition and the running surface is almost identical. The abstract for this study is shown below:

Abstract

A combination of techniques has been used to examine the composition of smoke generated by landing aircraft. A sample of dust from the undercarriage from several commercial airliners was examined with SEM/EDX (Scanning Electron Microscope/Energy Dispersive X-ray) to determine its elemental composition and also with an aerosizer/aerodisperser in order to measure the particle size spectrum. The observed size spectrum was bimodal with equal numbers of particles at peaks of aerodynamic diameter ~10 µm and ~50 µm. The EDX analysis suggested that the former peak is carbonaceous, while the latter consists of elements typical of an asphalt concrete runway. In the field, a scanning Lidar, in combination with optical and condensation particle counters, was deployed to obtain limits to the number concentration and size of such particles. Most of these (strong) Lidar signals are from the coarser 50 µm aerosol, while respirable aerosol was too sparse to be detected by the optical particle counters.

A study was published in 2001 by J. A. Gillies, A. W. Gertler, J. C. Sagebiel, and W. A. Dippel titled On-Road Particulate Matter (PM_{2.5} and PM_{10}) Emissions in the Sepulveda Tunnel, Los Angeles, California. This study found a relationship between PM_{2.5} and PM_{10} emissions, where PM_{2.5} emission was approximately 74% of the PM_{10} emissions. PM_{2.5} emissions were found to be dominated by organic and elemental carbon, accounting for approximately 79% of emissions in this particle size. The remainder of PM_{2.5} emissions consisted of crustal elements including iron, magnesium, aluminium, calcium and manganese with ions Cl\textsuperscript{-}, NO\textsubscript{3}\textsuperscript{-}, NH\textsubscript{4}\textsuperscript{+}, SO\textsubscript{4}\textsuperscript{2-}, and K\textsuperscript{+} together constituting another 9.8%. PM_{10} emissions were also found to be dominated by organic and elemental carbon with other geological components accounting for approximately 12.6% of PM_{10} emissions. This study did not consider PM_{10} and did not specifically study tyre smoke. The abstract for the study is shown below:

Abstract
Total and speciated particulate matter (PM2.5 and PM10) emission factors from in-use vehicles were measured for a mixed light- (97.4% LD) and heavy-duty fleet (2.6% HD) in the Sepulveda Tunnel, Los Angeles, CA. Seventeen 1-h test runs were performed between July 23, 1996, and July 27, 1996. Emission factors were calculated from mass concentration measurements taken at the tunnel entrance and exit, the volume of airflow through the tunnel, and the number of vehicles passing through the 582 m long tunnel. For the mixed LD and HD fleet, PM2.5 emission factors in the Sepulveda Tunnel ranged from 0.016 (±0.007) to 0.115 (±0.019) g/vehicle-km traveled with an average of 0.052 (±0.027) g/vehicle-km. PM10 emission factors ranged from 0.030 (±0.009) to 0.131 (±0.024) g/vehicle-km with an average of 0.069 (±0.030) g/vehicle-km. The PM2.5 emission factor was ~74% of the PM10 factor. Speciated emission rates and chemical profiles for use in receptor modeling were also developed. PM2.5 was dominated by organic carbon (OC) (31.0 ± 19.5%) and elemental carbon (EC) (48.5 ± 20.5%) that together account for 79% (±24%) of the total emissions. Crustal elements (Fe, Mg, Al, Si, Ca, and Mn) contribute ~7.8%, and the ions Cl-, NO3-, NH3+, SO42-, and K+ together constitute another 9.8%. In the PM10 size fraction the particulate emissions were also dominated by OC (31 ± 12%) and EC (35 ± 13%). The third most prominent species was Fe (18.5 ± 9.0%), which is greater than would be expected from purely geological sources. Other geological components (Mg, Al, Si, K, Ca, and Mn) accounted for an additional 12.6%. PM10 emission factors showed some dependence on vehicle speed, whereas PM2.5 did not. For test runs in which the average vehicle speed was 42.6 km/h a 1.7 times increase in PM10 emission factor was observed compared to those runs with an average vehicle speed of 72.6 km/h. Speciated emissions were similar. However, there is significantly greater mass attributable to geological material in the PM10, indicative of an increased contribution from resuspended road dust. The PM2.5 shows relatively good correlation with NOx emissions, which indicates that even at the low percent of HD vehicles, which emit significantly more NOx than LD vehicles, they may also have a significant impact on the PM2.5 levels.
The data above reveals that tyre smoke and dust consists of:

- a mix of elements typical of the running surface, with aerodynamic diameter approximately 50µm;
- predominantly carbonaceous material with aerodynamic diameter approximately 10µm; and
- predominantly carbonaceous material with aerodynamic diameter 2.5µm and less.

Approximate proportions of each particulate are shown below:

During the monitoring for the Summemats car show in 2010, PM$_{10}$ concentrations peaked at a value of 34µg/m$^3$, with background or control levels at 9µg/m$^3$. It is also noted that the real-time peak in PM$_{10}$ particulate concentration corresponded with the fireworks display. It is likely that the levels recorded for the other days of the event, being 17µg/m$^3$ and 14µg/m$^3$ reflect a more accurate measure of the concentrations of tyre smoke. Using the ratio above, this gives an estimated PM$_{2.5}$ concentration of 12.6µg/m$^3$ and 10.4µg/m$^3$ respectively. These figures represent a real-time PM$_{2.5}$ concentration of about 50% of the maximum allowable level specified in the NEPM guidelines, which refers to a 1-day averaged concentration.
Prevailing Wind Speed and Direction

Bureau of Meteorology have records of wind speed and direction data for Dubbo. The historical data is presented in the format of a "rose" showing the average wind direction and speed for the respective time period. The records use wind speed and direction measured at 9am and 3pm. The wind speed and direction roses for Dubbo can be seen in Appendix F. The data has been collected at two locations, being Dubbo Airport and Darling Street Dubbo. The data indicates that mean wind speeds at the Dubbo Airport tend to be higher than Darling Street by between 7 and 10km/h. The subject land is located south of both BOM sites. It is anticipated that wind speeds at the subject site will be more similar to the figures for Darling Street than the Airport due to topography. Prevailing wind directions at the subject site are expected to be more similar to the figures for Darling Street than the Airport.

Based on historical data the mean wind direction at 9am at Dubbo Airport is from the west. Wind speeds at 9am at Dubbo Airport average between 12.9km/h and 21.5km/h. Based on historical data the mean wind direction at 9am at Darling Street, Dubbo is from the north-west. Wind speeds at 9am at Darling Street, Dubbo average between 8.4km/h and 12.1km/h. Based on historical data the mean wind direction at 3pm at Dubbo Airport is from the east. Wind speeds at
3pm at Dubbo Airport average between 16.2km/h and 20.2km/h. Based on historical data the mean wind direction at 3pm at Darling Street, Dubbo is from the north east. Wind speeds at 9am at Darling Street Dubbo average between 10.0km/h and 13.6km/h.

The prevailing wind directions indicate that smoke, dust and noise from an event at Morris Park Motor Sport Complex generally will be directed away from the subject land by the prevailing winds when considering the 9am statistics. When considering 3pm statistics, smoke, dust and noise from an event at Morris Park Motor Sport Complex will generally be directed by the prevailing winds obliquely across the southernmost parts of the subject land.

**Separation Distance**

The NSW Environmental Protection Authority has prepared *Guidelines for Managing Air Pollution*, a copy of which is included in Appendix E. The guidelines discuss the effectiveness of dispersion in dealing with air pollution. The Guideline states that pollutants are diluted to the order of 1000 to 1 after less than 1 kilometre of travel in the atmosphere. Separation of the pollution source and receptor by distance is an effective use of atmospheric dispersion.

The SA Environmental Protection Authority has prepared a table of recommended separation distances for airborne emissions in a document titled *Guidelines for Separation Distances*, a copy of which is included in Appendix E. Anticipated emissions from the Morris Park Motor Sport Complex include noise, dust and smoke. The SA EPA Guidelines for Separation Distances does not provide a recommended separation distance for tyre smoke or dust from motor sport events. Given the similar nature of wood smoke to tyre smoke, especially in relation to the way it travels, it is noted that the Guidelines recommend a separation distance of 300 metres when dealing with incineration for wood waste. The Guidelines also refer to Rubber production/mixing, recommending a separation distance of 300 metres. The nearest proposed dwelling envelope on the subject land is located approximately 450 metres west of the speedway at Morris Park Motor Sport Complex. The nearest proposed dwelling envelope is located 300 metres from the western boundary of the Morris Park Motor Sport Complex.
Conclusion

The impact upon the subject land of smoke and dust from the Morris Park Motor Sport Complex is considered to be minimal. Separation distances have been provided and exceed the minimum distances recommended by EPA SA. Monitoring of the Summer Mats car show in 2010 determined that the event did not exceed acceptable PM10 concentrations. Any event held at Morris Park Motor Sport Complex is unlikely to generate particulate matter on a scale similar to the Summer Mats car show. The prevailing wind direction and speed is such that smoke and other particulate matter generated by any activity at Morris Park Motor Sport Complex is likely to be directed generally away from the subject land. Burnout competition events at Morris Park Motor Sport Complex are held only occasionally. Smoke from burnout competitions and other airborne particle emissions are not likely to cause health issues to occupants of proposed lots within the subject land.

Recommendations

Tyre smoke and dust from burnout competitions may be considered to be a nuisance by residents nearby. In the interests of informing potential purchasers of land that such a nuisance may exist, it is recommended that Western Plains Regional Council utilise a notation on a Section 149(5) certificate for each lot created upon the subject land. In this way potential purchasers can see prior to purchase that the site is liable to be occasionally subjected to tyre smoke. An alternative is to require a Restriction on the use of land upon each dwelling lot, stating that each lot is liable to be occasionally subject to tyre smoke and specifying minimum PM10 and PM2.5 concentrations which can be considered to be more than a nuisance.
Conclusion

The subject land has been zoned SP3 Tourist for over 10 years. Uptake of tourist related development in the Camp Road area has been sporadic at best, with minimal functioning tourism sites in operation. The large size of the subject land presents a barrier to developing the land for tourism purposes, even if demand for such development were proven. The land has historically been used for agricultural purposes and is currently a small farm lifestyle lot, requiring off-farm income to be financially sustainable.

The proponent wishes to rezone the land to a split zoning, retaining the vegetated hilly area to the east of the site as E3 Environmental Protection zone, with land on undulating land to the west to be zoned RU2 Rural Lifestyle. Minimum lot size mapping is proposed to be amended to allow lots of 3 hectares in the proposed RU2 zone, with no dwellings permitted or proposed in the E3 Environmental Protection zone. Tourism based land uses are still permitted within the RU2 Rural Lifestyle zone.

Assessments have been undertaken in regard to flora and fauna, groundwater, heritage, and contamination. The proposed rezoning and subsequent development of the land can be undertaken in accordance with recommendations made in the report. Additional assessment has been undertaken in regard to noise from motor sport events held at the adjacent Morris Park Motor Sport Complex. The proposed rezoning and subsequent development of the land can be undertaken in accordance with recommendations made in the report. Smoke from burnout competitions at Morris Park Motor Sport Complex has been addressed and separation distances provided meet or exceed minimum recommended distances.

Site access is adequate and options for future development have been identified, to be investigated for subsequent applications to develop the land. Electricity and telecommunications services are currently available and connected to the site. The site has been determined to be suitable for on-site treatment of sewage subject to the recommendations relating to groundwater protection. Reticulated water is available nearby and can be connected to the proposed development. Water pressure has been determined to be adequate for all proposed dwelling lots.

The site is identified as bushfire prone, and asset protection zones will be required for all proposed dwellings. All lots are of sufficient size to provide asset protection zones as required.

Demand for rural lifestyle lots is currently adequate and is anticipated in increase as the Dubbo Zirconia Project comes online. It is likely that the site would provide accommodation for employees of the Dubbo Zirconia Project. The location of the subject land in relation to the Dubbo Zirconia Project and the city of Dubbo gives
employees an opportunity to live closer to their place of work and still be close to the city of Dubbo for shopping and schools.

Surrounding land uses do not comply with the current zoning and minimum lot size provisions. The proposed rezoning and development of the subject land will not impact adjoining land adversely.

The proposed rezoning and subsequent development is suitable for the subject land.

Eric Smith
B.Surv. MIS Aust.
Surveyor Registered Under The Surveying and Spatial Information Act, 2012
References

Robson Environmental Pty Ltd
Environmental Dust Monitoring
Summernats Car Festival, Watson, Canberra, ACT 2911
28 June 2010

Kouji Adachi, Yoshiaki Tainosho
Characterization of heavy metal particles embedded in tire dust
Environment International 2004

J. A. Gillies, A. W. Gertler, J. C. Sagebiel, and, and W. A. Dippel
On-Road Particulate Matter (PM2.5 and PM10) Emissions in the Sepulveda
Tunnel, Los Angeles, California
Environmental Science & Technology 2001 35 (6), 1054-1063

Michael Bennett, Simon M. Christie, Angus Graham, Bryony S. Thomas, Vladimir
Vishnyakov, Kevin Morris, Daniel M. Peters, Rhys Jones, and Cathy Ansell
Composition of Smoke Generated by Lading Aircraft
Environmental Science & Technology 2011

Bureau of Meteorology
Climate statistics, Dubbo Airport and Darling Street Dubbo.

NSW Environmental Protection Authority
Reducing Wood Smoke Emissions
11 July 2013

NSW Environmental Protection Authority
Noise Guide for Local Government
Part 3 Noise Management Principles
2013

NSW Environmental Protection Authority
Local Government Air Quality Toolkit, Module 3: Guidelines for Managing Air
Pollution

NSW Environmental Protection Authority
Managing Particles and Improving Air Quality in NSW
2013

SA Environmental Protection Authority
Guidelines for Separation Distances
August 2000
Appendix A – Diagrams
Appendix B – Site Plans
Appendix C – Impax Group Report
Appendix D – Noise and Sound Services Report
Appendix E – Documents relating to Smoke/Dust and Noise
Doherty Smith & Associates Pty Ltd

www.dohertysmith.com.au

Appendix F – Wind Speed and Direction Roses
Appendix G – GCA Water Reticulation Analysis
Appendix H – Archaeological Study
Appendix A - Diagrams
Current zoning of subject land and surrounding area.
Dubbo Local Environmental Plan 2012
Minimum Lot Size of subject land and surrounding area
Dubbo Local Environmental Plan 2012
Groundwater Mapping for subject land and surrounding area
Dubbo Local Environmental Plan 2012
**DOCUMENT CONTROLS**

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TABLE OF CONTENTS

1 INTRODUCTION ........................................................................................................... 1
  1.1 PROJECT OBJECTIVES ......................................................................................... 1
  1.2 SCOPE OF WORK ................................................................................................. 1
  1.3 LIMITATIONS OF THIS REPORT ........................................................................ 2

2 SITE DESCRIPTION ....................................................................................................... 3
  2.1 SITE LOCATION ................................................................................................... 3
  2.2 SITE LAYOUT AND FEATURES .......................................................................... 3
  2.3 ADJOINING LAND USES .................................................................................... 3
  2.4 SITE TOPOGRAPHY ........................................................................................... 3
  2.5 SURFACE WATER DRAINAGE ............................................................................ 3

3 SITE HISTORY AND RELEVANT INFORMATION ..................................................... 4
  3.1 AERIAL PHOTOGRAPHY REVIEW ..................................................................... 4
  3.2 LAND TITLE RECORDS ....................................................................................... 6
  3.3 NSW OFFICE OF ENVIRONMENT AND HERITAGE RECORDS ......................... 7
     3.3.1 Contaminated Land Management Act 1997 ................................................. 7
     3.3.2 Protection of Environment Operations Act 1997 ......................................... 7
  3.4 SUMMARY OF SITE HISTORY ............................................................................. 7

4 FLORA AND FAUNA ASSESSMENT ............................................................................. 8
  4.1 EXISTING ENVIRONMENT .................................................................................. 8
  4.2 NSW THREATENED SPECIES CONSERVATION ACT 1995 ............................... 8
     4.3 THREATENED SPECIES DESCRIPTIONS ............................................................. 9
         4.3.1 Pine Donkey Orchid - Dianthus tricolor ...................................................... 9
         4.3.2 Glossy Black-Cockatoo - Calyptorhynchus lathami ................................. 9
         4.3.3 Grey-crowned Babbler - Pomatostomus temporalis temporalis .......... 10
  4.4 POTENTIAL FLORA AND FAUNA IMPACTS ...................................................... 10

5 GROUNDWATER ASSESSMENT ............................................................................... 11
  5.1 SOILS ................................................................................................................. 11
  5.2 HYDROLOGY .................................................................................................... 12
  5.3 POTENTIAL GROUNDWATER IMPACTS ............................................................ 12
  5.4 RECOMMENDED MITIGATION MEASURES .................................................... 12
  5.5 GROUNDWATER IMPACT ASSESSMENT .......................................................... 13

6 NON-ABORIGINAL HERITAGE ASSESSMENT .......................................................... 15
  6.1 EXISTING ENVIRONMENT ................................................................................ 15
  6.2 STATEMENT OF HERITAGE SIGNIFICANCE .................................................. 15
  6.3 POTENTIAL NON-ABORIGINAL HERITAGE IMPACTS ..................................... 15

7 ABORIGINAL HERITAGE ASSESSMENT ................................................................ 16
  7.1 REVIEW OF PREVIOUSLY PREPARED ABORIGINAL ARCHAEOLOGICAL ASSESSMENT .......................................................... 16
  7.2 ABORIGINAL HERITAGE INFORMATION MANAGEMENT SYSTEM ............ 16
  7.3 DUE DILIGENCE CODE OF PRACTICE FOR THE PROTECTION OF ABORIGINAL OBJECTS IN NSW ......................................................... 17
  7.4 POTENTIAL ABORIGINAL HERITAGE IMPACTS ............................................. 17

8 CONTAMINATION INVESTIGATION ......................................................................... 18
  8.1 SAMPLING LOCATIONS AND METHODOLOGY .............................................. 18
  8.2 FIELD OBSERVATIONS ..................................................................................... 19
  8.3 SAMPLE ANALYSIS ........................................................................................... 19
LIST OF ATTACHMENTS

ATTACHMENT A: FIGURES
ATTACHMENT B: LABORATORY RESULTS SUMMARY TABLES
ATTACHMENT C: LABORATORY CERTIFICATE OF ANALYSIS
ATTACHMENT D: HISTORICAL AERIAL PHOTOGRAPHS
ATTACHMENT E: LAND TITLE SEARCH RESULTS
ATTACHMENT F: FLORA AND FAUNA SEARCH RESULTS
ATTACHMENT G: AHIMS SEARCH RESULTS
1 Introduction

The Impax Group was commissioned by Doherty Smith and Associates Consulting Surveyors to undertake a Flora and Fauna Assessment, Groundwater Assessment, Archaeological Assessment and Preliminary Contamination Investigation for a proposed rural-residential subdivision located at 4L Camp Road – Lot 8 DP 1063425 Dubbo NSW 2830 (the ‘site’).

1.1 Project Objectives

The objectives of the project is to determine if the site is suitable for the proposed development.

1.2 Scope of Work

To achieve the objectives outlined in Section 1.1 The Impax Group conducted the following work:

- Obtained and reviewed aerial photographs for the site for the period 1959 to present;
- Conducted a land title records search for the site;
- Conducted a search of the NSW OEH database for notices pertaining to the site under the NSW Contaminated Land Management Act 1997, and the Protection of Environment Operations Act 1997;
- Conducted a search of the NSW Office of Environment and Heritage (OEH) Atlas of NSW Wildlife database for records of flora and fauna species recorded at the site that are listed in Schedule 1, 2 or 3 of the NSW Threatened Species Conservation Act 1995;
- Prepared a desktop flora and fauna assessment for the site highlighting any potential impacts the proposed development may have on threatened species at the site;
- Conducted a search of the NSW OEH Natural Resource Atlas database for records of groundwater bores at the site;
- Prepared a desktop groundwater assessment to determine if any aquifers were present beneath the site, determine the current use of water from such aquifers, and examine the potential impacts the proposed development may have on such aquifers;
- Conducted a search of the NSW OEH State Heritage Inventory online heritage database for the site for information on non-aboriginal heritage sites located in the area;
- Conducted a search of the relevant schedule of the Dubbo Local Environment Plan for information on whether any part of the site is listed as a heritage item, heritage conservation area or archaeological site;
- Prepared a desktop non-aboriginal heritage assessment for the site highlighting any potential impacts the proposed development may have on non-aboriginal heritage at the site;
- Conducted a search of the NSW OEH Aboriginal Heritage Information Management System (AHIMS) database for information on Aboriginal Objects or Aboriginal places in or around the site;
- Reviewed and comment on the previously prepared Aboriginal Heritage Assessment Report prepared for the site;
- Prepared a desktop Aboriginal heritage assessment for the site highlighting any potential impacts the proposed development may have on Aboriginal Objects or Aboriginal Places in or around the site;
- Provided a scientist to conduct a site inspection and soil sampling works at the site;
- Used a hand auger and sampling trowel to collect 21 surface (0.0-0.1m) soil samples at the site;
- Analysed primary soil samples from within each hole in a laboratory for organochlorine pesticides (OCPs), organophosphorus pesticides (OPPs), priority heavy metals (arsenic, cadmium, chromium, copper, nickel, zinc, mercury, lead), pH and electrical conductivity (EC);
- Compared the soil sampling analytical results against the National Environment Protection (Assessment of Site Contamination) Measure (2011) Schedule B1: 'Guidelines on Investigation Levels for Soil and Groundwater' (NEPM 2011). Analytical results were assessed against the Health Investigation Level 'Residential A' (HIL A) applicable for sites used for residential purposes; and
- Prepared this report outlining the results of the flora and fauna assessment, groundwater assessment, archaeological assessment and preliminary contamination assessment.

1.3 Limitations of this Report

The findings of this report are based on the Scope of Work outlined in Section 1.2. The Impax Group performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental consulting profession. No warranties, express or implied are made. The results of this assessment are based upon the information documented and presented in this report. All conclusions and recommendations regarding the site are the professional opinions of The Impax Group personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, The Impax Group assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside of The Impax Group, or developments resulting from situations outside the scope of this project.

The Impax Group’s assessment is limited strictly to a walkover of the area within the study area boundary, and surface investigations in soil material at 21 locations across the site. Soil samples were analysed for common contaminants and/or indicators of contamination. The absence of these compounds in soil samples collected from the surface cannot be interpreted as a guarantee that such materials, or other potentially toxic or hazardous compounds, do not exist at the site.

The results of this assessment are based on the site conditions identified at the time of the site inspection and validation sampling. The Impax Group will not be liable to revise the report to account for any changes in site characteristics, regulatory requirements, assessment criteria or the availability of additional information, subsequent to the issue date of this report.

The Impax Group is not engaged in environmental consulting and reporting for the purpose of advertising sales promoting, or endorsement of any client interests, including raising investment capital, recommending investment decisions, or other publicity purposes.
2 Site Description

2.1 Site Location

The site location details are summarised in Table 1.

Table 1: Summary of Site Details

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street Address:</td>
</tr>
<tr>
<td>Lot and DP Number:</td>
</tr>
<tr>
<td>Local Government Area:</td>
</tr>
<tr>
<td>Site Area:</td>
</tr>
<tr>
<td>Geographical Coordinates of Site:</td>
</tr>
</tbody>
</table>

The study area for this Preliminary Contamination Investigation is limited to Lot 8 DP 1063425. The study area boundaries are shown in Figure 1 of Attachment A.

2.2 Site Layout and Features

The site layout and features are shown in Figure 1 of Attachment A.

The site occupied an area of approximately 130ha on the southern side of Camp Road, approximately 5km south of the Dubbo General Post Office.

The site consisted of approximately 55% cleared land and 45% remnant native vegetation. Remnant vegetation was predominately restricted to an elevated rocky outcrop in the central southern portion of the site.

Building improvements at the site consisted of a homestead, stockyards and machinery sheds which were located in the northern portion of the site.

2.3 Adjoining Land Uses

At the time of the site inspection the site was surrounded by rural properties to the south, east and west. The Taronga Western Plains Zoo was located to the north of the site on the other side of Camp Road. The Morris Park Speedway dirt racing track was located adjacent to the site on the south eastern boundary.

2.4 Site Topography

The site had a moderate rolling topography, falling from an elevation of 316m (AHD) near the centre of the site at the top of a rocky outcrop to an elevation of 270m (AHD) along the northern boundary on Camp Road.

2.5 Surface Water Drainage

The nearest surface water body to the site was the Macquarie River, located approximately 1,500m to the north-north east of the site. Stormwater draining at the site would likely flow towards the Macquarie River through local drainage lines running in a generally northerly direction at the site. 7 farm dams were present within the site, with no permanent creeks or water courses present.
3 Site History and Relevant Information

3.1 Aerial Photography Review

In order to assess past land uses at the site and on adjoining properties, The Impax Group reviewed aerial photography archives held by the NSW Land and Property Information. Photographs reviewed were as follows:

- Dubbo 1959: NSW 450 1:56,000, 13 March 1959 – black and white
- Dubbo 1964: NSW 1217 1:51,000, 29 May 1964 – black and white
- Dubbo 1971: NSW 1968 1:72,555, 17 August 1971 – black and white
- Dubbo 1980: NSW 2900 1:50,000, 4 November 1980 – black and white
- Dubbo 1991: NSW 5794 1:50,000, 10 April 1991 – black and white
- Dubbo 2000: NSW 4532 1:50,000, 16 December 2000 – colour
- Dubbo 2004: NSW 4840 1:50,000, 16 April 2004 – colour

Copies of these aerial photographs are presented in Attachment D.

In the 1959 aerial photograph the site appears similar to the site's present condition with regards to the cleared farmland area and remnant native vegetation area. A number of buildings appear to be present in the northern portion of the site, with a track running east from these buildings to connect with Obley Road.

A small portion of land in the north-east corner of the site appears to have been ploughed for cropping activities, with the remainder of the cleared land at the site appearing to have naturally occurring annual grasses suitable for grazing.

Two farm dams are located to the south of the buildings, with an additional farm dam located in the north-western portion of the site.

Land adjacent to the site appears to be predominately cleared for farming purposes. Camp Road does not appear to be fully formed as a public road along the northern boundary of the site. There appears to be a basic dirt track circuit to the south east of the site, consistent with the present location of Morris Park Speedway.

In the 1964 aerial photograph the site appears similar to the 1959 aerial photograph. No further clearing has occurred at the site, and the surrounding land use also appears similar to the 1959 aerial photograph.

In the 1971 aerial photograph the site appears similar to the 1964 aerial photograph. Land use adjacent to the site appears similar to the 1964 aerial photograph.

In the 1980 aerial photograph the site appears similar to the 1971 aerial photograph. Land use adjacent to the site appears similar to the 1971 aerial photograph.

In the 1991 aerial photograph the site appears similar to the 1980 aerial photograph. A new building can be seen in the northern portion of the site, and appears to have replaced older building that were previously present at this location. One new farm dam is present in the western portion of the site, with another new farm dam present in the south-western portion of the site. The remnant native vegetation associated with the rocky outcrop at the site appears to have a denser canopy. Camp Road appears to have been sealed into a permanent public road running from Obley Road to the Newell Highway. The dirt track speedway is still present to the south east of the site.

In the 2000 aerial photograph the site appears similar to the 1991 aerial photograph. Two new buildings appear to have been established in the northern portion of the site near the location of the
current buildings at the site. Land use adjacent to the site appears similar to the 1991 aerial photograph.

In the 2004 aerial photograph the site appears similar to the 2000 aerial photograph, and to conditions at the site presently. Land use adjacent to the site appears similar to the 2004 aerial photograph and to conditions to land adjacent to the site presently.

Based on the review of aerial photographs from 1959 – 2004, land use within the site appears to have been predominately used for grazing activities, with some cropping activities occurring in the north-eastern portion of the site. No potentially contaminating activities appear to have been undertaken at the site during this period.
3.2 Land Title Records

A search of land titles records for Lot 8 DP 1063425 was undertaken for the site. A summary of the land title records for the site is presented in Table 2. Results of the search are presented in Attachment E.

Table 2: Summary of Land Title Records

<table>
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<th>Period</th>
<th>Site Owner</th>
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<tr>
<td>2004 – on date</td>
<td>Lot 8 DP 1063425</td>
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<tr>
<td>2004 – 2009</td>
<td>Leonard Kish Bender</td>
</tr>
<tr>
<td>2001 – 2004</td>
<td>Warren Thomas Quick</td>
</tr>
<tr>
<td>2000 – 2001</td>
<td>Warren Thomas Quick</td>
</tr>
<tr>
<td>Note A</td>
<td>Lot 236 DP 4052</td>
</tr>
<tr>
<td>1995 – 2000</td>
<td>Warren Thomas Quick</td>
</tr>
<tr>
<td>1985 – 1988</td>
<td>Ian Cyril McNaught</td>
</tr>
<tr>
<td>1980 – 1985</td>
<td>John Archibald Morris, Builder</td>
</tr>
<tr>
<td></td>
<td>Portion 395 Parish Dubbo – Area 215 Acres – CTVol 12228 Fol 103</td>
</tr>
<tr>
<td>1942 – 1947</td>
<td>William Aggubara Campbell, Grantor</td>
</tr>
<tr>
<td>Note B</td>
<td>Lot 1941 DP 866937</td>
</tr>
<tr>
<td>1997 – 2000</td>
<td>Warren Thomas Quick</td>
</tr>
<tr>
<td>1984 – 1997</td>
<td>Warren Thomas Quick</td>
</tr>
<tr>
<td>1980 – 1994</td>
<td>Ian Kevin Hartley</td>
</tr>
<tr>
<td></td>
<td>Portions 194 Parish Dubbo – Area 305 Acres, 3 Roads – CTVol 2228 Fol 208</td>
</tr>
<tr>
<td>1986 – 1989</td>
<td>Ian Kevin Hartley</td>
</tr>
<tr>
<td>1966 – 1966</td>
<td>Emma Hartley (formerly Emma Hilton)</td>
</tr>
<tr>
<td>1928 – 1966</td>
<td>Emma Hilton, Widow</td>
</tr>
<tr>
<td>1912 – 1913</td>
<td>Charles William Hilton, Grantor</td>
</tr>
</tbody>
</table>

The site has a land title record going back to 1912. The current Lot 8 DP 1063425 was first consolidated into one holding in 2004.
3.3 NSW Office of Environment and Heritage Records

3.3.1 Contaminated Land Management Act 1997

The NSW Environment Protection Authority (EPA) has received notifications from owners or occupiers of sites where they believe the sites are contaminated, as reported to the EPA under Section 60 (duty to report contaminated sites) of the Contaminated Land Management Act 1997.

A search of the EPA database (http://www.epa.nsw.gov.au/clm/publiclist.htm) for the site revealed that the site has not been reported as contaminated under Section 60 of the Contaminated Land Management Act 1997.

3.3.2 Protection of Environment Operations Act 1997

The Protection of the Environment Operations Act 1997 establishes the NSW environmental regulatory framework and includes a licensing requirement for certain activities. Environment protection licences are a central means to control the localised, cumulative and acute impacts of pollution in NSW.

A search of the EPA public register (http://www.epa.nsw.gov.au/prproeco/index.htm) for the site revealed that the site is not currently subject to an environment protection licence under the Protection of the Environment Operations Act 1997.

3.4 Summary of Site History

Based on the aerial photography review, land title records and OEH records it would appear that no potentially contaminating activities have been undertaken at the site.

No areas of potential environment concern were identified as part of the site history review.
4 Flora and Fauna Assessment

4.1 Existing Environment

Ground cover vegetation at the site was comprised a variety of native annual grasses and weed (weeds) species. Over storey vegetation at the site was comprised of a variety of eucalyptus, wax and casuarina species. A variety of native flora and fauna species were observed at the site. Native flora and fauna species observed at the site are listed in Table 3.

Table 3: Native Flora and Fauna Species Observed at the Site

<table>
<thead>
<tr>
<th>Species Name</th>
<th>Common Name</th>
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<tr>
<td>Flora</td>
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<tr>
<td>Acacia decora</td>
<td>Western Silver Wattle</td>
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<tr>
<td>Acacia dealbata</td>
<td>Streaked Wattle</td>
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</tr>
<tr>
<td>Callitris columnellaris</td>
<td>White Cypress Pine</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Chloris truncata</td>
<td>Windmill Grass</td>
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<tr>
<td>Chloris mechantea</td>
<td>Feather Grass</td>
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</tr>
<tr>
<td>Eucalyptus globulus</td>
<td>White Box</td>
<td>Not Listed</td>
</tr>
<tr>
<td>Eucalyptus consilidens</td>
<td>River Red Gum</td>
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<td>Eucalyptus macrorreana</td>
<td>Western Grey Box</td>
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<td>Eucalyptus sideroxylon</td>
<td>Mountain Ironbark</td>
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<td>Eucalyptus globulus</td>
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</tr>
<tr>
<td>Eucalyptus globulus</td>
<td>Wallaby Grass</td>
<td>Not Listed</td>
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<td>Fauna - Birds</td>
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<tr>
<td>Cuculus phobos</td>
<td>Sulphur-crested Cockatoo</td>
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<tr>
<td>Chlamydera unicolor</td>
<td>Australian Wood Duck</td>
<td>Protected (NSW Act 1974)</td>
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<td>Corvus coronoides</td>
<td>Australian Raven</td>
<td>Protected (NSW Act 1974)</td>
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<td>Corvus crassus</td>
<td>Australian Magpie</td>
<td>Protected (NSW Act 1974)</td>
</tr>
<tr>
<td>Eudocimus rubicollis</td>
<td>Galah</td>
<td>Protected (NSW Act 1974)</td>
</tr>
<tr>
<td>Oxyrrhina novaehollandiae</td>
<td>Crested Pigeon</td>
<td>Protected (NSW Act 1974)</td>
</tr>
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<td>Rhipidura leucophrys</td>
<td>Willie Wagtail</td>
<td>Protected (NSW Act 1974)</td>
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<tr>
<td>Fauna - Mammals</td>
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<td></td>
</tr>
<tr>
<td>Macropus giganteus</td>
<td>Eastern Grey Kangaroo</td>
<td>Protected (NSW Act 1974)</td>
</tr>
</tbody>
</table>

4.2 NSW Threatened Species Conservation Act 1995

A search for flora and fauna species listed in Schedule 1a, Schedule 1b and Schedule 2 of the NSW Threatened Species Conservation Act 1995 (TSC Act) using the Atlas of NSW Wildlife (biome.nsw.gov.au) was conducted for an area of 10 km² centred on the site.

The atlas of NSW wildlife is the NSW GIEH database of fauna and flora records, and covers all areas of NSW.

Twenty-five fauna species and five flora species listed in the TSC Act were recorded within the search area. The full results of the flora and fauna search along with a map showing recorded locations are presented in Attachment E.
Of those thirty threatened species listed in the TSC Act recorded within the search area, none were recorded within the site boundary. One threatened flora species and two threatened fauna species were recorded within 1,000m of the site, as shown in the maps presented in Appendix V and described in Table 4.

Table 4: Threatened Species Recorded within 1,000m of the Site

<table>
<thead>
<tr>
<th>Species Name</th>
<th>Common Name</th>
<th>Classification (NSW TSC Act)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flora</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diuris tricolor</td>
<td>Pine Donkey Orchid</td>
<td>Vulnerable</td>
</tr>
<tr>
<td>Fauna – Birds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calyptorhynchus latham</td>
<td>Glossy Black-Cockatoo</td>
<td>Vulnerable</td>
</tr>
<tr>
<td>Pomatostomus temporalis temporalis</td>
<td>Grey-crowned Babbie</td>
<td>Vulnerable</td>
</tr>
</tbody>
</table>

4.3 Threatened Species Descriptions

4.3.1 Pine Donkey Orchid – Diuris tricolor

*Diuris tricolor* is a terrestrial orchid species growing to a height of 40cm. It has between one and three leaves, to 30 centimetres long and 4mm wide. The slightly taller flower stalk is between 20-40cm high and has 2-6 flowers, which are bright yellow to orange, speckled with red to purple and white markings.

*D. tricolor* is sporadically distributed on the western slopes of NSW, extending from south of Narrandera all the way to the north of NSW. The species is usually recorded growing within disturbed habitats within sandy soils, and is associated with *Eucalyptus* and *Acacia* shrub land. *D. tricolor* flowers in early spring.

Threats to the species include habitat clearing and habitat modification, weed competition and feral animal impacts.

The likelihood of *D. tricolor* occurring at the site is considered low.

NSW Threatened Species Conservation Act, 1995 Status: V – Vulnerable

4.3.2 Glossy Black-Cockatoo – Calyptorhynchus latham

*Calyptorhynchus latham* is a brown-black cockatoo with a large rounded bill and small crest. The tail panel of the females is yellow to orange-red, whereas the males have a prominent red tail panel. The females often have irregular pale-yellow markings on the head and neck with yellow flecks underneath. *C. latham* are most often recorded in pairs or small groups feeding in sheoaks.

*C. latham* are relatively uncommon within their widespread range, and inhabit open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Sheoaks are an important food source, as they feed almost exclusively on the seeds of these species, by way of shredding the cones with their massive bill. They are also dependent on large hollow bearing *Eucalyptus* for nest sites.

Threats to the species include habitat reduction, decline in hollow bearing trees, frequent forest fires, habitat infestation by introduced weeds and illegal bird smuggling and egg collection.

The likelihood of *C. latham* occurring at the site is considered low. No suitable sheoak food species were observed within the site.

NSW Threatened Species Conservation Act, 1995 Status: V – Vulnerable
4.3.3 Grey-crowned Babbler — *Pomatostomus temporalis temporalis*

*Pomatostomus temporalis temporalis* is a medium to large babbler that grows to 29cm in length. It has a distinctive pale crown, as implied by the common name. It also has a distinctive scimitar-shaped bill which is long and heavy. A dark band passes from the bill through the eye, separating the pale throat and brow to give it a masked appearance. The call is also distinctive, a loud and often repeated “ya-woo” call which is a duet between the male and the female.

The species is gregarious, communal and noisy, and they are widespread across NSW to become locally common in some areas of its range. *P. temporalis* prefers open box-gum woodlands, and they tend to hop and glide from tree to tree. Flight is awkward for the species and they are generally unable to cross large open areas. They forage on invertebrates, hunting amongst fallen timber, and digging in the ground.

Threats to the survival of *P. temporalis* include the clearing of woodland remnants, heavy grazing resulting in the removal of debris within remnants, and nest predation in highly fragmented areas.

The likelihood of *P. temporalis* occurring at the site is considered moderate. The species was recorded within the road reserve along Camp Road adjacent to the northern boundary of the site, and suitable open box woodland habitat is present at the site.

NSW Threatened Species Conservation Act, 1995 Status: V — Vulnerable

4.4 Potential Flora and Fauna Impacts

No threatened flora or fauna species were recorded within the site. Of the three threatened species recorded within 1,000m of the site one threatened fauna species (Grey-crowned Babbler) was assessed as having a moderate likelihood of occurring within the site.

The proposed residential development may result in some habitat disturbance and vegetation removal. The proposed lot layout has resulted in each lot containing a suitable residential dwelling location without the need for any further excessive vegetation removal. It is expected that most subsequent developments will aim to minimise the amount of disturbance, as the presence of such remnant native vegetation at the site is one of the main reasons prospective purchasers will be looking to buy into the development.

The proposed development is expected to have a low potential to impact upon biodiversity, threatened flora species or fauna species at the site.
5 Groundwater Assessment

5.1 Soils

The 'Soil Landscapes of the Dubbo 1:250 000 Sheet' (Murphy and Lawrie, 1998) indicates that the site is located on the 'Eudomogo' soil landscape group and the 'Splitters Hill' soil landscape group.

The 'Eudomogo' soil landscape group covered approximately half of the site, and was generally consistent with the cleared farmland at the site. The 'Eudomogo' soil landscape group is described as follows:

- These soils are found on gently undulating rises ranging in elevation between 280 and 400m above sea level. They are typically occupied by savannah woodland dominated by white box on the upper slopes, yellow box on lower slopes and along drainage lines and white cypress on shallow soils on rocky ridges;
- The soils are derived from the Ballinmore formation (colluvial-alluvial material) and pockets of tertiary basalt;
- The landscape consists of Red Earths. Dark reddish brown to light reddish brown sandy loam in the upper 0.2m of the soil profile, underlain by dark reddish brown to light reddish brown fine sandy clay loam (0.2m to 1.0m bgl), underlain by mottled yellow and grey clay (1.0 to 1.5 m bgl);
- Soils have low to moderate fertility;
- Soils are susceptible to structural degradation including surface sealing, low infiltration and poor friability. Their water holding capacity is low to moderate and profile permeability is moderate to high. Subsoils are considered suitable for root growth; and
- Soil salinity is described as low however, there is potential for soil salinity to develop in the medium to long term.

The 'Splitters Hill' soil landscape group covered the remainder of the site, and was generally consistent with the remnant native vegetation present on the central rocky outcrop at the site. The 'Splitters Hill' soil landscape group is described as follows:

- These soils are located on scattered hillocks and ridges in the vicinity of Arthurville, Nabingerie and Wangbangalangal at elevations of 400-620m above sea level;
- These soils are typically occupied by dry-sclerophyll woodland, dominated by grey box, white box, and white box - yellow box -- white cypress pine associations;
- These soils are derived from a variety of geological units associated with the Cowra Trough Physiographic unit including sandstones, shales, tuffs and chalcedy;
- The landscape consists of mainly red podzolic soils with non-calcareous brown soils on the lower slopes with shallow soils on steep/rocky slopes and small areas of red-brown earths and red earths in association with the red podzolic soils;
- Soils have moderate fertility and are slightly acidic;
- Soils have a generally moderate to high erosion hazard; and
- Soil salinity problems are described as low;

The geology map 'Dubbo 1:100,000 Geological Series Sheet 8633 (2000)' indicates that the cleared portion of the site is located on the Triassic 'Napperby Formation' of the Gunnedah Basin Group Formation described as 'siltstone, thinly interbedded with fine to medium grained lithic quartz sandstone and minor conglomerate with bioturbation and burrows common'.
The geology map 'Dubbo 1:100,000 Geological Series Sheet 8633 (2000)' indicates that the remnant native vegetation area present on the central rocky outcrop of the site is located on the older Devonian 'Darnsen Docie' of the Hyland Creek Group Formation described as 'chertite and rhyolite'.

5.2 Hydrology

The Impact Group conducted a search of the NSW Government NSW Natural Resource Atlas website (http://www.nuratlas.nsw.gov.au) for registered groundwater works located within 1,000m of the Site. One registered bore was identified within 1,000m of the site. No groundwater bores were located within the site. Bore details are summarised in Table 5

Table 5: Groundwater Bores Located within 1,000m of the Site

<table>
<thead>
<tr>
<th>Bore ID</th>
<th>Date</th>
<th>Aquifer Type</th>
<th>Depth (m)</th>
<th>SWL (M)</th>
<th>Salinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>GW802318</td>
<td>2001</td>
<td>Granite – fractured rock</td>
<td>42.0</td>
<td>21.0</td>
<td>not stated</td>
</tr>
</tbody>
</table>

GW802318 was located approximately 300m to the north of the site and was licensed for stock, domestic and irrigation purposes. The bore intercepted groundwater at a depth of 37.0m below ground level within a granite – fractured rock formation. The bore had a recorded yield of 0.37 Litres per second, which is considered low. No details on water quality/salinity were available.

Based on this information there does not appear to be a significant aquifer used for beneficial purposes located beneath the site.

5.3 Potential Groundwater Impacts

The three main activities that have the potential to impact upon groundwater at the site are as follows:

- Standard household garden water use practices resulting in an increase in the amount of water being applied at the site;
- Rainwater run-off from additional hard stand areas resulting in an increased concentration of water being applied at the site; and
- The installation of an onsite sewage management system resulting in an increase in the amount of water being applied at the site (in the event that the development is not connected to the Dubbo sewerage system).

Each of these three activities involves the addition of water or treated effluent either at the surface or within 0.5m of the surface. The main potential impact of such activities would be a degradation of groundwater quality in the vicinity of the site.

5.4 Recommended Mitigation Measures

The following mitigation measures should be adopted to minimise the impact the proposed development may have on groundwater in the vicinity of the site:

- Implement water conservative irrigation practices and garden designs (i.e. native plants, water wise gardens, mulch and spray or dripper systems);
- Minimise the amount of reticulated water used to irrigate lawns and gardens;
- Retain as much native vegetation as possible especially deep rooted adult trees and shrubs;
- Re-vegetate and re-generate native vegetation across the property wherever possible;
- Ensure any construction or earthmoving minimises the ponding of surface water at the site;
• Ensure downpipes are fitted correctly and that they drain to rainwater tanks and not onto the ground next to buildings;
• Minimise the amount of additional hard surface area that is created at the site;
• Adopt household water use practices that minimise the loading placed on the onsite sewage management system;
• Minimise the amount of contaminants (chemicals/detergents, food scraps, oils/fats etc.) entering the onsite sewage management system;
• Locate the effluent disposal area (either the absorption bed or surface irrigation area) in an open, unshaded area to allow for maximum evaporation;
• Install a diversion drain on the high side of any effluent disposal area to divert surface water run-off away from the disposal area. This will help to minimise the loading on the effluent disposal area during wet weather;
• Do not drive over or disturb the effluent disposal area;
• Do not use any other water sources (town water, stored rain water etc.) to irrigate the effluent disposal area; and
• Ensure that the minimum buffer distances contained in Table 6 are maintained between the effluent disposal area and sensitive environments, as per The Dubbo City Council (2006) “Onsite Sewage Management Strategy”;

Table 6: Buffer Dimensions for Effluent Disposal Areas

<table>
<thead>
<tr>
<th>Feature</th>
<th>Buffer Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Drip / Trickle</td>
</tr>
<tr>
<td></td>
<td>Upslope</td>
</tr>
<tr>
<td>Dwelling</td>
<td>6</td>
</tr>
<tr>
<td>Driveway</td>
<td>6</td>
</tr>
<tr>
<td>Path</td>
<td>6</td>
</tr>
<tr>
<td>Pool</td>
<td>6</td>
</tr>
<tr>
<td>Permanent Water</td>
<td>100</td>
</tr>
<tr>
<td>Dam, non-permanent water</td>
<td>40</td>
</tr>
<tr>
<td>Property Boundary</td>
<td>6</td>
</tr>
<tr>
<td>Groundwater Bore</td>
<td>250</td>
</tr>
</tbody>
</table>

5.5 Groundwater Impact Assessment

The proposed development is likely to result in an increase in the amount of irrigation water applied at the site, in line with typical household garden water use practices.

The creation of additional hard stand areas at the site is likely to increase the concentration of water applied at the site, but not the amount of water applied at the site. The rainwater would have fallen on the site in any case, but any rain that falls on hard stand areas is concentrated as it runs off the hard stand area and onto the ground at the site.
The installation of an onsite sewage management system (in the event that the development is not
connected to the Dubbo sewerage system) is likely to result in an increase in the amount of water
applied at the site.

The information presented in Section 5.1 indicates that the first water bearing zone within the vicinity
of the site is likely to be at least 30m below ground level. This water bearing zone is likely to be low
yielding. The first aquifer accessed for stock and domestic purposes within the vicinity of the site is
likely to occur at a depth of between 35 to 40m below ground level. The closest registered
groundwater bores licensed to extract groundwater for stock and domestic purposes was located
250m to the north of the site. This separation distance meets the minimum required buffer distance
of 250m.

The site specific soil and climatic characteristics would act to limit the amount of water percolating
through the soil and potentially making its way into the groundwater system. The soils would slow
down the rate of water movement through the profile, and make this water available for uptake by
vegetation. High evaporation rates at the site would also act to limit the amount of surface water
infiltrating the upper subsoil.

The addition of water at the site by way of residential lawn and garden surface irrigation would not
be expected to result in a degradation of groundwater quality within the vicinity of the site provided
the mitigation measures outlined in Section 5.3 are adhered to.

Rainwater runoff from additional hard stand areas resulting in an increased concentration of water
being applied at the site would not be expected to result in a degradation of groundwater quality
within the vicinity of the site provided the mitigation measures outlined in Section 5.3 are adhered to.

The installation of an onsite sewage management system would result in appropriately treated
effluent being applied to site over a suitable area at the designed loading/irrigation rate. The addition
of effluent directly into the subsurface at an appropriately designed loading rate would not be expected
to result in a degradation of groundwater quality within the vicinity of the site provided the mitigation
measures outlined in Section 5.3 are adhered to.
6 Non-Aboriginal Heritage Assessment

6.1 Existing Environment

A search of the State Heritage Inventory online heritage database (http://www.environment.nsw.gov.au/heritageapp/heritagesearch.aspx#amapsearch) for the site indicated that there were no non-indigenous heritage sites located in the area.

A search of Schedule 5 of the Dubbo Local Environment Plan 2011 indicated that the site was not listed as a heritage item, heritage conservation area or archaeological site.

6.2 Statement of Heritage Significance

No items of heritage value are expected to be affected by the proposed works. A statement of heritage significance is not required.

6.3 Potential Non-Aboriginal Heritage Impacts

The proposed development is expected to have a low potential to impact upon non-aboriginal heritage at the site.
7 Aboriginal Heritage Assessment

7.1 Review of Previously Prepared Aboriginal Archaeological Assessment

The Impax Group reviewed the following Aboriginal Archaeological Assessment Report:

- Central West Archaeological and Heritage Services – Kelton, J. (December 1995): “An Archaeological Assessment for the Proposed “Glen Lee” Tourism Development, Camp Road, Dubbo, NSW.”

The report considered a study area which included the entire site (Lot 8 DP 1063425), along with an additional area between the northern boundary of the site and Camp Road, and an additional area between the eastern boundary of the site and Obley Road.

The report identified a total of eight open campsites, two scarred tree sites and one isolated artefact within the study area. Of these eleven identified Aboriginal Heritage Sites, six were located within the site (Lot 8 DP 1063425), comprising four open camp sites and two scarred tree sites, as described in Table 7.

Table 7: Aboriginal Heritage Sites identified within the Site (Lot 8 DP 1036425)

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Type</th>
<th>Location (GDA94 Zone SS)</th>
<th>Description</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-OS-1</td>
<td>Open campsite</td>
<td>649 150 E; 6 425 443 N</td>
<td>Scattering of 57 stone artefacts within a 500m x 20m area along an ephemeral creek</td>
<td>Moderate</td>
</tr>
<tr>
<td>GL-OS-2</td>
<td>Open campsite</td>
<td>649 610 E; 6 425 260 N</td>
<td>7 stone artefacts within a 20m x 5m area along an ephemeral creek</td>
<td>Low-moderate</td>
</tr>
<tr>
<td>GL-OS-6</td>
<td>Open campsite</td>
<td>648 870 E; 6 426 260 N</td>
<td>3 stone artefacts within a 5m x 3m area, 40m west of an ephemeral creek</td>
<td>Low-moderate</td>
</tr>
<tr>
<td>GL-OS-7</td>
<td>Open campsite</td>
<td>649 029 E; 6 425 371 N</td>
<td>3 stone artefacts within a 5m x 3m area, 20m west of an ephemeral creek</td>
<td>Low-moderate</td>
</tr>
<tr>
<td>GL-ST-1</td>
<td>Scarred Tree</td>
<td>649 060 E; 6 425 420 N</td>
<td>Standing dead Eucalyptus tree stump, 1.5m high, rated as ‘possible’ Aboriginal origin, associated with OS-1 and OS-7</td>
<td>Moderate</td>
</tr>
<tr>
<td>GL-ST-2</td>
<td>Scarred Tree</td>
<td>649 150 E; 6 424 561 N</td>
<td>Standing live Eucalyptus macrocarpa, rated as ‘possible’ Aboriginal origin. Tree diameter at scar location is 94cm, scar has dimensions of 266cm long, 30cm wide at middle, Moderate bark regrowth</td>
<td>Low</td>
</tr>
</tbody>
</table>

The six identified Aboriginal Heritage Sites located within the site (Lot 8 DP 1063425) were assessed as having low to moderate significance and Aboriginal Community Value.

7.2 Aboriginal Heritage Information Management System

A search of the Aboriginal Heritage Information Management System (AHIMS) database for the site indicated that six Aboriginal Sites or Aboriginal Places were recorded at or near the site. A copy of the AHIMS search is attached as Attachment G.

The six recorded Aboriginal Sites or Aboriginal Places on the AHIMS register were the six sites identified within the site (Lot 8 DP 1063425) by Central West Archaeological and Heritage Services in their 1995 report and described in Table 7.
7.3 Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW

The Impax Group reviewed the requirements of the NSW OEH (2010) "Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW" (Due Diligence CoP) in order to determine if the project required consent in the form of an Aboriginal Heritage Impact Permit (AHIP).

The flowchart presented in Section 1 of the Due Diligence CoP indicated that the generic due diligence code of practice presented in Section 8 of the Due Diligence CoP should be followed for the project, as follows:

1. Will the activity disturb the ground surface or any culturally modified trees?
   The proposal will disturb the ground surface at the site. No culturally modified trees would be disturbed.

2. Are there any:
   a) relevant confirmed site records or other associated landscape feature information on AHIMS?
      Yes.
      There are 16 recorded Aboriginal Sites recorded on AHIMS for the site, comprising of four open camp sites and two scar trees.
   b) any other sources of information of which a person is already aware?
      Yes.
      An Aboriginal Archaeological Assessment for the site was conducted in 1995.
   c) landscape features that are likely to indicate presence of aboriginal objects?
      No.

3. Can harm to Aboriginal objects listed in AHIMS or identified by other sources of information and/or the carrying out of the activity at the relevant landscape features be avoided?
   Yes.
   The location of the six recorded Aboriginal Sites is well documented and the proposed development at the site should be able to proceed without locating the six recorded Aboriginal Sites.

Answering yes to Question 3 above means that the generic due diligence process is complete. An AHIP application is not necessary, and the project may proceed with caution. If any Aboriginal Objects are found, work must be stopped and the OEH notified. If human remains are found, work must be stopped, the site secured and the OEH and the NSW Police Service must be notified.

7.4 Potential Aboriginal Heritage Impacts

The assessment of potential Aboriginal Heritage Impacts at the site is considered suitable with regards to the NSW Due Diligence CoP.

All Aboriginal Sites and Aboriginal Places are protected under the NSW National Parks and Wildlife Act 1974. It is an offence as per Part Six of the Act to harm or desecrate an Aboriginal Site or Aboriginal Place without authorisation of an Aboriginal Heritage Impact Permit (AHIP).

The location of the six recorded Aboriginal Sites within the site (Lot 8 DP 1065425) is well documented, and the proposed development should be able to proceed without impacting on any Aboriginal Sites, provided the development complies with its legal obligations under the NSW National Parks and Wildlife Act 1974.
8 Contamination Investigation

8.1 Sampling Locations and Methodology

Soil samples were collected at twenty-one separate locations across the study area. Soil sample locations are shown in Figure 1 of Attachment A. One soil sample was collected from within each of the new proposed Lots. The rationale behind soil sampling locations is documented in Table 8.

Table 8: Soil Sampling Locations

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot 1 0.0-0.1m</td>
<td>Located within Lot 1, in a lower lying sediment deposition area</td>
</tr>
<tr>
<td>Lot 2 0.0-0.1m</td>
<td>Located within Lot 2, in the centre of the Lot</td>
</tr>
<tr>
<td>Lot 3 0.0-0.1m</td>
<td>Located within Lot 3, on a break of slope transitioning to cleared land</td>
</tr>
<tr>
<td>Lot 4 0.0-0.1m</td>
<td>Located within Lot 4, on a break of slope transitioning to cleared land</td>
</tr>
<tr>
<td>Lot 5 0.0-0.1m</td>
<td>Located within Lot 5, within a clearing amongst remnant vegetation</td>
</tr>
<tr>
<td>Lot 6 0.0-0.1m</td>
<td>Located within Lot 6, on a break of slope transitioning to cleared land</td>
</tr>
<tr>
<td>Lot 7 0.0-0.1m</td>
<td>Located within Lot 7, adjacent to stockpiled soil material</td>
</tr>
<tr>
<td>Lot 8 0.0-0.1m</td>
<td>Located within Lot 8, at the downstream termination of a formed contour bank</td>
</tr>
<tr>
<td>Lot 9 0.0-0.1m</td>
<td>Located within Lot 9, at the downstream termination of a formed contour bank</td>
</tr>
<tr>
<td>Lot 10 0.0-0.1m</td>
<td>Located within Lot 10, upstream of a dam in the lower portion of the Lot</td>
</tr>
<tr>
<td>Lot 11 0.0-0.1m</td>
<td>Located within Lot 11, within an ephemeral creek bed</td>
</tr>
<tr>
<td>Lot 12 0.0-0.1m</td>
<td>Located within Lot 12, in the centre of the Lot</td>
</tr>
<tr>
<td>Lot 13 0.0-0.1m</td>
<td>Located within Lot 13, in the centre of the Lot</td>
</tr>
<tr>
<td>Lot 14 0.0-0.1m</td>
<td>Located within Lot 14, within a dry farm dam</td>
</tr>
<tr>
<td>Lot 15 0.0-0.1m</td>
<td>Located within Lot 15, within an ephemeral creek bed</td>
</tr>
<tr>
<td>Lot 16 0.0-0.1m</td>
<td>Located within Lot 16, upstream of a dam</td>
</tr>
<tr>
<td>Lot 17 0.0-0.1m</td>
<td>Located within Lot 17, in the centre of the Lot</td>
</tr>
<tr>
<td>Lot 18 0.0-0.1m</td>
<td>Located within Lot 18, on a break of slope transitioning to cleared land</td>
</tr>
<tr>
<td>Lot 19 0.0-0.1m</td>
<td>Located within Lot 19, within a local drainage line</td>
</tr>
<tr>
<td>Lot 20 0.0-0.1m</td>
<td>Located within Lot 20, in the centre of the lot</td>
</tr>
<tr>
<td>Lot 21 0.0-0.1m</td>
<td>Located within Lot 21, within a clearing amongst remnant vegetation</td>
</tr>
</tbody>
</table>

Soil samples were collected on 24-25 May 2016. Samples were collected using a stainless steel hand trowel, shovel and auger. Sampling equipment was thoroughly cleaned and rinsed between sampling locations.

Samples were collected directly into a 125mL laboratory supplied glass jar. The sampler wore a clean pair of disposable nitrile gloves at each sampling location to minimise potential cross contamination of samples. Care was taken to minimise volatile and semi-volatile organic compound losses during sampling by minimising the head space in each sample jar. Soil samples were placed into an ice filled cooler immediately after sampling to minimise potential losses of volatile and semi-volatile compounds during transport.
8.2 Field Observations

Field observations recorded at each sampling location are summarised in Table 9.

Table 9: Field Observations

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot 1 0.0-0.1m</td>
<td>Light brown dry sandy silt, no staining, no odour</td>
</tr>
<tr>
<td>Lot 2 0.0-0.1m</td>
<td>Light brown dry sandy silt, no staining, no odour</td>
</tr>
<tr>
<td>Lot 3 0.0-0.1m</td>
<td>Light brown dry sandy silt with ironstone/mudstone chips, no staining, no odour</td>
</tr>
<tr>
<td>Lot 4 0.0-0.1m</td>
<td>Light brown dry sandy clay, no staining, no odour</td>
</tr>
<tr>
<td>Lot 5 0.0-0.1m</td>
<td>Light brown dry silty sand, no staining, no odour</td>
</tr>
<tr>
<td>Lot 6 0.0-0.1m</td>
<td>Light brown dry silty sand, no staining, no odour</td>
</tr>
<tr>
<td>Lot 7 0.0-0.1m</td>
<td>Light brown/brown dry sandy silt, no staining, no odour</td>
</tr>
<tr>
<td>Lot 8 0.0-0.1m</td>
<td>Brown dry silt, no staining, no odour</td>
</tr>
<tr>
<td>Lot 9 0.0-0.1m</td>
<td>Brown dry sandy silt, no staining, no odour</td>
</tr>
<tr>
<td>Lot 10 0.0-0.1m</td>
<td>Brown dry sandy silt, no staining, no odour</td>
</tr>
<tr>
<td>Lot 11 0.0-0.1m</td>
<td>Brown dry silt, no staining, no odour</td>
</tr>
<tr>
<td>Lot 12 0.0-0.1m</td>
<td>Light brown dry sandy silt, no staining, no odour</td>
</tr>
<tr>
<td>Lot 13 0.0-0.1m</td>
<td>Light brown dry sandy silt, no staining, no odour</td>
</tr>
<tr>
<td>Lot 14 0.0-0.1m</td>
<td>Brown dry clay, no staining, no odour</td>
</tr>
<tr>
<td>Lot 15 0.0-0.1m</td>
<td>Brown dry silty clay, no staining, no odour</td>
</tr>
<tr>
<td>Lot 16 0.0-0.1m</td>
<td>Brown dry silty clay, no staining, no odour</td>
</tr>
<tr>
<td>Lot 17 0.0-0.1m</td>
<td>Light brown dry sandy silty clay, no staining, no odour</td>
</tr>
<tr>
<td>Lot 18 0.0-0.1m</td>
<td>Brown dry sandy silt, no staining, no odour</td>
</tr>
<tr>
<td>Lot 19 0.0-0.1m</td>
<td>Brown dry sandy silt, no staining, no odour</td>
</tr>
<tr>
<td>Lot 20 0.0-0.1m</td>
<td>Brown dry sandy clay, no staining, no odour</td>
</tr>
<tr>
<td>Lot 21 0.0-0.1m</td>
<td>Light brown dry sandy silt, no staining, no odour</td>
</tr>
</tbody>
</table>

No odours or staining indicative of potential contamination were observed within soils at the site.

8.3 Sample Analysis

Sample details and analytical requirements were documented on a Chain of Custody (COC) form. The COC and samples were couriered to Envirolab Services in Sydney for analysis.

Soil samples were analysed for organochlorine and organophosphorus pesticides (OCPs and OPPs), priority heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, mercury and zinc), pH and electrical conductivity (EC).

Envirolab Services performed all laboratory analysis using National Association of Testing Authorities (NATA) accredited analytical methods.

8.4 Soil Assessment Criteria

Soil analytical results were assessed against the Health Investigation Levels (HILs) outlined in National Environmental Protection (Assessment of Site Contamination) Measure (NEPM 2013), 'Schedule B1 – Guideline on Investigation Levels for Soil and Groundwater'. Soil analytical results were assessed against HIL/HSL A – Residential with gardens/accessible soil.
The assessment criteria are considered appropriate considering the sites proposed future use for rural-residential purposes.

8.5 Analytical Results

Soil analytical results are summarised and compared to the adopted assessment criteria in Table B1, Table B2 and Table B3 of Attachment B.

The laboratory certificates of analysis for the surface soil samples collected at the site are presented as Attachment C.

The reported concentrations of all analytes in all samples were less than the adopted assessment criteria.

8.6 The Impax Group QA/QC

All field work was conducted in accordance with industry accepted standards and in accordance with The Impax Group’s standard operating field procedures. Field quality control included rigorous sample collection, sample documentation, use of clean gloves for the collection of each sample, correct use of field equipment and storage of samples with appropriate cooling media.

Standard sampling procedures were employed to ensure that the soil collected had not been in direct contact with the sampling tool (where used). Hand excavation equipment was cleaned between sampling locations to minimise potential for cross contamination to occur.

Laboratory analytical results were consistent with field observations. No stained areas of soil material were observed, and no odours were detected during the site inspection.

The consistency of results and field observations indicates that the sampling and analytical methods used during the project are repeatable and that results obtained from sampling are representative of actual conditions within soil at the study area.

8.7 Laboratory QA/QC

An evaluation of QA/QC procedures, including COC documentation, sample integrity and holding times, use of acceptable NATA analytical methods and laboratory QA/QC test results was completed by The Impax Group.

Chain of custody documentation was signed and dated by the laboratory stating that all samples were received cool and in good order, and were presented in appropriate sample containers. Samples submitted for volatile compound analysis were correctly contained with no headspace and all samples were labelled appropriately according to current field sampling protocols undertaken by The Impax Group.

Laboratory analysis of soil samples for all analytes was undertaken within the required technical holding times.

Envirolab performed internal QA/QC testing and a review in accordance with NATA requirements, and standards established by them. Laboratory QA/QC testing included analysis for laboratory surrogates and analysis of laboratory duplicates, matrix spikes, method blanks and laboratory control samples.

Results of laboratory QA/QC sample analysis were as follows:

- Analytes were not detected in any of the method blank samples;
- Recovery of surrogates and spiked compounds in all samples were within the laboratories acceptable range.
- Calculated RPDs for laboratory duplicates were within the laboratories target range.

The results of the laboratory QAQC review indicate that the analytical results reported by Envirolab are accurate and precise, and can be relied upon to make the conclusions outlined in this report.
9 Conclusions

The Impax Group concludes the following:

Based on the aerial photography review, land title records and OEH records it would appear that no potentially contaminating activities have been undertaken at the site.

- Based on the aerial photography review, land title records and OEH records it would appear that no potentially contaminating activities have been undertaken at the site;
- No areas of potential environment concern were identified as part of the site history review;
- No threatened flora or fauna species were recorded within the site. Of the three threatened species recorded within 1,000m of the site one threatened fauna species (Grey-crowned Babbler) was assessed as having a moderate likelihood of occurring within the site;
- The proposed development is expected to have a low potential to impact upon biodiversity, threatened flora species or fauna species at the site;
- The site is located on the 'Edomogo' soil landscape group and the 'Splitters Hill' soil landscape group, which are described as low to moderate fertility red earth and red podzolic soils with low soil salinity;
- No groundwater bores were present within the site;
- There does not appear to be a significant aquifer used for beneficial purposes located beneath the site;
- The addition of water at the site by way of residential lawn and garden surface irrigation would not be expected to result in a degradation of groundwater quality within the vicinity of the site;
- Rainwater runoff from additional hard stand areas resulting in an increased concentration of water being applied at the site would not be expected to result in a degradation of groundwater quality within the vicinity of the site;
- The addition of effluent directly into the subsoil at an appropriately designed loading rate would not be expected to result in a degradation of groundwater quality within the vicinity of the site;
- The proposed development is expected to have a low potential to impact upon non-aboriginal heritage at the site;
- The assessment of potential Aboriginal Heritage impacts at the site is considered suitable with regards to the NSW Due Diligence CoP;
- The location of the six recorded Aboriginal Sites within the site (Lot 8 1063425) is well documented, and the proposed development should be able to proceed without impacting on any Aboriginal Sites, provided the development complies with its legal obligations under the NSW National Parks and Wildlife Act 1974.
- 21 primary soil samples were collected from the site;
- Soils from the site consisted of dry sandy silts, silty clays, silty sands and clays and with no odours or staining;
- Concentrations of common contaminants of concern within soils at the study area were below the threshold concentrations for residential land use; and
- The soil within the study area is considered suitable for the proposed development with regards to contamination.
Attachment A: Figures
Attachment B:

Laboratory Results Summary Table
### TABLE B1

Summary of Analytical Results - Heavy Metals in Soil (mg/kg)  
Camp Road

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Sample Depth (m bgl)</th>
<th>Sampling Date</th>
<th>Arsenic</th>
<th>Cadmium</th>
<th>Chromium</th>
<th>Copper</th>
<th>Lead</th>
<th>Mercury</th>
<th>Nickel</th>
<th>Zinc</th>
<th>Electrical Conductivity (usm/cm)</th>
<th>pH</th>
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</thead>
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<td>1</td>
<td>1</td>
<td>0.1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
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<td>&lt;0.4</td>
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<td>8</td>
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<td>6.5</td>
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<td>&lt;0.4</td>
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<td>5</td>
<td>7</td>
<td>&lt;0.1</td>
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<td>12</td>
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<td>5.8</td>
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<td>&lt;0.4</td>
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<td>4</td>
<td>15</td>
<td>&lt;0.1</td>
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<tr>
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<td>&lt;0.4</td>
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<td>7</td>
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<tr>
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<td>&lt;0.4</td>
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<td>12</td>
<td>12</td>
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<td>31</td>
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<td>16</td>
<td>8</td>
<td>&lt;0.1</td>
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<td>46</td>
<td>188</td>
<td>5.3</td>
</tr>
<tr>
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</tr>
<tr>
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<td>24-May-16</td>
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<td>16</td>
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<td>7</td>
<td>11</td>
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<td>&lt;0.1</td>
<td>6</td>
<td>21</td>
<td>39</td>
<td>5.6</td>
</tr>
</tbody>
</table>

Shaded cell indicates concentration exceeds assessment criteria.
### Summary of Analytical Results - Organochlorine Pesticides in Soil (ng/kg)

#### Camp Road


#### Table B2

Shaded cells indicate concentration exceeds assessment criteria.
### TABLE B3

Summary of Analytical Results - Organophosphorus Pesticides in Soil (mg/kg)
Camp Road

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Depth (m)</th>
<th>Sampling Date</th>
<th>Median</th>
<th>95th</th>
<th>99th</th>
<th>Diuron</th>
<th>Dichlorvos</th>
<th>Dinoseb</th>
<th>Diuron</th>
<th>Diquat</th>
<th>Etox</th>
<th>Fenuron</th>
<th>Fenuron HBA</th>
<th>Malathion</th>
<th>Parathion</th>
<th>Residues</th>
<th>Round</th>
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<tbody>
<tr>
<td>EQI</td>
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</table>

**Assessment Criteria**

ASC NEPM 2013 Soil HIL A

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<th>&lt;0.1</th>
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</thead>
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<td>&lt;0.1</td>
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</tr>
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<tr>
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</tr>
<tr>
<td>Lot 5</td>
<td>0.0-0.1m</td>
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</tr>
<tr>
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<td>&lt;0.1</td>
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</tr>
<tr>
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Shaded cell indicates concentration exceeds assessment criteria.
Attachment C: Laboratory Certificates of Analysis
CERTIFICATE OF ANALYSIS

147410

Client:
The Impax Group Pty Ltd
PO Box 6157
Dubbo
NSW 2830

Attention: Brendan Allen

Sample log in details:

Your Reference: 2016-022, Matt Bender Construction
No. of samples: 21 Soils
Date samples received / completed instructions received 26/05/16 / 26/05/16

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:
Date results requested by / Issue Date: 2/05/16 / 1/06/16
Date of Preliminary Report: Not Issued
NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025. Tests not covered by NATA are denoted with *.

Results Approved By:

[Signature]
Laboratory Manager

Envirolab Reference: 147410
Revision No: R 00
<p>| Organic and Pesticides in soil | UNITS | 14741|1-1 | 14741|1-2 | 14741|1-3 | 14741|1-4 | 14741|1-5 |
|-------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Date Sampled                  | mL    | 25/05/2016 | 25/05/2016 | 25/05/2016 | 25/05/2016 | 25/05/2016 |
| Type of soil                  | mL    | Soil   | Soil   | Soil   | Soil   | Soil   |
| Date extracted                | mL    | 25/05/2016 | 25/05/2016 | 25/05/2016 | 25/05/2016 | 25/05/2016 |
| Hexane                       | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| alpha-BHC                    | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| gamma-BHC                   | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| beta-BHC                    | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| Heptachlor                   | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| delta-BHC                   | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| Aldrin                       | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| Heptachlor Epoxyres           | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| gamma-Criptoxyres           | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| alpha-chlordane             | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| Endosulfan II                | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| ype-DCO                       | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| Dieldrin                   | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| Endrin                      | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| Endosulfan III               | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| ype-DDT                       | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| Endrin Aldehyde             | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| Endosulfan Ethylene           | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| Neomycin                   | g/kg | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   | &lt;0.1   |
| Somaplast TCM         | %    | 93     | 93     | 94     | 92     | 83    |</p>
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### Client Reference:
2016-022, Matt Bender Construction

### Environmental Parameters

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### Additional Notes
- Envirolab Reference: 147410
- Revision No: R.00

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**APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD**

**ITEM NO: PDEC17/14**

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**PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE**

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error lab Reference: 147410
Revision No: R.03
### Organophosphorus Pesticides

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**Organophosphorus Pesticides:**

| **Azinphos-methyl (Guthion)** | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 |
| **Biomphoraphos-ethyl** | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 |
| **Chlorpyrifos** | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 |
| **Chlorpyrifos-methyl** | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 |
| **Diazinon** | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 |
| **Dichlorvos** | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 |
| **Dimethoate** | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 |
| **Ethion** | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 |
| **Fenitrothion** | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 |
| **Malathion** | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 |
| **Parathion** | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 |
| **Rhodrin** | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 |
| **Surrogate TCM** | % | 93 | 93 | 97 | 99 | 93 | 93 |

**Note:** All values are below the detection limit (BDL) unless indicated.

---

**Emenetlab Reference:** 147410

**Revision No:** R.02
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<th>ITEM NO: PDEC17/14</th>
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### Acid Extractable metals in soil

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### Acidity Extractable metals (local)

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Envilab Reference: 147410-
Revision No: R-02

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Revision No: R00
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#### APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

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| Date Prepared   | 31/05/2016 | 31/05/2016 | 31/05/2016 | 31/05/2016 | 31/05/2016 |
| Date Analysed   | 31/05/2016 | 31/05/2016 | 31/05/2016 | 31/05/2016 | 31/05/2016 |

| pH of Soil/water | pH Units | 8.8 | 8.2 | 8.2 | 8.1 | 8.2 |
| Electrical Conductivity of soil/water | μS/cm | 143 | 48 | 93 | 42 | 93 |

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| Date Prepared   | 31/05/2016 | 31/05/2016 | 31/05/2016 | 31/05/2016 | 31/05/2016 |
| Date Analysed   | 31/05/2016 | 31/05/2016 | 31/05/2016 | 31/05/2016 | 31/05/2016 |

| pH of Soil/water | pH Units | 8.1 | 8.0 | 8.0 | 8.0 | 8.0 |
| Electrical Conductivity of soil/water | μS/cm | 52 | 120 | 75 | 110 | 71 |

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| Date Analysed   | 31/05/2016 | 31/05/2016 | 31/05/2016 | 31/05/2016 | 31/05/2016 |

| pH of Soil/water | pH Units | 8.3 | 8.0 | 8.0 | 8.0 | 8.0 |
| Electrical Conductivity of soil/water | μS/cm | 200 | 38 | 100 | 45 |

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<td>Lot 18</td>
<td>Lot 19</td>
<td>Lot 20</td>
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<td>0.0-0.1m</td>
<td>0.0-0.1m</td>
<td>0.0-0.1m</td>
</tr>
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| Date Analysed   | 31/05/2016 | 31/05/2016 | 31/05/2016 | 31/05/2016 | 31/05/2016 |

| pH of Soil/water | pH Units | 8.2 | 8.4 | 8.4 | 8.4 | 8.4 |
| Electrical Conductivity of soil/water | μS/cm | 39 | 89 | 39 | 99 | 99 |

---

**Environlab Reference:** 147410

**Revision No:** 8.00

**Page 15 of 25**
<table>
<thead>
<tr>
<th>Client Reference</th>
<th>2016-022, Matt Bender Construction</th>
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<tr>
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Emiolab Reference: 147410
Revision No: R.92
### Method ID | Methodology/Summary
--- | ---
Org-005 | Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-008 | Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Metals-020 | Determination of various metals by ICP-AES.
Metals-021 | Determination of Mercury by Cold Vapour AAS.
Inorg-008 | Moisture content determined by heating at 105±5 deg C for a minimum of 12 hours.
Inorg-001 | pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analyses outside of the APHA storage times.
Inorg-002 | Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Raymont & Lyons.
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<thead>
<tr>
<th>Compound</th>
<th>Units</th>
<th>PDL</th>
<th>Method</th>
<th>Blank</th>
<th>Duplicate 1</th>
<th>Duplicate 2</th>
<th>Spike</th>
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*Envirolab Reference: 147410*
### 2016-022, Matt Bender Construction

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#### Organophosphorus Pesticides

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#### Azoxy-azo-methyl (Sulphur)

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#### Acid Extractable metals in soil

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### Quality Control

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### Quality Control

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<td>Surrogate TCMD %</td>
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## Quality Control

### Organic Phosphorus

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<th>Duplicates Base + Duplicate + % RPD</th>
<th>Spike Similar</th>
<th>Spike % Recovery</th>
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<tr>
<td>147405-11</td>
<td>147405-2</td>
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### Acid Extractable metals in soil

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<th>Spike % Recovery</th>
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<td>27/05/2016</td>
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<tr>
<td>----------------</td>
<td>-------</td>
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<td>Organochlorine Pesticides</td>
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<tr>
<td>Insoil</td>
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<tr>
<td>gamma-BHC</td>
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<tr>
<td>beta-BHC</td>
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<tr>
<td>Heptachlor</td>
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<td>delta-BHC</td>
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<td>Endosulfan I</td>
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<td>pp-DDE</td>
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<td>pp-DDD</td>
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<td>Dichlorvos</td>
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<td>Dinichlodone</td>
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<td>Fenithion</td>
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<td>Methion</td>
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### QUALITY CONTROL

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<td>Misc inorganic - soil</td>
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<td>Date analysed</td>
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<td>pH 1:5 soil/water</td>
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<td>89/87 RPD:2</td>
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Envirolab Reference: 147410  
Revision No: R 00
Report Comments:

Asbestos ID was analysed by Approved Identifier: Not applicable for this job
Asbestos ID was authorised by Approved Signatory: Not applicable for this job

INS: Insufficient sample for this test  PQL: Practical Quantitation Limit  NT: Not tested
NR: Test not required  RPD: Relative Percent Difference  NA: Test not required
<: Less than  >: Greater than  LCS: Laboratory Control Sample
Quality Control Definitions
Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike: A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample): This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria
Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 80-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Environment are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.
<table>
<thead>
<tr>
<th>Item No</th>
<th>Description</th>
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<tr>
<td>PDEC17/14</td>
<td>Original Planning Proposal - 4L Camp Road</td>
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Attachment D:  
Historical Aerial Photographs
APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

ITEM NO: PDEC17/14

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 177
Attachment E: Land Title Search Records
ADVANCE LEGAL SEARCHERS PTY LTD
(ACN 147 943 842)
ABN 82 149 943 842

P.O. Box 149
Yagoona NSW 2199

Telephone:  +612 9644 1679
Mobile:  0412 169 809
Facsimile:  +612 8076 5026
Email: alsearch@optusnet.com.au

13th May, 2016

THE IMPAX GROUP PTY LIMITED
PO Box 6157,
DUBBO NSW 2830

Attention: Brendan Allen,

RE:  4L Camp Road,
     Dubbo

Current Search

Folio Identifier 8/1063425 (title attached)
DP 1063425 (plan attached)
Dated 10th May, 2016
Registered Proprietor:
LEETINA KISH BENDER
-2-

Title Tree
Lot 8 DP 1063425

Folio Identifier 8/1063425
Folio Identifier 6/1033752
Folio Identifier 4/1017984

(a) Folio Identifier 236/40152
CTVol 14130 Folio 104
CTVol 2228 Folio 193

(b) Folio Identifier 1941/866937
Folio Identifier 194/753233
CTVol 2228 Folio 208

****     ****

Summary of proprietor(s)
Lot 8 DP 1063425

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<td>(Lot 8 DP 1063425)</td>
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<tr>
<td>2004 — to date</td>
<td>Leetina Kish Bender</td>
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<tr>
<td>2004 — 2004</td>
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See Notes (a) & (b)
Note (a)

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<td>Margaret Leah Anthony</td>
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<td>1988</td>
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<td>Edwin Walter Anthony</td>
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<td>1985</td>
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<td>Ian Cecil McMonigal</td>
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<td>Kathleen Elizabeth McMonigal</td>
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<td>1980</td>
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<td>John Archibald Morris, builder</td>
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<td>(Portion 195 Parish Dubbo – Area 215 Acres – CTVol 2228 Fol 193)</td>
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<td>1970</td>
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Note (b)

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<td>(Portions 194 Parish Dubbo – Area 305 Acres 3 Roods – CTVol 2228 Fol 208)</td>
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<td>1966</td>
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<td>1913</td>
<td>1966</td>
<td>Emma Hilton, widow</td>
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APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 191
**APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD**

**ITEM NO: PDEC17/14**

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**Advance Legal Searchers Pty Ltd**

Phone: 02 9644 1679

Advance Legal Searchers Pty Ltd hereby certifies that the information contained in this document has been provided electronically by the Registrar General.

Information provided through Tri-Search an approved LPAINS Information Broker

LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

---

**SEARCH DATE**

10/5/2016 4:15PM

---

**FOLIO:** 4/1017984

---

**First Title(s):** VGL 2228 FOL 108

**Prior Title(s):** 216/40122 1941/866937

---

**Recorded Number** | **Type of Instrument** | **C.T. Issue**
--- | --- | ---
3/10/2000 | DEPOSITED PLAN | FOLIO CREATED

---

**Edition 1**

18/9/2001 | DEPOSITED PLAN | FOLIO CANCELLED

---

*** END OF SEARCH ***

---

*ANY ENTERIES PRECEDED BY AN ASTERISK DO NOT APPEAR ON THE CURRENT EDITION OF THE CERTIFICATE OF TITLE. MAKING THE INFORMATION APPEARING UNDER NOTIFICATIONS HAS NOT BEEN FIRMLY ENTERED IN THE REGISTER.*
Advance Legal Searchers Pty Ltd

APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

Information provided through T4 Search an approved LPINSW Information Broker

LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH

SEARCH DATE

10/5/2016 4:13PM

FOLIO: 6/1033792

First Title(s): VOLL FOL 193 VOLL FOL 208
Print Title(s): 4/1037994

Recorded Number Type of Instrument C.T. Issue
18/9/2001 DP1033792 DEPOSITED PLAN FOLIO CREATED EDITION 1
21/1/2004 DP1063428 DEPOSITED PLAN FOLIO CANCELLED

*** END OF SEARCH ***

Impax - Dubbo

PRINTED ON 10/5/2016

*Any entries preceded by an asterisk do not appear on the current edition of the Certificate of Title. Warning: The information appearing under notices has not been formally recorded in the Registry.

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
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Impex - Dubbo

PRINTED ON 10/5/2016

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APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

| Item No: PDEC17/14 |

**Advance Legal Searchers Pty Ltd**

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**LAND AND PROPERTY INFORMATION NEW SOUTH WALES - HISTORICAL SEARCH**

**Search Date**

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10/5/2016 4:17PM

**Folio:** 236/40152

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**Prior Title(s):** VOL 14190 PG 704

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*Items recorded prior to an asterisk do not appear on the current edition of the Certificate of Title. Warning: The information appearing under mutations has not been formally recorded in the Register.*
TRANSFER
Real Property Act, 1900

Office of the Registrar

(A) LAND TRANSFERRED

194/753233

(B) LODGED BY

LTO. Box
PO Box 193
Scone, NSW 2337

Name, Address or DIX and Telephone

(C) TRANSFEROR

IAN KEVIN HARTLEY

(D) acknowledges receipt of the consideration of $190,000.00

(E) subject to the following ENCUMBRANCES

(F) TRANSFEREE

WARREN THOMAS QUIRK

(G) TENANCY:

(H) We certify that this transfer is correct for the purposes of the Real Property Act, 1900.

SIGNED IN MY PRESENCE BY THE TRANSFEROR WHO IS PERSONALY KNOWN TO ME.

CLIFFORD JAMES MATT

Address of Witness

INSTRUCTIONS FOR FILING OUT THIS FORM ARE AVAILABLE FROM THE LAND REGISTERS OFFICE

CHECKED BY (office use only)

Australasian Commercial and Law Stationery 1991
APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

ITEM NO: PDEC17/14

TRANSFER
Real Property Act, 1900

Reg:Cipax - dubbo /Strt:T

(A) LAND TRANSFERRED
Show as more than 30 References to Title.
If appropriate, specify the chain transferred.

236/40152

(B) LODGED BY
LTO. Rec Name, Address or DK and Telephone
21om
PETER J CORCORAN

(C) TRANSFEROR
EDWIN WALTER ANTHONY and MARGARET LEAH ANTHONY

(D) acknowledges receipt of the consideration of $250,999.00 and as regards the land specified above transfers to the Transferee an estate in fee simple

(E) subject to the following ENCUMBRANCES

1.  
2.  
3.  

(F) TRANSFEEEE
TWARREN THOMAS QUIRK

(G) TENANCY:

(H) We certify this dealing correct for the purposes of the Real Property Act, 1900. DATED 12-3-1995
Signed in my presence by the Transferor who is personally known to me.

K.A. Baker

KENNETH ALBERT BAKER
34 CHURCH STREET DUBBO

(SIGNATURE)
SOLICITOR

Signed in my presence by the Transferee who is personally known to

Signature of Witness

INSTRUCTIONS FOR FILLING OUT THIS FORM ARE AVAILABLE FROM THE LAND TITLES OFFICE

Page 199

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
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**PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE**
Page 201
Attachment F:
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Attachment G:  
AHIMS Search Results
AHIMS Web Services (AWS) Search Result

Dear Sir or Madam,

AHIMS Web Service search for the following area at Lot B, DP 1863425 with a Buffer of 50 meters, conducted by Brendan Allen on 27 June 2016.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.

A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

- Aboriginal sites are recorded in or near the above location.
- Aboriginal places have been declared in or near the above location.

---

APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

ITEM NO: PDEC17/14
If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of Practice.
- You can get further information about Aboriginal places by looking at the gazetted notice that declared it.
- Aboriginal places gazetted after 2001 are available on the NSW Government Gazette (http://www.nsw.gov.au/gazette) website. Gazette notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request.

Important information about your AHIMS search:

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested, it is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister.
- Information recorded on AHIMS may vary in its accuracy and may not be up-to-date. Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings.
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in these areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remain valid for 12 months.
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Report generated by AHIMS Web Service on 17/06/2011 for Brendan Allen for the following area or site : B: DP091043125 with a Buffer of 50 meters. Additional Info: Dist. Diggings. Number of Aboriginal sites and Aboriginal objects found in it.

The information contained herein is the result of a search conducted by the Australian Heritage Information Management System (AHIMS). It should be noted that the information contained herein is not an indication of the legal status of the site or object and should not be relied upon as such.
Proposed New Residential Development
Noise Assessment of Motor Sports

At:
4L Camp Road,
Dubbo,
NSW 2830.

May 2016

Report No. nss 22429 – Final

Prepared at the Request of:-
DOHERTY SMITH & ASSOCIATES
4/2 Blueridge Drive
Dubbo NSW 2830

Prepared by:-
NOISE AND SOUND SERVICES
Spectrum House, 3, Cassandra Avenue, St Ives, NSW 2075
Tel: (02) 9449 6499. Mob: 0411 648153
E-mail: noisesound@optusnet.com.au Website: www.noiseandsound.com.au
A member firm of the Association of Australian Acoustical Consultants
ABN: 7277 134 9599
CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>1</td>
</tr>
<tr>
<td>1. INTRODUCTION</td>
<td>2</td>
</tr>
<tr>
<td>2. SITE AND BUILDING DESCRIPTION</td>
<td>2</td>
</tr>
<tr>
<td>2.1 Site Description</td>
<td>2</td>
</tr>
<tr>
<td>2.2 Development Description</td>
<td>3</td>
</tr>
<tr>
<td>3. CRITERIA</td>
<td>3</td>
</tr>
<tr>
<td>4. MEASURED NOISE LEVELS</td>
<td>4</td>
</tr>
<tr>
<td>4.1 Measurement Procedure</td>
<td>4</td>
</tr>
<tr>
<td>4.2 Instrumentation - Attended</td>
<td>4</td>
</tr>
<tr>
<td>4.3 Instrumentation – Unattended</td>
<td>5</td>
</tr>
<tr>
<td>4.4 Noise Level Results</td>
<td>5</td>
</tr>
<tr>
<td>5. NOISE MODELS</td>
<td>7</td>
</tr>
<tr>
<td>5.1 External Noise Modelling Specifications</td>
<td>7</td>
</tr>
<tr>
<td>5.2 Noise Modelling Equations</td>
<td>7</td>
</tr>
<tr>
<td>5.3 Internal Noise Levels</td>
<td>8</td>
</tr>
<tr>
<td>6. RECOMMENDATIONS</td>
<td>9</td>
</tr>
<tr>
<td>6.1 Roof / Ceiling and Wall Construction</td>
<td>9</td>
</tr>
<tr>
<td>6.2 Wall Construction</td>
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<tr>
<td>6.3 Plasterboard Corner Details</td>
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<td>6.4 Windows and Glazed Doors</td>
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<td>6.5 Ventilation</td>
<td>11</td>
</tr>
<tr>
<td>7. CONCLUSIONS</td>
<td>11</td>
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APPENDIX A – EXAMPLE MATERIAL SUPPLIERS 12
EXECUTIVE SUMMARY

It is proposed to rezone Lot 8 DP1063425, 4L Camp Road, Dubbo. Currently the land is zoned SP3 Tourist. The proponent wishes to rezone the land so that much of the area is changed to RU2 Rural Landscape. It is proposed to subdivide the land into 26 Lots with new dwellings on 24 of the Lots (Lots 2 to 25). Located adjacent to the site is the Morris Park Motorsport Complex. This report considers the impact of noise from motorsport events at Morris Park on future residences on the subject land and suggests mitigation measures.

The noise assessment was carried out during a motor sports event close to Camp Road, Dubbo, NSW 2830 and provides an independent and accurate appraisal of the noise levels. This was during the use of the Morris Park Speedway, Obley Road/ Belowie Road, Dubbo adjacent to the proposed residential development at Lot 8 DP1063425, 4L Camp Road, Dubbo, NSW 2830.

Noise levels have been measured at three locations and the external sound pressure level from a source noise has been modelled for the whole site using the International Standard ISO 9613-2 (1996(E)) ‘Acoustic – Attenuation of sound during propagation outdoors Part 2 General method of calculation’.

With the recommended building element acoustical designs, the internal noise goals can be met for future dwellings during motor sports events. Hence it is concluded that the internal noise criteria as given in The State Environmental Planning Policy (Infrastructure) 2007, Subdivision 2 Development Clause 102, Impact of road noise on non-road can be fully met for proposed residential dwellings at Lot 8 DP1063425, 4L Camp Road, Dubbo, NSW 2830 during the use of motorsport events at Morris Park.
1. INTRODUCTION

Noise and Sound Services was requested by Doherty Smith & Associates of 4/2 Blueridge Drive, Dubbo NSW 2830, to carry out a noise assessment on behalf of Matt Bender Constructions during a motor sports event close to Camp Road, Dubbo, NSW 2830.

The purpose of the assessment is to provide an independent and accurate appraisal of the noise levels from the Morris Park Motor Sport Complex: Dubbo (Morris Park Speedway) Obley Road/Beulawrie Road, Dubbo, NSW 2830 at the proposed residential development at Lot 8 DP1063425, 4L Camp Road, Dubbo, NSW 2830 to enable internal noise goals to be met in future dwellings during motor sports events.

2. SITE AND DEVELOPMENT DESCRIPTION

2.1 Site Description

The site is in a rural area approximately 6.5 km south-southeast of Dubbo City centre. The Morris Park Speedway is located on an existing track as shown in Figure 1 below.

![Image of site plan](https://via.placeholder.com/150)

*Figure 1. Site Plan. Source: Google Earth.*
2.2 Development Description

It is proposed to rezone Lot 8 DP1063425, 4L Camp Road, Dubbo. Currently the land is zoned SP3 Tourist. The proponent wishes to rezone the land so that multi of the area is changed to RU2 Rural Landscape. It is proposed to subdivide the land into 26 Lots with new dwellings on 24 of the Lots (Lots 2 to 25). The Lot sizes will be between 3 ha and 5 ha in size as shown in Figure 2 below. See Doherty Smith and Associates drawings for Job 15066 Rev D dated 25/02/16 for full details.

Located adjacent to the site is the Morris Park Motorsport Complex. Council have requested this noise study to consider the impact of noise from motorsport events at Morris Park on proposed residences to be built the subject land.

![Figure 2. Development Plan Showing Proposed Plots and House Locations. Source: Doherty Smith and Associates.](image)

3. CRITERIA

There are no specific criteria for this type of application. However there is for road traffic noise. The State Environmental Planning Policy (Infrastructure) 2007, Subdivision 2 Development Clause 102, Impact of road noise on non-road development states that: "If the development is for the purposes of a building for
residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following $L_{eq}$ levels are not exceeded:

(a) in any bedroom in the building — 35 dBA at any time between 10 pm and 7 am,
(b) anywhere else in the building (other than a garage, kitchen, bathroom or hallway) — 40 dBA at any time.”

4. MEASURED NOISE LEVELS

4.1 Measurement Procedure

Attended noise measurements were carried out on Saturday 7th May 2016 before and during the normal use of the Morris Park Speedway. In addition unattended noise measurements were carried out before, during and after the normal use of the Morris Park Speedway which included early Sunday morning 8th May 2016. The noise measurements were taken at approximate positions of the proposed residential development Lots to the speedway. For the noise surveys the noise levels were typical and the weather did not have an adverse effect on the measurements.

The results are necessarily a “snapshot” of the noise levels on the particular days of the surveys. Noise levels can vary with time due to different weather or traffic conditions, also low level measurements can be affected by fauna noise.

4.2 Instrumentation – Attended

The instrumentation used during the noise source survey consisted of two Brüel and Kjær sound level meters model 2250 (serial numbers 3008564 and 2446904). These meters conform to Australian Standard AS IEC 61672.1-2004: “Electroacoustics - Sound level meters – Specifications” as class 1 precision sound level meters and have an accuracy suitable for both field and laboratory use. The calibration of the meters was checked before and after the measurement period with a Brüel and Kjær acoustical calibrator model 4231 (serial no. 2445757). No significant system drift occurred over the measurement period.

The sound level meters and calibrator were checked, adjusted and aligned to conform to the Brüel and Kjær factory specifications and issued with conformance certificates within the last 24 months as required by the regulations. The internal test equipment used is traceable to the National Measurement Laboratory at C.S.I.R.O., Lindfield, NSW, Australia.
4.3 Instrumentation – Unattended

The instrumentation used during the noise survey consisted of an "Acoustic Research Laboratories Pty Limited" (ARL) – Type 2 Environmental Noise Logger serial number 194550. This instrument conforms to Australian Standard 1259 "Acoustics - Sound Level Meters", (1990) and has an accuracy suitable for both field and laboratory use.

The calibration of the meter was checked before and after the measurement period with a Brüel and Kjær acoustical calibrator model 4230 (serial no. 2445349). No significant system drift occurred over the measurement periods.

The environmental noise logger and calibrator have been checked, adjusted and aligned to conform to the Brüel and Kjær or ARL factory specifications and issued with conformance certificates within the last 12 months as required by the regulations. The internal test equipment used is traceable to the National Measurement Laboratory at C.S.I.R.O., Lindfield, NSW, Australia.

4.4 Noise Level Results

The measured noise level from the motor sports event was between 60 dBA and 70 dBA with the A frequency weighted octave band frequency analysis as shown in Figure 3 below.

![Noise Level Graph]

*Figure 3. Attended Measured Noise Levels of the Motor Sports at the Closest Future Boundary Position, approximately 470 metres from the Racetrack.*
Figure 4. Attended Measured Noise Levels from the Motor Sports at the Closest Future Boundary Position, approximately 350 metres from the Race track.

Figure 5. Unattended Measured Noise Levels of the Motor Sports at the Closest Future Boundary Position, approximately 550 metres from the Race track.

The noise from the motor sports occurred intermittently between 8:00 pm and midnight as shown above in the unattended noise logger measurements.
5. NOISE MODELS

This section provides details of the calculations used to determine the potential noise levels at receiver locations, both externally and internally within the proposed dwelling lots, from the specific noise source.

5.1 External Noise Modelling Specifications

The external sound pressure level from a source noise has been modelled using the International Standard ISO 9613-2 (1996(E)) 'Acoustic – Attenuation of sound during propagation outdoors Part 2 General method of calculation'. This Standard specifies methods for the description of noise outdoors in community environments. The method described in the Standard is general in the sense that it may be applied to a wide variety of noise sources, and covers the major mechanism of attenuation. The method allows for downwind propagation conditions within an angle of ± 45° of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region with the wind blowing from source to receiver, and wind speed between approximately 1 m/s and 5 m/s measured at a height of 3 m to 11 m above the ground.

5.2 Basic Noise Modelling Equations

Equivalent continuous downwind sound pressure level (L_{eq}) at each receiver point has been calculated for each noise source using the equation below:

\[ L_{eq} = L_w + D_d - A \]

Where:
- \( L_w \) is the sound power level of the noise source;
- \( D_d \) is directivity correction; and
- \( A \) is the attenuation that occurs during the propagation from source to receiver.

The attenuation term \( A \) in the equation above is given by:

\[ A = A_{gdr} + A_{atm} + A_{gr} + A_{bar} + A_{misc} \]

Where:
- \( A_{gdr} \) is the attenuation due to geometric divergence;
- \( A_{atm} \) is the attenuation due to atmospheric absorption;
- \( A_{gr} \) is the attenuation due to the ground effects;
- \( A_{bar} \) is the attenuation due to a barrier; and
- \( A_{misc} \) is the attenuation due to miscellaneous other effects.
The last term \( A_{\text{misc}} \) is of minor significance and generally refers to miscellaneous propagation through foliage, industrial sites and areas of houses. Due to the vicinity of the neighbouring dwellings to the race track the attenuation due to ground effects and atmospheric absorption effects are included at this site.

![Site Plan with Measured and Predicted Raceway Sound Pressure Level (\( L_{\text{eq}} \) dB).](image)

5.3 **Internal Noise Levels**

The internal noise levels for the proposed residences are dependent upon the sound transmission loss of the building components. For convenience the sound transmission loss can be given in a single number known as the weighted sound reduction index \( (R_w) \). This is similar to the sound transmission class (STC) used previously. In addition to distance attenuation, the internal noise level \( (L_{eq}) \) in various rooms of the proposed development is found from the formula:

\[
L_{eq} = L_{ext} - R_w + 10 \log_{10} (S/A) - K + 6 \text{ dBA}
\]

**Where:**  
\( L_{ext} \) is the external noise level;  
\( R_w \) is the weighted sound reduction index of the partition;  
\( S \) is the area of the partition (e.g. window or glazed door);  
\( A \) is the room acoustic absorption; and  
\( K \) is an angle of view correction.
By applying this formula, the selection of the weighted sound reduction index \( R_w \) of the building components, particularly the windows and glazed doors in all façades and the roof can be found. The glazed areas are normally the acoustically weakest partitions in the façades in nearly all situations. It is assumed that the rooms, particularly the bedrooms, will be normally furnished (e.g. bed, carpet and curtains) giving an average reverberation time of approximately 0.5 seconds for bedrooms and 0.8 seconds for living areas. As the room and building components sizes are not known at this stage, assumptions have been made based on standard sizes. Once the architectural drawings of the proposed dwellings are known this part of the modelling can be refined.

6. FUTURE RESIDENCES - RECOMMENDATIONS

From the calculated results given in Figure 6 above, the roof / ceilings should have a weighted sound reduction index \( R_w \) of at least 48 dB and the walls should have an \( R_w \) of at least 52 dB. The windows for all the residences should have an \( R_w \) as shown in Table 1 below.

6.1 Roof / Ceiling Construction

A pitched concrete or terracotta tile or sheet metal roof with aearing, one layer of 13 mm thick plasterboard fixed to the ceiling joists and acoustic absorption in the roof cavity will have an \( R_w \) of at least 48 dB and hence will be suitable for the roof / ceiling application. The acoustic absorption material should be at least 50 mm thick with a Noise Reduction Coefficient (NRC) of at least 0.7. Thermal rating of R2 would normally be suitable to meet the acoustic requirements; however the NRC should be checked with the relevant supplier before purchase to ensure it is at least 0.7.

6.2 Wall Construction

The external walls must have a minimum \( R_w \) of 52 dB, which is standard for:

- Brick veneer consisting of 110 mm thick exterior face brick, 90 mm thick timber stud or 92 mm metal stud, at least 50 mm clearance between the masonry and stud frame and 10 mm thick plasterboard internal wall constructions and R2 insulation batts in wall cavity; or

- Double brick consisting of 2 layers of 110 mm brickwork separated by at least a 50 mm gap.
If a timber frame cladding construction is used for the dwellings this should consist of 6 mm thick fibre cement sheeting or weatherboard or plank cladding externally, 90 mm deep timber stud or 92 mm metal stud 13 mm thick standard plasterboard internally with R2 thermal insulation in the wall cavity. The above design will only be suitable for dwellings exposed to noise level below 55 dBA as shown in Figure 6 above.

6.3 Plasterboard Corner Details

It is essential for sound insulation that plasterboard walls and ceilings for all proposed residences are well sealed. The joint between the wall and ceiling can be sealed, for example, with a resilient layer such as mastic and covered with a plasterboard cornice or the joint can be sealed with tape and cornice cement.

6.4 Windows and Glazed Doors

The generalised recommended minimum weighted sound reduction index $R_w$ is shown for the glazing in Table 1 below. Once the architectural drawings of the proposed dwellings are known these $R_w$ ratings can be confirmed.

**TABLE 1 – MINIMUM GLAZING THICKNESS AND $R_w$ RATINGS**

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Recommended Minimum Type and Thickness of Glazing</th>
<th>Required Minimum $R_w$ or STC (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For Dwellings Exposed to Noise Level Above 55 dBA as shown in Figure 6 Above.</td>
<td></td>
</tr>
<tr>
<td>Bedrooms</td>
<td>6.38 mm Laminated Awning Windows with Qlon Seals</td>
<td>33</td>
</tr>
<tr>
<td>Living Areas</td>
<td>6.38 mm Laminated Awning Windows with Qlon Seals</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>10.38 mm Laminated Sliding Doors with Fin Seals</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>For Dwellings Exposed to Noise Level Below 55 dBA as shown in Figure 6 Above.</td>
<td></td>
</tr>
<tr>
<td>Bedrooms</td>
<td>4 mm Float Awning Windows with Standard Seals or 6.38 nm Laminated Sliding Windows</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>with Fin Seals</td>
<td></td>
</tr>
<tr>
<td>Living Areas</td>
<td>4 mm Float Awning Windows with Standard Seals or 6.38 mm</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Laminated Sliding Windows with Fin Seals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 mm Laminated Sliding Doors with Fin Seals</td>
<td>24</td>
</tr>
</tbody>
</table>
Notes:-
- All glazing, given in Table 1 above, must be in solid frames and well sealed when closed;
- All glazing, given in Table 1 above, must be fixed with acoustic seals to meet the required weighted sound reduction index ($R_w$) when closed;
- Glazing systems recommended are minimum requirements for acoustic purposes. In some cases thicker glass may be required for safety or other purposes.

6.4.1 Glazing Manufacturers

Glazing manufacturers as listed in Appendix A below have provided attenuation data for their windows and will meet the requirements given in this report. Should other suppliers be used, laboratory test data to support the window system ratings must be provided.

6.5 Ventilation

An acoustically insulated building must be kept virtually air tight to exclude external noise. Therefore for the windows requiring laminated glazing in Table 1 above, and to achieve the required $R_w$ ratings, the windows must be kept closed. Hence there is a requirement for mechanical ventilation or air-conditioning to provide fresh air to control odours. Specific ventilation requirements are outside of our scope of expertise, however requirements for indoor-air quality are given in Australian Standard AS 1668.2 -2012, "The use of ventilation and air-conditioning in buildings - Ventilation design for indoor air contaminant control". Internal noise levels from mechanical ventilation or air-conditioning should not exceed 35 dBA for bedroom areas and 40 dBA for all other habitable areas. External noise levels from mechanical ventilation or air-conditioning should not exceed 5 dB over the lowest existing background noise level ($L_{A95}$) when in day time use and when measured at the neighbouring boundary. Night time noise levels must meet the requirements of the Protection of the Environment Operations (Noise Control) Regulation 2008.

7 CONCLUSIONS

It is concluded that the internal noise criteria as given in The State Environmental Planning Policy (Infrastructure) 2007, Subdivision 2 Development Clause 102, Impact of road noise on non-road can be fully met. This is for the proposed residential dwellings for the subdivision of Lot 8 DP1063425, 4L Camp Road, Dubbo, NSW 2830 during motorsports events at Morris Park adjacent to the site.

Recommendations given in section 6 above must also be fully complied with. Once the architectural drawings for each of the proposed dwellings are known the
recommended minimum weighted sound reduction index can be confirmed for each individual dwelling.

<table>
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</tr>
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<td>21st May 2016</td>
<td>Ken Scammell MSc, MIAA, MIPA, Acoustician</td>
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<tr>
<td>Final</td>
<td>31st May 2016</td>
<td>Ken Scammell MSc, MIAA, MIPA, Acoustician</td>
</tr>
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</table>

**Important Note.** All products and materials suggested by ‘Noise and Sound Services’ are selected for their acoustical properties only. All other properties such as airflow, aesthetics, chemical, corrosion, combustion, construction details, decomposition, expansion, fire rating, green or tile rating, loading, shrubbery, ventilation, etc. are outside of ‘Noise and Sound Services’ field of expertise and must be checked with the supplier or suitably qualified specialist before purchase.
APPENDIX A - EXAMPLE MATERIAL SUPPLIERS

Acoustic Glazing Suppliers

- "Wideline Pty Ltd" telephone (02) 8304 6400.
- "Trend Windows & Doors Pty Ltd" telephone (02) 9840 2000.
- "Vantage Windows" telephone 1300 026 189
- "Thermoglaze Windows" telephone 1500 166 571.
- "Christoffel Pty Ltd" telephone (02) 9627 4811.
- "Sound Barrier Systems Pty Ltd" telephone (02) 9540 4333

Acoustic Absorbent Material

- Pyrotek - telephone 13 17 44.
- Textline Website: www.textline.com.au/acousticabsorbentmaterial.htm

Acoustic Door Seals

- Kilargo - telephone 1300 838 010
- Raven - telephone 1800 888 123

Internal Wall-Mounted Air Ventilators

- Acoustica - telephone 1300 722 825
- Sonair - telephone 1300 828 674
Environmental Dust Monitoring

Summernats Car Festival
Watson
Canberra
ACT 2911

29 June 2010

Client: ACT EPA
Job No: 5250
CERTIFICATE OF APPROVAL FOR ISSUE OF DOCUMENTS

Document No: 5250_0H_EDM_SUM_20100303  Revision Status: B2
Title: EDM for Summernats Watson  ACT 2602
Client: Environmental Protection Authority  Copy No: One

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<tr>
<td>Prepared by:</td>
<td>Maggie Davidson</td>
<td>Trainee Hygienist</td>
<td>29/06/10</td>
</tr>
<tr>
<td>Approved by:</td>
<td>Venessa Thelan</td>
<td>Manager Occupational Health and Hygiene</td>
<td>29/06/10</td>
</tr>
<tr>
<td>Released by:</td>
<td>John Robson</td>
<td>Managing Director</td>
<td>29/06/10</td>
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</tbody>
</table>

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<td>David Power</td>
<td>1</td>
<td>JR 29/06/10</td>
</tr>
<tr>
<td>Robson Environmental Pty Ltd</td>
<td>John Robson</td>
<td>2</td>
<td>JR 29/06/10</td>
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Client: EPA  5250_Dust_Nats_EPA_B2_20100317_Final.docx  Page 2 of 28
# TABLE OF CONTENTS

1. EXECUTIVE SUMMARY .................................................4
2. SCOPE OF WORK ...................................................6
3. METHÖDÖLÖGY .....................................................7
4. RESULTS ..................................................................8
5. DISCUSSION ..........................................................11
6. CONCLUSION AND RECOMENDATIONS .......................13
7. REFERENCES ..........................................................14
8. APPENDIX A – DustTrak Real Time Dust Monitoring Graphed Results .... 16
9. APPENDIX B – Calibration Certificates for DustTrak Monitors ...............25
1. EXECUTIVE SUMMARY

At the request of the ACT Environmental Protection Authority (EPA), Robson Environmental Pty Ltd was commissioned to carry out particulate monitoring of ambient air at two sites in the suburb of Watson, ACT during the Summernats car festival held at the Exhibition Park in Canberra (EPIC) in Mitchell between 7 January and 11 January 2010. Monitoring of particulates less than 10 μm in diameter (PM₁₀) was used to assess the impact of this event on ambient air quality because PM₁₀ is the current particulate indicator for assessing ambient air quality as part of the National Environment Protection (Ambient Air Quality) Measure 2003 (NEPM) framework. The current exposure standard for PM₁₀ in ambient air is no more than 5 daily exceedences of greater than 50 μg m⁻³ (24 hours) in a year.

Monitoring of PM₁₀ was conducted during the weekend of the Summernats Car festival from Friday 8 January 2010 at 10:00am to Monday 11 January 2010 around 9:45am. Follow up monitoring was conducted one week later, commencing on Friday 15 January 2010 around 10:00am and finishing on Monday 18 January 2010 around 9:30am. The results from the follow up monitoring were used as a control sample to compare ambient air quality when burnouts and other Summernats activities were being carried out, with ambient air quality during regular traffic conditions. At Site A, located adjacent to the riding track in Watson (Map 1), gravimetric monitoring was carried out according to AS/NZS 3580.9.8:2003 to give a time weighted average of PM₁₀ concentrations over a 24 hour period (PM₁₀ TWA₂₄ hours), as well as real time monitoring of PM₁₀ concentrations with a DustTrak, which were calculated as geometric means for each day (mean daily PM₁₀). At Sites B, adjacent to the Federal Highway in Watson (Map 1) only real time monitoring of PM₁₀ with a DustTrak was carried out.

The results show that the PM₁₀ TWA₂₄ hours Concentrations were below the NEPM of 50 μg m⁻³. PM₁₀ concentrations (TWA₂₄ hours and mean daily) were higher on the weekend of the Summernats, in comparison to follow up monitoring. Concentrations of Copper, Lead and Chromium in the PM₁₀ particulate fraction were also higher on the Saturday of the Summernats weekend, in comparison to the following Saturday. A review of Summernats activities shows that when burnout activities occurred there was an increase in real time PM₁₀ concentrations measured at either one or both monitoring sites on a number of occasions. There was also an increase in real time PM₁₀ concentrations which coincided with the fireworks and main stage concert on the Saturday night. The PM₁₀ concentrations measured may have been influenced by changes in wind direction, ambient air temperature, and the occurrence of rain on the Sunday during the follow up monitoring.

In conclusion, Robson Environmental Pty Ltd advises that while TWA₂₄ hours PM₁₀ concentrations were below the NEPM of 50 μg m⁻³, Summernats activities appeared to have an adverse effect on PM₁₀ concentrations at both monitoring sites. However,
there are a number of uncertainties due to the small number of sampling sites and indicators monitored.
2. SCOPE OF WORK

The aim of the monitoring was to determine if concentrations of atmospheric particulate matter measuring less than 10 μm in diameter (PM$_{10}$) were within the National Environmental Protection Measure (NEPM) guideline for acceptable ambient air quality of 50 μg m$^{-3}$ over a 24 hour period (EHPC, 2003).

The scope of the work was as follows:

- Gravimetrically measure ambient PM$_{10}$ concentrations (24 hour samples) according to AS/NZS 3580.9.6:2003 for the duration of the Summernats at one location (Site A), please refer to Map 1 below;

- Log real-time PM$_{10}$ concentrations for the duration of the Summernats at two locations (Site A & Site B), please refer to Map 1 below;

- Monitor background PM$_{10}$ concentrations in ambient air using both gravimetric and real-time monitoring methods;

- Assessment of PM$_{10}$ concentrations against the NEPM for ambient PM$_{10}$ over a 24 hour period, and best practice;

- Report on the findings of the assessment, and Make recommendations where appropriate based on these findings.

Map 1: Location of Monitoring Sites in Relation to Summernats Burnout Strip
3. METHODOLOGY

Sampling of PM$_{10}$ during the Summernats commenced around 10:00am on Friday 8 January 2010, and finished on Monday 11 January 2010 around 9:45am. Background PM$_{10}$ sampling commenced the following week on Friday 15 January 2010 around 10:00am, and finished on Monday 18 January 2010 around 9:30am.

Gravimetric sampling of PM$_{10}$ particulates was carried out at Site A according to AS/NZS 3580.9.6:2003, which is the specified method for statutory monitoring of PM$_{10}$ in ambient air according to the National Environment Protection (Ambient Air Quality) Measure 2003. Prior to sampling, PVC filters were conditioned for 24 hours in a controlled environment, and weighed on a calibrated microbalance (Mettler Toledo, Model No. AT201). On completion of sampling, the PVC filters were reconditioned for 24 hours prior to reweighing, and the difference in weights recorded. The High Volume Sampler (Thermo Scientific Model VFC-PM10) was fitted with a PM$_{10}$ size selective inlet and the flow rate calibrated at 1.13 L min$^{-1}$.

Real-time monitoring of PM$_{10}$ particulates was conducted at Sites A and B with TSI DustTraks (model 8520; serial No 23651 & 85202572, respectively). The PM$_{10}$ size selective inlet was attached and the flow rates calibrated at 1.7 L min$^{-1}$. The monitors were placed at a height of approximately 0.5-1m, and logging set for 1 minute intervals. Data from the DustTraks was analysed with TSI TrakPro software version 4.0.3.0.


Site A was located in an east south easterly direction from the Summernats burn out strip and Site B was located to the south/south east of the Summernats burn out strip (please refer to Map 1).
4. RESULTS

Table 1 shows the TWA(24 hour) PM$_{10}$ concentrations for each sample collected during the monitoring periods. The TWA(24 hour) PM$_{10}$ concentrations during the Summernats monitoring sessions were higher in comparison to follow up monitoring sessions, but none of the samples exceeded the PM$_{10}$ NEPM of 50 µg m$^{-3}$.

The PM$_{10}$ control sample for Sunday 17 of January 2010 was voided because the calculated concentration was higher than would be realistic (>100 µg m$^{-3}$) given the data from the DustTrak indicated that PM$_{10}$ concentrations on the Sunday were lower in comparison to those collected during the Summernats weekend. The BOM also reported that 1.6 mm of rain was recorded on Sunday 17 January 2010, and it is possible that moisture gain may have affected the filter condition and subsequently, the result.

Additional information on PM$_{10}$ concentrations could be sought from the ACT Government Analytical Laboratory (GAL), which monitors daily PM$_{10}$ concentrations in accordance with the National Environment Protection (Ambient Air Quality) Measure 2003. Results of monitoring conducted by the ACT GAL could be used as an indication of background PM$_{10}$ concentration on the monitoring days.

<table>
<thead>
<tr>
<th>Sampling Day</th>
<th>Summernats</th>
<th>Control</th>
<th>NEPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Date</td>
<td>PM$_{10}$ (µg m$^{-3}$)</td>
<td>Wind Direction</td>
<td>Start Date</td>
</tr>
<tr>
<td>Friday</td>
<td>8/01/10</td>
<td>17</td>
<td>WNW</td>
</tr>
<tr>
<td>Saturday</td>
<td>9/01/10</td>
<td>34</td>
<td>WSW</td>
</tr>
<tr>
<td>Sunday</td>
<td>10/01/10</td>
<td>14</td>
<td>W</td>
</tr>
</tbody>
</table>
Summernats–Environmental Dust Assessment

Table 2 shows that the mean daily PM$_{10}$ concentrations were all below 50 µg m$^{-3}$ during both Summernats and follow-up monitoring sessions. The mean concentrations declined significantly at both Site A and Site B between the initial and subsequent monitoring periods. Site A PM$_{10}$ concentrations declined from a range of 12 to 14 µg m$^{-3}$ during Summernats, to 1 to 11 µg m$^{-3}$ on the following weekend. At Site B, mean daily PM$_{10}$ concentrations declined from a range of 15 to 22 µg m$^{-3}$, to 4 to 13 µg m$^{-3}$ after the event.

The daily PM$_{10}$ graphs for the DustTraks show an increase in real-time PM$_{10}$ concentrations, which coincides with various Summernats activities including the burnouts and fireworks, as well as a large reduction in the number of peaks that exceeded 50 µg m$^{-3}$ during post Summernats monitoring sessions. The full set of graphs is provided in Appendix A.

Site B had higher mean daily PM$_{10}$ concentration during the Summernats monitoring in comparison to Site A PM$_{10}$. However, statistical analysis indicated that the difference was not significant. The mean daily PM$_{10}$ concentrations at Sites A and B during the Summernats weekend were strongly correlated, indicating that PM$_{10}$ concentrations at both sites were being influenced by the same source.

The mean daily PM$_{10}$ concentrations measured with the DustTrak at Site B were correlated with the TWA$_{24h}$ PM$_{10}$ concentrations measured at Site A with the High Volume Sampler. Site A had a weaker correlation between the mean daily PM$_{10}$ concentration and the TWA$_{24h}$ PM$_{10}$ concentration. The correlation suggests that the PM$_{10}$ concentrations at both sites indicate that all samples were being influenced by the same source. However, it must be noted that there was a difference between the sampling periods for the two types of data reported. Gravimetric TWA PM$_{10}$ concentrations are based on the amount of sample collected over 24 hours starting from 10:00 am, while the daily mean PM$_{10}$ concentrations are based on DustTrak data starting from 12:00 am each day, with the exception of Fridays at 10:00 am.
Table 2: Mean Daily (±Standard Error) PM$_{10}$ Concentrations Measured with DustTraks at Sites A and B, January 2010

<table>
<thead>
<tr>
<th>Date</th>
<th>Daily PM$_{10}$ Mean$^*$ (±SE) ($\mu$g m$^{-3}$)</th>
<th>Temperature$^*$ (°C)</th>
<th>Relative Humidity$^*$ (%RH)</th>
<th>Wind Speed$^*$ (km/h)</th>
<th>Wind Direction$^*$</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Site A</td>
<td>Site B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/01/10</td>
<td>13 ±1</td>
<td>22 ±5</td>
<td>30.7</td>
<td>28</td>
<td>17</td>
</tr>
<tr>
<td>9/01/10</td>
<td>14 ±1</td>
<td>22 ±3</td>
<td>33.6</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>10/01/10</td>
<td>14 ±0</td>
<td>20 ±5</td>
<td>37.6</td>
<td>11</td>
<td>28</td>
</tr>
<tr>
<td>11/01/10</td>
<td>12 ±0</td>
<td>15 ±0</td>
<td>34.6</td>
<td>26</td>
<td>24</td>
</tr>
<tr>
<td>15/01/10</td>
<td>10 ±0</td>
<td>10 ±1</td>
<td>28.3</td>
<td>41</td>
<td>9</td>
</tr>
<tr>
<td>16/01/10</td>
<td>11 ±0</td>
<td>13 ±1</td>
<td>29.2</td>
<td>43</td>
<td>17</td>
</tr>
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<td>17/01/10</td>
<td>1 ±0</td>
<td>6 ±3</td>
<td>25.0</td>
<td>19</td>
<td>33</td>
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<td>18/01/10</td>
<td>3 ±0</td>
<td>4 ±3</td>
<td>17.5</td>
<td>22</td>
<td>31</td>
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$^*$ Geometric mean, data log normally distributed

*15/00 data sourced from Bureau of Meteorology website

Table 3 shows that concentrations of lead, copper and chromium in the PM$_{10}$ particulate fraction were higher on Saturday 9 January 2010 during the Summernats Car Festival in comparison with Saturday 16 January 2010 on the following weekend. Potential sources of heavy metals in the atmosphere would have included tyre particles emitted during the burnout competitions and the fireworks on Saturday the 9 January 2010.

Table 3: Metals Analysis of For Gravimetric PM$_{10}$ Samples Collected on Saturday the 9 & 16 January 2010

<table>
<thead>
<tr>
<th>Sampling Day</th>
<th>Date</th>
<th>Metals Analysed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lead (µg m$^{-3}$)</td>
</tr>
<tr>
<td>Summernats Saturday</td>
<td>9/01/10</td>
<td>0.008</td>
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<tr>
<td>Control Saturday</td>
<td>16/01/10</td>
<td>0.001</td>
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Client: EPA 5250_Dust_Nats_EPA_B2_20100317_Final.docx Page 10 of 28
5. DISCUSSION

Gravimetric monitoring of PM$_{10}$ according to the AS3580.9.6:2003 indicated that ambient air quality was acceptable during both the Summernats and the following weekend because the PM$_{10}$ NEPM of 50 µg m$^{-3}$ was not exceeded. However, the TWA daily PM$_{10}$ and daily mean PM$_{10}$ concentrations shown in Section 4 indicate that Summernats activities affected ambient PM$_{10}$ concentrations, with higher concentrations recorded on the weekend of the Summernats in comparison to the following weekend. Analysis of gravimetric filters showed a higher concentration of lead, copper and chromium was present in the PM$_{10}$ particulate fraction on the Saturday of the Summernats (9 January 2010) in comparison with the following Saturday (16 January 2010), although the lead concentration did not exceed the NEPM of 0.5 µg m$^{-3}$.

Further evidence of the impact of Summernats activities on ambient air quality was the simultaneous increase in real time PM$_{10}$ concentrations at both sites when burnout trials were scheduled for Friday 8 January 2010 between 2:00pm and 6:00pm, and at Site B on Sunday 10 January 2010 between 12:45 and 4:30pm, as shown in Appendix A. There was also a large reduction in the frequency of short term PM$_{10}$ peaks in the daily real time DustTrak graphs which exceeded 50 µg m$^{-3}$ during follow up monitoring. The wind direction at 3:00pm on the Friday 8 January 2010 was west-north-west, heading in the general direction of both Site A and Site B from the burnout track and on the Sunday 10 January 2010 the wind was blowing in a westerly direction at 3:00pm in the general direction of Site B. On Saturday 9 January 2010 burnout trials were scheduled between 4:30pm to 6:30pm, but this activity did not appear to affect real time PM$_{10}$ concentrations as significantly as the other monitoring days. This difference may be because the wind direction on the Saturday 9 January 2010 was different to the Friday 8 January 2010 (west south west at 3:00pm). A change in wind direction would also explain the greater frequency and concentration of real time PM$_{10}$ peaks during burnout finals on Sunday 10 January 2010, in comparison to the PM$_{10}$ peaks during the burnout semi finals (please refer to Appendix 2). For future monitoring, it would be advisable that a weather station be placed at each monitoring location to capture changes in wind speed and direction that may influence airborne particulate concentrations. In addition, videography of smoke plumes at each location could be a powerful tool for confirming if spikes in real time PM$_{10}$ data are related to Summernats activities.

The BOM reported 1.6 mm rain fell on Sunday 17 January, which would have affected airborne PM$_{10}$ concentrations on this day, due to particle wash out from the atmosphere. Ambient air temperature may also have been affecting PM$_{10}$ concentrations because the two indicators were significantly correlated at both sites, and ambient air temperatures, as reported at 3:00pm were significantly lower during follow up monitoring. The PM$_{10}$ concentrations reported for the Summernats weekend were not likely to have been impacted by hazard reduction burns or major
bushfire activity, because there were no reports of these activities in the Canberra region over the Summernats weekend from either the NSW Rural Fire Service or ACT Territory and Municipal Services.

The increase in ambient air PM$_{10}$ in relation to the Summernats activities represents a potential health risk to people in the monitoring locations because it was related to motor vehicle emissions. Wallenius et al., (2005) observed that short term increases in air pollution relating to motor vehicles emissions may trigger acute heart congestion in heart failure patients. In addition, Larrieu et al., (2009) reported that an increase of 10 μg m$^{-3}$ above mean ambient concentrations (21 μg m$^{-3}$) was linked with increases in general practitioner visits for upper and lower respiratory disease, headaches and asthma, skin rash and conjunctivitis, while Medina Raton et al., (2005) reported that 10 μg m$^{-3}$ increase (mean 30 μg m$^{-3}$) during the warm season was associated with an increase in hospital admissions for chronic obstructive pulmonary disease and pneumonia. There has also been a link between increased mortality rates and hospital admissions when the average ambient PM$_{10}$ concentration increased by 10 μg m$^{-3}$ in comparison to the previous day (Dominici et al., 2004). A number of researchers have also reported links between mean ambient PM$_{10}$ concentrations and hospital admissions for respiratory diseases (Atkinson et al., 2001; Lee & Ferguson 2009).

The relationship between the occurrence of burnouts and airborne PM$_{10}$ concentrations is of particular concern because dust from car tyres can contain potentially hazardous materials including heavy metals such as iron (5.5%), copper (0.1%), zinc (1.6%) and lead (0.1%), as well as asphalt materials which include aluminium (7.5%), calcium (10.1%) and silica (21.2%) (Adachi & Tainosho, 2004). This indicates that the increase in lead and copper concentrations in the PM$_{10}$ fraction recorded on the Saturday of the Summernats may be related to the burnouts.

A large peak in real time PM$_{10}$ concentrations occurred at both sites on the Saturday night which started around 9:00pm, and declined at approximately 2:00am on the Sunday morning. The peak occurred in conjunction with main stage activities including the super Summernats concert and fireworks. The use of fireworks has been reported to cause increases in ambient PM$_{10}$ concentrations (Vecchi et al., 2008), as well as atmospheric concentrations of lead from 0.017 to 0.379 μg m$^{-3}$ and copper from 0.012 to 0.071 μg m$^{-3}$ (Morsano et al., 2007). Therefore the fireworks on the Saturday 9 January 2010 may also have contributed to increases in lead and copper concentrations, in comparison to the concentrations measured on the following Saturday 16 January 2010. To determine whether the fireworks or the burnouts are causing the higher atmospheric metal concentrations during the Summernats, future monitoring would need to involve metals analysis of daily PM$_{10}$ samples when there were burnout events scheduled, but no fireworks, and vice versa.
6. CONCLUSION AND RECOMMENDATIONS

In conclusion, Robson Environmental Pty Ltd advises that Summernats activities appeared to have an adverse effect on both PM\(_{10}\) and atmospheric metal (copper, lead and chromium) concentrations; although none of the concentrations exceeded the Australian NEPM TWA\(_{24}\) of 50 μg m\(^{-3}\) for PM\(_{10}\) in ambient air or 0.5 μg m\(^{-3}\) for atmospheric lead. However, there are a number of uncertainties due to the small number of sampling sites and indicators monitored and further assessment would be recommended to confirm the potential impact of Summernats activities on ambient air quality in the Canberra region.

To address the uncertainty caused by changing wind direction, future monitoring would need to be conducted at discrete distances around the entirety of the park using a minimum of 4 locations to the north, east, south and west of the burnout strip. Additional sampling for air pollutants such as heavy metals, PAH, and diesel particulates should also be included to help differentiate between PM\(_{10}\) sources. PAH monitoring could include analysis for specific tracer compounds such as retene for wood smoke and benzene/phenylene for motor vehicle emissions (Bostrom et al., 2002; Li et al., 2009). The monitoring of particulates less than 2.5 μm in diameter (PM\(_{2.5}\)) could be carried out and compared with the NEPM TWA\(_{24}\) advisory standard of 25 μg m\(^{-3}\) to help differentiate between combustion source pollution and mechanically generated particulates which contribute substantially to the PM\(_{10}\) particulate mass fraction. However, it must be noted that the PM\(_{2.5}\) particulate fraction does not exclusively measure combustion particulates, and will contain some mechanically generated particles. The collection of meteorological data (wind speed, direction, temperature and relative humidity) at each sampling site is also recommended to help identify the potential origin of pollution incidents, which could be combined with videoing of the smoke plumes direction.

Robson Environmental Pty Ltd would be happy to assist the EPA with the formulation of a more comprehensive study for future events. However, a 6 month lead time would be recommended to ensure that suitable sampling equipment and media is readily available prior to the event.
7. REFERENCES


Summernats—Environmental Dust Assessment


8. APPENDIX A – DustTrak Real Time Dust Monitoring Graphed Results

DustTrak Data Friday 8 January 2010

Client: EPA 5250_Dust_Nats_EPA_B2_20100317_Final.docx Page 16 of 28
DustTrak Sunday 10 January 2010

Client: EPA 5250_Dust_Nats_EPA_B2_20100317_Final.docx  Page 19 of 28
Summernats – Environmental Dust Assessment

DustTrek Monday 11 January 2010

Site A
Monday 11 January 2010

Wind Directional Data

Site B
Monday 11 January 2010

Wind Directional Data

Client: EPA
5250_Dust_Nats_EPA_B2_20100317_Final.docx  Page 20 of 28
DustTrek Friday 15 January 2010

- Site A
- Site B

- Hazard reduction burn scheduled for Cotter Road (20x20m) from 19:00
- Small grassfire at Tumbarumba NSW (0 Ha) under control at 10:00

Client: EPA
DustTrak Saturday 16 January 2010

* Hazard reduction burn scheduled for Cotter Road (20x20m) from 8:00
DustTrak Sunday 17 January 2010

--- Graphs showing dust concentration over time at Site A and Site B. ---

--- End of document. ---
DustTrak Monday 18 January 2010

Site A
Monday 18 January 2010

Site B
Monday 18 January 2010
9. APPENDIX B – Calibration Certificates for DustTrak Monitors

KENELEC SCIENTIFIC PTY LTD
CALIBRATION LABORATORY

CALIBRATION CERTIFICATE

Certificate Number 2730
Date of Test 18 December 2008

CLIENT Robson Environmental
9 Lyell Street
Fyshwick, ACT 2609

Contact Marcus Donnelly

Test Method: Kenelec test method LARP 1

Client Instrument Details:
TSI DustTrak Model 8520
Serial No. 85200372

Condition as received: As left

Environmental Conditions:
Ambient Temp: 25.0°C
Humidity: 25.8%RH
Barometric Pressure: 745.0 mmHg.

This calibration certificate shall not be reproduced except in full, without the written approval of Kenelec Scientific Pty Ltd.

Signed:

Mark Williams
Laboratory Manager

Page 1 – Cover Sheet
Page 2 – Calibration after adjustment
APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

Item No: PDEC17/14

KEENELEC SCIENTIFIC PTY LTD
CALIBRATION LABORATORY

CALIBRATION CERTIFICATE

Certificate Number: 2722
Date of Test: 18 December 2009

CLIENT
Robson Environmental
9 Lyell Street
FYSHWICK, ACT 2609

Contact
Marcus Donnelly

Test Method
Kenelse test method LABP 1

Client Instrument details
TSI DustTrek Model 8520
Serial No. 23851

Condition as received
As left

Environmental Conditions
Ambient Temp. 25.0°C
Humidity 25.0%RH
Barometric Pressure 740.0mmHg

This calibration certificate shall not be reproduced except in full, without the written approval of Kenelse Scientific Pty Ltd.

Signed
Mark Williams
Laboratory Manager

Page 1 - Cover Sheet
Page 2 - Calibration after adjustment
CERTIFICATE OF CALIBRATION AND TESTING

Model: 8766
Serial No: 214032

Description: DustTrak

Calibration Standard: Aerosol Calibration Zeros #1

DustTrak Linearity Plot

Environmental Conditions:
Temperature: 20.00°C
Pressure: 1015.8 mmHg
Humidity: 31.00% RH

Kenlec Scientific: These results verify that the performance and accuracy of this device meets or exceeds the specified requirements. The device was tested and calibrated using an acceptable mass standard NO 13001:1.1 Titre: Titre: Titre: Title of document:
The instrument was calibrated and the final test was conducted in 1.00 line.

This report has not to be reproduced. Any reproduction for the publication of an approved subject is obtained
in writing from the publishing organization during this report.

Applicable Test Report: 8766

Report Number: 200214032-2

Date Last Verified: 24-03-98

Time Due: 36-03-98

Client: EPA

5250_Dust_Nats_EPA_B2_20100317_Final.docx Page 28 of 28
Composition of Smoke Generated by Landing Aircraft

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ABSTRACT: A combination of techniques has been used to examine the composition of smoke generated by landing aircraft. A sample of dust from the undercarriage of several commercial airliners was examined with SEM/EDX (Scanning Electron Microscope/Energy Dispersive X-ray) to determine its elemental composition and also with an aerosol/erosion counter in order to measure the particle size spectrum. The observed size spectrum was bimodal with equal numbers of particles at peaks of aerodynamic diameter ~10 μm and ~50 μm. The EDX analysis suggested that the former peak is carbonaceous, while the latter consists of elements typical of an asphalt concrete runway. In the field, a scanning lidar, in combination with optical and condensation particle counters, was deployed to obtain limits to the number concentration and size of such particles. Most of the (strong) lidar signal probably arose from the coarser 50 μm aerosol, while respirable aerosol was too sparse to be detected by the optical particle counters.

INTRODUCTION

Local air quality is one of several issues concerning the development of airports. In Europe, the noise impacts of such airports are considered to be the legally enforceable limit on the long-term average of NO₂, e.g. at Heathrow. Strategically, however, one might be more concerned by local concentrations of respirable particulates. While concentrations of fine particulate matter (PM) in the Heathrow area have comfortably been within the proposed long-term limit for PM₁₀, of 25 μg m⁻³, there is apparently no clear threshold for such PM with even very modest variations in fine when assessed against epidemiologically detectable effect on mortality.

Conventionally, most of the modeling of the impact of commercial aviation on PM concentrations has concentrated on emissions from engines. This is despite the smoke emitted from aircraft landing being clearly visible to the naked eye, while that from modern engines are so fine it is scarcely visible. When an aircraft lands, the main wheels make contact with the ground and spin up the nose wheel drops to the ground, the brakes are then applied to bring the aircraft to a halt. Visible smoke is usually only released only as the wheels spin up, though the brakes must subsequently be released as they are already integrated into the landing and takeoff (LTO) cycle, it is unclear what should be the upper limit of resolvable aerosol.

From mass balance calculations, we have shown that the number lost for landing is very large (anything up to ~10⁶ kg from a B747). We know — both from the volume and from aerosol measurements — of organic carbon and associated trace metals in nearby ambient PM — that some must be emitted as fine aerosol, but we do not know how much of this is so dispersed and how much adheres to the runway in scattered macroscopic fragments. By contrast, recent estimates using the best available understanding of PM emissions from aircraft engines, including interactions, sensitivities, and volatile organic carbon, suggest that total engine emissions are somewhat smaller (anything up to ~0.25 kg of PM per LTO cycle from a B747 with four RB211—S&S engines), though in this case all of the emissions are initially released as fine aerosol. Furthermore, while PM emission integrated over the LTO cycle may be a useful metric to the development of airport emission inventories, it may not be the best metric for other air quality applications, since here it is the ground level emissions that dominate. Then, levels and the exposure were estimated for the dominant source of PM at Gatwick, accounting for 65% of the total ground level PM; emissions from aircraft. Overall, however, this contribution is subject to significant uncertainty. PM emissions from tires and brakes are dependent on many factors including aircraft weight, speed, number of vehicles, brake material (carbon or steel), weather conditions, and undercarriage design, pilot actions, and operation procedures.
The proportion of the mass loss from aircraft tires and brakes that becomes suspended as fine PM has not been extensively studied. For road vehicles it is generally estimated that less than 10% of tire loss is emitted at PM$_{10}$, though the proportion could be as high as 30%.$^{2}$ Within this, the larger particles may be generated through mechanical abrasion, while the submicrometer fraction may arise from the thermal degradation of tire polymer and the volatilization of extender oils.$^{3}$ For road vehicle brakes wear, on the other hand, ref 11 observed that between 50% and 90% of brake emissions are emitted as airborne PM with a number-weighted mean aerodynamic diameter of 1–2 $\mu$m. Similarly, a study described in ref 12 estimated that 70% of the eroded material from road vehicle brakes ends up as airborne PM.

For estimating the PM$_{2.5}$ emissions from aircraft tires and brakes, the Project for the Sustainable Development of Heathrow$^{4}$ used upper limits of 10% for tire wear and 100% for brake wear. These limits were chosen to reflect the fact that braking conditions for aircraft are considerably more aggressive than those for road vehicles in normal use. It was also assumed that PM emissions scale linearly with the weight of the aircraft. Such estimates, however, remain speculative.

To tighten the upper emission limits of respirable aerosol in tire smoke, we report here a field trial of Lidar measurements with simultaneous point observations of tire smoke, together with SEM and size spectrum analyses of dust collected from aircrafts' undercarriages.

In the past few years, Lidar has become the technique of choice for examining the dispersion of material in aircraft exhaust plumes. The principal limitation of the method is that the observed signal strength depends on the size spectrum of the scattering particles and on their refractive index. If neither is known, a simple backscatter Lidar is normally limited to measuring advection and dispersion rather than absolute concentrations. In the case of this study, however, we have additional information arising from laboratory analyses of undercarriage dust, which we presume to be representative of the coarse fraction of landing-generated smoke. This has enabled us to make geometric estimates of the quantity of coarse dust which must have been present to generate the observed Lidar signal. In addition the deployment of optical particle counters (OPCs) within the Lidar scanning plane allows us to put an upper limit on fine particle concentrations within the plume.

Size Spectrum of Undercarriage Dust. We analysed a composite sample of 909 mg of landing and braking dust collected from the undercarriage (steel legs) and wheel hub of three Airbus A320–232 aircraft of the BA fleet, parked on the stands at Heathrow. The sample was greyish-black, consistent with its containing a high proportion of black carbon. It was dry, containing no visible lubricant. The dust was simply collected with a paint brush into a sealed jar.

Such a sample must have contained PM from a variety of sources (tires, brakes, runway, tarmac etc.). Not having the analytical tools to predict with any confidence which might be preferentially deposited where, however, we considered that a well-mixed composite sample was most appropriate. Conversely, the aircraft landing gear would be extremely inefficient in collecting respirable aerosol. Coarse aerosol will thus be overrepresented in the sample. We may note that all the runways at Heathrow are of grooved asphalt, while apron surfaces are concrete. Brakes are carbon–carbon.

A second sample was collected from a B757–235 and a B747–436 aircraft. During collection it was noted that the amount of dust adhering to these aircraft appeared to be much greater than those of the A320. This presumably happens since the Boeing bogies are mounted fore-and-aft the aft undercarriage and wheel can thus collect the aerosol generated by the forward wheel.

The size spectrum of dust from the A320s was determined using an Aerokon instrument which determines the aerodynamic diameter of PM through time-of-flight measurements.$^{5}$ It does so by accelerating the particles in a supersonic flow and then measuring their velocity. The instrument was calibrated with NIST-traceable polystyrene microspheres, a lower size cutoff at an aerodynamic diameter of $\approx 0.5 \mu$m.

An Aerokon instrument was used to transfer the dust sample into the instrument. It consists of a polished stainless steel spherical cup into which the powder sample is placed. High pressure air from a small nozzle is pulsed into the cup and any entrained dust is then transferred to the Aerokon sample line. The duty cycle (throughput) of the pulses is gradually increased to 100%, by which point the entire sample has been used up: none remains in the cup. The sample is then passed through an aperture into the optical sensing chamber. Adjusting the diameter of the aperture adjusts the shear experienced by the particles; this may lead to aerosol disaggregation.$^{6}$

The dust sample size distribution was measured using a range of aperture settings, with the results shown in Figure 1. As may be seen, the distribution is bimodal, with peaks at aerodynamic
and EDS. X-ray spectra peaks integrated over the observation area were mapped for Al, Ga, C, Cl, Ge, Cu, Se, Fe, K, Mg, Mn, Na, Ni, O, P, S, Si, Ti, V, and Zn. A selection of these maps is shown in Figures 3-5.

Figure 2 shows the Si distribution in the sample. This element may be taken as a general indicator of dust derived from eroded rocks or ground surface (though it should be noted that precipitated synthetic silica is also added to the treads to improve wet traction). Particle sizes and shape in the image range from 1 mm (the spatial resolution of the map) up to 6.5 mm. By correlating the elemental compositions of these particles, an attempt at identification of various minerals may be made. Thus, the large dark particle at the bottom of the image is probably a silicate in Si and O. another may represent a quartz, a component of many rocks or of concrete elsewhere in the image, there are many particles containing Ca). Convexly a particle in the top right corner of the image is also associated with Al (Figure 3). Si, O and Ca may indicate it as quartz, a component of many rocks or of concrete elsewhere in the image.

All of these mineral particles appear to be embedded in a carbonaceous matrix (Figure 4), At this stage, this matrix no longer showed any very clear structure; some aggregates have little mechanical strength. We thus have little indication of the presence in initial size structure of the carbonaceous matrix. Some may arise from the burning of the tire rubber, or from the tar binding asphalt. A clear indication of the absence of combustion, some indication of the source may be given by the presence of other trace elements, e.g., S or Zn. S is used as a vulcanizing agent in rubber and will also be present in tire. The EDS images did indeed show a weak background of S, associated with the C signal, consistent with the rest arising from one of these sources. There were also some 1 mm particles of S, a line of which were associated with Cl (e.g., gypsum), while others gave a strong signal on the backscattered SEM signal but not from any of the other cations which we measured, nor from Ca. They may have been particles of MoS2, which is commonly used as a lubricant in gears.

Zn is used as an additive to S in vulcanizing rubber, while Cr may also be present in tires. A few 1 mm particles of Cr/Zn were indeed detected, though not associated with S. If these particles originated from burning rubbers, the implication is that the S measurements were the result of vulcanizing processes.
Environmental Science & Technology

Figure 5. HREM image of Fe in undercooking dust. Plane width is 380 nm.

Figure 6. SEM image showing the LIMS detector mounted on the microscope. The LIMS probe is 5 mm in diameter and 50 mm in length. The probe is connected to the optic axis, which is the instrument's center of the microscope.

Figure 7. LIDAR system at low altitude through the smoke. The graph shows the location of signal as a function of range, corrected for geometric spreading. The closed line is an attempt to fit the backscatter arriving from the airfield. In this case the algorithm has been confirmed by lasering at 400 and 800 m, making manual analysis unnecessary.

We will present here. The BAC-146 has two pairs of landing wheels, each with Goodyear 39R5-31 tires. There is a preference to land and take off toward the NW. The LIDAR was set up near the N end of the airfield and for the monitoring of the smoke scanned vertically on an azimuth of 175° (true), crossing the runways centerline at a range of 2.3 km.

There was a moderate NW crosswind on the day of the trial, affecting both engines and the smoke emissions away from the LIDAR. The pilots sampled were deployed on the airfield close to the LIDAR's scanning plane and at a distance of 1.3 km beyond the runway centerline. At this position, flying rubber could be smelled on all landings and hover operations of the taxiing and takeoff (hydrocarbon emissions are greater at lower power settings).

The Grimsley LIDAR easily detected the emissions from the aircraft on taxiing, takeoff, and landing, with typical peak number concentrations being respectively: 7 × 10^6 cm^-3, 5 × 10^6 cm^-3, and 1 × 10^6 cm^-3. On landing, the arrival point was usually identified by the wing motion. On takeoff, the aircraft would not yet have been moving fast enough at the measurement point to generate significant lift at the point of landing, by contrast, it flies and would have been generating lift slightly more than its weight. We note that although the field while taking off was 10% of that of the takeoff run, the aircraft had a much lower lift magnitude more slowly. This is all basically, since the 50% cutoff point for the sampling line was at an aerodynamic diameter of about 3 μm. The number density of coarse 43 μm should in no case be negligible by comparison.

The LIDAR was capable of detecting the engine points, engine exhaust, and the smoke on landing -6 out of the 8 landings were detected. The LIDAR signal comes from outgoing radiation backscattered by atmospheric aerosols. This is normally expressed through a parameter, βi, being the properties backscattered per unit path length per unit solid angle. Insetility, this is associated with an extinction, 0, which is the fraction of radiation lost per unit path length. A log-linear plot of signal against range in uniformly laser air will thus appear as a straight line of slope −2α.

3338
For a landing speed of 57.1 m s⁻¹, this implies a total smoke emission time of 1.3 s. This is much longer than the time for which visible smoke was generated, the video footage showing that this lasted for 0.32 s at most, with the main wheels landing essentially simultaneously. The Likar is of course much more sensitive than the eye. Part of the greater longitudinal extension of the smoke may possibly arise from some PM being entrained in the wake of the aircraft.

Although the Likar signal is dominated by the largest particles, these would be barely observable by the point sampler. Above 41 Lm, the smoke may be too fine and may be aerodynamically too small to pass through the sample line. The 50% capture point of the system is at an aerodynamic diameter of about 8 μm. On the other hand, the measured size spectrum (Figure 1) suggests that the number density at d = 10 μm is at least comparable with that at d = 50 μm, given the poor capture efficiency of respirable PM by the structure of the aircraft; there may in fact be many more fine particles than coarse particles emitted. If so, we should have been able to detect the larger particles with the Likar and the smaller particles with the OPCs. The volumetric sampling rates of the Osiris and the Grimm 1.108 were 0.65 L min⁻¹ and 1.2 L min⁻¹ respectively, each with a 1 s sampling time, so over the ~5 s period for the puff to pass they should have provided number sensitivities of ~20 L⁻¹ and ~10 L⁻¹ respectively. In practice, however, the sensitivity was determined by the background noise. Thus, for the Osiris, the observed background signal levels were 3.5 ± 2.0 μg L⁻¹ for PM₁₀, 10 ± 1.5 μg L⁻¹ for PM₁₅, and 3.1 ± 0.5 μg L⁻¹ for PM₁₅₅, corresponding to respective number densities of 4.1 L⁻¹, 815 L⁻¹, and 3830 L⁻¹ for spheres at the top end of these size ranges. PM₁₀ in the tire smoke should thus have been at or above the practical detection limit of this instrument. In fact, nothing significant was seen with either instrument in any size range, implying that Figure 1 has not greatly underestimated the number density at 10 μm. It is clear that the visible smoke cannot be associated with a substantial emission of respirable PM.

The ultrafine plume measured with the Grimm OPC arrived at the sampling point simultaneously with the tire smoke, but not the tire smoke, however, it persisted for 40 s. As for other landings, this ultrafine plume (i.e., engine smoke) was double-peaked, with a peak number concentration of 2.1 × 10⁷ L⁻¹ and 1.3 × 10⁶ L⁻¹. Almost nothing of the second peak, however, was visible with the Likar. It is interesting that almost all of this smoke should apparently have been entrained into the plume with the Likar.

Sections 3 and 4 suggest that the particles could be represented as aged concrete (a ≈ 0.25, p = 2000 kg m⁻³) of diameter ~10 μm. Hence, peak concentrations within the plume should be ~40 L⁻¹ and ~50 mg m⁻³. The supplementary peak in PM₁₀ at aerodynamic diameters of ~10 μm is likely to contribute very little to the backscatter since, as may be seen from Figure 1, its peak number density is comparable to that of the larger particles. Even for such coarse particles, the Stokes fall velocity is ~0.3 m s⁻¹, so sedimentation is initially secondary to the gross flow and turbulence within the emission. Over the 27 s for which it was observed, the center-of-gravity of the puff did not fall but rose by 3.5 m.

Figure 8 shows the implied footprint of the tire smoke at a height of ~4 m and at the time when it was passing over the point samplers. For this analysis we have used the 10 m wind speed and direction observed at the Likar to shift the envelope of tire smoke observed in earlier or later scans to that at the reference time. We can see that the smoke extends 75 m along the line of the runway.
the poor statistics of a particle happening to be within the
sampled volume (30 mL) is not but also because analytical
extrapolation makes coarse aerosol unlikely to pass along the
sampling line. Jointly, these observations suggest that the blog
of the visible aerosol in smoke is not large enough to be observable;
it seems to consist largely of mechanically generated dust from the
cursory surface. Mass balance on millimeters implyng that the major-
ity of the smoke aerosol is released as fine aerosol.
The condensation particle counter (Grimit LPC) on the
other hand, is extremely sensitive for ultrafine particles. While it
detected the engine emissions very sensitively, there were simply
for too few particles in the smoke to provide a distinguishable
signal.
Overall, it would appear that while fine smoke emissions can be
aggregated, and may have operational implications in terms of
tire area and runway vapor density, the emissions of visible TPM
is relatively small. There may, however, still be health issues
arising from flagstone organisms (e.g., PABA) released from the
rubber or nuisance from the associated odor.

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REFERENCES

[1] UK Department for Transport. Project for the Sustainable
Development of Harlow, Annex 3, 2006, www.dft.gov.uk/transport/uk-
environmental/land/motorway/ID6000_rid008.pdf (accessed March
10, 2013).
[2] Environmental Protection Agency. Final Assessment of Aircraft
Emissions on Health Effects of Persistent Organic Pollutants (POPs):
ER10000-REP-080-2006/0805/July 2006. www.epagov/lib/pall/604_pop_jan-
10, 548-561.
and the environment. In: Landscape Architecture (eds. J. A. Haynes
and J. A. Haynes). 
mechanical processing of British new and used tires. Environmental
envimpactassessrev.2006.03.003.
a rubber tire rubber material analysis method. Journal of Environmental
Science, 2005, 26, 1-10.
a rubber tire rubber material analysis method. Journal of Environmental
Science, 2005, 26, 1-10.
a rubber tire rubber material analysis method. Journal of Environmental
Science, 2005, 26, 1-10.
a rubber tire rubber material analysis method. Journal of Environmental
Science, 2005, 26, 1-10.

Characterization of heavy metal particles embedded in tire dust

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Abstract

Tire dust is a significant pollutant, especially as a source of zinc in the urban environment. This study characterizes the morphology and chemical composition of heavy metal particles embedded in tire dust and traffic-related materials (brake dust, yellow paint, and tire tread) as measured by a field emission scanning electron microscope equipped with an energy dispersive X-ray spectrometer (FESEM/EDX). In 60 samples of tire dust, we detected 2288 heavy metal particles, which we classified into four groups using cluster analysis according to the following typical elements: cluster 1: Fe; cluster 2: Cu, Pb; cluster 3: multiple elements (Cr, Cu, Fe, Co, Zn, Sn, Zr, Zn, Na, Si, Al, Fe, Ti, and Ba); cluster 4: ZnO. According to their morphologies and chemical compositions, the possible sources of each cluster were as follows: (1) brake dust (particles rich in Fe and with trace Cu, Si, and Ba), (2) yellow paint (CuO, CuO2 particles), (3) brake dust (particles Ti, Fe, Cu, Zn, Si, Zr, and Ba) and heavy metals (Y, Zr, Sn, and Co), (4) tire tread (zinc oxide). When the chemical composition of tire dust was compared to that of tire tread, the tire dust was found to have greater concentrations of heavy metal elements as well as mineral or asphalt pavement material characterized by Al, Si, and Ca. We conclude that tire dust consists not only of the debris from tire wear but also of the dust particles emitted from traffic materials such as brake lining and road paint.

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Keywords: Heavy metal particles; Tire dust; Traffic-related materials

1. Introduction

Tire wear debris (tire dust) is generated by the rolling shear of tire tread against road surfaces (Regge et al., 1993). The mass of annual emission of tire dust was estimated to be 5.3 × 10^9 kg in 1996 in the UK (Environment Agency, 1998) and 2.1 × 10^8 kg in 2001 in Japan (Adachi and Tainosho, 2003), and tire abrasion on urban road in Germany was estimated from 55 to 657 kg/km/year on various roads (Mauchack, 1990). This large amount of tire dust is a significant cause of pollution in the urban environment (Environment Agency, 1998). Zinc oxide is added as an activator during the vulcanization process, comprising from 0.4% to 4.3% of the resulting tire tread (Smolders and De Gryse, 2002), and zinc from tire dust is a significant pollutant in soil (Smolders and De Gryse, 2002; Sadig et al., 1989), air (Regge et al., 1993), street dust (Ferguson and Kim, 1991), and urban runoff (Davis et al., 2001). Other heavy metal elements in tire dust also pollute the environment. Fukuzaki et al. (1985) showed that tire tread contains heavy metals such as Mn, Fe, Cu, Ni, Co, Zn, Cr, Cd, and Pb, and tire dust pollution contributes to some of these elements in the form of airborne dust. Sadig et al. (1989) analyzed the metal concentrations in tires and showed that tire dust was a soil pollutant. The road paving aggregates embedded in tire dust have been investigated (Cummins et al., 2001; Smith and Veith, 1982), but heavy metal particles derived from other sources have not yet been examined. Heavy metal particles are emitted on the road surface as part of brake dust, road paint, diesel exhaust particles (DEP), road construction materials, or car catalyst materials. When tire tread is abraded against the road surface, the tire tread debris will assimilate these particles. In this study, we examined brake dust, yellow...
polystyrene and the trend materials as possible sources of metal particles in the dust.

Brake dust has been recognized as a significant pollutant for Cu, Sb, and Bi in the aerosol composition (Siegel et al., 2002) and is contributed 47% of the total loading for Cu in urban runoff (Devis et al., 2007). Yellow paint contributed from 0.3% to 1.0% of airborne dust in Niigata, Japan (Koike et al., 1989). The bulk chemical composition and manufacturing process of brake dust, yellow paint, and the tread are well known, but detailed morphologies and individual elemental compositions of the metal particles included have not been thoroughly investigated by the scanning electron microscopy (SEM) method. The aims of this study were to characterize the heavy metal particles embedded in the dust and the traffic-related metal particles (brake dust, yellow road paint, and tire tread) as sources of embedded particles in the dust.

The diameter of embedded particles in the dust and traffic-related particles ranged from several micrometers to 0.3 μm, which is too small to detect by normal SEM. Therefore, we used field emission scanning electron microscopy with energy dispersive X-ray spectrometry (FESEM/EDX) for the single particle analysis of these metal particles. FESEM is a very useful tool for analyzing individual particles at high resolution because a field emission cathode in the electron gun of the SEM provides narrower probing beams than that found in tungsten filament SEM, resulting in improved spatial resolution.

2. Experimental procedure

2.1. Sampling site

Street dust samples were collected from six sites in Kobe, Hyogo Prefecture, Japan (Fig. 1) during August of 2002. The population of the city of Kobe was 1,810,000 in 2002. The northern part of the study area is a mountain, and the southern part is a harbor. The sampling sites selected were the same points at which a traffic census was carried out by the city of Kobe as a part of a national traffic census conducted in October of 1999 (Hyogo Prefecture, 1999). According to the data, the traffic volume ranged from 4944 to 30,368 vehicles per day, and the proportion of heavy-vehicle traffic ranged from 4.7% to 23.3%. Sites 1, 2, and 6 are residential areas. Sites 3 and 4 are industrial areas, and Site 5 is a commercial area. Site 1 is located on a down slope, while the other sites are almost flat. Sites 2, 4, and 5 are crossroads. Sites 3 and 4 are different locations on the same road.
2.2. Sample collection

The tire dust samples investigated here were collected from street dust, which were the depositions from natural and human activities on the road (Brekan and Dvorinek, 1981). The tire dust composition analysis, found in Appendix A, indicates the composition of the street dust. More than 100 g of street dust were gathered from roadsides with a nylon mesh at each sampling site. The collected samples were stored in plastic bags for subsequent sample preparation and analysis.

In addition to the street dust sampling, we collected five brake dust samples from the rim of front brake linings. The five selected cars were manufactured by three different Japanese automakers. We also picked up a yellow road paint sample from the edge of an inner road surface in the study area, and a tire tread sample was shipped off from the surface of a used tire (Bridgestone, 6-40814, Japan).

2.3. Single particle analysis

The FSEM measurements were performed with a JSM-6330F cold-field emission SEM (JEOL, Tokyo) with an energy dispersive X-ray spectrometry (EDX) detector: Link ISIS (Oxford-Instrument, Tokyo). The EDX detector is equipped with a super atmospheric thin window, which allows one to determine the low atomic number elements (from Be to U). For the single particle analysis of the heavy metal particles embedded in tire dust, we used an acceleration voltage of 15 kV, a working distance of 15 mm, and an EDX collection time of 20 s. For the bulk analysis of traffic-related materials, we used 500 x 1000 s of EDX collection time.

The street dust samples were dried at room temperature and sieved through a 149-μm nylon screen. They were attached to a carbon tape attached to aluminum stubs. All samples were coated with carbon so they would have conducting properties.

Ten larger tire dusts whose shape had not been broken were selected from each street dust sample (Fig. 2a, b). The length of the selected particles ranged from 220 to 1280 μm. The dust samples were distinguished from other types of debris by the following three features: (1) sausage-shaped particles (Diasis, 1974), (2) surface morphology resembling characteristic rough and rugged
3. Results and discussion

3.1. Brake dust

Three or four fragments from each brake dust sample were analyzed to determine their bulk chemical compositions and the particulate compositions by FESEM/EDX. The BEI and distribution of Cu, Sr, S, and Fe of brake dust are shown in Fig. 5a and 5b, respectively. The diameter of particles in the brake dust was about 1 μm, which was within the range of average mass median diameters of brake dust measured under several conditions (from 0.62 to 2.49 μm) [Yang et al., 2006].

The brake dust consisted mainly of particulate Al, Si, S, Ti, Fe, Cu, and Sr (Fig. 5b). Iron particles also contained slight amounts of S, Cu, Sr, and Zn. Some brake dust samples contained particulate BaSO₄ and Zn. When we averaged the bulk compositions of the brake dust fragments, we found that Fe was the most abundant heavy element, followed by Sr, Cu, Sr, and Zn (Table 1: Table 1). Segerstedt et al. (2002) propose diagnostic criteria for brake wear particles that included a ratio of 4.6 ± 3.3 for Cu/Sr. The ratio in our analysis was 1.3. The low ratio compared to the criterion was because of the presence of Cu-free brake dust samples in this study.

Cu is used to control heat transport, and Sr is used to enhance stability (ORNL, 2001). BaSO₄ is used to increase the density of the brake pad (ORNL, 2001).

3.2. Yellow paint

The typical morphology and EDX spectra of yellow paint are shown in Fig. 4. The bulk chemical composition is high in Sr, Ca, Cu, and Fe (Table 1). The yellow
Table 1

Chemical compositions of clays and clays-related materials (wt% of SiO₂ standard deviation)

<table>
<thead>
<tr>
<th>Mg</th>
<th>Fe</th>
<th>Ca</th>
<th>K</th>
<th>Na</th>
<th>TiO₂</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>Fe₂O₃</th>
<th>MgO</th>
<th>CaO</th>
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<tr>
<td>0.5±0.5</td>
<td>1.2±0.2</td>
<td>0.6±0.6</td>
<td>1.8±1.2</td>
<td>0.3±0.2</td>
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</tbody>
</table>

The table consists of basic, Ca, and Fe₂O₃ particle amounts of Fe, Mg, Zn, and TiO₂ (16/8:1). The chemical composition was quite different from that of the tarred. Mineral materials were found at high levels compared to the composition of the clays and some heavy metal elements were detected.

The embedded particles were divided into four clusters based on the consistent Mg²⁺ and Ca²⁺ post-compositions, Fe²⁺, Cr²⁺, and Zn²⁺ particles were classified into clusters 1, 2, and 3, respectively. The particles with multi-elemental composition were classified into cluster 3. Typical morphology and EDS spectra of the heavy metal particles are shown in Fig. 6. In each EDS spectrum, Al, Si, and Ca may reflect neighboring material of the targeted heavy metal particles, such as asphalt pavement material, soil clays, or the tire track itself.

3.3. Clusters

Cluster 1 is characterized by high Fe²⁺ composition. Other heavy metal elements such as Mn, Ca, Zn, and Ba are contained in slight amounts in this cluster (Fig. 3). The average particle diameter is relatively large (1.17 µm). Iron is the most abundant heavy metal element in street dirt.
APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

The abundance ratio of this cluster in each tire dust samples showed large variation among individual tire dusts.

Cluster 3 is characterized by multiple elements (Si, Ca, Fe, Cu, Zn, Sr, Y, Zr, Nb, Ba, La, Ce, and Pb) (Table 5). The average particle diameter in this cluster is 1.03 μm. The typical morphology and EDX spectra of this cluster are shown in Fig. 4a. Because the brake dust has many Ti, Fe, Ca, Cu, Zn, Sr, and Ba particles, these particles are significant contributors to this cluster. The ratio of Ca/Sr (3.8) which was in good agreement with the diagnostic criteria for brake wear particles (4.6 ± 2.3) (Sternbeck et al., 2002), also suggests the contribution of brake dust.

De Miguel et al. (1997) has classified the elements in street dust (La, Sr, Y) as natural elements, and Sternbeck et al. (1997) has classified the elements in brake dust (Zn, Ca, Cu) as brake dust elements.
Fig. 6. Typical image of metal particles and in the size:  {a) Cluster 1, (b) Cluster 2, (c) Cluster 3, (d) Cluster 4.}

[202] showed that rare earth elements such as Ce, La, and Pr are hosted in an mineral phase in airborne particles. We found some heavy minerals such as allanite (Ca, Ce, Fe, Al, Si), zircon (Zr, Si), and monazite (P, Ce, La, Y, Th) by single particle analysis. This study area has a granite geological background, which includes these heavy minerals (White and Kassouf, 1993), so one of the possible sources of these elements is a natural source.
Classification into cluster 3 indicates multiple sources. Because the classification in this analysis was based on only major components of the particulate, it is difficult to distinguish the particles with multi-elemental composition with exactness. Further division based on elemental ratios or statistical mathematical analyses will help to classify them.

3.5 Cluster 4

Cluster 4 mainly consists of ZnO with an average particle diameter of 0.52 μm. The most typical morphology of the particles is square or multi-angular (Fig. 5a). These characteristics agree with that of ZnO in tire dust (Fig. 5a), so we conclude that most of the particles in this cluster come from ZnO in tire dust. The abundance ratio of Cluster 4 was very different in each tire dust sample. (Average: 22%, S.D.: 37%, Max: 56%, Min: 3%). Some tire dust samples contained no particular ZnO. The presence of particular ZnO may depend on the manufacturing process of the tire.

Other possible sources of particulate ZnO in road materials, galvanized, from roads (Ferguson and Rim, 1995), and brake dust (Davis et al., 2011; Emerick et al., 1999).

4. Conclusion

In this study, we characterized the morphologic and elemental composition of traffic-related material (tire dust, yellow paint, and tire tread) and heavy metal particles embedded in tire dust. Brake dust contains heavy metal particles such as Fe, Cu, Zn, Sb, and Ba with a particle diameters of about 1 μm. Yellow paint consists of ZnO particles with an unusual morphology and a characteristic of about 0.5 μm. Tread dust has multi-angular ZnO particles 1 μm or less in diameter. Moreover, a total of 2286 heavy metal particles were counted and embedded in the tire dust, and they were classified into four groups by cluster analysis. Cluster 1 is rich in K, cluster 2 is rich in Cl, and cluster 3 is characterized by multiple elements. Cluster 4 consists mainly of ZnO. Judging from its electrical composition, particle diameter, and morphology, brake dust is a possible contributor of clusters 1 and 3, and yellow paint is a possible contributor of cluster 3. ZnO seen in tire dust is a significant source for cluster 4.

These results suggest that tire dust assimilates traffic-related metal particles when the dust is raised between roadways and abraded. The interactions between tire wear slivers and heavy metal particles may give the heavy metal risk to the tire dust. Further study that discusses the risk of heavy metal particles embedded in tire dust is needed.

Acknowledgements

We would like to acknowledge the two anonymous referees for their constructive comments.

References


Andersen, K., Drablos F. Filling material properties regarding the behavior of urban dust, Int. Arch. Photogr. 1995:2175-84.

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APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

ITEM NO: PDEC17/14


Summary statistics DUBBO AIRPORT AWS:

A summary of the major climate statistics recorded at this site is provided below. There is also an extended table with more statistics available. More detailed data for individual sites is available.

Site Information:
- Site name: DUBBO AIRPORT AWS
- Site number: 065070
- Latitude: 32.22° S
- Longitude: 148.58° E
- Elevation: 284 m
- Commenced: 1946
- Status: Open
- Latest available data: 31 Mar 2016

Additional Information:
- Additional site information:

Nearest Alternative Sites:
1. 065012 DUBBO (DARLING STREET) (3.7 km)
2. 065035 WELLINGTON RESEARCH CENTRE (48.6 km)
3. 065034 WELLINGTON (D&J RURAL) (51.6 km)
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Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: D60070 • Opened Jan 1994 • Site Open • Latitude: -32.2209° • Longitude: 149.5793° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Jan
528 Total Observations

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Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 060070 • Opened Jan 1996 • Site Open • Latitude: -32.2209° • Longitude: 148.3795° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Feb
501 Total Observations

Prepared by National Climate Centre of the Bureau of Meteorology.
Contact us by phone on (03) 9689 4083, by fax on (03) 9689 4516, or by email on climate.data@bom.gov.au
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TO2MONTH Page 1
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 060070 • Opened Jan 1946 • Elevation: 322.230m • Longitude: 149.3795° • Latitude: 32.2300°

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Mar
549 Total Observations

Prepared by National Climate Centre of the Bureau of Meteorology.
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Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 660072 • Opened Jan 1946 • Still Open • Latitude: 32.2206° • Longitude: 149.5795° • Elevation 284m
An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Apr
512 Total Observations

Calm
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 665072 • Opened Jan 1946 • SIII Open • Latitude: -32.2209° • Longitude: 149.3795° • Elevation 284m
An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm May
152 Total Observations
Calm 1%
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details.

DUBBO AIRPORT AWS
Site No: D60070 • Opened Jan 1994 • Site Open • Latitude: -32.2206° • Longitude: 149.3795° • Elevation 284 m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Jun
517 Total Observations

Calm 1%
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 060070 • Opened Jan 1994 • 88m Open • Latitude: -32.2309° • Longitude: 149.5759° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: D60070 • Opened Jan 1996 • Sill Open • Latitude: -32.2200° • Longitude: 149.3795° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details.

DUBBO AIRPORT AWS
Site No: 665072 • Opened: Jan 1994 • Site: Open • Latitude: -32.2209°, Longitude: 149.3795°, Elevation: 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Sep
551 Total Observations

Calm
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: D60072 • Opened Jan 1994 • Site Open • Latitude: -32.2209° • Longitude: 149.5793° • Elevation 284m
An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Oct
515 Total Observations

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PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 282
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 665072 • Operational Jan 1946 • Sill Open • Latitude: -32.2209° • Longitude: 149.2795° • Elevation 284m
An asterisk (*) indicates that calm is less than 0.5%,
Other important info about this analysis is available in the accompanying notes.

3 pm Nov
498 Total Observations

Calm
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached notes for details

DUBBO AIRPORT AWS
Site No: 060070 • Opened Jan 1996 • BII Open • Latitude: -32.2209° • Longitude: 148.5795° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm Dec
512 Total Observations

Calm
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: D60072 • Opened Jan 1996 • 30h Open • Latitude: -32.2209° • Longitude: 148.5795° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: D60070 • Opened Jan 1946 • BHI Open • Latitude: -32.2200° • Longitude: 148.5795° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

Feb 2009
504 Total Observations

Calm 1%
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached notes for details

DUBBO AIRPORT AWS
Site No: D60070 • Opened Jan 1993 • Site: Open • Latitude: -32.2209° • Longitude: 149.9795° • Elevation 844m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

24 Mar
547 Total Observations
Calm 1%

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TO2MONTH Page 1
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: D60070 • Opened Jan 1994 • Sill Open • Latitude: -32.2209° • Longitude: 148.3795° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 660072 • Opened Jan 1946 • Sill Open • Latitude: -32.2209° • Longitude: 149.3795° • Elevation: 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details
DUBBO AIRPORT AWS
Site No: 060072 • Opened Jan 1994 • Site Open • Latitude: -32.2209° • Longitude: 149.5753° • Elevation 284m
An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: D00072 • Opened Jan 1986 • Situated Great Plains • Latitude: -32.2204° • Longitude: 148.5795° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details.

DUBBO AIRPORT AWS
Site No: D69870 • Opened Jan 1994 • Elevation: 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

8 am Aug
541 Total Observations

Calm
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 060072 • Opened Jan 1986 • Site Open • Latitude: -32.2205° • Longitude: 149.2795° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

24 Sep
123 Total Observations

Calm 1%
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 063002 • Opened Jan 1986 • Bil Open • Latitude: -32.2209° • Longitude: 148.5759° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

9am Oct
573 Total Observations
Calm 1%
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 060072 • Opened Jan 1994 • Site Open • Latitude: -32.2204° • Longitude: 148.5795° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 060072 • Opeated Jan 1996 • Bli Open • Latitude: -32.2203° • Longitude: 148.5769° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

[Graph depicting wind direction and speed]

Data Dep
502 Total Observations

Calm

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Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 060070 • Opened Jan 1946 • Bil: Open • Latitude: -32.2209° • Longitude: 149.3759° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm
6299 Total Observations

Calm
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times selected, refer to attached note for details

DUBBO AIRPORT AWS

Site No: 660702 • Opened Jan 1946 • SS (Open) • Latitude: -33.2209° • Longitude: 149.3795° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.

Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details.

DUBBO (DARLING STREET)
Site No: 065012 • Opened Jan 1970 • Closed Nov 2009 • Latitude: -32.3236° • Longitude: 148.6999° • Elevation 280m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Jan
215 Total Observations

Cal 10%

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Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached notes for details

DUBBO (DARLING STREET)

Site No: 060712 • Opened: Jan 1970 • Closed: Nov 2001 • Latitude: -32.2398° • Longitude: 148.6099° • Elevation: 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Feb 1990 Total Observations

Calm 11%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)

Site No: 060012 • Opened Jan 1921 • Closed Nov 2009 • Latitude: -32.2338° • Longitude: 148.6999° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.

Other important info about this analysis is available in the accompanying notes.

3 pm Mar
2284 Total Observations

Calm 12%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)
Site No: D60012 • Opened Jan 1870 • Closed Nov 2009 • Latitude: -33.2396° • Longitude: 148.6599° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Apr
2229 Total Observations
Calm 15%

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Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)

Site No: 060012 • Opened Jan 1970 • Closed Nov 2009 • Latitude: -33.2990 • Longitude: 148.6599 • Elevation: 280m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm May 2014 Total Observations

Calm 17%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details.

DUBBO (DARLING STREET)
Site No: 060102 • Opened: Jan 1870 • Closed: Nov 2009 • Latitude: -32.239° • Longitude: 148.659° • Elevation: 260 m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Jun
2272 Total Observations

Calm 16%

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Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)

Site No: 066012 • Opened Jan 1870 • Closed Nov 2009 • Latitude: -32.3333° • Longitude: 148.6667° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)
Site No: 060012 • Opened Jan 1870 • Closed Nov 2009 • Latitude: -32.2398° • Longitude: 148.6959° • Elevation: 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)
Site No: 060012 • Opened Jan 1870 • Closed Nov 2000 • Latitude: -33.2336° • Longitude: 148.6599° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Sep
2232 Total Observations

Calm 11%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)

Site No: 065012 • Opened Jan 1870 • Closed Nov 2009 • Latitude: -32°23'00" • Longitude: 148°6'00" • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Oct 2291 Total Observations

Calm 10%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)

Site No: 060012 • Opened Jan 1870 • Closed Nov 2009 • Latitude: -32.2369° • Longitude: 148.6699° • Elevation: 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Dec
2258 Total Observations

Col Jan 10%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details.

DUBBO (DARLING STREET)

Site No: 060012 • Opened: Jan 1870 • Closed: Nov 2009 • Latitude: -32.2336° • Longitude: 148.6099° • Elevation: 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Nov
2194 Total Observations

Colas 93%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)
Site No: 660012 • Opened Jan 1970 • Closed Nov 2009 • Latitude: -33.2388° • Longitude: 148.6999° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom times selected, refer to attached file for details

DUBBO (DARLING STREET)
Site No: 066012 • Opened Jan 1870 • Closed Nov 2009 • Latitude: -32.2398° • Longitude: 148.6599° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)
Site No: 060012 • Opened Jan 1870 • Closed Nov 2009 • Latitude: -32.2388° • Longitude: 148.6099° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)

Site No: 066012 • Opened Jan 1879 • Closed Nov 2009 • Latitude: -32.2398° • Longitude: 148.6989° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.

Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)
Site No: 060012 • Opened Jan 1870 • Closed Nov 2001 • Latitude: -32.2349° • Longitude: 148.6699° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)

Site No: 060012 • Opened Jan 1870 • Closed Nov 2009 • Latitude: -33.2325° • Longitude: 148.6999° • Elevation 286m

An asterisk (*) indicates that calm is less than 0.5%

Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)
Site No: 660012 • Opened Jan 1870 • Closed Nov 2001 • Latitude: -33.2368° • Longitude: 148.6989° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

An asterisk (*) indicates that calm is less than 0.5%.

Other important info about this analysis is available in the accompanying notes.

2 pm Aug 2000 Total Observations

Calm 36%

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Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)
Site No: 060012 • Opened Jan 1870 • Closed Nov 2000 • Latitude: -32.2383° • Longitude: 148.6549° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)
Site No: 069012 • Opened Jan 1870 • Closed Nov 2001 • Latitude: -32.2369° • Longitude: 148.6999° • Elevation 280m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom times selected, refer to attached note for details

**Dubbo (Darling Street)**
Site No: 069012 • Opened Jan 1890 • Closed Nov 2009 • Latitude: -32.2398° • Longitude: 148.6599° • Elevation: 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)
Site No: 66012 • Opened Jan 1870 • Closed Nov 2009 • Lat/Long: -32.2396° • Longitude: 148.6099° • Elevation 289m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details

DUBBO (DARLING STREET)

Site No: 060012 • Opened Jan 1897 • Closed Nov 2004 • Latitude: -32.2398° • Longitude: 148.6598° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.

Other important info about this analysis is available in the accompanying notes.

3 pm
26805 Total Observations

Calm 12%

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Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times selected, refer to attached note for details.

DUBBO (DARLING STREET)

Site No: 066012 • Opened Jan 1870 • Closed Nov 2009 • Latitude: -32.2389° • Longitude: 148.6999° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
<table>
<thead>
<tr>
<th>Statistics</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Annual</th>
<th>Mean</th>
<th>Max</th>
<th>Min</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>0.2°C</td>
<td>0.6°C</td>
<td>0.3°C</td>
<td>0.4°C</td>
<td>0.5°C</td>
<td>0.7°C</td>
<td>0.8°C</td>
<td>0.9°C</td>
<td>1.0°C</td>
<td>1.1°C</td>
<td>1.2°C</td>
<td>1.3°C</td>
<td>1.4°C</td>
<td>1.5°C</td>
<td>1.6°C</td>
<td>1.7°C</td>
<td>1.8°C</td>
</tr>
<tr>
<td>Rainfall</td>
<td>3.0 mm</td>
<td>5.0 mm</td>
<td>7.0 mm</td>
<td>9.0 mm</td>
<td>11.0 mm</td>
<td>13.0 mm</td>
<td>15.0 mm</td>
<td>17.0 mm</td>
<td>19.0 mm</td>
<td>21.0 mm</td>
<td>23.0 mm</td>
<td>25.0 mm</td>
<td>27.0 mm</td>
<td>29.0 mm</td>
<td>31.0 mm</td>
<td>33.0 mm</td>
<td>35.0 mm</td>
</tr>
<tr>
<td>Precipitation (mm)</td>
<td>3.0 mm</td>
<td>5.0 mm</td>
<td>7.0 mm</td>
<td>9.0 mm</td>
<td>11.0 mm</td>
<td>13.0 mm</td>
<td>15.0 mm</td>
<td>17.0 mm</td>
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<td>23.0 mm</td>
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<td>27.0 mm</td>
<td>29.0 mm</td>
<td>31.0 mm</td>
<td>33.0 mm</td>
<td>35.0 mm</td>
</tr>
<tr>
<td>Mean number of days of rain</td>
<td>0.5</td>
<td>0.7</td>
<td>0.9</td>
<td>1.1</td>
<td>1.3</td>
<td>1.5</td>
<td>1.7</td>
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<td>2.5</td>
<td>2.7</td>
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<td>3.7</td>
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<td>Other daily elements</td>
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<td></td>
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</tr>
<tr>
<td>Mean daily sunshine (hours)</td>
<td>6.0</td>
<td>5.0</td>
<td>4.0</td>
<td>3.0</td>
<td>2.0</td>
<td>1.0</td>
<td>0.0</td>
<td>0.0</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Mean number of days of sunshine</td>
<td>300</td>
<td>280</td>
<td>260</td>
<td>240</td>
<td>220</td>
<td>200</td>
<td>180</td>
<td>160</td>
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<td>100</td>
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<td>60</td>
<td>40</td>
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<td>0</td>
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<tr>
<td>A m conditions</td>
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<td></td>
<td></td>
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<tr>
<td>Mean Tmin (temperature °C)</td>
<td>0.0°C</td>
<td>0.0°C</td>
<td>0.0°C</td>
<td>0.0°C</td>
<td>0.0°C</td>
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1. Water concept plan

A concept subdivision layout for the subject property provides for 25 residential lots ranging in area between 3.0 and 7.6 hectares. Site elevations vary between 269 and 315m AHD.

The conceptual water network arrangement and model structure adopted for this report is shown on Figure 1 (attached). Model nodes are placed in locations that generally coincide with logical locations for future service connections.

Future water mains were assumed to be 100mm in diameter which is the minimum normally adopted for residential areas. If a larger diameter were adopted as part of future subdivision design then head loss would be lower and supply pressures improved further on the results presented in this report.

2. Preliminary assessment

Dubbo City Council’s Customer Service Standards (2016-2016) state that Council will supply at least 170 kPa (17m head) to properties within an urban Water Supply pressure 95% of the time.

In an e-mail dated 22 July 2016 Dubbo City Council advised that the peak daily demand for each lot is 0.042 l/s.

In an e-mail dated 26 July 2016 Council provided an estimate of the 24hr static pressures at the existing water main in Camp Road. The pressure ranged between 880kPa and 800kPa throughout the 24-hour period.

This assessment has adopted the lower range value of 680kPa (or 68m) which provides a conservative estimate of the minimum water pressure available to properties within the concept water network during the highest demand periods.

The elevation of the connection point in Camp Road is 269.5m resulting in a minimum Hydraulic Grade Line (HGL) of 337.5m AHD.
It is noted that the highest service elevation within the subject land is 315m AHD. Assuming minimal head loss in the water supply network, the highest point of the subject land would be supplied with at least 22.5m pressure. This complies with Dubbo City Council’s Customer Service Standards (2016-2018).

3. Water supply modelling

GCA conducted preliminary water network modelling to evaluate the assumption that there would be minimal head loss in the future water mains constructed within the land to supply development lots.

The computer software program EPANET, developed by the United States Environmental Protection Agency, was used to model the conceptual trunk water linkages and estimate supply pressures at each node for the peak demand scenario.

The model network layout is shown on Figure 1 (attached). For the purpose of this exercise the network was modelled as a steady state system for the critical condition only, using the appropriate lower bound boundary condition value of 68m pressure (337.8m HGL).

Summary model results (HGL and pressure) at each model node and for each demand scenario are provided in Table 1 (attached).

The model results indicate that model nodes are supplied with pressure between 50.43 and 68m of residual pressure which is well above Dubbo City Council’s minimum customer service standard of 17m (170kPa).

Estimated flow velocities vary between 0.01 and 0.13 m/s.

The total predicted head loss is only 0.37m (37kPa) between the connection point and the extremities of the concept water network, correlating with a very low average unit head loss rate of 0.25 m/km of water main. This very low head loss is due to the low density of development proposed and the associated low water demand, combined with the minimum 100mm water main diameter.

Accordingly, the assumption of minimal head loss in local water mains adopted for the preliminary assessment in Section 2 (above) is considered valid, and hence, all areas of the subject land should be serviceable with the minimum 17m head (170kPa) pressure as required under Dubbo City Council’s Customer Service Standards (2016-2018).

4. Conclusion

This report has assessed water supply pressure availability within Lot 8 DP1003429 from a connection point into the existing water main in Camp Road.

Preliminary assessment combined with water supply modelling has demonstrated that all areas of the site should be serviceable with the minimum 17m head (170kPa) pressure as required under Dubbo City Council’s Customer Service Standards (2016-2018). In reality, the building envelopes shown are at lower site elevations and residual pressures will be closer to 51 – 58m (510 – 580kPa) as calculated using the water supply network model.

Therefore, the site is generally suitable for the proposed residential land use from a water supply servicing perspective.

Yours sincerely,

Stuart Holle
Principal Civil Engineer
for and on behalf of GCA Engineering Solutions
Table 1: Water Supply Model Results (Peak Demand Period)

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AN ARCHAEOLOGICAL SURVEY

FOR

THE PROPOSED
"GLENN LEE" TOURISM DEVELOPMENT,
CAMP ROAD, DUBBO, NSW.

A report for:
Development Consultants,
Haynes Wheeler & Thorne Pty. Ltd.
P.O. Box 1842
Dubbo, NSW, 2830

Prepared by:
J. Kelton,
Central West Archaeological and Heritage Services,
92 Darling Street, Cowra, NSW, 2794.
Phone/Fax: (063) 413254

December 1993
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page No.</th>
</tr>
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<tbody>
<tr>
<td>1.0 INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Aim of the Investigation</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Aboriginal Community Consultation</td>
<td>2</td>
</tr>
<tr>
<td>2.0 The Development</td>
<td>3</td>
</tr>
<tr>
<td>3.0 LOCAL ENVIRONMENT</td>
<td>6</td>
</tr>
<tr>
<td>3.1 LANDFORM</td>
<td>9</td>
</tr>
<tr>
<td>4.0 ARCHAEOLOGICAL BACKGROUND</td>
<td>9</td>
</tr>
<tr>
<td>4.1 Archival Search</td>
<td>12</td>
</tr>
<tr>
<td>4.2 Previous Archaeological Studies</td>
<td>15</td>
</tr>
<tr>
<td>4.3 Previous Archaeological Models</td>
<td>18</td>
</tr>
<tr>
<td>5.0 METHODOLOGY</td>
<td>17</td>
</tr>
<tr>
<td>5.1 Survey Area Site Prediction</td>
<td>17</td>
</tr>
<tr>
<td>5.2 Site Location: Predictive Modelling</td>
<td>20</td>
</tr>
<tr>
<td>6.0 ARCHAEOLOGICAL SURVEY</td>
<td>27</td>
</tr>
<tr>
<td>6.1 Survey Strategy</td>
<td>27</td>
</tr>
<tr>
<td>6.2 Field Recording Methods</td>
<td>28</td>
</tr>
<tr>
<td>6.3 Field Survey Methodology and Coverage Data</td>
<td>28</td>
</tr>
<tr>
<td>7.0 Survey Results &amp; Significance Assessment</td>
<td>37</td>
</tr>
<tr>
<td>8.0 DISCUSSION</td>
<td>61</td>
</tr>
<tr>
<td>9.0 CONCLUSIONS</td>
<td>63</td>
</tr>
<tr>
<td>10.0 RECOMMENDATIONS</td>
<td>65</td>
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<td>11.0 LEGAL OBLIGATIONS</td>
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<td>97</td>
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<td>69</td>
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### Table of Contents (Cont'd)

#### Plates

- **Figures**
  - **Figure 1**: Study Area Map
  - **Figure 2**: Study Area Landform
  - **Figure 3**: Archaeologically Sensitive Areas
  - **Figure 4**: Archaeological Site Location Map
  - **Figure 5**: Map of Survey Sample Units

#### Appendix

- **Appendix 1**: Copy of Statement of Involvement in "Glenn Lee" Archaeological Survey by Central Region Aboriginal Land Council, Dubbo
- **Appendix 2**: Gazetteer of Sites Previously Recorded Within 5 Kilometres of "Glenn Lee" Survey Area (NPWS Records)
- **Appendix 3**: Gazetteer of Sites Recorded During "Glenn Lee" Survey
- **Appendix 4**: Summary Details of Open Campsites Recorded During "Glenn Lee" Archaeological Survey
- **Appendix 5**: Summary Details of Artefacts
- **Appendix 6**: Summary of Site Significance Assessment
- **Appendix 7**: Copies of NPWS Site Forms
Figure 1
"Glenn Lee" Study Area Map
Map Datum Map: 58,000 CAD Topographic.
AN ARCHAEOLOGICAL SURVEY FOR THE PROPOSED GLENN LEE TOURISM DEVELOPMENT, CAMP ROAD, DUBBO, NSW.

J. Kelton, Central West Archaeological and Heritage Services, Cowra, NSW.

1.0. INTRODUCTION

Development consultants Hoynes Wheeler and Thorne Pry, Ltd., of Dubbo, have engaged Central West Archaeological and Heritage Services, Cowra, to conduct an archaeological survey over the site of a proposed tourism accommodation development, near Dubbo, in the north-west slopes of New South Wales.

The field component of the study, conducted by archaeological consultant, Jim Kelton, was carried out over two days, between 12th-13th October 1990. Mr. Kelton was assisted by Aboriginal field representative, Mr. Cecil Sete, Manager, Central Region Aboriginal Land Council, Dubbo.

The report provides details of the local environment, the known archaeology of the area, as well as documenting survey methods and results. Where appropriate, the report also analyses aspects of site management and management options and recommendations, under the provisions of the New South Wales National Parks and Wildlife Act, 1974 (NSW NPW Act, 1974).

The proposed development has the potential to disturb or destroy Aboriginal archaeological relics and sites located within the identified survey area. Activities which threaten to impact upon Aboriginal sites during the proposed development include the following:

1. The removal of standing and fallen timber.
2. All earthworks associated with the proposed development.

1.1. Aims of the Investigation

The aims of the "Glenn Lee" archaeological study were to assess the potential impact of the development upon Aboriginal sites and relics (including historical archaeological sites), and, based upon the results of the field component of the study, assess site significance and develop management recommendations for sites if sites were found. The field investigation focused upon the location and documentation of relics and/or sites, as well as determining the potential for additional sites to occur over the survey area (i.e. as noninvasive surface material or as sub-surface deposits).
1.2 Aboriginal Community Consultation (see Appendix 1)

The "Geena Lee" archaeological survey area is located within the area administered by the Dubbo Local Aboriginal Land Council, Dubbo, NSW; however, because the Local Land Council does not have the resources to assist in archaeological investigations, they have arranged with the Central Region Aboriginal Land Council (which covers the broader Wiradjuri region, including Dubbo) to act as their representative during such investigations.

Every attempt was made prior to the commencement of the current archaeological field survey to make contact and consult with the appropriate Aboriginal communities.

Initial contact with the Central Region Land Council occurred with a fax sent to the Manager, Mr. Cecil See, on the 10/10/95, requesting the Land Council to appoint a representative for the pending survey. The Land Council was also asked to provide information regarding the possible location of known sites either within or adjacent to the survey area (a map of the survey area was sent to the Land Council).

In addition, the consultant arranged a meeting with the manager and members of Dubbo Local Aboriginal Land Council to discuss any significance the study area might have for members of that community. The meeting with the Land Council was conducted on 12/10/95 in the presence of Cecil See and the Dubbo Elders group. Following that meeting, it was clear that the Dubbo Aboriginal community has no knowledge of sites within or immediately adjacent to the survey area. Dubbo Aboriginal community members stressed during the meeting that while they believed their people would have travelled through this area, the break in the passing down of "traditional" knowledge, as a result of land dispossession and subsequent government administrative regimes, has meant a loss of knowledge of sites throughout the region. They stressed that although a significant loss of knowledge of "traditional culture" and lifestyles has occurred, the re-location of sites throughout the region was significant to the Aboriginal community, providing an important link with their past.

The field survey was commenced on 12/10/95 and was completed in the company of Mr. Cecil See, Central Region Aboriginal Land Council, on 13/10/95. Normally, an informal meeting would have been conducted between the consultant and Land Council staff to discuss the results of the survey and site management options (where required); however, because the survey was completed late on a Friday evening, no meeting was held.

After completion of the field survey, a fax was sent to Central Region Aboriginal Land Council (14/10/95), providing an informal report on the details of the findings of the survey and possible management options, and requesting a response to the findings and/or a statement of involvement from the Land Council.

A statement of involvement was received from the Central Region Aboriginal Land Council, dated 2/11/95, briefly stating the Land Council's involvement in the field survey (Appendix 1). Whilst a request was made to the Land Council for written comment on tentative management recommendations (discussed during the field
2.0. THE DEVELOPMENT

The proposed development is located within the Parish of Dubbo, County of Gordon, City of Dubbo, and includes Portions 184, 236, 237. (DP 753233, DP 40152). The development site's north-eastern corner can be located on the Bulomogo Map Sheet No. 8633-3-N, 1:25,000 topographic map, at grid reference s50370E, s25600N.

The area of the proposed "Glenn Lee" tourism development is approximately 200 hectares (referred to in this report as the survey area) (Figure 1). The development proposal consists of the sub-division of the survey area into 5 portions, with varying levels of development construction proposed within, including the development of small residential lots, and the provision of a small number of larger residential lots; and active and passive based recreation areas. The developers intend that a continuation of present landuse patterns occur over a large part of the survey area (i.e. cropping/ grazing).

The "Glenn Lee" development proposal consists of the following basic works:

* 3 x small residential lots along Camp Road (area to be decided, but approx. 5 hectares each);
* 55 x 4000m² - 5000m² lots, intended for the construction of hostel / cottage type tourist accommodation;
* the provision of services, i.e. water, electricity, phone, sewerage/septic system, etc, to accommodation units;
* the development of an internal, formed, access and service road from Camp Road;
* the possible construction of a mini-golf course along the eastern boundary area (with Olney Road), (to be confirmed);
* the possible construction of additional diversion drainage and soil conservation works (as required) and.
planting of vegetation sight-sound buffer zones between the development and Morris Park Speedway.

the maintenance of open grazing and natural bushland areas.

It is anticipated that the construction of the proposed development will include surface disturbance resulting from the construction of the above, and may require the removal of a small number of oldgrowth trees as well as a larger amount of regrowth vegetation.

The proposed development has the potential to disturb or destroy Aboriginal and non-Aboriginal archaeological relics located within its boundaries.

2.1 Potential Impacts Upon The Archaeological Record

The proposed development is tourism oriented with a focus upon a relaxed and "natural" environmental setting. For that reason, the developers intend to retain as much of the existing native vegetation as possible, and to restrict clearing of standing timber and surface disturbance to a bare minimum.

As mentioned above, the development proposal is for the construction of a range of residential, and short-term accommodation units (referred to by the developer as community development lots). The site of this component of the development shall be referred to as the 'primary development site'. The primary development site occurs over the central and eastern portion of the survey area, where 55 x 4,000 m² - 5,000 m² residential lots have been identified for sub-division. The total area of the primary development site, including the provision of a connecting service and access road is approximately 31 hectares (Figure 1). However, whilst surface disturbance associated with the construction of relatively high density residential lots could be expected to be extensive, the location of this part of the development over landform, which, from an archaeological perspective, is considered low in sensitivity (see Section 5.2, and Figure 2), means that the potential impact upon the archaeological record from development activities directly associated with the primary development site will be insignificant.

The only section of the primary development site which may impinge even slightly on archaeologically sensitive landform occurs along the western perimeter of the development site near proposed lots 49, 50, and 51. However, of the three lots, only Lot 50 is located closest to sensitive landform (Section 5.2, Figure 3).

The primary development site area has been subject to varying levels of past disturbance, mainly as a result of grazing and crop cultivation (and mainly along the outer perimeter where the proposed service and access road traverses), as well as from selective logging and clearing, and post internal property vehicle track development. Recently, the primary development site has been covered by a dense stand of native pines and eucalyptus regrowth. Scattered trees sites were the only site...
type predicted to occur over this landform unit, however, based on the past level of
mid-growth timber removal and associated agricultural disturbance, the potential for
sites to occur is considered remote.

With regard to rocky outcrops occurring over the survey area's highest ground, and
adjacent to the primary development site, it is anticipated that these areas will not be
significantly impacted by the proposed development and will remain relatively
undisturbed. Rocky outcrops in the survey area were afforded low sensitivity
assessment based on their unsuitability for use by past Aboriginal groups (for stone
tool resource purposes or for ceremonial purposes). Also, these natural formations
have no known cultural significance attached (known to the local Aboriginal
community).

Whilst the surface of the primary development site will be impacted more than
adjacent areas, much of the western half of the survey area, comprising approximately
half of the survey area (approx. 100 hectares), will continue to be used for agricultural
and grazing purposes, remaining relatively undisturbed.

The development of 3 larger residential or commercial lots along Camp Road (areas
to be decided, but approx. 5 hectares each), poses a potential threat to archaeological
sites or relics in the vicinity, bearing in mind that the eastern end of this portion of the
proposed development occurs within landform (Section 3.6) which is assessed to be
potentially archaeologically sensitive (Section 5.2.1, Figure 3). However, given that
these lots occur over already heavily disturbed ground (impacted by extensive
cultivation and domestic stock grazing) whilst not reducing the archaeological
sensitivity of the sites, reduces considerably the potential for sites (if located over
these areas), to have high levels of significance, particularly where the significance
assessment is based on their integrity in terms of scientific or educational value (see
Section 6.6 on significance assessment).

The connection of services to the primary development site, and possibly to the 3
larger residential or commercial lots located adjacent to Camp Road, poses a potential
threat to archaeological sites and relics. However, at the time of the field survey, this
level of detail for the proposed project had not been finalised and so, apart from the
route of a proposed service and access road, no specific impact assessment (upon the
archaeological record) could be conducted.

With regard to the proposed service and access road which extends approximately 4
kilometres x approximately 8 metres wide, around the proposed community
development lots, and covering a total area of approximately 3.5 hectares, there
occurs a potential for sections of the proposed route to impact upon surface/sub-
surface archaeological deposits and more obtrusive site types such as scarred and
carved tree sites. However, given the planned route of the service and access road,
the only archaeologically sensitive areas which will be impacted are located adjacent
to ephemeral drainage lines on the “Glenmore” property (along the western boundary
of the community development lot), and adjacent to a single drainage line located
near the eastern boundary on the “Glenmore” property (see Figure 3, identifying
archaeological sensitivity over the survey area).
The proposal to develop a mini golf course along the survey area's eastern boundary has the potential to impact upon sites or relics located adjacent to the creek line. The golf course extends over an area of an estimated 3.8 hectares (subject to confirmation) adjacent to and immediately to the north of the existing Marris Park Roadway, and between the survey area's eastern boundary and the primary development site's eastern boundary (delimited by an existing ephemeral creek line running north-south). Pre-field survey archaeological sensitivity assessment indicated that all landform units within the survey area, creek lines and adjacent alluvial terraces were predicted to have the highest level of archaeological sensitivity and that the location of a mini-golf course running parallel to a sensitive landform unit poses a potential threat to the archaeological record.

Some areas within the western half of the survey area may be required, in the future, for use in the construction of development drainage, diversion drains, and creek bank erosion, stabilisation, and rehabilitation earthworks (yet to be determined) (Colman, pers. comms. 10/95). Diversionary drainage and associated soil conservation works have the potential to impact upon surface and sub-surface archaeological deposits, especially where these earthworks traverse archaeologically sensitive landform units. Potential impact could occur through the construction of trenches and similar earthworks, and also, as a result of additional impacts such as the removal of standing and fallen timber and through the effects of drainage related, gully and surface, erosion.

3.0 LOCAL ENVIRONMENT

The Dubbo area, referred to by Ketteg (1985:12) as part of a physiographic transition zone between the ranges and tablelands of the Great Dividing Range and the Darling River plains, is situated within the north-west slopes of New South Wales, in the Macquarie River floodplain.

The Macquarie River floodplain was a major Wiradjuri (and adjacent group) Aboriginal resource zone and the focus of past Aboriginal occupation. Past Aboriginal occupation extended over a broad region of the central tablelands, slopes and plains. In the past, the river was often subject to periods of reduced flow, and, during extremely dry periods prior to the construction of water storage and flow controlling dams by Europeans, the river was known to be sometimes restricted, on the surface, to a series of still water holes (See, pers. comms. 1995).

However, past Aboriginal occupation of the local area was not necessarily restricted to the immediate river banks and associated alluvial terraces. There is evidence to support the belief that local area perennial and seasonally reliable ephemeral water sources (forming tributaries of the Macquarie River) were also often a focus of Aboriginal occupation patterns, providing necessary water supplies and allowing the exploitation of a far broader resource zone than that which would have otherwise been inhabited (due to limitations in the availability of water).
3.1 Climate

Dubbo is subject to hot summers and dry, mild winters. The average annual temperature ranges from 8°C in July to 26°C in January. Extremes of temperature are not uncommon, with frosts occurring during the cooler winter months and brief periods of extremely high summer temperatures in the summer. Temperatures in the high 30°C and low 40°C are sometimes experienced. The hotter months often feature prolonged dry periods and occasional heavy storm deluges. Dubbo's average annual rainfall recorded fairly evenly throughout the year, allowing for a slight rise in precipitation during the colder winter months.

3.2 Vegetation

The survey area was open woodland at the time of European settlement. However, the vegetation regime has been dramatically altered since then. There occurs relatively extensive stands of native timber over approximately 70% of the survey area, however, a large proportion of this vegetation is regrowth. Old-growth native timber occurs over a large portion of the remaining timber stands, but mainly as isolated trees surrounded by regrowth. An estimated 90% of all old-growth timber has been removed from the study area (Plate 1).

Prior to European settlement, the study area floodplain and adjacent landform units would have been heavily timbered, providing an abundant resource of plant (and animal) species for past Aboriginal inhabitants. Large stands of grey box (E. microcarpa), white eucalypt pine (Callitris columellaris), black pine (Callitris endlicheri), and hill gum (E. delegata) are believed to have dominated the upper hill slopes and rocky ridge flanks, and associated lower hill slopes, while stands of yellow box (E. melliodora), grey and fuzzy box (E. costata) are believed to have been the dominant species across the lower ephemeral drainage lines and alluvial terraces. Rough-barked apple (Angophora floribunda) is believed to have occurred often on sandstone based soils in the vicinity of the north eastern corner of the survey area, near Obby Road. Understorey would have included Acacia species and a range of native grass species. A number of acacias and grass species are known to have been significant in the region, to past Aboriginal groups as seed meal species. Ground cover probably included Poaceae family species such as neverfail (Eragrostis sp), blown grass (Agrostis sp.), and panicum (Panicum decaisneanum). In addition, pimpernel (Portulaca oleracea), needle (Marsilea drummondii), and bogans (Cirsium flaccidum) were observed by early settlers, to be exploited by Aboriginal people in the area.
3.3 Fauna

A variety of animal species were hunted by local area Aboriginal people. Some of the fauna which are known to have been significant as food and material resources to past Aboriginal communities in the area included emu (Dromaius novaehollandiae), grey kangaroo (Macropus giganteus and M. eugenii), red kangaroo (Macropus rufus), and wallaroo (Macropus robustus), as well as wallabies (Lagorchestes lagotis, Oryctochilus framati, and Petrogale penicillata). In addition, a number of smaller marsupial species were also known to be important as food sources to local Aboriginal groups. These included brush tailed possum (Trichosurus vulpecula), bilby (Macrotis lagotis), as well as wombat (Phascolomis migueli) and koala (Phascolarctos cinereus) (both locally extinct in the study area).

Other species which are believed to have inhabited the area at the time of European settlement, and which are known to have been significant to Aboriginal people, included dingo, numerous aquatic and terrestrial bird species such as a variety of ducks, budgerigars, quateron, and bustards (plains turkeys). Echidnas were also observed being hunted, while reptiles, including goanna and snakes, were also important food species. A variety of aquatic animal species were also hunted and collected in nearby rivers and billabongs. These would have included freshwater mussels, crayfish, long-necked turtle, and fish species such as yellow belly, bream, catfish and eel.

3.4 Present Land Use

Land use over the survey area currently revolves around mainly agricultural activities, including commercial cropping (and related cultivation) and the grazing of domestic stock. In addition, there occurs two farm residences and associated farm building complexes within the survey area. Homesteads include the “Glen Lyle” and “Glenmore” homesteads.

3.5 Geology and Soils

The primary development site, and therefore the main area of impact, is comprised of skeletal soils, interspersed by heavily eroded and exposed rocky outcrops or sub-crops, of volcanic, Trum.engene sliver (Coleman, pers. comm. 11/10/95), bordered to the north- and west by Ballimore Formation quartz sandstone, lithic sandstone, conglomerate and ferruginous sandstones and siltstones. The mid and lower hill slopes feature surface lag deposits of dacite rock material (mainly exposed due to commercial crop cultivation) and sandy, colluvial soils.

The survey area skeletal soils are generally sandy, and highly susceptible to surface and gully erosion.
3.6 Landform (see Figure 2)

Landform plays a significant role in assessing the presence of sites and the level of past Aboriginal occupation and site types throughout the region for at a local level, with some landform units considered more archaeologically sensitive than others. This conclusion is based on site occurrence data collected during various archaeological investigations over adjacent areas (e.g. Koettig 1985, Pearson 1981, Kelton 1995a,b). Relatively flat areas, generally occurring along creek banks, associated elevated terraces and adjacent low ridge and spur lines are considered to be the most sensitive landform units within the local area. Other generally flat landform units within the survey area, although not considered sensitive within the survey area, include the crests of hills and associated ridge and spur lines.

There are no potential sources of surface water within the survey area (a significant factor in determining past Aboriginal occupation patterns in the local area). The only water which would have been available to past Aboriginal inhabitants prior to European settlement, would have been that resulting from seasonally filled soaks and associated ephemeral creeks. Little has been documented in the region regarding the sensitivity or potential sensitivity of these ephemeral water courses, and past models of Aboriginal occupation developed for the region have largely ignored these landscape features (i.e. Koettig 1985, Pearson 1981).

Landform over the survey area is comprised of three major units which also constitute corresponding archaeological land systems (Figure 2, landform map). Landform units encountered within the survey area include the following:

1. Ephemeral drainage lines and associated alluvial and colluvial terraces.
2. Lower hill slopes.
3. Combined upper hill slopes and hill tops, and associated elevated ridge lines.

4.0 ARCHAEOLOGICAL BACKGROUND

4.1 Ethno-Historical Context

At the time of white settlement in the Dubbo region, the study area was occupied by Aboriginal people who spoke the Wiradjuri language. These people were referred to by Garney (cited in See 1985,2) as the Wañye Jath group, a portion of the Wirra Jath ‘tribe’ (possum men tribe). White (1986:24) concurred with Garney’s earlier conclusions as to whom the Aboriginal people in the Dubbo locality were and identified the same people as the Wiradjuri. However, White’s interpretation of the meaning of the word Wiradjuri contradicts Garney’s, in that White broke the word Wiradjuri down to mean ‘jat’ meaning ‘having’, originating from the words Wiru ‘or Thurray meaning ‘having’. While there may occur a degree of disagreement over the origin or meaning of the group name, both
researchers agree that the people were Wiradjuri (Wirrin - Jari). Also, and
despite the uncertainty on the part of some researchers as to Wiradjuri group
boundaries, the study area was known to be occupied by the Dubboqa although
contact with the neighbouring groups including the Eumalga (to the east), the
Warripa and Dandallamal to the south and south west respectively, no doubt would
have occurred.

In relation to group boundaries, Tindale (1974 map) drew an arbitrary line on the
Wiradjuri's territory, bounded by the Talbragar River in the north. Edward Garnsey
who was born in the Dubbo area in 1874 and developed a close relationship with an
extensive knowledge of Aboriginal group structure in the local area, produced maps
of group boundaries which contradicted the cultural line of northern Wiradjuri
occupation drawn by Tindale (Garnsey cited in See 1985). Garnsey found that the
Aboriginal groups who inhabited the area immediately north of the Talbragar River,
from the northern banks of the Talbragar River, were in fact still Wirrin - Jari people,
but a different group. Garnsey (cited in See 1985:3) identified this particular group
as the Mungo. Grounds (1984:60), following Tindale's lead, stated that the northern
boundary of the study area, the Talbragar River, formed the north - western boundary
of Wiradjuri 'country'. It would appear that the area, while being part of Wiradjuri
territory, may have actually been a transitional zone between the Wiradjuri, the
southern Kawambur, and the north - eastern Wongalun. Neighbouring groups are
known to have shared a number of similar cultural characteristics including language,
marrage and inheritance laws, religious beliefs, and ceremonies. With regard to the
definition of group boundaries by contemporary researchers, and particularly in
relation to the Wiradjuri people, White (1986:84) argued that the modern, day notion
of "boundaries" should only be applied with caution, because the delineation of
group boundaries using single criterion will not always correspond with a particular
group named and identified using another criterion, i.e. language. Nevertheless,
while similarities are believed to have existed between the groups such as Wiradjuri
and Kamilaroi, the Wiradjuri are recognised as a separate 'tribe' or alliance of tribes, a
'block', linked by distinctive linguistic and cultural features (Grounds 1984:60).

Definitions of group identities provided by Garnsey (cited in See 1985:2,3) support
White's argument where he argues that clan or major group boundaries are more
complex than those which have been postulated by a number of early European
researchers, i.e. Tindale (1974 map) etc.

According to Garnsey (cited in See 1985: 2) the survey area was occupied by the
Dandallamal sub-group. The Dandallamal sub-group were a part of the larger Wirrie
group (Warrie - Jari) which in turn was a sub-group of the greater Wirrin - Jari tribe
(postum man), the Wiradjuri. The Dandallamal's country included land to the north
and south of Cumbongle Creek which is located to the south of the survey area, and is
a tributary of the Macquarie River.

Early accounts of local Aboriginal camp life in the Dubbo area indicate that people
camped according to a range of prescribed rules (Garnsey cited in See 1985 : 6).
These rules determined a number of campsite characteristics including the actual
shape of the campsite, and also - spatial organisation.
Based on Garnsey’s accounts, it would appear that the Durnullahal were relatively settled in the occupation of their territory. Few accounts exist on the movement by the Aboriginal people of Dubbo area within their territory. However, from accounts in the nearby Wellington area, camps were moved frequently, either over short distances or else to new locations several kilometres distant. Movement would appear dictated by a number of factors including changing social conditions, changes in weather, the dictates of hygiene or for a number of non-specific factors. Large scale movement often occurred in response to social obligations such as ceremonies, warfare, or changes to resource availability. Death in a camp also meant that in certain cases, the campsite where the death occurred could not be re-occupied for extensive periods (time frames were determined by group law) (Koetzing 1985:23).

With regard to the current survey area, the area along and adjacent to both the Macquarie River and Cambogool Creek would certainly have provided an abundance of aquatic and terrestrial plant and animal resource species for local Aboriginal inhabitants. In addition, the confluence of the Macquarie River and Cambogool Creek (adjacent to survey area) is referred to by Grounds (1984:61) as an important red ochre quarry site and ... the site of the Dubbo - ga: grinding industry.

Mathews (1901) recorded several Wiradjuri initiation ceremonies in the Dubbo area during the period 1885 to 1901. Mathews also noted, in the locality, the presence of significant ceremonial sites, including large circular ‘bora grounds’ and associated ground drawings, sculptures and carved trees. Mathews and Garnsey (cited in See: 1985) both referred to carved trees in the region, occurring also as burial markers for important, deceased tribal men.

Garnsey (cited in See 1984:4) documented a significant ceremonial location known to past local Aboriginal people as Boranul (‘place of boranul’). The site occurs on nearby ‘Old Dubbo’ station, on the opposite side of the Macquarie River from the survey area. Garnsey (cited in See 1984:4) documented a burial site located several hundred metres to the north west of the survey area, on the opposite side of the river and located near the river, at a place named by local Aboriginal people as Woonom (‘melting graves’). A number of other significant sites are believed to have existed in the vicinity, in close proximity to the Macquarie River and the current survey area.

European settlement in the Dubbo area began with the early explorers, including John Oxley, in 1817. Oxley had his first recorded encounters with local Aboriginal people of the region at Wyandra and Paddy’s Creeks near Toongi. This and subsequent encounters were relatively friendly, with an interesting account of a male Aboriginal encountered at a chance meeting at Willandra Crossing. The individual had in his possession a steel axe, which had obviously been traded through the extensive trade networks known to exist throughout the country, preceding personal contact with European settlers (Oxley 1820:220).

Charles Sturt travelled through the area in 1828 and crossed the Macquarie River at Dhillamile, and both Oxley and Sturt indicated in their reports to the authorities that brief encounters with local Aboriginal people usually conducted on friendly terms.
Unfortunately, other than the above, there are very few accounts of early European settlement contact with local Aboriginal people in the vicinity of the study area. It is known that around 1837–1838, relations between the Windjari at nearby Wellington Valley and local missionaries, soured dramatically when attempts were made to force Christianity upon local Aboriginal groups in that area (Read 1968:12), and there are accounts of local Dubbo Aboriginal people, in later years, being employed on surrounding stations (Koertig 1985:19, Mrs. Howey, pers. comm. 1995).

With regard to European settlement history, properties within the study area and in close vicinity, have an extensive European history. The "Holmwood" homestead and property, located in the south west corner of the study area, dates back to 1867. European settlement in the vicinity of the study area dates back at least another 30 years to 1833, with the establishment of Dullum's "Old Dubbo" property. Located approximately 1 kilometre to the north east of the survey area and close to the Macquarie River, occurs the locally well known and historic "Dundullimal" property (on the Register of the National Estate).

4.2 Archival Searches

According to NPWS records, there are no Aboriginal sites previously recorded within the survey area; however, a search of New South Wales National Parks and Wildlife Service records revealed 38 Aboriginal sites had been recorded in the NPWS data base system within a 10 kilometre radius of the study area. A further 30 sites have been recorded by Kelton (April - July 1995) in the Dubbo – Tallongar River – Troy Junction - Macquarie River area; however, those sites have not yet been entered onto the NPWS data base. Known site types within a 10 kilometre radius of the study area, including those on the NPWS data base and those recorded by Kelton, are comprised of 27 open campsites, 34 scarred tree sites, 3 carved tree sites, 3 axe grinding grove sites and a single burial site (as well as a number of isolated artefact finds).

In addition, further searches were conducted to determine the presence of sites of historical archaeological significance. Searches were conducted with the Register of the National Estate for sites on the Register, with the NSW Heritage Council, the National Trust and the local Dubbo Historical Society. There are no sites within the study area on the Register of The National Estate, (the closest site being Dundullimal Homestead and Barn). "Holmwood" homestead, located on the opposite side of the river is Classified under the National Trust of NSW.

4.3 Previous Archaeological Studies

The Dubbo area has been the subject of a considerable number of systematic and other archaeological investigations, ranging from purely Aboriginal archaeology sample site activities to more comprehensive scientific studies. Early accounts of the region's Aboriginal archaeological resources included extensive site recording and erratic collections by Gresser (c. 1940), Mils (1899-1915), Garney (c.1880), etc. Several more recent archaeological studies have also been conducted in the Dubbo region, and generally at a higher scientific level.
The earliest known ethnographic-archaeological account of Aboriginal people in the Dubbo region was produced by Edward Garnsey, a resident of Dubbo from around 1974 (born in Dubbo, 1874) (cited in See, 1985). Garnsey's ethno-ethnographical account of the 'Dubbo Wiradjuri people' (the term 'Wiradjuri' referring to the period of early contact between local Aboriginal peoples and European settlers), their society and lifestyle, is invaluable as a reference source on the region's Wiradjuri people, particularly during the late contact period.

Gresser, during the 1940's, conducted the first known, formal archaeological studies in the Dubbo area, with his studies including the collection of large numbers of artefacts and the identification of a considerable number of Aboriginal sites in the region. Unfortunately, at least in relation to the study area and environs, much of Gresser's site information and directions were not relocation oriented and the relocation of sites based on the information provided by Gresser is not always possible.

Gresser (n.d.; c, 1941) recorded the presence of a number of significant sites within one kilometre of the study area. These sites include burial sites, ceremonial or Borah grounds, and mythological sites. However, the majority of these sites do not appear in the NPWS database.

A number of significant archaeological studies have been conducted in the Dubbo region in more recent times. These include both academic and environmental impact assessment related studies.

Pearson (1981) conducted a comprehensive academic analysis of Aboriginal and European settlement patterns in the upper Macquarie area. Pearson's study did not include a strong field component, and much of his assessment was based on the results of previous archaeological investigations conducted throughout the region. Pearson's study area extended from Oberon in the central tablelands to an area on the Macquarie River to the south (upstream) of Dubbo, between Dubbo and Wellington.

Koeltz (1983, 1985) has produced perhaps the most comprehensive, planning and development related, archaeological study in the Dubbo area in recent times. Koeltz (1985) conducted a systematic archaeological investigation into Aboriginal archaeological heritage of the Dubbo area. This study was subsequent to Koeltz's 1983 preliminary assessment of the district's archaeological resources.

Koeltz's 1985 report was produced for inclusion in a Dubbo City Council, Local Environmental Planning Study, conducted by Cameron McNabara Pty. Ltd. The document assessed the known Aboriginal archaeological resources of the district within both a regional and local context. In addition, Koeltz established a map of archaeological sensitivity and a rather general model for the district. She also produced broad management recommendations relating to future development and their impacts on Aboriginal archaeological sites in the Dubbo City Council area and district.
A number of more isolated, minor surveys, mainly development and environmental impact assessment related, have been conducted at locations east and north of Dubbo. Haglund (1982) conducted a survey at Ulmar Creek area, and the study included excavations at several rockshelter sites. Haglund concluded from the results of this study that there was a correlation between landform and terrain, and site size and artifact density. In addition, Haglund found that the stone assemblages represented by the artifacts observed in the study were consistent with a period of occupation less than 4,000 - 5,000 years.


Reference occurs in the NPWS data base to a report (NPWS C1383) and a number of sites recorded by Bluff (1994). However, the NPWS Site Register could not locate the report on 3/7/95, which is now believed temporarily misplaced. A later attempt to locate the report was also unsuccessful.

From information provided on the NPWS Site Print-Out (7/7/95), it appears that Bluff recorded 5 scarred tree sites and a single open campsite along the Oboloy Pond and on "Dundullima" property, on the opposite side of the Macquarie River from the current Keswick study, and approximately 1 kilometre south west.

One of the more recent archaeological investigations to be conducted in the vicinity of the study area was conducted by Kelton (1995a) for Dubbo City Council. The archaeological survey was carried out over the location of a proposed expansion of an existing sewerage treatment works at Troy Junction, along the southern bank of the Tabbagar River, near the junction of the Tabbagar and Macquarie Rivers, approximately 8 kilometres north of the current Keswick study area.

During the Troy Junction survey, Kelton recorded 4 open camp sites, 12 scarred tree sites, 1 axe grinding groove site, and 2 isolated artefact finds. The Troy Junction study area is comprised mainly of flood prone, river bank land, within the Macquarie and Tabbagar River floodplain. The open campsites which Kelton recorded, although heavily impacted by European land management practices (mainly domestic stock grazing and commercial crop cultivation), provided evidence of extensive and intense levels of past Aboriginal occupation. Stone assemblages were generally comprised of large quantities of river pebble materials consisting of both modified and unmodified flaked artefacts, a quantity of mainly broken, millstone artefacts of both metamorphic and sandstone material, pebble hammerstones / anvils, random fashioned, unfacial pebble axes, as well as more carefully manufactured, bifacial ground edge axes made from metamorphic mudstone type material and local area basalt. Flaked stone artefacts made from pebble material of chert, quartzite, and quartzite stone origin were the most dominant artefacts and materials present at all sites.

Scarred tree sites recorded by Kelton during the Tabbagar River - Troy Junction survey occurred mainly on fuzzy box trees (E. contata), however, a lesser but still considerable number were also located on river red gums (E. viminalis). Most scarred tree sites reflected the opportunistic removal of sections of bark for use as either coolations, bark shelters or perhaps during the manufacture of shields.
Kelton also recorded an axe grinding groove site on the northern and immediate banks of the Tallongang River, situated on a coarse sandstone outcrop along the water’s edge. The site is very similar in nature to those located at the nearby Terramuranah Reserve site (on the Register of the National Estate), but the Tallongang River site is nowhere on the same extensive scale as the Terramuranah site.

Kelton (1995b) conducted a survey over the site of the proposed “Keswick” housing subdivision at Dubbo, located approximately 3 kilometers south-east of the city centre. The survey area occurred over an area of sandstone and basalt country, similar in nature to that of the current survey.

Eulomogo Creek formed a significant landform unit within the “Keswick” study area. This creek is generally perennial in nature, however, during dry years, it is known to stop flowing and is restricted to a series of still water holes.

Kelton (1995b) found evidence of three relatively large open campsites located adjacent to Eulomogo Creek and an ephemeral drainage line located to the north of Eulomogo Creek.

Stone artefact scatters recorded by Kelton at the “Keswick” sites indicated a range of activities including use as stone workshop areas as well as seed meal processing and general occupation areas.

Although Eulomogo Creek is considered to be a more reliable water source than ephemeral drainage lines encountered during the “Glenlee” survey, the evidence seems to indicate that streams of a less than permanent nature (and subject to seasonal and yearly variation) were a resource to local area Aboriginal groups.

4.4 Previous Archaeological Models

Pearson (1981) produced a model of Aboriginal occupation for the lower Macquarie River. One of the conclusions of Pearson’s Ph.D. study (1981) was that there was a distinct pattern relating to the location of open scatter sites and their distance from water. In the tablelands south-east of the survey area, the majority of sites were found to occur, on average, within approximately 90 metres from water sources (Pearson, 1993:16). Pearson found that 90% of the sites were located on ridge tops, spurs, or on hill slopes all adjacent to water sources. The above observations also concur generally, with the authors observations in field surveys along the lower Aberdourme River, Cowra’s Lachlan River region of the central tablelands, and from observations in the upper reaches of the Macquarie River catchment around Wattle Flat, north of Bathurst. Inconsistencies in site occurrence, between the different tablelands and slope locations, appear only in the distance of open campsites from reliable sources of water, and that aspect of occupation patterning is generally determined by factors such as climate, reliability of water sources (whether perennial or ephemeral in nature) landform gradient, ruggedness of terrain, as well as flooding patterns.
Pearson (cited in Dallas, 1995: n.p.) established the following criteria for suitable campsite location throughout his study area, of which Dubbo is situated on the northwestern extremity. Dallas summarised these as follows:

1. Accessibility to water.
2. Level ground with good drainage.
3. Elevation above cold air currents and lingering frost prone valley systems often with good views of the river flats and watercourses.
4. Sheltered from cold winter winds and with adequate summer cooling breezes and.
5. Adequate fuel supplies.

The archaeological model developed by Koetzig (1985), is very broad and tends to be developed in general terms only, although, with regard to the immediate Dubbo-Macquarie River area, her model is more specific. Koetzig's model is very heavily supported by that offered by Pearson (1981), and in fact there occurs very little variation between the two, in that Koetzig also argues that the evidence for the highest level of past Aboriginal occupation throughout the Dubbo-Macquarie River region should be expected to occur along watercourses. However, Koetzig added to Pearson's work by indicating an observed preference for more extensive occupation, mainly in the form of open campsites, as occurring in close proximity to larger waterholes which would have contained water, even during periods of reduced or flat surface flow (Koetzig, 1985: 84-85).

A number of recent archaeological investigations conducted by Kelton (1995 a,b,c,d) around the Dubbo area, all EIA related, occur at face value as isolated studies. However, when the results of all of Kelton's studies are placed in their local area context, a picture of past Aboriginal occupation in the local area begins to emerge. This picture very much conforms with models produced by Pearson (1981) and Koetzig (1985), however, what becomes particularly apparent, is the previously ignored significance of seasonally reliable ephemeral water courses throughout the local area. Koetzig's model did not include assessment of these resources and further investigation in the future (throughout the local area) will help to strengthen the local area occupation model.
5.0 METHODOLOGY

5.0.1 Pre-Field Survey Investigation

Initial investigation, prior to commencement of the field survey, included site and archivial searches with the NSW NPWS site data base in Sydney, and the search of the Register of the National Estate, Canberra, for sites on the Register.

5.0.2 Pre-Field Survey Assessment

Prior to commencement of the field survey, a desk top study of survey area landform and assessment of survey area archaeological land systems was conducted. As a result of this pre-field work assessment, models of site prediction and sensitivity were developed, in conjunction with a strategy for survey area coverage. The development of these models revolves around a knowledge of the existing land form units and archaeological land systems of the survey area, and so assessment of these was also essential. At this pre-field work level of assessment, a survey strategy was developed, based on a need to assess the entire survey area for the presence of sites and the potential to contain sites. Preliminary selection of survey area sample units was also conducted.

5.1 Survey Area Site Prediction

A range of Aboriginal archaeological sites have been recorded in the Dubbo area, and with the knowledge of these site types and their distribution across the landscape, it is possible to develop a model of site patterning and archaeological sensitivity. The interaction between past Aboriginal groups and their environment, within a specific locality, can be further analysed in terms of archaeological land systems.

A number of factors had an influence upon past Aboriginal land use strategies and lifestyle, almost all of which can be related to landform, and it is believed that the distribution of sites within the study area and environs will be subject to the same biases and selection criteria which Pearson (1981) identified in his regional occupation model (Section 5.4).

For the purpose of this report, the survey area will be broken up into identifiable landform units (Section 3.6, Figure 2., Table 1).

5.1.1 Site Types

Based on the above information and on the consultant's personal experience within the study area, it is predicted that the following site types may be encountered in the broader Macquarie River region:
1. Open campsites / stone artefact scatters and associated hearth sites.
2. Scarred trees.
3. Carved trees.
4. Isolated hearth sites.
5. Burials.
6. Ceremonial sites including stone arrangements and 'born' grounds.
7. Axe grinding grooves (in close proximity to the study area) and.
8. Mythological sites (e.g. 'Dreaming' sites).

Sites can occur as isolated occurrences, i.e. single scarred tree sites, or sites as components of a complex of occupation evidence and a range of cultural activities, e.g. an open campsite complex containing cooking fire hearths, scarred trees and perhaps shell scatters or middens.

Statistically, approximately 60% of all recorded sites located within a 10 kilometre radius of the study area (including those recorded by Kelton, 1985) occur over floodplain environments, within 500 metres of the Macquarie or Talbragar Rivers.

Of the remaining 40% of sites, 66% of these sites occur within 1 kilometre of the Macquarie River (and Talbragar River) while all of the remaining sites occur within 2.5 kilometres of the river.

Based on the known site recordings in close proximity to the study area, it is predicted that open campsites and scarred tree sites will occur with the greatest frequency across the survey area, however, the following discussion on site prediction and archaeological sensitivity will also consider the potential for other site types to occur.

5.1.2. Open Campsites (Open Artefact Scatter Sites).

It is predicted that open campsites can be expected to occur in the study area, particularly along the elevated banks and terraces of ephemeral creeks. Past studies and observations in the region indicate that open campsites tend to occur throughout the region on areas of elevated ground, with elevated locations generally chosen in response to the vulnerability of lower lands to flooding. All previously recorded sites in the vicinity of the study area occur within close proximity (less than 500 metres) of reliable water sources.

Previously, recorded open campsites in the region, particularly along the Macquarie and Talbragar River floodplains are often extensive, and camps consist of evidence of a range of group activities, including cooking fire hearths, stone workshop areas, general occupation areas, etc.
5.1.3 Scarred / Carved Trees

Because such a large area of old-growth native timber has been removed (estimated 90%) as a result of past European land management practices, the likelihood of scarred tree or carved tree sites occurring is considerably reduced. However, scarred trees can be expected to occur in the study area where old-growth timber, mainly eucalyptus trees, have remained, although scarring or carving of white cypress pines, whilst not known to occur with the same high frequency as scarring on eucalyptus trees, is not an uncommon occurrence throughout the region. In the vicinity of the study area, tree species normally subjected to past Aboriginal scarring are restricted to E. melliodora, E. interossea, E. conica, and Callitris columnaraffa.

During the region's prehistory, sheets or strips of bark and often sections of outer tree cambium were removed by Aboriginals for a variety of purposes. Removal purposes included the manufacture of wooden implements such as "boomerangs", shields and "coolamon" (containers), roofing and sides of bark shelters, "wurung" (throwing sticks), spears, bark for canoe construction, cultural boundaries or resource site markers, and burial and ceremonial area markers. In addition to the above, small areas of bark and timber were chopped out by Aboriginal people using stone axes, and later using European steel axes, to facilitate the removal of birds, bird eggs, honey and possums, from hollows in mainly eucalyptus trees.

It is predicted that where old-growth timber remains, there will be a potential for the more common scars such as "coolamon", bark shelter, and shield type scars to occur as well as the less common scars types including bird, possum, bees nest, honey cut-out scars, and "toe-hold" scars.

It is also predicted that the study area has, where old-growth timber remains, the potential to contain all of the above types of Aboriginal scarred trees, plus carved trees. Carved trees were a characteristic feature of Aboriginal culture in the North-Western Rivers region including Dubbo, and of the Wiradjuri of the central tablelands. Carved trees associated with initiation areas and burials (dendroglyphs) have been recorded in the region. Carved trees were also used to indicate the presence of significant burial sites and are referred to as "tulenglyphs" by Bell and Wakin. King (1984:213).
5.1.4 Burials and Burial Grounds

Because Aboriginal burials are known to have occurred along the Macquarie River system, often in close proximity to the river, and usually relying on the softer, lighter soils of river banks and the edges of billabongs to facilitate interment, it is predicted that the potential for this site type to occur over the current survey area is very remote.

While burials were common along the banks of western region rivers, accounts of burials carried out considerable distances from the river banks are also not surprising, given the sandy nature of the soils in the region, and also the tendency for local Aboriginal people to maintain fairly permanent and static campsite locations. That factor alone would have meant that the people would have chosen, at least for hygienic reasons, but more than likely due to a number of religious and spiritual beliefs, to inter their deceased some distance from major occupation areas. If burials had occurred at campsite locations, this would have prevented groups from re-entering camps or remaining in a considerable periods of time after an individual’s death.

Hypothetically speaking, if burials had consistently occurred at favourite campsite locations, the Gundanurlam people would have inevitably run out of favoured occupation areas (depending upon the determined length of absence from a site).

Many Wiradjuri and Kamilaroi burials (and adjacent groups) consisted of either earthen mounds adjacent to river banks and within suitable distance from major campsites or as simple, often unmarked, river bank interment. However, variations in burial practices and isolated burials are known to have occurred as a result of a range of varying factors and often unusual circumstances.

Mound burials, often incorporating carved trees, were usually associated with the death of a significant Aboriginal person (usually male). Other common forms of interment included open interment where bodies were placed, above ground, in a range of positions including the 'fetal position', sitting upright, squatting positions, at the base of large trees (Garnsey cited in See 1985: 36). While mound burials are believed to have been afforded to only those of considerable stature within the communities, Garnsey (cited in See 1985: 36) gave an account of a ‘big man’ being buried in a similar above ground fashion, similar to that mentioned above, however, the body was covered with a sheet of bark with the individual’s tribal markings painted in oxide, assumedly on the smoother, underside of the bark strip. Another account of an Aboriginal burial in the Dubbo area occurred around 1885 by an O’Sullivan White (cited in Koestig 1985:25). The account relates how the burial was conducted with the deceased placed in a skin cloak and buried under a mound of sand, “...about one mile from the river.” Trees around the grave site were carved with the deceased’s tribal markings.

Another form of burial site noted in the region, and associated with the use of timber in the area, was the practice of placing human skeletal remains into hollow logs or standing hollow trees. Bonhomme (1987:25) refers to this burial practice as an alternative method employed by Kamilaroi people in areas where no soft ground was available for burial. Similar burial procedures were observed in the Ouyen area of...
the upper Lachlan River (Herden 1991: pers. comm.), and these burials were found to be reasonably common in the district. However, Mszetan (cited in Bothamne 1987: 25) stated that this kind of disposal was resorted to in special, "unfamiliar or unpleasant circumstances". Circumstances referred to included burial during the early 'contact' period with Europeans, when incidents of death from disease and misadventure rapidly accelerated.

The likelihood of these types of burials having occurred in the vicinity of the study area is considerable, however, the high degree of surface disturbance and loss of old-growth timber which has occurred during the history of European farming in the locality may mean that any intact burial sites may have been long since destroyed by agricultural disturbance or natural attrition and erosion, or as was often the case, their contents (human remains) and carved tree grave markers pillaged by European collectors.

5.1.5 Ceremonial Sites

Ceremonial sites in the region are known to have varied in structure, and included large, circular, earthen 'Bora' grounds believed used for mainly male initiation ceremonies, ceremonial stone arrangement sites used for a number of specific ceremonial functions not necessarily related to rites of passage, to ceremonial sites located at naturally occurring landform features, e.g. rock formations, elevated, highland areas, secluded gorges and bends in rivers. The two types of ceremonial sites recorded in the Dubbo area include stone arrangements and earthen 'Bora' grounds.

a. Earthen 'Bora' Grounds

A Bora ground was documented by Gresser in 1941, as being located on "Old Dubbo" property, opposite the entrance gates to "Holmwood" homestead over the river from the current survey area. However, from Gresser's documentation, it is difficult to determine the exact location of the site. A high, flat knoll occurs on the "Miriam" property on the opposite side of Old Dubbo Road from the "Holmwood" property and opposite the "Holmwood" entrance gates, and there is some speculation that the Bora ground described by Gresser was located at this site on the "Miriam" property, located on the opposite side of the river to the current survey area.

Because of the generally known location of the above site, and because duplication of such a site would normally not have occurred at least in close proximity to an existing site, it is predicted that the likelihood of a Bora ground being located within the study area, is remote.

b. Stone Arrangements

Due to a number of factors, the location of stone arrangement sites within the study area is considered extremely unlikely. Stone arrangement sites previously recorded in the region tend to occur over
areas where suitable stone material was available, and at relatively
isolated areas of elevated ground, usually on knolls, but still in relatively close
proximity to major water courses and occupation areas (Koettig 1985:45). For
example, the stone arrangement site located on the "Marrington" property,
north of Dubbo. While geographic location was important in the location of
such sites, perhaps just as important, was the cultural factor.

A large portion of the study area, particularly along the central and eastern
high ground, may have been suitably elevated, and on relatively flat ground
conducive to the location of stone arrangement sites. Also, an abundance of
suitably sized rock material would have provided an appropriate rock
material source. However, given the heavily weathered nature of the country
rock and the extremely rugged terrain over this area (being non-conducive to
past Aboriginal occupation), it is therefore predicted that the likelihood of
stone arrangement sites occurring within the survey area is remote.

5.1.6 Hearth Sites

Hearth sites commonly occur across the region in the form of stone, clay and termite
nest hearths (occurring as heat retaining material), and often in association with other
site types, i.e. open campsites and occupation shelters. Whilst stone material was
used mainly in areas where there occurred an abundance of suitable material, clay and
termite nest material was an alternative heat retaining - cooking material, particularly
in areas where suitable stone material was not available. Both clay and termite nest
material are known to have more than satisfactory heating and heat retaining qualities

Termite nest material was favoured by past Aboriginal groups who inhabited the
region, for use in their cooking fires as heat retaining hearth stones. These sites can
occur across the landscape as individual, isolated sites, reflecting short term
occupation of an area, or else they can be a component of much larger open campsites
and stone artefact scatter site complexes. A difficulty encountered in the
interpretation of termite nest hearth sites arises when what are believed to be termite
nest material hearths occur isolated from any other cultural material, in what appears
to be an Aboriginal fire hearth formation. Natural termite nest formations can break
down in much the same way as Aboriginal people would break up termite nest
material from a tree or mound, and use subject to fire in a similar fashion to material
which has been collected by past Aboriginal people for use in their cooking fires.

Naturally deposited material can also be broken down and remain in the surface soil
horizon, resembling an Aboriginal hearth site. One of the major differences, where no
other cultural material is present, is the actual size of hearth stones. Naturally
occurring termite nest material is often larger than that broken up by Aboriginal
people for use in cooking fire hearths. However, there are many inconsistent
variables which also have to be considered, for example, the effects of erosion of
naturally occurring hearth material.
Where actual stone material has been used for cooking stones, often broken stone artefacts such as sandstone, seed grinding millstones etc. were used, or else suitable river stone material. Often, this material bears evidence of having been subject to intense heat. The use of stone material was generally dependent on the availability of the resource.

While hearth sites are not as common a site type across the local area as, for example, open campsites, it is anticipated that hearth sites composed of torrite nest, clay and stone hearth material may occur.

However, due to the high level of surface disturbance across almost the entire study area, where intact hearth sites may have existed in the past, the likelihood of intact sites remaining is considered remote.

5.1.7 Isolated Artefact Finds

Isolated artefact finds can represent casual, 'trampant' movement across the landscape, or else, depending on their context, they can be indicators of more substantial occupation evidence, possibly held in sub-surface soft deposits.

While isolated artefact finds are not considered significant as indicating levels of occupation, etc., the material is significant in establishing a level of movement of past Aboriginal people across the landscape, and indirectly can point to a level of occupation, based on the level of frequency isolated artefact finds occur across the landscape. Obviously, the larger the study area, the more representative the data.

Unfortunately the presence of isolated artefacts on the surface of a landscape is affected by similar variables which also impact other more substantial evidence of occupation across the landscape, such as open campsites - scatter sites. These might include man-made surface disturbances, and natural features such as soil types and formations, erosion and geomorphic processes in the region. For these reasons, isolated artefact finds rapidly disappear from the surface archaeological record.

It is anticipated that isolated artefact finds may occur across the whole study area, possibly on all landform units.

5.1.8 Mythological Sites

No known mythological sites exist within the study area, however, if the mythology of the local Aboriginal people was consistent with that of neighbouring groups, and if in fact consistent with many known Aboriginal mythologies across the country, then the Macquarie River would indeed have had a mythological significance (a significance which could not be established during the study due to an apparent lack of local Aboriginal knowledge, and the constraints in time and funding).
3.1.9 Axe Grinding Grooves

Due to the almost total absence of suitably exposed sandstone rock outcrops in the study area, it is predicted that the potential for axe grinding groove sites to occur is extremely remote.

3.1.10 Contact - Historic Sites

Contact sites are those which reflect that early period of contact between Aboriginal people and European settlers, and generally dating to the time of first settlement.

The Dubbo – Macquarie River – Talbragar River areas have an extensive history of European occupation, dating back to the late 1820’s. In relation to the study area, there is an absence of known historical sites and it is anticipated that absence will extend across the entire survey area.

5.2 Site Prediction and Archaeological Sensitivity Assessment (see Figure 3)

Factors which have to be taken into account when developing a site location model for a specific area, include those listed by Pearson (1981) (Section 5.4). English & Gay (1995:38), in their site modelling assessment for the occurrence of sites in the upper Lachlan River-Abercrombie River areas in the central tablelands, included the additional factors:

1. Access to stone material sources for use in the production of stone artefacts;
2. Seasonal availability of water, plant and animal resources and the structure of resource habitat;
3. The ease of which past Aboriginal groups moved across the landscape;
4. The effects of socio-cultural constraints on group movement and occupation patterns.

Due to the limited range of landform and therefore archaeological land systems within the survey area, the survey area was divided into only three separate and identifiable landform - archaeological land system units. These units are defined generally by often subtle differences in vegetation, and more pronounced variation in topography and elevation. A fourth division based on existing vegetation, was also identified, but only for a preliminary level of scoured tree investigation during the survey.

The close proximity of the survey area to the Macquarie River, and location within, and along the outer margin of the ‘riverine corridor’, may have played a significant role in determining a potentially higher level of past Aboriginal occupation than that which would have been expected over similar landform further away from the river.
Major landform units-archaeological land systems identified within the survey area, and assessed during the current study, included the following:

### 5.2.1 Ephemeral Drainage Lines, Immediate Creek Banks and Adjacent Alluvial Terraces:

The first landform unit, or land system occurs as a combination of topographically low, and generally heavily incised, ephemeral drainage lines, their immediate creek banks, and adjacent, mainly alluvial, terraces (creek banks and terraces with slopes generally less than 10%).

All ephemeral creek systems within the survey area drain into the Macquarie River. There occur two major drainage lines in the survey area, the first located in the western half, which drains from the survey area’s southwestern boundary and the southwestern high ground to the northern boundary and the topographically lower ground (approximately 1 km in length). The second un-named ephemeral creek drains parallel to and approximately 200 metres west of the survey area’s eastern boundary, and also extending approximately 1 kilometre. The upper reaches of both ephemeral drainage lines extend only several hundreds of metres outside the survey area, and serve as a drainage system for the series of elevated ridge lines above. Ephemeral drainage lines and creek banks, and adjacent alluvial terraces occur over approximately 35 hectares (17.5%) of the survey area.

The first mentioned major ephemeral creek intersects with a second (also un-named) ephemeral creek, approximately 100 metres south of the survey area’s northern boundary (within the survey area; see Figure 1), with both creek systems draining the remaining several hundred metres as one, to the north-east into the Macquarie River (approximately 1 km). The northern section of the major creek is heavily incised, particularly towards the point of intersection with a short section of a second creek line, and was observed to hold pools of still water at three separate locations within and immediately adjacent to the survey area (at the time of the field survey in October).

The second major drainage line within the survey area, located in the east (Figure 1), is less defined than the first, and drains from a reduced catchment area. This creek also drains into the same system as that extending from the survey area’s west. The two creek systems intersect approximately 50 metres outside the survey area, where they combine and complete their journey of approximately 400 metres, as one, draining into the Macquarie River.

Soils over this landform unit, within the survey area, are comprised of mainly alluvial and colluvial sediments of skeletal soil, originating from surrounding volcanic and sandstone geological formations. Soils along creek lines and adjacent alluvial terraces over the survey area are highly erodable, and extensive gully and related surface erosion were observed during the field survey.
The surface of this landform unit varies from creek bed and creek bank shoulders (gradient >10%) where a series of soil deposition and erosion processes have occurred and are ongoing, to adjacent alluvial terraces between lower hill slopes and the creek banks, where a combination of aggradation and erosion processes have occurred (slope <15%). Where gradient is the greatest and surface disturbance occurs, there also occurs a potential for the exposure of sub-soil deposits, and therefore, the potential exposure of archaeological deposits (where those deposits exist). Alluvial terrace areas closer to lower hill slopes have been subjected to a build up of eroded and weathered stone material from adjacent hill slopes. These deposits occur in the form of lag material and colluvial deposits exposed on the surface by past commercial crop cultivation activities, i.e. ploughing etc.

Based on site distribution data for the local area, this landform unit is believed to be the most sensitive within the survey area (Figure 3).

5.2.2 Lower Hill Slopes

The second identifiable landform unit consists of low hill slopes with slope generally less than 20°, and covering approximately 60 hectares (30%) of the survey area. Soils over this landform unit are comprised of highly erodible, skeletal soils originating from adjacent weathered dacite and sanstone deposits.

Whilst gradient and terrain over at least the flatter areas of this landform would have been relatively conducive to past Aboriginal occupation, there appears no reason for extensive occupation over this landform unit when the adjacent creek banks and alluvial terraces, most of which are flood free, provided all that was required for comfortable campsite location, particularly proximity to water.

This landform unit is subject to ongoing surface erosion and is considered to be low in archaeological sensitivity (Figure 3). This assessment is based upon site distribution data throughout the local area and also as a result of the extensive clearing of old-growth native timber which has occurred over this landform unit in the past.

5.2.3 Upper Hill Slopes - Hill Tops, Associated Elevated Ridge Lines

The third landform unit (for other archaeological landforms, because this archaeological landform, for the purposes of this report, is a combination of several landform units), is comprised of upper hill slopes, rocky outcrops and associated hill tops and elevated ridge lines, covering approximately 105 hectares (52.5%) of the survey area. There occurs extensive scatters of weathered Dusun Dacite rock material (of volcanic origin) over the central and eastern portion of the survey and an exposed outcrop of Hallymore Formation sandstone over a small area along the western edge of the survey area.

Soils over this third landform are comprised of shallow skeletal soils and are subject to an ongoing level of surface erosion.
This third landsystem is assessed to be low in archaeological sensitivity (Figure 3), bearing in mind that the landsystem units involved are the furthest from reliable water (i.e. the Macquarie River and the seasonally reliable ephemeral creeks located within the survey area) have been heavily impacted by past European landuse management practices, and the low incidence of sites near similar landsystem units in the region.

Table 1

<table>
<thead>
<tr>
<th>Landform-Landsystem Unit</th>
<th>Vegetation</th>
<th>Site Prediction (Type)</th>
<th>Available Resources</th>
<th>Stone Assemblage Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ephemeral Drainage Lines - Associated Alluvial Terraces</td>
<td>Open Eucalyptus Woodland</td>
<td>Seasonally ephemeral campsites, scavenged trees</td>
<td>Grass and tree seeds, yams, gams, yabbies</td>
<td>Core and flake, tool, seed, grinding artifacts</td>
</tr>
<tr>
<td>Lower Hill Slopes</td>
<td>Open Eucalyptus Woodland</td>
<td>Isolated artifacts, scavenged trees</td>
<td>Grass and tree seeds, yams and game</td>
<td>Core and flake, tool, seed, grinding artifacts</td>
</tr>
<tr>
<td>Upper Hill Steps &amp; Fall, Top &amp; Association Freestall Ridge Lines</td>
<td>Open Eucalyptus Woodland</td>
<td>Isolated artifacts, possibly dome arrangements</td>
<td>Grass and tree seeds, yams and game</td>
<td>Core and flake, tool</td>
</tr>
</tbody>
</table>

6.0 ARCHAEOLOGICAL SURVEY

6.1 Survey Strategy

Firstly, a decision was made to cover as much of the identified survey area as possible, ensuring that coverage was effective as possible given the constraints of time and funding, and using a combination of vehicle and on-foot surface coverage methods (Figure 5).

In consideration of the above, a further decision was made that where possible, "total" coverage of the survey area would occur, in order to conform to the aims of the field survey described in Section 1.1, where a need was identified to determine the presence or potential for archaeological sites to occur within the survey area. The
results of this level of investigation would also be useful to the client in determining levels and types of impact over certain areas and the requirements for appropriate Aboriginal site management (where sites occur).

However, despite total survey area coverage during the field survey, the overall level of effective surface coverage was far less than total (see Section 6.3, Table 3). Secondly, coverage of the survey area was to include a representative sample of the three identified landform units and landuse units described in Section 3.6 and Table 1. The level of assessment would include investigation into site distribution, past Aboriginal landuse, and site significance. Selection of sample units was based on criteria including areas which provided high levels of surface visibility and exposure, as well as accessibility determined mainly by terrain, as well as the selection of areas appeared to have been relatively undisturbed (where such areas occurred).

A description of survey sample units, and environmental conditions is provided in Table 1. Locations of landform units and sample units is provided in Figure 2, Figure 3 respectively.

6.2 Field Recording Methods.

The survey was conducted using the CaLM 1:25,000 topographic map, Ealesomogo, Map Sheet No. 6663-3 N.

Site details, landform, and environmental conditions relating to the detectability of sites, were recorded on data sheets developed for the survey. The development of these forms was designed to facilitate the rapid documentation of basic site and environmental details, and to assist in the compilation of report summary descriptions of the same (see Appendices). Copies of site recording forms are provided in Appendix 8 where they occur as field notes attached to copies of all NPSW site forms completed during the field survey.

6.3 Field Survey Methodology and Coverage Data

A total of 8 sample units were surveyed over a comprehensive representation of all three separate landform units identified within the survey area. Sample units ranged in size from 1 hectares (ha) to 101 ha (Table 3 following, and Figure 5, proceeding page 37). Survey area coverage totaled approximately 146 ha, representing approximately 73% of the survey area, whilst effective coverage was somewhat less at approximately 92.2 ha, (64.1% of the total survey area).

Site detectibility varied over the survey area, and was determined by factors such as surface visibility (see Table 2, following), geomorphology, the size of the survey team and experience, background scatter, and the type of sites present (i.e. whether abrasive or ambigious). The measurement of site detectibility is difficult given the range of factors which may influence site detectibility, some of which are mentioned above. However, it is important to at least attempt to quantify the effective of
Effective coverage analysis can determine the interpreted accuracy of a field investigation (Witter, 1990c). For the purpose of the "Climatic Lee" study, a method of coverage analysis where effective coverage can be reasonably accurately calculated was adopted from Witter (cited in Bonhomme, 1993:50), where the following applies:

Effective Coverage = Sample Coverage (1) (2) (3) (4) (5).

where:

(1) = the area of 100% visibility

(2) = an estimate of prevailing visibility

(3) = calculate the proportion of the area of the total sample unit that the vegetation estimate represents, i.e. if surface visibility est. 20% = 20% of total sample unit

(4) = above figure added to area with 100% visibility = total area with 100% visibility

(5) = resulting figure calculated as % of sample unit giving effective coverage figure of sample unit (6).

Table 2

<table>
<thead>
<tr>
<th>Surface Visibility Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil, soil visibility</td>
</tr>
<tr>
<td>Occasional glimpses of sand/soil</td>
</tr>
<tr>
<td>Frequent patches of bare ground</td>
</tr>
<tr>
<td>Apton, 50% bare surface</td>
</tr>
<tr>
<td>&gt; 50% bare surface</td>
</tr>
<tr>
<td>Survey Area</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>Timbered Areas Access. The Survey Area</td>
</tr>
<tr>
<td>Ephemeral Drainage Lines &amp; Associated Adjacent Alluvial Terraces</td>
</tr>
<tr>
<td>Lower Hill Slope</td>
</tr>
<tr>
<td>Upper Hill Shale &amp; Shaped Topo &amp; Associated Elevated Ridge Lines</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
Initial coverage of the survey area comprised vehicle reconnaissance of the survey area perimeter to determine the boundaries, general levels of surface disturbance and visibility, landform, terrain, vegetation, and briefly assess the area for potentially sensitive landform units.

Following initial vehicle reconnaissance of the study area, preliminary site investigation was conducted over all stands of remaining old-growth timber and isolated single trees or small clumps (conducted over an area > 180 ha). These stands were identified and surveyed extensively for the presence of scarred tree sites using a combination of vehicle and on-foot coverage, (where terrain allowed vehicle coverage), but employing a 'total coverage' grid system of parallel transects over all timbered areas whether surveyed by vehicle or on-foot. The most densely timbered areas within the survey area occurred mainly over two landform units, including mid to upper hill slopes and associated elevated ridge lines, and secondly, low to lower mid hill slopes, although at a number of separate locations in the survey area, timbered areas extended to the edge of ephemeral creek lines, the (third landform unit).

The inspection of both live and dead timber over the survey area involved rapid movement across the landscape, using mainly vehicle inspection, but, where difficult terrain required it, on-foot coverage occurred. This level of coverage required a level of systematic investigation, and so the area was covered with parallel transects, ranging between 15 and 30 metres apart.

Two sample units were selected over elevated upper hill slopes, hill tops and associated elevated ridge lines. The largest sample unit, covered an area of approximately 103 hectares, whilst the second sample unit located along the western boundary of the survey area, consisted of approximately 8 ha. Surface visibility was estimated at around 70% average, for selected sample units within this landform unit. A series of parallel vehicle transects were conducted by vehicle, approximately 20 metres apart, over selected sample units. Where vehicle access was restricted by terrain or vegetation, areas were covered using an on-foot two man survey team, employing parallel transects conducted approximately 20 metres apart, (the distance between transects depending mainly upon terrain and surface visibility). Whilst inspection of old-growth timber occurred for the presence of scarred trees, observation was maintained over the ground surface for areas of bare or exposed earth or rocky outcrops, for the presence of open campsites or other less obtrusive site types. Where exposed areas occurred located amongst old-growth timber, coverage of the surface occurred employing on-foot, 10 metres apart, parallel transects and general surface observation between transects. The distance between transects depended upon terrain and surface visibility. Effective coverage over this landform unit was 70%.

Once all stands of remaining old-growth timber, areas of isolated timber, and upper hill slopes, hill tops and associated elevated ridge lines had been inspected, investigation was then carried out, on-foot, of all areas located within the most sensitive landform unit, along creek banks and adjacent alluvial terraces. Coverage of these areas included complete, total coverage of extensive sample units, extending the full length of all ephemeral creek lines within the survey area, and covering an...
average width of approximately 50 metres either side of creek beds. Parallel transects were carried out approximately 10–15 metres apart over the length of the landform unit, with supplementary general observation between transects, including a particular focus over areas of high surface visibility. Average surface visibility was estimated at around 70% over sample units within this landform unit. Effective coverage over this landform unit was 22.38%.

Upon completion of vehicle and on-foot coverage of the ephemeral drainage lines and adjacent alluvial terraces, coverage was afforded to low to mid hill slopes. This level of coverage included the selection of four sample units, each approximately 5 hectares in area. Coverage of selected 5 ha. sample units comprised a combination of vehicle and on-foot transects (Table 3). Effective coverage over this landform unit was calculated at approximately 70%, whilst surface visibility was estimated at around 70% average.

6.4 Definition of Sites and Establishing Site Boundaries

Flood (1989:286) defined a site as "...a place where past human activity is identifiable." Based on the discussion of site prediction in Section 5.1, it can be seen that site types vary considerably in form and function and generally in response to a variety of cultural complexities and environmental influences. These factors affected the development of the site and the activities of the people in prehistoric times. A site can be evidence of a complex of cultural activities, e.g. a large open scatter site of stone artefacts, cooking hearths etc., or a mound site. Alternatively, a site might be represented by a single, isolated occupation incident, for example a scarred tree, a small camp site, artefact scatter, or an isolated burial site. For the purpose of surface surveys, site boundaries are determined by the presence of Aboriginal cultural material. NPWS guidelines indicate that a site is determined by the presence of two artefacts located within 50 metres of each other. This is generally applied to open campsites and artefact scatters, whilst other site types may be determined by the presence of a single artefact (i.e. a scarred tree site) or even by the presence of a recognised significant area, with no visible artefacts (often with ceremonial or religious significance).

The extent of a site, in the case of open campsites and similar artefact scatters is often difficult to assess due to the effects of the geomorphic processes which may have impacted a particular area and therefore the archaeological deposits. However, surface deposits of archaeological material should be considered good indicators as to the archaeological sensitivity of a specific location, and in the western region, surface deposits tend to be reliable guides to a particular area's archaeological potential.

It should be acknowledged that EIS related surface studies do have their limitations, and where the archaeologist believes there is a potential for presence of sub-surface archaeological deposits to exist, the issue should be raised, and steps taken to accommodate that potential within a management framework. That framework might include a recommendation for further more extensive archaeological investigations or site simply taking into account the likelihood of sub-surface deposits during the...
APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

6.5 Origin Assessment of Aboriginal Scarred Trees

Scarred tree sites present a range of assessment, interpretation and management problems. Because a number of both natural and man-made effects impacted old growth timber in the past, one of the most difficult problems in scarred tree assessment is that of determining the origin of scars, whether particular scars on trees have an Aboriginal origin or else stem from a range of natural impacts.

Aboriginal scars can be found on a number of tree species within the region and study area, however, the most apparent and in some cases conclusive Aboriginal scars in the region, occur on either old growth yellow box, fuzzy box, or river red gum trees, with a lesser number occurring on grey box and white eucalypt pine.

Scars can occur on trees for a number of reasons, not all relating to human cultural activities, and where scars are the result of human cultural activity, not all scars necessarily relate to Aboriginal culture and yet they may be the result of Aboriginal people employed during the early post-contact period as European station workers involved in related station activities. Scars can occur from a number of non-traditional causes including bark removal from bird attacks, fire, flooding, European introduced stock rubbing and eating bark, European land clearing and ring-barking, fencing, rabbiting, farm and other machinery damage, and survey markers, to name some of the more obvious impacts. Rabbiting scars are an interesting anomaly where during the early part of this century, particularly in the south east of the country, Aboriginal people were conducting varying levels of ‘traditional’ lifestyles which included the adaptation of hunting practices and diet to include the exploitation of a number of introduced plant and animal species, of which rabbits are just one. Scarred trees relating to this activity are difficult to assess for their Aboriginal origin because both Aboriginal and non-Aboriginal people exploited rabbits as a significant food source, particularly during the period around the Great Depression in the 1920s-1930s, and both are known to have used steel axes to cut both possums and rabbits out of either standing or fallen hollow trees.

Scars which generally reflect traditional Aboriginal occupation over the study area are a focus of this report. In the case of scarred trees recorded during the study which are believed to be of Aboriginal origin, three categories of origin assessment have been employed. A fourth category of “definitely not” Aboriginal scars receives no further consideration in the report. Categories used in the report include the following:

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PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 368
6.5.1 "Possible" Aboriginal Scarred Trees

This category includes all scars which are ‘more than likely’ a result of human cultural activities, but which are very difficult to distinguish from scars of non-Aboriginal or European origin. While the shape of scars in this category are generally irregular, the shape of these scars can often resemble the shape of more definite Aboriginal scarred trees. Scars in this category may often be found in association with scars of a more definite Aboriginal origin or other Aboriginal site types. "Possible" Aboriginal scars may or may not have axe marks visible and where axe marks are visible, they may be the results of either a stone or steel axe. Where axe marks are visible, they are generally not consistent with recognizable Aboriginal bark removal patterns or stone axe scarred scars. These scars are generally more easily identifiable with regular scar shapes and patterns in the region, and quite often, although not necessarily, they may display axe marks. Axe marks on these scars need not necessarily resemble or be consistent with observed normal bark/cambium removal in the region, but will often be the results of stone axe scarring, although steel axe removal is not uncommon. Scars in this category also fit within height parameters which would have been conducive to comfortable bark removal, although multiple scars may be found in areas at heights which may be otherwise considered outside the normal comfort range for removal.

Generally, the recorder should have considerable doubt as to the Aboriginal origin of the scar, however, the over-riding factor for inclusion in the survey would be the scarred tree’s association with other more positive Aboriginal scarred trees (although not necessarily the only determining factor for inclusion in a report).

6.5.2 "Probable" Aboriginal Scarred Trees

"Probable" Aboriginal scarred trees are often found in association with other more definite Aboriginal scarred trees or in association with other Aboriginal site types. These scars are generally more easily identifiable with regular scar shapes and patterns in the region, and quite often, although not necessarily, they may display axe marks. Axe marks on these scars need not necessarily resemble or be consistent with observed normal bark/cambium removal in the region, but will often be the results of stone axe scarred scars. Scars in this category also fit within height parameters which would have been conducive to comfortable bark removal, although multiple scars may be found in areas at heights which may be otherwise considered outside the normal comfort range for removal.

The local Aboriginal community would have no knowledge of the particular site, and generally the recorder may have some doubts as to the Aboriginal origin of the scar due to some of the above characteristics or for other legitimate reasons.

6.5.3 "Definite" Aboriginal Scarred Trees

These scars fit the regular scar shape pattern of the area and their removal patterns can often be immediately identified with the removal of bark and/or outer cambium layers for the production of certain artefacts. Scars in this category may or may not display axe marks, where axe marks occur, they conform to normal bark and cambium removal pattern observed in the region. Axe scarving can be either the...
result of Aboriginal stone axe impact or from steel axe removal. The height of scars usually falls within a normal comfort range for removal. Quite often 'definite' Aboriginal scars will have a known ethnico-history within the local Aboriginal community.

Generally, the observer should have no doubt from an informed, experienced viewpoint, that the scar is of Aboriginal origin.

Note: Scars should not be assessed, other than in a very broad sense, on the basis of outer bark regrowth patterns. Regrowth patterns can be extremely misleading in determining the type of implement which was removed or the scar served. Scar shapes displayed by bark regrowth patterns can assist in vaguely identifying scar dimensions, allowing for estimated regrowth over the original scar.

6.5.4 Range of Assessment Criteria

Criteria used in the field to assess the origin of scarred/scarred trees include shape; whether consistent with known removal patterns; estimated age of the tree; whether axe marks are visible or not; and what type of axe marks and the patterns of axe marks, tree species, proximity to other scarred trees, amount of regrowth, any known Aboriginal history.

6.6 Significance Assessment

Significance assessment has occurred for all sites recorded during the field survey (see summary in Appendix 7). The assessment of an individual site's significance is determined by a number of criteria which in their broadest terms and under NPAR Guidelines, consider the site's scientific, educational, and Aboriginal significance.

However, upon analysis, these broad criteria can be further broken up into more specific criteria which could also be used in significance assessment.

Witter (1995) has identified a range of significance assessment criteria which can be applied to sites during the process of significance assessment. Witter describes these criteria as "objectifiable" and they are intended to supersede the existing criteria of scientific, educational and Aboriginal value assessment, or at least, for the present, complement them.

The broad terms of reference (or criteria) listed by Witter (1995) for the significance assessment of Aboriginal sites includes the following:

1. Identification and reconstruction of behaviour;
2. Cultural patterning and;
3. Prehistory.
Writer's criteria tend to fall within the Scientific Value assessment criteria previously recommended for use by NPWS in significance assessment. For the purposes of this report, both sets of criteria will be considered and where appropriate, applied.

When applying the original NPWS criteria of scientific value, educational value, and Aboriginal value, the site significance assessment, the first two can be readily assessed by an experienced archaeologist; however, the only way in which the Aboriginal value can be effectively assessed is with input from the local Aboriginal community, presumably to whom the material or site(s) relate. Initial significance assessment which addresses the first two values, often occurs in the field, and is generally based on assessment through comparison; in other words the representativeness or commonness and quality of the site being assessed, in comparison with other sites in the region or locality (or the absence of previously recorded sites in the region or locality). Assessment is also carried out, bearing in mind the actual scientific value of a site in answering research questions and the representativeness of a site in providing such information and site integrity. This level of assessment also includes scarcity of a specific site type(s) in a region.

Significance assessment, for the purposes of this report, is based on the following three assessment criteria developed for significance assessment by New South Wales National Parks and Wildlife Service, and incorporating those developed by Witter (1995):

1. **Scientific Value:**
   
   Sites are assessed for their scientific value, using sub-criteria of site integrity, preservation, contents, location, uniqueness or representativeness, and the potential of a site(s) for future scientific research.

   Witter (1995) has developed alternative significance assessment criteria which are, in essence, an extension of existing significance assessment criteria.

   Witter (1995) uses additional criteria within a largely scientific framework: Headings used by Witter include, 'identifications and reconstruction of behaviour', 'cultural patterning', and 'prehistoric', relating to past Aboriginal occupation of an area. The 'new' criteria adapted by Witter can be applied as supplementary levels of assessment when assessing a site's scientific value.

2. **Educational Value:**

   This level of assessment can be closely linked with a site’s scientific value; however, this level of assessment can also reflect a site’s integrity and value as a learning tool through its visual appeal as an example of a certain site type, and clear evidence of past Aboriginal occupation over an area. The educational value of sites can vary considerably depending upon the condition of the site, (site integrity), representativeness, and location, to name several of the aspects upon which it would be assessed. Sections of the community which may place educational value to a site may include, tertiary education institutions and the general education system, Aboriginal communities, the general public, etc.
3. **Aboriginal Value**

The Aboriginal community places a range of values on sites. Aboriginal values can often vary from those held by the non-Aboriginal community. In some instances, the archaeological significance of a site is considered by the Aboriginal community to be a secondary consideration when assessing a site's significance. A greater emphasis may be placed by the Aboriginal community on the social-cultural significance of a site, or else value placed upon a site for its educational value, particularly for teaching community members about the lifestyles of their ancestors, and the value of a site in providing a link with living community members and their ancestors.

Based on personal experience, it appears that Aboriginal communities tend to place far greater significance on sites relating to contemporary Aboriginal heritage and historic events, for example, missions sites and fringe campsites, however, the reverence for burial sites or is almost never compromised.

7.0 **SURVEY RESULTS AND SIGNIFICANCE ASSESSMENT**

A total of 8 open campsites, 3 scarred tree sites and 1 isolated artefact were recorded during the "Glenn Lee" archaeological survey. Figure 4 shows the locations of all sites recorded during the field survey. Figure 5 (following) indicates the approximate locations of survey area sampling units, and Appendix 3 provides a gazetteer of recorded sites. A summary of open campsite and isolated artefact finds details is provided in Table 4 in Appendix 4, whilst data on scarred tree sites is provided in Appendix 6. Summary details on stone artefacts recorded during the field survey are included in Appendix 5, whilst a summary of Site Significance Assessment is given in Appendix 7.

For additional site location and site dimension details other than those provided in this section of the report, refer to Appendix 8 for copies of site location and site dimension sketch maps provided in NPWS Site Recording Forms.

As predicted, all recorded sites occurred in relatively close proximity to seasonally reliable water sources, i.e., the two major ephemeral creek lines located within the survey area, and within the landform unit predicted to be archaeologically sensitive. The following is a description of all sites located and documented during the current field study:
7.1 OPEN CAMPSITES

7.1.1 Site Name: GL-OS-1 (Plates)

Location: G.R. 649280E, 6425510N

This open campsite is an extensive open campsite, comprised of exposed artefact scatter occurring along the eroded banks and adjacent elevated alluvial terrace of an un-named ephemeral creek line located in the western half of the survey area. The creek line extends from the south-western boundary of the survey area to a central point along the northern boundary, where it proceeds eastward towards the Macquarie River.

Site Dimensions:

The scatter of stone artefacts was observed to occur over an approximate area of 900 metres x 20 metres (18,000 m²) (Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface, which in turn results from the level of surface and sub-surface exposure which has occurred due to the effects of wind and gully erosion.

The site’s eastern boundary is determined by the level of apparent surface erosion caused by the effects of slope, combined with effects of vegetation removal, and the grazing of domestic stock. However, whilst the site’s western boundary is similarly defined, the effects of gully erosion have been more severe and a more extensive loss of site integrity may be the result (this could be verified by sub-surface investigation).

The most northern extent of the open campsite is delineated by the presence of an existing property track and a large earthen-walled stock dam. The construction of the dam along the southern most site trajectory has effectively marked the southern most limit of the site, with no further evidence of artefactual material located on the surface beyond the dam (on the eastern side of the creek). The eastern-most limit of the site is similarly defined by the construction of another property dam, and an internal property track, on the south-eastern side of the creek, adjacent to the "Glenn Lee" homestead. A further site is located downstream of open campsite GL-OS-1 on the steep bank of the same creek, on the eastern side of the dam, between the dam and the "Glenmore" homestead (GL-OS-2).
Site Formation and Condition:

The site was detected as an exposed stone artefact scatter located along the
crested shoulder of the elevated alluvial terrace on an up-dated ephemeral
stream (Figure 4).

The site probably, and to some degree surprisingly, given its distance from the
Macquarie River, represents a relatively extensive occupation area, located
along the immediate creek banks and associated alluvial terraces of the creek.
The creek line was probably a focus of past Aboriginal groups, exploiting a
seasonally reliable supply of fresh water, and possibly a range of animal and
plant species which would have populated the area, at least seasonally.

The site location could be generally described as an eroding landscape, and an
indeterminate level of surface and gully erosion has resulted at the site,
occurring from a range of surface disturbances, including commercial-tree
plantation, the grazing of domestic stock; fence construction, the removal of
timber; the construction of a property dam and the effects of internal track
development. The result has been a loss of the sandy, easily erodable topsoil
around the site, and therefore, a loss of site integrity due to artefact exposure
and down-slope artefact movement and scatter (resulting from some or all of
the previously mentioned impacts).

However, having noted that a degree of erosion is currently occurring at the
site, areas along the eastern edge of the site may have been subjected to a
degree of topsoil build-up resulting from erosion of steeper lower hill slopes,
and could therefore be referred to as an eroding landform. Therefore there is
a potential for sub-surface material to exist along the site’s eastern margin. In
summary, whilst there may be a build up of topsoil along the eastern margin
of the site, this build up is being countered by a loss of topsoil and sub-soil
deposits along the site’s western edge as a result of surface and gully erosion.

Coverage:

The level of surface visibility at the time of survey was consistent with surface
visibility for the whole sample unit, at around 70%, whilst effective coverage
afforded during site investigation was calculated at the same (70%), with total
site area coverage occurring by way of on-foot parallel transects
approximately 10 metres apart. Areas of exposed ground (mainly resulting
from surface, sheet erosion) between transects were also inspected for the
presence of artefacts.

Surface exposure occurred between patches of grass and along exposed
internal vehicle track lines. In the eastern section of the site, near the "Glebe
Lee" homestead, an area of approximately 30 m x 10 m investigated along the
creek bank shoulder probably as a result of stock movement and the
development of an internal property track across the ephemeral track line,
exposing a quantity of mainly quartz artefacts. However, this level of


exposure over the site was not common and generally restricted to the area mentioned. Although, at the southern extremity of the site, another area of surface exposure occurred as a result of internal, property track disturbance. A small scatter of artefacts was exposed by subsequent erosion which has occurred over the track area near the creek bed (erosion due to the effects of soil compaction and vegetation loss).

**Artfact Types, Numbers and Density:**

All stone artefacts, including a representative sample of stone and termite nest hearth material, were documented. A total of 57 stone artefacts were recorded, including 15 flakes, 14 flaked pieces, 4 cores, 26 debitage pieces, and one cyleon (broken into two sections). A representative sample of 12 sandstone, mudstone, and termite nest hearth stones was also recorded; however, this number was not included in the artefact count. Rather interestingly, an incomplete cyleon (broken and found as two large fragments) was documented. The artefact was located on the surface, approximately 30 metres from the site’s southern extremity. This artefact was made from a soft, argillaceous sandstone, each piece measuring approximately 125 mm long x 55 mm diameter at the thickest end) and 95 mm x 55 mm respectively.

Stone artefact maximum density over the site was recorded at 1 artefact/m²; whilst average artefact density was found to be less than 1 stone artefact/m². The presence of a relatively large quantity of stone artefacts and termite nest hearth material at the site tends to indicate that the level of occupation at the site was more than just casual visitation and that a range of activities were occurring at the site. This is further supported by the presence of a number of (approximately 40% of the total assemblage).

**Raw Materials:**

Stone artefact raw material was comprised of quartz (39.6%), chert (26.3%), quartzite (12.3%) and silcrete (1.8%).

**Significance Assessment:**

The site is assessed to have **moderate significance**. This assessment is based on the site having moderate scientific value and moderate educational value. An increased level of assessment would be provided for the site should the site be found to contain relatively undisturbed sub-surface archaeological deposits, thus having the potential to reveal information on identification and reconstruction of the behaviour, cultural patterning, and priorities, of past Aboriginal groups in the local area and the broader region.
With regard to the site's scientific value, the site has been subject to an undetermined level of surface disturbance, and is currently being impacted by active, sheet and gully erosion. This level of disturbance detracts from the site's integrity as an intact site, however, whilst the site is not considered an exceptional example of this particular site type, the scientific value of the site is reduced slightly by the relative absence of other similar site types recorded in the local area, and the potential for adjacent areas to contain additional archaeological deposit in the form of sub-surface material (unable to be assessed during the surface investigation).

Following consultation with the Central Region Aboriginal Land Council, the site is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.4.2 Site Name: GL-OS-2 (Plates)

Location: G.R. 639611E, 6425499N

This exposed scatter of stone artefacts is located along an eroded, ephemeral creek bank, approximately 120 metres east of the eastern end of open campsite GL-OS-1, and on the same side of the creek (Figure 4).

Site Dimensions:

Difficulty was encountered in measuring the site due to a quantity of artefactual material found totally out of original context and impregnated in collapsing, sandy sub-soil material on the creek bank. However, the approximate site area was found to extend approximately 20 m x 5 m (100 m²), with extent determined by the presence of visibly stone artefacts upon the surface (Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface, which in turn results from the level of surface and sub-surface exposure which has occurred due to the effects of sheet and gully erosion.

The site's eastern boundary is determined by the level of apparent surface erosion caused by the effects of slope, combined with effects of vegetation removal and the grading of domestic stock and gully erosion. The site's western boundary is similarly defined, with the effects of gully and sheet erosion most pronounced. The site's southern boundary is delineated by a marked absence of stone artefacts visible upon the surface, and extends some...
In south of the heavily eroded creek banks. The site appears to have been subjected to a far higher level of gully erosion than that which has occurred on the adjacent GL-OS-1, and it is assumed that the site boundaries have been correspondingly reduced with a loss of site integrity due to the loss of archaeological material into the creek bed. However, given the loss of site integrity due to erosion, the site does not appear to have originally been as extensive as GL-OS-1. Despite the apparent loss of site integrity due mainly to gully erosion, there is a potential for sub-surface archaeological deposits to occur along the site's southern boundary.

The most eastern and western limits of the open campsite are delineated by the absence of stone artefacts and a loss of topsoil due to gully erosion. The northern boundary is also abruptly marked by a steeply-eroded gully and the creek bed. The site's southern boundary is marked by an absence of stone artefacts visible upon the surface.

**Site Formation and Condition:**

The site was detected as an exposed stone artefact scatter located along the eroded shoulder of the elevated alluvial terrace on an unnamed ephemeral creek.

The site is probably an extension of open campsite GL-OS-1, with a high level of surface disturbance between the two sites responsible for a loss of site integrity and fabric, resulting in the identification of two separate sites. The creek bed was probably a focus of past Aboriginal groups, exploiting a seasonally reliable supply of fresh water and associated plant and animal life.

The site location could be generally described as a degrading landscape. An indeterminate level of surface and gully erosion has resulted at the site, occurring from a range of surface disturbances, including commercial crop cultivation, the grazing of domestic stock, fence construction, the removal of timber, the construction of a property dam and the effects of internal creek development. The result has been a loss of the sandy, easily erodible topsoil around the site, and therefore, a loss of site integrity due to artefact exposure and downslope artefact movement and scatter.

However, having stated that a degree of erosion is currently occurring at the site, areas along the southern and south-eastern edge of the site may have been subjected to a degree of topsoil build-up resulting from erosion of adjacent, steeper hill slopes. This section of the site could therefore be referred to as degrading. In summary, whilst there may be a build up of topsoil along the south-eastern margin of the site, this build up is being countered by an ongoing loss of topsoil and sub-soil deposits along the site's western edge as a result of surface and gully erosion.
The level of surface visibility at the site is consistent with general landform unit data analysis, at around 70%, whilst effective coverage afforded during the investigation was calculated at around the same (70%). Coverage of the site area was 'total' in that the entire surface was inspected during the survey for the presence of stone artefacts. Due to the limited nature of the site, coverage was carried out using a zig-zagging method of on-foot coverage.

Artifact Types, Numbers and Density:

All stone artefacts observed upon the surface of the site were documented. A total of 7 stone artefacts were recorded, including: 1 flake, 1 hammerstone, 4 millstone, 1 molar, 1 debris piece, and a single heath stone. In addition, a single burnt sandstone fragment was recorded, presumably a heath stone.

Stone artefact maximum density over the site was recorded at 0.3 artefacts/m², whilst average artefact density was found to be less than 1 stone artefact/m².

Raw Materials:

Stone artefact raw material was comprised of 3 quartz (43%), 2 quartzite (28%), 1 indurated mudstone (14%), 1 siltstone (14%).

Significance Assessment:

The site is afforded low-moderate significance assessment. This assessment is based on the site having low scientific value and low educational value. An increased level of assessment is provided for the site based on the potential of the site to contain relatively undisturbed sub-surface archaeological deposits, thus having the potential to reveal information on identification and reconstruction of the behaviour, cultural patterning, and prehistories, of past Aboriginal groups in the local area and the broader region.

With regard to the site's scientific value, the site has been subject to an intermediate, but apparently high level of surface disturbance, and is currently being impacted by active, sheet and gully erosion. This level of disturbance detracts from the site's integrity as an intact site, however, whilst the site is not considered an exceptional example of this particular site type, the scientific value of the site is raised slightly, by the relative absence of other similar site types recorded in the local area, and the potential for adjacent areas to contain additional archaeological deposit in the form of sub-surface material (unable to be assessed during the surface investigation).
Following consultation with the Central Region Aboriginal Land Council, the site is afforded low/moderate Aboriginal community value. The Land Council emphasised the value of the site as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.1.3: Site Name: GLOS-3 (Plates )

Location: G.R. 649610E, 6425584N

This open campsite is a small open artefact scatter located on a flat alluvial terrace on the northern bank and associated alluvial terrace of an un-named ephemeral creek, and situated approximately 40 metres and on the opposite side of the creek to open campsite GLOS-2 (approximately 200 metres east of "Glenlee" homestead) (Figure 4).

Site Dimensions:

The scatter of stone artefacts was observed to occur over an approximate area of 20 metres x 20 metres (400 m²) (Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface. However, the extent of the site was difficult to determine, given the high level of surface disturbance which has occurred, particularly as a result of commercial crop cultivation.

The site's southern boundary is delineated by creek bank erosion, and an apparent absence of stone artefacts. The site's northern boundary is marked by a steep hill slope and a pronounced absence of stone artefacts. The eastern and western site boundaries are identified by an absence of stone artefacts visible upon the surface.

Site Formation and Condition:

The site was detected as an exposed stone artefact scatter located over the surface of an alluvial creek flat adjacent to an un-named ephemeral creek (Figure 4).

The site would have probably been very similar in nature (and occupation use) to other sites recorded during the survey. However, due to the effects of European land management practices, the site has virtually no remaining surface integrity as an intact deposit, although there occurs the remote...
possibility that undisturbed sub-surface archaeological deposits may exist below normal plough depth, bearing in mind that the alluvial flat may have been subject to indeterminate levels of topsoil movement both as a result of erosion, and aggradation from creek wash and adjacent hill slopes.

Coverage,

The level of surface visibility at the site at the time of survey was consistent with surface visibility for the whole sample unit, although slightly less at an estimated 30% due to recent grass cover, whilst effective coverage afforded during site investigation was calculated at the same (50%), mainly as a result of restricted surface inspection due to grass cover. Total surface coverage occurred during the field survey by way of on-foot inspection, employing a general zig-zagging coverage method as opposed to a more systematic process. This level of surface coverage was chosen due to the relatively small area of artefact scatter (and therefore site area). Surface exposure was generally limited to exposed ground between grass cover.

Artifact Types, Numbers and Density,

All stone artefacts at the site were documented during the field survey; however, a small quantity of apparently manuport material was not documented although a sample was included. A total of 3 stone artefacts were recorded; including 1 millstone (muller), and 2 manjoins river pebbles.

Stone artefact maximum density over the site was recorded at less than 1 artefact/m². There occurs an anomaly at the sight in that no flaked artefacts were observed, however, factors such as grass cover and surface disturbance may have been responsible for a possible bias in artefacts visible upon the surface.

Raw Materials,

Stone artefact raw material was comprised of 100% quartzite, river pebble material.

Significance Assessment,

The site is assessed to have low significance. This assessment is based on the site having low scientific value and low educational value.

With regard to the site's scientific value, the site has been heavily disturbed as a result of commercial crop cultivation, and a major loss in site integrity has occurred. This level of disturbance detracts from the site's integrity as an
Intact site, however, whilst the site is not considered an exceptional example of this particular site type, the scientific value of the site is raised slightly, by the relative absence of other similar sites types recorded in the local area, and the potential for adjacent areas to contain additional archaeological deposit in the form of subsurface material (unable to be assessed during the surface investigation).

Following consultation with the Central Region Aboriginal Land Council, the site is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site as an educational resource for the local Aboriginal and non-Aboriginal communities.

2.4. Site Name: GL-OS-4 (Plates )

Location: G.R. 850134E, 6424938N

This open camps site is a relatively small open artefact scatter occurring along the eroded banks of an un-named ephemeral creek line located in the eastern half of the survey area, approximately 200 metres west of Obley Road, and approximately 350 metres north of Morris Park Speedway. The creek line extends from the higher ground near the south-eastern boundary of the survey area to the north eastern corner, where it proceeds northward to a junction outside the survey area, with the second ephemeral creek where four other open campsites were recorded during the survey (i.e. GL-OS-1 to GL-OS-5 and GL-OS-6). From the junction of the two creeks, the creek then drains approximately 1 km, eastward, to the Macquarie River (Figure 4).

Site Dimensions:

The scatter of stone artefacts was observed to occur over an approximate area of 10 metres x 10 metres (100 m²) (Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface, which in turn results from the level of surface and subsurface exposure which has occurred due to the effects of sheet and gully erosion.

The site’s western boundary is determined by a level of surface and gully erosion along the creek bank, whilst the site’s northern and southern boundaries are similarly defined by areas of erosion and the creek bank, however the north-eastern and south-eastern margins have not been subject to the same levels of surface disturbance resulting from gully erosion, and there depicts the remote potential for subsurface archaeological deposits to exist.
Site Formation and Condition:

The site was detected as an exposed stone artefact scatter located along the generally flat, eroded alluvial and colluvial banks of an un-named ephemeral creek.

Judging by the limited number of surfaces visible upon the surface, the site probably reflects seasonal movement and short term occupation of the creek line and not the remains of a larger site destroyed by the effects of surface and gully erosion.

Surface disturbance from crop cultivation, the movement of grazing stock, and gully erosion, have meant considerable loss of site integrity, although the eastern margin of the site is thought to have potential for sub-surface archaeological deposits. Should sub-surface material be located at the site, it is anticipated that the extent of such deposits would be limited to within relatively close proximity to the creek line and past supplies of seasonally available water.

The reason that consideration has been given to the potential of the site to contain sub-surface deposits is based on the generally mild slope over the site area (being conducive to campsite location), and an assessed moderate level of disturbance, both natural (geomorphological) and human-initiated.

Coverage:

The level of surface visibility at the site, at the time of survey, was consistent with surface visibility for the whole sample unit and landform unit, at around 80%, whilst effective coverage afforded during site investigation was calculated at the same (70%); with total site area coverage occurring by way of on-foot parallel transects approximately 10 metres apart. Areas of exposed ground (mainly resulting from surface, sheet erosion) between transects were also inspected for the presence of artefacts.

Surface exposure occurred between patches of grass and along exposed internal vehicle track lines and sheep and cattle pads (approximately 80% of site area).
Artifactual Types, Numbers and Density:

All stone artefacts observed upon the surface of the site were documented. A total of 8 stone artefacts were recorded, including 2 flakes (plus a single backed blade of flake origin), 1 flaked piece, and a single piece of debitage. Stone artefact maximum density over the site was recorded at less than 1 artefact/m².

Raw Materials:

Stone artefact raw material was comprised of 3 quartz (60%), and 2 quartzite (40%).

Significance Assessment:

The site is assessed to have low significance. This assessment is based on the site having low scientific value and low educational value. A potential for an increased level of assessment is accepted for the site based on the potential of the site to contain relatively undisturbed sub-surface archaeological deposits, thus having the potential to reveal information on identification and reconstruction of the behaviour, cultural patterning, and prehistories, of past Aboriginal groups in the local area and the broader region.

With regard to the site's scientific value, the site has been subject to an indeterminate level of surface disturbance, and is currently being impacted by active sheet and gullying erosion. This level of disturbance detracts from the site's integrity as an intact site, however, whilst the site is not considered an exceptional example of this particular site type, the scientific value of the site is raised slightly, by the potential for adjacent areas to contain additional archaeological deposit in the form of sub-surface material (unable to be assessed during the surface investigation).

Following consultation with the Central Region Aboriginal Land Council, the site is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.1.5 Site Name: GL-OS-S5 (Plates)

Location: G.R. 659082E 6424674N

This open campsite is a relatively small open artefact scatter occurring along the eroded banks of an un-named ephemeral creek line located in the eastern half of the survey area, approximately 200 metres west of Olley Road, and approximately 500 metres north of Morris Park Speedway. The creek line...
extends from the higher ground near the south-eastern boundary of the survey area to the north-eastern corner, where it proceeds northward to a junction outside the survey area, with the second ephemeral creek where four other open campfires were recorded during the survey (i.e. OL-OS-1 to OL-OS-3 and OL-OS-6). From the junction of the two creeks, the creek then drains approximately 1 km, eastwards to the Marquette River (Figure 4).

Site Dimensions:

The scatter of stone artefacts was observed to occur over an approximate area of 15 metres x 10 metres. (100 m²) (Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface, which in turn results from the level of surface and sub-surface exposure which has occurred due to the effects of sheet and gully erosion.

The site's western boundary is determined by a level of surface and gully erosion along the creek bank, whilst the site's northern and southern boundaries are similarly defined by areas of erosion and the creek bank, however the north-eastern and south-eastern margins have not been subject to the same levels of surface disturbance resulting from gully erosion, and there occurs the remote potential for sub-surface archaeological deposits to exist.

These deposits, should they exist, would be located below normal plough depth, bearing in mind that the area has been heavily disturbed by commercial crop-cultivation activities, i.e. ploughing. The site's eastern boundary is similarly defined by the presence of visible surface artefacts, and a distinct absence of such material. The eastern edge of the site also has the potential to be more extensive, if sub-surface material was found to exist.

Site Formation and Conditions:

The site was detected as an exposed stone artefact scatter located along the generally flat, eroded alluvial and colluvial banks of an unnamed ephemeral creek (Figure 4).

Judging by the limited number of artefacts visible upon the surface, the site probably reflects seasonal movement and short term occupation of the creek line and not the remains of a larger site, destroyed by the effects of surface and gully erosion.

Surface disturbance from crop cultivation, the movement of grazing stock, and gully erosion, have meant considerable loss of site integrity, although the eastern margin of the site is thought to have a potential for sub-surface...
archaeological deposits. Should sub-surface material be located at the site, it is anticipated that the extent of such deposits would be limited to within relatively close proximity to the creek line and past springs of seasonally available water.

The reason that consideration has been given to the potential of the site to contain sub-surface deposits is based on the generally mild slope over the site area, and an assessed moderate level of disturbance, both natural (geomorphological) and human initiated.

Coverage:

The level of surface visibility at the site, at the time of survey, was slightly higher than that recorded for the whole sample unit and landform unit, at around 50%, whilst effective coverage afforded during site investigation was calculated at the same (70%), with total site area coverage occurring by way of ten-foot parallel transects approximately 10 metres apart. Areas of exposed ground (mainly resulting from surface, sheet erosion), between transects, were also inspected for the presence of artefacts.

Surface exposure occurred between patches of grass and along exposed internal vehicle track lines and sheep and cattle pads (approximately 50% of site area).

Artifact Types, Numbers and Density:

All stone artefacts observed upon the surface of the site were documented. A total of 3 stone artefacts were recorded, including 1 flake, 1 flaked piece, and 3 debris pieces. Stone artefact maximum density over the site was recorded at less than 1 artefact/m^2.

Raw Materials:

Stone artefact raw material was comprised of 4 quartz (80%), and 1 chert (20%).

Significance Assessment:

The site is assessed to have low significance. This assessment is based on the site having low scientific value and low educational value. A potential for an increased level of assessment is accepted for the site based on the potential of the site to contain relatively undisturbed sub-surface archaeological deposits, thus having the potential to reveal information on identification and reconstruction of the behaviour, cultural patterning and prehistory, of past Aboriginal groups in the local area and the broader region.
With regard to the site's scientific value, the site has been subject to an indeterminate level of surface disturbance, and is currently being impacted by active, sheet and gully erosion. This level of disturbance detracts from the site's integrity as an intact site, however, whilst the site is not considered an exceptional example of this particular site type, the scientific value of the site is raised slightly by the potential for adjacent areas to contain additional archaeological deposit in the form of sub-surface material (unable to be assessed during the surface investigation).

Following consultation with the Central Region Aboriginal Land Council, the site is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.1.6 Site Name: GL-OS-6 (Plates)
Location: G.R. 648878E 6425265N

This open campsite is a very small scatter of stone artefacts, situated on the western edge of an elevated alluvial/colluvial terrace of an unnamed ephemeral creek. The site is located in the western half of the survey area, on an ephemeral creek, upstream, on the same creek where open campsite GL-OS-1 site, occurs (on the opposite side of the creek). The site is actually located approximately 100 metres south of GL-OS-1, and an estimated 40 metres west of the creek bed. The artefacts are positioned on the floor of a colluvial slope (Figure 4).

Site Dimensions:

The scatter of stone artefacts was observed to occur over an approximate area of 5 metres x 3 metres (15 m²) (Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface.

The site's eastern boundary is determined by the absence of stone artefacts, whilst the northern, southern and western boundaries are similarly delineated. Whilst there occurs a distinctly low number of artefacts, the site has the potential to contain additional material in the form of sub-surface archaeological deposit. Unfortunately the level of past surface disturbance will no doubt be a significant factor in site extent and boundaries, and the integrity of potential sub-surface deposits.
Site Formation and Condition:

The site was detected as an extremely small, stone artefact scatter, located along the western boundary of an alluvial creek flat (or terrace). The site would appear to be a southern extension of an occupation area which may have extended along a large portion of the immediate creek banks and adjacent alluvial terraces (along the western side of the creek, and opposite the extensive scatter identified in the report as GL-OS-1) (Figure 4). This view is supported by the presence of a second open campsite recorded approximately 100 metres to the north-east of GL-OS-6. This second site is referred to as GL-OS-7, and occurs as a slightly larger open campsite along the elevated creek banks (Figure 4).

However, the surface around open campsite GL-OS-6 has been subjected to an indeterminate level of surface disturbance, mainly from commercial crop cultivation and the grazing of domestic stock. As a result, the site location surface is best described as a degrading, and the site lost in integrity due to a loss of intactness. The past cultural and environmental context in which the site would have occurred would have been similar to other sites recorded along the creek line.

Coverage:

The level of surface visibility at the site at the time of survey was consistent with surface visibility for the whole sample unit and landform unit, at around 70%, while effective coverage afforded during site investigation was also calculated at the same (70%), with total site area coverage occurring by way of on-foot zig-zagging conducted over the entire area for approximately 10000 m². Areas of exposed ground (mainly resulting from surface sheet erosion) were also inspected for the presence of artefacts.

Surface exposure occurred between patches of grass and along exposed internal vehicle track lines.

Artefact Types, Numbers and Density:

All stone artefacts observed upon the surface of the site were documented. A total of 3 stone artefacts were recorded, including 1 broken millstone (adapted as a producer core), 1 flaked piece, and 1 producer core.

Stone artefact maximum density over the site was recorded at less than 1 artefact/m².

Raw Materials:

Stone artefact raw material was comprised of entirely of quartzite (100%).
Significance Assessment:

The site is assessed to have low significance. This assessment is based on the site having low scientific value and low educational value. An increased level of assessment is provided for the site based on the potential of the site to contain relatively undisturbed sub-surface archaeological deposits, that having the potential to reveal information on identification and reconstruction of the behaviour, cultural patterning, and prehistories, of past Aboriginal groups in the local area and the broader region. However, where such sub-surface deposits might exist, their integrity may too be compromised due to surface disturbance (unless they are located below normal plough depth).

Following consultation with the Central Region Aboriginal Land Council, this site, in conjunction with the suite of sites located along the creek line, is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.1.7 Site Name: GL-OS-7 (Plates)

Location: G.R. 64906SE, 6425392N

This open campsite is a relatively small scatter of stone artefacts, situated on the western edge of a gently sloping (<10° slope) elevated alluvial/sediment terrace of an up-ranged ephemeral creek (on the opposite bank to GL-OS-1). The site is found approximately 20 metres west of the creek bed (Figure 4).

Site Dimensions:

The scatter of stone artefacts was observed to occur over an approximate area of 5 metres x 3 metres (15 m²) (see Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface.

The site’s eastern boundary is determined by the absence of stone artefacts visible upon the surface, and is marked by the presence of a scarred-tree site (GL-SE-1), whilst the western, northern and southern boundaries are similarly delineated, by the absence of stone artefacts visible upon the surface. Whilst, there occurs a relatively low number of artefacts visible upon the surface, the
The site has the potential to contain additional material in the form of sub-surface archaeological deposits. Unfortunately the level of past surface disturbance will no doubt be a significant factor in site extent and boundaries.

Site Formation and Conditions:

The site was detected as a relatively small, stone artefact scatter, located along the western boundary of an alluvial creek flat (or terrace). The site would appear to be a second surface deposit located approximately 100 metres to the south (GL-OS-6), and should more extensive investigation occur (in the form of sub-surface excavation), the site may be found to be far more extensive than that which is currently visible upon the surface. This conclusion is reached due to the apparent build up of deposit along an internal property fence line which cuts through the eastern edge of the site. This build up is probably due to the past cultivation practices on the property. What may also have occurred, as a result of extensive ploughing of the section of the property, is the complete disturbance of the site and re-deposition during the ploughing process, with material re-deposited on the down-hill slope, and out of its original context. A narrow strip of ground located between the fence line in question and the creek bed may have some potential for sub-surface archaeological deposits to remain relatively undisturbed.

In summary, the site around open campsite GL-OS-7 has been subjected to an indeterminate level of surface disturbance, mainly from commercial crop cultivation and the grazing of domestic stock. As a result, the site location surface is best described as a degrading, and the site low in integrity due to a loss of intactness. The past cultural and environmental context in which the site would have occurred would have been similar to other sites recorded along the creek line.

Coverage:

The level of surface visibility at the site at the time of survey was consistent with surface visibility for the whole sample unit and drilliform unit, at around 70%, whilst effective coverage attained during site investigation was also calculated at the same (70%), with total site area coverage occurring by way of 10000 m² drilliform sampling conducted over the entire area for approximately 10000 m² (a sample unit within a sample unit). Areas of exposed ground (mainly resulting from surface, sheet erosion) were also inspected for the presence of artefacts. Surface exposure occurred between patches of grass.
Artefact Types, Numbers and Density:

All stone artefacts observed upon the surface of the site were documented. A total of 2 stone artefacts were recorded, including 2 production cores and one flake.

The cores located at the site were really fine examples of production cores. Both cores showed evidence of a number of negative flake scars, and one core was uni-platformed whilst the other was multi-platformed and rotated.

Negative flake scars present on cores at the site indicated that long-stripped type flakes had been removed, with one core showing signs of extensive reduction, containing a combination of plunge, hinge, and feather terminations. Stone artefact maximum density over the site was recorded at less than 1 artefact m⁻².

Raw Materials:

Stone artefact raw material was comprised of 2 chert artefacts (66%) and 1 silexite artefact (33%).

Significance Assessment:

The site is assessed to have low to moderate significance. This assessment is based on the site having low scientific value and low educational value. An increased level of assessment is provided for the site based on the site containing a single scored tree (GL-ST-1), and the potential for the site to contain relatively undisturbed sub-surface archaeological deposits, thus having the potential to reveal information on identification and reconstruction of the behaviour, cultural patterning, and histories, of past Aboriginal groups in the local area and the broader region. However, where such sub-surface deposits might exist, their integrity may be compromised due to surface disturbance (unless they are located below normal plough depth). With regard to the presence of the scored tree site, whilst there is a spatial relationship between the open campsite and the scored tree site, assuming that the scar is of Aboriginal origin, however, at this level of investigation there is no way of constraining the two sites temporally.

Following consultation with the Central Region Aboriginal Land Council, this site, in conjunction with the suite of sites located along the creek line, is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site, in conjunction with the surrounding sites, as an educational resource for the local Aboriginal and non-Aboriginal communities.
7.1.3 Site Name: GL-OS-8 (Plates)

Location: G.R. 649066E, 6425392N

This open campsite is a relatively extensive, but low artefact density, scatter of stone artefacts, situated in the centre of a ploughed paddock, on elevated alluvial terrace, approximately 200 metres west of the "Glenn Lee" homestead, between the junction of two un-named, ephemeral creeks (Figure 4).

Site Dimensions:
The scatter of stone artefacts was observed to occur over an approximate area of 50 metres x 30 metres (1,500 m²) (see Figure 4).

Site Boundaries:
For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface.

Whilst there occurs a relatively low number of artefacts visible upon the surface, the site has the potential to contain additional material in the form of sub-surface archaeological deposits. Unfortunately the level of past surface disturbance will no doubt be a significant factor in site extent and boundaries.

Site Formation and Condition:
The site was detected as a relatively extensive stone artefact scatter of low artefact density, located over an elevated alluvial creek flat (or terrace).

Whilst artefact density on the surface of the site is low, considering the sensitive landform, and because of the extent of artefacts visible upon the surface, it is anticipated that sub-surface investigation may uncover additional material. However, given the level of surface and sub-surface disturbance which has occurred at the site, where shallow sub-surface material exists, the integrity of such deposits would be severely compromised. There is a possibility that deeper sub-surface deposits might occur, given the relatively stable nature of the landform unit (apart from surface disturbance) and the geomorphological processes which probably formed the landform in its present state, as an aggraded landform unit.

In summary, the surface around open campsite GL-OS-8 has been subjected to an indeterminate level of surface disturbance, mainly from commercial crop cultivation and the grazing of domestic stock. As a result, the site location surface is best described as a degraded, and the site low in integrity due to a loss of intactness. However, the site may have a potential for deep sub-surface deposits to occur in relatively undisturbed condition.
The past cultural and environmental context in which the site would have occurred would have been similar to other sites recorded along the creek line.

**Coverage:**

The level of surface visibility at the site at the time of survey was slightly higher than the average for the rest of the survey area, due to recent cultivation and grazing down by stock. Surface visibility for the site was estimated at around 90%. Surface coverage over the site was estimated at 100%, and effective coverage afforded during site investigation was calculated at between 90% - 100%. Total site coverage occurred by way of on-foot zig-zagging conducted over the entire area for approximately 10,000 m² (1 sample unit within a sample unit). Areas of exposed ground (mainly resulting from surface, sheet erosion) were also inspected for the presence of artefacts. Surface exposure occurred between patches of grass, however, no creation was visible.

**Artefact Types, Numbers and Density:**

All stone artefacts observed upon the surface of the site were documented. A total of 4 stone artefacts were recorded, including 2 producer cores, 1 flake, and a manoport river pebble.

The cores located at the site were good examples of producer cores. Both cores showed evidence of a number of negative flake scars, and both cores were uni-platformed. Negative flake scars present on cores at the site indicated that long ‘alliter’ type flakes had been removed, with one core showing signs of extensive reduction, containing a combination of plunge, fling, and feather terminations. Stone artefact maximum density over the site was recorded at less than 1 artefact/m².

**Raw Materials:**

Stone artefact raw material was comprised of 3 chert artefacts (75%) and 1 quartzite artefact (25%).

**Significance Assessment:**

The site is assessed to have low significance. This assessment is based on the site having low scientific value and low educational value. An increased level of assessment would be provided for the site if sub-surface investigations revealed intact sub-surface deposits.
Following consultation with the Central Region Aboriginal Land Council, this site, in conjunction with the suite of sites located along the creek line, is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site, in conjunction with the surrounding sites, as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.2 SCARRED TREE SITES

The presence of scarred tree sites within the landform unit is consistent with site predictions for the study area and environs made in Section 5.1. The only scarred tree sites located during the archaeological survey occur on old-growth timber; one on a living Eucalyptus microcarpa and the second on a dead eucalypt (Plates). The following is a brief description of scarred tree sites recorded during the "Glenn Lee" archaeological survey.

7.2.1 Site Name: GL-ST-1 (Plates)

Location:
G.R. 649065E  6425492N

The scarred tree site is located at the eastern edge of open campsites GL-CS-7, immediately adjacent to the extensive, unnamed ephemeral creek in the western half of the survey area (located approximately 3 m. from the creek bed, on the western bank) (see Figure 4).

Site Description:

Scarred tree site R-ST-1 is a standing, dead, tree stump, probably E. camaldulensis. The scar is roughly ovate in shape although some what irregular, and is considered to be the possible result of the removal of bark by past Aboriginal people in the area.

The scar is rated as of "possible" Aboriginal origin (see Section 6.5). More positive Aboriginal origin assessment is difficult due to the poor definition of the scar, absence of axe marks, and lack of any known Aboriginal history or specific significance. The likelihood of the scar being of Aboriginal origin is increased because of the scarred trees close proximity to an open campsite. The scar appears to be the result of both bark and outer cambium removal.
Site Condition:

The scarred tree, a dead eucalypt, is in poor condition, remaining only as a tree stump, approximately 1.5 m high. The actual scar is assessed to be in good condition, although there is no clear shape which can be said to be consistent with known artefact shapes from the area.

Site Dimensions:

The tree trunk is approximately 40 cm diameter at the centre of the scar. The scar measures 20 cm in length, 11 cm wide at the centre of the scar and the base of the scar is approximately 95 cm above the ground.

Site Context:

The scarred tree occurs in extremely close association with open campsites GL-OS-2, and GL-OS-1.

Significance Assessment:

The scarred tree is given a slightly higher assessment than would perhaps be given to scarred trees in a similar poor condition due to its association with another site. A Moderate Significance Assessment is afforded to the site due to the low number of previously recorded scarred tree sites in this area of the Macquarie River Floodplain and the representativeness of the site. The site is considered to be of low scientific value and moderate value as an educational resource (in association with the two open campsites).

Following consultation with the Central Region Aboriginal Land Council, the site is given moderate Aboriginal value, based mainly on the expressed value of the community regarding the site’s educational value to the Aboriginal community.

7.2.2 Site Name: GL-ST-2 (Plate)

Location: G.R. 639156E 6425561N.

The scarred tree site is a standing, live, grey box (E. microcarpa) and is located in the south-western corner of the survey, adjacent to the southern boundary fence, near the head of an ephemeral creek line (approximately 700 m south of open campsite GL-OS-1 etc. (see Figure 4).
Site Description:

Scarred tree site GL-ST-2 is a standing, live, old-growth grey box tree, situated on a gentle north western slope, with the scar facing north. The scar is elongated in shape, and is considered to be the 'possible' result of the removal of bark by past Aboriginal people in the area.

The scar is noted as 'possible' Aboriginal origin (see Section 6.5). More positive Aboriginal origin assessment is difficult due to the poor definition of the scar, (due to bark regrowth), absence of axe marks, and lack of any known Aboriginal history or specific significance. The scar appears to be the result of bark removal only.

Site Condition:

The scarred tree, a live eucalypt, is considered to be in good condition, however, the scar has received moderate bark regrowth, covering the original scar pattern. The scar shape is thought to be reasonably consistent with similar scar shapes throughout the region.

Site Dimensions:

The tree trunk is approximately 94 cm, diameter at the centre of the scar. The scar measures 266 cm in length, 50 cm wide at the centre of the scar, and the base of the scar extends to ground level (most likely as a result of bark regrowth).

Site Context:

The scarred tree occurs as an isolated site, although, still in relatively close proximity to open campsites recorded during the current survey.

Significance Assessment:

A low significance assessment is afforded to the site due to the low level of Aboriginal origin assessment, low scientific value and low educational value.

Following consultation with the Central Region Aboriginal Land Council, the site is given moderate Aboriginal value, based mainly on the expressed value of the community regarding the site's educational value to the Aboriginal community.
7.3 ISOLATED ARTIFACT FINDS

One isolated artifact, given field name GL-1F-2, was recorded during the current survey, at grid reference 649150E 6124561N (Figure 4). The reason the isolated artifact was recorded as site number (2) was because a previously recorded site, originally recorded as an isolated artifact (GL-1F-1), upon further investigation was found to be an open campsite rather than an isolated artifact find (containing >2 artifacts within 50 m. of each other).

Isolated artifact find GL-1F-2 was located on the elevated banks of an ephemeral creek, approximately 350 m. east of 'Glenn Lee' homestead, on the opposite side of the creek (Figure 4). The isolated artifact, a grey-brown sandstone lower millstone, measuring 170 mm. x 100 mm. x 50 mm, was found partially undulating alluvial creek flat.

8.6 DISCUSSION

The observed pattern of Aboriginal site distribution across the study area is consistent with that predicted for the region, with the greatest number of sites recorded along the banks of seasonally reliable water courses, in this case two ephemeral creeks:

Sites types located and recorded during the current archaeological investigation also correspond with Aboriginal settlement patterns described in the early European settlement history of the district, and reflect a pattern of relatively long-term occupation. The evidence of past Aboriginal occupation over the study area is also consistent with that predicted in this report for all landform units within the study area, with the greatest evidence of occupation found to occur within 1 kilometre (in this case just outside the 1 kilometre zone), of the Macquarie River.

With regard to the availability of stone resources within the survey area, it appears that the study area contains no anomalies in resource materials, apart from water. Whilst past Aboriginal peoples would have found the plant and animal species of the locality to be significant resources, there was no evidence located during the archaeological survey to confirm that dacite stone material deposits were exploited by past local Aboriginal peoples (bearing in mind the coarse nature of the materials, and its unsuitability for stone artefact manufacture).

The stone artefact assemblages observed during the study indicated that water worn river pebbles provided a significant stone material source to past Aboriginal people in the locality, with approximately 33% of all stone artefacts recorded during the survey (including fire heath material) containing water worn cortex. There is an assumption, based on the close proximity of the Macquarie and Talbragar Rivers to the study area, that river worn stone material was gathered from either of these two local rivers; however, further investigation is warranted to determine if indeed the Macquarie River and/or the Talbragar River did provide this particular important resource material or whether the material was procured from an alternative source, i.e. locally exposed alluvial sand deposits associated with past geological formations in the area or river sources (other than local rivers) and located some distance away.
Stone artefact assemblages observed within the study area are similar to those observed at other sites in the Dubbo area (i.e. at the site of the proposed Tallyagra River – Troy Sewage works extensions), with large quantities of proportions of quartz, chert, and quartzitic flaked stone artefacts present at all sites in the current study area. Also noticeable from the results of the current “Glenlee” study, is the presence of many large stone flakes, many of which appear to be unmodified, primary flakes. This may reflect an abundance of stone material and the minimal reduction of stone material to produce suitable stone tools, or else the loss of more identifiable stone tool types from the sites as a result of geomorphological processes or past artefact collection. In addition, very few identifiable flaked stone tools fitting a specific manufactured tool type or regional sequence (McCarthy 1976:04-05) were observed during the study. No artefact showed definite use wear, and very few indicated evidence of secondary flaking or retouch.

A total absence of stone axes and stone seed grinding millstones at sites during the current study may indicate the sorting of artefacts from the sites by past artefact collectors, and in fact Gresser (c. 1941) referred to large collections of artefacts which he and others had removed from sites in the locality. Some of the material collected by Gresser is known to be located in the Australian Museum in Sydney, and the location of that material, depending upon the representativeness of Gresser’s collecting, may provide a more comprehensive insight into the stone artefact assemblages of past Aboriginal people in the Dubbo area.

The presence of a single, broken, sandstone clypeus (McCarthy 1976:60) was interesting, particularly because the consultant had not found similar artefacts located so far east from the region which they are commonly associated, e.g. the Darling River region, etc.

With regard to significance assessment of sites recorded during the “Glenlee” study, no sites are considered to be scientifically significant, however, if sub-surface investigation revealed relatively undisturbed archaeological material, then a revision of the site significance would need to occur.

Whilst the scientific value of sites is considered low, the educational value of the suite of sites along both ephemeris creek lines is considered to have slightly raised value as an educational resource, to both the Aboriginal and non-Aboriginal communities, and considering the type of development proposed over the “Glenlee” survey area (tourism oriented) the sites may have value to certain sections of the community, as tourism resources (although an consideration of this aspect of exploitation should occur without first conducting proper consultation with NPWS and the local Aboriginal community).

Generally, the sites offer enhancement to the proposed development, and should be considered in that light. Developments of this nature, can generally accommodate the undisturbed presence (where at all possible) of archaeological sites.
9.0 CONCLUSIONS

All sites recorded during the "Glenelg" survey appear to be typical of others located in the local area, with one exception, that they occur along the banks of ephemeral drainage courses. Until this survey, these landscape features would not have been considered archaeologically sensitive, or at least, where occupation evidence occurred, that it would have been expected to reflect extremely short term occupation levels, and not to the extent which was found during the current study and especially that observed in the case of GL-O-1. Although the open cairnsites recorded during the survey may have some potential for scientific assessment using sub-surface investigation, that value is not known at this stage, and therefore, significance of sites is assessed accordingly.

According to the development plan, the proposed development should not impact directly upon recorded sites, although slight adjustment may be necessary in several instances where the boundaries of proposed development overlap slightly over archaeologically sensitive areas, i.e. proposed neighbourhood Lots 2, 3, and residential Lots 12, 13, 14, and 15. Further archaeological investigation in the form of sub-surface testing is recommended. To ensure that development does not impact upon any sites, a buffer zone of 50 metres along both sides of all ephemeral creek lines located within the survey area (incorporating recorded sites and an allowance for archaeologically sensitive areas) has been recommended by the archaeologist. A variation to this recommendation occurs along the banks of the ephemeral drainageline located near Morisc Park, Speedwell, in the eastern half of the proposed development. At this location, due to the existing landform, it is considered that a buffer zone of 30 metres along either side of the creek is adequate and will ensure that development does not impact upon any identified sites, and, in such areas, extends beyond 50 metres.

Note: Variation to the buffer zones occurs over areas where sensitivity is believed to extend beyond 30 metres (see Figure 3). These areas include elevated alluvial terraces found adjacent to existing alluvial flats and drainage lines.

The provision of buffer zones and archaeologically sensitive areas as indicated by hatched in areas in Figure 3 of the report are not meant to be disruptive to the development proposals, but to signal a warning that either known sites occur over the area, or that another occurs in an area. The sensitivity assessment over the areas identified as elevated alluvial terraces and deposits to exist, and that further assessment is warranted prior to any development occurring over areas identified as sensitive.

Identified sensitive areas in Figure 3 tend to correspond with existing landform, i.e. alluvial creek flats and associated alluvial and colluvial terraces. For example, the areas identified by the developer as Lots 2 & 3 (proposed), located adjacent to Camp Road, have two distinct landform units, including alluvial creek banks and adjacent flats, and an area of elevated alluvial terrace. The sensitivity assessment over these lots is intended to extend over the alluvial creek flats, but not the elevated terrace area which immediately adjoins Camp Road. The identified sensitive area over proposed Lot 2, comprising elevated alluvial and colluvial terraces does not include the existing "Glenelg" farm complex area comprising sheds, yards and houses, this
area is considered to have very little archaeological potential due to past surface and sub-surface disturbance. With regard to Lot 1, the eastern half of this Lot is considered archaeologically sensitive, however, the developer has indicated that as a result of the field survey and discussion with the archaeologist, that no impact over sensitive areas will occur.

A concern was raised by the project officer from Hoynes Wheeler & Thorne Pty. Ltd. regarding the possible need, in the future, to impact upon archaeologically sensitive areas for the construction of services to the proposed development and additional stormwater diversion drains and settlement dams. Because no specific plans had been developed for these additional works within the proposed development, no assessment could be conducted as to the potential impact upon the archaeological record from these activities. However, if it must be stressed that where future plans are developed for such works, and there occurs a potential for such further development to impact upon areas assessed to be archaeologically sensitive, then a need will occur for further archaeological assessment, probably, in the form of subsurface archaeological investigations.

With regard to impact over archaeologically sensitive areas, whilst it is desirable to avoid archaeological sites, mainly because they are a non-renewable resource (protected by the NPW Act 1974), where the developer finds that impact is necessary, the developer will be required to satisfy the National Parks and Wildlife Service (and the Consent Authority under the Environmental Planning and Assessment Act 1979) that no impact will occur, not only to surface deposits, but also to sub-surface archaeological deposits, (without first establishing whether such deposits occur, particularly over sensitive areas). The significance of potential sub-surface sites should be assessed in the same way that surface deposits are assessed. This assessment would assist in determining whether destruction of sites should be allowed to occur or not; destruction of sites would occur in the form of a Consent to Destroy (which, when considered appropriate, would be issued by the Director of National Parks and Wildlife Service).

Note: With further regard to the management of areas assessed to be sensitive, where sub-surface investigation is conducted and reveals that no sub-surface material exists, then the level of sensitivity afforded to these areas should be re-assessed, and re-defined as low in sensitivity. Despite a change in sensitivity status, monitoring of development-related excavations over areas previously assessed to be sensitive should be conducted. This would provide an additional safeguard for previously undetected archaeological deposits, and allow for proper management, particularly where the Land Council has requested salvage of surface stone material.

The developer has indicated that as a result of the archaeological survey and subsequent sensitivity assessment, a general policy of avoidance of sites will occur, and that development will not occur over sensitive landform.
10.0 SITE MANAGEMENT RECOMMENDATIONS

The consultant believes that because archaeological sites, and in particular Aboriginal archaeological relics, are a non-renewable resource, then where possible, sites should not be disturbed (irrespective of significance assessment).

The following recommendations have been developed for sites recorded during the current "Glenn Lee" archaeological survey:

10.1 Recommendation 1.

There is no archaeological or anthropological reason why the proposed development should not proceed, provided the developer complies with their obligations under the NPW Act 1974, with regard to the protection of archaeological relics within the "Glenn Lee" study area.

If a Consent is granted by the Director for National Parks, for the disturbance of sites, then that Consent should only be given provided certain management conditions are incorporated into that consent.

In order for the developer to comply with the requirements of the Act and to ensure appropriate management for sites recorded during the "Glenn Lee" survey, the following recommendations have been developed.

10.2 Recommendation 2.

If at all technically possible, total avoidance of all Aboriginal sites should occur. This would require the development of protected, conservation or buffer zones around all archaeological sites.

10.3 Recommendation 3.

It is recommended that a general 50 metre buffer zone be established along all ephemeral creeklines located within the survey area (both sides of sensitive creek lines) (Figure 3), except where stated in Section 9.0. A sensitive area zone, incorporating a buffer zone, is designed to provide protection of all recorded sites and areas assessed to be archaeologically sensitive.

10.4 Recommendation 4.

It is recommended that additional sensitive areas and buffer zone areas (identified in Figure 3) also be avoided during potential development.
10.3.1 Recommendation 5. (Sub-surface Relics)

It is recommended that no impact should occur to identified sensitive areas without first conducting further archaeological investigation in the form of sub-surface testing (i.e. excavated test trenches) to establish whether sub-surface relics occur and, if so, the extent and significance of such deposits. Such investigation should be conducted by a qualified archaeologist, and include appropriate local Aboriginal community involvement.

10.5.2

At the completion of any sub-surface investigation (where initiated) and if no sites are present, development can then proceed, however, as an added precaution, monitoring of earthworks over such areas should still occur (preferably by an archaeologist or Aboriginal community representative with appropriate archaeological site identification skills).

10.5.3

In addition to the above, where sub-surface investigation reveals the absence of sub-surface deposits, subsequent sensitivity reassessment should occur, with a downgrading of sensitivity assessment to low sensitivity over sub-surface areas found to be "sterile".

10.5.4

Should relics be uncovered during monitored earthworks, work should immediately cease at the location, and NPWS should be contacted for further direction.

10.5.5

Should relics be uncovered during sub-surface investigations, appropriate documentation of such material should occur, including stone tools analysis and possible dating, to be followed by further significance assessment of such deposits (should they occur).

10.5.6

Should sub-surface relics occur as a result of sub-surface investigation over sensitive areas, and the developer finds the impact is still the only option over such areas, the developer will be required to apply for a Consent to Destroy (including both surface and sub-surface deposits) from the Director of NPWS.

10.5.7

Where no sub-surface relics occur as a result of sub-surface investigation, and the developer finds that impact is still necessary over surface deposits recorded by during the field survey, a Consent to Destroy will be required from the Director.
10.6 Recommendation 6.

Where avoidance of sites is an option, and where sites occur as isolates, it is recommended that 25 metre buffer zones be established around the identified site boundaries (identified in the report and possibly by subsequent on site identification by the archaeologist). In the case of scarred tree sites, that will mean a protected area of 25 metres radius from the tree trunk.

10.7 Recommendation 7.

Should the proposed development proceed, and where the developer feels that there are no alternatives but to impact sites, application will have to be made to the Director of National Parks and Wildlife Service, for Consent to Destroy.

10.8 Recommendation 8.

Where a Consent is required, consideration should be made by the local Aboriginal community (to be contacted by the developer) for an application for a Permit to Salvage Artefacts to be incorporated into any Consent applications made to the Director.

10.9 Recommendation 9.

For the duration of development earthworks and clearing, all sites and archaeologically sensitive landform units should be identified using either temporary fencing or flagging.

10.10 Recommendation 10.

All contractors working within the development site should be made aware by the developer, in writing, of the presence of sites, site locations, and individual contractor’s obligations under the NPW Act, 1974. A copy of such correspondence (from the developer) should be forwarded to the Regional Archaeologist, NSW NPWS Zone Office, 54 Wingewarra Street, Dubbo, NSW 2830.

10.11 Recommendation 11.

Additional archaeological investigation, where found to be necessary, shall be conducted by an archaeologist, and should involve local Aboriginal Land Council involvement.
10.12 Recommendation 12:

Where impact upon sites has been found to be necessary and a Consent to Destroy has been granted, as part of the Consent, it is recommended that all relics to be impacted should be further documented by an archaeologist and involvement of the local Aboriginal community should occur where possible. It is anticipated that this level of assessment would require a level of rapid, sub-surface investigation which could be conducted in conjunction with development related earthworks, using a blade skimming process over the surface, and appropriate documentation.

10.13 Recommendation 13:

The granting of a Permit to Salvage by the Aboriginal community will depend upon the Director being satisfied that the Aboriginal community has appropriate storage facilities for the storage/display of salvaged artefacts, and will require consultation between the Director, the Aboriginal community and Australian Museum in Sydney (the designated State repository for the collection of all salvaged Aboriginal artefacts).

11.0 LEGAL REQUIREMENTS AND OBLIGATIONS

All Aboriginal relics (sites and objects), other than those made for sale, are protected under the New South Wales National Parks and Wildlife Service Act 1967 (amended 1974). Aboriginal archaeological sites are a non-renewable resource valued for the information they can provide on the lifestyles of Aboriginal people in the past, and are also valued by some Aboriginal communities who have maintained cultural links with specific sites in their country.

It is illegal to damage or destroy a site or relic without the prior consent of the Director of NSW NPWS. Any such disturbance requires a permit from the Director. The Act requires that relics recovered under such a permit come under the custody of the Australian Museum in Sydney.

In order for Aboriginal communities to have access to their cultural material recovered during development disturbance or surveys, they must first obtain the consent of the Director.

Should evidence of unrecorded sub-surface archaeological deposits be uncovered as a result of development activities, the Developer is reminded of their obligation under the above mentioned Act and should cease work at that particular location immediately. Should archaeological material be uncovered during development earthworks, District Zone Offices of the NPWS should be notified immediately of the discovery of any material.
REFERENCES


References (Cont'd):


Personal Communications


<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artifact</td>
<td>Any object made by human agency.</td>
</tr>
<tr>
<td>Assemblage</td>
<td>A range of artefacts found in close association with each other.</td>
</tr>
<tr>
<td>Backed blade</td>
<td>A stone artefact, blade shaped, with one margin deliberately trimmed to provide an edge where pressure could be applied to the opposite, cutting edge.</td>
</tr>
<tr>
<td>Basalt</td>
<td>A fine grained, often porphyritic, darkly coloured, igneous rock.</td>
</tr>
<tr>
<td>Blade</td>
<td>Parallel sided flake, approximately twice as long as wide.</td>
</tr>
<tr>
<td>Bora ground</td>
<td>A ceremonial ground generally consisting of one or two earth-banked circles, and often connected by a 'pathway'.</td>
</tr>
<tr>
<td>Chert</td>
<td>A fine grained, crystalline aggregate of silica.</td>
</tr>
<tr>
<td>Compaction</td>
<td>A term used in this report to identify the possible accumulation of once stratified archaeological deposits, the evidence of isolated occupation events (often isolated in time and place), into one large deposit at a single level, with no stratigraphy present due to erosion of the surface strata and subsequent occupation matrix below each deposit. What can occur, is the accumulation of archaeological evidence of many thousands of years of occupation once separated by sand or soil deposits, dropping down to a bench layer and forming into a misleadingly single large site artefact scatter site.</td>
</tr>
<tr>
<td>Conchoidal fracture</td>
<td>Shell-like, bulbous and curved rippled zone resulting from fracture of certain rock types.</td>
</tr>
<tr>
<td>Core</td>
<td>A slab of stone from which flakes of stone have been removed.</td>
</tr>
<tr>
<td>Core tool</td>
<td>A core with evidence of trimming and/ or use wear, indicating its use as an implement.</td>
</tr>
<tr>
<td>Debitage</td>
<td>Discarded flaked stone material, often showing no evidence of flaking, but associated with the flaking operation.</td>
</tr>
<tr>
<td>Flake</td>
<td>A piece of stone detached from another stone; usually removed from the core using another stone.</td>
</tr>
</tbody>
</table>
Glossary of Terms (Cont'd)

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geomorphology</td>
<td>Study of the form of the earth's surface.</td>
</tr>
<tr>
<td>Gneiss</td>
<td>A metamorphic medium to coarse grained rock, characterised by mineral banding.</td>
</tr>
<tr>
<td>Hammerstone</td>
<td>Stone implement used to produce other stone tools and grind plant materials.</td>
</tr>
<tr>
<td>Hearth</td>
<td>Site of a campfire. Usually indicated by presence of charcoal, burnt earth, discoloration, organic material, or stone.</td>
</tr>
<tr>
<td>Holocene</td>
<td>comparatively recent geological time, over past 10,000 years.</td>
</tr>
<tr>
<td>Jasper</td>
<td>An impure opaque silica, commonly red in colour due to the presence of iron oxides in silica.</td>
</tr>
<tr>
<td>Midden</td>
<td>An Aboriginal refuse site.</td>
</tr>
<tr>
<td>Millstone</td>
<td>Stone artefact used for grinding seeds, fruits, foodstuffs and sometimes bone and ochre.</td>
</tr>
<tr>
<td>Open campsite</td>
<td>A surface scatter of artefacts; usually stone.</td>
</tr>
<tr>
<td>Pleistocene</td>
<td>Glacial epoch preceding Holocene, to approximately 2 million years.</td>
</tr>
<tr>
<td>Quartz</td>
<td>A rock material consisting of crystalline silica SiO₂, usually white in colour.</td>
</tr>
<tr>
<td>Quartzite</td>
<td>Metamorphosed sandstone.</td>
</tr>
<tr>
<td>Retouch</td>
<td>Trimming of an artefact; usually stone, after it was detached from its core.</td>
</tr>
<tr>
<td>Sandstone</td>
<td>Compacted and cemented sedimentary rocks consisting essentially of rounded grains of sand.</td>
</tr>
<tr>
<td>Silcrete</td>
<td>A poorly defined metamorphic (?) rock of generally fine, grainy siliconic nature occurring as a silica replacement.</td>
</tr>
<tr>
<td>Scraper</td>
<td>Stone tool manufactured from a flake and often with one or more working edges.</td>
</tr>
</tbody>
</table>
### Glossary of Terms (Cont'd)

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stratigraphy</strong></td>
<td>Superimposed layering of deposits, with older material overlain by later deposits.</td>
</tr>
<tr>
<td><strong>Striking platform</strong></td>
<td>Area on a core where a flake is detached. The detached flake carries a section of the core’s striking platform on the butt end.</td>
</tr>
<tr>
<td><strong>Use wear</strong></td>
<td>Worn or smooth area produced on the working edge of an implement resulting from the use of the implement.</td>
</tr>
</tbody>
</table>
Plate 1: View of survey area landform / vegetation from western high ground looking east.

Plate 2: View of the survey area’s central / eastern high ground looking east.
Plate 3: View of "Glenn Lee" farm house complex looking east from open campsite GL-OS-6.

Plate 4: View of pool near "Glenn Lee" house complex on ephemeral drainage line, looking south towards open campsite GL-OS-1.
Plate 5: A view of landform/vegetation along ephemeral drainage line in western half of survey area (at location of open campsite Gl-OS-1), looking north towards “Glenn Lee” homestead.

Plate 6: View of open campsite Gl-OS-1 along the banks of an ephemeral drainage line, looking north towards “Glenn Lee” house.
Plate 7: View of eroded, exposed surface of open campsite GL-OS-1 looking south from a point near the banks of an ephemeral drainage line, immediately south of "Glenn Lee" house and farm complex.

Plate 8: Example of pink-grey quartzite core from open campsite GL-OS-1.
Plate 9: Photo of quartz flaked stone material observed at open campsite GL-OS-1.

Plate 10: Photo of river pebble, manoport from open campsite GL-OS-1.
Plate 11: Photo of termite nest hearth stone from open campsite GL-OS-1.

Plate 12: Photo of a 'mudstone' core from open campsite GL-OS-1.
Plate 13: View of open campsite GL-OS-2 looking east along southern bank of an ephemeral drainage line, between "Glenn Lee" and "Glenmore" houses.

Plate 14: View of open campsite GL-OS-3 looking south across ephemeral drainage line. Note gully erosion along southern edge of creek bank.
Plate 15: View of open campsite GL-OS-4, looking north along eastern bank of ephemeral drainage near Morris Park Speedway and Obley Road.

Plate 16: Broken quartzite point located at open campsite GL-OS-4.
Plate 17. Example of typical quartz material found at open campsite GL-OS-4, typical of material found at all "Glenn Lee" sites.

Plate 18. View of open campsite GL-OS-5 looking south towards Morris Park Speedway.
Plate 19: View of open campsite GL-OS-7 looking east towards ephemeral drainage line in western section of survey area, and open campsite GL-OS-1 on opposite bank of creek.

Plate 20: Example of quartzite or indurated "mudstone" core from open campsite GL-OS-7.
Plate 21: View of open campsite GL-OS-8 looking south towards ephemeral drainage line and survey area central / eastern highground.

Plate 23: View of scarred tree site GI-ST-2 looking south towards survey area southern boundary fence.

Plate 24: View of trig station located near survey area’s western boundary.
APPENDIX 1

COPY OF STATEMENT OF INVOLVEMENT IN THE "GLENN LEE" ARCHAEOLOGICAL SURVEY BY CENTRAL REGION ABORIGINAL LAND COUNCIL.
J. Kelton
CENTRAL WEST ARCHAEOLOGICAL AND HERITAGE SERVICES,
92 DARLING ST.
COWRA NSW 2794

2 NOVEMBER 1995

TO WHOM IT MAY CONCERN

This letter is to verify that this office was consulted by Mr. Jim Kelton, of Central West Archaeological & Heritage Services, on the archaeological survey on the property "Gilg Lee" Dubbo.

I personally participated in this survey, both on site and post/pre consultations, on behalf of Central Region Aboriginal Land Council, as this site is within this Council's area.

At the completion of the survey, Jim provided a brief summary of the survey and we discussed future options.

Yours in unity

[Signature]

CECEL SER.
BRANCH MANAGER

[Office Address]

[Phone Number]

[Fax Number]
APPENDIX 2

GAZETTEER OF PREVIOUSLY RECORDED SITES
(NPWS RECORDS)
### Gazetteer of Previously Recorded Sites

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Location</th>
<th>Date Recorded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1</td>
<td>Site 2</td>
<td>2021-01-01</td>
</tr>
<tr>
<td>Site 3</td>
<td>Site 4</td>
<td>2021-01-02</td>
</tr>
<tr>
<td>Site 5</td>
<td>Site 6</td>
<td>2021-01-03</td>
</tr>
<tr>
<td>Site 7</td>
<td>Site 8</td>
<td>2021-01-04</td>
</tr>
<tr>
<td>Site 9</td>
<td>Site 10</td>
<td>2021-01-05</td>
</tr>
</tbody>
</table>

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**Appendix 2**

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**Appendix 3**

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**Appendix 4**

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**Appendix 5**

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**Appendix 6**

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**Appendix 7**

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**Appendix 8**

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**Appendix 9**

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**Appendix 10**

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APPENDIX 3

GAZETTEER OF SITES RECORDED DURING THE "GLENN LEE" ARCHAEOLOGICAL SURVEY
### Gazetteer of Sites Recorded During The "Glenn Lee" Archaeological Survey

<table>
<thead>
<tr>
<th>Site Field Name</th>
<th>AMG Co-ordinates</th>
<th>Site Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-OS-1</td>
<td>640250  6425510</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-2</td>
<td>640610  6425490</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-3</td>
<td>640610  6425580</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-4</td>
<td>650130  6434930</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-5</td>
<td>650080  6424870</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-6</td>
<td>648870  6425260</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-7</td>
<td>649120  6425760</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-8</td>
<td>649120  6425740</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-ST-1</td>
<td>649065  6425392</td>
<td>Scarred Tree</td>
</tr>
<tr>
<td>GL-ST-2</td>
<td>649156  6425392</td>
<td>Scarred Tree</td>
</tr>
<tr>
<td>GL-LF-1</td>
<td>649450  6425600</td>
<td>Isolated Artefact</td>
</tr>
</tbody>
</table>
APPENDIX 4

SUMMARY DETAILS OF OPEN CAMPSITES - ISOLATED
ARTEFACT FINDS LOCATED DURING "GLENN LEE"
ARCHAEOLOGICAL SURVEY.
### Appendix 4

**SUMMARY DETAILS OF OPEN CAMPSITES & ISOLATED ARTIFACT FINDS RECORDED DURING "GLENN LEE" ARCHAEOLOGICAL SURVEY**

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Site Type</th>
<th>Grid Ref.</th>
<th>Landform Unit</th>
<th>Site Dimensions (m²)</th>
<th>Site Boundary</th>
<th>Surface Visibility (%)</th>
<th>Contents</th>
<th>Artifacts density (max/m²)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-OS-1</td>
<td>Open Campsite</td>
<td>849580, 8425512</td>
<td>J</td>
<td>500m x 20m (10,000 m²)</td>
<td>Visible artefacts</td>
<td>70%</td>
<td>&gt;100 stone artefacts including quartz, quartzite, chert, flaked stone artefacts and sandstone and terracotta hearth stones; small sandstone boulder artefact</td>
<td>21 m²</td>
<td>Site disturbed by cultivation, grading, track, fencing, vehicle track, sheet and gully erosion. Potential for sub-surface deposits.</td>
</tr>
<tr>
<td>GL-OS-2</td>
<td>Open Campsite</td>
<td>849610, 8425408</td>
<td>J</td>
<td>20 m x 2.5 m (100 m²)</td>
<td>Visible artefacts</td>
<td>90%</td>
<td>Total of 7 stone artefacts observed on surface, including 1 flake, 1 hammerstone, 1 millstone, 1 mace head, 1 pebble, 1 piece of diabasite and a single sandstone hearthstone. Material consisting of quartz, quartzite, sandstone.</td>
<td>17 m²</td>
<td>Heavily disturbed site due to gully erosion. Probably more extensive than visible artefacts indicate. Potential for sub-surface investigation along southern edge.</td>
</tr>
<tr>
<td>GL-OS-3</td>
<td>Open Campsite</td>
<td>849610, 8425580</td>
<td>J</td>
<td>20 m x 20 m (400 m²)</td>
<td>Visible artefacts</td>
<td>70%</td>
<td>Total of 3 river pebble stone artefacts recorded. However, this was only a representative sample with an estimated 20 similar river pebbles located upon the surface at the site. Raw material mainly quartzite.</td>
<td>41 m²</td>
<td>Surface visibility 70% over main artefacts. Exposure. Site has been subject to extensive surface disturbance over adjacent areas. Site has been subject to extensive surface disturbance.</td>
</tr>
</tbody>
</table>

Key to Landform Units:
1. Episodical drainage lines and associated alluvial terraces
2. Lower hill slopes
3. Upper hill slope and elevated hill tops
4. Ridge tops
<table>
<thead>
<tr>
<th>Site No.</th>
<th>Site Type</th>
<th>Site Name</th>
<th>Site Location</th>
<th>Site Area (ha)</th>
<th>Site Area (sq m)</th>
<th>Site Area (sq ft)</th>
<th>Site Area (sq yd)</th>
<th>Site Area (sq km)</th>
<th>Site Area (sq mi)</th>
</tr>
</thead>
</table>
## Appendix 4

### SUMMARY DETAILS OF OPEN CAMPSITES & ISOLATED ARTEFACT FINDSRecorded During "Glen Lake" Archaeological Survey (Cont’d)

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Site Type</th>
<th>Grid Ref.</th>
<th>Landform Unit</th>
<th>Site Dimensions (m²)</th>
<th>Site Boundary (%)</th>
<th>Contents</th>
<th>Artefact Density (max/m²)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-OS-6</td>
<td>Open Campsite</td>
<td>849220</td>
<td>64500</td>
<td>3m x 3m (9m²)</td>
<td>20%</td>
<td>Total of 3 stone artefacts observed and recorded on site surface, however, it is felt that more intensive search would locate more artefacts. Artefacts include a broken millstone, a flaked piece, and 1 producer core. The dominant stone material was quartzite (100%).</td>
<td>0.1m</td>
<td>Surface visibility good, approx. 70%. Site subject to surface disturbance from crop cultivation and grazing stock; however, due to landform and considered geomorphic processes, there is potential for sub-surface deposits to occur.</td>
</tr>
<tr>
<td>GL-OS-7</td>
<td>Open Campsite</td>
<td>849385</td>
<td>64500</td>
<td>20 m x 20 m (400m²)</td>
<td>50%</td>
<td>Total of 3 stone artefacts observed and recorded on site surface, including 1 biface core, 1 chert flake, and 1 obsidian core (producer)</td>
<td>0.45m</td>
<td>Site surface disturbed by cultivation and grazing stock. Possible scoured trend indicated on eastern edge of site.</td>
</tr>
<tr>
<td>GL-OS-8</td>
<td>Open Campsite</td>
<td>849545</td>
<td>64500</td>
<td>30 m x 30 m (900m²)</td>
<td>20-90%</td>
<td>Total of 6 stone artefacts recorded at site, including 2 chert cores (producers), a chert flake and a single quartzite flake, and 1 pebble</td>
<td>0.15m</td>
<td>Site originally recorded as an isolated artefact but later changed its campsite with more stone artefacts recorded. Site heavily disturbed by crops, cultivation and grazing stock.</td>
</tr>
</tbody>
</table>

Key to Landform Units: 1. Ephemeral drainage lines and associated alluvial terraces. 2. Lower hill slopes. 3. Upper hill slopes, and elevated hill tops and ridge lines.
### Appendix 4

**Summary Details of Open Campsites & Isolated Artefact Finds Recorded During "Glenn Lea", Archaological Survey (Cont'd)**

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Site Type</th>
<th>Grid Ref (Easting / Northing)</th>
<th>Landform Unit</th>
<th>Site Dimensions (m²) (approx)</th>
<th>Site Boundary</th>
<th>Surface Visibility (%)</th>
<th>Contents</th>
<th>Artifact Density (max. m²)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLCF-2</td>
<td>Isolated artefact</td>
<td>646450 / 642900</td>
<td>1</td>
<td>20%</td>
<td>A single lower millstone, sandstone, bifacial</td>
<td>Located on creek bank at location, similar to all open campfires</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key to Landform Units: 1 - ephemeral drainage lines and associated alluvial terraces; 2 - Lower Hill Slopes; 3 - Upper hill slopes and elevated hill tops and ridge lines.
APPENDIX 5

SUMMARY DETAILS OF STONE ARTEFACTS
RECORDED DURING THE "GLENN LEE"
ARCHAEOLOGICAL SURVEY
## APPENDIX 5

**SUMMARY DETAILS OF STONE ARTIFACTS FROM OPEN CAMPSITES & ISOLATED ARTIFACT FINDS RECORDED DURING "GLEN LEE" ARCHAEOLOGICAL SURVEY**

<table>
<thead>
<tr>
<th>Site</th>
<th>Artfact Type</th>
<th>Raw Material</th>
<th>Colour</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thick. (mm)</th>
<th>Cortex</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL+OS-1</td>
<td>Flake</td>
<td>Chert</td>
<td>Grey</td>
<td>13</td>
<td>18</td>
<td>5</td>
<td>NIL</td>
<td>Platform (heand), bulb, core base</td>
</tr>
<tr>
<td></td>
<td>Flake</td>
<td>Chert</td>
<td>Grey-green</td>
<td>31</td>
<td>19</td>
<td>9</td>
<td>NIL</td>
<td>Platform, bipolar, long, flake scar</td>
</tr>
<tr>
<td></td>
<td>Flake (scraper)</td>
<td>Quartz</td>
<td>Flakes brown</td>
<td>19</td>
<td>17</td>
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<td>Grey</td>
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<td>87</td>
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**Legend:** Neg. - Negative Flake Scar; WW - Cortex, river scar; Cor. - Cordill origin
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### APPENDIX 5

**Summary Details of Stone Artefacts from Open Campsites & Isolated Artefact Finds Recorded During "Glenn Lee" Archaeological Survey (Cont'd)**

<table>
<thead>
<tr>
<th>Site</th>
<th>Artifact Type</th>
<th>Raw Material</th>
<th>Colour</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thick. (mm)</th>
<th>Cortex</th>
<th>Comments</th>
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<tbody>
<tr>
<td>GL-OS-1</td>
<td>Hearth stone</td>
<td>Mudstone</td>
<td>Red-brown</td>
<td>150</td>
<td>130</td>
<td>55</td>
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<td>75</td>
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<td>Red-brown</td>
<td>140</td>
<td>410</td>
<td>50</td>
<td></td>
<td>Burst stone</td>
</tr>
<tr>
<td></td>
<td>Hearth stone</td>
<td>Tufa (white)</td>
<td>Red-brown</td>
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<td>80</td>
<td>60</td>
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<td>Burst (white)</td>
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<td>Milky white</td>
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<td>11</td>
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<td>2 mm, flake scar</td>
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<td>Quartz</td>
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<td>Milky white</td>
<td>20</td>
<td>22</td>
<td>9</td>
<td>2%</td>
<td>Platform (broad), butt,</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>ring crack, hinge</td>
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<td>Quartz</td>
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<td>Milky white</td>
<td>29</td>
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<td>10</td>
<td>3</td>
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<td>Platform (local), butt</td>
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## Appendix 5

### Summary Details of Stone Artefacts from Open Campsites & Isolated Artefact Finds Recorded during "Glenn Laker" Archaeological Survey (Cont'd)

<table>
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<tr>
<th>Site</th>
<th>Artifact Type</th>
<th>Raw Material</th>
<th>Colour</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thick (mm)</th>
<th>Core</th>
<th>Comment</th>
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<tbody>
<tr>
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<td>10</td>
<td>20%</td>
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<td>5</td>
<td>50%</td>
<td>WW</td>
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<td>4</td>
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<td>20</td>
<td>14</td>
<td>5</td>
<td>50%</td>
<td>WW</td>
</tr>
<tr>
<td></td>
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<td>Quartz</td>
<td>Milky white</td>
<td>15</td>
<td>11</td>
<td>5</td>
<td>50%</td>
<td>WW</td>
</tr>
<tr>
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<td>Quartz</td>
<td>Milky white</td>
<td>21</td>
<td>11</td>
<td>5</td>
<td>50%</td>
<td>WW</td>
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<td>14</td>
<td>5</td>
<td>50%</td>
<td>WW</td>
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<td>21</td>
<td>10</td>
<td>5</td>
<td>50%</td>
<td>WW</td>
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<tr>
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<td>Debitage</td>
<td>Quartz</td>
<td>Milky white</td>
<td>19</td>
<td>12</td>
<td>5</td>
<td>50%</td>
<td>WW</td>
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<tr>
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<td>Milky white</td>
<td>15</td>
<td>12</td>
<td>5</td>
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<td>WW</td>
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### APPENDIX 5

**Summary Details of Stone Artefacts from Open Campsites & Isolated Artefact Finds Recorded During: Glenn Lee Archaeological Survey (Cont'd)**

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<th>Width (mm)</th>
<th>Thick. (mm)</th>
<th>Cortex</th>
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<td>3</td>
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<tr>
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<td>Quartz</td>
<td>Milky white</td>
<td>15</td>
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<td>*</td>
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<tr>
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<tr>
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<td>Quartz</td>
<td>Milky white</td>
<td>19</td>
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<tr>
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<td>Quartz</td>
<td>Milky white</td>
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<tr>
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<td>Quartz</td>
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<td>23</td>
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<td>Broken, proximal section (compares with several, mid-section fractured)</td>
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<tr>
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<td>Sandstone</td>
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<td>Broken, mid-section, compares with located proximal section, distal section missing</td>
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<td>70</td>
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### Appendix 5

**Summary Details of Stone Artefacts from Open Campsites & Isolated Artefact Finds Recorded During “Glenn Lee” Archaeological Survey (Cont’d)**

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<th>Width (mm)</th>
<th>Thick (mm)</th>
<th>Cortex</th>
<th>Comments</th>
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<td>Red-brown</td>
<td>25</td>
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<td>10</td>
<td>30%</td>
<td>Blunt</td>
</tr>
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<td>Chert</td>
<td>Red-brown</td>
<td>35</td>
<td>24</td>
<td>12</td>
<td>40%</td>
<td>Blunt, 1 seg. flake scar</td>
</tr>
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<td>Chert</td>
<td>Red-brown</td>
<td>35</td>
<td>24</td>
<td>12</td>
<td>40%</td>
<td>Blunt, 1 seg. flake scar</td>
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<tr>
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<td>Core</td>
<td>Chert</td>
<td>Dark brown</td>
<td>35</td>
<td>25</td>
<td>35</td>
<td>10%</td>
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<td>24</td>
<td>12</td>
<td>40%</td>
<td>Blunt, 1 seg. flake scar</td>
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<tr>
<td></td>
<td>Flaked piece</td>
<td>Quartz</td>
<td>Milky white</td>
<td>35</td>
<td>24</td>
<td>12</td>
<td>40%</td>
<td>Platform, 1 seg. flake scar</td>
</tr>
<tr>
<td></td>
<td>Flaked piece</td>
<td>Quartz</td>
<td>Milky white</td>
<td>34</td>
<td>28</td>
<td>13</td>
<td>40%</td>
<td>Platform, 1 seg. flake scar</td>
</tr>
<tr>
<td></td>
<td>Flaked piece</td>
<td>Quartz</td>
<td>Milky white</td>
<td>34</td>
<td>28</td>
<td>13</td>
<td>40%</td>
<td>Platform, 1 seg. flake scar</td>
</tr>
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<td>Chert</td>
<td>Grey-brown</td>
<td>35</td>
<td>24</td>
<td>12</td>
<td>40%</td>
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<td>40%</td>
<td>Broken, lacerated, 1 flake, milling surface</td>
</tr>
<tr>
<td></td>
<td>Hammerstone</td>
<td>Quartzite</td>
<td>Blue-grey</td>
<td>30</td>
<td>20</td>
<td>12</td>
<td>40%</td>
<td>River pebble, impact abrasion at one end</td>
</tr>
<tr>
<td></td>
<td>Hearth stone</td>
<td>Sandstone</td>
<td>Red-brown</td>
<td>35</td>
<td>24</td>
<td>12</td>
<td>40%</td>
<td>Blunt</td>
</tr>
<tr>
<td></td>
<td>Flaked piece</td>
<td>Quartz</td>
<td>Milky white</td>
<td>35</td>
<td>24</td>
<td>12</td>
<td>40%</td>
<td>Blunt, 1 seg. flake scar</td>
</tr>
<tr>
<td></td>
<td>Flaked piece</td>
<td>Quartz</td>
<td>Milky white</td>
<td>35</td>
<td>24</td>
<td>12</td>
<td>40%</td>
<td>Blunt, 1 seg. flake scar</td>
</tr>
</tbody>
</table>
**APPENDIX 5**

**SUMMARY DETAILS OF STONE ARTIFACTS FROM OPEN CAMPSITES & ISOLATED ARTIFACT FINDS RECORDED DURING "GLENELE" ARCHAEOLOGICAL SURVEY (Cont'd)**

<table>
<thead>
<tr>
<th>Site</th>
<th>Artifact Type</th>
<th>Raw Material</th>
<th>Colour</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thick. (mm)</th>
<th>Cortex</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-O3-2</td>
<td>Unmodified</td>
<td>River Pebble</td>
<td>Light brown</td>
<td>55</td>
<td>29</td>
<td>20</td>
<td>100% (WW)</td>
<td>River pebble, transport.</td>
</tr>
<tr>
<td></td>
<td>Flake</td>
<td>Silcrete</td>
<td>Light brown</td>
<td>20</td>
<td>14</td>
<td>3</td>
<td>Nil</td>
<td>Platform (local), built.</td>
</tr>
<tr>
<td></td>
<td>Debitage</td>
<td>Quartz</td>
<td>Milky white</td>
<td>11</td>
<td>9</td>
<td>8</td>
<td>Nil</td>
<td>—</td>
</tr>
<tr>
<td>GL-O3-3</td>
<td>Unmodified</td>
<td>River Pebble</td>
<td>Light brown</td>
<td>60</td>
<td>42</td>
<td>42</td>
<td>100% (WW)</td>
<td>River pebble, transport.</td>
</tr>
<tr>
<td>Upper</td>
<td>multivene</td>
<td>quartzite</td>
<td>Light brown</td>
<td>100</td>
<td>60</td>
<td>45</td>
<td>100% (WW)</td>
<td>River pebble, flat surface.</td>
</tr>
<tr>
<td>section</td>
<td>(muller)</td>
<td>quartzite</td>
<td>Grey</td>
<td>Not recorded</td>
<td>Not recorded</td>
<td>Not recorded</td>
<td>40% (WW)</td>
<td>River pebble, transport.</td>
</tr>
<tr>
<td>GL-O4-4</td>
<td>Flaked blade</td>
<td>Lithic</td>
<td>Pink, grey</td>
<td>54</td>
<td>15</td>
<td>8</td>
<td>Nil</td>
<td>One lateral margin backed and flake trimmed with secondary flake scars visible.</td>
</tr>
<tr>
<td></td>
<td>Flaked piece</td>
<td>Quartz</td>
<td>Milky white</td>
<td>40</td>
<td>35</td>
<td>18</td>
<td>50% (WW)</td>
<td>1 seg. Flake near.</td>
</tr>
<tr>
<td></td>
<td>Debitage</td>
<td>Quartz</td>
<td>Milky white</td>
<td>40</td>
<td>13</td>
<td>12</td>
<td>Nil</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Flake</td>
<td>Quartz</td>
<td>Milky white</td>
<td>24</td>
<td>12</td>
<td>4</td>
<td>Nil</td>
<td>Platform (local), built. 1 seg. Flake near.</td>
</tr>
<tr>
<td></td>
<td>Flake</td>
<td>Quartz</td>
<td>Milky white</td>
<td>25</td>
<td>14</td>
<td>4</td>
<td>Nil</td>
<td>Platform (local), seg. Flake near.</td>
</tr>
</tbody>
</table>
### Appendix 5

**Summary Details of Stone Artefacts From Open Campsites & Isolated Artefact Finds Recorded During "Glenn Lee" Archaeological Survey (Cont'd)**

<table>
<thead>
<tr>
<th>Site</th>
<th>Artifact Type</th>
<th>Raw Material</th>
<th>Colour</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thick. (mm)</th>
<th>Cortex</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-OS5</td>
<td>Flaked piece</td>
<td>Chert</td>
<td>Tiny green</td>
<td>32</td>
<td>27</td>
<td>10</td>
<td>100% (WW)</td>
<td>2 neg. flake scars</td>
</tr>
<tr>
<td></td>
<td>Flake</td>
<td>Quartz</td>
<td>Milky white</td>
<td>26</td>
<td>24</td>
<td>6</td>
<td>Nil</td>
<td>Platform/broken</td>
</tr>
<tr>
<td></td>
<td>Debitage</td>
<td>Quartz</td>
<td>Milky white</td>
<td>19</td>
<td>16</td>
<td>5</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Debitage</td>
<td>Quartz</td>
<td>Milky white</td>
<td>13</td>
<td>12</td>
<td>2</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Debitage</td>
<td>Quartz</td>
<td>Milky white</td>
<td>28</td>
<td>12</td>
<td>2</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>GL-OS6</td>
<td>Core/Missed(!)</td>
<td>Quartzite</td>
<td>Red-brown</td>
<td>130</td>
<td>60</td>
<td>55</td>
<td>75% (WW)</td>
<td>River Pebble, broken, 1 platform, possible flake, upper millstone surface, 4 neg. flake scars</td>
</tr>
<tr>
<td></td>
<td>Core</td>
<td>Quartzite</td>
<td>Red-brown</td>
<td>32</td>
<td>55</td>
<td>55</td>
<td>60% (WW)</td>
<td>River Pebble, broken, 1 platform, 4 neg. flake scars</td>
</tr>
<tr>
<td></td>
<td>Flaked piece</td>
<td>Quartzite</td>
<td>Cream</td>
<td>23</td>
<td>26</td>
<td>11</td>
<td>Nil</td>
<td>1 neg. flake scar</td>
</tr>
<tr>
<td>GL-OS7</td>
<td>Core</td>
<td>Chert</td>
<td>Light brown</td>
<td>38</td>
<td>42</td>
<td>22</td>
<td>75%</td>
<td>Uni-platform, 4 neg. flake scars</td>
</tr>
<tr>
<td></td>
<td>Flake</td>
<td>Chert</td>
<td>Light brown</td>
<td>38</td>
<td>42</td>
<td>22</td>
<td>sc3%</td>
<td>Bulky platform (broad)</td>
</tr>
<tr>
<td></td>
<td>Core</td>
<td>Silcrete</td>
<td>Pink</td>
<td>32</td>
<td>10</td>
<td>Nil</td>
<td>Nil</td>
<td>Blunted, 2 platforms, 9 neg. flake scars</td>
</tr>
</tbody>
</table>
### APPENDIX 5

**Summary Details of Stone Artefacts From Open Campsites & Isolated Artefact Finds Recorded During "Glenn Lies" Archaeological Survey (Cont'd)**

<table>
<thead>
<tr>
<th>Site</th>
<th>Artifact Type</th>
<th>Raw Material</th>
<th>Colour</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thick. (mm)</th>
<th>Cortex</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-OS-3</td>
<td>Core</td>
<td>Chert</td>
<td>Grey-green</td>
<td>140</td>
<td>70</td>
<td>60</td>
<td>90% (WW)</td>
<td>River pebble, uniflare, normal, 100 mg, flake scars</td>
</tr>
<tr>
<td>Core</td>
<td>Chert</td>
<td>Light brown</td>
<td>90</td>
<td>60</td>
<td>20</td>
<td>80% (WW)</td>
<td>River pebble, platform, 50 mg, flake scars, oxblad, coated</td>
<td></td>
</tr>
<tr>
<td>Flake</td>
<td>Chert</td>
<td>Light brown</td>
<td>70</td>
<td>40</td>
<td>20</td>
<td>100% (WW)</td>
<td>Bulb, platform (bread), 4 mg, flake scars</td>
<td></td>
</tr>
<tr>
<td>Unmodified</td>
<td>River pebble</td>
<td>Diabase</td>
<td>Brown</td>
<td>320</td>
<td>75</td>
<td>70</td>
<td>100% (WW)</td>
<td>River pebble, transport</td>
</tr>
<tr>
<td>GL-W-2 (no 10-1)</td>
<td>Millstone</td>
<td>Sandstone</td>
<td>Grey-brown</td>
<td>170</td>
<td>100</td>
<td>50</td>
<td>SI</td>
<td>Black, bifacial, bifacial</td>
</tr>
</tbody>
</table>

**Legend:** Neg. = Negative Flake Scar; WW = Cortex, river wear; Cox = Core origin
APPENDIX 6

SUMMARY DETAILS OF SCARRED TREE SITES 
RECORDED DURING THE 
"GLENN LEE" ARCHAEOLOGICAL SURVEY
Appendix 6

Summary Details of Scarred Tree Sites; "Glenn Lee" Archaeological Survey

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E.mic.</td>
<td>Poor</td>
<td>D</td>
<td>40</td>
<td>Ovoid</td>
<td>20 11 85</td>
<td>2</td>
<td>Nil</td>
<td>South</td>
<td>Poor</td>
</tr>
<tr>
<td>2</td>
<td>E.mic.</td>
<td>Good</td>
<td>L</td>
<td>94</td>
<td>Elong.</td>
<td>206 30 9</td>
<td>13 25</td>
<td>Nil</td>
<td>North</td>
<td>Poor</td>
</tr>
</tbody>
</table>

Key to Scarred Tree Charts:

Cond. = Condition of scar / scarred tree
Spec. = Species
State (D/I) = Whether tree dead or alive
DIF = Dead and fallen
Shape = Scar shape
Elong. = Elongated shape
Ovoid = Shape
Irreg. = Irregular shape
HAG = Height of base of scar above ground
G = Scar / recession extends to ground
Reth. = Amount of bark / cambium regrowth
Axe Marks = Whether axe marks are visible or not
Orient. = Orientation of scar

Key to Tree Species:

Ric. = Eucalyptus species
E.mic. = Eucalyptus melliodora
E.sha. = Eucalyptus saligna
E.lem. = Eucalyptus lehmanniana

Appendix 7

SUMMARY OF SITE SIGNIFICANCE ASSESSMENT
<table>
<thead>
<tr>
<th>Site Type</th>
<th>Site No.</th>
<th>Integrity</th>
<th>Structure</th>
<th>Potential Environmental Impact</th>
<th>Social Value</th>
<th>Potential Economic Impact</th>
<th>Other Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Landscape</td>
<td>1</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Closed Landscape</td>
<td>2</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Figure 1**

Unsuitable for residential development due to the presence of Natural Reserve and potential for erosion and flooding. Unsuitable for other uses due to the potential for soil contamination and ecological disturbance. Unsuitable for any development due to the presence of cultural heritage sites and potential for archaeological disturbance.
### Appendix 7

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Site Type</th>
<th>Integrity</th>
<th>Structure</th>
<th>Representative Value</th>
<th>Scientific Value</th>
<th>Educational Value</th>
<th>Other Value</th>
<th>Significance Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-02/1</td>
<td>Open/Campsite</td>
<td>Low due to high level of surface disturbance</td>
<td>Disturbed by cultivation and grazing, however, there is a potential for subsurface deposits to exist</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Aboriginal (Moderate)</td>
<td>Low, due to poor surface integrity, subsurface deposits likely to be present</td>
</tr>
<tr>
<td>GC-02/2</td>
<td>Open/Campsite</td>
<td>Low due to high level of surface disturbance</td>
<td>Disturbed by cultivation and grazing, however, there is a potential for subsurface deposits to exist</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Aboriginal (Moderate)</td>
<td>Low, due to poor surface integrity, subsurface deposits likely to be present</td>
</tr>
<tr>
<td>GC-03/3</td>
<td>Open/Campsite</td>
<td>Low due to high level of surface disturbance</td>
<td>Disturbed by cultivation and grazing, however, there is a potential for subsurface deposits to exist</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Aboriginal (Moderate)</td>
<td>Low, due to poor surface integrity, subsurface deposits likely to be present</td>
</tr>
</tbody>
</table>

Note: All items are subject to further investigation and potential mitigation measures.
### Appendix 7

#### SUMMARY OF SITE SIGNIFICANCE ASSESSMENT, "Glen Laid" ARCHAEOLOGICAL SURVEY (CONT'D)

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Site Type</th>
<th>Integrity</th>
<th>Structure</th>
<th>Scientific Value</th>
<th>Educational Value</th>
<th>Other Value</th>
<th>Significance Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLT-1</td>
<td>Shovel Trial</td>
<td>Compromised due to damage or tree growth and questionable origin</td>
<td>Size is clear, but no definite evidence of Aboriginal origin decreases its value</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Aboriginal: Moderate as an educational resource</td>
</tr>
<tr>
<td>GLT-2</td>
<td>Shovel Trial</td>
<td>Low due to dubious Aboriginal origin assessment</td>
<td>Size is clear, but damage and change indicating more-positive Aboriginal origin is an area matter to</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>GLT-3</td>
<td>Shovel Trial</td>
<td>Low due to low scientific and educational value and only moderate Aboriginal value</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 449
APPENDIX 8

COPIES OF NPWS SITE FORMS FOR THE "GLENNY LEE" ARCHAEOLOGICAL SURVEY
National Parks and Wildlife Service

Location: 60° 05' 1" S 150° 43' 3" E
Grid Reference: 60° 05' 1" S 150° 43' 3" E

Site Name: 60° 05' 1" S
Locality/Property Name: Glenn Lee

Region: Western
Camp & Obey Rd, Dubbo

Request for Investigation: Arch. Survey

Formal no: 2986
Para: 7

Photos taken?: Yes
How many attached?: 2 (0)

How to get to the site - Refer to permanent features that give best approach to site eg. From ahead, below, above etc

Clue diagram on separate sheet:
Site located along channel creek bank, shoulder at

Evidence of creek with house past Glenn Lee house. The north west corner of the site is located approx. 150m south of Glenn Lee house.

Other sites in this area:
Yes
Site Type(s): Open Campsite

Have artefacts been removed from site?: No
When?: Described where?

Is site important to local Aboriginals?: Yes
Cultural Region: ns, Dubbo

Contacted for site recording?: Yes
Additional information needed?: If not, why not?

Verbatim written reference sources including (i.e. site of accompanying report):

The Proposed "Glenn Lee" Tourist Development, Camp & Obey Rd, Dubbo

Checks:

Surface visibility

Incolorful scale

Inland track

Recommendations for additional analysis or further research as necessary:

As per report.

Site recorded by:
Jim Kelton
42, Darling St
Coonabarabran

Date: 12/10/1995
APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

ITEM NO: PDEC17/14

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 452
### Artefact Details

<table>
<thead>
<tr>
<th>Artefact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flake</td>
<td>45</td>
<td>Chert</td>
<td>Grey</td>
<td>nil</td>
<td>Platform (round) broken, overlain scar, broken, bulb,Platform, Andy flaking.</td>
</tr>
<tr>
<td>Flake</td>
<td>38</td>
<td>Chert</td>
<td>Grey</td>
<td>nil</td>
<td>Broken, Platform, 2nd flake, broken.</td>
</tr>
<tr>
<td>Flake</td>
<td>28</td>
<td>Quartzite</td>
<td>Pink/brown</td>
<td>nil</td>
<td>Platform, flake Scar, bulb, 2nd flake, new material, broken, 2nd flake, rotated, 2nd platform, new flake scar, Burnt Stone.</td>
</tr>
<tr>
<td>Flake</td>
<td>31</td>
<td>Quartzite</td>
<td>Pink/white</td>
<td>nil</td>
<td>Burnt Stone.</td>
</tr>
<tr>
<td>Core</td>
<td>12</td>
<td>Chert</td>
<td>Grey/Brown</td>
<td>5 to 10%</td>
<td>Burnt Stone.</td>
</tr>
<tr>
<td>Hearth Stone</td>
<td>150</td>
<td>Mudstone</td>
<td>Red/Brown</td>
<td>5 to 10%</td>
<td>Burnt Stone.</td>
</tr>
<tr>
<td>Core</td>
<td>87</td>
<td>Quartzite</td>
<td>Red</td>
<td>&lt;5%</td>
<td>Burnt Stone.</td>
</tr>
</tbody>
</table>

**Site Name / No:** GL-05-1

**Date:** 13/10/85

**Site Name / No:** GL-05-1

**Date:** 13/10/85
<table>
<thead>
<tr>
<th>Site Name / No:</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flaked Area</td>
<td>35</td>
<td>20</td>
<td>11</td>
<td>nil</td>
<td>20%</td>
</tr>
<tr>
<td>Flakes</td>
<td>30</td>
<td>22</td>
<td>9</td>
<td>nil</td>
<td>Platform, bulb, cortex 20%</td>
</tr>
<tr>
<td>Flaked Area</td>
<td>29</td>
<td>19</td>
<td>6</td>
<td>nil</td>
<td>20%</td>
</tr>
<tr>
<td>Flakes</td>
<td>23</td>
<td>20</td>
<td>6</td>
<td>nil</td>
<td>20%</td>
</tr>
<tr>
<td>Flakes</td>
<td>19</td>
<td>14</td>
<td>5</td>
<td>nil</td>
<td>20%</td>
</tr>
<tr>
<td>Flakes</td>
<td>16</td>
<td>10</td>
<td>3</td>
<td>light brown</td>
<td>20%</td>
</tr>
<tr>
<td>Flakes</td>
<td>12</td>
<td>18</td>
<td>10</td>
<td>light brown</td>
<td>Platform, broken bulb, cortex 20%</td>
</tr>
<tr>
<td>Flaked Area</td>
<td>31</td>
<td>28</td>
<td>9</td>
<td>nil</td>
<td>20%</td>
</tr>
<tr>
<td>Debroke</td>
<td>22</td>
<td>16</td>
<td>7</td>
<td>nil</td>
<td>20%</td>
</tr>
<tr>
<td>Debroke</td>
<td>22</td>
<td>16</td>
<td>5</td>
<td>nil</td>
<td>20%</td>
</tr>
<tr>
<td>Debroke</td>
<td>19</td>
<td>16</td>
<td>5</td>
<td>nil</td>
<td>20%</td>
</tr>
<tr>
<td>Debroke</td>
<td>22</td>
<td>15</td>
<td>10</td>
<td>nil</td>
<td>20%</td>
</tr>
<tr>
<td>Burnt</td>
<td>22</td>
<td>15</td>
<td>10</td>
<td>nil</td>
<td>20%</td>
</tr>
<tr>
<td>Burnt</td>
<td>22</td>
<td>15</td>
<td>10</td>
<td>nil</td>
<td>20%</td>
</tr>
<tr>
<td>Burnt</td>
<td>22</td>
<td>15</td>
<td>10</td>
<td>nil</td>
<td>20%</td>
</tr>
<tr>
<td>Burnt</td>
<td>22</td>
<td>15</td>
<td>10</td>
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</tr>
<tr>
<td>Artefact</td>
<td>Dimensions (cm)</td>
<td>Material</td>
<td>Colour</td>
<td>Cortex (%)</td>
<td>Comments</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------</td>
<td>----------</td>
<td>--------------</td>
<td>------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Flake</td>
<td>22</td>
<td>23</td>
<td>Milky White</td>
<td>5%</td>
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</tr>
<tr>
<td>Debitage</td>
<td>12</td>
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<td>Flake</td>
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<td>5%</td>
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<tr>
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<td>Milky White</td>
<td>5%</td>
<td>Rectangular</td>
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<tr>
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<td>20</td>
<td>15</td>
<td>Milky White</td>
<td>5%</td>
<td>Rectangular</td>
</tr>
<tr>
<td>Debitage</td>
<td>15</td>
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<tr>
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<td>Milky White</td>
<td>5%</td>
<td>Rectangular</td>
</tr>
<tr>
<td>Debitage</td>
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<td>11</td>
<td>Milky White</td>
<td>5%</td>
<td>Rectangular</td>
</tr>
<tr>
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<td>5%</td>
<td>Rectangular</td>
</tr>
<tr>
<td>Artefact</td>
<td>Date</td>
<td>Site Name/No.</td>
<td>Dimensions (cm)</td>
<td>Material</td>
<td>Colour</td>
</tr>
<tr>
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<td>------------------</td>
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<tr>
<td>Cylcon</td>
<td></td>
<td>GL-05-1</td>
<td>125</td>
<td>95</td>
<td>White/pink</td>
</tr>
<tr>
<td>Core</td>
<td></td>
<td></td>
<td>100</td>
<td>80</td>
<td>Pink/Red</td>
</tr>
<tr>
<td>Horde.</td>
<td></td>
<td></td>
<td>60</td>
<td></td>
<td>Red/brown</td>
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<tr>
<td>Bone</td>
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<td>125</td>
<td></td>
<td></td>
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<tr>
<td>Flake Pte</td>
<td></td>
<td></td>
<td>32</td>
<td>20</td>
<td>Red/brown</td>
</tr>
<tr>
<td>Flake Pte</td>
<td></td>
<td></td>
<td>25</td>
<td>20</td>
<td>Red/brown</td>
</tr>
<tr>
<td>Core</td>
<td></td>
<td></td>
<td>40</td>
<td>55</td>
<td>Brown/Chert</td>
</tr>
<tr>
<td>Mammal</td>
<td></td>
<td></td>
<td>30</td>
<td>50</td>
<td>Light/brown</td>
</tr>
<tr>
<td>Flake</td>
<td></td>
<td></td>
<td>40</td>
<td>20</td>
<td>Milky white</td>
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<td>25</td>
<td>15</td>
<td>Milky white</td>
</tr>
<tr>
<td>Flake</td>
<td></td>
<td></td>
<td>30</td>
<td>20</td>
<td>Grey/brown</td>
</tr>
</tbody>
</table>
APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

ITEM NO: PDEC17/14

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 459
**APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD**

**ITEM NO:** PDEC17/14

---

**Site 4:**
- Hard core
- 2 flake

**Site 5:**
- 3 quantity flakes
- 1 chert flake

**Site 6:**
- New "Glenm Lee" House
  - 1 quantity chert flakes
  - Burnt Stones: scattered across eroded surface

- Location
  - GR 699089E
  - 6425492N

- Location
  - GR 649126E
  - 6425429N
<table>
<thead>
<tr>
<th>AMG Grid reference: 649610 mE 6264710 mN</th>
<th>HEAD OFFICE USE ONLY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale of map used for grid reference: 1:2000</td>
<td>Site type:</td>
</tr>
<tr>
<td>Reason for investigation: Adh Suage</td>
<td>Accessory by:</td>
</tr>
<tr>
<td>Property no: PCE</td>
<td>Data entered by:</td>
</tr>
<tr>
<td>Photos taken?: Yes</td>
<td>Owner/Manager:</td>
</tr>
<tr>
<td>How many attached?: 2(1)</td>
<td></td>
</tr>
<tr>
<td>How to get to site: Site located on Southern bank of foreshore of planed</td>
<td></td>
</tr>
<tr>
<td>Other sites in locality?: Yes</td>
<td>Site Types include: Scrub Trees, Open Country</td>
</tr>
<tr>
<td>Are sites in npws register?: Yes</td>
<td></td>
</tr>
<tr>
<td>Have structures been removed from site?: No</td>
<td>Where?: Deposited where?</td>
</tr>
<tr>
<td>Is site important to local aboriginal?: Yes</td>
<td>Control by: ABGAC</td>
</tr>
<tr>
<td>Site visited and recorded?: Yes</td>
<td>Additional information required:</td>
</tr>
<tr>
<td>Additional information required: Is site of archaeological significance?</td>
<td></td>
</tr>
<tr>
<td>Additional information required: For the proposed &quot;Glenlee&quot; Town Development, Rugby Camp Rd, Dubbo</td>
<td></td>
</tr>
<tr>
<td>Additional information required: Archaelogical Survey Dubbo</td>
<td></td>
</tr>
<tr>
<td>Additional information required: A Per Report</td>
<td></td>
</tr>
</tbody>
</table>

**Site Condition:**
- **Surface visibility:** Fairly good |
- **Vegetation/Intimate:** Foliage, Stumps |
- **Heath in Site:** Bushy, Mallee, Shrubs |

**Recommendations for Management & Protection:**
- Assess site, prepare Management Plan |

**Site recorded by:** Jim Kelton |
**Address/Institution:** 42 Darley St, Dubbo, 2830.
APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

ITEM NO: PDEC17/14

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 462
Open Artefact Scatter Site

Site Name / No: 6L-05-2
Grid Ref:

Date: 23/10/1965

1. Landform Unit: EOH/ed Creek Flat
   (hillside, ridge top, floodplain etc)

2. Nature of deposit: Sandy, gravelly, clay etc.

3. Erosion - On Site: Sheet, Rilling, Gully

4. Site Exposure / Extent: 5 x 5 m2
   (artefacts visible)

5. Surface Visibility (est.): 5 to 10%
   10 to 50% 50 to 75% 75 to 100%

6. Present Landuse: 

7. Type of Archaeological Material Present: 

8. Artifacts in situ?: No
   (erosion occurring etc)

9. Artifactual Density: 
   artifacts/m2 Max.

10. Total Number of artifacts: 10

11. Site complex characteristics:
    (associated hearths, knapping, doors, etc)

   Estimated Number of artifacts: 50-100 100-200 250-500 500+

   Raw Material Site: 

   Quality:

   Site complex characteristics: 
   (associated hearths, knapping, doors, etc)
### ARTEFACT DETAILS:

**Site Name/No:** Gl-02-2

<table>
<thead>
<tr>
<th>Artifact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millstone</td>
<td>25, 100, 40</td>
<td>Indurated sandstone</td>
<td>Red/brown</td>
<td>11</td>
<td>Broken, cracks, sandstone, surface.</td>
</tr>
<tr>
<td>Handstone</td>
<td>30, 60</td>
<td>Quartzite</td>
<td>Blue/grey</td>
<td>9%</td>
<td>Present at end of core, flat surface.</td>
</tr>
<tr>
<td>Flaked Stone</td>
<td>55</td>
<td>Sandstone</td>
<td>Red/brown</td>
<td>-</td>
<td>Bent</td>
</tr>
<tr>
<td>Flaked Stone</td>
<td>35, 25, 20</td>
<td>Quartz</td>
<td>Milky white</td>
<td>9%</td>
<td>Perforated Stone (?)</td>
</tr>
<tr>
<td>Flaked Stone</td>
<td>25, 16, 8</td>
<td>Quartz</td>
<td>-</td>
<td>50%</td>
<td>-</td>
</tr>
<tr>
<td>Scraped</td>
<td>15, 20</td>
<td>Quartzite</td>
<td>Light brown</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>Flake</td>
<td>10</td>
<td>Quartzite</td>
<td>Light brown</td>
<td>-</td>
<td>Flat/rectangular (?)</td>
</tr>
<tr>
<td>Debitage</td>
<td>10</td>
<td>Quartz</td>
<td>Milky white</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### National Parks and Wildlife Service

**APPENDIX NO:** 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

**Item No:** PDEC17/14

---

### Site Information

- **Site Name:** GL 05-2
- **Locality Property Name:** "Glenlea - Duty Camp Rd, Dubbo"
- **Region:** Central Western
- **Reason for Investigation:** Archaeology

---

### Description

- **Photo Taken:** Yes
- **Photo Attached:** 2
- **Description:** Site located on eastern bank of unnamed creek 30 m east of "Glenlea" house

---

### Other Sites

- **Yes:** Site types include: Scared Trees, Open Campfire
- **Yes:** Have all trees been removed from site?
- **No:** When?
- **No:** Where?
- **Yes:** Site important to local Aboriginals
- **Yes:** Site contact's name(s) and address(s)
- **Yes:** Contacted for site recording
- **Yes:** Attach additional information separately if not, copy here

---

### Recommendations

- **Recommendation:** Further assessment required before any works proceed
- **Contact:** Archaeological Survey and Cultural Protection Section
- **Site:** Glenlea, "Glenlea," Dubbo

---

### Reporting

- **Recording:** Site recorded
- **Date:** 12/10/1995
- **Author:** Jim Keaton

---

**Page 466**

**PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE**
<table>
<thead>
<tr>
<th>Site Name / No:</th>
<th>GL 05-2</th>
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</thead>
<tbody>
<tr>
<td>Grid Ref.</td>
<td></td>
</tr>
<tr>
<td>Date:</td>
<td>01/10/95</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Landform Unit:</th>
<th>Elevated Creek Flat</th>
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</thead>
<tbody>
<tr>
<td>(full slope, ridge top, floodplain etc)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Nature of deposit:</th>
<th>Sandy / Gravelly</th>
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</thead>
<tbody>
<tr>
<td>(sandy, gravelly, clay etc)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Erosion - On Site:</th>
<th>Sheet</th>
<th>Filling</th>
<th>Gully</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Environment:</td>
<td>Open</td>
<td>Gully</td>
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</table>

<table>
<thead>
<tr>
<th>Site Exposure / Extent:</th>
<th>30 x 2 m</th>
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<tbody>
<tr>
<td>Area:</td>
<td>60 m²</td>
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<td>(artefacts visible)</td>
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<table>
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<tr>
<th>Surface Visibility (est.):</th>
<th>&lt;1%</th>
<th>1-10%</th>
<th>10-50%</th>
<th>50-70%</th>
<th>75-100%</th>
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</table>

<table>
<thead>
<tr>
<th>Present Landuse:</th>
<th>?</th>
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</table>

<table>
<thead>
<tr>
<th>Type of Archaeological Material Present:</th>
<th>?</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Artifacts in situ?:</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>(erosion occurring etc)</td>
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</table>

<table>
<thead>
<tr>
<th>Artifact Density:</th>
<th>&lt;1.5 Artif/m² Max</th>
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<table>
<thead>
<tr>
<th>Total Number of Artefacts:</th>
<th>10</th>
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<tbody>
<tr>
<td>Estimated Number of Artefacts:</td>
<td>50-100 100-200 x500 &gt;500</td>
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<table>
<thead>
<tr>
<th>Raw Material:</th>
<th>?</th>
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<table>
<thead>
<tr>
<th>Site complex characteristics:</th>
<th>Associated hearths, knapping floors, SPs etc</th>
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<tbody>
<tr>
<td></td>
<td>No!</td>
</tr>
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</table>
### Artfact Details

**Site Name/No:** GL-05-2

<table>
<thead>
<tr>
<th>Artifact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millstone</td>
<td>25 100 40</td>
<td>Indurated headstone</td>
<td>Red/brown</td>
<td>Nil</td>
<td>Broken, ground, red from surrounding</td>
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<tr>
<td>Hammerstone</td>
<td>70 30 60</td>
<td>Sandstone</td>
<td>Blue/grey</td>
<td>7%</td>
<td>Present at front of rock surface</td>
</tr>
<tr>
<td>Hoax</td>
<td>20</td>
<td>B.7e.</td>
<td>Black</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Flaked Piece</td>
<td>35 25 20</td>
<td>Quartz</td>
<td>Milky white</td>
<td>3%</td>
<td>12% flat top</td>
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<tr>
<td>Flaked Piece</td>
<td>25 16 8</td>
<td>Quartz</td>
<td>Milky white</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Mosaic</td>
<td>65 29 20</td>
<td>Quartzite</td>
<td>Light brown</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>Flake</td>
<td>20 19 3</td>
<td>Quartzite</td>
<td>Light brown</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>Debrite</td>
<td>11 9 8</td>
<td>Quartz</td>
<td>Milky white</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Artifact</td>
<td>Dimensions (cm)</td>
<td>Material</td>
<td>Colour</td>
<td>Cortex (%)</td>
<td>Comments</td>
</tr>
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<td>----------</td>
<td>--------</td>
<td>------------</td>
<td>----------</td>
</tr>
<tr>
<td>Marang</td>
<td>60 45 40</td>
<td>Quartzite</td>
<td>Light brown</td>
<td>90%</td>
<td>Ruin Pebble Broken</td>
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<tr>
<td>Mullor</td>
<td>100 60 45</td>
<td>Quartzite</td>
<td>Light brown</td>
<td>100%</td>
<td>Ruin Pebble Broken</td>
</tr>
<tr>
<td>Marang?</td>
<td>40 40 40</td>
<td>Quartzite</td>
<td>Fugitive</td>
<td>40%</td>
<td>Ruin Pebble Broken</td>
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</table>
**SITE POSITION & ENVIRONMENT**

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<thead>
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<th>Item</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Local rock type: Sandstone/Dolostone</td>
</tr>
<tr>
<td>2.</td>
<td>Distance from drinking water: 5m</td>
</tr>
<tr>
<td>3.</td>
<td>Resource Zone associated with site: Flinders Ranges National Park</td>
</tr>
<tr>
<td>4.</td>
<td>Vegetation: Eucalyptus, Acacia, Melaleuca</td>
</tr>
</tbody>
</table>

**DESCRIPTION OF SITE & CONTENTS**

As per Attached Sheet

---

Attach sketches (e.g., plan B, section of shelter, show relation between site contents, and relative north, show scale.)

Attach annotated photos (where useful) showing scale, particularly for artefacts.

---

**CHECKLIST TO HELP:**
- Length, width, depth
- Height of site, shelter: deposit, structure, element, eg, tree trunk
- Grooves, rills
- Deposition: depth, strength, size, shape, distribution of these, stone types, sizes, etc.
- ART: lines of surface: decors, motifs, patterns, etc.
- Painted, abstract, etc.

**BURIALS:**
- Number, description of bones, position, associated artefacts
- Tree: number, size, tree age, shape, position, size, pattern, artefacts

**CULTURE:**
- Trees, rocks, shelter, rock art, artefacts, etc.

**OTHER SITES:**
- Structures of the type:
- Stone arrangements, rock art, artefacts, etc.
- Holes, engravings, grooves, etc.

---

**PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE**

Page 476
Open Artefact Scatter Site

Site Name / No: 6k-05-4  Date: 12/10/90

1. Landform Unit: Creek Bank
   (hill slope, ridge top, floodplain etc)

2. Nature of deposit: Sandy / Gravelly
   (sandy, gravelly, clay etc)

3. Erosion - On Site:
   Sheet, Rill, Gully

Environment:

4. Site Exposure / Extent: 15 x 10 m, Area: 150 m²
   (artefacts visible)

5. Surface Viability (est.): 75% 50-75% 20-50% 0-20%

6. Present Landuse: Grazing / Cultivation

7. Type of Archaeological Material Present:
   Site Name: Creek Bank / Excav.

8. Artifacts in situ: Yes
   (erosion occurring etc)

9. Artifacts Density: 2v/1m² Max

10. Total Number of Artifacts: 5

11. Estimated Number of Artifacts: 50-100 100-200 250 500

12. Raw Material:
   (flint, bone, pottery, etc)
   Gravel 60%  Quartz 40%

13. Site complex characteristics:
   (associated hearths, knapping floors, STs etc)
   No
<table>
<thead>
<tr>
<th>Artifact</th>
<th>Dimensions (mm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point</td>
<td>134 x 13 x 8</td>
<td>Quartz</td>
<td>Pink/yellow</td>
<td>nil</td>
<td>One margin on dorsal surface trimmed</td>
</tr>
<tr>
<td>Flaked Piece</td>
<td>40 x 35 x 16</td>
<td>Quartz</td>
<td>Milky white</td>
<td>80%</td>
<td>Neg-flake scars</td>
</tr>
<tr>
<td>Debitage</td>
<td>40 x 15 x 12</td>
<td>Quartz</td>
<td>Milky white</td>
<td>nil</td>
<td>Neg-flake scars</td>
</tr>
<tr>
<td>Flake</td>
<td>21 x 12 x 4</td>
<td>Quartz</td>
<td>Milky white</td>
<td>nil</td>
<td>Platform (Bead) Bulb Neg-flake scars</td>
</tr>
<tr>
<td>Flake</td>
<td>25 x 14 x 4</td>
<td>Quartz</td>
<td>Pink</td>
<td>nil</td>
<td>Platform (Round) Neg-flake scars</td>
</tr>
</tbody>
</table>

Site Name/No: GL-05-04  Date: 13/10/1995
Open Arтеfact Scatter Site

Site Name / No: GL-05 S
Grid Ref: Date: 12/10/95

1. Landform Unit: Creek Bank
   (hill slope, ridge top, floodplain etc)

2. Nature of deposit: Sandy gravel
   (sandy, gravelly, clay etc)

3. Erosion: On Site
   Sheet
   Rilling
   Gully

- Environment: Open grazing

4. Site Exposure / Extent: 15 x 10 m
   Area: 150 m²
   (artefacts visible)

5. Surface Visibility (est.):
   <5% 5-10% 10-50% 50-70% 75-100%

6. Present Landuse: Grazing, Crop Cultivation

7. Type of Archaeological Material Present:
   Stone Flakes
   Bone Tools

8. Artifacts in situ?
   No (erosion occurring etc)

9. Artifact Density: 0.4 m⁻², max 1 m⁻²

10. Total Number of artifacts:
    8

11. Estimated Number of artifacts:
    50-100

12. Raw Material %:
    Stone 80%
    Chert 20%

13. Site complex characteristics:
    (associated hearths, knapping floors, ST's etc)

---

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 482
<table>
<thead>
<tr>
<th>Artefact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaked Pea</td>
<td>32</td>
<td>27</td>
<td>Chart</td>
<td>10%</td>
<td>Deep flake seen</td>
</tr>
<tr>
<td>Flaked Shale</td>
<td>26</td>
<td>24</td>
<td>Milky White</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Deluge</td>
<td>19</td>
<td>16</td>
<td>Chalk</td>
<td>40%</td>
<td>Platform broken</td>
</tr>
<tr>
<td>Deluge</td>
<td>15</td>
<td>12</td>
<td>Milky White</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Deluge</td>
<td>24</td>
<td>12</td>
<td>Chalk</td>
<td>10%</td>
<td></td>
</tr>
</tbody>
</table>
National Parks and Wildlife Service

Head Office Use Only.

NPWS Code:

AME Grid Reference:

Site Type:

Site Name:

NPWS District:

Original Proposal - 4L Camp Road

Archaeological Survey Report

As Req. Report

Jim Keller

Page 485
Site Position & Environment

1. Location:
   Site:

2. Topography:
   Landform:

3. Vegetation:
   Edible plants noted:

4. Faunal resources (include shellfish):

5. Other exploitatble resources (liver, oysters, etc.):

Site Type: Artifactual

Description of Site & Contents:
Note that conservation of site & contents. Do NOT dig or damage site or contents.

Checklist to Help with:
- Length, width, depth, height of site, shelter, deposit, structures, element, etc.
- Tree, rock, grooves or rocks
- Deposit, location, size, etc.
- Orientation, size, continuity, etc.
- Condition of bone, position, age, sex, associated artifacts:
- Trees, number, size, etc.
- Shape, position, waste, tools, etc.
- Quarters, count type, etc.
- Artifacts, recognition, etc.
- Artifacts, condition, etc.
- Other sites EQ:
  - Structures, rock, soil, etc.

Attach sketches, etc. eg. plan & section of shelter, slow motion between site contents, indicate north, show scale.
Attach annotated photos (where useful) showing scale, particularly for art sites.
<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Landform Unit.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Erosion - On Site.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Nature of deposit:</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Site Exposure / Extent (artefacts visible)</td>
<td>5 x 3 m</td>
</tr>
<tr>
<td>5.</td>
<td>Surface Visibility (artefact)</td>
<td>&lt;5%</td>
</tr>
<tr>
<td>6.</td>
<td>Present Landuse</td>
<td>Grazing</td>
</tr>
<tr>
<td>7.</td>
<td>Type of Archaeological Material Present</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Artifacts in situ?</td>
<td>No</td>
</tr>
<tr>
<td>9.</td>
<td>Artefact Density</td>
<td>0.1 per m²</td>
</tr>
<tr>
<td>10.</td>
<td>Total Number of artefacts</td>
<td>3</td>
</tr>
<tr>
<td>11.</td>
<td>Site complex characteristics (associated hearths, knapping floors, SP's etc.)</td>
<td>No</td>
</tr>
</tbody>
</table>
4L Camp Road

Location Sketch

x 2 pebble manifolds

10 metres apart - same material
### Appendix No: 1 - Original Planning Proposal - 4L Camp Road

**Artifact:**  
- **Dimensions (mm):** L 130 x W 60 x T 55  
- **Material:** Quartzite  
- **Colour:** Red/brown  
- **Cortex (%):** 75%  
- **Comments:** Possibly broken, possible flake striking surface.

**Site Name / No:** 6L-05-6  
**Date:** 13-10-25

**Artifact:**  
- **Dimensions (mm):** L 82 x W 55 x T 55  
- **Material:** Quartzite  
- **Colour:** Red/brown  
- **Cortex (%):** 60%  
- **Comments:** 2 possible ny flakes, score (broken).

**Artifact:**  
- **Dimensions (mm):** L 37 x W 20 x T 11  
- **Material:** Quartzite  
- **Colour:** Grey  
- **Cortex (%):** Nil  
- **Comments:** 1 possible ny flake, score.
APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 490
Open Artefact Scatter Site

1. **Site Name / No:** CL-05-7
   **Grid Ref:** 649065 e
   6425392 n

2. **Landform Unit:** Eroded Bank
   (hill slope, ridge top, floodplain etc)

3. **Nature of deposit:** Gravelly Sandy Loam
   (gravelly, sandy, clay etc)

4. **Erosion On Site:** Sheet / Filling / Gully
   (erosion occurring etc)

5. **Environment:** Open Grazing / Cultivation

6. **Site Exposure / Extent:** 20 x 20 m
   Area: 400 m²
   (artefacts visible)

7. **Surface Visibility (es1):** 0% 5-10% 20-50% 50-70% 75-100%

8. **Present Landuse:** Grazing / Culthrive

9. **Type of Archaeological Material Present:**

10. **Artifacts in situ?** No

11. **Artifact Density:** 2/40 x 1 m² Max

12. **Total Number of artifacts:** 3

13. **Estimated Number of artifacts:** 50-100 100-200 500-1000 >1000

14. **Raw Material %:**

15. **Class / Type:** Sandstone (ST1)

16. **Site comment characters:**
    ( associated hearths; knapping floors, ST1's etc)
<table>
<thead>
<tr>
<th>Artefact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>80</td>
<td>Chart</td>
<td>Light brown</td>
<td>75%</td>
<td>Platform</td>
</tr>
<tr>
<td>Flake</td>
<td>38</td>
<td>22</td>
<td>Chart</td>
<td>Light brown</td>
<td>25%</td>
</tr>
<tr>
<td>Core</td>
<td>52</td>
<td>Silcrete</td>
<td>Pink</td>
<td>nil</td>
<td>Topped</td>
</tr>
</tbody>
</table>

Date: 13/09/15
APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 495
SITE POSITION & ENVIRONMENT

1. Local rock type:
   Sedimentary

2. Distance from drinking water source:
   20 m

3. Resource Zone associated with site (either, native, invasive, forest etc):
   Open Woodland

4. Vegetation:
   Eucalyptus and Acacia

5. Edible plants noted:
   No

6. Faunal resources (include shrubland):
   No

7. Other exploitable resources (river pebbles, rocks, etc):
   No

SITE TYPE:
   Campsite

DESCRIPTION OF SITE & CONTENTS:
   As Per Attached Sheet

CHECKLIST TO HELP:
   - Importance to flora and fauna
   - Condition of site
   - Other significant features

ATTACH: sketches, photos, etc.

APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD
ITEM NO: PDEC17/14
Open Artefact Scatter Site

Site Name / No:
Grid Ref: GL-05-8 Date: 18/10/95

1. Landform Unit: Low Hill Slope (hill slope, ridge top, floodplain etc)
2. Nature of Deposit: Sandy loam/gravel (sandy, gravelly, clay etc)
3. Erosion On Site: Sheet Rilling Gully
   Environment: Open Grazing/Cultivation

4. Site Exposure / Extent: 50 x 50 m Area: 2500 m²
   (artefacts visible)

5. Surface Visibility (est.): 5% 10% 20-50% 50-70% 75-100%

6. Present Landuse: Cultivation (grazing)

7. Type of Archaeological Material Present: Isolated Artefact

8. Artefacts in situ?: No 1-2 Distant from Neighbours

9. Artefact Density: m² Max

10. Total Number of artefacts: 4

11. Raw Material Type:

12. Site complex characteristics: (associated hearths, knapping floors, ST’s etc)
<table>
<thead>
<tr>
<th>Artifact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>110 x 70 x 60</td>
<td>Chert</td>
<td>Grey/green</td>
<td>90%</td>
<td>Platform Run Pebble to neg-flake scars</td>
</tr>
<tr>
<td>Core</td>
<td>90 x 60 x 50</td>
<td>Chert</td>
<td>Light brown (oxide)</td>
<td>80%</td>
<td>Bowl</td>
</tr>
<tr>
<td>Flake</td>
<td>70 x 40 x 18</td>
<td>Chert</td>
<td>Light brown (oxide)</td>
<td>Both</td>
<td>10%</td>
</tr>
<tr>
<td>Mammal</td>
<td>120 x 75 x 70</td>
<td>Quartzite</td>
<td>Brown</td>
<td>100%</td>
<td>Run Pebble</td>
</tr>
</tbody>
</table>
National Parks and Wildlife Service

APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

ITEM NO: PDEC17/14

Date: 12/10/1995

Sitename: Glengowrie Farm

Address: 92 Darling St, Cudgen

Category: Archaeological Survey

Condition of Site: Poor

Find Report

Final Report

Recommendations for Management & Protection (if necessary)

Checklist:

Surface visibility

Damage/Rehabilitation

Inference site

Site recorded by: Jim Kettie

Address: 92 Darling St, Cudgen

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 500
APPENDIX NO: 1 - ORIGINAL PLANNING PROPOSAL - 4L CAMP ROAD

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 503
### Scarred Tree Site Details

<table>
<thead>
<tr>
<th>Tree</th>
<th>Date: 12/10/95</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>Spec.</td>
</tr>
<tr>
<td>ST-2</td>
<td>Euc.</td>
</tr>
<tr>
<td>ST-1</td>
<td>Euc.</td>
</tr>
</tbody>
</table>

---

*Note: This table contains details of scarred trees at a site, including species (Euc.), condition (Good, Poor), status (Live, Dead), and measurements of trunk diameter and height.*
PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 506
<table>
<thead>
<tr>
<th>No.</th>
<th>Spec.</th>
<th>Cond.</th>
<th>State</th>
<th>Trunk diam (cm)</th>
<th>Shape</th>
<th>Measurements (cm)</th>
<th>Regis. (cm)</th>
<th>Axe marks</th>
<th>Orient</th>
<th>Condit.</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>S79</td>
<td>Euc</td>
<td>Good</td>
<td>Live</td>
<td>3.4</td>
<td>2.26</td>
<td>30</td>
<td>5</td>
<td>M/F</td>
<td>M/F</td>
<td>C/F</td>
<td>4503</td>
</tr>
</tbody>
</table>

Date: 12/16/15
<table>
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<tr>
<th>Item No.</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Site Name / No: GL-1F-2</td>
</tr>
<tr>
<td>2</td>
<td>Grid Ref:</td>
</tr>
<tr>
<td>3</td>
<td>Site Name / No: Open Artfact Scatter Site</td>
</tr>
<tr>
<td>4</td>
<td>Date: 13/10/95</td>
</tr>
<tr>
<td>5</td>
<td>Landform Unit: Alluvial Creek Flat (hillslope, ridge top, floodplain etc)</td>
</tr>
<tr>
<td>6</td>
<td>Nature of deposit: Sandy (sandy, gravelly, clay etc)</td>
</tr>
<tr>
<td>7</td>
<td>Erosion: Sheet, Filling, Gully</td>
</tr>
<tr>
<td>8</td>
<td>Environment: Open, Grazing / Cultivation</td>
</tr>
<tr>
<td>9</td>
<td>Site Exposure / Extent: Area: Artifacts visible</td>
</tr>
<tr>
<td>10</td>
<td>Surface Visibility (est.): &lt;5% 5-10% 10-20% 20-50% 50-70% 75-100%</td>
</tr>
<tr>
<td>11</td>
<td>Present Landuse: Grazing / Cultivated</td>
</tr>
<tr>
<td>12</td>
<td>Type of Archaeological Material Present:</td>
</tr>
<tr>
<td>13</td>
<td>Artefacts in situ: (erosion occurring etc)</td>
</tr>
<tr>
<td>14</td>
<td>Artefact Density:</td>
</tr>
<tr>
<td>15</td>
<td>Total Number of artefacts: 1</td>
</tr>
<tr>
<td>16</td>
<td>Estimated Number of artefacts: 50-100 100-200 200-500 500-1000</td>
</tr>
<tr>
<td>17</td>
<td>Raw Material Type:</td>
</tr>
<tr>
<td>18</td>
<td>Site complex characteristics: (associated hearths, knapping, tools, G1's etc)</td>
</tr>
<tr>
<td>Artfact</td>
<td>Dimensions (cm)</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Millstone</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 4: Archaeological Site Locations

Legend:
- Archaeological Site & Buffer Zone Area

"Glenn Lee"
Scrip. 5/4/99
PLANNING PROPOSAL
Lot 8 DP1063425
4L Camp Road
Dubbo
Parish of Dubbo
County of Gordon

Report prepared by

Doherty Smith & Associates
Consulting Surveyors

PO Box 4764
4/2 Blue Ridge Drive
Dubbo Post
NSW 2830
T: 02 6884 1008

PO Box 87
30 Swift Street
Wollongong NSW 2520
T: 02 6045 1403
Table of Contents

PLANNING PROPOSAL ................................................................. 3
Summary of Proposal ............................................................. 3

Part 1: Objectives and Intended Outcomes Of Proposal ..................... 6
Objectives of Proposal ............................................................ 6
Outcomes of Proposal ............................................................. 6

Part 2: Planning Provisions ......................................................... 7

Part 3: Justification ................................................................. 8
Questions to consider when demonstrating the justification ................. 8
Background .............................................................................. 11
Demand .................................................................................. 13
Land Use ................................................................................. 14
Topography and Vegetation ......................................................... 15
Bushfire Prone Land ................................................................. 15
Site Access and Traffic ............................................................. 20
Connection to Services .............................................................. 21
Flora and Fauna ...................................................................... 22
Groundwater Impacts .............................................................. 22
Non-Aboriginal Archaeological Heritage ........................................ 23
Aboriginal Archaeological Heritage ............................................. 23
Preliminary Contamination Investigation ....................................... 25
Noise (Adjoining land – Morris Park Motor Sport Complex) ............. 26
Background .............................................................................. 26
Noise Assessment .................................................................... 26
Conclusion ............................................................................... 27
Recommendations ................................................................... 27

Smoke/Dust – Morris Park Motor Sport Complex ......................... 31
Background .............................................................................. 31
Tyre Burnout Smokes/Dust ....................................................... 33
Composition of tyre smoke ....................................................... 34
Prevailing Wind Speed and Direction ......................................... 38
Separation Distance ................................................................ 39
Conclusion ............................................................................... 40
Recommendations ................................................................... 40

Part 4 – Maps and Diagrams ....................................................... 42
Part 5 – Community Consultation .............................................. 43
Conclusion ............................................................................... 45
PLANNING PROPOSAL

Summary of Proposal

This planning proposal relates to 4L Camp Road Dubbo, being Lot 8 DP1063425. The subject land is owned by Mrs Leetina Kish Bender. Mrs Bender is the applicant for this proposal.

The subject land currently has one dwelling standing upon it. The current land use is dryland agriculture, specifically grazing of stock and limited dryland cropping. The western and northern portions of the site are gently sloping with established grasses and scattered old growth eucalypt and regrowth eucalypt trees, with some invasive black pine scrub. A small watercourse flows through western portion of the land from south to north. The eastern portion of the land encompasses a small hill that is heavily vegetated with regrowth native eucalypt trees and invasive black pine scrub.

The soil on the site varies depending on the topography. The lower, more gently sloping land has heavier and more fertile soil consisting of sandy loam. Land situated on the slopes of the hill on the eastern side of the subject land is infertile light sandy loam.

The land is bounded by Camp Road and adjoining properties to the north; enclosed crown road to the west, with small agricultural holdings beyond; Crown road and Belowie Road to the south, with small agricultural holdings beyond; Morris Park Motor Sport Complex and small tourism zoned lots to the east.

The land is currently zoned SP3, Tourist, according to the Dubbo Local Environmental Plan 2012. Adjoining land to the north, west and east is also zoned SP3. Land to the south of the subject land is zoned RU1, consisting of lots with varying sizes, with the majority less than 40 hectares. Many adjoining lots in the RU1 zone have dwellings upon them as a result of being existing holdings. Adjacent land in the RU1 zone has a prescribed Minimum Lot Size of 800 hectares. The subject land has an area of 131.9 hectares and is the largest single lot within the SP3 zoned land in private ownership. Taronga Western Plains Zoo is located on the northern side of Camp Road, and is zoned SP3 Tourist.

Permitted land uses in the SP3 zone include Aquaculture; Cellar door premises; Food and drink premises; Health consulting rooms; Markets; Medical centres; Roadside stalls; Shop top housing; Tourist and visitor accommodation; Viticulture; Waste or resource transfer stations; Water reticulation systems and any other development that is not prohibited. Prohibited land uses in the SP3 zone include Advertising structures; Agriculture; Air transport facilities; Bed and breakfast accommodation; Boat building and repair facilities; Car parks; Cemeteries; Commercial premises; Correctional centres; Crematoria; Depots; Educational establishments; Electricity generating works; Exhibition homes;
Exhibition villages; Extractive industries; Flood mitigation works; Forestry; Freight transport facilities; Health services facilities; Heavy industrial storage premises; Home-based child care; Home businesses; Home occupations; Home occupations (sex services); Industrial retail outlets; Industrial training facilities; Industries; Marinas; Mortuaries; Open cut mining; Public administration buildings; Residential accommodation; Restricted premises; Rural industries; Sewerage systems; Sex services premises; Storage premises; Transport depots; Truck depots; Vehicle body repair workshops; Vehicle repair stations; Warehouse or distribution centres; Waste or resource management facilities; Water supply systems; Wholesale supplies. According to Minimum Lot Size mapping, the subject land currently has no prescribed minimum lot size for subdivision. Current zoning and Minimum Lot Size mapping can be seen in Appendix A.

Although the subject land and many of the adjoining SP3 zoned lots are currently used as small agricultural holdings, Agriculture is not permitted within the zone. The current agricultural land use is subject to existing use rights, having been used for this purpose continuously since prior to the introduction of the current zoning for the land.

The site is located approximately 7.5km drive from the centre of Dubbo with an average drive time of between 7 and 12 minutes. The site has existing access from Camp Road which joins Obley Road to gain access to the Newell Highway.

Examples of other sites located within 7 to 12 minutes’ drive time from the centre of Dubbo include:

- Kintyre Residential Estate located approximately 3km north-west of the subject land. Zoned R2 Low Density Residential with minimum lot sizes of 4000m² and 6000m².
- Outlook Residential Estate located north of Minore Road approximately 5km west of Dubbo. Zoned R2 Large Lot Residential with minimum lot size of 600m².
- Homestead Green residential estate, located approximately 6km east of Dubbo on Buninyong Road. Zoned R2 Low Density Residential with minimum lot size 4000m².
- Whitewood Road, Mugga Downs, located approximately 6km east of Dubbo. Zoned RU2 Rural Landscape with minimum lot size 8 hectares.
- Richmond Residential Estate located north of Whitewood Road approximately 9km east of Dubbo. Zoned RU2 Rural Landscape with minimum lot size of 1.5 hectares.
- Angle Park residential estate, located east of Old Dubbo Road approximately 10km south of Dubbo. Zoned RU2 Rural Landscape with minimum lot size of 8 hectares.

The proponent is applying to have the zone for the subject land changed from SP3 Tourist with no prescribed Minimum Lot Size to a split zoning with environmentally sensitive areas zoned E3 Environmental Management and less sensitive areas zoned RU2 Rural Landscape with a 3 hectare minimum lot size.
Street Address: 4L Camp Road Road
Town: Dubbo, NSW
Postcode: 2830
Local Government Area: Western Plains Regional Council
Lot/DP: Lot 8 DP1063425
Owner: Mrs Leetina Kish Bender
Current Zoning of Area: SP3 Tourist
Proposed Zoning Amendment: RU2 Rural Landscape, E3 Environmental Management
Current Minimum Lot Size: No MLS prescribed
Proposed Minimum Lot Size: 3 hectares
Number of Existing Lots: 1
Total area of site: 131.9 hectares
Part 1: Objectives and Intended Outcomes Of Proposal

Objectives of Proposal

The subject land is Lot 8 in DP1063425. This parcel is currently 131.9 hectares in size. The zoning under the Dubbo Local Environmental Plan 2012 is SP3 Tourist. There is no Minimum Lot Size for the subject land. Under the current zoning, subject to Council approval, the land could be developed for tourism related purposes to a high density.

The proponent is applying to have the zone for the subject land changed from SP3 Tourist with no prescribed Minimum Lot Size to a split zoning. Part of the land is proposed to be zoned RU2 Rural Landscape with a 3 hectare minimum lot size, with a vegetated hill located on the eastern portion of the land proposed to be zoned E3 Environmental Management. The proposed rezoning will allow future development of the land for rural residential purposes, while protecting an existing natural feature. A layout for a potential subdivision of the subject land has been prepared which provides a total of 25 rural residential lots varying in size from 3 hectares to 7.59 hectares. The vegetated hill along the eastern boundary, has been set aside from the development to protect the vegetated hill area and to provide a buffer for the proposed residential lots from the adjacent SP3 zoned land, including the Morris Park Motor Sport Complex.

The proposed objectives for the proposal are for the zoning of the land to be changed as outlined above, with the more open land zoned RU2 Rural Landscape and the more heavily vegetated, steeper hill area zoned E3 Environmental Management. In addition, the application of a Minimum Lot Size of 3 hectares for the RU2 zoned land will allow the site to be ultimately developed for rural-residential purposes. The land proposed to be zoned E3 will have no dwelling entitlement.

Outcomes of Proposal

The proposal will allow for the development of the land proposed to be zoned RU2 Rural Landscape. A concept layout for this land has been prepared, creating up to 25 rural-residential lots, including one lot which will encompass the existing dwelling on the site.

Approximately 25.42 hectares of the site is proposed to be zoned E3 Environmental Management. This land includes the more heavily vegetated and steeper sloping land to the east of the site. This land will also act as a buffer for potential noise, smoke and dust emissions from Morris Park Motor Sport Complex located to the south-east of the site. The land zoned E3 Environmental Management is not proposed to have a dwelling entitlement, and will be retained in the ownership of the proponent.

The subject land is currently zoned SP3 Tourist under the Dubbo LEP 2012. The objectives of the SP3 Tourist zone are as follows:

- To provide for a variety of tourist-oriented development and related uses.
- To recognise the importance of the Taronga Western Plains Zoo as a key tourist facility with the area of the City of Dubbo.
- To facilitate tourist-oriented development along major transport corridors and at key nodes throughout the City of Dubbo.
- To ensure that further tourism related development in the Cobra Street and Whylandra Street precincts will not interfere with established uses on adjoining residentially zoned land.
- To ensure that development in the Camp Road precinct will not interfere with the continued operation of the Taronga Western Plains Zoo.

It is proposed to change the zoning of the land to RU2 Rural Landscape under the Dubbo Local Environmental Plan 2012. The objectives of the RU2 Rural Landscape zone are as follows:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To maintain the rural landscape character of the land.
- To provide for a range of compatible land uses, including extensive agriculture.

The changing of zone for the subject land from SP3 Tourist to RU2 Rural Landscape will not interfere with the operation of tourist facilities on adjoining land. In particular, Taronga Western Plains Zoo will not be adversely affected and any future development on the site will be sympathetic to adjacent land uses. In addition, the use of land zoned RU2 Rural Landscape for tourism purposes, including eco-tourist facilities, is permissible with consent.

It is proposed to change the Minimum Lot Size for the proposed RU2 Rural Landscape land to 3 hectares.

No dwelling entitlement is proposed for the E3 Environmental Management zoned land. This land is sloping and not well suited to either residential development or agricultural pursuits such as dryland cropping or grazing of stock. The proposed E3 land will constitute a buffer between the proposed RU2 land and the source of occasional noise, smoke and dust (Morris Park Motor Sport Complex). In addition, the proposed E3 land represents remnant vegetation, having never been cleared for farming. The creation of an E3 zone over this land is intended to protect this remnant vegetation. Nothing prevents the use of E3 land for ecologically friendly tourism-related activities.
Part 3: Justification

Questions to consider when demonstrating the justification

Q1: Is the planning proposal a result of any strategic study or report?

The subject planning proposal is not a direct result of any current strategic study or report by Dubbo Regional Council or the NSW Department of Planning.

Q2: Is the planning proposal the best means of achieving the objectives or intended outcomes, or is there a better way?

Alternative models of achieving the objectives of the subject planning proposal were considered, however the best way to achieve the proposed outcomes is the proposed rezoning and variation to the MLS mapping.
Q3: Is the planning proposal consistent with the objectives and actions of the applicable regional, sub-regional or district plan or strategy (including any exhibited draft plans or strategies)?

Dubbo Regional Council has provided the following information in relation to the Dubbo Urban Areas Development Strategy:

The subject land is currently zoned SP3 Tourist under the provisions of the Dubbo Local Environmental Plan 2011. Prior to the gazettal of the Dubbo LEP 2011, the land was zoned 3(d) Tourism and Leisure in accordance with the provisions of the former Dubbo Local Environmental Plan 1998 – Urban Areas.

Development of the Camp Road tourism precinct is included as a component part of the Dubbo Commercial Areas Development Strategy 1998. The following details the function and principles of the precinct:

"Camp Road Precinct
Action Plan for the Camp Road Precinct
Description
The Camp Road precinct south of Dubbo includes the land east of the Newell Highway to the river and down to properties fronting Camp Road. This area has been managed as rural but is now proposed to be incorporated into an extended urban LEP. As such its foremost role will be to ensure the rural areas to the immediate south remain buffered from the impacts of urban encroachment.

However, when considering what land uses would be most compatible with this objective it became evident that this area, which includes the Western Plains Zoo – a major tourism investment that is arguably the most significant single attraction in Rural NSW – was not comparable with any other part of the City. The current land use pattern is unique as it is dominated by tourist developments, it is in a crucial location close to the city, adjoins important transport routes and it is elevated and still partially vegetated.

These features identify the Camp Road – Zoo – Macquarie River locale as a distinct, separate precinct which already has unique tourism assets and potential for further tourism development."

"The role of the Camp Road Precinct is to provide a suitable environment for tourist attractions that are compatible with the Zoo and opportunities for a concentration of activities for visitors willing to extend their stay."

The subject planning proposal is generally consistent with the Dubbo Commercial Areas Development Strategy and previous Council resolutions as follows:

The proposed change to zoning and Minimum Lot Size will allow the land to be subdivided in the future, creating rural-residential lots in a self-contained development. The proposal includes a concept lot layout for future development
of the land, which provides dwelling envelopes located in such a way as to provide a buffer for adjoining agricultural land. It is considered that the impact of rural-residential development on the subject land is similar to the potential impact of tourism related development on the subject land.

Further to this and in consideration of the area of the subject land, any tourism related development on the subject land which is large enough to take advantage of the entire site is likely to have potential for significant impact on adjoining agricultural land. The range of possible future tourism uses for the subject land means that future tourism development could range from eco-tourism to a theme park, with varying levels of impact on adjoining land.

The objectives of the RU2 Rural Landscape zone are as follows:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To maintain the rural landscape character of the land.
- To provide for a range of compatible land uses, including extensive agriculture.

Land uses permitted in the RU2 Rural Landscape Zone are as follows:

Agricultural produce industries; Agriculture; Animal boarding or training establishments; Boat launching ramps; Camping grounds; Caravan parks; Cellar door premises; Child care centres; Community facilities; Correctional centres; Depots; Dwelling houses; Eco-tourist facilities; Educational establishments; Environmental facilities; Extractive industries; Farm buildings; Forestry; Group homes; Health consulting rooms; Highway service centres; Home businesses; Home industries; Industrial training facilities; Information and education facilities; Jetties; Mooring pens; Moorings; Open cut mining; Plant nurseries; Recreation areas; Recreation facilities (outdoor); Research stations; Respite day care centres; Secondary dwellings; Sewerage systems; Signage; Tourist and visitor accommodation; Truck depots; Water recreation structures; Water supply systems; Wharf or boating facilities

Nothing in the objectives, permitted or prohibited land uses of the RU2 Rural Landscape zone prevents the land being used for the purpose of an "Eco-Tourist facility" or "Tourist and Visitor Accommodation". The current tourism land uses in the Camp Road Precinct include a vineyard, bed-and-breakfast (approved), and Observatory. Any similar tourism related development on the subject land would be compatible with the objectives and permissible land uses of the RU2 Rural Landscape zone.

The possible future subdivision of the subject land enables the introduction of smaller tourism enterprises if there is sufficient demand. The provision of smaller lots in the RU2 Rural Landscape zone may, in fact, allow more tourism related development on the subject land than if the current layout of one large lot is
retained. In addition, the RU2 Rural Landscape zone has the ability to act as a buffer between adjacent agricultural land and the current SP2 Tourism zoned land on Camp Road.

The subject planning proposal is generally consistent with the objectives and actions of the Dubbo Urban Areas Development Strategy.

**Background**

The subject land is currently zoned SP3 Tourist under the Dubbo LEP 2012. The land directly west, north, and east of the subject land is also zoned SP3 Tourist. Land to the south of the subject land is zoned RU1 Primary Production under the Dubbo LEP 2012.

Lots to the west, north and east have existing dwellings and tourist facilities upon them. All of the lots in the immediate area have areas of less than 800 hectares. The layout of the land boundaries and dwellings in the area largely conforms with the objectives of the RU2 Rural Landscape zone under the Dubbo LEP 2012, providing residential housing in a rural setting.

The proposed changing of zone and minimum lot size will allow the development of the subject land in such a way that potential impacts on environmentally sensitive locations are minimised and scenic quality of the area is not adversely affected. A proposed layout for the subdivision of the land sets aside a large part of the land, reserving it from the residential development, while retaining sufficient land for 25 dwelling lots. Dwelling envelopes have been provided on each lot with locations chosen to minimise impact on existing vegetation and vulnerable land forms such as water courses.

The rezoning of the subject land and the application of a minimum lot size is likely to decrease the potential future demand for public services and public facilities. Under the current zoning of SP3 Tourist, the site could be developed to a high level for tourist accommodation and facilities. Such development generates a high demand for public services and public facilities based on the turnover of visitors and higher potential number of accommodation units which could be placed upon the land.
Adjoining land to the south is currently zoned RU1 Primary Production with a minimum lot size of 800 hectares. Adjoining land to the north and east is currently zoned SP3 Tourist with no prescribed minimum lot size. Directly adjoining lots, with sizes are listed below:

<table>
<thead>
<tr>
<th>Lot and DP</th>
<th>Address</th>
<th>Zoning</th>
<th>Area (Approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot 6 DP249414</td>
<td>21L Camp Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>16.44 Ha</td>
</tr>
<tr>
<td>Lot 1942 DP666937</td>
<td>20L Camp Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>10.10 Ha</td>
</tr>
<tr>
<td>Lot 1 DP1017984</td>
<td>18L Camp Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>8.341 Ha</td>
</tr>
<tr>
<td>Lot 4 DP1033752</td>
<td>16L Camp Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>5.391 Ha</td>
</tr>
<tr>
<td>Lot 5 DP1033752</td>
<td>14L Camp Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>6.964 Ha</td>
</tr>
<tr>
<td>Lot 5 DP1062444</td>
<td>3L Camp Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>7.263 Ha</td>
</tr>
<tr>
<td>Lot 3 DP1062444</td>
<td>40R Obley Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>6.158 Ha</td>
</tr>
<tr>
<td>Lot 2 DP1062444</td>
<td>42R Obley Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>5.731 Ha</td>
</tr>
<tr>
<td>Lot 1 DP1082444</td>
<td>44R Obley Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>6.253 Ha</td>
</tr>
<tr>
<td>Lot 237 DP40152</td>
<td>48R Obley Road, Dubbo</td>
<td>SP3 Tourist</td>
<td>14.31 Ha</td>
</tr>
<tr>
<td>Lot 205 DP753233</td>
<td>48R Obley Road, Dubbo</td>
<td>RU1 Primary Production</td>
<td>36.42 Ha</td>
</tr>
<tr>
<td>Lot 138 DP753233</td>
<td>Obley Road, Dubbo</td>
<td>RU1 Primary Production</td>
<td>16.19 Ha</td>
</tr>
<tr>
<td>Lot 162 DP753233</td>
<td>48R Obley Road, Dubbo</td>
<td>RU1 Primary Production</td>
<td>23.98 Ha</td>
</tr>
<tr>
<td>Lot 163 DP753233</td>
<td>46L Peak Hill Road, Dubbo</td>
<td>RU1 Primary Production</td>
<td>50.99 Ha</td>
</tr>
</tbody>
</table>

Of the lots above, Lot 163 DP753233 and Lot 205 DP753233 are part of larger holdings. Lot 163 DP753233 is part of a holding with a total area of 866.6 hectares. Lot 205 DP753233 is part of a holding with a total area of 74.28 hectares.

The impact on the adjoining land of changing the zone and applying a 3 hectare minimum lot size to the subject land is anticipated to be minimal. Sufficient buffers between potential dwelling sites and adjoining land have been provided. Rural-residential land uses are not incompatible with either Tourist or Primary Production land uses. The adjoining land zoned RU1 Primary Production consists of lots and holdings that are all less than the prescribed minimum lot size. The existing adjoining lots zoned RU1 Primary Production are between 6% and 2% of the prescribed minimum lot size.

The amendment to the Minimum Lot Size mapping to reflect a 3 hectare minimum lot size on the subject land is unlikely to adversely affect adjoining land. The proposed changes to the zone and Minimum Lot Size will result in a satisfactory outcome for the subject land and adjoining land.

Impacts on scenic quality and environmentally sensitive locations caused by the existing housing density are difficult to assess. Given the long-term nature of development in the area, occurring over the past 150 years, it would appear that the most obvious and noticeable change on the site would have been caused immediately following the initial occupation by European settlers. The land would have been cleared with the intention of being used for agricultural purposes,
fences constructed and dwellings erected. In subsequent years, changes would have been more incremental, including updated and additional dwellings.

The subject land was first surveyed in 1906, consisting of two separate portions of land, being Portions 194 and 195 in the Parish of Dubbo, County of Gordon. At the time of the initial survey, both portion 194 and 195 were vacant, with the only improvements listed being fencing of nominal value. The two portions, 194 and 195, which were subdivided to form the subject land, were shown in separate ownership on the original plans. The land was described in some detail on the plans, with vegetated areas and topography shown diagrammatically. Copies of the original portion plans for the subject land can be seen in Appendix A.

In 1906, portions 194 and 195 had thick gum, pine and she-oak on the stony ridge, with open box and pine vegetation on the gentler slopes to the west. In general, the vegetation as annotated on the original plans of survey matches the vegetation on site today although it is apparent that some clearing of the site has taken place.

In the years between the initial occupation and the present, the land has remained largely unchanged, with minimal additional impact caused by the construction of dwellings on the lots.

**Demand**

Demand for rural lifestyle lots in the Dubbo area is quite high. As at 6 July 2016, only 7 vacant rural lifestyle properties in excess of 2 hectares were listed on realestate.com.au in the Dubbo and Wellington areas. Of those listed, the majority had land areas in excess of 10 hectares, which puts them in a different class to the proposed development. In close proximity to Dubbo, there are very few opportunities for rural lifestyle development, with the subject land offering short travel times to the Dubbo CBD. Future road links will increase the connectivity to and from Dubbo.

The Dubbo Zirconia Project is commencing work and is anticipated to employ over 240 people to staff their mining and processing operations. The Dubbo Zirconia Project is located at Toongi and will be accessed from Dubbo via Obeley Road. It can reasonably be expected that, if the rezoning proposal and subsequent development occurs, many employees of the Dubbo Zirconia Project will find the subject land an attractive place to live. The subject land is located close to Dubbo, however will save employees of the Dubbo Zirconia Project travel time to work and offer an attractive rural-residential lifestyle.
Land Use

The subject land is currently used for dryland agriculture including grazing of stock. The land has one dwelling standing upon it with associated outbuildings. The existing dwelling is located on the north-eastern portion of the land. The agricultural capacity of the land is not sufficient for the land to be self-supporting in a financial sense. As such, the land is a “lifestyle block” allowing rural residential living in close proximity to the city of Dubbo. If the subject land were to be sold it could be expected that a new owner/s would have at least one occupant with a full-time job to supplement any income generated by agricultural pursuits on the land.

Permitted land uses in the SP3 zone include Aquaculture; Cellar door premises; Food and drink premises; Health consulting rooms; Markets; Medical centres; Roadside stalls; Shop top housing; Tourist and visitor accommodation; Viticulture; Waste or resource transfer stations; Water reticulation systems and any other development that is not prohibited. Due to the nature of tourism, most tourism developments are likely to generate traffic and waste, with potential for noise impacts and increased demand for services.

In relation to the subject land, the large area available for development means that there is potential for tourism development on a very large scale. Approximately 47 hectares of the total area of the site consists of heavily vegetated land. This leaves approximately 85 hectares available for development for tourism purposes without the requirement for clearing. Existing tourism development in the area includes a vineyard and cellar door as well as several tourist accommodation developments.

If the site were developed for tourist accommodation purposes, it is estimated that up to 600 individual accommodation units could be placed upon the site. This figure is subject to approval and economic feasibility, however the impact of a single large tourism focused development on the subject land is likely to be significant.

Under the proposed rezoning, the future development of the land will be limited by lot size, vegetation and topography. A proposed layout for the subdivision of the subject land has been prepared, with a maximum of 25 dwelling lots. This layout provides for dwelling envelopes that have minimal impact on existing vegetation and sets aside a large area to the east of the site as a vegetated buffer. The proposal requires the construction of approximately 2200 metres of road as well as services required for rural residential development.

When considering an appropriate layout for the subdivision of the land, the total area of 131.9 hectares can yield 25 dwelling lots with a nominal size of 5 hectares each. By setting aside 25 hectares of land to provide a buffer and protect the story vegetated ridge, a minimum lot size of 3 hectares is required in order to achieve the same yield of 25 dwelling lots. The potential impact of rural
residential development on the subject land, while significant, is manageable and limited by the proposed minimum lot size.

**Topography and Vegetation**

The site is gently undulating, with an overall slope from south to north. The western and northern portions of the site are gently sloping with established grasses and scattered old growth eucalypt and regrowth eucalypt trees, with some black pine scrub. A small watercourse flows through western portion of the land from south to north. The eastern portion of the land encompasses a small hill that is heavily vegetated with regrowth native eucalypt trees and invasive black pine scrub.

The soil on the site varies depending on the topography. The lower, more gently sloping land has heavier and more fertile soil consisting of sandy loam. Land situated on the slopes of the hill on the eastern side of the subject land is infertile light sandy loam.

**Bushfire Prone Land**

The subject land is partially identified as bushfire prone. The bushfire prone land is largely limited by the hilly vegetated land to the east of the site. Where dwellings are proposed on bushfire prone land, consideration must be given to the predominant vegetation, effective slope of the land, fire weather, fire intensity and building classification. These factors are used to design an appropriate asset protection zone.

The vegetation on the site, as described above, most closely conforms to a vegetation class formation of Central Western Grasslands for most proposed building sites. Where sites are located near the vegetated hilly area of the site, the vegetation classification more closely conforms to a vegetation class formation of Dry Sclerophyll Forests with Shrubby sub formation. Proposed dwelling sites have been located downslope from the vegetated hilly land which poses the greatest risk in terms of bushfire attack. The effective slope from proposed dwelling sites in the direction of the bushfire prone land has been measured using LiDAR data, with a maximum value of 9% slope or 5.8°. All upslope vegetation is considered to have an effective slope classification of [i] or 0°. When considering downslope vegetation, all proposed dwelling sites have a predominant downslope vegetation classification of Central Western Grasslands. Effective downslopes have been measured using LiDAR data, with average downslopes of 2.5°, and maximum downslopes of 3.3°. This gives an effective downslope classification of [ii] >0 to 5° downslope vegetation.

The Dubbo area falls within the Lower Central West Plains Fire Weather Area, with a Fire Danger Index (FDI) of 80.
Planning for Bushfire Protection 2006, Appendix 2, Section 2.3 (d) states:

*Grasslands of 100 metres from any boundary (subdivision) or buildings (SFPPs) do not require construction requirements in conformity with AS 3959 – 1999 or this document but requires an APZ of 10 metres for slopes <18°.*

In consideration of upslope or >0.5° downslope Dry Sclerophyll Forests with Shrubby sub formation vegetation in FDI 80 areas, Table A2.5 of Planning for Bushfire Protection requires an asset protection zone of 20 or 25 metres respectively based on a construction level of 3. For a Level 1 construction, separation distances of 23 to 100m are required to the predominant vegetation. All lots shown on the proposed site plan in Appendix B have sufficient area to provide setbacks to boundaries of at least 25 metres.

An APZ consists of two areas, an Inner Protection Area (IPA) and an Outer Protection Area (OPA). The OPA serves to reduce the potential length of the flames, filtering embers and reducing the likelihood of crown fire. The OPA should provide tree canopy cover of less than 30% and should have the understorey managed (mowed) to treat all shrubs and grasses on an annual basis in advance of the fire season. The IPA is critical and provides a defendable space and manages heat intensities at the building surface. The IPA should provide tree canopy cover of less than 15% and should be located greater than 2 metres from any part of the roofline of the dwelling. Garden beds of flammable shrubs are not to be located under trees and should be no closer than 10 metres from an exposed window or door. Trees should have lower limbs removed up to a height of 2 metres above the ground.

A diagram explaining asset protection zones is shown below:
If an adequate APZ is not able to be provided within the subject land, the level of construction of the dwelling will have to be increased. Bushfire mapping for the subject land can be seen below:

Planning for Bushfire Protection 2006 requires that any LEP amendment which changes the zoning and/or land use of bushfire prone land address the following items:

*Planning Principles for Rezoning to Residential Land in Bush Fire Prone Areas*

- (a) Provision of a perimeter road with two way access which delineates the extent of the intended development;
- (b) Provision, at the urban bushland interface, for the establishment of adequate asset protection zones for future housing;
- (c) Specifying minimum residential lot depths to accommodate asset protection zones for lots on perimeter roads;
- (d) Minimising the perimeter of the area of land, interfacing the hazard, which may be developed;
- (e) Introduction of controls which avoid placing inappropriate developments in hazardous areas; and
- (f) Introduction of controls on the placement of combustible materials in asset protection zones.
The planning proposal meets the requirements of Planning for Bushfire Protection 2006 as follows:

a) The proposed road servicing the development is a through road. Where lots are serviced by a cul-de-sac, the land is not classified as bushfire prone. In the land not classified as bushfire prone, there is a perimeter road (crown road). This crown road could be formed to provide suitable access for rural fire service vehicles. Proposed dwelling lots within the bushfire prone land are situated with the fire danger areas upslope and have frontage to a fully formed and sealed proposed through road. Such access is considered adequate.

b) Adequate asset protection zones are able to be provided as outlined above.

c) All lots in the concept layout plan provided have been designed with consideration for provision of adequate asset protection zones.

d) Minimal development is proposed in land which is classified as bushfire prone. The interface between the proposed development and the hazard has been minimised by the lot design.

e) No inappropriate development is proposed on the subject land. Controls are currently in place at development application stage for bushfire hazard, requiring a Bushfire Assessment Report to be prepared and submitted to Rural Fire Service NSW with a development application for subdivision. Any dwelling proposed within bushfire prone land must meet the requirements of Planning for Bushfire Protection 2006.

f) It is possible for Council to require asset protection zones to be created on dwelling lots within bushfire prone areas. This can be done at development consent by way of a condition requiring a restriction on the use of land which ensures that the land will create and maintain an asset protection zone over the land. The possible wording for such a restriction is as follows:

Land shown as (A) on the plan must be maintained as an Asset Protection Zone for bush fire fighting purposes. The Asset Protection Zone is to be a buffer zone between a bush fire hazard and the dwelling envelope which is managed to reduce potential radiant heat levels, flame ember and smoke attack. The Asset Protection Zone should provide tree cover of less than 15% and should be located further than 2 metres from any part of the roofline of a dwelling. Garden beds of flammable shrubs are not to be located under trees and should be no closer than 10 metres to an exposed window or door. Trees should have lower limbs removed up to a height of 2 metres above the ground. Understorey vegetation should be managed (mowed) to treat all shrubs and grasses on an annual basis in advance of the fire season.
**Site Access and Traffic**

The subject land is currently accessed from Camp Road. Camp Road is a bitumen sealed two-way through road, connecting to Obley Road approximately 400 metres to the east of the subject land and to the Newell Highway approximately 3.2km to the west of the subject land.

Obley Road is a bitumen sealed two-way through road, and is in the process of being upgraded to cater for additional traffic loads anticipated to be generated by the commencement of the Dubbo Zirconia Project at Toongil. Obley Road will be constructed to cater for heavy vehicle traffic, with an expected 150 heavy vehicles per day using the road, as well as passenger vehicles accessing the Dubbo Zirconia Project and typical traffic currently using the road. The intersection of Camp Road with Obley Road provides adequate site distance in both directions, and the road has been widened to allow for merging traffic. Some upgrade of this intersection may be required if the subject land is rezoned, however until a development application is submitted with a specified number of lots it is not possible to determine whether such an upgrade is necessary.

Traffic accessing Dubbo from the subject land is anticipated to follow a route along Camp Road to Obley Road, then north to the Newell Highway. The intersection of Obley Road with the Newell Highway is currently an uncontrolled intersection with a channelised arrangement of turning and merging lanes. This intersection arrangement is anticipated to be adequate for the potential added traffic if the subject land is rezoned and subsequently developed for rural-residential purposes.

In addition to the Camp Road access, the subject land has frontage to Belowrie Road at the southern end of the site. Belowrie Road is currently a gravel sealed two-way rural road, catering for several rural dwellings at the western end and for Morris Park Motor Sport Complex at the eastern end. Belowrie Road meets Obley Road at an uncontrolled intersection. Sight distance at this intersection is marginal to adequate, and it is doubtful whether this intersection has been designed with consideration to the levels of traffic using it to access Morris Park Motor Sport Complex. As the site is classified Bushfire Prone, a second access may be required. This will provide a second escape route from the subject land if the other access is blocked due to bush fire. The proponent would prefer to use Belowrie Road as an emergency access only, however recognises that Council may require Belowrie Road to be upgraded and opened as a trafficable road. If Belowrie Road is upgraded and used as access for the site, it is anticipated that about 20% of the land will use Belowrie Road for access.

While a final lot layout has not been determined, the proposed site plan in Appendix B, creating 25 dwelling lots, is a possible future layout. On this layout, it can be anticipated that Lots 16-18 would utilise Belowrie Road for access, while Lots 15 and 19 may use either Belowrie Road or Camp Road. All other dwelling lots would be most likely to use Camp Road for access. If the land is rezoned in
accordance with this proposal, and a development application is subsequent submitted for the subdivision of the land, the proponent will investigate more thoroughly the road layout and costs involved with upgrading Belowie Road.

**Connection to Services**

The subject land is currently connected to overhead electricity and underground telecommunications services. These services can be extended to service the development of the subject land in the future.

Reticulated water services currently exist at Obley Road with an extension proposed to service Camp Road. A water reticulation analysis has been undertaken to determine whether the subject land can be provided water from the existing infrastructure. Pressure and capacity for the provision of water to the subject land have been determined to be adequate. In addition, it is anticipated that most dwellings constructed on the subject land will have rainwater tanks installed. This assists home designers in meeting the requirements of BASIX as well as bushfire requirements. Planning for Bushfire Protection requires for subdivisions creating rural/lifestyle lots in excess of 1 hectare in size and with no access to reticulated water to provide a minimum of 20,000 litres static water per lot, dedicated to fire fighting. Where reticulated water supply is available, fire hydrants are to be spaced and sized in accordance with AS2419.1 – 2005. It is anticipated that all requirements in relation to water supply and firefighting provisions can be met.

Currently, the site utilises on-site sewage treatment, with a septic system. Lots to the east of the subject land have access to a low capacity sewer effluent line, which drains overflow from septic tanks on each site. If the land is rezoned and an application to subdivide submitted, it will be proposed that sewage be managed by bio-environmental on-site systems.

Currently, the site is undeveloped and rainfall runoff follows natural overland flow paths to established creeks. Due to the nature of the proposed rezoning and likely form of development on the site, proposed roads will not have kerb and guttering and a piped stormwater system. Water sensitive urban design principles including grassed swales beside roads will be adopted to direct stormwater flows to natural drainage channels. Runoff from proposed dwellings and outbuildings is anticipated to be largely captured by rainwater tanks. Runoff from hardstands and driveways within proposed lots is anticipated to be directed to road swales and then to natural drainage channels. If the rezoning is successful, a design for civil works including disposal of stormwater will be submitted with any subsequent development application for subdivision of the land.

Reticulated gas is not anticipated to be provided to the subject land.
Flora and Fauna

Impax Group were engaged to prepare a Flora and Fauna Assessment on the subject land to determine what, if any, species of flora and fauna are likely to be impacted by subsequent development on the site. The assessment identified several threatened species which may exist upon the subject land:

1. Pine Donkey Orchid – Diuris tricolor
2. Glossy Black-Cockatoo – Calyptorhynchus lathamii
3. Grey-crowned Babbler – Pomatostomus temporalis temporalis

Of these threatened species, the likelihood of the Pine Donkey Orchid occurring at the site is considered low. The likelihood of the Glossy Black Cockatoo occurring at the site is considered low and no suitable sheoak feed species were observed within the site. The likelihood of the Grey Crowned Babbler occurring at the site is considered moderate, with suitable open box woodland being present on the site for habitat. The assessment concludes that the proposed development is expected to have a low potential impact upon biodiversity, threatened flora species or fauna species at the site.

Further analysis of the site has been undertaken, considering the proportions of dense vegetation (specifically trees and shrubs) which will potentially be cleared if the planning proposal goes ahead. Approximately 2.16% (2081 hectares) of the dense vegetation on site is likely to be cleared for road construction and dwelling envelopes if the planning proposal goes ahead. All proposed vegetation clearing that will occur as part of the planning proposal would be undertaken to the minimum extent necessary and would therefore be considered a Routine Agricultural Management Activity under the NSW Native Vegetation Act 2003, and may be undertaken without a permit.

Groundwater Impacts

Impax Group were engaged to prepare a Groundwater Assessment to determine whether the site is vulnerable to groundwater contamination or damage to aquifers by subsequent development on site.

The groundwater assessment found that the soil types on site are consistent with the ‘Euromogo’ soil type on cleared areas, and the ‘Splitters Hill’ soil type on the central rocky outcrop. Euromogo soils described as low to moderate fertility, reddish brown fine sandy clay loam overlain with mottled yellow and grey clay. Splitters Hill soils are described as moderate fertility, mainly red podzolic soils with non-calcareous brown soils on the lower slopes with shallow soils on steep/rocky slopes and small areas of red-brown earths and red earths in association with red podzolic soils. The assessment indicates that there does not appear to be a significant aquifer used for beneficial purposes below the site.
The report identified likely future activities which have potential to impact upon groundwater, as follows:

1. Standard household garden water use practices resulting in an increase in the amount of water being applied at the site;
2. Rainwater run-off from additional hard stand areas resulting in an increased concentration of water being applied at the site; and
3. The installation of an onsite sewage management system resulting in an increase in the amount of water being applied at the site (in the event that the development is not connected to the Dubbo sewerage system).

The report recommended multiple mitigation measures which could be implemented to minimise the impact of any subsequent rural-residential development on the site (see Recommended Mitigation Measures, Page 12, Report by Impax Group 2016-022 RPI).

**Non-Aboriginal Archaeological Heritage**

Impax Group were engaged to prepare an assessment of non-Aboriginal Heritage items on or near the site and potential impacts of developing the land for rural-residential purposes in the future. No items of heritage value were found on the site, and no items of heritage value were expected to be impacted by subsequent development of the land for rural-residential purposes.

**Aboriginal Archaeological Heritage**

Impax Group were engaged to prepare an assessment of Aboriginal Heritage items on the site. As such, a review of an existing Aboriginal Archaeological Assessment Report was conducted and related to the current proposal. Impax Group reviewed the document titled "An Archaeological Assessment for the Proposed "Glenn Lee" Tourism Development, Camp Road, Dubbo, NSW." This report was prepared in 1995 by Central West Archaeological and Heritage Services in December 1995. The report considered a study area which included the subject land. The report identified a total of eight open camp sites, two scarred tree sites and one isolated artefact within the study area. Of the eleven identified sites, six were located within the subject land, comprising four open camp sites and two scarred tree sites.

The report by Impax Group considered the potential impacts of development on the site in relation to Aboriginal Heritage items, in accordance with the NSW Due Diligence Code of Practice. The report concludes that the proposed development should be able to proceed without impacting on any Aboriginal Sites, provided the development complies with its legal obligations under the NSW National Parks and Wildlife Act 1974.
A plan showing the location of the identified Aboriginal Archaeological sites within the subject land has been included in Part 4 (Appendix A).
Preliminary Contamination Investigation

Impax Group were engaged to prepare a site history and preliminary contamination investigation on the subject land. This assessment utilised historical records including title information, aerial photography and other records. Soil sampling was undertaken on site with the samples analysed for organochlorine and organophosphorus pesticides (OCPs and OPPs), priority heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, mercury and zinc), pH and electrical conductivity (EC). The study concludes that no potentially contaminating activities have been undertaken at the site. Concentrations of common contaminants of concern within soils at the study area were below the threshold concentrations for residential land use. The soil within the study area is considered suitable for the proposed development with regards to contamination.
Noise (Adjoining land – Morris Park Motor Sport Complex)

Background

Morris Park Motor Sport Complex, located to the south east of the subject land, regularly holds motorsport competitions including off-road motorcycle events, speedway events and occasionally burnout competitions. Noise generated by motorsport events at Morris Park has been raised by Western Plains Regional Council as an issue to be addressed prior to any development on the site. Noise and Sound Services, were engaged to prepare an assessment of noise from motor sports in relation to the subject land.

Noise Assessment

The noise assessment was carried out during a speedway event on 7 May 2016. This event featured Super Sedans in a NSW title race. Qualifying and racing occurred from late afternoon until approximately midnight. Approximately 25 cars were entered in the event.

The noise assessment concluded that the internal noise criteria set out in SEPP (Infrastructure) 2007, Subdivision 2, Clause 102, can be met. The report submitted by Noise and Sound Services recommended several measures to be adopted in construction of future dwellings on the subject land in order that the noise emitted by Morris Park not exceed the internal noise criteria.
Conclusion

The impact upon the subject land of noise from the Morris Park Motor Sport Complex is considered to be minimal. Separation distances have been provided and expected noise levels within dwellings constructed on the subject land in future can meet the requirements of SEPP (Infrastructure) 2007. The prevailing wind direction and speed is such that noise generated by any activity at Morris Park Motor Sport Complex is likely to be directed generally away from the subject land. Motor sport events at Morris Park Motor Sport Complex are held regularly, averaging 12 events per year. Noise from motor sport events and held at Morris Park Motor Sport Complex is not likely to cause health issues to occupants of proposed lots within the subject land.

Recommendations

Noise from motor sport events at Morris Park may be considered to be a nuisance by residents nearby. In the interests of informing potential purchasers of land that such a nuisance may exist, it is recommended that Western Plains Regional Council utilise a notation on a Section 149(5) certificate for each lot created upon the subject land. In this way potential purchasers can see prior to purchase that the site is liable to be occasionally subjected to noise from motor sports.

It is noted that sales of land in NSW are subject to the Caveat Emptor rule, or Buyer Beware. It is legislated that a Section 149 certificate is a required vendor disclosure statement. Despite this, a Section 149(5) certificate is not always requested. The option to request a Section 149(5) certificate, if not taken up, is considered to be a risk by the purchaser. It is also considered unlikely, given the anticipated lot size and expected sale prices, that prospective purchasers of land will forgo the Section 149(5) certificate.

In order to ensure that potential purchasers are aware of the issue relating to noise, a positive covenant or restriction on the use of land could be created upon each dwelling lot, stating that each lot is liable to be occasionally subject to noise from motorsport at Morris Park and specifying minimum sound levels which can be considered to be more than a nuisance. A covenant is a restriction on the use of land and must contain at least one clause that restricts the use of the land. Not all clauses of the covenant or restriction on the use of land must be restrictive. If Council conditions any approval for subdivision of the land such that, for example, dwelling envelopes are required on dwelling lots, this can be created as either a covenant or restriction on the use of land, with one clause referring to the potential noise impact.

Plans of the land and related documents, such as a Section 88B instrument, must be included with a contract for the sale of land. Unfortunately, the likelihood
of a potential purchaser reading through a Section 88B instrument is similar to them reading and understanding a Section 149(5) certificate. After researching several similar sites in NSW, the most similar was found in Lismore, where a motorsport facility is located near new residential development. Council in this case created a clause in their DCP (Part B Chapter 10, Section 7.3) which specifies advisory acoustic controls for new dwellings within the area impacted by noise generated by motorsport events.

"New dwellings and alterations and additions to existing dwellings can be constructed without acoustic controls pursuant to the provisions of State Environmental Planning Policy (Exempt and Complying Development Codes) 2008. Consequently, these acoustic controls are advisory only and not a compulsory requirement."

The model adopted by Lismore City Council is considered less effective than a Section 149(5) notation, as it occurs at the time of application for a dwelling, after the land has been purchased. If Dubbo Regional Council is concerned about the noise issues, potential purchasers must have the information available at the time of purchase. The only way for purchasers to find the DCP requirements under the Lismore City Council model is to obtain a Section 149(5) certificate. An alternative to a Section 149(5) notation is the creation of a restriction on the use of land likely to be affected by noise from the motorsport activities which will be noted on the certificate of title for each lot.
### Objective

- To protect the population from noise generated from new existing and proposed operations of nearby commercial and industrial land uses and to extend this to the Murrumbeena Shopping Centre, Murrumbeena, Cheltenham, Cheltenham Central, and local residents.

### Performance Criteria (advisory only)

<table>
<thead>
<tr>
<th>A1</th>
<th>Dwellings located at the 55 dBA noise contour line (refer to Appendix E - Noise Contour Map) or greater, meet the acceptable solutions listed below.</th>
</tr>
</thead>
</table>
| A2 | 55 dBA to 60 dBA:  
- Provision of air-conditioning or sealed mechanical ventilation to habitable rooms;  
- Laminated glass in operable acoustic grade frames and seals for windows and sliding doors (Rw rating 25 – 30) of habitable rooms;  
- Standard wall and roof ceiling constructions. |
| A3 | 60 dBA to 65 dBA:  
- Provision of air-conditioning or sealed mechanical ventilation to habitable rooms;  
- Laminated glass in operable acoustic grade frames and seals for windows and sliding doors (Rw rating 25 – 30) of habitable rooms;  
- Standard wall and roof ceiling constructions. |
| A4 | 65 dBA to 70 dBA:  
- Provision of air-conditioning or sealed mechanical ventilation to habitable rooms;  
- Laminated glass (Rw rating 30 – 35) in operable acoustic grade frames and seals for windows and sliding doors;  
- Standard wall and roof ceiling constructions. |
| A5 | 70 dBA to 72 dBA:  
- Provision of air-conditioning or sealed mechanical ventilation to habitable rooms;  
- Laminated glass or double glazing in acoustic grade frames and seals for windows and sliding doors (Rw rating 35 – 37);  
- Standard wall and roof ceiling constructions with insulation baffles in voids. |

### Acceptable Solutions (advisory only)

<table>
<thead>
<tr>
<th>A1</th>
<th>Dwellings located at the 55 dBA noise contour line (refer to Appendix E - Noise Contour Map) or greater, meet the acceptable solutions listed below.</th>
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</thead>
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- Laminated glass in operable acoustic grade frames and seals for windows and sliding doors (Rw rating 25 – 30) of habitable rooms;  
- Standard wall and roof ceiling constructions. |
| A3 | 60 dBA to 65 dBA:  
- Provision of air-conditioning or sealed mechanical ventilation to habitable rooms;  
- Laminated glass in operable acoustic grade frames and seals for windows and sliding doors (Rw rating 25 – 30) of habitable rooms;  
- Standard wall and roof ceiling constructions. |
| A4 | 65 dBA to 70 dBA:  
- Provision of air-conditioning or sealed mechanical ventilation to habitable rooms;  
- Laminated glass (Rw rating 30 – 35) in operable acoustic grade frames and seals for windows and sliding doors;  
- Standard wall and roof ceiling constructions. |
| A5 | 70 dBA to 72 dBA:  
- Provision of air-conditioning or sealed mechanical ventilation to habitable rooms;  
- Laminated glass or double glazing in acoustic grade frames and seals for windows and sliding doors (Rw rating 35 – 37);  
- Standard wall and roof ceiling constructions with insulation baffles in voids. |
Smoke/Dust – Morris Park Motor Sport Complex

Background

Morris Park Motor Sport Complex, located to the south east of the subject land, occasionally holds burnout competitions. Smoke from burnout competitions has been raised by Western Plains Regional Council as an issue to be addressed prior to any development on the site. Contact with various consultants and the NSW Environmental Protection Authority have provided information in relation to air quality, however specific reference to burnout completion tyre smoke and dust does not currently exist.

Levels of particulate matter with particles less than 10 µm in diameter (PM$_{10}$) is a method used to assess ambient air quality according to the National Environment Protection (Ambient Air Quality) Measure (NEPM). Fine particles with a diameter of less than 2.5 µm (PM$_{2.5}$) are also subject to reporting standards.

The current compliance standard for particles categorised as PM$_{10}$ is 50 µg/m$^3$ averaged over 24 hours and the maximum concentration averaged over a year is 25 µg/m$^3$. No exceedances of PM$_{10}$ concentrations greater than 50 µg/m$^3$ are permitted per year under the National Environment Protection (Ambient Air Quality) Measure (as amended). The current advisory reporting standard for PM$_{2.5}$ in ambient air is 25 µg/m$^3$ averaged over 24 hours and the maximum concentration averaged over a year is 8 µg/m$^3$ per year. No exceedances of PM$_{2.5}$ concentrations greater than 25 µg/m$^3$ are permitted under the National Environment Protection (Ambient Air Quality) Measure (as amended).

<table>
<thead>
<tr>
<th>Item</th>
<th>Pollutant</th>
<th>Averaging Period</th>
<th>Maximum Concentration Standard</th>
<th>Maximum Allowable Exceedances</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Carbon monoxide</td>
<td>8 hours</td>
<td>9.0 ppm</td>
<td>1 day a year</td>
</tr>
<tr>
<td>2</td>
<td>Nitrogen dioxide</td>
<td>1 hour 1 year</td>
<td>0.12 ppm 0.03 ppm</td>
<td>1 day a year 1 day a year</td>
</tr>
<tr>
<td>3</td>
<td>Photochemical oxidants (as ozone)</td>
<td>1 hour 4 hours</td>
<td>0.10 ppm 0.08 ppm</td>
<td>1 day a year 1 day a year</td>
</tr>
<tr>
<td>4</td>
<td>Sulfur dioxide</td>
<td>1 hour 1 day 1 year</td>
<td>0.20 ppm 0.08 ppm 0.02 ppm</td>
<td>1 day a year 1 day a year None</td>
</tr>
<tr>
<td>5</td>
<td>Lead</td>
<td>1 year</td>
<td>0.50 µg/m$^3$</td>
<td>None</td>
</tr>
<tr>
<td>6</td>
<td>Particles as PM$_{10}$</td>
<td>1 day 1 year</td>
<td>50 µg/m$^3$ 25 µg/m$^3$</td>
<td>None  None</td>
</tr>
<tr>
<td>7</td>
<td>Particles as PM$_{2.5}$</td>
<td>1 day 1 year</td>
<td>25 µg/m$^3$ 8 µg/m$^3$</td>
<td>None  None</td>
</tr>
</tbody>
</table>

Table 1 – Standards for Pollutants (NEPM)
There are health implications related to particle emissions. Particulates with diameter greater than 10μm collect in the hairs of nose and throat and are eliminated by coughing and blowing the nose. Particulates with diameter between 10μm and 2.5μm are usually trapped in the upper respiratory system. Particles with diameter less than 2.5μm can make their way to the air sacs in the lungs (alveoli). These particles are of most concern in relation to health. The NSW Environmental Protection Authority document *Managing Particles and Improving Air Quality in NSW* states, in part:

“Unlike larger particles, these smaller particles invisible to the naked eye can be breathed deep into the lungs and even pass into the bloodstream. They also travel under the influence of wind and weather and can produce effects many kilometres from their source. Long and short-term exposure to particles is linked to an increased risk of respiratory and cardiovascular disease and of death from those diseases. Long-term exposure is most harmful and those most affected by particle pollution are the elderly, children and people with existing cardiovascular and respiratory health conditions. The evidence is clear that long-term exposure to PM2.5 has a larger health effect than short-term exposure, indicating that strategies that provide long-term reductions in fine particle pollution are likely to produce the greatest health benefit.”
Tyre Burnout Smoke/Dust

Monitoring of burnout smoke has been undertaken for the Summernats car show in Canberra. Monitoring and reporting occurred during the 2010 Summernats car show from 8 January 2010 until 11 January 2010. PM$_{10}$ concentrations were measured at two locations adjacent to the site. The consultant, Robson Environmental Pty Ltd, offered the opinion that “Summernats activities appeared to have an adverse effect on both PM$_{10}$ and atmospheric metal (copper, lead and chromium) concentrations; although none of the concentrations exceeded the Australian NEPM $^{24}$ of 50µg/m$^3$ for PM$_{10}$ in ambient air or 0.5µg/m$^3$ for atmospheric lead.”

Further to this, a peak in real-time PM$_{10}$ concentrations corresponded with main stage activities including the Summernats concert and fireworks. According to the report by Robson Environmental Pty Ltd, fireworks have been reported to cause increases in ambient PM$_{10}$ concentrations, as well as atmospheric concentrations of lead and copper. The report stated that fireworks at Summernats may have contributed to the increases in lead and copper concentrations detected during the course of the Summernats car show. The Robson Environmental report in relation to Summernats 2010 can be seen in Appendix E.

While the air quality monitoring undertaken by Robson Environmental for the Summernats car show in 2010 provides a valuable benchmark, it is noted that PM$_{2.5}$ particle concentrations were not monitored, and that these particles are considered to be a more significant risk to the health or persons inhaling them than PM$_{10}$ particles.
Composition of tyre smoke

A study titled *Characterization of heavy metal particles embedded in tire dust* was published by Adachi & Tainosho in 2004. The study found that tyre smoke and dust can contain potentially hazardous materials including heavy metals such as iron (5.5%), copper (0.1%), zinc (1.6%) and lead (0.1%), as well as asphalt materials which include aluminium (7.5%), calcium (10.1%) and silica (21.2%) (Adachi & Tainosho, 2004). According to the study, tyre dust consists of debris from tyre wear and assimilated heavy metal particles emitted from road traffic materials such as brake lining and road paint. The abstract from the study is shown below:

**Abstract**

Tyre dust is a significant pollutant, especially as a source of zinc in the urban environment. This study characterizes the morphology and chemical composition of heavy metal particles embedded in tire dust and traffic-related materials (brake dust, yellow paint, and tire tread) as measured by a field emission scanning electron microscope equipped with an energy dispersive X-ray spectrometer (FESEM/EDX). In 60 samples of tire dust, we detected 2288 heavy metal particles, which we classified into four groups using cluster analysis according to the following typical elements: cluster 1: Fe, cluster 2: Cr/Pb, cluster 3: multiple elements (Ti, Cr, Fe, Cu, Zn, Sr, Y, Zr, Sn, Sb, Ba, La, Ce, Pb), cluster 4: ZnO. According to their morphologies and chemical compositions, the possible sources of each cluster were as follows: (1) brake dust (particles rich in Fe and with trace Cu, Sb, and Ba), (2) yellow paint (CrPbO4 particles), (3) brake dust (particulate Ti, Fe, Cu, Sb, Zr, and Ba) and heavy minerals (Y, Zr, La, and Ce), (4) tire tread (zinc oxide). When the chemical composition of tire dust was compared to that of tire tread, the tire dust was found to have greater concentrations of heavy metal elements as well as mineral or asphalt pavement material characterized by Al, Si, and Ca. We conclude that tire dust consists not only of the debris from tire wear but also of assimilated heavy metal particles emitted from road traffic materials such as brake lining and road paint.

A study was published in 2011 by Michael Bennett, Simon M. Christie, Angus Graham, Bryony S. Thomas, Vladimir Vishnyakov, Kevin Morris, Daniel M. Peters, Rhys Jones, and Cathy Ansell titled *Composition of Smoke Generated by Landing Aircraft*. This study determined that the particle size of tyre smoke generated by landing aircraft has equal numbers of particles at peaks of aerodynamic diameter ~10µm and ~50µm. The peak at 10µm was determined to be predominantly carbonaceous, while the peak at 50µm was determined to be elements typical of an asphalt concrete runway. One of the chosen measurement methodologies adopted for the study, LiDAR, was not suitable to measure particles smaller than 10µm. The study notes in the conclusion "these observations suggest that the bulk of the visible aerosol in tire smoke is too coarse to be respirable: it seems to consist largely of mechanically generated..."
dust from the runway surface. Mass balance considerations imply that very little of the tire rubber lost is released as fine aerosol.” The conclusion goes on to note “Overall, it would appear that while tire smoke emissions can be spectacular, and may have operational implications in terms of tire wear and runway degradation, the emission of respirable PM is relatively modest. There may, however, still be health issues arising from hazardous organics (e.g., PAHs) volatilized from the rubber or of nuisance from the associated odor.”

The parallel between smoke generated by landing aircraft and smoke generated by a car spinning tyres is that tyre composition and the running surface is almost identical. The abstract for this study is shown below:

Abstract

A combination of techniques has been used to examine the composition of smoke generated by landing aircraft. A sample of dust from the undercarriage from several commercial airliners was examined with SEM/EDX (Scanning Electron Microscope/Energy Dispersive X-ray) to determine its elemental composition and also with an aerosizer/aerodisperser in order to measure the particle size spectrum. The observed size spectrum was bimodal with equal numbers of particles at peaks of aerodynamic diameter ~10 μm and ~50 μm.

The EDX analysis suggested that the former peak is carbonaceous, while the latter consists of elements typical of an asphalt concrete runway. In the field, a scanning Lidar, in combination with optical and condensation particle counters, was deployed to obtain limits to the number concentration and size of such particles. Most of the (strong) Lidar signal probably arose from the coarser 50 μm aerosol, while respirable aerosol was too sparse to be detected by the optical particle counters.

A study was published in 2001 by J. A. Gillies, A. W. Gertler, J. C. Sagebiel, and W. A. Dippel titled On-Road Particulate Matter (PM2.5 and PM10) Emissions in the Sepulveda Tunnel, Los Angeles, California. This study found a relationship between PM2.5 and PM10 emissions, where PM2.5 emission was approximately 74% of the PM10 emissions. PM2.5 emissions were found to be dominated by organic and elemental carbon, accounting for approximately 73% of emissions in this particle size. The remainder of PM2.5 emissions consisted of crustal elements including iron, magnesium, aluminium, calcium and manganese with ions Cl-, NO3-, NH4+, SO42-, and K+ together constituting another 9.8%. PM10 emissions were also found to be dominated by organic and elemental carbon with other geological components accounting for approximately 12.6% of PM10 emissions. This study did not consider PM10 and did not specifically study tyre smoke. The abstract for the study is shown below:

Abstract
Total and speciated particulate matter (PM2.5 and PM10) emission factors from in-use vehicles were measured for a mixed light- (97.4% LD) and heavy-duty fleet (2.6% HD) in the Sepulveda Tunnel, Los Angeles, CA. Seventeen 1-h test runs were performed between July 23, 1996, and July 27, 1996. Emission factors were calculated from mass concentration measurements taken at the tunnel entrance and exit, the volume of airflow through the tunnel, and the number of vehicles passing through the 582 m long tunnel. For the mixed LD and HD fleet, PM2.5 emission factors in the Sepulveda Tunnel ranged from 0.016 (±0.007) to 0.115 (±0.019) g/vehicle-km traveled with an average of 0.052 (±0.027) g/vehicle-km. PM10 emission factors ranged from 0.030 (±0.009) to 0.131 (±0.024) g/vehicle-km with an average of 0.089 (±0.030) g/vehicle-km. The PM2.5 emission factor was ~74% of the PM10 factor. Speciated emission rates and chemical profiles for use in receptor modelling were also developed. PM2.5 was dominated by organic carbon (OC) (31.0 ± 19.5%) and elemental carbon (EC) (48.5 ± 20.5%) that together account for 79% (±24%) of the total emissions. Crustal elements (Fe, Mg, Al, Si, Ca, and Mn) contribute ~7.8%, and the ions Cl-, NO3-, NH3+, SO42-, and K+ together constitute another 9.8%. In the PM10 size fraction the particulate emissions were also dominated by OC (31 ± 12%) and EC (35 ± 13%). The third most prominent species was Fe (16.5 ± 9.0%), which is greater than would be expected from purely geological sources. Other geological components (Mg, Al, Si, K, Ca, and Mn) accounted for an additional 12.6%. PM10 emission factors showed some dependence on vehicle speed, whereas PM2.5 did not. For test runs in which the average vehicle speed was 42.6 km/h a 1.7 times increase in PM10 emission factor was observed compared to those runs with an average vehicle speed of 72.6 km/h. Speciated emissions were similar. However, there is significantly greater mass attributable to geological material in the PM10, indicative of an increased contribution from resuspended road dust. The PM2.5 shows relatively good correlation with NOx emissions, which indicates that even at the low percent of HD vehicles, which emit significantly more NOx than LD vehicles, they may also have a significant impact on the PM2.5 levels.
The data above reveals that tyre smoke and dust consists of:

- a mix of elements typical of the running surface, with aerodynamic diameter approximately 50μm;
- predominantly carbonaceous material with aerodynamic diameter approximately 10μm; and
- predominantly carbonaceous material with aerodynamic diameter 2.5μm and less.

Approximate proportions of each particulate are shown below:

![COMPOSITION OF TYRE SMOKE]

During the monitoring for the Summernats car show in 2010, PM$_{10}$ concentrations peaked at a value of 34μg/m$^3$, with background or control levels at 9μg/m$^3$. It is also noted that the real-time peak in PM$_{10}$ particulate concentration corresponded with the fireworks display. It is likely that the levels recorded for the other days of the event, being 17μg/m$^3$ and 14μg/m$^3$ reflect a more accurate measure of the concentrations of tyre smoke. Using the ratio above, this gives an estimated PM$_{2.5}$ concentration of 12.6μg/m$^3$ and 10.4μg/m$^3$ respectively. These figures represent a real-time PM$_{2.5}$ concentration of about 50% of the maximum allowable level specified in the NEPM guidelines, which refers to a 1-day averaged concentration.
Prevailing Wind Speed and Direction

Bureau of Meteorology have records of wind speed and direction data for Dubbo. The historical data is presented in the format of a "rose" showing the average wind direction and speed for the respective time period. The records use wind speed and direction measured at 9am and 3pm. The wind speed and direction roses for Dubbo can be seen in Appendix F. The data has been collected at two locations, being Dubbo Airport and Darling Street Dubbo. The data indicates that mean wind speeds at the Dubbo Airport tend to be higher than Darling Street by between 7 and 10km/h. The subject land is located south of both BOM sites. It is anticipated that wind speeds at the subject site will be more similar to the figures for Darling Street than the Airport due to topography. Prevailing wind directions at the subject site are expected to be more similar to the figures for Darling Street than the Airport.

Based on historical data the mean wind direction at 9am at Dubbo Airport is from the west. Wind speeds at 9am at Dubbo Airport average between 12.9km/h and 21.5km/h. Based on historical data the mean wind direction at 9am at Darling Street, Dubbo is from the north-west. Wind speeds at 9am at Darling Street, Dubbo average between 6.4km/h and 12.1km/h. Based on historical data the mean wind direction at 3pm at Dubbo Airport is from the east. Wind speeds at
3pm at Dubbo Airport average between 16.2km/h and 20.2km/h. Based on historical data the mean wind direction at 3pm at Darling Street, Dubbo is from the north east. Wind speeds at 9am at Darling Street Dubbo average between 10.0km/h and 13.5km/h.

The prevailing wind directions indicate that smoke, dust and noise from an event at Morris Park Motor Sport Complex generally will be directed away from the subject land by the prevailing winds when considering the 9am statistics. When considering 3pm statistics, smoke, dust and noise from an event at Morris Park Motor Sport Complex will generally be directed by the prevailing winds obliquely across the southernmost parts of the subject land.

Separation Distance

The NSW Environmental Protection Authority has prepared Guidelines for Managing Air Pollution, a copy of which is included in Appendix E. The guidelines discuss the effectiveness of dispersion in dealing with air pollution. The Guideline states that pollutants are diluted to the order of 1000 to 1 after less than 1 kilometre of travel in the atmosphere. Separation of the pollution source and receptor by distance is an effective use of atmospheric dispersion.

The SA Environmental Protection Authority has prepared a table of recommended separation distances for airborne emissions in a document titled Guidelines for Separation Distances, a copy of which is included in Appendix E. Anticipated emissions from the Morris Park Motor Sport Complex include noise, dust and smoke. The SA EPA Guidelines for Separation Distances does not provide a recommended separation distance for tyre smoke or dust from motor sport events. Given the similar nature of wood smoke to tyre smoke, especially in relation to the way it travels, it is noted that the Guidelines recommend a separation distance of 300 metres when dealing with incineration for wood waste. The Guidelines also refer to Rubber production/mixing, recommending a separation distance of 300 metres. The nearest proposed dwelling envelope on the subject land is located approximately 450 metres west of the speedway at Morris Park Motor Sport Complex. The nearest proposed dwelling envelope is located 306 metres from the western boundary of the Morris Park Motor Sport Complex.
Conclusion

The impact upon the subject land of smoke and dust from the Morris Park Motor Sport Complex is considered to be minimal. Separation distances have been provided and exceed the minimum distances recommended by EPA SA. Monitoring of the Summemats car show in 2010 determined that the event did not exceed acceptable PM_{10} concentrations. Any event held at Morris Park Motor Sport Complex is unlikely to generate particulate matter on a scale similar to the Summemats car show. The prevailing wind direction and speed is such that smoke and other particulate matter generated by any activity at Morris Park Motor Sport Complex is likely to be directed generally away from the subject land. Burnout competition events at Morris Park Motor Sport Complex are held only occasionally. Smoke from burnout competitions and other airborne particle emissions are not likely to cause health issues to occupants of proposed lots within the subject land.

Recommendations

Tyre smoke and dust from burnout competitions may be considered to be a nuisance by residents nearby. In the interests of informing potential purchasers of land that such a nuisance may exist, it is recommended that Western Plains Regional Council utilise a notation on a Section 149(5) certificate for each lot created upon the subject land. In this way potential purchasers can see prior to purchase that the site is liable to be occasionally subjected to tyre smoke.

It is noted that sales of land in NSW are subject to the Caveat Emptor rule, or Buyer Beware. It is legislated that a Section 149 certificate is a required vendor disclosure statement. Despite this, a Section 149(5) certificate is not always requested. The option to request a Section 149(5) certificate, if not taken up, is considered to be a risk by the purchaser. It is also considered unlikely, given the anticipated lot size and expected sale prices, that prospective purchasers of land will forgo the Section 149(5) certificate.

In order to ensure that potential purchasers are aware of the issue relating to tyre smoke and dust, a covenant or restriction on the use of land could be created upon each dwelling lot, stating that each lot is liable to be occasionally subject to noise from motorsport at Morris Park and specifying minimum sound levels which can be considered to be more than a nuisance. A covenant is a restriction on the use of land and must contain at least one clause that restricts the use of the land. Not all clauses of the covenant or restriction on the use of land must be restrictive. If Council conditions any approval for subdivision of the land such that, for example, dwelling envelopes are required on dwelling lots, this can be created as either a covenant or restriction on the use of land, with one clause referring to the potential noise impact.
Plans of the land and related documents, such as a Section 88B instrument, must be included with a contract for the sale of land. Unfortunately, the likelihood of a potential purchaser reading through a Section 88B instrument is similar to them reading and understanding a Section 149(5) certificate.

After researching several similar sites in NSW, the most similar was found in Lismore, where a motorsport facility is located near new residential development. Council in this case created a clause in their DCP (Part B Chapter 10, Section 7.3) [https://www.lismore.nsw.gov.au/page.asp?i=RES-XYB-37-22-03] which specifies advisory acoustic controls for new dwellings within the area impacted by noise generated by motorsport events.

“New dwellings and alterations and additions to existing dwellings can be constructed without acoustic controls pursuant to the provisions of State Environmental Planning Policy (Exempt and Complying Development Codes) 2008. Consequently, these acoustic controls are advisory only and not a compulsory requirement.”

The model adopted by Lismore City Council is considered less effective than a Section 149(5) notation, as it occurs at the time of application for a dwelling, after the land has been purchased. If Dubbo Regional Council is concerned about the noise issues, potential purchasers must have the information available at the time of purchase. The only way for purchasers to find the DCP requirements under the Lismore City Council model is to obtain a Section 194(5) certificate.
Part 4 – Maps and Diagrams

Relevant maps and diagrams of the site are included in Appendix A.
Part 5 – Community Consultation

Varying levels of consultation have been undertaken for the matters covered by this proposal. In addition, the public consultation process required by the Department of Planning after the Gateway Determination is outlined below.

Community Consultation - Post Gateway Determination

It is considered that the proposal is a "low impact planning proposal" under Section 5.2.2 of "A guide to preparing local environmental plans" as the planning proposal is:

- Consistent with the pattern of surrounding land use zones and land uses
- Consistent with the strategic planning framework
- Presents no issues with regard to infrastructure servicing
- Is not a principal LEP, and
- Does not reclassify public land.

Community consultation will commence by giving notice of the public exhibition of the planning proposal:

a) in the Council’s news page of a local newspaper;  
b) on Council’s web-site.

Written notification to adjoining landowners.

Written notice will be provided to relevant Government Departments and agencies, service providers and other key stakeholders, as determined in the Gateway determination

The written notice will provide:

(a) a description of the objectives or intended outcomes of the planning proposal;  
(b) the land affected by the planning proposal; 
(c) advice where and when the planning proposal can be located and viewed; 
(d) the contact details for the receipt of submissions; and 
(e) the closing date for submissions.

During the exhibition period, the following material will be made available:

(a) the planning proposal, including appendices and attachments, in the form approved for community consultation by the Director General of Planning and Environment; 
(b) the Gateway determination; and
(c) any studies relied upon by the planning proposal.
At the conclusion of the notification and public exhibition period Council staff will consider submissions made with respect to the Planning Proposal and prepare a report to Council.

It is considered unlikely that a Public Hearing will be required for the proposal.
Conclusion

The subject land has been zoned SP3 Tourist for over 10 years. Uptake of tourist related development in the Camp Road area has been sporadic at best, with minimal functioning tourism sites in operation. The large size of the subject land presents a barrier to developing the land for tourism purposes, even if demand for such development were proven. The land has historically been used for agricultural purposes and is currently a small farm lifestyle lot, requiring off-farm income to be financially sustainable.

The proponent wishes to rezone the land to a split zoning, retaining the vegetated hilly area to the east of the site as E3 Environmental Protection zone, with land on undulating land to the west to be zoned RU2 Rural Lifestyle. Minimum lot size mapping is proposed to be amended to allow lots of 3 hectares in the proposed RU2 zone, with no dwellings permitted or proposed in the E3 Environmental Protection zone. Tourism based land uses are still permitted within the RU2 Rural Lifestyle zone.

Assessments have been undertaken in regard to flora and fauna, groundwater, heritage, and contamination. The proposed rezoning and subsequent development of the land can be undertaken in accordance with recommendations made in the report. Additional assessment has been undertaken in regard to noise from motor sport events held at the adjacent Morris Park Motor Sport Complex. The proposed rezoning and subsequent development of the land can be undertaken in accordance with recommendations made in the report. Smoke from burnout competitions at Morris Park Motor Sport Complex has been addressed and separation distances provided meet or exceed minimum recommended distances.

Site access is adequate and options for future development have been identified, to be investigated for subsequent applications to develop the land. Electricity and telecommunications services are currently available and connected to the site. The site has been determined to be suitable for on-site treatment of sewage subject to the recommendations relating to groundwater protection. Reticulated water is available nearby and can be connected to the proposed development. Water pressure has been determined to be adequate for all proposed dwelling lots.

The site is identified as bushfire prone, and asset protection zones will be required for all proposed dwellings. All lots are of sufficient size to provide asset protection zones as required.

Demand for rural lifestyle lots is currently adequate and is anticipated in increase as the Dubbo Zirconia Project comes online. It is likely that the site would provide accommodation for employees of the Dubbo Zirconia Project. The location of the subject land in relation to the Dubbo Zirconia Project and the city of Dubbo gives
employees an opportunity to live closer to their place of work and still be close to
the city of Dubbo for shopping and schools.

Surrounding land uses do not comply with the current zoning and minimum lot
size provisions. The proposed rezoning and development of the subject land will
not impact adjoining land adversely.

The proposed rezoning and subsequent development is suitable for the subject
land.

Eric Smith
B.Surv. M.S Aust.
Surveyor Registered Under The
Surveying and Spatial Information Act, 2012
References

Robson Environmental Pty Ltd
Environmental Dust Monitoring
Summernats Car Festival, Watson, Canberra, ACT 2911
29 June 2010

Kouji Adachia, Yoshiaki Tainosho
Characterization of heavy metal particles embedded in tire dust
Environment International 2004

J. A. Gillies,* A. W. Gertler, J. C. Sagebiel, and, and W. A. Dippel
On-Road Particulate Matter (PM2.5 and PM10) Emissions in the Sepulveda
Tunnel, Los Angeles, California
Environmental Science & Technology 2001 35 (6), 1054-1063

Michael Bennett, Simon M. Christie, Angus Graham, Bryony S. Thomas, Vladimir
Vishnyakov, Kevin Morris, Daniel M. Peters, Rhys Jones, and Cathy Ansell
Composition of Smoke Generated by Landing Aircraft
Environmental Science & Technology 2011

Bureau of Meteorology
Climate statistics, Dubbo Airport and Darling Street Dubbo.

NSW Environmental Protection Authority
Reducing Wood Smoke Emissions
11 July 2013

NSW Environmental Protection Authority
Noise Guide for Local Government
Part 3 Noise Management Principles
2013

NSW Environmental Protection Authority
Local Government Air Quality Toolkit, Module 3: Guidelines for Managing Air
Pollution

NSW Environmental Protection Authority
Managing Particles and Improving Air Quality in NSW
2013

SA Environmental Protection Authority
Guidelines for Separation Distances
August 2000
Appendix A – Maps and Diagrams
Doherty Smith & Associates Pty Ltd  
www.dohertysmith.com.au

Appendix B – Impax Group Report
Appendix C – Noise and Sound Services Report
Appendix D – Documents relating to Smoke/Dust and Noise
Appendix E – Wind Speed and Direction Roses
Appendix F – GCA Water Reticulation Analysis
Appendix G – Archaeological Study
# DOCUMENT CONTROLS

## Project Details

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<th>The Impax Group - Environmental</th>
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## Report Details

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<tr>
<th>Prepared For:</th>
<th>Doherty Smith &amp; Associates Consulting Surveyors</th>
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<tr>
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<td>5 May 2017</td>
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<tr>
<td>File Name:</td>
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TABLE OF CONTENTS

1 INTRODUCTION

1.1 REPORT OBJECTIVES

1.2 PROVISION OF FURTHER INFORMATION

1.2.1 Flora and Fauna

1.2.2 Aboriginal Archaeology

1.2.3 Groundwater Vulnerability / Salinity

1.3 SCOPE OF WORK

1.4 LIMITATIONS OF THIS REPORT

2 FLORA AND FAUNA

2.1 EXTENT OF VEGETATION REMOVAL AT THE SITE

2.2 LIKELIHOOD OF THREATENED SPECIES OCCURRENCE WITHIN THE SITE

2.3 IMPACTS ON KEY THREATENING PROCESSES ON THREATENED SPECIES

2.3.1 Clearing of Native Vegetation

2.3.2 Loss and Degradation of Native Habitat by Invasion of Garden Plants

2.3.3 Loss of Hollow Bearing Trees

2.3.4 Removal of Dead Wood and Dead Trees

2.4 RECOMMENDED MITIGATION MEASURES

3 ABORIGINAL HERITAGE

3.1 LOCATION OF ABORIGINAL HERITAGE SITES IN RELATION TO BUILDING ENVELOPES

3.2 DUE DILIGENCE CODE OF PRACTICE FOR THE PROTECTION OF ABORIGINAL OBJECTS IN NSW

3.3 POTENTIAL ABORIGINAL HERITAGE IMPACTS

3.4 RECOMMENDED MITIGATION MEASURES

4 GROUNDWATER VULNERABILITY / SALINITY

4.1 GROUNDWATER IMPACT ASSESSMENT

4.2 RECOMMENDED MITIGATION MEASURES

4.3 IMPLEMENTATION OF RECOMMENDED MITIGATION MEASURES

5 CONCLUSIONS

LIST OF ATTACHMENTS

ATTACHMENT A: FIGURES
1 Introduction

The Impax Group was commissioned by Doherty Smith and Associates Consulting Surveyors to undertake a Flora and Fauna Assessment, Groundwater Assessment, Archaeological Assessment and Preliminary Contamination Investigation for a proposed rural-residential subdivision located at 4L Camp Road – Lot 8 DP 1063425 Dubbo NSW 2830 (the ‘site’).

This original report was submitted on July 1 2016. Dubbo Regional Council reviewed the report as part of the overall Planning Proposal and subsequently identified the need for further information in a letter dated 6 December 2016, with regards to Flora and Fauna, Aboriginal Archaeology and Groundwater Vulnerability / Salinity.

1.1 Report Objectives

The objectives of the report is to provide the requested further information to Council with regards to Flora and Fauna, Aboriginal Archaeology and Groundwater Vulnerability / Salinity as part of the overall Planning Proposal.

1.2 Provision of Further Information

1.2.1 Flora and Fauna

Dubbo Regional Council provided the following information with regards to the Flora and Fauna Report previously submitted as part of the Planning Proposal for the site:

The flora and fauna report provided with the Planning Proposal has been reviewed by Council’s Environment and Health Officers. Review of the report has identified that a detailed flora and fauna assessment has not been carried out for the subject site, which was previously requested in a meeting with Council officers on 13 January 2016.

A detailed flora and fauna assessment is required to be undertaken to assess the ecological values of the land. A detailed flora and fauna assessment is also required to quantify the likely impacts as a result of vegetation removal on the site including impacts on Key Threatening Processes, and how mitigation measures will be implemented so as to avoid potential adverse environmental impacts on remnant vegetation. Further information is also needed to quantify how much remnant vegetation will be potentially removed within building zones and for new roads, boundary fence lines and services to be constructed.

It is noted that the Planning Proposal has proposed rezoning the area containing the majority of vegetation on the land E3 Environmental Management. One of the main objectives of the E3 zone is to protect areas with special ecological, scientific, cultural or aesthetic value; however, the Planning Proposal has not demonstrated the value of this particular area of vegetation on the site. It is unclear from the information submitted with the Planning Proposal as to the overall value of flora and fauna in this area, how the proposed E3 Environmental Management zone would be managed and what ownership regime would apply to this parcel in the future.

1.2.2 Aboriginal Archaeology

Dubbo Regional Council provided the following information with regards to the Aboriginal Archaeology assessment previously submitted as part of the Planning Proposal for the site:

The Impax Group Report provided with the Planning Proposal has been assessed by Council’s Environment and Health Officers. This review has raised a requirement for further information regarding the location of the existing six (6) recorded Aboriginal sites in relation to the proposed zoning boundaries and potential building zones. Further
information is also requested to demonstrate how potential development on the site can be controlled and how the measures can be implemented.

1.2.3 Groundwater Vulnerability / Salinity

Dubbo Regional Council provided the following information with regards to the groundwater assessment previously submitted as part of the Planning Proposal for the site:

The Impax Group Report provided with the Planning Proposal has been assessed by Council’s Environment and Health Officers. This review has raised a requirement for further information to demonstrate how the proposed mitigation measures will manage any significant adverse environmental impact and how these measures can be implemented.

1.3 Scope of Work

To achieve the objectives outlined in Section 1.1 The Impax Group conducted the following work:

- Reviewed the Dubbo Regional Council letter identifying the need for the provision of further information dated 6 December 2016;
- Arranged for Doherty Smith & Associates to prepare a site map showing vegetation that will likely be impacted by the planning proposal at the site;
- Arranged for Doherty Smith & Associates to prepare a site map showing the location of existing recorded Aboriginal sites in relation to the proposed zoning boundaries and potential building zones; and
- Prepared this report providing the requested further information to Council with regards to Flora and Fauna, Aboriginal Archaeology and Groundwater Vulnerability / Salinity as part of the overall Planning Proposal.

1.4 Limitations of this Report

The findings of this report are based on the Scope of Work outlined in Section 1.3. The Impax Group performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental consulting profession. No warranties, express or implied are made.

The results of this assessment are based upon the information documented and presented in this report. All conclusions and recommendations regarding the site are the professional opinions of The Impax Group personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, The Impax Group assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside of The Impax Group, or developments resulting from situations outside the scope of this project.

The results of this assessment are based on the site conditions identified at the time of the report. The Impax Group will not be liable to revise the report to account for any changes in site characteristics, regulatory requirements, assessment criteria or the availability of additional information, subsequent to the issue date of this report.

The Impax Group is not engaged in environmental consulting and reporting for the purpose of advertising sales promoting, or endorsement of any client interests, including raising investment capital, recommending investment decisions, or other publicity purposes.
2 Flora and Fauna

2.1 Extent of Vegetation Removal at the Site

The site covers an area of approximately 130ha. Of this 130ha, approximately 51.23ha of the site is covered in vegetation. The remaining 78.71ha has been predominately cleared for farming and grazing purposes. Figure 1 of Attachment A shows the approximate area of dense vegetation at the site.

The planning proposal would result in approximately 1.12ha of vegetation being cleared to allow for the construction of proposed roads within the site. A further area of approximately 1.69ha of vegetation would be cleared to allow for the establishment of building envelopes within the proposed new lots. The planning proposal will result in the removal of approximately 2.81ha of vegetation at the site, reducing the total amount of vegetation at the site from approximately 51.23ha to approximately 48.42ha, as summarised in Table 1.

<table>
<thead>
<tr>
<th>Description</th>
<th>Approximate Area (ha)</th>
<th>% of Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire site</td>
<td>130ha</td>
<td>100%</td>
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<tr>
<td>Dense vegetation</td>
<td>51.23ha</td>
<td>39.41%</td>
</tr>
<tr>
<td>Previously cleared farmland</td>
<td>78.71ha</td>
<td>60.59%</td>
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<tr>
<td>Vegetation cleared for proposed road</td>
<td>1.12ha</td>
<td>0.86%</td>
</tr>
<tr>
<td>Vegetation cleared for proposed building envelopes</td>
<td>1.69ha</td>
<td>1.30%</td>
</tr>
<tr>
<td>Total vegetation cleared</td>
<td>2.81ha</td>
<td>2.16%</td>
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<tr>
<td>Vegetation remaining after clearing</td>
<td>48.42ha</td>
<td>37.25%</td>
</tr>
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</table>

Clearing of Native Vegetation in NSW is managed under the NSW Native Vegetation Act 2003. Under the Act, a landholder is permitted to undertake Routine Agricultural Management Activities (RAMAs) which cover a wide range of day-to-day farming, safety and other activities where clearing of native vegetation does not require approval under the Act if the clearing is only undertaken to the minimum extent necessary.

Under the Act, clearing vegetation for rural infrastructure (fences, roads), dwellings (building envelopes), maintenance of public utilities (electricity, water, gas etc.) and clearing to remove or reduce an imminent risk of personal injury or damage to property (bushfire protection zones) are considered RAMAs and as such this clearing can be undertaken without approval.

All proposed vegetation clearing that will occur as part of the planning proposal would be undertaken to the minimum extent necessary and would therefore be considered a Routine Agricultural Management Activity under the NSW Native Vegetation Act 2003, and may be undertaken without a permit.

2.2 Likelihood of Threatened Species Occurrence within the Site

The flora and fauna report submitted as part of the planning proposal identified one threatened flora species and two threatened fauna species as having been recorded within 1,000m of the site as summarised in Table 2. No threatened flora or fauna species were recorded within the site. The flora and fauna report also assessed the likelihood of the three threatened species occurring within the site.
Table 2: Threatened Species Recorded within 1,000m of the Site

<table>
<thead>
<tr>
<th>Species Name</th>
<th>Common Name</th>
<th>Classification (NSW TSC Act)</th>
<th>Likelihood of Occurrence within Site</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Diaris tricolor</em></td>
<td>Pine Donkey Orchid</td>
<td>Vulnerable</td>
<td>Low</td>
</tr>
<tr>
<td><em>Calyptrathynchus lathami</em></td>
<td>Glossy Black-Cockatoo</td>
<td>Vulnerable</td>
<td>Low</td>
</tr>
<tr>
<td><em>Pomatostoma temporalis temporalis</em></td>
<td>Grey-crowned Babble</td>
<td>Vulnerable</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

The likelihood of *D. tricolor* occurring at the site is considered low, as the species is usually recorded from disturbed habitats such as road cuttings, quarries, etc. No such disturbed environments were present within the site.

The likelihood of *C. lathami* occurring at the site is considered low, as no suitable sheoak feed species were observed within the site.

The likelihood of *P. temporalis* occurring at the site is considered moderate, as the species was recorded within the road reserve along Camp Road adjacent to the northern boundary of the site, and suitable open box woodland habitat is present at the site.

### 2.3 Impacts on Key Threatening Processes on Threatened Species

A total of 38 Key Threatening Processes are listed in Schedule 3 of the NSW Threatened Species Conservation Act 1995.

*P. temporalis* is the only threatened species listed in Schedule 1 or Schedule 2 of the NSW Threatened Species Conservation Act 1995 which is considered likely to occur within the site.

The planning proposal has the potential to result in 4 of these Key Threatening Processes impacting upon *P. temporalis*, which are as follows:

- Clearing of native vegetation;
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants;
- Loss of hollow-bearing trees; and
- Removal of dead wood and dead trees.

#### 2.3.1 Clearing of Native Vegetation

Approximately 2.81ha of vegetation is expected to be cleared for roads and building envelopes as part of the planning proposal.

All proposed vegetation clearing that will occur as part of the planning proposal would be undertaken to the minimum extent necessary and would therefore be considered a Routine Agricultural Management Activity under the NSW Native Vegetation Act 2003, and may be undertaken without a permit.

Conducting a Routine Agricultural Management Activity would not be considered a Key Threatening Process.
2.3.2 Loss and Degradation of Native Habitat by Invasion of Garden Plants

The planning proposal will result in the establishment of 24 new dwellings, all of which would likely be established with gardens that would have the potential to degrade the habitat of *P. temporalis* in the event that garden plants escape their planted area and become invasive within the surrounding native habitat.

The infestation of habitat by invasive weeds/grasses is a threat to *P. temporalis*, as the invasive species can cover inter-tussock spaces preventing access to leaf and stick litter where the species commonly forage for invertebrates. The recovery plan for *P. temporalis* recommends that action be taken to control invasive exotic perennial pasture grasses within known habitat.

The proposed mitigation measures outlined in Section 2.4 would result in the planning proposal having a low potential to impact upon this Key Threatening Process at the site.

2.3.3 Loss of Hollow Bearing Trees

The planning proposal may result in the loss of hollow bearing trees at the site. *P. temporalis* do not nest in hollow bearing trees, but rather build and maintain several conspicuous, dome-shaped stick nests about the size of a football typically located in shrubs or sapling eucalypts.

The loss of hollow bearing trees is not likely to represent a Key Threatening Process to *P. temporalis* at the site, as they do not make use of such hollow bearing trees.

The proposed mitigation measures outlined in Section 2.4 would result in the planning proposal having a low potential to impact upon this Key Threatening Process at the site.

2.3.4 Removal of Dead Wood and Dead Trees

The planning proposal may result in the removal of dead wood and dead trees at the site. Fallen dead timber and dead trees are not considered an important habitat for *P. temporalis*, as the species typically forages on the trunks and branches of standing live trees, or on the ground digging and probing amongst leaf litter and tussock grass.

The removal of dead wood and dead trees is not likely to represent a Key Threatening Process to *P. temporalis* at the site, as they do not make use of such habitat for foraging or nesting.

The proposed mitigation measures outlined in Section 2.4 would result in the planning proposal having a low potential to impact upon this Key Threatening Process at the site.

2.4 Recommended Mitigation Measures

- All proposed vegetation clearing conducted as part of Routine Agricultural Management Activity should be undertaken to the minimum extent necessary;
- Vegetation removal would be restricted to the minimum necessary to successfully complete the planning proposal;
- The area of vegetation to be removed would be clearly marked on site, and on site plans;
- Action should be taken to control invasive exotic perennial pasture grasses at the site;
- Prior to clearing, trees would be checked to ensure that there are no nesting fauna within hollows. If hollows are polished or have white-wash below them, this would indicate a resident nesting pair;
- Nesting hollows suspected to be occupied would be inspected by a suitably qualified ecologist for the presence of any fauna. Any fauna found within hollow bearing trees would be reported to Council, who would determine the need for further assessment;
- Existing fallen dead timber would be relocated where practical to adjoining areas to provide habitat;
- The contact details for the Dubbo Office of the National Parks and Wildlife Service (NPWS) is to be kept on site;
- All reasonable measures would be taken to ensure that no protected fauna are harmed or placed at risk during the course of the planning proposal;
• Wherever practicable vehicular access will be limited to using existing roadways, access tracks and clearings;
• Revegetation works (where required) would occur in progressive stages at the; and
• Locally native species would be used for revegetation, where appropriate.
3 Aboriginal Heritage

3.1 Location of Aboriginal Heritage Sites in Relation to Building Envelopes

The Impax Group reviewed the following Aboriginal Archaeological Assessment Report:

- Central West Archaeological and Heritage Services -- Kelton, J. (December 1995): "An Archaeological Assessment for the Proposed "Glenn Lee" Tourism Development, Camp Road, Dubbo, NSW."

The report considered a study area which included the entire site (Lot 8 DP 1063425), along with an additional area between the boundary of Camp Road and Obley Road, and an additional area between the eastern boundary of the site and Obley Road.

The report identified a total of eight open campsites, two scarred tree sites and one isolated artefact within the study area. Of these eleven identified Aboriginal Heritage Sites, six were located within the site (Lot 8 DP 1063425), comprising four open campsites and two scarred tree sites. A map showing the building envelopes for each of the proposed new lots, along with the location of the 6 Aboriginal Heritage Sites is presented as Figure 2 of Attachment A, and further described in Table 3.

### Table 3: Location of Aboriginal Heritage Sites in Relation to Building Envelopes

<table>
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<th>Site Name</th>
<th>Description</th>
<th>Significance</th>
<th>Impacted by Building Envelope</th>
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<tr>
<td>GL-OS-1</td>
<td>Scattering of 57 stone artefacts within a 50m x 20m area along an ephemeral creek</td>
<td>Moderate</td>
<td>Proposed Lot 5 building envelope slightly overlaps Site</td>
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<tr>
<td>GL-OS-2</td>
<td>7 stone artefacts within a 20m x 5m area along an ephemeral creek</td>
<td>Low-moderate</td>
<td>No</td>
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<tr>
<td>GL-OS-6</td>
<td>3 stone artefacts within a 5m x 3m area, 40m west of an ephemeral creek</td>
<td>Low-moderate</td>
<td>Proposed Lot 12 building envelope slightly overlaps Site</td>
</tr>
<tr>
<td>GL-OS-7</td>
<td>3 stone artefacts within a 5m x 3m area, 20m west of an ephemeral creek</td>
<td>Low-moderate</td>
<td>No</td>
</tr>
<tr>
<td>GL-ST-1</td>
<td>Standing dead Eucalyptus tree stump, 1.5m high, rated as ‘possible’ Aboriginal origin, associated with OS-1 and OS-7</td>
<td>Moderate</td>
<td>No</td>
</tr>
<tr>
<td>GL-ST-2</td>
<td>Standing live Eucalyptus macrocarpa, rated as ‘possible’ Aboriginal origin. Tree diameter at scar location is 94cm, scar has dimensions of 266cm long, 30cm wide at middle. Moderate bark regrowth</td>
<td>Low</td>
<td>Within building envelope for proposed Lot 18</td>
</tr>
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Three of the sites (GL-OS-2, GL-OS-7 and GL-ST-1) are located entirely outside the building envelopes for the proposed new lots at the site. The planning proposal is not expected to result in any significant adverse environmental impact to these three sites.

The location of GS-OS-1 slightly overlaps with the building envelope for proposed Lot 5. GL-OS-1 is located entirely within an ephemeral creek, and as such it is considered unlikely that any building, development or earthworks would occur within this ephemeral creek that would have the potential to impact upon GS-OS-1. The planning proposal is not expected to result in any significant adverse environmental impact to this site.

The location of GS-OS-6 slightly overlaps with the building envelope for proposed Lot 12. GL-OS-6 consisted of 3 stone artefacts within a 5m x 3m (15m²) area. It is only the buffer zone (50m x 50m – 2,500m²) which slightly overlaps with the building envelope for proposed Lot 12, and not the actual
15m² area where the 3 stone artefacts were located. The planning proposal is not expected to result in any significant adverse environmental impact to this site.

The location of GL-ST-2 is located within the building envelope for proposed Lot 18. GL-ST-2 is described as scar tree of ‘possible’ Aboriginal origin. The Central West Archaeological and Heritage Services Report (1995) states that ‘More positive Aboriginal origin assessment is difficult due to the poor definition of the scar, (due to bark regrowth), absence of axe marks, and lack of any known Aboriginal history or specific significance’.

The building envelop for proposed Lot 18 covers an area approximately 75m wide x 100m long (7,500m²), with GS-ST-2 located in the southern third of the building envelope. Further assessment regarding the actual Aboriginal origin of GS-ST-2 may be required, along with an assessment of other suitable building envelopes within proposed Lot 18. It should be possible to develop proposed Lot 18 without having any significant adverse environmental impact on GS-ST-2, if in fact it is proven to be of Aboriginal origin. The planning proposal is not expected to result in any significant adverse environmental impact to this site.

3.2 Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW

The Impax Group reviewed the requirements of the NSW OEH (2010) 'Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW' (Due Diligence CoP) in order to determine if the project required consent in the form of an Aboriginal Heritage Impact Permit (AHIP).

The flow chart presented in Section 1 of the Due Diligence CoP indicated that the generic due diligence code of practice presented in Section 8 of the Due Diligence CoP should be followed for the project, as follows:

- Will the activity disturb the ground surface or any culturally modified trees?
  
  The proposal will disturb the ground surface at the site. No culturally modified trees would be disturbed.

- Are there any:
  
  a) relevant confirmed site records or other associated landscape feature information on AHIMS?

  Yes.

  There are six recorded Aboriginal Sites recorded on AHIMS for the site, comprising of four open camp sites and two scar trees

  b) any other sources of information of which a person is already aware?

  Yes.

  An Aboriginal Archaeological Assessment for the site was conducted in 1995.

  c) landscape features that are likely to indicate presence of aboriginal objects?

  No.

- Can harm to Aboriginal objects listed in AHIMS or identified by other sources of information and/or the carrying out of the activity at the relevant landscape features be avoided?

  Yes.

  The location of the six recorded Aboriginal Sites is well documented, and the planning proposal at the site should be able to proceed without harming the six recorded Aboriginal Sites. The location of the building envelopes within the proposed new lots should allow for the site to be developed without causing any significant adverse environmental impact to the Aboriginal objects at the site.
Answering yes to Question 3 above means that the generic due diligence process is complete. An AHP application is not necessary, and the project may proceed with caution. If any Aboriginal Objects are found, work must be stopped and the OEH notified. If human remains are found, work must be stopped, the site secured and the OEH and the NSW Police Service must be notified.

### 3.3 Potential Aboriginal Heritage Impacts

The assessment of potential Aboriginal Heritage impacts at the site is considered suitable with regards to the NSW Due Diligence CoP.

All Aboriginal Sites and Aboriginal Places are protected under the NSW *National Parks and Wildlife Act* 1974. It is an offence as per Part Six of the Act to harm or desecrate an Aboriginal Site or Aboriginal Place without authorisation of an Aboriginal Heritage Impact Permit (AHIP).

The location of the six recorded Aboriginal Sites within the site (Lot 8 DP 1063425) is well documented, and the planning proposal should be able to proceed without impacting on any Aboriginal Sites, provided the development complies with its legal obligations under the NSW *National Parks and Wildlife Act* 1974 and provided the recommended mitigation measures outlined in Section 3.4 are implemented.

### 3.4 Recommended Mitigation Measures

- Prior to works commencing, contractors should be advised of their legal obligation with respect to Aboriginal Heritage and Aboriginal Objects;
- Contractors involved in the planning proposal should be made aware of the legislative protection requirements for all Aboriginal sites and objects under the NSW *National Parks and Wildlife Act* 1974;
- Contractors should be provided with the location of the Aboriginal Sites as per Figure 2 of Attachment A;
- In the unlikely event that the proposed works uncover items of Aboriginal Heritage or Aboriginal Objects, all work within the project area must cease and the following people and organisations must be notified:
  - NSW Office of Environment and Heritage;
  - NSW National Parks and Wildlife Service;
  - Dubbo Local Aboriginal Land Councils;
  - NSW Police Service (in the event of skeletal remains being discovered); and
  - Dubbo Regional Council
- Contractors should undergo cultural heritage induction to ensure they recognise Aboriginal artefacts and are aware of the legislative protection of Aboriginal objects under the NPW Act and the contents of the Unanticipated Finds Protocol.
4 Groundwater Vulnerability / Salinity

4.1 Groundwater Impact Assessment

The previously submitted groundwater assessment highlighted 3 activities that would have the potential to impact upon groundwater at the site, generally described as follows:

- household garden watering;
- rainwater run-off from hard stand areas; and
- installation of on-site sewage management systems within each block.

Each of these three activities involves the addition of water or treated effluent either at the surface or within 0.5m of the surface. The main potential impact of such activities would be a degradation of groundwater quality in the vicinity of the site.

The planning proposal is likely to result in an increase in the amount of irrigation water applied at the site, in line with typical household garden water use practices.

The creation of additional hard stand areas at the site is likely to increase the concentration of water applied at the site, but not the amount of water applied at the site. The rainwater would have fallen on the site in any case, but any rain that falls on hard stand areas is concentrated as it runs off the hard stand area and onto the ground at the site.

The installation of an onsite sewage management system (in the event that the development is not connected to the Dubbo sewage system) is likely to result in an increase in the amount of water applied at the site.

The information presented in the previously submitted groundwater assessment indicates that the first water bearing zone within the vicinity of the site is likely to be at least 30m below ground level. This water bearing zone is likely to be low yielding. The first aquifer accessed for stock and domestic purposes within the vicinity of the site is likely to occur at a depth of between 35 to 40m below ground level. The closest registered groundwater bores licensed to extract groundwater for stock and domestic purposes was located 250m to the north of the site. This separation distance meets the minimum required buffer distance of 250m.

The site-specific soil and climatic characteristics would act to limit the amount of water percolating through the soil and potentially making its way into the groundwater system. The soils would slow down the rate of water movement through the profile, and make this water available for uptake by vegetation. High evaporation rates at the site would also act to limit the amount of surface water infiltrating the upper subsoil.

The addition of water at the site by way of residential lawn and garden surface irrigation would not be expected to result in a degradation of groundwater quality within the vicinity of the site provided the recommended mitigation measures are adhered to.

Rainwater runoff from additional hard stand areas resulting in an increased concentration of water being applied at the site would not be expected to result in a degradation of groundwater quality within the vicinity of the site provided the recommended mitigation measures are adhered to.

The installation of an onsite sewage management system would result in appropriately treated effluent being applied to site over a suitable area at the designed loading/irrigation rate. The addition of effluent directly into the subsoil at an appropriately designed loading rate would not be expected to result in a degradation of groundwater quality within the vicinity of the site provided the recommended mitigation measures are adhered to.
4.2 Recommended Mitigation Measures

The following mitigation measures should be adopted to minimise the impact the planning proposal may have on groundwater in the vicinity of the site:

- Implement water conservative irrigation practices and garden designs (i.e. native plants, water wise gardens, mulch and spray or dripper systems);
- Minimise the amount of reticulated water used to irrigate lawns and gardens;
- Retain as much native vegetation as possible especially deep rooted adult trees and shrubs;
- Re-vegetate and re-generate native vegetation across the property wherever possible;
- Ensure any construction or earthmoving minimises the ponding of surface water at the site;
- Ensure downpipes are fitted correctly and that they drain to rainwater tanks and not onto the ground next to buildings;
- Minimise the amount of additional hard surface area that is created at the site;
- Adopt household water use practices that minimise the loading placed on the onsite sewage management system;
- Minimise the amount of contaminants (chemicals/detergents, food scraps, oils/fats etc.) entering the onsite sewage management system;
- Locate the effluent disposal area (either the absorption bed or surface irrigation area) in an open, unshaded area to allow for maximum evaporation;
- Install a diversion drain on the high side of any effluent disposal area to divert surface water run-off away from the disposal area. This will help to minimise the loading on the effluent disposal area during wet weather;
- Do not drive over or disturb the effluent disposal area;
- Do not use any other water sources (town water, stored rain water etc.) to irrigate the effluent disposal area; and
- Ensure that the minimum buffer distances contained in Table 3 are maintained between the effluent disposal area and sensitive environments, as per The Dubbo City Council (2006) “Onsite Sewage Management Strategy”;

Table 3: Buffer Dimensions for Effluent Disposal Areas

<table>
<thead>
<tr>
<th>Feature</th>
<th>Buffer Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Drip/Trickle</td>
</tr>
<tr>
<td></td>
<td>Upslope Down slope</td>
</tr>
<tr>
<td>Dwelling</td>
<td>6 3 15 15 6 3 6 3</td>
</tr>
<tr>
<td>Driveway</td>
<td>6 3 6 3 6 3 6 3</td>
</tr>
<tr>
<td>Path</td>
<td>6 3 3 3 6 3 6 3</td>
</tr>
<tr>
<td>Pool</td>
<td>6 3 6 6 6 3 6 3</td>
</tr>
<tr>
<td>Permanent Water</td>
<td>100 100 100 100 100 100 100 100 100</td>
</tr>
<tr>
<td>Dam, non-permanent water</td>
<td>40 40 40 40 40 40 40 40 40 40</td>
</tr>
<tr>
<td>Property Boundary</td>
<td>6 3 6 3 6 3 12 3</td>
</tr>
<tr>
<td>Groundwater Bore</td>
<td>250 250 250 250 250 250 250 250 250 250</td>
</tr>
</tbody>
</table>
4.3 Implementation of Recommended Mitigation Measures

The groundwater assessment concluded that if these mitigation measures were implemented and adhered to the planning proposal would not be expected to result in a degradation of groundwater quality within the vicinity of the site.

The groundwater assessment is clear on how the proposed mitigation measures will manage any significant adverse environmental impact to groundwater at the site. The mitigation measures are designed to limit the amount of additional water applied to the surface/subsurface at the site, which would minimise the potential of any adverse environmental impact to ground at the site.

It is recommended that the groundwater salinity/vulnerability mitigation measures outlined in Section 4.2 be included as general conditions as part of the DA approval process.
5 Conclusions

The Inpx Group concludes the following with regards to Flora and Fauna, Aboriginal Archaeology and Groundwater Vulnerability / Salinity as part of the overall Planning Proposal:

- The planning proposal will result in the removal of approximately 2.81ha of vegetation at the site, reducing the total amount of vegetation at the site from approximately 51.23ha to approximately 48.42ha;

- All proposed vegetation clearing that will occur as part of the planning proposal would be undertaken to the minimum extent necessary and would therefore be considered a Routine Agricultural Management Activity under the NSW Native Vegetation Act 2003, and may be undertaken without a permit.

- No threatened flora or fauna species were recorded within the site. Of the three threatened species recorded within 1,000m of the site one threatened fauna species (P. temporalis) was assessed as having a moderate likelihood of occurring within the site;

- The planning proposal has the potential to result in 4 Key Threatening Processes impacting upon P. temporalis at the site;

- The proposed mitigation measures outlined in Section 2.4 would result in the planning proposal having a low potential to impact upon Key Threatening Processes at the site;

- The assessment of potential Aboriginal Heritage impacts at the site is considered suitable with regards to the NSW Due Diligence CoP;

- The location of the six recorded Aboriginal Sites within the site (Lot 8 DP 1063425) is well documented, and the planning proposal should be able to proceed without impacting on any Aboriginal Sites, provided the development complies with its legal obligations under the NSW National Parks and Wildlife Act 1974 and provided the recommended mitigation measures outlined in Section 3.4 are implemented;

- No groundwater bores were present within the site;

- There does not appear to be a significant aquifer used for beneficial purposes located beneath the site;

- The addition of water at the site by way of residential lawn and garden surface irrigation would not be expected to result in a degradation of groundwater quality within the vicinity of the site;

- Rainwater runoff from additional hard stand areas resulting in an increased concentration of water being applied at the site would not be expected to result in a degradation of groundwater quality within the vicinity of the site;

- The addition of effluent directly into the subsoil at an appropriately designed loading rate would not be expected to result in a degradation of groundwater quality within the vicinity of the site; and

- It is recommended that the groundwater salinity / vulnerability mitigation measures outlined in Section 4.2 be included as general conditions as part of the DA approval process.
Attachment A:
Figures
Figure 1:
Area of Vegetation

(Map courtesy: Deberty Smith and Associates Consulting Surveying)
Figure 2: Archaeological Site Locations

(Map courtesy: Debby Smith and Associates Consulting Surveyors)
Proposed New Residential Development
Noise Assessment of Motor Sports

At:
4L Camp Road,
Dubbo,
NSW 2830.

May 2016

Report No. nss 22429 – Final

Prepared at the Request of:-
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# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>1</td>
</tr>
<tr>
<td>1. INTRODUCTION</td>
<td>2</td>
</tr>
<tr>
<td>2. SITE AND BUILDING DESCRIPTION</td>
<td>2</td>
</tr>
<tr>
<td>2.1 Site Description</td>
<td>2</td>
</tr>
<tr>
<td>2.2 Development Description</td>
<td>3</td>
</tr>
<tr>
<td>3. CRITERIA</td>
<td>3</td>
</tr>
<tr>
<td>4. MEASURED NOISE LEVELS</td>
<td>4</td>
</tr>
<tr>
<td>4.1 Measurement Procedure</td>
<td>4</td>
</tr>
<tr>
<td>4.2 Instrumentation - Attended</td>
<td>4</td>
</tr>
<tr>
<td>4.3 Instrumentation – Unattended</td>
<td>5</td>
</tr>
<tr>
<td>4.4 Noise Level Results</td>
<td>5</td>
</tr>
<tr>
<td>5. NOISE MODELS</td>
<td>7</td>
</tr>
<tr>
<td>5.1 External Noise Modelling Specifications</td>
<td>7</td>
</tr>
<tr>
<td>5.2 Noise Modelling Equations</td>
<td>7</td>
</tr>
<tr>
<td>5.3 Internal Noise Levels</td>
<td>8</td>
</tr>
<tr>
<td>6. RECOMMENDATIONS</td>
<td>9</td>
</tr>
<tr>
<td>6.1 Roof / Ceiling and Wall Construction</td>
<td>9</td>
</tr>
<tr>
<td>6.2 Wall Construction</td>
<td>9</td>
</tr>
<tr>
<td>6.3 Plasterboard Corner Details</td>
<td>10</td>
</tr>
<tr>
<td>6.4 Windows and Glazed Doors</td>
<td>10</td>
</tr>
<tr>
<td>6.5 Ventilation</td>
<td>11</td>
</tr>
<tr>
<td>7. CONCLUSIONS</td>
<td>11</td>
</tr>
<tr>
<td>APPENDIX A – EXAMPLE MATERIAL SUPPLIERS</td>
<td>12</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

It is proposed to rezone Lot 8 DP1063425, 4L Camp Road, Dubbo. Currently the land is zoned SP3 Tourist. The proponent wishes to rezone the land so that much of the area is changed to RU2 Rural Landscape. It is proposed to subdivide the land into 26 Lots with new dwellings on 24 of the Lots (Lots 2 to 25). Located adjacent to the site is the Morris Park Motorsport Complex. This report considers the impact of noise from motorsport events at Morris Park on future residencies on the subject land and suggests mitigation measures.

The noise assessment was carried out during a motor sports event close to Camp Road, Dubbo, NSW 2830 and provides an independent and accurate appraisal of the noise levels. This was during the use of the Morris Park Speedway, Obey Road/ Belowie Road, Dubbo adjacent to the proposed residential development at Lot 8 DP1063425, 4L Camp Road, Dubbo, NSW 2830.

Noise levels have been measured at three locations and the external sound pressure level from a source noise has been modelled for the whole site using the International Standard ISO 9613-2 (1996(E)) 'Acoustic — Attenuation of sound during propagation outdoors Part 2 General method of calculation'.

With the recommended building element acoustical designs, the internal noise goals can be met for future dwellings during motor sports events. Hence it is concluded that the internal noise criteria as given in The State Environmental Planning Policy (Infrastructure) 2007, Subdivision 2 Development Clause 102, Impact of road noise on non-road can be fully met for proposed residential dwellings at Lot 8 DP1063425, 4L Camp Road, Dubbo, NSW 2830 during the use of motorsport events at Morris Park.
1. INTRODUCTION

Noise and Sound Services was requested by Doherty Smith & Associates of 4/2 Blueridge Drive, Dubbo NSW 2830, to carry out a noise assessment on behalf of Matt Bender Constructions during a motor sports event close to Camp Road, Dubbo, NSW 2830.

The purpose of the assessment is to provide an independent and accurate appraisal of the noise levels from the Morris Park Motor Sport Complex: Dubbo (Morris Park Speedway) Obley Road/Beelawrie Road, Dubbo, NSW 2830 at the proposed residential development at Lot 8 DP1063425, 4L Camp Road, Dubbo, NSW 2830 to enable internal noise goals to be met in future dwellings during motor sports events.

2. SITE AND DEVELOPMENT DESCRIPTION

2.1 Site Description

The site is in a rural area approximately 6.5 km south southeast of Dubbo City centre. The Morris Park Speedway is located on an existing track as shown in Figure 1 below.

Figure 1. Site Plan. Source: Google Earth.
2.2 Development Description

It is proposed to rezone Lot 8 DP1063425, 4L Camp Road, Dubbo. Currently the land is zoned SP3 Tourist. The proponent wishes to rezone the land so that much of the area is changed to RU2 Rural Landscape. It is proposed to subdivide the land into 26 Lots with new dwellings on 24 of the Lots (Lots 2 to 25). The Lot sizes will be between 3 ha and 5 ha in size as shown in Figure 2 below. See Doherty Smith and Associates drawings for Job 15066 Rev D dated 25/02/16 for full details.

Located adjacent to the site is the Morris Park Motorsport Complex. Council have requested this noise study to consider the impact of noise from motorsport events at Morris Park on proposed residences to be built the subject land.

![Development Plan Showing Proposed Plots and House Locations. Source: Doherty Smith and Associates.]

3. CRITERIA

There are no specific criteria for this type of application. However there is for road traffic noise. The State Environmental Planning Policy (Infrastructure) 2007, Subdivision 2 Development Clause 102, Impact of road noise on non-road development states that: "If the development is for the purposes of a building for
residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following $L_{Aeq}$ levels are not exceeded:

(a) in any bedroom in the building — 35 dBA at any time between 10 pm and 7 am,

(b) anywhere else in the building (other than a garage, kitchen, bathroom or hallway) — 40 dBA at any time."

4. MEASURED NOISE LEVELS

4.1 Measurement Procedure

Attended noise measurements were carried out on Saturday 7th May 2016 before and during the normal use of the Morris Park Speedway. In addition unattended noise measurements were carried out before, during and after the normal use of the Morris Park Speedway which included early Sunday morning 8th May 2016. The noise measurements were taken at approximate positions of the proposed residential development Lots to the speedway. For the noise surveys the noise levels were typical and the weather did not have an adverse effect on the measurements.

The results are necessarily a "snapshot" of the noise levels on the particular days of the surveys. Noise levels can vary with time due to different weather or traffic conditions, also low level measurements can be affected by fauna noise.

4.2 Instrumentation — Attended

The instrumentation used during the noise source survey consisted of two Bruel and Kjaer sound level meters model 2250 (serial numbers 3008564 and 2446904). These meters conform to Australian Standard AS IEC 61672.1-2004: ‘Electroacoustics - Sound level meters — Specifications’ as class 1 precision sound level meters and have an accuracy suitable for both field and laboratory use. The calibration of the meters was checked before and after the measurement period with a Bruel and Kjaer acoustical calibrator model 4231 (serial no. 2445757). No significant system drift occurred over the measurement period.

The sound level meters and calibrator were checked, adjusted and aligned to conform to the Bruel and Kjaer factory specifications and issued with conformance certificates within the last 24 months as required by the regulations. The internal test equipment used is traceable to the National Measurement Laboratory at C.S.I.R.O., Lindfield, NSW, Australia.
4.3 Instrumentation – Unattended

The instrumentation used during the noise survey consisted of an ‘Acoustic Research Laboratories Pty Limited’ (ARL) - Type 2 Environmental Noise Logger serial number 194550. This instrument conforms to Australian Standard 1259 "Acoustics - Sound Level Meters", (1990) and has an accuracy suitable for both field and laboratory use.

The calibration of the meter was checked before and after the measurement period with a Briel and Kjær acoustical calibrator model 4230 (serial no. 2445349). No significant system drift occurred over the measurement periods.

The environmental noise logger and calibrator have been checked, adjusted and aligned to conform to the Briel and Kjær or ARL factory specifications and issued with conformance certificates within the last 12 months as required by the regulations. The internal test equipment used is traceable to the National Measurement Laboratory at C.S.I.R.O., Lindfield, NSW, Australia.

4.4 Noise Level Results

The measured noise level from the motor sports event was between 60 dBA and 70 dBA with the A frequency weighted octave band frequency analysis as shown in Figure 3 below.

![Graph](image)

*Figure 3. Attended Measured Noise Levels of the Motor Sports at the Closest Future Boundary Position, approximately 470 metres from the Racetrack.*
Figure 4. Attended Measured Noise Levels from the Motor Sports at the Closest Future Boundary Position, approximately 350 metres from the Racetrack.

Figure 5. Unattended Measured Noise Levels of the Motor Sports at the Closest Future Boundary Position, approximately 550 metres from the Racetrack.

The noise from the motor sports occurred intermittently between 8:00 pm and midnight as shown above in the unattended noise logger measurements.
5. NOISE MODELS

This section provides details of the calculations used to determine the potential noise levels at receiver locations, both externally and internally within the proposed dwelling lots, from the specific noise source.

5.1 External Noise Modelling Specifications

The external sound pressure level from a source noise has been modelled using the International Standard ISO 9613-2 (1996(E)) 'Acoustic – Attenuation of sound during propagation outdoors Part 2 General method of calculation'. This Standard specifies methods for the description of noise outdoors in community environments. The method described in the Standard is general in the sense that it may be applied to a wide variety of noise sources, and covers the major mechanism of attenuation. The method allows for downwind propagation conditions within an angle of ± 45° of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region with the wind blowing from source to receiver, and wind speed between approximately 1 m/s and 5 m/s measured at a height of 3 m to 11 m above the ground.

5.2 Basic Noise Modelling Equations

Equivalent continuous downwind sound pressure level \( L_{Aeq} \) at each receiver point has been calculated for each noise source using the equation below:

\[
L_{Aeq} = L_{eq} + D_k - A
\]

Where:
- \( L_{eq} \) is the sound power level of the noise source;
- \( D_k \) is directivity correction; and
- \( A \) is the attenuation that occurs during the propagation from source to receiver.

The attenuation term \( A \) in the equation above is given by:

\[
A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}
\]

Where:
- \( A_{div} \) is the attenuation due to geometric divergence;
- \( A_{atm} \) is the attenuation due to atmospheric absorption;
- \( A_{gr} \) is the attenuation due to the ground effects;
- \( A_{bar} \) is the attenuation due to a barrier; and
- \( A_{misc} \) is the attenuation due to miscellaneous other effects.
The last term ($A_{att}$) is of minor significance and generally refers to miscellaneous propagation through foliage, industrial sites and areas of houses. Due to the vicinity of the neighbouring dwellings to the race track the attenuation due to ground effects and atmospheric absorption effects are included at this site.

Figure 6. Site Plan with Measured and Predicted Raceway Sound Pressure Level ($L_{Aeq}$ dB).

5.3 Internal Noise Levels

The internal noise levels for the proposed residences are dependent upon the sound transmission loss of the building components. For convenience the sound transmission loss can be given in a single number known as the weighted sound reduction index ($R_w$). This is similar to the sound transmission class (STC) used previously. In addition to distance attenuation, the internal noise level ($L_{eq}$) in various rooms of the proposed development is found from the formula:

$$L_{eq} = L_{p1} - R_w + 10 \log_{10} (S/A) - K + 6 \text{ dBA}$$

Where:
- $L_{p1}$ is the external noise level;
- $R_w$ is the weighted sound reduction index of the partition;
- $S$ is the area of the partition (etc. window or glazed door);
- $A$ is the room acoustic absorption; and
- $K$ is an angle of view correction.
By applying this formula, the selection of the weighted sound reduction index ($R_w$) of the building components, particularly the windows and glazed doors in all façades and the roof can be found. The glazed areas are normally the acoustically weakest partitions in the façades in nearly all situations. It is assumed that the rooms, particularly the bedrooms, will be normally furnished (e.g. bed, carpet and curtains) giving an average reverberation time of approximately 0.5 seconds for bedrooms and 0.8 seconds for living areas. As the room and building components sizes are not known at this stage assumptions have been made based on standard sizes. Once the architectural drawings of the proposed dwellings are known this part of the modelling can be refined.

6. FUTURE RESIDENCES - RECOMMENDATIONS

From the calculated results given in Figure 6 above, the roof / ceilings should have a weighted sound reduction index ($R_w$) of at least 48 dB and the walls should have an $R_w$ of at least 52 dB. The windows for all the residences should have an $R_w$ as shown in Table 1 below.

6.1 Roof / Ceiling Construction

A pitched concrete or terracotta tile or sheet metal roof with sarking, one layer of 13 mm thick plasterboard fixed to the ceiling joists and acoustic absorption in the roof cavity will have an $R_w$ of at least 48 dB and hence will be suitable for the roof / ceiling application. The acoustic absorption material should be at least 50 mm thick with a Noise Reduction Coefficient (NRC) of at least 0.7. Thermal rating of R2 would normally be suitable to meet the acoustic requirements; however the NRC should be checked with the relevant supplier before purchase to ensure it is at least 0.7.

6.2 Wall Construction

The external walls must have a minimum $R_w$ of 52 dB, which is standard for:

- Brick veneer consisting of 110 mm thick exterior face brick, 90 mm timber stud or 92 mm metal stud, at least 50 mm clearance between the masonry and stud frame and 10 mm thick plasterboard internal wall constructions and R2 insulation batts in wall cavity; or
- Double brick consisting of 2 layers of 110 mm brickwork separated by at least a 50 mm gap.
If a timber frame cladding construction is used for the dwellings this should consist of 6 mm thick fibre cement sheeting or weatherboard or plain cladding externally, 90 mm deep timber stud or 92 mm metal stud 13 mm thick standard plasterboard internally with R2 thermal insulation in the wall cavity. The above design will only be suitable for dwellings exposed to noise level below 55 dBA as shown in Figure 6 above.

6.3 Plasterboard Corner Details

It is essential for sound insulation that plasterboard walls and ceilings for all proposed residences are well sealed. The joint between the wall and ceiling can be sealed, for example, with a resilient layer such as mastic and covered with a plasterboard cornice or the joint can be sealed with tape and cornice cement.

6.4 Windows and Glazed Doors

The generalised recommended minimum weighted sound reduction index $R_w$ is shown for the glazing in Table 1 below. Once the architectural drawings of the proposed dwellings are known these $R_w$ ratings can be confirmed.

**TABLE 1 – MINIMUM GLAZING THICKNESS AND $R_w$ RATINGS**

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Recommended Minimum Type and Thickness of Glazing</th>
<th>Required Minimum $R_w$ or STC (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>For Dwellings Exposed to Noise Level Above 55 dBA as shown in Figure 6 Above.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedrooms</td>
<td>6.38 mm Laminated Awning Windows with Qlen Seals</td>
<td>33</td>
</tr>
<tr>
<td>Living Areas</td>
<td>6.38 mm Laminated Awning Windows with Qlen Seals</td>
<td>31</td>
</tr>
<tr>
<td>Living Areas</td>
<td>10.58 mm Laminated Sliding Doors with Fin Seals</td>
<td>31</td>
</tr>
<tr>
<td><strong>For Dwellings Exposed to Noise Level Below 55 dBA as shown in Figure 6 Above.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedrooms</td>
<td>4 mm Float Awning Windows with Standard Seals or 6.38 mm Laminated Sliding Windows with Fin Seals</td>
<td>29</td>
</tr>
<tr>
<td>Living Areas</td>
<td>4 mm Float Awning Windows with Standard Seals or 6.38 mm Laminated Sliding Windows with Fin Seals</td>
<td>24</td>
</tr>
<tr>
<td>Living Areas</td>
<td>5 mm Laminated Sliding Doors with Fin Seals</td>
<td>24</td>
</tr>
</tbody>
</table>
Notes:-
- All glazing, given in Table 1 above, must be in solid frames and well sealed when closed.
- All glazing, given in Table 1 above, must be fixed with acoustic seals to meet the required weighted sound reduction index ($R_w$) when closed.
- Glazing systems recommended are minimum requirements for acoustic purposes. In some cases thicker glass may be required for safety or other purposes.

6.4.1 Glazing Manufacturers

Glazing manufacturers as listed in Appendix A below have provided attenuation data for their windows and will meet the requirements given in this report. Should other suppliers be used, laboratory test data to support the window system ratings must be provided.

6.5 Ventilation

An acoustically insulated building must be kept virtually air tight to exclude external noise. Therefore for the windows requiring laminated glazing in Table 1 above, and to achieve the required $R_w$ ratings, the windows must be kept closed. Hence there is a requirement for mechanical ventilation or air-conditioning to provide fresh air to control odours. Specific ventilation requirements are outside of our scope of expertise, however requirements for indoor-air quality are given in Australian Standard AS 1668.2-2012, “The use of ventilation and air-conditioning in buildings - Ventilation design for indoor air contaminant control”. Internal noise levels from mechanical ventilation or air-conditioning should not exceed 35 dBA for bedroom areas and 40 dBA for all other habitable areas. External noise levels from mechanical ventilation or air-conditioning should not exceed 5 dB over the lowest existing background noise level ($L_{Aeq}$) when in day time use and when measured at the neighbouring boundary. Night time noise levels must meet the requirements of the Protection of the Environment Operations (Noise Control) Regulation 2008.

7 CONCLUSIONS

It is concluded that the internal noise criteria as given in The State Environmental Planning Policy (Infrastructure) 2007, Subdivision 2 Development Clause 102, Impact of road noise on non-road can be fully met. This is for the proposed residential dwellings for the subdivision of Lot 8 DP1063425, 4L Camp Road, Dubbo, NSW 2830 during motorsports events at Morris Park adjacent to the site.

Recommendations given in section 6 above must also be fully complied with. Once the architectural drawings for each of the proposed dwellings are known the
recommended minimum weighted sound reduction index can be confirmed for each individual dwelling.

<table>
<thead>
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<th>Date</th>
<th>Prepared by</th>
<th>Notes</th>
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<td>Draft</td>
<td>23rd May 2016</td>
<td>Ken Scammell MSc, MEng, MEng MIA</td>
<td>Acoustician</td>
</tr>
<tr>
<td>Final</td>
<td>31st May 2016</td>
<td>Ken Scammell MSc, MEng, MIA</td>
<td>Acoustician</td>
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Important Note. All products and materials suggested by 'Noise and Sound Services' are selected for their acoustical properties only. All other properties such as airflow, aesthetics, chemical, corrosion, combustion, construction details, decomposition, expansion, fire rating, grout or tile cracking, loading, shrinkage, ventilation, etc are outside of 'Noise and Sound Services' field of expertise and must be checked with the supplier or suitably qualified specialist before purchase.
APPENDIX A - EXAMPLE MATERIAL SUPPLIERS

Acoustic Glazing Suppliers

‘Wideline Pty Ltd’ telephone (02) 8304 6400.
www.wideline.com.au
‘Trend Windows & Doors Pty Ltd’ telephone (02) 9840 2000.
www.trendwindows.com.au
‘Vantage Windows’ telephone 1300 026 189
http://www.vantagewindows.com.au
‘Thermoglaze Windows’ telephone: 1300 166 571
www.thermoglazewindows.com.au
‘Christoffel Pty Ltd’ telephone (02) 9627 4811
www.christoffel.com.au/contact.htm
‘Sound Barrier Systems Pty. Ltd’ telephone (02) 9540 4333
www.soundbarrier.com.au

Acoustic Absorbent Material

Pyrotek - telephone 13 17 44.

Acoustic Door Seals

Kilargo - telephone 1300 858 010 www.kilargo.com.au
Raven – telephone 1800 888 123 www.raven.com.au

Internal Wall-Mounted Air Ventilators

Sonair – telephone 1300 858 674 www.edmonds.com.au
Environmental Dust Monitoring

Summernats Car Festival
Watson
Canberra
ACT 2911

29 June 2010

Client: ACT EPA
Job No: 5250
CERTIFICATE OF APPROVAL FOR ISSUE OF DOCUMENTS

Document No: 5250_OH_EDM_SUM_20100303  Revision Status: B2
Title: EDM for Summemats Watson  Date of Issue: 29/06/10
Client: Environmental Protection Authority  Copy No: One

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<tr>
<td>Prepared by:</td>
<td>Maggie Davidson</td>
<td>Trainee Hygienist</td>
<td>29/06/10</td>
</tr>
<tr>
<td>Approved by:</td>
<td>Venessa Thelan</td>
<td>Manager Occupational Health and Hygiene</td>
<td>29/06/10</td>
</tr>
<tr>
<td>Released by:</td>
<td>John Robson</td>
<td>Managing Director</td>
<td>29/06/10</td>
</tr>
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</table>

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<td>Robson Environmental Pty Ltd</td>
<td>John Robson</td>
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Client: EPA  5250_Dust_Nats_EPA_B2_20100317_Final.docx  Page 2 of 28
TABLE OF CONTENTS

1. EXECUTIVE SUMMARY .................................................................4
2. SCOPE OF WORK ........................................................................6
3. METHODOLOGY ........................................................................7
4. RESULTS ...................................................................................8
5. DISCUSSION ............................................................................11
6. CONCLUSION AND RECOMMENDATIONS ...............................13
7. REFERENCES ...........................................................................14
8. APPENDIX A – DustTrak Real Time Dust Monitoring Graphed Results .... 16
9. APPENDIX B – Calibration Certificates for DustTrak Monitors ..........25
1. EXECUTIVE SUMMARY

At the request of the ACT Environmental Protection Authority (EPA), Robson Environmental Pty Ltd was commissioned to carry out particulate monitoring of ambient air at two sites in the suburb of Watson, ACT during the Summernats car festival held at the Exhibition Park in Canberra (EPIC) in Mitchell between 7 January and 11 January 2010. Monitoring of particulates less than 10 \( \mu m \) in diameter (PM\(_{10}\)) was used to assess the impact of this event on ambient air quality because PM\(_{10}\) is the current particulate indicator for assessing ambient air quality as part of the National Environment Protection (Ambient Air Quality) Measure 2003 (NEPM) framework. The current exposure standard for PM\(_{10}\) in ambient air is no more than 5 daily exceedences of greater than 50 \( \mu g \ m^{-3} \) (24 hours) in a year.

Monitoring of PM\(_{10}\) was conducted during the weekend of the Summernats Car festival from Friday 8 January 2010 at 10:00am to Monday 11 January 2010 around 9:45am. Follow up monitoring was conducted one week later, commencing on Friday 15 January 2010 around 10:00am and finishing on Monday 18 January 2010 around 9:30am. The results from the follow up monitoring were used as a control sample to compare ambient air quality when burnouts and other Summernats activities were being carried out, with ambient air quality during regular traffic conditions. At Site A, located adjacent to the riding track in Watson (Map 1), gravimetric monitoring was carried out according to AS/NZS 3580.9.8:2003 to give a time weighted average of PM\(_{10}\) concentrations over a 24 hour period (PM\(_{10}\) TWA\(_{24 \text{hour}}\)), as well as real time monitoring of PM\(_{10}\) concentrations with a DustTrak, which were calculated as geometric means for each day (mean daily PM\(_{10}\)). At Site B, adjacent to the Federal Highway in Watson (Map 1) only real time monitoring of PM\(_{10}\) with a DustTrak was carried out.

The results show that the PM\(_{10}\) TWA\(_{24 \text{hour}}\) Concentrations were below the NEPM of 50 \( \mu g \ m^{-3} \). PM\(_{10}\) concentrations (TWA\(_{24 \text{hour}}\) and mean daily) were higher on the weekend of the Summernats, in comparison to follow up monitoring. Concentrations of Copper, Lead and Chromium in the PM\(_{10}\) particulate fraction were also higher on the Saturday of the Summernats weekend, in comparison to the following Saturday. A review of Summernats activities shows that when burnout activities occurred there was an increase in real time PM\(_{10}\) concentrations measured at either one or both monitoring sites on a number of occasions. There was also an increase in real time PM\(_{10}\) concentrations which coincided with the fireworks and main stage concert on the Saturday night. The PM\(_{10}\) concentrations measured may have been influenced by changes in wind direction, ambient air temperature, and the occurrence of rain on the Sunday during the follow up monitoring.

In conclusion, Robson Environmental Pty Ltd advises that while TWA\(_{24 \text{hour}}\) PM\(_{10}\) concentrations were below the NEPM of 50 \( \mu g \ m^{-3} \), Summernats activities appeared to have an adverse effect on PM\(_{10}\) concentrations at both monitoring sites. However,
there are a number of uncertainties due to the small number of sampling sites and indicators monitored.
2. **SCOPE OF WORK**

The aim of the monitoring was to determine if concentrations of atmospheric particulate matter measuring less than 10 μm in diameter (PM$_{10}$) were within the National Environmental Protection Measure (NEPM) guideline for acceptable ambient air quality of 50 μg m$^{-3}$ over a 24 hour period (EHPC, 2003).

The scope of the work was as follows:

- Gravimetrically measure ambient PM$_{10}$ concentrations (24 hour samples) according to AS/NZS 3580.9.6:2003 for the duration of the Summernats at one location (Site A), please refer to Map 1 below;

- Log real-time PM$_{10}$ concentrations for the duration of the Summernats at two locations (Site A & Site B), please refer to Map 1 below;

- Monitor background PM$_{10}$ concentrations in ambient air using both gravimetric and real-time monitoring methods;

- Assessment of PM$_{10}$ concentrations against the NEPM for ambient PM$_{10}$ over a 24 hour period, and best practice;

- Report on the findings of the assessment, and Make recommendations where appropriate based on these findings.

Map 1: Location of Monitoring Sites in Relation to Summernats Burnout Strip
3. METHODOLOGY

 Sampling of PM$_{10}$ during the Summemats commenced around 10:00am on Friday 8 January 2010, and finished on Monday 11 January 2010 around 9:45am. Background PM$_{10}$ sampling commenced the following week on Friday 15 January 2010 around 10:00am, and finished on Monday 18 January 2010 around 9:30am.

 Gravimetric sampling of PM$_{10}$ particulates was carried out at Site A according to AS/NZS 3580.9.6:2003, which is the specified method for statutory monitoring of PM$_{10}$ in ambient air according to the National Environment Protection (Ambient Air Quality) Measure 2003. Prior to sampling, PVC filters were conditioned for 24 hours in a controlled environment, and weighed on a calibrated microbalance (Mettler Toledo, Model No. AT201). On completion of sampling, the PVC filters were reconditioned for 24 hours prior to reweighing, and the difference in weights recorded. The High Volume Sampler (Thermo Scientific Model VFC-PM10) was fitted with a PM$_{10}$ size selective inlet and the flow rate calibrated at 1.13 L min$^{-1}$.

 Real-time monitoring of PM$_{10}$ particulates was conducted at Sites A and B with TSI DustTraks (model 8520; serial No 23651 & 85202572, respectively). The PM$_{10}$ size selective inlet was attached and the flow rates calibrated at 1.7 L min$^{-1}$. The monitors were placed at a height of approximately 0.5-1m, and logging set for 1 minute intervals. Data from the DustTraks was analysed with TSI TrakPro software version 4.0.3.0.


 Site A was located in an east south easterly direction from the Summemats burn out strip and Site B was located to the south/south east of the Summemats burn out strip (please refer to Map 1).
4. RESULTS

Table 1 shows the TWA$_{24\text{ hour}}$ PM$_{10}$ concentrations for each sample collected during the monitoring periods. The TWA$_{24\text{ hour}}$ PM$_{10}$ concentrations during the Summernats monitoring sessions were higher in comparison to follow up monitoring sessions, but none of the samples exceeded the PM$_{10}$ NEPM of 50 µg m$^{-3}$.

The PM$_{10}$ control sample for Sunday 17 of January 2010 was voided because the calculated concentration was higher than would be realistic (>100 µg m$^{-3}$) given the data from the DustTrak indicated that PM$_{10}$ concentrations on the Sunday were lower in comparison to those collected during the Summernats weekend. The BOM also reported that 1.6mm of rain was recorded on Sunday 17 January 2010, and it is possible that moisture gain may have affected the filter condition and subsequently, the result.

Additional information on PM$_{10}$ concentrations could be sought from the ACT Government Analytical Laboratory (GAL), which monitors daily PM$_{10}$ concentrations in accordance with the National Environment Protection (Ambient Air Quality) Measure 2003. Results of monitoring conducted by the ACT GAL could be used as an indication of background PM$_{10}$ concentration on the monitoring days.

**Table 1: TWA$_{24\text{ hour}}$ PM$_{10}$ Concentrations (µg m$^{-3}$) at Site A, January 2010**

<table>
<thead>
<tr>
<th>Sampling Day</th>
<th>Start Date</th>
<th>PM$_{10}$ (µg m$^{-3}$)</th>
<th>Wind Direction</th>
<th>Start Date</th>
<th>PM$_{10}$ (µg m$^{-3}$)</th>
<th>Wind Direction</th>
<th>PM$_{10}$ (µg m$^{-3}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friday</td>
<td>8/01/10</td>
<td>17</td>
<td>WNW</td>
<td>15/01/10</td>
<td>7</td>
<td>NE</td>
<td>50</td>
</tr>
<tr>
<td>Saturday</td>
<td>9/01/10</td>
<td>34</td>
<td>WSW</td>
<td>16/01/10</td>
<td>9</td>
<td>NNW</td>
<td>50</td>
</tr>
<tr>
<td>Sunday</td>
<td>10/01/10</td>
<td>14</td>
<td>W</td>
<td>17/01/10</td>
<td>Void</td>
<td>W</td>
<td>50</td>
</tr>
</tbody>
</table>
Table 2 shows that the mean daily PM$_{10}$ concentrations were all below 50 µg m$^{-3}$ during both Summernats and follow up monitoring sessions. The mean concentrations declined significantly at both Site A and Site B between the initial and subsequent monitoring periods. Site A PM$_{10}$ concentrations declined from a range of 12 to 14 µg m$^{-3}$ during Summernats, to 1 to 11 µg m$^{-3}$ on the following weekend. At Site B, mean daily PM$_{10}$ concentrations declined from a range of 15 to 22 µg m$^{-3}$, to 4 to 13 µg m$^{-3}$ after the event.

The daily PM$_{10}$ graphs for the DustTraks show an increase in real time PM$_{10}$ concentrations, which coincides with various Summernats activities including the burnouts and fireworks, as well as a large reduction in the number of peaks that exceeded 50 µg m$^{-3}$ during post Summernats monitoring sessions. The full set of graphs is provided in Appendix A.

Site B had higher mean daily PM$_{10}$ concentration during the Summernats monitoring in comparison to Site A PM$_{10}$. However, statistical analysis indicated that the difference was not significant. The mean daily PM$_{10}$ concentrations at Sites A and B during the Summernats weekend were strongly correlated, indicating that PM$_{10}$ concentrations at both sites were being influenced by the same source.

The mean daily PM$_{10}$ concentrations measured with the DustTrak at Site B were correlated with the TWA$_{(24 \text{ hour})}$ PM$_{10}$ concentrations measured at Site A with the High Volume Sampler. Site A had a weaker correlation between the mean daily PM$_{10}$ concentration and the TWA$_{(24 \text{ hour})}$ PM$_{10}$ concentration. The correlation suggests that the PM$_{10}$ concentrations at both sites indicate that all samples were being influenced by the same source. However, it must be noted that there was a difference between the sampling periods for the two types of data reported. Gravimetric TWA PM$_{10}$ concentrations are based on the amount of sample collected over 24 hours starting from 10:00am, while the daily mean PM$_{10}$ concentrations are based on DustTrak data starting from 12:00am each day, with the exception of Fridays at 10:00am.
Table 2: Mean Daily (±Standard Error) PM$_{10}$ Concentrations Measured with DustTraks at Sites A and B, January 2010

<table>
<thead>
<tr>
<th>Date</th>
<th>Daily PM$_{10}$ Mean* (±SE) μg m$^{-3}$</th>
<th>Temperature* (°C)</th>
<th>Relative Humidity* (%RH)</th>
<th>Wind Speed* (km/h)</th>
<th>Wind Direction*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Site A</td>
<td>Site B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/01/10</td>
<td>13 ±1</td>
<td>22 ±5</td>
<td>30.7</td>
<td>28</td>
<td>17</td>
</tr>
<tr>
<td>9/01/10</td>
<td>14 ±1</td>
<td>22 ±3</td>
<td>33.6</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>10/01/10</td>
<td>14 ±0</td>
<td>20 ±5</td>
<td>37.6</td>
<td>11</td>
<td>28</td>
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<tr>
<td>11/01/10</td>
<td>12 ±0</td>
<td>15 ±0</td>
<td>34.6</td>
<td>26</td>
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</tr>
<tr>
<td>15/01/10</td>
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<td>41</td>
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<tr>
<td>16/01/10</td>
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<td>13 ±1</td>
<td>29.2</td>
<td>43</td>
<td>17</td>
</tr>
<tr>
<td>17/01/10</td>
<td>1 ±0</td>
<td>6 ±0</td>
<td>25.0</td>
<td>19</td>
<td>33</td>
</tr>
<tr>
<td>18/01/10</td>
<td>3 ±0</td>
<td>4 ±0</td>
<td>17.5</td>
<td>22</td>
<td>31</td>
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* Geometric mean, data log normally distributed
* 15/00 data sourced from Bureau of Meteorology website

Table 3 shows that concentrations of lead, copper and chromium in the PM$_{10}$ particulate fraction were higher on Saturday 9 January 2010 during the Summernats Car Festival in comparison with Saturday 16 January 2010 on the following weekend. Potential sources of heavy metals in the atmosphere would have included tyre particles emitted during the burnout competitions and the fireworks on Saturday the 9 January 2010.

Table 3: Metals Analysis of For Gravimetric PM$_{10}$ Samples Collected on Saturday the 9 & 16 January 2010

<table>
<thead>
<tr>
<th>Sampling Day</th>
<th>Date</th>
<th>Metals Analysed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lead (μg m$^{-3}$)</td>
</tr>
<tr>
<td>Summernats Saturday</td>
<td>9/01/10</td>
<td>0.008</td>
</tr>
<tr>
<td>Control Saturday</td>
<td>16/01/10</td>
<td>0.001</td>
</tr>
</tbody>
</table>
5. DISCUSSION

Gravimetric monitoring of PM$_{10}$ according to the AS3580.9.8:2003 indicated that ambient air quality was acceptable during both the Summernats and the following weekend because the PM$_{10}$ NEPM of 50 µg m$^{-3}$ was not exceeded. However, the TWA$_4$ and daily mean PM$_{10}$ concentrations shown in Section 4 indicate that Summernats activities affected ambient PM$_{10}$ concentrations, with higher concentrations recorded on the weekend of the Summernats in comparison to the following weekend. Analysis of gravimetric filters showed a higher concentration of lead, copper and chromium was present in the PM$_{10}$ particulate fraction on the Saturday of the Summernats (9 January 2010) in comparison with the following Saturday (16 January 2010), although the lead concentration did not exceed the NEPM of 0.5 µg m$^{-3}$.

Further evidence of the impact of Summernats activities on ambient air quality was the simultaneous increase in real time PM$_{10}$ concentrations at both sites when burnout trials were scheduled for Friday 8 January 2010 between 2:00pm and 6:00pm, and at Site B on Sunday 10 January 2010 between 12:45 and 4:30pm, as shown in Appendix A. There was also a large reduction in the frequency of short term PM$_{10}$ peaks in the daily real time DustTrak graphs which exceeded 50 µg m$^3$ during follow up monitoring. The wind direction at 3:00pm on the Friday 8 January 2010 was west-north-west, heading in the general direction of both Site A and Site B from the burnout track and on the Sunday 10 January 2010 the wind was blowing in a westerly direction at 3:00pm in the general direction of Site B. On Saturday 9 January 2010 burnout trials were scheduled between 4:30pm to 6:30pm, but this activity did not appear to affect real time PM$_{10}$ concentrations as significantly as the other monitoring days. This difference may be because the wind direction on the Saturday 9 January 2010 was different to the Friday 8 January 2010 (west south west at 3:00pm). A change in wind direction would also explain the greater frequency and concentration of real time PM$_{10}$ peaks during burnout finals on Sunday 10 January 2010, in comparison to the PM$_{10}$ peaks during the burnout semi finals (please refer to Appendix 2). For future monitoring, it would be advisable that a weather station be placed at each monitoring location to capture changes in wind speed and direction that may influence airborne particulate concentrations. In addition, videotaping of smoke plumes at each location could be a powerful tool for confirming if spikes in real time PM$_{10}$ data are related to Summernats activities.

The BOM reported 1.6 mm rain fell on Sunday 17 January, which would have affected airborne PM$_{10}$ concentrations on this day, due to particle wash out from the atmosphere. Ambient air temperature may also have been affecting PM$_{10}$ concentrations because the two indicators were significantly correlated at both sites, and ambient air temperatures, as reported at 3:00pm were significantly lower during follow up monitoring. The PM$_{10}$ concentrations reported for the Summernats weekend were not likely to have been impacted by hazard reduction burns or major
bushfire activity, because there were no reports of these activities in the Canberra region over the Summernats weekend from either the NSW Rural Fire Service or ACT Territory and Municipal Services.

The increase in ambient air PM\textsubscript{10} in relation to the Summernats activities represents a potential health risk to people in the monitoring locations because it was related to motor vehicle emissions. Wallenius \textit{et al.}, (2005) observed that short term increases in air pollution relating to motor vehicle emissions may trigger acute heart congestion in heart failure patients. In addition, Larrieu \textit{et al.}, (2009) reported that an increase of 10 $\mu$g m\textsuperscript{-3} above mean ambient concentrations (21 $\mu$g m\textsuperscript{-3}) was linked with increases in general practitioner visits for upper and lower respiratory disease, headaches and asthenia, skin rash and conjunctivitis, while Medina Raton \textit{et al.}, (2006) reported that 10 $\mu$g m\textsuperscript{-3} increase (mean 30 $\mu$g m\textsuperscript{-3}) during the warm season was associated with an increase in hospital admissions for chronic obstructive pulmonary disease and pneumonia. There has also been a link between increased mortality rates and hospital admissions when the average ambient PM\textsubscript{10} concentration increased by 10 $\mu$g m\textsuperscript{-3} in comparison to the previous day (Dominici \textit{et al.}, 2004). A number of researchers have also reported links between mean ambient PM\textsubscript{10} concentrations and hospital admissions for respiratory diseases (Atkinson \textit{et al.}, 2001; Lee & Ferguson 2009).

The relationship between the occurrence of burnouts and airborne PM\textsubscript{10} concentrations is of particular concern because dust from car tyres can contain potentially hazardous materials including heavy metals such as iron (5.5%), copper (0.1%), zinc (1.6%) and lead (0.1%), as well as asphalt materials which include aluminium (7.5%), calcium (10.1%) and silica (21.2%) (Adachi & Tainosho, 2004). This indicates that the increase in lead and copper concentrations in the PM\textsubscript{10} fraction recorded on the Saturday of the Summernats may be related to the burnouts.

A large peak in real time PM\textsubscript{10} concentrations occurred at both sites on the Saturday night which started around 9:00pm, and declined at approximately 2:00am on the Sunday morning. The peak occurred in conjunction with main stage activities including the super Summernats concert and fireworks. The use of fireworks has been reported to cause increases in ambient PM\textsubscript{10} concentrations (Vecchi \textit{et al.}, 2008), as well as atmospheric concentrations of lead from 0.017 to 0.379 $\mu$g m\textsuperscript{-3} and copper from 0.012 to 0.071 $\mu$g m\textsuperscript{-3} (Morsino \textit{et al.}, 2007). Therefore the fireworks on the Saturday 9 January 2010 may also have contributed to increases in lead and copper concentrations, in comparison to the concentrations measured on the following Saturday 16 January 2010. To determine whether the fireworks or the burnouts are causing the higher atmospheric metal concentrations during the Summernats, future monitoring would need to involve metals analysis of daily PM\textsubscript{10} samples when there were burnout events scheduled, but no fireworks, and vice versa.
6. CONCLUSION AND RECOMMENDATIONS

In conclusion, Robson Environmental Pty Ltd advises that Summernats activities appeared to have an adverse effect on both PM₁₀ and atmospheric metal (copper, lead and chromium) concentrations; although none of the concentrations exceeded the Australian NEPM TWA₂₄ (hour) of 50 µg m⁻³ for PM₁₀ in ambient air or 0.5 µg m⁻³ for atmospheric lead. However, there are a number of uncertainties due to the small number of sampling sites and indicators monitored and further assessment would be recommended to confirm the potential impact of Summernats activities on ambient air quality in the Canberra region.

To address the uncertainty caused by changing wind direction, future monitoring would need to be conducted at discrete distances around the entirety of the park using a minimum of 4 locations to the north, east, south and west of the burnout strip. Additional sampling for air pollutants such as heavy metals, PAH, and diesel particulates should also be included to help differentiate between PM₁₀ sources. PAH monitoring could include analysis for specific tracer compounds such as retene for wood smoke and benzopyrene for motor vehicle emissions (Bostrom et al., 2002; Li et al., 2009). The monitoring of particulates less than 2.5 µm in diameter (PM₂.₅) could be carried out and compared with the NEPM TWA₂₄ (hour) advisory standard of 25 µg m⁻³ to help differentiate between combustion source pollution and mechanically generated particulates which contribute substantially to the PM₁₀ particulate mass fraction. However, it must be noted that the PM₂.₅ particulate fraction does not exclusively measure combustion particulates, and will contain some mechanically generated particles. The collection of meteorological data (wind speed, direction, temperature and relative humidity) at each sampling site is also recommended to help identify the potential origin of pollution incidents, which could be combined with videoing of the smoke plume direction.

Robson Environmental Pty Ltd would be happy to assist the EPA with the formulation of a more comprehensive study for future events. However, a 6 month lead time would be recommended to ensure that suitable sampling equipment and media is readily available prior to the event.
7. REFERENCES


8. APPENDIX A – DustTrak Real Time Dust Monitoring Graphed Results

DustTrak Data Friday 8 January 2010

Site A
Friday 8 January 2010

Site B
Friday 8 January 2010
DustTrak Data Saturday 9 January 2010

Site A
Satuday 9 January 2010

Site B
Saturday 9 January 2010
Summernats– Environmental Dust Assessment
DustTrak Monday 11 January 2010

Site A

Monday 11 January 2010

Wind direction at 9:10
180° 4 km/h

Site B

Monday 11 January 2010

Wind direction at 9:10
180° 4 km/h
DustTrak Friday 15 January 2010

- Hazard reduction burn scheduled for Cotter Road (20x20m) from 19:00
- Small grassfire at Tumbarumba NSW (0 Ha) under control at 10:00
**DustTrak Saturday 16 January 2010**

- Hazard reduction burn scheduled for Cotter Road (20x20m) from 8:00
DustTrak Sunday 17 January 2010

![Graph of Site A and Site B PM Concentration](image-url)
Summernats – Environmental Dust Assessment

DustTrak Monday 18 January 2010

Site A
Monday 18 January 2010

Site B
Monday 18 January 2010
9. APPENDIX B – Calibration Certificates for DustTrak Monitors

KENELEC SCIENTIFIC PTY LTD
CALIBRATION LABORATORY

Certificate Number 2730  Date of Test 18 December 2009

CLIENT  Robson Environmental
9 Lyell Street
FYSHWICK, ACT 2609

Contact  Marcus Donnelly

Test Method  Kenelec test method LABP 1

Client Instrument details  TSI DustTrak Model 8520
Serial No. 85202572

Condition as received  As left

Environmental Conditions

<table>
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<th>Reading</th>
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<tbody>
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<tr>
<td>Humidity</td>
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</tr>
<tr>
<td>Barometric Pressure</td>
<td>745.00mmHg</td>
</tr>
</tbody>
</table>

This calibration certificate shall not be reproduced except in full, without the written approval of Kenelec Scientific Pty Ltd.

Signed
Mark Williams
Laboratory Manager

Page 1 - Cover Sheet
Page 2 - Calibration after adjustment

Kenelec Scientific
**KENELCE SCIENTIFIC PTY LTD**  
**CALIBRATION LABORATORY**  
**CALIBRATION CERTIFICATE**  

<table>
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<td>18 December 2009</td>
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**CLIENT**  
Robson Environmental  
9 Lyell Street  
FYSHWICK, ACT 2609

**Contact**  
Marcus Donnelly

**Test Method**  
Kenelec test method LABP 1

**Client Instrument details**  
TSI DustTrak Model 8520  
Serial No. 23851

**Condition as received**  
As left

**Environmental Conditions**  
- Ambient Temp.: 25.0°C  
- Humidity: 25.0%RH  
- Barometric Pressure: 745.0mmHg

This calibration certificate shall not be reproduced except in full, without the written approval of Kenelec Scientific Pty Ltd.

Signed  
Mark Williams  
Laboratory Manager

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**2550_Dust_Nats_EPA_B2_20100317_Final.docx**  
Page 27 of 28
Total and speciated particulate matter (PM2.5 and PM10) emission factors from in-use vehicles were measured for a mixed light- (97.4% LD) and heavy-duty fleet (2.6% HD) in the Sepulveda Tunnel, Los Angeles, California. Seventeen 1-h test runs were performed between July 23, 1998, and July 27, 1998. Emission factors were calculated from mass concentration measurements taken at the tunnel entrance and exit, the volume of airflow through the tunnel, and the number of vehicles passing through the 582 m long tunnel. For the mixed LD and HD fleet, PM2.5 emission factors in the Sepulveda Tunnel ranged from 0.018 (±0.007) to 0.116 (±0.019) g/vehicle-km traveled with an average of 0.052 (±0.027) g/vehicle-km. PM10 emission factors ranged from 0.039 (±0.009) to 0.131 (±0.034) g/vehicle-km with an average of 0.069 (±0.030) g/vehicle-km. The PM2.5 emission factor was ~74% of the PM10 factor. Speciated emission rates and chemical profiles for use in receptor modeling were also developed. PM2.5 was dominated by organic carbon (OC) (21.6 ± 19.5%) and elemental carbon (EC) (48.5 ± 20.5%) that together account for 79% (±24%) of the total emissions. Crustal elements (Fe, Mg, Al, Si, Ca, and Mn) contribute ~7%, and the ions Cl−, NO3−, NH4+, SO42−, and K+ together constitute another 8.6%. In the PM10 size fraction, the particulate emissions were also dominated by OC (31 ± 12%) and EC (35 ± 13%). The three most prominent species were Fe (16.5 ± 9.0%), which is greater than would be expected from purely geological sources. Other geological components (Mg, Al, Si, K, Ca, and Mn) accounted for an additional 12.6%. PM2.5 emission factors showed some dependence on vehicle speed, whereas PM10 did not. For tests in runs in which the average vehicle speed was 42.6 km/h, a 1.7 times increase in PM10 emission factor was observed compared to runs with an average vehicle speed of 72.6 km/h. Speciated emissions were similar. However, there is significantly greater mass attributable to geological material in the PM10, indicative of an increased contribution from resuspended road dust. The PM2.5 shows relatively good correlation with NOx emissions, which indicates that even at the low percent of HD vehicles, which emit significantly more NOx than LD vehicles, they may also have a significant impact on the PM2.5 levels.

Introduction
Atmospheric particulate matter (PM) has been implicated in human health effects. Recent studies have discussed the
ranging between 0.14 and 1.77 g/vehicle-km. These values appear to be heavily influenced by the driving cycles chosen for the emissions testing. Emission factors from older studies such as Gerier et al.’s tunnel study (21) and Lowenthal et al.’s dynamometer study (28) report values of 0.42 and 0.6 g/vehicle-km, respectively, for PM2.5.

Mass and chemically specified particulate emission rates from on-road, in-use vehicles remain relatively limited, and newer data are required for inventory modeling and source apportionment studies. Data on emission rates are also required periodically to develop a record of changes in fleet emissions with time. The purpose of this paper is to present PM2.5 and PM10 total and speciated emission factors (grams per vehicle per kilometer) for a mixed LD and HD fleet and compare these with other recent tunnel and dynamometer-derived emission factor data. In addition, these data can be used to define trends in mobile source PM emissions in the South Coast Air Basin and elsewhere. The on-road emission factors were estimated from ambient PM samples collected in the Sepulveda Tunnel located near Los Angeles International Airport in Los Angeles, CA, in July 1996.

Situ

The Sepulveda Boulevard Tunnel is 582 m long, straight, and approximately flat in the covered portion, although there is a downgrade approaching the tunnel and an upgrade leaving it. There are two tunnels, three lanes each with a sidewalk on the right side of each bore. There is no breakdown lane, although there are three pullout areas in each direction. Each pullout is large enough to accommodate two vehicles. All of the openings between the two bores were sealed to prevent air transfer between the bores. The ventilation system within the tunnel was not in operation during the sampling periods.

The test runs were conducted in the west bore of the tunnel that carries Sepulveda Boulevard southbound from the Los Angeles International Airport. Immediately after the tunnel there is a turn lane to allow access to the on-ramps to Highway 105, which connects to Highway 405.

Methodology

Instrumentation and Chemical Analysis. Particulate matter samples were collected using two PM10 and two PM2.5 mediuvm-volume samplers designed to collect samples for chemical analysis (28). This type of sampler employs a 0.8-mm Aer Monrometer (Tenneco, Inc.) to collect PM10 or 0.4-mm Teflon membrane filter (Gelman Scientific, Ann Arbor, MI) and one with a 0.8-mm Teflon membrane filter (Phillips Corp., Putnam, CT) to collect samples for gravimetric and chemical analyses. The remaining 73 rpm was drawn through a make-up air. The flow rates were set with a calibrated rotometer to monitor and control the air passing through the sample chamber. The PM2.5 and PM10 samplers were positioned inside the tunnel, on the sidewals, at both the inlet and the outlet, and programmed to sample for the same time interval.

The volume of airflow through the tunnel, which is required for the emission factor calculation, was determined by a tracer method (40). A known amount of inert SF6 gas was released at the tunnel entrance, and measurements were made for the duration of each sampling period. The dilution ratio of SF6 at the tunnel outlet gives the tunnel volumetric flow. The concentration of SF6 at the tunnel exit was determined with a Lager model 215AP portable tracer gas analyzer. Videotaped records of the vehicle traffic moving through the monitored tunnel bore were used to determine the number of vehicles, the mixture of LD and HD vehicles, and age characteristics of the LD fleet. A endurance gun was used to determine the speed characteristics of the vehicles during a sampling interval.

The Teflon membrane filters were weighed on a Cahn 31 electro-microbalance before and after sampling to determine mass concentrations. Chemical analyses were performed on both the Teflon membrane and quartz fiber filters following the methodology described by Watson and Chow (31). Briefly, the Teflon membrane filters were analyzed for elements by X-ray fluorescence. Half of the quartz filters was extracted with distilled-deionized water and the extract analyzed for chloride, nitrate, and nitrite ions by ion chromatography, for ammonium by automated colorimetry, and for sodium and potassium by atomic absorption spectrometry. Organic and elemental carbon were measured by thermal-optical reflectance on 0.5 cm2 punches taken from the remaining half of the quartz filter filter (31). The individual chemical concentrations of PM2.5 and PM10 determined from the analytical techniques carried out on the Teflon membrane and quartz fiber filters were used to calculate the sum of species concentrations.

Emission Factors

The emission factors for PM10 and PM2.5 were calculated following the methodology of Peterson et al. (16, 30, 33). Briefly, samples are taken simultaneously of the air entering and exiting the tunnel portals to determine the concentrations of the species of interest in the sampled air. The mass of PM produced by vehicles traveling through the tunnel can be determined from

\[ E = \sum (C_{\text{air}} V_{\text{veh}}) - \sum (C_{\text{in}} V_{\text{veh}}) \]  

where \( E \) = emission factor in g/vehicle-km, \( C_{\text{air}} \) = PM concentration in the outlet air (g/m3), \( V_{\text{veh}} \) = volume of air for each of the i outlet channels (m3), \( C_{\text{in}} \) = PM concentration in the inlet air (g/m3), \( V_{\text{veh}} \) = volume of air for each of the i inlet channels (m3), \( N \) = traffic count, and \( L \) = length of the tunnel (km).

Results

Basic Descriptions. The 17 runs were carried out over the period July 22–27, 1996. The exact times, environmental conditions, and vehicle characteristics for each run are given in Table 1. The average ambient temperature during the sampling period was 22 °C. The average speed for the 17 runs was 65.5 ± 11.7 km/h and ranged between 30.2 and 144.0 km/h and 80.8 (± 10.9) km/h. For all runs the vehicles came to a complete stop due to the presence of a traffic light. The average speed was 72.6 km/h and the speed with an average speed of 45.0 km/h (average speed = 42.6 km/h).

LD vehicles dominated all runs. The average number of vehicles entering the tunnel was 3037 per hour with a maximum of 4186 and a minimum of 182 per hour. The average speed was 97.4 km/h and clear ID. The average model year of the LD vehicles was 1987.0.

PM10 Emission Factors. The PM10, sum of species recon- structed mass loadings on the filters were used to calculate the emission factors. This was done because light filter loadings that resulted in some gravimetric measurements being highly uncertain. For filter samples taken at the tunnel entrance PM10 concentrations ranged from 166 (± 8) to 350 (±46) µg/m3. For filter samples taken at the tunnel exit the
APPENDIX NO: 2  -  AMENDED PLANNING PROPOSAL

| TABLE 2. PM10 Emission Factors (Grams per Vehicle-Kilometer), 1998 Sepulveda Tunnel Study |
|---------------------------------|---------------------------------|
| run  | PM10 emission factor | PM10 emission factor |
| 1    | 0.046 ± 0.011        | 0.069 ± 0.009        |
| 2    | 0.084 ± 0.007        | 0.098 ± 0.007        |
| 3    | 0.576 ± 0.020        | 0.076 ± 0.007        |
| 4    | 0.030 ± 0.009        | 0.016 ± 0.007        |
| 5    | 0.026 ± 0.012        | 0.028 ± 0.012        |
| 6    | 0.033 ± 0.010        | 0.016 ± 0.009        |
| 7    | 0.078 ± 0.010        | 0.074 ± 0.008        |
| 8    | 0.131 ± 0.024        | 0.115 ± 0.019        |
| 9    | 0.026 ± 0.007        | 0.026 ± 0.007        |
| 10   | 0.104 ± 0.014        | 0.207 ± 0.019        |
| 11   | 0.036 ± 0.021        | 0.040 ± 0.011        |
| 12   | 0.110 ± 0.009        | 0.201 ± 0.009        |
| 13   | 0.080 ± 0.010        | 0.086 ± 0.009        |
| 14   | 0.045 ± 0.014        | 0.060 ± 0.009        |
| 15   | 0.060 ± 0.010        | 0.076 ± 0.009        |
| 16   | 0.084 ± 0.010        | 0.075 ± 0.009        |
| av   | 0.069 ± 0.015        | 0.069 ± 0.010        |
| SD   | 0.030 ± 0.006        | 0.0274 ± 0.003       |

* Inlet filters failed, sample malfunction.  
* PM10 inlet filter mass concentration greater than outlet filter mass concentration.  
* PM10 inlet filter mass concentration greater than outlet filter mass concentration.  
* Particulate measurements not taken for run 13.  
* PM10 inlet filter mass concentration greater than outlet filter mass concentration.  
* PM2.5 carbon analysis not available.  
* Not including run 12.

The range was 248 (±9) to 498 (±19) µg/m³. The sum of species uncertainties is calculated as the square root of the sum of squares of the individual uncertainties for each measured species. PM10 emission factors calculated from the reconstructed mass concentrations are compared in Table 2. Emission factors for runs 2 and 6 were invalid due to a sampler malfunction for run 2 and a higher inlet than outlet concentration for run 6. Particulate measurements were not taken during run 13.

The PM10 emission factors ranged from 0.030 (±0.009) to 0.131 (±0.024) g/vehicle-km, with an average of 0.069 (±0.030) g/vehicle-km. The uncertainty in an individual emission factor was calculated by propagating the combined uncertainty of the inlet and outlet sum of species concentrations through eq 1 using the measured tunnel airflow volume and vehicle kilometers traveled.

For the four runs with mean vehicle speeds <64 km/h, the average emission factor was 0.074 (±0.025) g/vehicle-km. For the 11 higher speed runs (>64 km/h), the average emission factor was 0.062 (±0.029) g/vehicle-km. PM2.5 Emission Factors, PM2.5 emission factors were also calculated on the basis of the sum of the species reconstructed mass from the chemical analyses. Invalid filter measurements for runs 2, 10, and 16 and inlet sum of species mass that exceed outlet mass for run 4 resulted in no emission factor calculations for these runs. For runs 4 and 16 (both low-vehicle runs), the problem can be traced to light filter loadings that resulted in high analytical uncertainties for the measured species. The valid emission factors for the runs are shown in Table 2. Uncertainties in the PM2.5 emission factors were calculated in the same manner as for the PM10 calculation.

The PM2.5 emission factors ranged from 0.016 (±0.007) to 0.267 (±0.019) g/vehicle-km (Table 2). However, the highest emission factor value (run 13) is suspect as the run is species-derived concentration value for the filter from the exit portal is anomalously high and is even greater than the corresponding PM10 sum of species measurement. The average PM2.5 emission factor with run 12 removed is 0.052 (±0.027)
g/vehicle-km. The PM2.5 emission factor as a function of the PM10 emission factor is shown in Figure 1. With runs 12 removed from the data set, the ratio of PM2.5 to PM10 emissions is ~0.74. When the data based on mean vehicle speeds of less than or greater than 64 km/h are partitioned, the PM2.5 emission factors show a similar mean value. The average PM2.5 emission factor for the runs with mean vehicle speed <64 km/h (seven runs) was 0.052 (±0.008) g/vehicle-km, with runs 12 excluded. For the runs having mean vehicle speeds of >64 km/h (seven runs) the average emission factor was 0.052 (±0.034) g/vehicle-km. Vehicle speed appears to have less of an effect on PM2.5 than was observed for the PM10 emission factor.

Speculated Emission Factors. The mass loadings on the filters were sufficient to calculate speculated emission factors for PM10 and PM2.5 which can be used to develop real-world, mixed-fleet chemical profiles for use in source apportionment studies. The average emission factors for PM10 and PM2.5 for each measured species and their associated uncertainties are shown in Table 3. These averages and the uncertainties were calculated from the data for the runs for which there were matched pairs of valid emission factors for both PM10 and PM2.5 (runs 1, 3, 5, 7–9, 11, 14, 15, and 17). Because only valid and matched pairs were used to calculate the average emission factor for each species, the total sum of species emission factor values for PM10 and PM2.5 in Table 3 are slightly different from those shown in Table 2. The average emission factor values in Table 2 included data from all valid runs. 

The PM2.5 emissions in the Sepulveda Tunnel in 1996 were dominated by the organic carbon (OC) (30.4 ±10.3%) and the elements carbon (EC) (15.2%) fractions (Figure 2). Together they account for, on average, 68.1% (±11.3%) of the total PM2.5 emissions. The three most prominent species are iron (Fe), which accounted for ~15.0% (±2.1%) of the PM2.5 emissions (Figure 2). Some of the Fe can be explained by contributions from nontapicnic sources such as the resuspension of dust or geological materials from the roadway, but the level of enrichment suggests an additional nongeological source. Potential sources of Fe include particulate liberated from processes such as engine and brake wear. Other elements usually associated with a predominantly geologic source, such as Mg, Al, nonsoluble K, Si, Ca, and Mn account for ~5.2% (±2.5%) of the PM2.5 emissions. 

The ions (nitrate, ammonium, sulfate, potassium, and sodium) contribute 7.9% (±9.5%). The remaining species including Cu, Zn, Br, Sr, Mo, Sb, Ba, and Pb make up, on average, 3.9% (±2.3%) of the total PM2.5 emissions. The speculated PM2.5 emission factors, normalized to the total emissions and expressed as a percent value, are shown in Table 3. In the PM2.5 fraction the emissions are dominated, as were the PM10 emissions, by the OC (30.4 ±14.7%) and EC (44.3 ±8.7%) components that together account for 77.7% (±17.1%) of the total emissions. Iron still accounts for a significant fraction of the PM2.5 emissions, 4.0% (±0.9%). Other elemental species (Mg, Al, Si, Ca, and Mn) contribute ~2.5% (±0.6%) to the total. The ions nitrate, ammonium, sulfate, and potassium together constitute 13.2% (±4.5%) of the total PM2.5 emissions.

Discussion

Emission Factors and Fleet Contributions. There are estimates of emission factors available for PM10, but less so for PM2.5, especially from mixed LD and HD road-use fleets. Recent studies have measured PM mass and speciated emission factors based on dynamometer testing that provides some basis for comparison with the data presented in this paper. However, most of these studies targeted vehicles with specific emission characteristics such as smokers or high emitters of CO and EC as identified through remote sensing instruments, PM emission factors from a number of recent studies as well as the emission factors derived for this study are listed in Table 4. The data presented in Table 4 show that the PM2.5 emissions for on-road-use vehicles in the Sepulveda Tunnel are much higher than the emissions from newer cars and trucks. However, smoking and high-CO-emitting vehicles have much higher emission rates as measured by Bagoli et al. (9) and Cadle et al. (17, 34) in their dynamometer studies. Comparing the average Sepulveda PM2.5 emission factor with the average non-smoker emission factor of Bagoli et al. (9), there is a difference of ~54% between the two. There is a difference of only ~16% between the average Sepulveda PM2.5 emission factor and the average non-smoker emission factor of Cadle et al. (34).

Compared with Durbin et al.'s (22) PM emission rates for vehicles also within the South Coast Air Basin, the tunnel-derived emission factor is higher than the factors reported for each of their vehicle age categories. For 1986-1996 vehicles, Durbin et al. (22) report an average emission factor of 0.069 g/vehicle-km. In the Sepulveda Tunnel, where the fleet had an average model-year age of 1987, the average emission factors were 0.069 and 0.052 g/vehicle-km for PM10 and PM2.5, respectively. This is considered a much higher than the dynamometer-derived estimates for similar aged vehicles. The PM emission factors measured in the Sepulveda Tunnel as compared to those derived from the data suggest several possibilities with respect to contributions from the different types of emitting vehicles (average, high emitters, and smokets). It is apparent, however, that data are required to characterize the proportions of these classes of vehicles to determine their relative contributions to the average emission factors observed for in-use, on-road fleets, such as those determined in this study. These data suggest that high-emitting domestic light vehicles and heavy-emitting vehicles for high-emitting vehicles are close to the value observed in the Sepulveda Tunnel. Alternatively, the tunnel-derived PM emission factors are influenced not even greater degree by a small percentage of smokers. Clean or newer vehicles, as demonstrated by Mokwa et al. (9) and ERC (15), are likely contributing very little to the ambient levels of particulate matter.

A second question that can be addressed is, "what is the relative contribution of HD vehicles to the Sepulveda Tunnel particulate emission factors?" The emissions data collected in the Sepulveda Tunnel did not allow for the separation of the relative contributions from the LD and HD vehicles because of the small run-to-run variation in the percent composition of the fleet. However, some results of the range of HD contribution can be estimated on the basis of the observed percent of HD vehicles in the fleets and published HD diesel emission factors for PM.
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<th>PM2.5</th>
<th>PM10</th>
<th>PM2.5/PM10</th>
<th>Cadle et al. (20)</th>
<th>Cadle et al. (18)</th>
<th>Norbeck et al. (18)</th>
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<td>0.90</td>
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<td>0.65</td>
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<td>Ammonium ion</td>
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<td>1.61±1.08</td>
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<td>Sodium by XRF</td>
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<td>Potassium</td>
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<td>0.02</td>
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<td>Calcium</td>
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<td>0.30±0.27</td>
<td>0.38</td>
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<td>0.19</td>
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<td>Titanium</td>
<td>0.00±0.52</td>
<td>0.00±0.50</td>
<td>1.50</td>
<td>0.001</td>
<td>0.002</td>
<td>0.0002</td>
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<tr>
<td>Vanadium</td>
<td>0.03±0.23</td>
<td>0.05±0.21</td>
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<td>0.000</td>
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<td>Chromium</td>
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<td>1.00</td>
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<td>0.02±0.03</td>
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<tr>
<td>Copper</td>
<td>0.53±0.06</td>
<td>0.17±0.02</td>
<td>0.32</td>
<td>0.01</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.32±0.04</td>
<td>0.14±0.02</td>
<td>0.44</td>
<td>0.13</td>
<td>0.17</td>
<td>0.34</td>
</tr>
<tr>
<td>Gallium</td>
<td>0.01±0.04</td>
<td>0.01±0.04</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.01±0.06</td>
<td>0.00±0.05</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selenium</td>
<td>0.01±0.02</td>
<td>0.03±0.02</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bromine</td>
<td>0.01±0.01</td>
<td>0.01±0.02</td>
<td>1.00</td>
<td>0.004</td>
<td>0.02</td>
<td>0.001</td>
</tr>
<tr>
<td>Rubidium</td>
<td>0.00±0.02</td>
<td>0.00±0.02</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strontium</td>
<td>0.07±0.01</td>
<td>0.02±0.02</td>
<td>0.39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yttrium</td>
<td>0.06±0.03</td>
<td>0.00±0.03</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc</td>
<td>0.03±0.03</td>
<td>0.01±0.03</td>
<td>0.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0.02±0.06</td>
<td>0.01±0.06</td>
<td>0.60</td>
<td>0.001</td>
<td>0.09</td>
<td>0.01</td>
</tr>
<tr>
<td>Palladium</td>
<td>0.02±0.18</td>
<td>0.02±0.18</td>
<td>1.00</td>
<td>0.001</td>
<td>0.01</td>
<td>0.005</td>
</tr>
<tr>
<td>Silver</td>
<td>0.04±0.20</td>
<td>0.04±0.20</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.02±0.22</td>
<td>0.02±0.22</td>
<td>1.00</td>
<td>0.001</td>
<td>0.01</td>
<td>0.0</td>
</tr>
<tr>
<td>Iodine</td>
<td>0.07±0.25</td>
<td>0.06±0.25</td>
<td>0.86</td>
<td>0.002</td>
<td>0.01</td>
<td>0.001</td>
</tr>
<tr>
<td>Tin</td>
<td>0.07±0.32</td>
<td>0.10±0.31</td>
<td>1.43</td>
<td>0.004</td>
<td>0.01</td>
<td>0.001</td>
</tr>
<tr>
<td>Antimony</td>
<td>0.04±0.30</td>
<td>0.15±0.37</td>
<td>0.88</td>
<td>0.003</td>
<td>0.01</td>
<td>0.002</td>
</tr>
<tr>
<td>Barium</td>
<td>1.04±0.93</td>
<td>0.38±1.37</td>
<td>0.35</td>
<td>0.03</td>
<td>0.16</td>
<td>0.04</td>
</tr>
<tr>
<td>Lanthanum</td>
<td>0.01±0.01</td>
<td>0.00±0.13</td>
<td>1.00</td>
<td>0.04</td>
<td>0.01</td>
<td>0.001</td>
</tr>
<tr>
<td>Gold</td>
<td>0.02±0.06</td>
<td>0.00±0.06</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td>0.01±0.05</td>
<td>0.01±0.05</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thallium</td>
<td>0.00±0.05</td>
<td>0.00±0.05</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>0.08±0.04</td>
<td>0.03±0.06</td>
<td>0.38</td>
<td>0.02</td>
<td>0.10</td>
<td>0.02</td>
</tr>
<tr>
<td>Uranium</td>
<td>0.00±0.05</td>
<td>0.00±0.05</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Species: g/vehicle-km measured in the Ft. McHenry Tunnel. Weighting this emission factor by the percent of HED vehicles observed in the Sepulveda Tunnel (HED = 2.6%) and assuming the emitted PM from HED vehicles is predominately PM2.5 suggests that HED diesels contribute ~25% of the PM2.5. Lovelace et al. (25) measured PM2.5 emissions factors using a mobile source factor measurement (25) for vehicles in Phoenix, AZ, and reported an average combined factor for trucks and buses without particulate traps of 0.66 g/vehicle-km. This is also close to the average value of 0.64 g/vehicle-km for all of the diesel emission factors listed in Table 14. Using the Lovelace et al. (25) emission factor, the HED vehicles in the Sepulveda Tunnel would be contributing 30% of the total PM2.5 emissions. However, based on the uncertainty in these previous measurement studies, the above estimates are also uncertain. Given that ~97% of the vehicles passing through the tunnel are LD vehicles, this source of particulate matter may have a greater significance than it is currently attributed. This observation is also supported by recent studies by Watson et al. (36) and Gertler et al. (37).
FIGURE 2. Average percent contribution by an individual species to total PM$_{10}$ emissions.
FIGURE 3. Average percent contribution by an individual species to total PM$_{10}$ emissions.
### Table 4: Comparison of PM Emission Factors among Several Recent Studies

<table>
<thead>
<tr>
<th>Vehicles Tested</th>
<th>Measurement Methodology</th>
<th>PM Emissions (g/vehicle-km)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed LD and HD in the Seepulva Tunnel</td>
<td>Tunnel measurements</td>
<td>0.095 (±0.030)</td>
<td>This study</td>
</tr>
<tr>
<td>Mixed LD and HD in roadways tunnels</td>
<td>HD emission rate estimated from tunnel measurements</td>
<td>0.42 (±0.08)</td>
<td>Gerster et al. (21)</td>
</tr>
<tr>
<td>In-use LD</td>
<td>Dynamometer (using FTP)</td>
<td>0.018 (1991 and newer)</td>
<td>Durbin et al. (22)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.0388 (1988 – 1990)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.034 (1981 – 1985)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.021 (1985 and older)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.022 (1991 – 1996, summer)</td>
<td>Cadle et al. (17)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.022 (1991 – 1996, winter)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.028 (1986 – 1990, summer)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.027 (1986 – 1990, winter)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.039 (1981 – 1985, summer)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.039 (1981 – 1985, winter)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.059 (1971 – 1980, summer)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.036 (1971 – 1980, winter)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.14 (smoker, summer)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.242 (smoker, winter)</td>
<td></td>
</tr>
<tr>
<td>In-use LD high emitters of either CO or HC</td>
<td>Portable dynamometer (HM 240)</td>
<td>0.346 (smokers)</td>
<td>Sagebiel et al. (9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.032 (non-smokers)</td>
<td>Cadle et al. (30)</td>
</tr>
<tr>
<td>3 LD medium CO or HD</td>
<td>Portable dynamometer</td>
<td>0.239 (smokers)</td>
<td>Cadle et al. (30)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.039 (non-smokers)</td>
<td>Mulawa et al. (30)</td>
</tr>
<tr>
<td>CA RFG fueled LD</td>
<td>Dynamometer</td>
<td>0.0034 (ears)</td>
<td>ERC (19)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.0068 (trucks)</td>
<td></td>
</tr>
<tr>
<td>In-use HD trucks</td>
<td>Chassis dynamometer (WWU truck cycle and WWU 5-hr route cycle)</td>
<td>0.46</td>
<td>Wang et al. (26)</td>
</tr>
<tr>
<td>In-use HD trucks and buses</td>
<td>Chassis dynamometer (CBD cycle)</td>
<td>0.179 (1996 DDC series 90)</td>
<td>Clark et al. (24)</td>
</tr>
<tr>
<td>In-use HD</td>
<td>Chassis dynamometer (CBD and WWU truck cycle)</td>
<td>0.177 (CBD)</td>
<td>Graboski et al. (27)</td>
</tr>
<tr>
<td>In-use diesel trucks and buses</td>
<td>Chassis dynamometer (CBD cycle)</td>
<td>0.197 (WWU)</td>
<td></td>
</tr>
</tbody>
</table>

*PM_{10} emissions. PM_{2.5} emissions. PM site not stated.

The lower proportion of OC in the Seepulva Tunnel PM may be due to the EC being emitted in greater proportion by the HD vehicles traveling through the tunnel. This can be demonstrated by examining the HD emission data of Lowenthal et al. (20). Lowenthal et al. (20) found that the CO concentrations were the greatest at 21% and 30% of the PM_{2.5} of which ~35% is emitted PM_{10}. Assuming that the HD vehicles are contributing between 21% and 30% of the PM_{2.5} of which ~35% is EC, the lower proportion of OC in the Seepulva Tunnel can be explained.

The emission rates and associated uncertainties for the measured elemental species (Na through U) are listed in Table 3. Some comparisons between the specified emissions found for this study can be made with those of Cadle et al. (34, 36), Norbeck et al. (39), and Lowenthal et al. (20). The specified emission rates presented in these studies (28, 34, 36) show significant contrast with the Seepulva Tunnel data (Table 3). For all comparable species (Na, Mg, Al, Si, P, Cl, K, Ca, Ti, V, Cu, Mn, Fe, Ni, Cu, Zn, Br, Mo, Pd, Cd, I, Sn, Sb, Ba, La, and Pb) between the studies, the assumed contribution for these elements is ~10 times higher by Cadle et al. (34) and Norbeck et al. (39) were 4.91 and 2.51 g/vehicle-km, respectively. Individual differences for specific species over 3 orders of magnitude between these studies and the emissions measured in the Seepulva Tunnel. Twelve of the 27 comparable elements measured showed emission factors 10 times greater in the Seepulva study than in the dynamometer studies (34, 36, 39). The following elements show the greatest differences: Na, Ti, V, Mn, Fe, Cu, Pd, Cd, I, Sn, Sb, and Ba (Table 3). The larger emission factors for these species can be attributed to resuspended road dust that incorporates material eroded from mechanical wear processes associated with vehicle operation as well as geological material. The larger average emission factors reported by Cadle et al. (34) and Sagebiel et al. (9) are a result of higher emission rates for the carbonaceous components.

Speciated emissions for HD vehicles presented by Lowenthal et al. (20) show several distinct differences as compared to the Seepulva Tunnel data. The largest contribution of OC in the HD vehicle emissions was already noted above. The OC and EC rates are 12 and 19 times higher on a mass per unit vehicle kilometer traveled basis for the HD vehicles tested by Lowenthal et al. (20) than was observed in the Seepulva Tunnel. The other species found by Lowenthal et al. (20) that are at much higher rates for HD vehicles were sulfur (sulfate and elemental sulfur) and zinc. The differences cannot be characterized by trace elements. Removing the sulfate, OC, EC, and S (measured by XRF), and any paired species where the emissions are zero in this study, and the Lowenthal et al. (20) study, results in a sum of species emission factor for the species Na, Ni, V, Fe, Cu, Zn, Rb, Sr, Br, Mo, Pd, Ag, Cd, In, Sn, Sb, and Pb of 10.2 g/vehicle-km for the Seepulva Tunnel and 7.2 g/vehicle-km for the HD data of Lowenthal et al. (20). Due to the similarity in emissions between HD and I3D vehicles, except for a few key species (e.g., EC, OC, and S), the differences cannot be characterized by trace elements. This leads to the conclusion that the characterization of both carbon fractions will be important in allowing for the relative contributions of each component of the entire fleet to be apportioned to their respective sources.
PM$_2.5$ speciated emissions of diesel vehicles compared with the Sepulveda Tunnel data show that the HD vehicles emit much greater amounts of OC, EC, sulfate, and zinc than was observed in the tunnel. Previously published HD emission factor estimates suggest that the contributions from this source category account for 21 and 36% of the PM$_{2.5}$ mass, with very small contributions from other elemental species. However, contributions to PM$_{2.5}$ by HD vehicles through reuspersion of road dust may be important as they create larger vertical cells capable of entraining dust at greater elevations than automobiles.

More research is needed to characterize the flow in terms of the relative contributions of the different types of emitters to the overall emission factors observed in real-world situations. In this study we were not able to differentiate the relative contributions from the LD and HD vehicles because of the relatively constant proportion of each type in the tunnel. This would be possible to do if the range of HD and LD vehicles were greater; as may be the case in other tunnels. These data did suggest, however, that HD vehicles were contributing significantly to the PM$_{2.5}$ size fraction.

PM and Gaseous Emissions. The EPA Motor Vehicle-Related Air Toxics Study (60) reported that there was insufficient PM emission rate data to directly estimate the PM$_{2.5}$ emissions from the in-use LD gasoline vehicle fleet. However, some dependence was reported on the relationship between particulate matter and HC emissions, with PM tendency to increase as HC emissions increase. Cadle et al. (37) found no correlation between PM$_{2.5}$ and HC for the set of vehicles tested using ID 840 in Orange County, California. In contrast, Mulawa et al. (39) found a good correlation between PM$_{2.5}$ and HC for their tests on well-maintained, low-mileage gasoline vehicles. Cadle et al. (37) re-examined the PM$_{2.5}$ and HC relationship and found that HC is not a good indicator for gasoline PM emissions on an individual basis.

The particulate matter measurements taken in the Sepulveda Tunnel were taken as part of a larger study (41). In which gaseous emission factors were also measured during each of the test runs. In this study PM$_{2.5}$ was found to correlate with gaseous emissions of NO$_x$ (Figure 4). The reason for this is that vehicles contribute significantly greater amounts of NO$_x$ and PM$_{2.5}$ on a per vehicle basis than LD vehicles. Changes in the percent of I/D can have a greater impact on these pollutants than the LD vehicles. Even at the low flow composition percentage of HD vehicles observed in this study, they may contribute significantly to the total observed PM$_{2.5}$ and NO$_x$ emissions.

Comparisons between PM$_{2.5}$, PM$_{10}$, CO, and THC emissions showed a high degree of variability. However, a general trend of increased PM$_{2.5}$ with increased hydrocarbon emission rates was observed (41). Within the mixed I/D and LD flow in the Sepulveda Tunnel there may be a significant fraction of PM$_{2.5}$ contributed by particulate matter that is not correlated with HC. This was suggested by Cadle et al. (37) and, if true, would obscure the relationship between PM$_{2.5}$ and HC observed by Mulawa et al. (39).

Acknowledgments

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data references


Characterization of heavy metal particles embedded in tire dust

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Abstract

Tire dust is a significant pollutant, especially as a source of zinc in the urban environment. This study characterizes the morphology and chemical composition of heavy metal particles embedded in tire dust and traffic-related materials (brake dust, yellow paint, and tire tread) as measured by a field emission scanning electron microscope equipped with an energy dispersive X-ray spectrometer (FESEM/EDX). In 60 samples of tire dust, we detected 2288 heavy metal particles, which we classified into four groups using cluster analysis according to the following typical elements: cluster 1: Fe; cluster 2: Cr, Pb; cluster 3: multiple elements (Ti, Cu, Zn, Sr, Y, Zr, Sm, Nb, Ba, La, Cr, Pb); cluster 4: ZnO. According to their morphologies and chemical compositions, the possible sources of each cluster were as follows: (1) brake dust (particles rich in Fe and with trace Cu, Sm, and Ba), (2) yellow paint (Cu(OH)\textsubscript{2} particles), (3) brake dust (particles Ti, Fe, Cu, Zn, Sr, and Ba) and heavy metals (Y, Zr, La, and Co), (4) tire tread (zinc oxide). When the chemical composition of tire dust was compared to that of tire tread, the tire dust was found to have greater concentrations of heavy metal elements as well as mineral or asphalt pavement material characterized by Al, Si, and Ca. We conclude that tire dust consists not only of the debris from tire wear but also of assimilated heavy metal particles emitted from road traffic materials such as brake lining and road paint.

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Keywords: Heavy metal particles; Tire dust; Traffic-related materials

1. Introduction

Tire wear debris (tire dust) is generated by the rolling shear of tire tread against road surfaces (Regge et al., 1993). The mass of annual emission of tire dust was estimated to be $5.3 \times 10^8$ kg in 1996 in the UK (Environment Agency, 1998) and $2.1 \times 10^8$ kg in 2001 in Japan (Adachi and Tainosho, 2003), and tire abrasion on urban roads in Germany was estimated from 55 to 657 kg/km/year on various roads (Muschack, 1990). This large amount of tire dust is a significant cause of pollution in the urban environment (Environment Agency, 1998). Zinc oxide is added as an activator during the vulcanizing process, comprising from 0.4% to 4.3% of the resulting tire tread (Smolders and Degryse, 2002), and zinc from tire dust is a significant pollutant in soil (Smolders and Degryse, 2002; Sadiq et al., 1989), air (Regge et al., 1993), street dust (Ferogiovanni and Kim, 1991), and urban runoff (Davis et al., 2001). Other heavy metal elements in tire tread also pollute the environment. Fuikzakiai et al. (1986) showed that tire tread contains heavy metals such as Mn, Fe, Cr, Ni, Cu, Zn, Cd, and Pb, and tire dust pollution contributes to some of these elements in the form of airborne dust. Sadiq et al. (1989) analyzed the metal concentrations in tires and showed that tire dust was a soil pollutant. The road paving aggregates embedded in tire dust have been investigated (Cannatini et al., 2001; Smith and Veith, 1982), but heavy metal particles derived from other sources have not yet been examined. Heavy metal particles are emitted on the road surface as part of brake dust, road paint, diesel exhaust particles (DEP), road construction materials, or car catalyst materials. When tire tread is abraded against the road surface, the tire tread debris will assimilate these particles. In this study, we examined brake dust, yellow...
paint, and tire tread materials as possible sources of metal particles in tire dust.

Brake dust has been recognized as a significant pollutant for Cu, Sb, and Ba in the aerosols composition (Sternbeck et al., 2002), and it contributed 47% of the total loading for Cu in urban runoff (Davis et al., 2001). Yellow paint contributed from 0.3% to 1.0% of airborne dust in Niigata, Japan (Fukuzaki et al., 1986). The bulk chemical composition and fractioning process of brake dust, yellow paint, and tire tread are well known, but detailed morphologies and individual chemical compositions of the metal particles included have not been thoroughly investigated by the scanning electron microscopy (SEM) method. The aims of this study were to characterize the heavy metal particles embedded in tire dust and the traffic-related metal particles (brake dust, yellow road paint, and tire tread) as sources of embedded particles in tire dust.

The diameter of embedded particles in tire dust and traffic-related particles ranged from several micrometers to 0.2 μm, which is too small for detection by normal SEM. Therefore, we used field emission scanning electron microscopy with energy dispersive X-ray spectrometry (FESEM/EDX) for the single particle analysis of these metal particles. FESEM is a very useful tool for analyzing individual particles at high resolution because a field emission cathode in the electron gun of the SEM provides narrower probing beams than that found in tungsten hairpin filament SEM, resulting in improved spatial resolution.

2. Experimental procedures

2.1. Sampling site

Street dust samples were collected from six sites in Kobe, Hyogo Prefecture, Japan (Fig. 1) during August of 2002. The population of the city of Kobe was 1,510,000 in 2002. The northern part of the study area is a mountains, and the southern part is a harbor. The sampling sites selected were the same points at which a traffic census was carried out by the city of Kobe as a part of a national traffic census conducted in October of 1999 (Hyogo Prefecture, 1999). According to the data, the traffic volume ranged from 4944 to 50,356 vehicles per day, and the proportion of heavy truck traffic ranged from 4.7% to 22.3%. Sites 1, 2, and 6 are residential areas. Sites 3 and 4 are industrial areas, and Site 5 is a commercial area. Site 1 is located on a down slope, while the other roads are almost flat. Sites 2, 4, and 5 are crossroads. Sites 3 and 4 are different locations on the same road.
2.2. Sample collection

The tire dust samples investigated here were collected from street dust, which were the deposits from natural and human activities on the road (Devokorn and Dreben, 1981). The tire dust comprises a significant composition of the street dust. More than 100 g of street dust were gathered from road sides with a nylon trowel at each sampling site. The collected samples were stored in plastic bags for subsequent sample preparation and analysis.

In addition to the tire dust samples, we collected five brake dust samples from the rim of front brake linings. The five selected cars were manufactured by three different Japanese automobile makers. We also picked up a yellow road paint sample from a fragment of tire material painted on the road surface in the study area, and a tire tread sample was chipped off from the surface of a used tire (Bridgestone; 6,40814, Japan).

2.3. Single particle analysis

The FESEM measurements were performed with a JSM-6330F cold field emission SEM (JEOL, Tokyo) with an energy dispersive X-ray spectroscopy (EDX) detector Link ISIS (Oxford-Instrument, Tokyo). This EDX detector is equipped with a super atmospheric thin window, which allows one to determine the low atomic number elements (from Be to U). For the single particle analysis of the heavy metal particles embedded in tire dust, we used an acceleration voltage of 15 kV, a working distance of 15 mm, and an EDX collection time of 20 s. For the bulk analysis of traffic-related materials, we used 500 or 1000 s of EDX collection time.

The street dust samples were dried at room temperature and sieved through a 149-μm nylon screen. They were affixed to a carbon tape attached to aluminum stubs. All samples were coated with carbon so they would have conducting properties.

Ten larger tire dusts whose shape had not been broken were selected from each street dust sample (Fig. 2a, b). The length of the selected particles ranged from 220 to 1230 μm. Tire dust samples were distinguished from other types of debris by the following three features: (1) sausage-shaped particles (Danis, 1974), (2) surface morphology resembling characteristic rough and ragged...
tire tread wear, (3) the presence of C, Al, Si, S, Ca, Fe, and Zn (Camatini et al., 2001; Kim et al., 2001). Back-scattered electron images (BEIs) were taken in the range of 0.01 nm² at ×1000 (Fig. 2c) from the middle part of each particle. Chemical compositions of the areas were also determined by EDX (Fig. 2d), and they were defined as the bulk chemical compositions of tire dust.

Heavy metal particles were brighter than silicate mineral particles in the BEI; the brightness of the BEI reflects the atomic number of the object. The BEIs were converted to show high contrast with negative images to clearly distinguish heavy metal particles from the minerals (Fig. 2e). All detected particles more than 0.2 μm in diameter were analyzed to determine their chemical composition and diameter.

The EDX quantification was determined using the standardless ZAF method, and recalculated to 100% for 24 elements (Mg, Al, Si, P, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Sr, Y, Zr, Sn, Sb, Ba, La, Ce, and Pb). Because of the complex shape of the particles surface and their small diameters compared to the electron diffusion range, the quantification could lead to over- or underestimation. Therefore, we used a statistical method (a hierarchical cluster analysis program (HCA)) based on their major component elements to classify the particles. The HCA was based on Euclidian distances with Ward's error sum classification. The consistent Akaike's information criteria (AIC) were used to determine the most effective number of the cluster.

3. Results and discussion

3.1. Brake dust

Three or four fragments from each brake dust sample were analyzed to determine their bulk chemical compositions and the particulate compositions by EBSEM/EDX. The BEI and distribution of Cu, Sb, S, and Fe of brake dust are shown in Fig. 3a and b, respectively. The diameter of particles in the brake dust was about 1 μm, which was within the range of average mass median diameters of brake dust measured under several condition tests (from 0.62 to 2.49 μm) (Cing et al., 2000).

The brake dust consisted mainly of particulate Al, Si, S, Ti, Fe, Cu, and Sb (Fig. 3b). Iron particles also contained slight amounts of S, Cu, Sb, and Ba. Some brake dust samples contained particulate BaSO₄ and Zr. When we averaged the bulk compositions of the brake dust fragments, we found that Fe was the most abundant heavy element, followed by Ba, Cu, Sb, and Zr (Table 1). Stensolm et al. (2002) proposed diagnostic criteria for brake wear particles that included a ratio of 4.6±2.3 for Cu/Sb. The ratio in our analysis was 1.3. The low ratio compared to the criterion was because of the presence of Cu-free brake dust samples in this study.

Cu is used to control heat transport, and Sb is used to enhance stability (ORNL, 2001). BaSO₄ is used to increase the density of the brake pad (ORNL, 2001).

3.2. Yellow paint

The typical morphology and EDX spectra of yellow paint are shown in Fig. 4. The bulk chemical composition is high in Si, Ca, Cr, and Pb (Table 1). The yellow
### Chemical composition of clusters and traffic-related materials (mean ± SD ± standard deviation)

<table>
<thead>
<tr>
<th>Item No.</th>
<th>B.D.</th>
<th>V.P.</th>
<th>T.D.</th>
<th>Cluster 1</th>
<th>Cluster 2</th>
<th>Cluster 3</th>
<th>Cluster 4</th>
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<tr>
<td>Mg</td>
<td>0.1±0.3</td>
<td>1.9±1.6</td>
<td>ND</td>
<td>1.9±0.3</td>
<td>0.9±1.2</td>
<td>1.3±0.9</td>
<td>1.2±1.5</td>
</tr>
<tr>
<td>Al</td>
<td>0.6±0.3</td>
<td>0.6±0.2</td>
<td>2.7</td>
<td>1.5±0.2</td>
<td>2.5±1.7</td>
<td>1.6±2.1</td>
<td>1.5±2.6</td>
</tr>
<tr>
<td>Si</td>
<td>1.6±0.7</td>
<td>6.1±4.1</td>
<td>2.8</td>
<td>12.3±2.4</td>
<td>15.2±2.1</td>
<td>6.6±2.4</td>
<td>12.2±2.1</td>
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<tr>
<td>P</td>
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<td>ND</td>
<td>ND</td>
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<td>0.2±0.6</td>
<td>0.4±1.2</td>
<td>0.5±1.2</td>
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<tr>
<td>S</td>
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<td>25.6</td>
<td>26.6±0.9</td>
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<td>4.5±1.6</td>
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<tr>
<td>K</td>
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<td>ND</td>
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<td>0.4±0.5</td>
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<td>0.7±1.1</td>
</tr>
<tr>
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<td>1.4</td>
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<td>2.1±1.7</td>
<td>3.8±1.4</td>
<td>4.0±2.2</td>
</tr>
<tr>
<td>Ti</td>
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<td>ND</td>
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<td>0.2±1.2</td>
<td>0.6±1.2</td>
<td>0.4±1.1</td>
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<tr>
<td>V</td>
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<td>ND</td>
<td>ND</td>
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<td>0.0±0.2</td>
<td>0.1±0.5</td>
<td>0.1±0.6</td>
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<tr>
<td>Cr</td>
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<td>0.0±0.1</td>
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<td>0.6±1.7</td>
<td>1.7±0.8</td>
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<tr>
<td>Mn</td>
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<td>ND</td>
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<td>0.2±1.1</td>
<td>0.1±0.3</td>
<td>0.1±0.2</td>
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<tr>
<td>Fe</td>
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<td>ND</td>
<td>5.5±1.3</td>
<td>48.8±1.0</td>
<td>2.8±1.3</td>
<td>13.1±1.0</td>
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<td>ND</td>
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<td>0.1±1.0</td>
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<td>0.5±3.5</td>
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<tr>
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<td>ND</td>
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<td>4.8±1.1</td>
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<tr>
<td>Zn</td>
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<td>ND</td>
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<td>0.8±2.4</td>
<td>1.6±4.4</td>
</tr>
<tr>
<td>Sr</td>
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<td>ND</td>
<td>ND</td>
<td>0.0±0.1</td>
<td>0.1±0.4</td>
<td>0.4±0.9</td>
<td>1.6±9.7</td>
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<tr>
<td>Y</td>
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<td>ND</td>
<td>ND</td>
<td>0.0±0.1</td>
<td>0.2±0.1</td>
<td>0.3±0.1</td>
<td>0.2±1.6</td>
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<tr>
<td>Zr</td>
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<td>ND</td>
<td>ND</td>
<td>0.1±0.2</td>
<td>0.1±0.4</td>
<td>0.1±0.5</td>
<td>1.6±5.7</td>
</tr>
<tr>
<td>Sc</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>0.0±0.2</td>
<td>0.1±0.5</td>
<td>0.1±0.5</td>
<td>0.7±3.8</td>
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<tr>
<td>Sn</td>
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<td>ND</td>
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<td>Ba</td>
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<td>ND</td>
<td>0.1±0.2</td>
<td>0.5±1.5</td>
<td>0.2±0.9</td>
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</tr>
<tr>
<td>La</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>0.0±0.2</td>
<td>0.1±0.4</td>
<td>0.1±0.7</td>
<td>0.7±3.3</td>
</tr>
<tr>
<td>Ce</td>
<td>0.9±0.1</td>
<td>ND</td>
<td>ND</td>
<td>0.0±0.2</td>
<td>0.1±0.4</td>
<td>0.2±0.7</td>
<td>1.7±7.2</td>
</tr>
<tr>
<td>Pb</td>
<td>0.3±0.6</td>
<td>13.0±1.5</td>
<td>ND</td>
<td>0.1±0.2</td>
<td>0.1±0.4</td>
<td>2.6±1.2</td>
<td>0.5±1.2</td>
</tr>
<tr>
<td>Cd</td>
<td>3.0±0.6</td>
<td>30.5±3.3</td>
<td>50.1</td>
<td>46.9±1.2</td>
<td>34.3±2.4</td>
<td>33.7±4.5</td>
<td>36.0±5.2</td>
</tr>
</tbody>
</table>

**Note:**
- B.D.: Brake Dust
- V.P.: Yellow Paint
- T.D.: Tire Dust
- **n**: Number of particles
- \(\bar{d}\): Average diameter

The tire tread consists of bonds, Ca material, and PbCrO₄ particles. The PbCrO₄ is a particulate about 0.5 μm in diameter with an oval morphology (Fig. 4a). The PbCrO₄ in yellow paint is one of the Pb contributors in street dust (Pahukan et al., 1996; Ferguson and Kim, 1999).

### 3.3. Tire tread

A cross-sectional image of tire tread and EDX spectra is shown in Fig. 5. Determined elements in tire tread were O, Al, Si, S, Ca, and Zn (Table 1). The diameter of particulate ZnO was about 1 μm or less, and the morphology was multangular (Fig. 5a). Zinc oxide is added to activate vulcanization in the tire tread. Much of the Zn forms chelates with the accelerators, but the major part of the Zn in tire tread is excess ZnO and ZnS (Fauzer et al., 1999).

### 3.4. Heavy metal particles embedded in tire dust

We detected 228 heavy metal particles in 60 tire dust samples. The bulk chemical composition of the surface of tire dust debris was rich in mineral or asphalt pavement material characterized by Al, Si, K, and Ca, and smaller amounts of Fe, S, Mg, Zn, and Ti (Table 1). The chemical composition was quite different from that of tire tread. Mineral materials were found at high levels compared to the composition of tire tread, and some heavy metal elements were detected.

The embedded particles were divided into four clusters based on the consistent AIC and on particle compositions. Fe-, Cu-, Pb-, and Zn-rich particles were classified into clusters 1, 2, and 4, respectively. The particles with multielemental composition were classified into cluster 3. Typical morphology and EDX spectra of the heavy metal particles are shown in Fig. 6. In each EDX spectrum, Al, Si, and Ca may reflect neighboring material of the targeted heavy metal particles, such as asphalt pavement material, soil minerals, or tire tread itself.

### 3.5. Cluster 1

Cluster 1 is characterized by high Fe composition. Other heavy metal elements such as Mn, Cu, Zn, Sb, and Ba are contained in slight amounts in this cluster (Table 1). The average particle diameter is relatively large (1.17 μm). Iron is the most abundant heavy metal element in street dust.
of PbCrO₄ should be one. This decrease means a minor presence of Pb-rich particles in this cluster. One of the possible sources of Pb particles is lead used in motor vehicle wheel balance weights (Root, 2000).

The abundance ratio of this cluster in each tire dust samples showed large variation among individual tire dusts (Average: 7%; S.D.: 7%; Max: 32%; Min: 0%) but not among sampling sites. This means that heavy metals embedded in tire dust need not indicate the sampling location. Additional investigation is needed to learn when tire dust assimilates metal particles and when tires abrade, and how far tire dusts are distributed in the environment.

3.7. Cluster 3

Cluster 3 is characterized by multiple elements (Ti, Cr, Fe, Cu, Zn, Sr, Y, Zr, Sn, Nb, Ba, La, Co, and Pb) (Table 1). The average particle diameter in this cluster is 1.05 μm. The typical morphology and EDX spectra of this cluster are shown in Fig. 6c. Because the brake dust has many Ti, Fe, Cu, Sn, and Ba particles, these particles are significant contributors to this cluster. The ratio of Ca/Sb (3.8), which was in good agreement with the diagnostic criteria for brake wear particles (4.6 ± 2.3) (Sternbeck et al., 2002), also suggests the contribution of brake dust.

De Miguel et al. (1997) has classified the elements in street dust (La, Sr, Y) as natural elements, and Sternbeck et
Fig. 6. Typical image of metal particles embedded in tine dust. (a) Cluster 1, (b) Cluster 2, (c) Cluster 3, (d) Cluster 4.

al. (2002) showed that rare earth elements such as Ce, La, and Pr are hosted in a mineral phase in airborne particles. We found some heavy minerals such as allanite (Ca, Ce, Fe, Al, Si), zircon (Zr, Si), and monazite (P, Ce, La, Y, Th) by single particle analysis. This study area has a granite geological background, which includes these heavy minerals (Hirata and Kamada, 1983), so one of the possible sources of these elements is a natural source.
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

4. Conclusion

In this study, we characterize the morphology and chemical composition of traffic-related material (brake dust, yellow paint, and tire tread) and heavy metal particles embedded in tire dust. Brake dust contains heavy metal particles such as Fe, Cu, Zn, Sr, and Ba with a particle diameter of about 1 µm. Yellow paint contains Cr/Pb particles with an oval morphology and a diameter of about 0.5 µm. Tire tread is made of multi-angular ZnO particles 1 µm or less in diameter. A total of 2288 heavy metal particles were found embedded in tire dust and were classified into four groups by cluster analysis. Cluster 1 is rich in Cr, cluster 2 is rich in Pb, and cluster 3 is characterized by multiple elements. Cluster 4 consists mainly of ZnO. Judging from its chemical composition, particle diameter, and morphol-ogy, brake dust is a possible contributor to clusters 1 and 2, and yellow paint is a possible contributor of cluster 2. Zinc oxide in tire tread is a significant source for cluster 4.

These results suggest that tire dust assimilates traffic-related metal particles when the dust is rolled over surfaces and admire. The interactions between tire wear debris and heavy metal particles may give the heavy metal risk to the tire dust. Further study that discusses the risk of heavy metal particles embedded in tire dust is needed.

Acknowledgements

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References


Stenbeck J, Sjödin Å, Anheden E. Metal emissions from road traffic and the influence of resuspension—results from two tunnel studies. Atmos Environ 2002;36:4755–64.
Composition of Smoke Generated by Landing Aircraft

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ABSTRACT: A combination of techniques has been used to examine the composition of smoke generated by landing aircraft. A sample of dust from the undercarriage of several commercial airliners was examined with SEM/EDX (Scanning Electron Microscope/Energy Dispersive X-ray) to determine its elemental composition and also with an aerotest/aerosizer in order to measure the particle size spectrum. The observed size spectrum was bimodal with equal numbers of particles at peaks of aerodynamic diameter ~10 μm and ~50 μm. The EDX analysis suggested that the former peak is carbonaceous, while the latter consists of elements typical of an asphaltic concrete runway. In the field, a scanning LIDAR, in combination with optical and condensation particle counters, was deployed to determine limits to the number concentration and size of such particles. Most of the (strong) LIDAR signal probably arose from the coarse 50 μm aerosol, while respirable aerosol was too sparse to be detected by the optical particle counters.

INTRODUCTION

Local air quality is one of several issues constraining the development of airports. In Europe, the most pressing of such limits is that related to the legally enforceable limit on the long-term average of NO2, e.g. at Heathrow. Strategically, however, one might be more concerned by local concentrations of respirable particulate. While concentrations of fine particulate matter (PM) in the Heathrow area lie comfortably within the proposed long-term limit for PM2.5 of 25 μg m⁻³, there is apparently no safe threshold for such PM, with even very modest variations in fine urban aerosol having an epidemiologically detectable effect on mortality.

Conventionally, most of the modelling of the impact of commercial aviation on PM concentrations has concentrated on emissions from aero-engines. This is despite the smoke emitted from aircraft on landing being clearly visible to the naked eye, while that from modern aero-engines on full power is scarcely visible. When an aircraft lands, the main wheels make contact with the ground and spin up the nose wheel droppers to the ground; the brakes are then applied to bring the aircraft to a halt. Visible smoke is usually only released only as the wheels spin up, though the brakes must subsequently release fine aerosol as they abrade. Integrated over the landing and takeoff (LTO) cycle, it is not clear what should be the largest source of respirable aerosol. From mass balance calculations,⁵ we know that the rubber lost per landing is very large (anything up to ~1 kg from a B747). We know — both from the odor and from recent measurements⁶ of organic carbon and associated trace metals in nearby ambient PM — that some must be emitted as fine aerosol, but we do not know how much of this is so dispersed and how much adheres to the runway or is scattered as macroscopic fragments. By contrast, recent estimates using the best available understanding of PM emissions from aircraft engines, including nonvolatile, sooty, and volatile organics,⁷ suggest that total engine emissions are somewhat smaller (anything up to ~0.25 kg of PM per LTO cycle from a B747 with four RR211 — 324G power plant), though in this case all of the emissions are initially released as fine aerosol.⁷ Furthermore, while PM emission integrated over the LTO cycle may be a useful metric in the development of airport emissions inventories, it may not be the best metric for airport air quality applications, since here it is the ground level emissions that dominate. Thus, brake and tire wear were estimated to be the dominant source of PM at Gatwick, accounting for 60% of the total ground-level PM10 emissions from aircraft.⁸ Overall, however, this contribution is subject to significant uncertainty: PM emissions from tires and brakes are dependent on many factors including aircraft weight, speed, number of wheels, brake material (carbon or steel), weather conditions, undercarriage design, pilot actions, and airline procedures.

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Figure 1. Particle size spectrum of sample of dust on landing gear measured with an Aerosizer and an Aerodynamic employing (a) high and (b) low shear.

The proportion of the mass loss from aircraft tires and brakes that becomes suspended as fine PM has not been extensively studied. For road vehicles it is generally estimated that less than 10% of tire loss is emitted at PM<sub>10</sub> - though the proportion could be as high as 30%. Within this, the larger particles may be generated through mechanical abrasion, while the submicrometer fraction may arise from the thermal degradation of tire polymer and the volatilization of extenders off. For road vehicle brake wear, on the other hand, ref 11 observed that between 50% and 90% of brake emissions are emitted at airborne PM with a number weighted mean aerodynamic diameter of 1–2 µm. Similarly, a study described in ref 12 estimated that 70% of the soiled material from road vehicle brakes ends up as airborne PM.

For estimating the PM<sub>10</sub> emissions from aircraft tires and brakes, the Project for the Sustainable Development of Heathrow<sup>6</sup> used upper limits of 10% for tire wear and 100% for brake wear. These limits were chosen to reflect the fact that braking conditions for aircraft are considerably more aggressive than those for road vehicles in normal use. It was also assumed that PM emissions scale linearly with the weight of the aircraft. Such estimates, however, remain speculative.

To tighten the upper emission limits of respirable aerosol in tire smoke, we report here a field trial of LIDAR measurements with simultaneous points observations of tire smoke, together with SEM and size spectrum analyses of dust collected from aircrafts' undercarriage.

In the past few years, LIDAR has become the technique of choice for examining the dispersion of material in aircraft exhaust plumes. The most convenient realization of the method is that the observed signal strength depends on the size spectrum of the scattering particles and on their refractive index. If neither is known, a simple backscatter Lidar is normally limited to measuring advection and dispersion rather than absolute concentrations.

In the case of this study, however, we have additional information arising from laboratory analyses of undercarriage dust, which we presume to be representative of the coarse fraction of landing-generated smoke. This has enabled us to make gravimetric estimates of the quantity of coarse dust which must have been present to generate the observed Lidar signal. In addition, the deployment of optical particle counters (OPCs) within the LIDAR scanning plane allows us to put an upper limit on fine particle concentrations within the plume.

Size Spectrum of Undercarriage Dust. We analyzed a composite sample of 919 mg of landing and braking dust collected from the undercarriage (also legs) and wheel balls of three Airbus A320–332 aircraft of the BA fleet, parked on the stands at Heathrow. The sample was grayish-black, consistent with its containing a high proportion of black carbon. It was dry, containing no visible lubricant. The dust was simply collected with a paint brush into a sealed jar.

Such a sample must have contained PM from a variety of sources (tires, brakes, runway, tarmacs, etc.). Not having the analytical tools to predict with any confidence which might be preferentially deposited where, however, we considered that a well-mixed composite sample was most appropriate. Conversely, the aircraft landing gear would be extremely inefficient in collecting respirable aerosol. Coarse aerosol will thus be overrepresented in the sample. We may note that all the runways at Heathrow are of grooved asphalt, while apron surfaces are concrete. Brakes are carbon–carbon.

A second sample was collected from a B757–236 and a B747–436 aircraft. Dating collection it was noted that the amount of dust adhering to these aircraft appeared to be much greater than those of the A320s. This presumably happens since the Boeing machines are mounted fore-and-aft and the aft undercarriage and wheel can thus collect the aerosol generated by the forward wheel.

The size spectrum of dust from the A320s was determined using an Aerosizer instrument which determines the aerodynamic diameter of PM through time-of-flight measurements.<sup>10</sup> It does so by accelerating the particles in a supersonic flow and then measuring their velocity. The instrument was calibrated with NIST-traceable polyethylene. It has a lower size cutoff at an aerodynamic diameter of ~0.5 µm.

An Aerodisperper was used to transfer the dust sample into the instrument. It consists of a polished stainless steel spherical cup into which the powder sample is placed. High pressure air from a small nozzle is pulsed into the cup and any entrained dust is then transferred to the Aerosizer sample line. The duty cycle (though set the pressure) of the pulse is gradually increased to 100%, by which point the entire sample has been used up and none remains in the cup. The sample is then passed through an aperture into the optical measuring chamber. Adjusting the diameter of the aperture adjusts the shear experienced by the particles this may lead to aerosol degradation<sup>11</sup>.

The dust sample size distribution was measured using a range of aperture settings, with the results shown in Figure 1. As may be seen, the distribution is bimodal, with peaks at aerodynamic
Figure 2. EDX image of Si in underground dust. Frame width is 380 μm.

Figure 3. EDX image of Al in underground dust. Frame width is 380 μm.

Figure 4. EDX image of C in underground dust. Frame width is 380 μm.

and EDX X-ray spectral peaks integrated over the observation area were mapped. EDX X-ray spectral peaks maximized at 0.0 μm should be taken as a lower limit to the relative number density of particles of a similar size present.

It is interesting to note that an additional small peak of fine aerosol (1–2 μm) is seen at the highest shear settings. The captured dust originally been generated by a high shear event (e.g., between tires and runway) was not observed in the Aerodispercer to break up the dust further. The results of the visual inspection should therefore be of interest to the reader since the aerosol peak is lower in the presence of dust. On the other hand, soot agglomerates (e.g., from burning rubber) are relatively large and may be broken up by the higher shear settings in the Aerodispercer. The 1–2 μm peak may indicate the occurrence of a similar process.

SEM Measurements. The dust sample was also analyzed at the John Dibner Institute in MMU using a Zeiss Supra 40VP SEM. Besides electron backscatter analysis, this system can perform EDX for identification of the elemental composition of particles and micro-Raman for measurements of chemical composition. (The latter was not employed in the present study.)

Figure 4 shows the Si distribution in the sample. This element may be taken as a marker of dust lifted mechanically from the ground surface (though it should be noted that precipitated synthetic silica is also added to tire tread to improve wet traction). Particles sizes in the image range from 1 μm (the spatial resolution of the map) up to 63 μm. By correlating the elemental compositions of these particles, an attempt at identification of various minerals may be made. Thus, the large dark particle at the bottom of the image is only evident in Si and O; we may interpret it as quartz, a component of many rocks (or of concrete elsewhere in the image, there are many particles containing Ca). Conversely a particle in the top right corner of the image is also associated with Al (Figure 3). K, and O. It may be a type of feldspar which is, along with quartz, a component of granite. Aluminum hydroxide is also included in some tire formulations to enhance wet grip performance and abrasion resistance.

All of these mineral particles appear to be embedded in a carbonaceous substrate (Figure 4). At this stage, the substrate no longer shows any very clear structure; soot aggregates have little mechanical strength. We thus have little indication of the porosity and initial size structure of the carbonaceous aerosol. Soot may arise from the burning of the tire rubber, or of the tire binding asphalt concrete runway, or from abrasion of the brakes. Carbon black is, of course, a major component of tires, and carbonaceous aerosol might be generated on landing even in the absence of combustion. Some indication of the source may be given by the presence of other trace elements, e.g., S or Zn. S is used as a vulcanizing agent in rubber and will also be present in tar. The EDX images did indeed show a weak background of S associated with the C signal, consistent with the soot arising from one of these sources. There were also some 1 μm particles of S, a few of which were associated with Ca (i.e., gypsum), while others gave a strong signal on the backscattered SEM signal but not from any of the other cations which we measured, nor from O. They may have been particles of MoS₂ which is commonly used as a lubricant in aero-engines.

Zn is used as an additive to Si in vulcanizing rubber, while Cr may also be present in tire. A few 1 μm particles of Cr/Zn were indeed detected, though not associated with S. If these particles originated from burning rubber, the implication is that the S
compounds also generated were sufficiently volatile to be separated from more refractory products of combustion.

In Figure 5, we can see a small (35 μm) droplet of Fe, associated with Co and traces of Mn, Ni, V, and Zn. We note that it is quite common to find droplets of iron of diameter near asphalt concrete — this is presumably the extension of the size spectrum down to the microscopic scale. Figure 5 also shows some irregularly shaped Fe PM at diameters of 10 μm or below. The presence of these is not obvious.

Field Measurements. A field trial was made at Cranfield Airport (52° 4.33′ N, 0° 37.00′ E) on 17 February 2009. Instruments available were (among others) a Rapid-Scanning Lidar, a condensation particle counter (Grimm UPCA), and two OPCs (Grimm 1.108; Turnkey Instruments Optris) (Figure 6).

In addition, video recordings of all operations were taken with a video camera from the control tower. An instrumented RAe146 aircraft (www.fasn.ac.uk) made eight sorties, each consisting of a takeoff, circuit, and landing. On the final sortie, the pilot was requested to make a heavy landing (the final descent speed of the aircraft was 2.0 m s⁻¹ as against a more typical value of 1.4 m s⁻¹), and it is measurements of the smoke from this landing that we will present here. The RAe146 has two pairs of landing wheels, each with Goodyear 393F-55-1 tires.

The runway at Cranfield is aligned 313°-337° (true); there is a preference to land and take off toward the SW. The Lidar was set up near the N end of the airfield and for the monitoring of tire smoke scanned vertically on an azimuth of 175°-27° (true), crossing the runway centerline at a range of 233 m.

There was a moderate NW cross-wind on the day of the trial, affecting both engine and tire smoke emissions away from the Lidar. The point samplers were deployed on the airfield close to the Lidar’s scanning plane and at a distance of 233 m beyond the runway centerline. At this position, burning rubber could be smelted on all landings and bare bars on most of the testing out and take-offs (hydrocarbon emissions are greater at lower power settings).

The Grimm UPCA easily detected the emissions from the aircraft on taxiing, takeoff, and landing, with typical peak number concentrations being respectively 7 × 10⁴ cm⁻³, 4 × 10⁴ cm⁻³, and 1 × 10⁵ cm⁻³. On landing, the aerosol peak was usually bifurcated, presumably by the wing vortices. On takeoff, the aircraft would run yet have been moving fast enough at the measuring point to generate significant lift at the point of landing, in contrast, it flaps and would have been generating slightly more lift than its weight.) We note that although the fuel burned while taxing was only 13% of that in the takeoff run, the aircraft was moving an order of magnitude more slowly. This is all fine PM, since the 50% cutoff point for the sampling line was at an aerodynamic diameter of about 3 μm. The number density of coarse PM should in any case be negligible by comparison.

The Lidar was also capable of detecting the engine plume on takeoff and the tire smoke on landing —6 out of the 8 landings were so detected. The Lidar signal comes from outgoing radiation backscattered by atmospheric aerosol. This is normally expressed through a parameter, β, being the proportion backscattered per unit path length per unit solid angle. Invariably, this is associated with an extinction, α, which is the fraction of radiation lost per unit path length. A log-linear plot of signal against range in uniformly hazy air will thus appear as a straight line of slope −αβ.
Environmental Science & Technology

Figure 8. Footprint of tire smoke at 41 m above the surface in relation to point samplers at 14:15:31 UTC. For convenience, coordinates are relative to the Lidar scanning azimuth, with an origin where this crosses the runway centreline. Directions are given in degrees from true North.

Figure 7 shows a backscatter profile from a single shot at close to ground level shortly after the aircraft had landed. The strong returns at ranges of 450 and 600 m are from vegetation and may be ignored. The small backscatter peak at 350 m is the tire smoke, which has not yet reached the point samplers, which were at 375 m. In the following scan, 4 s later, the smoke puff had almost passed the point samplers. The peak backscatter of the smoke in Figure 7 corresponds to an excess backscatter of 58% relative to the ambient backscatter; in the following scan, it was 48%.

(The method of calculation is described in ref 16). From ref 20, we know that for a Lidar wavelength of $\lambda = 355 \text{ nm}$ in humid marine aerosol, the ambient extinction/backscatter ratio, $\alpha/\beta$, should be $\sim 24 \text{ m}$. Taking the average of several neighboring low-altitude shots, away from tire smoke or ground clutter, the ambient extinction was found to be $\alpha = 2.25 \times 10^{-5} \text{ m}^{-1}$. By implication, the peak excess backscatter when the puff passed over the samplers should be $\beta = 0.50 \times 10^{-5} \text{ m}^{-1}$. Suppose that the puff consists of spheres of number density $n$, diameter $d = 2r = \lambda n$, and density $\rho$, and that incident light is backscattered over $2\pi$ sr. Simple geometry then tells us that the backscatter should be $\beta = \pi r^2 \rho / (4n)$. Therefore, we can estimate the number density of the plume to be $n = 2\beta/(4\pi r^2 \rho)$.

Sections 3 and 4 suggest that the particles could be represented as aged concrete ($\rho = 2400 \text{ kg m}^{-3}$) of diameter $\sim 50 \text{ nm}$. Hence, peak concentrations within the plume should be $n = 64 \text{ L}^{-1}$ and $\rho = 50 \text{ mg cm}^{-3}$. The supplementary peak in PM2.5 aerosol at $10 \text{ nm}$ is likely to contribute very little to the backscatter since, as may be seen from Figure 1, its peak number density is comparable to that of the larger particles.

Even for such coarse particles, the Stokes fall velocity is $0.02 \text{ m s}^{-1}$, so sedimentation is initially secondary to the gross flow and turbulence within the plume. Over the 37 s for which it was observed, the center-of-gravity of the puff did not fall but rose by 3.5 m.

Figure 8 shows the footprints of the tire smoke at a height of $4-8 \text{ m}$ and at the time when it was passing over the point samplers. For this analysis, we have used the $10 \text{ m}$ wind speed and direction observed at the Lidar to shift the envelope of tire smoke observed earlier or later scans to that at the reference time. We can see that the smoke extends $75 \text{ m}$ along the line of the runway.

For a landing speed of $57.1 \text{ m s}^{-1}$, this implies a total smoke emission time of $1.3 \text{ s}$. This is much longer than the time for which visible smoke was generated, the video footage showing that this lasted for $0.32 \text{ s} at most, with the main wheels landing essentially simultaneously. The Lidar is of course much more sensitive than the eye. Part of the greater longitudinal extension of the smoke may possibly arise from some PM being entrained in the wake of the aircraft.

Although the Lidar signal is dominated by the largest particles, these would be barely observable by the point samplers, since they would be aerodynamically too massive to pass through the sample line. (The 50% capture point of the system is at an aerodynamic diameter of about 6 $\mu\text{m}$.) On the other hand, the measured size spectrum (Figure 1) suggests that the number density at $d = 10 \mu\text{m}$ is at least comparable with that at $d = 50 \mu\text{m}$; given the poorer capture efficiency of respirable PM by the structures of the aircraft, there may in fact be many more fine particles than coarse particles emitted. If so, we should have been able to detect the larger particles with the Lidar and the smaller particles with the OPCs. The volumetric sampling rates of the Ocius and the Grimm 1.108 were 0.6 L min$^{-1}$ and 1.2 L min$^{-1}$ respectively, each with a 1 s sampling time, so over the $\sim 5 \text{ s}$ period for the puff to pass they should have provided number sensitivities of $\sim 20 \text{ L}^{-1}$ and $\sim 10 \text{ L}^{-1}$, respectively.

In practice, however, the sensitivity was determined by the background noise. Thus, for the Ocius, the observed background signal levels were $33 \pm 16 \mu\text{g m}^{-3}$ for PM$_{10}$, $10 \pm 3 \mu\text{g m}^{-3}$ for PM$_{2.5}$ and $3 \pm 0.5 \mu\text{g m}^{-3}$ for PM$_{1.0}$ corresponding to respective number densities of $41 \text{ L}^{-1}$, $815 \text{ L}^{-1}$, and $3830 \text{ L}^{-1}$ for spheres at the top end of these size ranges. PM$_{2.5}$ in the tire smoke should thus have been at or above the practical detection limit of this instrument. In fact, nothing significant was seen with either instrument in any size range, implying that Figure 1 has not greatly underestimated the number density at $10 \mu\text{m}$. It is clear that the visible smoke cannot be associated with a substantial emission of respirable PM.

The ultrafine plume measured with the Grimm OPC arrived at the sampling point simultaneously with the tire smoke, however, it persisted for $40 \text{ s}$. As after other landings, this ultrafine plume (i.e., engine smoke) was double-peaked, with a peak number concentration of successively $1.1 \times 10^{5} \text{ cm}^{-3}$ and $1.3 \times 10^{5} \text{ cm}^{-3}$. Almost nothing of the secondary peak, however, was visible with the Lidar. It is interesting that almost all of the tire smoke should apparently have been entrained into the puff with the PM$_{2.5}$.

Reference 4 estimated that the rubber lost per aircraft landing amounts to a fraction $2 \times 10^{-5}$ of the maximum takeoff weight of the aircraft. For the EAAM, this is $74 \text{ g}$ landing per shot. Integrating over all shots in Figure 8 for which smoke was visible, and multiplying by the estimated lateral displacement ($60 \text{ m}$) between scans, we obtain a total mass of visible smoke within the puff of $54 \text{ g}$ (taken as $50 \mu\text{m}$ concrete particles).

The implication of Figure 1 is that these coarser particles comprise $\sim 200 \mu\text{m}$ as much mass as the $10 \mu\text{m}$ peak. The clear implication is that only a tiny proportion of the rubber lost can be as respirable aerosol; the great majority must remain on the runway surface.

**DISCUSSION**

The differing sensitivities of the various monitoring methods in these trials is quite striking. At the target distance in this trial, the Lidar had a sampling volume of $\sim 550 \text{ L}$. It was thus sensitive to the sparse, coarse aerosol generated by the landing aircraft. The point samplers struggle to resolve this, not merely because of
the poor statistics of a particle happening to be within the sampled volume (10 – 20 mL s⁻¹) but also because dynamical constraints make coarse aerosol unlikely to pass along the sampling line. Initially, these observations suggest that the bulk of the visible aerosol in the smoke is too coarse to be respirable; it seems to consist largely of mechanically generated dust from the runway surface. Mass balance considerations imply that very little of the tire rubber lost is released as fine aerosol.

The condensation particle counter (Grimpè UPPC), on the other hand, is extremely sensitive to ultrafine particles. While it detected the engine emissions very sensitively, there were simply far too few particles in the tire smoke to provide a distinguishable signal.

Overall, it would appear that while tire smoke emissions can be spectacular, and may have operational implications in terms of tire wear and runway degradation, the emission of respirable PM is relatively modest. There may, however, still be health issues arising from hazardous organic (e.g., PAHs) volatilized from the rubber or of nuisance from the associated odor.

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**ACKNOWLEDGMENT**

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**REFERENCES**


### Statistics

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Product ID: DCM0528 Prepared at Thu 31 Mar 2016 02:18:22 AM EST

Note: Highest value in bold; lowest in italic.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom base scaled, refer to attached note for details

DUBBO (DARLING STREET)

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm Jan 2193 Total Observations
Calm 10%

30°  60°  90°  120°  150°  180°  210°  240°  270°  300°  330°  0°
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom time scale used, refer to attached note for details

DUBBO (DARLING STREET)

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm Feb 1980 Total Observations
Calm [11%]
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom lines related, refer to attached notes for details.

DUBBO (DARLING STREET)

Site No: 069010 • Opened Jan 1979 • Closed Nov 2009 • Latitude: -32.3809° • Longitude: 148.5086° • Elevation 200m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm Mar
2284 Total Observations

Calm 12%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom lines selected, color is allotted here for details
DUBBO (DARLING STREET)
Site No: 065012 • Opened Jan 1970 • Closed Nov 2003 • Latitude: -32.23357 • Longitude: 148.6059 • Elevation 260m
An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm Apr
2228 Total Observations

Calm 15%

Prepared by National Climate Centre of the Bureau of Meteorology
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We have taken all reasonable steps to ensure that the information provided is accurate. However, we cannot provide any warranty or accept any liability for this information.
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom axes selected, refer to attached note for details.

**DUBBO (DARLING STREET)**

- Site No: 009012
- Opened Jan 1879
- Closed Nov 2008
- Latitude: -32.5385°
- Longitude: 148.4089°
- Elevation: 289m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm May 2011 Total Observations

Calm 17%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom axes selected, refer to attached notes for details
DUBBO (DARLING STREET)
Site No: 0001080186 Opened Jan 1870 Closed Nov 2009 Latitude: 32.3396° Longitude: 148.5308° Elevation 360m
An asterisk (*) indicates that calm is less than 0.3%. Other important info about this analysis is available in the accompanying notes.

3 pm Jun 2272 Total Observations
Calm 1.6%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom Rosette presented, refer to attached notes for details

DUBBO ( DARLING STREET)
Site No: 0005/13 • Opened Jan 1970 • Closed Mar 2008 • Latitude: -32.3302° • Longitude: 148.6049° • Elevation: 260m
An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm Jul
2343 Total Observations
Calm 15%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom times solved, refer to attached note for details

DUBBO (DARLING STREET)

Site No: O05012 • Opened Jan 1870 • Closed Nov 2009 • Latitude: -33.3695° • Longitude: 148.0089° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.

Other important info about this analysis is available in the accompanying notes.

3 pm Aug
2250 Total Observations

Calcult 1254
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom lines annotated, refer to attached scale for details
DUBBO (DARLING STREET)
An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm Sep
2232 Total Observations
Calm 1%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

DUBBO (DARLING STREET)

Site No: 005012 • Opened Jan 1970 • Closed Nov 2009 • Latitude: -30.8385° • Longitude: 148.6090° • Elevation: 280m

An asterisk (*) indicates that calm is less than 0.5%.

Other important information about this analysis is available in the accompanying notes.

3 pm Oct
2291 Total Observations

Calm 10%

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TCZMONTH Page 1
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom lines or symbols, refer to attached table for values.

Dubbo (Darling Street)

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm Nov
2194 Total Observations

Calm: 9.4%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Dubbo (Darling Street)

Site No: 015012 • Opened Jan 1876 • Closed Nov 2008 • Latitude: -32.3369° • Longitude: 148.6009° • Elevation: 280m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm Dec

2253 Total Observations

Calm 10%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom Rose selected, refer to attached note for details

DUBBO (DARLING STREET)
Site No: 055013 • Opened Jan 1921 • Close Dec 2008 • Latitude: -31.5386° • Longitude: 148.8269° • Elevation: 260m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

9 am Jan
2312 Total Observations

Calm 1.3%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Dubbo (Darling Street)
Site No: 000102 • Opened Jan 1870 • Closed Nov 2010 • Latitude: -32.9385° • Longitude: 147.4018° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5 km/h.
Other important info about this analysis is available in the accompanying notes.

9 am Feb
2074 Total Observations
Calm 12%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

DUBBO (DARLING STREET)
Site No: 000012 • Opened Jan 1970 • Closed Nov 2009 • Latitude: -33.2333° • Longitude: 146.6389° • Elevation 260m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

9 am Mar
2350 Total Observations

Calm 14%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom Rose selected, refer to attached notes for details

DUBBO (DARLING STREET)

Site No: 065912 • Opened Jan 1870 • Closed Nov 2003 • Latitude: -32.3989’ • Longitude: 148.0684’ • Elevation 206m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

9 am Apr
2326 Total Observations

Calm 21%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom Error selected, refer to attached note for details
DUBBO (DARLING STREET)
Site No: 069612 • Opened Jan 1978 • Closed Nov 2009 • Latitude: -32°38'50" • Longitude: 148°56'59" • Elevation 207m
An asterisk (*) indicates that calm is less than 0.5.
Other important info about this analysis is available in the accompanying notes.

9 am May
2400 Total Observations
Calm 23%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Dubbo (Darling Street)


An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

Sam Jun
2348 Total Observations
Calm 28%

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TCZMOTION Page 1
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Customised rose, refer to attached note for details
DUBBO (DARLING STREET)
Site No: 065012 • Opened Jan 1870 • Closed Nov 2009 • Latitude: -32.3998° • Longitude: 149.8588° • Elevation 360m
An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

9 am Jul
2429 Total Observations
Calm 32%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom data selected, refer to attached note for details

DUBBO (DARLING STREET)
Site No: 000102 • Opened Jan 1670 • Closed Nov 2003 • Latitudes: -32.3301° • Longitudes: 148.9988° • Elevation 261m

An asterisk (*) indicates that calm is less than 0.5%. Other information is available in the accompanying notes.

9 am Aug
2398 Total Observations

Calm 26%

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TOXMONDTH Page 1
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1998)

Custom Scales selected, refer to attached note for details

DUBBO (DARLING STREET)

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

9 am Sep 2319 Total Observations

Calm 20%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom lines selected, refer to attached notes for details.

DUBBO (DARLING STREET)
Site No: 068028 • Operated Jan 1870 • Closed Nov 2000 • Latitude: -32.3308° • Longitude: 148.6309° • Elevation 362m

An asterisk (*) indicates that calm is less than 0.3%.
Other important info about this analysis is available in the accompanying notes.

9 am Oct
2344 Total Observations
Calm 14.5%

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Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom area selected, refer to attached notes for details.

DUBBO (DARLING STREET)
Site No: 008171 • Opened Jan 1870 • Closed Nov 2010 • Latitude: -32.3356° • Longitude: 148.5089° • Elevation 390m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

9 am Nov 2252 Total Observations
Calm 12%
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

ITEM NO: PDEC17/14

Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom data selected, refer to attached note for details

DUBBO (DARLING STREET)

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

9 am Dec 23 Total Observations

Calm: 12%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)
Custom these selected, refer to attached file for details.

Dubbo (Darling Street)
Site No: 036321 - Opened Jan 1677 - Closed Nov 2008 - Latitude: -23.3000° - Longitude: 148.5000° - Elevation 360m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm
26905 Total Observations
Calm 1.2%
Rose of Wind direction versus Wind speed in km/h (01 Jan 1921 to 23 Dec 1999)

Custom bins selected, refer to attached scale for details

DUBBO (DARLING STREET)
Site No: 000512 - Opened Jan 1870 - Closed Nov 2009 - Latitude: -32.3000° - Longitude: 148.8000° - Elevation 360m

An asterisk (*) indicates that calm is less than 0.5%.

Other important info about this analysis is available in the accompanying notes.

9 am
27870 Total Observations

Calm 19%
<table>
<thead>
<tr>
<th>Statistics</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Annual</th>
<th>Years</th>
<th>Plot</th>
<th>Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
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<tr>
<td>Mean maximum temperature (°C)</td>
<td>53.1</td>
<td>31.1</td>
<td>23.7</td>
<td>24.0</td>
<td>20.6</td>
<td>16.3</td>
<td>15.6</td>
<td>17.5</td>
<td>21.2</td>
<td>26.1</td>
<td>31.7</td>
<td>31.2</td>
<td>24.5</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean minimum temperature (°C)</td>
<td>13.1</td>
<td>17.5</td>
<td>14.4</td>
<td>10.2</td>
<td>6.5</td>
<td>4.4</td>
<td>3.0</td>
<td>3.3</td>
<td>6.0</td>
<td>9.3</td>
<td>13.6</td>
<td>13.9</td>
<td>10.2</td>
<td>23</td>
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<tr>
<td>Rainfall</td>
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<tr>
<td>Mean rainfall (mm)</td>
<td>50.9</td>
<td>45.9</td>
<td>57.4</td>
<td>59.0</td>
<td>42.2</td>
<td>49.2</td>
<td>41.9</td>
<td>50.3</td>
<td>43.2</td>
<td>52.0</td>
<td>59.2</td>
<td>52.9</td>
<td>17</td>
<td>1994</td>
<td>2018</td>
<td></td>
</tr>
<tr>
<td>December (rainfall) rainfall (mm)</td>
<td>41.2</td>
<td>56.6</td>
<td>27.4</td>
<td>27.5</td>
<td>45.1</td>
<td>41.8</td>
<td>37.0</td>
<td>19.8</td>
<td>39.2</td>
<td>40.4</td>
<td>56.0</td>
<td>47.8</td>
<td>21</td>
<td>2016</td>
<td>2018</td>
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<tr>
<td>Mean number of days of rain ≥ 1 mm</td>
<td>8.6</td>
<td>7.5</td>
<td>5.2</td>
<td>3.2</td>
<td>3.1</td>
<td>5.5</td>
<td>9.2</td>
<td>4.9</td>
<td>6.7</td>
<td>4.3</td>
<td>3.9</td>
<td>5.9</td>
<td>0.1</td>
<td>30</td>
<td>1994</td>
<td>2018</td>
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<td>Other daily data</td>
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<td>Minimum daily temperature (°C)</td>
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<td>Mean number of clear days</td>
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<tr>
<td>Mean number of cloudy days</td>
<td></td>
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<td>Humidity</td>
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</tr>
<tr>
<td>Mean 5am relative humidity (%)</td>
<td>32</td>
<td>58</td>
<td>36</td>
<td>37</td>
<td>47</td>
<td>59</td>
<td>58</td>
<td>47</td>
<td>43</td>
<td>36</td>
<td>36</td>
<td>41</td>
<td>17</td>
<td>1995</td>
<td>2012</td>
<td></td>
</tr>
<tr>
<td>Mean 7am relative humidity (%)</td>
<td>16.9</td>
<td>18.1</td>
<td>17.5</td>
<td>18.8</td>
<td>18.2</td>
<td>17.1</td>
<td>17.1</td>
<td>18.3</td>
<td>18.9</td>
<td>19.7</td>
<td>20.1</td>
<td>20.2</td>
<td>18.4</td>
<td>17</td>
<td>2012</td>
<td></td>
</tr>
</tbody>
</table>

Product ID: DCJCM0028 Prepared at Thu 31 Mar 2016 02:16:25 AM EBT
Rose of Wind direction versus Wind speed in km/h (15 Jan 1993 to 30 Sep 2010)

DUBBO AIRPORT AWS
Site No: 980978 • Opened Jan 1946 • Bill Opn • Latitude: -32.2303° • Longitude: 148.5792° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm Jan
528 Total Observations

Calm °
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom times scaled, refer to attached note for details

DUBBO AIRPORT AWS

An asterisk (*) indicates that calm is less than 0.5%. Other important information about this analysis is available in the accompanying notes.

3 pm Feb
501 Total Observations

Calm
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

DUBBO AIRPORT AWS

Buffer No: 065700 - Opened Jan 1946 - Site Open - Latitude: -33.2300° - Longitude: 148.5700° - Elevation 284m

A square box (□) indicates that calm is less than 0.3.

Other important info about this analysis is available in the accompanying notes.

3 pm Mar
549 Total Observations

Calm
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom class selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 080570 - Opened:Jan 1946 - Bill Opn - Latitude: -32.2205° - Longitude: 148.9799° - Elevation 29.94m
An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Apr
512 Total Observations

* Calm
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom lines selected, refer to attached notes for details

DUBBO AIRPORT AWS
Site No: 06570 • Opened Jan 1993 • SWell Open • Latitude: -32.2308° • Longitude: 148.5732° • Elevation 294m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm May
552 Total Observations

Calm 1%
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom lines included, refer to attached note for details.

DUBBO AIRPORT AWS
Site No: 009790 - Opened Jan 1946 - 653 Open - Latitude -32.2308° - Longitude 149.5752° - Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Jun
517 Total Observations

Calm: 1%
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2013)
Custom frame selected, refer to shaded area for details
DUBBO AIRPORT AWS
Site No: 960470 • Opened Jan 1945 • Gill Open • Latitude: -32.2308° • Longitude: 148.0783° • Elevation 284m
An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Jul
549 Total Observations
Calm 6°
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom rose deleted, refer to attached notes for details

DUBBO AIRPORT AWS
Site No: 00970 • Opened Jan 1946 • Elevation: 364m

An asterisk (*) indicates that calm is less than 0.5.

Other important notes about this analysis are available in the accompanying notes.

3 pm Aug
535 Total Observations

Calm
Rose of Wind direction versus Wind speed in km/h (15 Jan 1993 to 30 Sep 2010)
Custom time selected, refer to attached note for details
DUBBO AIRPORT AWS
Site No: 295070 • Opened Jan 1986 • Bill Open • Latitude: -32.330° • Longitude: 148.970° • Elevation 284m
An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm Sep
531 Total Observations
Calm *
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom Grid selected. Refer to attached note for details
DUBBO AIRPORT AWS
B/S No: 06070 • Opened Jun 1990 • Site Open • Latitude: -33.3100° • Longitude: 148.5700° • Elevation 284m
An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Oct
516 Total Observations
Calm. °
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custon Rose saturated, refer to attached note for details.

DUBBO AIRPORT AWS
Site No: 061760 • Opened Jan 1996 • Site Open • Latitude: -32.5309° • Longitude: 148.8739° • Elevation 324m
An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

3 pm Nov
498 Total Observations
Calm *
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom lines selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 065790 • Opened Jan 1946 • Site Open • Latitude: -32.7900° • Longitude: 149.0703° • Elevation 384m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

3 pm Dec
512 Total Observations

Calm
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom axes scaled, refer to shaded note for details

DUBBO AIRPORT AWS
Site No: 055978 • Opened Jan 1940 • Hill Open • Latitude: -33.2308° • Longitude: 145.9752° • Elevation 294m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

DUBBO AIRPORT AWS
Site No: 005790 • Opened Jan 1946 • Site Open • Lat/lon -32.35208° • Long/lon 148.5735° • Elevation 264m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

9 am Feb
504 Total Observations

Calm 1%

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TCZMONTH Page 1
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

DUBBO AIRPORT AWS
Site No: 06876 Open Jan 1995 - 58m Open - Latitude -22.2206" - Longitude 145.5792" - Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

9 am Mar
547 Total Observations
Calm: 134
Rose of Wind direction versus Wind speed in km/h (18 Jan 1993 to 30 Sep 2010)
Custom Rose selected, refer to attached note for details
DUBBO AIRPORT AWS
Site No: 26970 - Opened Jan 1990 - Bill Open - Latitude: -32.2269° - Longitude: 148.0792° - Elevation 284m
An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

9 am Apr
508 Total Observations
Calm *

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Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Custom chart selected, refer to attached note for details

DUBBO AIRPORT AWS
Site No: 000076 • Opened Jan 1948 • Still Open • Latitude: -32.2366° • Longitude: 148.3703° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

9 am May
545 Total Observations

Calm 3%
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

DUBBO AIRPORT AWS
Site No: 669760 • Opened Jan 1946 • Site Open • Latitude: -32.2306° • Longitude: 146.5707° • Elevation: 884m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

9 am Jun
521 Total Observations
Calm 3%
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom Rose selected, refer to attached note for details
DUBBO AIRPORT AWS
Site No: 069780 - Opened Jan 1940 • S/B: Opn • Latitude: -32.2338° • Longitude: 148.8792° • Elevation 324m
An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

9 am Jul
544 Total Observations
Calm 2%
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)
Custom zones selected, refer to attached rule for details

DUBBO AIRPORT AWS
Site No: 06070 • Opened Jan 1940 • 86% Open • Latitude: -32.3306° • Longitude: 148.5753° • Elevation 284m
An asterisk (*) indicates that calm is less than 0.6%
Other important info about this analysis is available in the accompanying notes.

9 am Aug
541 Total Observations
Calm 2%
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Dubbo Airport AWS

Site No: 08970 - Opened Jan 1946 - Site Open, Latitude: -32.238603, Longitude: 144.578931, Elevation: 204m

An asterisk (*) indicates that calm is less than 0.5%

Other important info about this analysis is available in the accompanying notes.
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

DUBBO AIRPORT AWS

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

9 am Oct
513 Total Observations

Calm 1%
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

DUBBO AIRPORT AWS
Site No: 000730 • Opened Jun 1994 • Bill Open • Latitude: -32.3375° • Longitude: 145.9753° • Elevation 354m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.

9 am Nov
465 Total Observations

Calm
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

Dubbo Airport AWS

Bite No: 05/070 • Opened Jan 1994 • Bill Open • Latitude: -30.2358° • Longitude: 148.5723° • Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

9 am Dec
502 Total Observations

Calm Ø
Rose of Wind direction versus Wind speed in km/h (16 Jan 1993 to 30 Sep 2010)

DUBBO AIRPORT AWS
Site No: 003090 - Opened Jan 1948 - 600 Open - Latitude: -32.2206° - Longitude: 148.3767° - Elevation 284m

An asterisk (*) indicates that calm is less than 0.5%.

Other important info about this analysis is available in the accompanying notes.

3 pm
6296 Total Observations

Calm

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TCZANNUAL, Page 1
Rose of Wind direction versus Wind speed in km/h (18 Jan 1993 to 30 Sep 2010)
Custom bins selected, refer to attached notes for details
DUBBO AIRPORT AWS
Site No: 095070 • Operated Jan 1946 • Site Open • Latitude: -32.2200° • Longitude: 148.5830° • Elevation 284m
An asterisk (*) indicates that calm is less than 0.5%. Other important info about this analysis is available in the accompanying notes.

9 am
6271 Total Observations
Calm 1%

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1 September 2016

Matthew Bender
MG & LK Bender Partnership
4L Camp Road,
DUBBO NSW 2830

Dear Matthew

Proposed Residential Subdivision, Camp Road, Dubbo

GCA has reviewed water servicing arrangements to support a planning proposal to back zone land form SP3 Tourist to RU1 Primary Production and Minimum Lot Size Zone of 3ha at Lot 8 DP1063425 (4L Camp Road, Dubbo).

The purpose of this report is to confirm that sufficient service pressure can be provided to future properties within the subject land from a connection into the existing water main in Camp Road and therefore, the site is generally suitable for the proposed residential land use from a water supply servicing perspective.

1. Water concept plan

A concept subdivision layout for the subject property provides for 25 residential lots ranging in area between 3.0 and 7.6 hectares. Site elevations vary between 269 and 315m AHD.

The conceptual water network arrangement and model structure adopted for this report is shown on Figure 1 (attached). Model nodes were placed in locations that generally coincide with logical locations for future service connections.

Future water mains were assumed to be 100mm in diameter which is the minimum normally adopted for residential areas. If a larger diameter were adopted as part of future subdivision design then head loss would be lower and supply pressures improved further on the results presented in this report.

2. Preliminary assessment

Dubbo City Council’s Customer Service Standards (2016-2018) state that Council will supply at least 170 kPA (17m head) to properties within an Urban Water Supply pressure 95% of the time.

In an e-mail dated 22 July 2016 Dubbo City Council advised that the peak daily demand for each lot is 0.042 l/s.

In an e-mail dated 26 July 2016 Council provided an estimate of the 24hr static pressures at the existing water main in Camp Road. The pressure ranged between 690KPa and 800KPa throughout the 24 hour period.

This assessment has adopted the lower range value of 680KPA (or 68m) which provides a conservative estimate of the minimum water pressure available to properties within the concept water network during the highest demand periods.

The elevation of the connection point in Camp Road is 269.5m resulting in a minimum Hydraulic Grade Line (HGL) of 337.5m AHD.
It is noted that the highest service elevation within the subject land is 315m AHD. Assuming minimal head loss in the water supply network, the highest point of the subject land would be supplied with at least 22.5m pressure. This complies with Dubbo City Council’s Customer Service Standards (2016-2018).

3. Water supply modelling

GCA conducted preliminary water network modelling to evaluate the assumption that there would be minimal head loss in the future water mains constructed within the land to supply development lots.

The computer software program EPANET, developed by the United States Environmental Protection Agency, was used to model the conceptual trunk water linkages and estimate supply pressures at each node for the peak demand scenario.

The model network layout is shown on Figure 1 (attached).

For the purpose of this exercise, the network was modelled as a steady state system for the critical conditions only, using the appropriate lower bound boundary condition value of 66m pressure (337.5m HGL).

Summary model results (HGL and pressure) at each model node and for each demand scenario are provided in Table 1 (attached).

The model results indicate that model nodes are supplied with pressure between 50.43 and 68m of residual pressure which is well above Dubbo City Council’s minimum customer service standard of 17m (170kPA).

Estimated flow velocities vary between 0.01 and 0.13 m/s.

The total predicted head loss is only 0.37m (37kPA) between the connection point and the extremities of the concept water network, correlating with a very low average unit head loss rate of 0.25 m/km of water main. This very low head loss is due to the low density of development proposed and the associated low water demand, combined with the minimum 100mm water main diameter.

Accordingly, the assumption of minimal head loss in local water mains adopted for the preliminary assessment in Section 2 (above) is considered valid, and hence, all areas of the subject land should be serviceable with the minimum 17m head (170kPA) pressure as required under Dubbo City Council’s Customer Service Standards (2016-2018).

4. Conclusion

This report has assessed water supply pressure availability within Lot 8 DP1063425 from a connection point into the existing water main in Camp Road.

Preliminary assessment combined with water supply modelling has demonstrated that all areas of the site should be serviceable with the minimum 17m head (170kPA) pressure as required under Dubbo City Council’s Customer Service Standards (2016-2018). In reality, the building envelopes shown are at lower site elevations and residual pressures will be closer to 91 – 68m (510 – 800kPA) as calculated using the water supply network model.

Therefore, the site is generally suitable for the proposed residential land use from a water supply servicing perspective.

Yours sincerely,

Stuart Holle
Principal Civil Engineer
for and on behalf of GCA Engineering Solutions
Table 1: Water Supply Model Results (Peak Demand Period)

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AN ARCHAEOLOGICAL SURVEY
FOR
THE PROPOSED
"GLENN LEE" TOURISM DEVELOPMENT,
CAMP ROAD, DUBBO, NSW.

A report for:
Development Consultants,
Hoynes Wheeler & Thorne Pty. Ltd.
P.O. Box 1842
Dubbo, NSW, 2830

Prepared by:
J. Kelton,
Central West Archaeological and Heritage Services,
92 Darling Street, Cowra, NSW, 2794,
Phone/Fax: (063) 41 3294

December 1995
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Introduction</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Aim of the Investigation</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Aboriginal Community Consultation</td>
<td>2</td>
</tr>
<tr>
<td>2.0 The Development</td>
<td>3</td>
</tr>
<tr>
<td>3.0 Local Environment</td>
<td>6</td>
</tr>
<tr>
<td>3.6 Landform</td>
<td>9</td>
</tr>
<tr>
<td>4.0 Archaeological Background</td>
<td>9</td>
</tr>
<tr>
<td>4.1 Archival Search</td>
<td>12</td>
</tr>
<tr>
<td>4.2 Previous Archaeological Studies</td>
<td>12</td>
</tr>
<tr>
<td>4.4 Previous Archaeological Models</td>
<td>19</td>
</tr>
<tr>
<td>5.0 Methodology</td>
<td>17</td>
</tr>
<tr>
<td>5.1 Survey Area Site Prediction</td>
<td>17</td>
</tr>
<tr>
<td>5.2 Site Location - Predictive Modelling</td>
<td>24</td>
</tr>
<tr>
<td>6.0 Archaeological Survey</td>
<td>27</td>
</tr>
<tr>
<td>6.1 Survey Strategy</td>
<td>27</td>
</tr>
<tr>
<td>6.2 Field Recording Methods</td>
<td>28</td>
</tr>
<tr>
<td>6.3 Field Survey Methodology and Coverage Data</td>
<td>28</td>
</tr>
<tr>
<td>7.0 Survey Results &amp; Significance Assessment</td>
<td>37</td>
</tr>
<tr>
<td>8.0 Discussion</td>
<td>61</td>
</tr>
<tr>
<td>9.0 Conclusions</td>
<td>62</td>
</tr>
<tr>
<td>10.0 Recommendations</td>
<td>63</td>
</tr>
<tr>
<td>11.0 Legal Obligations</td>
<td>68</td>
</tr>
<tr>
<td>References</td>
<td>67</td>
</tr>
<tr>
<td>Glossary</td>
<td>69</td>
</tr>
</tbody>
</table>
TABLE OF CONTENTS (CONT'D)

PLATES

FIGURES

Figure 1. Study Area Map
Figure 2. Study Area Landform
Figure 3. Archaeologically Sensitive Areas
Figure 4. Archaeological Site Location Map
Figure 5. Map of Survey Sample Units

APPENDICES

Appendix 1. Copy of Statement of Involvement in "Glenn Leu" Archaeological Survey by Central Region Aboriginal Land Council, Dubbo.
Appendix 2. Gazetteer of Sites Previously Recorded Within 5 Kilometres of "Glenn Leu" Survey Area (NPWS Records)
Appendix 3. Gazetteer of Sites Recorded During "Glenn Leu" Survey
Appendix 4. Summary Details of Open Campsites Recorded During "Glenn Leu" Archaeological Survey
Appendix 5. Summary Details of Artefacts
Appendix 6. Summary of Site Significance Assessment
Appendix 7. Copies of NPWS Site Forms
AN ARCHAEOLOGICAL SURVEY FOR THE PROPOSED
"GLENN LEE" TOURISM DEVELOPMENT, CAMP ROAD,
DUBBO, NSW.

J. Kelton, Central West Archaeological and Heritage Services, Cowra, NSW.

1.0 INTRODUCTION

Development consultants Hoytac Wheeler and Thame Pty. Ltd. of Dubbo have engaged Central West Archaeological and Heritage Services, Cowra to conduct an archaeological survey over the site of a proposed tourism accommodation development, near Dubbo, in the north-west slopes of New South Wales.

The field component of the study, conducted by archaeological consultant, Jim Kelton, was carried out over two days, between 12th-13th October 1995. Mr. Kelton was assisted by Aboriginal field representative, Mr. Cecil Sec, Manager, Central Region Aboriginal Land Council, Dubbo.

The report provides details of the local environment, the known archaeology of the area, as well as documenting survey methods and results. Where appropriate, the report also analyses aspects of site management and management options and recommendations, under the provisions of the New South Wales National Parks and Wildlife Act, 1974 (NSW NPW Act, 1974).

The proposed development has the potential to disturb or destroy Aboriginal archaeological relics and sites located within the identified survey area. Activities which threaten to impact upon Aboriginal sites during the proposed development include the following:

1. The removal of standing and fallen timber;
2. All earthworks associated with the proposed development.

1.1. Aims of The Investigation

The aims of the "Glenn Lee" archaeological study were to assess the potential impact of the development upon Aboriginal sites and relics (including historical archaeological sites), and, based upon the results of the field component of the study, assess site significance and develop management recommendations for sites (if sites were found). The field investigation focused upon the location and documentation of relics and/or sites, as well as determining the potential for additional sites to occur over the survey area (i.e. as unobtrusive surface material or as sub-surface deposits).
I.2 Aboriginal Community Consultation (see Appendix I)

The “Glen Lass” archaeological survey area is located within the area administered by the Dubbo Local Aboriginal Land Council, Dubbo, NSW, however, because the Local Land Council does not have the resources to assist in archaeological investigations, they have arranged with the Central Region Aboriginal Land Council, (which covers the broader Wiradjuri region, including Dubbo) to act as their representative during such investigations.

Every attempt was made prior to the commencement of the current archaeological field survey to make contact and consult with the appropriate Aboriginal communities.

Initial contact with the Central Region Land Council occurred with a fax sent to the Manager, Mr. Cecil See, on the 10/10/95, requesting the Land Council to appoint a representative for the pending survey. The Land Council was also asked to provide information regarding the possible location of known sites either within or adjacent to the survey area (a map of the survey area was sent to the Land Council).

In addition, the consultant arranged a meeting with the manager and members of Dubbo Local Aboriginal Land Council to discuss any significance the study area might have for members of that community. The meeting with the Land Council was conducted on 12/10/95 in the presence of Cecil See and the Dubbo Elders group. Following that meeting, it was clear that the Dubbo Aboriginal community has no knowledge of sites within or immediately adjacent to the survey area. Dubbo Aboriginal community members stressed during the meeting that while they believed their people would have travelled through this area, the break in the passing down of traditional knowledge, as a result of land dispossession and subsequent government administrative regimes, has meant a loss of knowledge of sites throughout the region.

They stressed that although a significant loss of knowledge of traditional culture and lifestyles has occurred, the re-location of sites throughout the region was significant to the Aboriginal community, providing an important link with their past.

The field survey was commenced on 12/10/95 and was completed by the company of Mr. Cecil See, Central Region Aboriginal Land Council, on 13/10/95. Normally, an informal meeting would have been conducted between the consultant and Land Council staff, to discuss the results of the survey and site management options (where required), however, because the survey was completed late on a Friday evening, no meeting was held.

After completion of the field survey, a fax was sent to Central Region Aboriginal Land Council (14/10/95), providing an informal report on the details of the findings of the survey and possible management options, and requesting a response to the findings and/or a statement of involvement from the Land Council.

A statement of involvement was received from the Central Region Aboriginal Land Council, dated 2/11/95, briefly stating the Land Council’s involvement in the field survey (Appendix I). Whilst a request was made to the Land Council for written comment on tentative management recommendations (discussed during the field.
survey and in the brief which was faxed to the Land Council at completion of the study, no written comment was received. However, during the field survey and within the context of telephone discussion held between Cecil and myself (18/10/95), Cecil expressed a concern for the protection of sites recorded along the ephemeral creek line in Portion 154 of the survey area.

2.0 THE DEVELOPMENT

The proposed development is located within the Parish of Dubbo, County of Gordon, City of Dubbo, and includes Portions 194, 236, 237. (DP 753233, DP 40152). The development site’s north-eastern corner can be located on the Eulomong Map Sheet No 1653-3-41, 1:25 000 topographic map, at grid reference E507970E s254600N.

The area of the proposed “Glenn Lee” tourism development is approximately 200 hectares (referred to in this report as the survey area) (Figure 1). The development proposal consists of the sub-division of the survey area into 5 portions, with varying levels of development construction proposed within, including the development of small residential lots, and the provision of a small number of larger residential lots and active and passive-based recreation areas. The developers intend that a continuation of present land use patterns occur over a large part of the survey area (i.e. cropping / grazing).

The “Glenn Lee” development proposal consists of the following basic works:

- 5 small residential lots along Camp Road (area to be decided, but approx 5 hectares each);
- 55 x 4000m² - 5000m² lots, intended for the construction of hostel / cottage type tourist accommodation;
- the provision of services, i.e. water, electricity, phone, sewerage/septic system, etc, to accommodation units;
- the development of an internal, formed, access and service road from Camp Road;
- the possible construction of a mini-golf course along the eastern boundary area (with Obley Road), (to be continued);
- the possible construction of additional diversion drainage and soil conservation works (as required); and,
planting of vegetation sight-sound buffer zones between the development and Morrie Park Speedway.

- the maintenance of open grazing and natural bushland areas.

It is anticipated that the construction of the proposed development will include surface disturbance resulting from the construction of the above, and may require the removal of a small number of old-growth trees as well as a larger amount of regrowth vegetation.

The proposed development has the potential to disturb or destroy Aboriginal and non-Aboriginal archaeological relics located within its boundaries.

2.4 Potential Impacts Upon The Archaeological Record

The proposed development is tourism oriented with a focus upon a relaxed and 'natural' environmental setting. For that reason, the developers intend to retain as much of the existing native vegetation as possible, and to restrict clearing of standing timber and surface disturbance to a bare minimum.

As mentioned above, the development proposal is for the construction of a range of residential, and short-term accommodation units (referred to by the developer as community development lots). The site of this component of the development shall be referred to as the 'primary development site'. The primary development site occurs over the central and eastern portion of the survey area, where 55 x 4,000 m² - 5,000 m² residential lots have been identified for sub-division. The total area of the primary development site, including the provision of a connecting service and access road is approximately 31 hectares (Figure 1). However, whilst surface disturbance associated with the construction of relatively high density residential lots could be expected to be extensive, the location of this part of the development over landform, which, from an archaeological perspective, is considered low in sensitivity (see Section 5.2, and Figure 3), means that the potential impact upon the archaeological record from development activities directly associated with the primary development site will be insignificant.

The only section of the primary development site which may impinge even slightly on archaeologically sensitive landform occurs along the western perimeter of the development site near proposed lots 49, 50, and 51. However, of the three lots, only Lot 50 is located closest to sensitive landform (Section 5.2, Figure 3).

The primary development site area has been subject to varying levels of past disturbance, mainly as a result of grazing and crop cultivation (and mainly along the outer perimeter where the proposed service and access road traverses), as well as from selective logging and clearing, and past internal property vehicle track development. Recently, the primary development site has been covered by a dense stand of native shrub and eucalyptus regrowth. Scarred tree stumps were the only site...
type predicted to occur over this landform unit, however, based on the past level of
old-growth timber removal and associated agricultural disturbance, the potential for
sites to occur is considered remote.

With regard to rocky outcrops occurring over the survey area’s highest ground, and
adjacent to the primary development site, it is anticipated that these areas will not be
significantly impacted by the proposed development and will remain relatively
undisturbed. Rocky outcrops in the survey area were afforded low sensitivity
assessment based on their unsuitability for use by past Aboriginal groups (for stone
tool resource purposes or for ceremonial purposes). Also, these natural formations
have no known cultural significance attached (known to the local Aboriginal
community).

Whilst the surface of the primary development site will be impacted more than
adjacent areas, much of the western half of the survey area, comprising approximately
half of the survey area (approx. 100 hectares), will continue to be used for agricultural
and grazing purposes, remaining relatively disturbed.

The development of 3 larger residential or commercial lots along Camp Road (areas
to be decided, but approx. 5 hectares each), poses a potential threat to archaeological
sites or relics in the vicinity, bearing in mind that the eastern end of this portion of
the proposed development occurs within landform (Section 3.6) which is assessed to be
potentially archaeologically sensitive (Section 5.2.1, Figure 3). However, given that
these lots occur over already heavily disturbed ground (impacted by extensive
cultivation and domestic stock grazing), whilst not reducing the archaeological
sensitivity of the area, reduces considerably the potential for sites (if located over
these areas), to have high levels of significance, particularly where that significance
assessment is based on their integrity in terms of scientific or educational value (see
Section 6.6 on significance assessment).

The connection of services to the primary development site, and possibly to the 3
larger residential or commercial lots located adjacent to Camp Road, pose a potential
threat to archaeological sites and relics. However, at the time of the field survey, this
level of detail for the proposed project had not been finalised and so, apart from the
route of a proposed service and access road, no specific impact assessment (upon
the archaeological remedy could be conducted.

With regard to the proposed service and access road which extends approximately 4
kilometres x approximately 8 metres wide, around the proposed community
development lots, and covering a total area of approximately 3.5 hectares, there
occurs a potential for sections of the proposed route to impact upon surface/sub-
surface archaeological deposits and more obtrusive site types such as scarred and
carved tree sites. However, given the planned route of the service and access road,
the only archaeologically sensitive areas which will be impacted are located adjacent
to ephemeral drainage lines on the “Glenn Lee” property (along the western boundary
of the community development lots), and adjacent to a single drainage line located
near the eastern boundary on the “Glenmore” property (see Figure 9, identifying
archaeological sensitivity over the survey area).
The proposal to develop a mini golf course along the survey area’s eastern boundary, has the potential to impact upon sites or relics located adjacent to the creek line. The golf course extends over an area of an estimated 18 hectares (subject to confirmation), adjacent to and immediately to the north of the existing Morris Park Speedway, and between the survey area’s eastern boundary and the primary development site’s eastern boundary (delineated by an existing ephemeral creek line running north south). Pre-field survey archaeological sensitivity assessment indicated that all landform units within the survey area, creek lines and adjacent alluvial terraces were predicted to have the highest level of archaeological sensitivity and that the location of a mini-golf course running parallel to a sensitive landform unit poses a potential threat to the archaeological record.

Some areas within the western half of the survey area may be required, in the future, for use in the construction of development drainage, diversion drains, and creek bank erosion stabilisation, and rehabilitation earthworks (yet to be determined) (Coleman, pers. comm. 10/85). Diversionary drainage and associated soil conservation works have the potential to impact upon surface and sub-surface archaeological deposits, especially where these earthworks traverse archaeologically sensitive landform units. Potential impact could occur through the construction of trenches and similar earthworks, and also, as a result of additional impacts such as the removal of standing and fallen timber and through the effects of drainage related, gully and surface erosion.

3.0 LOCAL ENVIRONMENT

The Dubbo area, referred to by Kettig (1985:12) as part of a physiographic transition zone between the ranges and tablelands of the Great Dividing Range and the Darling River plains, is situated within the north west slopes of New South Wales, in the Macquarie River floodplain.

The Macquarie River floodplain was a major Wiradjuri (and adjacent group) Aboriginal resource zone and the focus of past Aboriginal occupation. Past Aboriginal occupation extended over a broad region of the central tablelands, slopes and plains. In the past, the river was often subject to periods of reduced flow, and during extremely dry periods prior to the construction of water storage and flow controlling dams by Europeans, the river was known to be sometimes restricted on the surface, to a series of still water holes (See, pers. comm.1995).

However, past Aboriginal occupation of the local area was not necessarily restricted to the immediate river banks and associated alluvial terraces. There is evidence to support the belief that local area perennial, and seasonally reliable ephemeral, water sources (forming tributaries of the Macquarie River) were also often a focus of Aboriginal occupation patterns, providing necessary water supplies and allowing the exploitation of a far broader resource zone than that which would have otherwise been inhabited (due to limitations in the availability of water).
The study area is located approximately 1.5 kilometres south-west of the Macquarie River, over undulating, relatively flat, open grazing–open eucalyptus woodland country. Elevation over the study area ranges from approximately 299 metres ASL (above sea level), over lower areas near the "Glenn Lee" and "Glenmore" homesteads, to approximately 316 metres ASL at the highest point in the centre of the survey area.

3.1 Climate

Dubbo is subject to hot summers and dry, mild winters. The average annual temperature ranges from 8°C in July to 26°C in January. Extremes of temperature are not uncommon, with frosts occurring during the cooler winter months and brief periods of extremely high summer temperatures in the summer. Temperatures in the high 30s% and low 40s% are sometimes experienced. The hotter months often feature prolonged dry periods and occasional heavy storm deluges. Dubbo’s average annual rainfall is around 512 mm, with rainfall recorded fairly evenly throughout the year, allowing for a slight rise in precipitation during the cooler winter months.

3.2 Vegetation

The survey area was open woodland at the time of European settlement. However, the vegetation regime has been dramatically altered since European then. There occurs relatively extensive stands of native timber over approximately 70% of the survey area, however, a large proportion of this vegetation is regrowth. Old-growth native timber occurs over a large portion of the remaining timber stands, but mainly as isolated trees surrounded by regrowth. An estimated 90% of all old-growth timber has been removed from the study area (Plate). Prior to European settlement, the study area floodplain and adjacent landform units would have been heavily timbered, providing an abundant resource of plant (and animal) species for past Aboriginal inhabitants. Large stands of grey box (E. microcarpa), white cypress pine (Callitris columellaris), black pine (Callitris endlicheri), and hill gum (E. deelebyana) are believed to have dominated the upper hill slopes and rocky ridge lines, and associated lower hill slopes, while stands of yellow box (E. melliodora), grey, and fuzzy box (E. condensata) were believed to have been the dominant tree species over the lower ephemerous drainage lines and alluvial terraces. Rough hanked apple (Angophora floribunda) is believed to have occurred over sandstone based soils in the vicinity of the north eastern corner of the survey area, near Obley Road. Undertrees would have included Acacia species and a range of native grass species. A number of acacia and grass species are known to have been significant, in the region, to past Aboriginal groups as seed meal species. Ground cover probably included Poaceae family species such as neverfail (Eragrostis sp.), blawn grass (Agrostis sp.), and panicum (Panicum decompositum). In addition, pigweed (Portulaca oleracea), nardoo (Marsilea drummondi), and bogan lilies (Crinum flavidum) were observed by early settlers, to be exploited by Aboriginal people in the area.
3.3 Fauna

A variety of animal species were hunted by local Aborigines. Some of the fauna which are known to have been significant as food and material resources to past Aboriginal communities in the area included emu (Dromaius novaehollandiae), grey kangaroo (Macropus rufus and M. giganteus), red kangaroo (Macropus rufus), and wallaroo (Macropus robustus), as well as wallabies (Lagorchestes sp.), Onychogalea fraenata, and Petrogale penicillata. In addition, a number of smaller marsupial species were also known to be important as food sources to local Aboriginal groups. These included brush-tailed possum (Trichosurus vulpecula), bilby (Macrotis lagotis), as well as wombat (Phascolomis mitchelli) and koala (Phascolarctos cinereus) (both locally extinct in the study area).

Other species which are believed to have inhabited the area at the time of European settlement, and which are known to have been significant to Aboriginal people, included dingo, numerous aquatic and terrestrial bird species such as a variety of ducks, budgerigars, quails, and bustards (plainturkeys). Emus were also observed being hunted, while reptiles, including goannas and snakes, were also important food species. A variety of aquatic animal species were also hunted and collected in nearby rivers and billabongs. These would have included freshwater mussels, crayfish, long-necked turtle, and fish species such as yellowbelly, bream, eel, and cod.

3.4 Present Land Use

Land use over the survey area currently revolves around mainly agricultural activities, including commercial cropping (and related cultivation) and the grazing of domestic stock. In addition, there occurs two farm residences and associated farm building complexes within the survey area. Homesteads include the “Glenn Lee” and “Clemmore” homesteads.

3.5 Geology and Soils

The primary development site, and therefore the main area of impact, is comprised of skeletal soils interrupted by heavily-eroded and exposed rocky outcrops or sub-crops of volcanic, Dunstan shale (Coleman, pers. comm., 31/10/95), bordered to the north, and west by Ballarat Formation quartz sandstone, lithic sandstone, conglomerate and ferruginous sandstone and siltstone. The mid and lower hillsheds feature surface lag deposits of clastic rock material (mainly exposed due to commercial crop cultivation) and sandy, colluvial soils.

The survey area skeletal soils are generally sandy, and highly susceptible to surface and gully erosion.
3.6 Landform (see Figure 2)

Landform plays a significant role in assisting in determining the presence of sites and the level of past Aboriginal occupation and site types throughout the region (or at a local level), with some landform units considered more archaeologically sensitive than others. This conclusion is based on site occurrence data collected during various archaeological investigations over adjacent areas (e.g., Koetig 1985, Pearson 1981, Kalton 1985a,b,c). Relatively flat areas, generally occurring along creek banks, associated elevated terraces and adjacent low ridge and spur lines are considered to be the most sensitive landform units within the local area. Other generally flat landform units within the survey area, although not considered sensitive within the survey area, include the crests of hills and associated ridge and spur lines.

There are no perennial sources of surface water within the survey area, a significant factor in determining past Aboriginal occupation patterns in the local area. Thereby water which would have been available to past Aboriginal inhabitants, prior to European settlement, would have been that resulting from seasonally filled soakages and associated ephemeral creeks. Little has been documented in the region regarding the sensitivity or potential sensitivity of these ephemeral water courses, and past models of Aboriginal occupation developed for the region have largely ignored these landscape features (i.e., Koetig 1985, Pearson 1981).

Landform over the survey area is comprised of three major units which also constitute corresponding archaeological land systems (Figure 2, landform map). Landform units encountered within the survey area include the following:

1. Ephemeral drainage lines and associated alluvial and colluvial terraces;
2. Lower hill slopes;
3. Combined upper hill slopes and hill tops, and associated elevated ridge lines.

4.0 ARCHAEOLOGICAL BACKGROUND

4.1 Ethno-Historical Context

At the time of whites settlement in the Dubbo region, the study area was occupied by Aboriginal people who spoke the Wiradjuri language. These people referred to by Garnsey (cited in see 1985:2) as the Warrie Jah group, a portion of the Wirruh Jah tribe (possum men tribe). White (1986:24) concurred with Garnsey’s earlier conclusions as to whom the Aboriginal people in the Dubbo locality were and identified the same people as the Wiradjuri. However, White’s interpretation of the meaning of the word Wiradjuri contradicts Garnsey’s, in that White broke the word Wiradjuri down to mean ‘no—having’, originating from the words ‘wir’ or ‘wirra’ meaning ‘no’ and the words ‘dju’ or ‘thurray’ meaning ‘having’. While there may occur a degree of disagreement over the origin or meaning of the group name, both
researchers agree that the people were Wiradjuri (Wiru - Jath). Also, and despite the uncertainty on the part of some researchers as to Wiradjuri group boundaries, the study area was known to be occupied by the Dubboys although contact with the neighbouring groups including the Eumulgis to the east and the Warrius and Dundullmali to the south and south west respectively, no doubt would have occurred.

In relation to group boundaries, Trindale (1974 map) drew an arbitrary line on the Wiradjuri's territory, bounded by the Talbragar River in the north. Edward Garnsey who was born in the Dubbo area in 1874 and developed a close relationship and an extensive knowledge of Aboriginal group structure in the local area, produced maps of group boundaries which contrasted the cultural line of northern Wiradjuri occupation drawn by Trindale (Garnsey cited in See 1985). Garnsey found that the Aboriginal groups who inhabited the area immediately north of the Talbragar River, from the northern banks of the Talbragar River, were in fact still Wiru - Jath people, but a different group. Garnsey (cited in See 1985:5) identified this particular group as the Mainga. Grounds (1984:60), following Trindale's lead, stated that the northern boundary of the study area, the Talbragar River, formed the north - western boundary of Wiradjuri 'country'. It would appear that the area, while being part of Wiradjuri territory, may have actually been a transitional zone between the Wiradjuri, the southern Kawamburi, and the north - eastern Wangaibon. Neighbouring groups are known to have shared a number of similar cultural characteristics including language, marriage and inheritance laws, religious beliefs, and ceremonies. With regard to the definition of group boundaries by contemporary researchers, and particularly in relation to the Wiradjuri people, White (1986:84) argued that the modern day notion of 'homogenous' should only be applied with caution, because the definition of group boundaries using single criterion will not always correspond with a particular group named and identified using another criterion, i.e. language. Nevertheless, while similarities are believed to have existed between the groups such as Wiradjuri and Kamilaroi, the Wiradjuri are recognised as a separate tribe or alliance of tribes; a 'tribe', linked by distinctive linguistic and cultural features (Grounds 1984:60).

Definitions of group identities provided by Garnsey (cited in See 1985:2,3) support White's argument where he argues that clan or major group boundaries are more complex than those which have been postulated by a number of early European researchers, i.e. Trindale (1974 map) etc.

According to Garnsey (cited in See 1985:5) the survey area was occupied by the Dundullamai sub-group. The Dundullamai sub-group were a part of the larger Warrius-group (Warrius - Jath) which in turn was a sub - group of the greater Wiru - Jath (possum men), the Wiradjuri. The Dundullamai's country included land to the north and south of Cumboogle Creek which is located to the south of the survey area, and is a tributary of the Macquarie River.

Early accounts of local Aboriginal camp life in the Dubbo area indicate that people camped according to a range of prescribed rules (Garnsey cited in See 1985:6). These rules determined a number of campsite characteristics including the actual shape of the campsite, and socio - spatial organisation.
Based on Garnsey’s accounts, it would appear that the Dambullaans were relatively settled in the occupation of their territory. Few accounts exist on the movement by the Aboriginal people of Dubbo area within their territory, however, from accounts in the nearby Wellington area, camps were moved frequently, either over short distances or else to new locations several kilometres distant. Movement would appear dictated by a number of factors including changing social conditions, changes in weather, the dictates of hygiene or for a number of non-specific factors. Large scale movement often occurred in response to social obligations such as ceremonies, warfare, or changes to resource availability. Death in a camp also meant that in certain cases, the campsite where the death occurred could not be re-occupied for extensive periods (time frames were determined by group law) (Kuettig 1983:25).

With regard to the current survey area, the areas along and adjacent to both the Macquarie River and Cumboogle Creek would certainly have provided an abundance of aquatic and terrestrial plant and animal resource species for local Aboriginal inhabitants. In addition, the confluence of the Macquarie River and Eulamago Creek (adjacent to survey area) is referred to by Grounds (1984:61) as an important red ochre quarry site and "... the site of the Dubbo - yoora grinding industry."

Mathews (1901) recorded several Winadjari initiation ceremonies in the Dubbo area during the period 1895 to 1901. Mathews also noted, in the locality, the presence of significant ceremonial sites, including large circular 'bora grounds' and associated ground drawings, sculptures and carved trees. Mathews and Garnsey (cited in See 1985) both referred to carved trees in the region, occurring, also as burial markers, for important deceased tribal men.

Garnsey (cited in See 1984:4) documented a significant ceremonial location known to past local Aboriginal people as Bowmbil (place of borah). The site occurs on nearby "Old Dubbo" station, on the opposite side of the Macquarie River from the survey area. Garnsey (cited in See 1985:4) documented a burial site located several hundred metres to the north-west of the survey area, on the opposite side of the river, and located near the river, at a place named by local Aboriginal people as Wooroon (meaning graves). A number of other significant sites are believed to have existed in the vicinity, in close proximity to the Macquarie River and the current survey area.

European settlement in the Dubbo area began with the early exploits of white explorers, including John Oxley, in 1817. Oxley had his first recorded encounter with local Aboriginal people of the region at Whykaulla and Paddy’s Creeks near Toowooli. Tuis and subsequent ancestors were relatively friendly, with an interesting account of a male Aboriginal encountered at a chance meeting at Willandra Crossing. The individual had in his possession a steel axe, which had obviously been traded through the extensive trade networks known to exist throughout the country, preceding personal contact with European settlers (Oxley 1820:220).

Charles Sturt travelled through the area in 1828 and crossed the Macquarie River at Dibbulambe, and both Oxley and Sturt indicated in their reports to the authorities that brief encounters with local Aboriginal people usually conducted on friendly terms.
Unfortunately, other than the above, there are very few accounts of early European settlement contact with local Aborigines in the vicinity of the study area. It is known that around 1837-1838, relations between the Wiradjuri and nearby Wellington Valley and local missionaries, soured dramatically when attempts were made to force Christianity upon local Aboriginal groups in that area (Read 1988:12), and there are accounts of local Dubbo Aboriginal people, in later years, being employed on surrounding stations (Koetter 1985: 19, Mrs. Howey, pers. comm. 1995).

With regard to European settlement history, properties within the study area and its close vicinity, have an extensive European history. The "Holmwood" homestead and property, located in the south west corner of the study area, dates back to 1862. European settlement in the vicinity of the study area dates back at least another 30 years to 1853, with the establishment of Dalhunty's "Old Dubbo" property. Located approximately 1 kilometre to the north east of the survey area and close to the Macquarie River, occupies the locally well-known historic "Dundullah" property (on the Register of the National Estate).

### 4.2 Archival Searches

According to the NPWS records, there are no Aboriginal sites previously recorded within the survey area; however, a search of New South Wales National Parks and Wildlife Service records revealed 38 Aboriginal sites had been recorded in the NPWS data base system within a 10 kilometre radius of the study area. A further 30 sites have been recorded by Kelton (April - July 1995) in the Dubbo - Tullamurra River - Troy Junction - Macquarie River areas; however, these sites have not yet been entered onto the NPWS data base. Known sites within a 10 kilometre radius of the study area, including those on the NPWS data base and those recorded by Kelton, are comprised of 27 open campsites, 34 scarred tree sites, 3 axe grinding grooves sites and a single burial site (as well as a number of isolated artefact finds).

In addition, further searches were conducted to determine the presence of sites of historical archaeological significance. Searches were conducted with the Register of the National Estate for sites on the Register, with the NSW Heritage Council, the National Trust and the local Dubbo Historical Society. There are no sites within the study area on the Register of National Estate, the closest site being Dundullah Homestead and Barn. "Holmwood" homestead, located on the opposite side of the river, is classified under the National Trust of NSW.

### 4.3 Previous Archaeological Studies

The Dubbo area has been the subject of a considerable number of systematic and other archaeological investigations, ranging from purely Aboriginal archaeology "hobbyist" activities to more comprehensive scientific studies. Early accounts of the region's Aboriginal archaeological resources include extensive site recording and artefact collections by Greer (c.1940), Milne (1891-1915), Garnsey (c1880), etc. Several more recent archaeological studies have also been conducted in the Dubbo region, generally at a higher scientific level.
The earliest known ethnological and archaeological account of Aboriginal people in the Dubbo region was produced by Edward Garnsey, a resident of Dubbo from around 1974 (born in Dubbo, 1874) (cited in See 1985). Garnsey's anthropological historical account of contact with Dubbo Wiradjuri people (the term 'contact' referring to the period of early contact between local Aboriginal people and European settlers), their society, lifestyle, is invaluable as a reference source for the region's Wiradjuri people, particularly during the late contact period.

Gresser, during the 1940's, conducted the first known, formal archaeological studies in the Dubbo area, with his studies including the collection of large numbers of artefacts and the identification of a considerable number of Aboriginal sites in the region. Unfortunately, at least in relation to the study area and environs, much of Gresser's site information and directions were not relocation orientated and the relocation of sites, based on the information provided by Gresser is not always possible.

Gresser (n.d. c.1941) recorded the presence of a number of significant sites within 1 kilometre of the study area. These sites include burial sites, ceremonial or 'Burah' grounds, and mythological sites. However, the majority of these sites do not appear in the NPWS database.

A number of significant archaeological studies have been conducted in the Dubbo region in more recent times. These include both academic and environmental impact assessment related studies.

Pearson (1981) conducted a comprehensive academic analysis of Aboriginal and European settlement patterns in the upper Macquarie area. Pearson's study did not include a strong field component, and much of his assessment was based on the results of previous archaeological investigations conducted throughout the region. Pearson's study area extended from Oberon in the central tablelands to an area on the Macquarie River to the south (upstream) of Dubbo, between Dubbo and Wellington.

Koettig (1983, 1988) has produced perhaps the most comprehensive, planning and development related, archaeological study in the Dubbo area in recent times. Koettig (1989) conducted a systematic archaeological investigation into Aboriginal archaeological heritage of the Dubbo area. This study was subsequent to Koettig's 1989 preliminary assessment of the district's archaeological resources.

Koettig's (1985) report was produced for inclusion in a Dubbo City Council Local Environmental Planning Study, conducted by Cameron McNamara Pty. Ltd. The document assessed the known Aboriginal archaeological resources of the district, within both a regional and local context. In addition, Koettig established a map of archaeological sensitivity and a rather general model for the district. She also produced broad management recommendations relating to future development and their impacts on Aboriginal archaeological sites in the Dubbo City Council area and district.
A number of more isolated, minor surveys, mainly development and environmental impact assessment related, have been conducted at locations east and north of Dubbo. Hagland (1982) conducted a survey at Ulan Creek area, and the study included excavations at several rockshelter sites. Hagland concluded from the results of this study that there was a correlation between landform and terrain, and site size and artifact density. In addition, Hagland found that the stone assemblages represented by the artefacts observed in the study were consistent with a period of occupation less than 4,000 to 5,000 years.


Reference occurs in the NPWS database to a report (NPWS/1C-1393) and a number of sites recorded by Bluff (1994). However, the NPWS Sites Registrar could not locate the report on 7/7/95, which is now believed temporarily misplaced. A later attempt to locate the report was also unsuccessful.

From information provided on the NPWS Site Print Out (7/7/95), it appears that Bluff recorded 3 scarred tree sites and a single open campsite along the Obey Road and on "Dundullimal" property, on the opposite side of the Macquarie River from the current Keswick study, and approximately 1 kilometre south west.

One of the more recent archaeological investigations to be conducted in the vicinity of the study area was conducted by Kelton (1995a) for Dubbo City Council. The archaeological survey was carried out over the location of a proposed expansion of an existing sewerage treatment works at Troy Junction, along the southern banks of the Talbragar River, near the junction of the Talbragar and Macquarie Rivers, approximately 8 kilometres north of the current Keswick study area.

During the Troy Junction survey, Kelton recorded 4 open campsites, 12 scarred tree sites, 1 axe grinding groove site, and 2 isolated artefact finds. The Troy Junction study area is comprised mainly of flood prone, river bank land, within the Macquarie and Talbragar River floodplain. The open campsites which Kelton recorded, although heavily impacted by European land management practices (mainly domestic stock grazing and commercial crop cultivation), provided evidence of extensive and intensive levels of past Aboriginal occupation. Stone assemblages were generally comprised of large quantities of river pebble materials consisting of both modified and unmodified flaked artefacts, a quantity of mainly broken, millstone artefacts of both metamorphic and sandstone material, pebble hammerstones (anvil), random fashioned, unifacial pebble axes, as well as more carefully manufactured, bifacial, ground edge axes made from metamorphic/mudstone type material and local area basalt. Plated stone artefacts made from pebble material of chert, quartzite, and quartzite origin were the most dominant artefacts and materials present at all sites.

Scarred tree sites recorded by Kelton during the Talbragar River - Troy Junction survey occurred mainly on fuzzy box trees (E. costea), however, a lesser but still considerable number were also located on river red gum (E. camaldulensis). Most scarred tree sites reflected the opportunistic removal of sections of bark for use as either vehicles, bark shelters or perhaps during the manufacture of utilised.
Kelton also recorded an axe grinding groove site on the northern and immediate banks of the Tallongui River, situated on a course sandstone outcrop along the water's edge. The site is very similar in nature to those located at the nearby Terramungamine Reserve site on the Register of the National Estate, but the Tallongui River site has on the same extensive scale as the Terramungamine site.

Kelton (1995b) conducted a survey over the site of the proposed "Keswick" housing sub-division at Dubbo, located approximately 3 kilometres south-east of the city centre. The survey area occurred over an area of sandstone and basalt country, similar in nature to that of the current survey.

Eulomogo Creek formed a significant landform unit within the "Keswick" study area. This creek is generally perennial in nature, however, during dry years, it is known to stop flowing, and is restricted to a series of still water holes.

Kelton (1995b) found evidence of three relatively large open campsites located adjacent to Eulomogo Creek and an ephemeral drainage line located to the north of Eulomogo Creek.

Stone artefact scatters recorded by Kelton at the "Keswick" sites indicated a range of activities including use as stone workshop areas as well as seed meal processing and general occupation areas.

Although Eulomogo Creek is considered to be a more reliable water source than ephemeral drainage lines encountered during the "Glenn Lee" survey, the evidence seems to indicate that streams of a less than permanent nature (and subject to seasonal and yearly variation) were a resource to local area Aboriginal groups.

4.4 Previous Archaeological Models

Pearson (1981) produced a model of Aboriginal occupation for the lower Macquarie River. One of the conclusions of Pearson's Ph.D. study (1981) was that there was a distinct pattern relating to the location of open scatter sites and their distance from water. In the tablelands south-east of the survey area, the majority of sites were found to occur, on average, within approximately 30 metres from water sources (Pearson, 1999:39, 130). Pearson found that 90% of the sites were located on ridges, tops, or on hill slopes, all adjacent to water sources. The above observations also concur, generally, with the authors' observations in field surveys along the lower Abercornbie River, Cowra - Lake fusion region of the central tablelands, and from observations in the upper reaches of the Macquarie River catchment around Wattle Flat, north of Bathurst. Inconsistencies in site occurrence, between the different tablelands and slopes locations, appear only in the distance of open campsites from reliable sources of water, and that aspect of occupation patterning is generally determined by factors such as climate, reliability of water sources (whether perennial or ephemeral in nature) landform gradient, ruggedness of terrain, as well as flooding patterns.
Pearson (cited in Dallas 1993 p.4) established the following criteria for suitable camp site location throughout his study area, of which Dubbo is situated on the north western extremity. Dallas summarised these as follows:

1. Accessibility to water;
2. Level ground with good drainage;
3. Elevation above cold air currents and lingering frost prone valley systems, often with good views of the river flats and water courses;
4. Sheltered from cold winter winds and with adequate summer cooling breezes; and,
5. Adequate fuel supplies.

The archaeological model developed by Koettig (1985), is very broad and tends to be developed in general terms only, although, with regard to the immediate Dubbo-Macquarie River area, her model is more specific. Koettig's model is very heavily supported by that offered by Pearson (1981), and in fact there occurs very little variation between the two, in that Koettig also argues that the evidence for the highest level of past Aboriginal occupation throughout the Dubbo-Macquarie River region should be expected to occur along water courses. However, Koettig adds to Pearson's work by indicating an observed preference for more extensive occupation, mainly in the form of open-campsites, as occurring in close proximity to larger waterholes which would have contained water, even during periods of reduced or nil surface flow (Koettig 1985:84,85).

A number of recent archaeological investigations conducted by Kelton (1995a,b,c,d) around the Dubbo area, all EIA-related, occur at face value as isolated studies. However, when the results of all of Kelton's studies are placed in their local area context, a picture of past Aboriginal occupation in the local area begins to emerge. This picture very much conforms with models produced by Pearson (1981) and Koettig (1985), however, what becomes particularly apparent, is the previously ignored significance of seasonally-reliable ephemeral water courses throughout the local area. Koettig's model did not include assessment of these resources and further investigation in the future (throughout the local area) will help to strengthen the local area occupation model.
5.6 METHODOLOGY

5.6.1 Pre - Field Survey Investigation

Initial investigation, prior to commencement of the field survey, included site and archival searches with the NSW NPWS site data base in Sydney, and the search of the Register of the National Estate, Canberra, for sites on the Register.

5.6.2 Pre - Field Survey Assessment

Prior to commencement of the field survey, a desk top study of survey area landform and assessment of survey area archaeological land systems was conducted. As a result of this pre-field work assessment, models of site prediction and sensitivity were developed, in conjunction with a strategy for survey area coverage. The development of these models revolved around a knowledge of the existing landform units and archaeological land systems within the survey area, and an assessment of these was also essential. At this pre-field work level of assessment, a survey strategy was developed, based on an attempt to assess the entire survey area for the presence of sites or the potential to contain sites. Preliminary selection of survey area sample units was also conducted.

5.1 Survey Area Site Prediction

A range of Aboriginal archaeological sites have been recorded in the Dubbo area, and with the knowledge of these site types and their distribution across the landscape, it is possible to develop a model of site patterning and archaeological sensitivity. The interaction between past Aboriginal groups and their environment, within a specific locality, can be further analysed in terms of archaeological land systems.

A number of factors had an influence upon past Aboriginal land use strategies and lifestyle, almost all of which can be related to landform, and it is believed that the distribution of sites within the study area and environs will be subject to the same biases and selection criteria which Pearson (1981) identified in his regional occupation model (Section 5.4).

For the purposes of this report, the survey area will be broken up into identifiable landform units (Section 3.6, Figure 2., Table 1.).

5.1.1 Site Types

Based on the above information and on the consultant's personal experience within the study area, it is predicted that the following site types may be encountered in the broader Macquarie River region:
1. Open campsites / stone artefact scatters and associated hearth sites;
2. Scarred trees;
3. Ceremonial sites including stone arrangements and "bora" grounds;
4. Isolated hearth sites;
5. Burials;
6. Ax grinding grooves (in close proximity to the study area); and,
7. Mythological sites (i.e. Dreaming sites).

Sites can occur as isolated occurrences, i.e. single scarred tree sites, or site as components of a complex of occupation; evidence and a range of cultural activities, e.g. an open campsite complex containing cooking fire hearths, scarred trees, and perhaps shell scatters or middens.

Statistically, approximately 80% of all recorded sites located within a 10 kilometre radius of the study area (including those recorded by Kelton 1993) occur over floodplain environments, within 500 metres of the Macquarie or Talbragar Rivers. Of the remaining 20% of sites, 60% of those sites occur within 1 kilometre of the Macquarie River (and Talbragar River) while all of the remaining sites occur within 2.5 kilometres of the river.

Based on the known site recordings in close proximity to the study area, it is predicted that open campsites and scarred tree sites will occur with the greatest frequency across the survey area, however, the following discussion on site prediction and archaeological sensitivity will also consider the potential for other site types to occur:

### 5.1.2 Open Campsites (Open Artefact Scatter Sites)

It is predicted that open campsites can be expected to occur in the study area, particularly along the elevated banks and terraces of ephemeral creeks. Past studies and observations in the region indicate that open campsites tend to occur throughout the region on areas of elevated ground, with elevated locations generally chosen in response to the vulnerability of lower landforms to flooding. All previously recorded sites in the vicinity of the study area occur within close proximity (less than 500 metres) of reliable water sources.

Previously recorded open campsites in the region, particularly along the Macquarie and Talbragar River floodplains are often extensive, and complex, containing evidence of a range of group activities, including cooking fire hearths, stone workshop areas, general occupation areas, etc.
In addition, smaller stone artefact scatter sites may be encountered throughout the study area and mainly on sensitive landform units, possibly considerable walking distances from major water sources, although the majority of open campsites so far recorded in the Dubbo region occur within a kilometre of the Macquarie or Tallagarr River. Sites located away from the river would tend to represent more casual and transitory occupation by Aboriginal people in the locality. Irrespective of location, virtually all open campsites needed to be located within reasonable walking distance from reliable water sources, plus afford to past Aboriginal inhabitants, all of the previously mentioned basic occupation requirements (after Pearson [cited in Dallas 1993:np.1]).

5.1.3 Scarred / Carved Trees

Because such a large area of old-growth native timber has been removed (estimated 90%) as a result of past European land management practices, the likelihood of scarred tree or carved tree sites occurring is considerably reduced. However, scarred trees can be expected to occur in the study area where old-growth timber, mainly eucalyptus trees, have remained, although scarring or carving of white eucalypt pines, whilst not known to occur with the same high frequency as scarring on eucalyptus trees, is not an uncommon occurrence throughout the region. In the vicinity of the study area, tree species normally subjected to past Aboriginal scarring are restricted to E. melliodora, E. microcarpa, E. conica, and Callitris columnaris.

During the region's prehistory, sheets or strips of bark and other sections of outer tree cambium were removed by Aboriginals for a variety of purposes. Removal purposes included the manufacture of wooden implements such as 'boomerangs', shields and 'coolamon' (containers), roofing and sides of bark shelters, 'wumirra' (throwing sticks), spears, bark for canoe construction, cultural boundaries or resources site markers, and burial and ceremonial area markers. In addition to the above, small areas of bark and timber were chopped out by Aboriginal people using stone axes, and later using European steel axes, to facilitate the removal of birds, bird eggs, honey and possums, from hollows in mainly eucalyptus trees.

It is predicted that where old-growth timber remains, that there will be a potential for the more common scars such as coolamon, bark shelter, and shield type scars to occur as well as the less common scar types including bird, possum, bees nest, honey 'cut out' scars, and 'hoe-hold' scars.

It is also predicted that the study area has, where old-growth timber remains, the potential to contain all of the above types of Aboriginal scarred trees, plus carved trees. Carved trees were a characteristic feature of Aboriginal culture in the North-Western Rivers region including Dubbo, and of the Wiradjuri of the central tablelands. Carved trees associated with initiation areas and burials (dendroglyphs) have been recorded in the region. Carved trees were also used to indicate the presence of significant burial sites and are referred to as dendroglyphs by Bell and Wakelin - King (1984:303).
5.1.4 Burials and Burial Grounds

Because Aboriginal burials are known to have occurred along the Macquarie River system, often in close proximity to the river, and usually relying on the softer, lighter soils of river banks and the edges of billabongs to facilitate interment, it is predicted that the potential for this site type to occur over the current survey area is very remote.

While burials were common along the banks of western region rivers, accounts of burials carried out considerable distances from the river banks are also not surprising, given the sandy nature of the soils in the region, and also the tendency for local Aboriginal people to maintain fairly permanent and static campsite locations. That factor alone would have meant that the people would have chosen, at least for hygienic reasons, but more than likely due to a number of religious and spiritual beliefs, to inter their deceased some distance from major occupation areas. If burials had occurred at campsite locations, this would have prevented groups from re-entering camps for considerable periods of time after an individual’s death.

Hypothetically speaking, if burials had consistently occurred at favourite campsite locations, the Djugun people would have inevitably run out of favoured occupation areas (depending upon the determined length of absence from a site).

Many Wiradjuri and Kamilaroi burials (an adjacent group) consisted of either earthen mounds adjacent to river banks and within suitable distance from major campites or as simple, often unmarked, river bank interments. However, variations in burial practices and isolated burials are known to have occurred as a result of a range of varying factors and often unusual circumstances.

Mound burials often incorporating carved trees were usually associated with the death of a significant Aboriginal person (usually male). Other common forms of interment included open interment where bodies were placed, above ground, in a range of positions including the ‘forest position’, sitting in upright, squatting positions, at the base of large trees (Garnsey cited in See 1985:36). While mound burials are believed to have been afforded to only those of considerable stature within the communities, Garnsey (cited in See 1985:36) gave an account of a ‘bigman’ being buried in a similar above ground fashion, similar to that mentioned above, however, the body was covered with a sheet of bark with the individual’s tribal markings painted in ochre, assumedly on the smoother, underside of the bark strip. Another account of an Aboriginal burial in the Dudley area occurred around 1846 by an Ò’Sullivan White (cited in Routley 1985:25). The account relates how the burial was conducted with the deceased placed in a skin cloak and buried under a mound of sand, "...about one mile from the river...". Trees around the grave site were carved with the deceased’s tribal markings.

Another form of burial site noted in the region, and associated with the use of timber in the area, was the practice of placing human skeletal remains into hollow legs or standing hollow trees. Bonhomme (1987:25) refers to this burial practice as an alternative method employed by Kamilaroi people in areas where no soft ground was available for burial. Similar burial procedures were observed in the Crowr area of.
the upper Lachlan River (Herden 1991:pers. commune), and these burials were found to be reasonably common in the district. However, Meekin (cited in Bonhomme 1987:25) stated that this kind of disposal was reserved to in special, "unfamiliar or unpleasant circumstances." Circumstances referred to included burial during the early "contact" period with Europeans, where incidents of death from disease and misadventure rapidly accelerated.

The likelihood of these types of burials having occurred in the vicinity of the study area is considerable, however, the high degree of surface disturbance and loss of old-growth timber which has occurred during the history of European farming in the locality may mean that any intact burial sites may have been long since destroyed by agricultural disturbance or natural attrition and erosion, or as was often the case, their contents (human remains) and carved tree grave markers pillaged by European collectors.

5.1.5 Ceremonial Sites

Ceremonial sites in the region are known to have varied in structure, and included large, circular, earthen 'Bora' grounds believed used for mainly male initiation ceremonies, ceremonial stone arrangement sites used for a number of specific ceremonial functions not necessarily related to 'rites of passage', to ceremonial sites located at naturally occurring landform features, e.g. rock formations, elevated highland areas, secluded gorges and bends in rivers. The two types of ceremonial sites recorded in the Dubbo area include stone arrangements and earthen 'Bora' grounds.

a. Earthen 'Bora' Grounds

A Bora ground was documented by Gresser in 1941, as being located on an "Old Dubbo" property, opposite the entrance gates to "Holmwood" homestead over the river from the current survey area. However, from Gresser's documentation, it is difficult to determine the exact location of the site. A high, flat knoll occurs on the "Miriam" property on the opposite side of Old Dubbo Road, from the "Holmwood" property and opposite the "Holmwood" entrance gate, and there is some speculation that the Bora ground described by Gresser was located at this site on the "Miriam" property, (located on the opposite side of the river to the current survey area).

Because of the generally known location of the above site, and because duplication of such a site would normally not have occurred (at least in close proximity to an existing site), it is predicted that the likelihood of a Bora ground being located within the study area, is remote.

b. Stone Arrangements

Due to the number of factors, the location of stone arrangement sites within the study area is considered extremely unlikely. Stone arrangement sites previously recorded in the region tend to occur over
areas where suitable stone material was available, and at relatively isolated areas of elevated ground, usually on knolls, but still in relatively close proximity to major water courses and occupation areas (Koettig 1985:45), for example, the stone arrangement site located on the "Marrigitha" property, north of Dubbo. While geographic location was important in the location of such sites, perhaps just as important, was the cultural factor.

A large portion of the study area, particularly along the central and eastern high ground, may have been suitably elevated and on relatively flat ground conducive to the location of stone arrangement sites. Also, an abundance of suitably sized rock material would have provided an appropriate rock material source. However, given the heavily weathered nature of the country rock and the extremely rugged terrain over this area (being non-conducive to past Aboriginal occupation), it is therefore predicted that the likelihood of stone arrangement sites occurring within the survey area is remote.

5.1.6 Hearth Sites

Hearth sites commonly occur across the region in the form of stone, clay and termite nest hearths (occurring as heat retaining material), and often in association with other site types, i.e. open campsites and occupation shelters. Whilst stone material was used mainly in areas where there occurred an abundance of suitable material, clay and termite nest material was an alternative heat retaining - cooking material, particularly in areas where suitable stone material was not available. Both clay and termite nest material are known to have more than satisfactory heating and heat retaining qualities.

Termite nest material was favoured by past Aboriginal groups who inhabited the region, for use in their cooking fires as heat retaining hearth stones. These sites can occur across the landscape as isolated, isolated sites reflecting shortl term occupation of an area, or else they can be a component of much larger open campsites and stone artefact scatter site complexes. A difficulty encountered in the interpretation of termite nest hearth sites arises when what are believed to be termite nest hearths occur isolated from any other cultural material, in what appears to be an Aboriginal fire hearth formation. Natural termite nest formations can break down in much the same way as Aboriginal people would break up termite nest material from a tree or mound, and be subjected to fire in a similar fashion to material which has been collected by past Aboriginal people for use in their cooking fires. 'Naturally' deposited material can also be broken down and remain in the surface soil horizon, resembling an Aboriginal hearth site. One of the major differences, when another cultural material is present, is the aerial size of 'hearth stones'. Naturally occurring termite nest material is often larger than that broken up by Aboriginal people for use in cooking fire hearths. However, there are many inconsistent variables which also have to be considered, for example, the effects of erosion of naturally occurring hearth material.
Where actual stone material has been used for cooking stones, often broken stone artefacts such as sandstone seed grinding millstones etc., were used, or else suitable river stone material. Often, this material bore evidence of having been subject to intense heat. The use of stone material was generally dependent on the availability of the resources.

While hearth sites are not as common a site type across the local area as, for example, open campsites, it is anticipated that hearth sites composed of termite nest, clay and stone hearth material may occur.

However, due to the high level of surface disturbance across almost the entire study area, where intact hearth sites may have existed in the past, the likelihood of intact sites remaining is considered remote.

5.1.7 Isolated Artefact Finds

Isolated artefact finds can represent casual, 'hinterland' movement across the landscape, or else, depending on their context, they can be indicators of more substantial occupation evidence, possibly held in sub-surface soil deposits.

While isolated artefact finds are not considered significant as indicating levels of occupation, etc., the material is significant in establishing a level of movement of past Aboriginal people across the landscape, and indirectly can point to a level of occupation, based on the level of frequency isolated artefact finds occur across the landscape. Obviously, the larger the study area, the more representative the data. Unfortunately the presence of isolated artefacts on the surface of a landscape is affected by similar variables which also impact other more substantial evidence of occupation across the landscape such as open campsites - scatter sites. These might include 'man-made' surface disturbances, and natural features such as soil types and formations, erosion and geomorphic processes in the region. For those reasons, isolated artefact finds rapidly disappear from the surface archaeological record.

It is anticipated that isolated artefact finds may occur across the whole study area, possibly on all landform units.

5.1.8 Mythological Sites

No known mythological sites exist within the study area, however, if the mythology of the local Aboriginal people was consistent with that of neighbouring groups, and in fact consistent with many known Aboriginal mythologies across the country, then the Macquarie River would indeed have had a mythological significance (a significance which could not be established during the study due to an apparent lack of local Aboriginal knowledge, and the constraints in time and funding).
5.1.9 Axe Grinding Grooves

Due to the almost total absence of suitably exposed sandstone rock outcrops in the study area, it is predicted that the potential for axe grinding groove sites to occur is extremely remote.

5.1.10 Contact - Historic Sites

Contact sites are those which reflect that early period of contact between Aboriginal people and European settlers, and generally dating to the time of first settlement.

The Dubbo - Macquarie River - Talbragar River areas have an extensive history of European occupation, dating back to the late 1830's. In relation to the study area, there is an absence of known historical sites and it is anticipated that absence will extend across the entire survey area.

5.2 Site Prediction and Archaeological Sensitivity Assessment (see Figure 3)

Factors which have to be taken into account when developing a site location model for a specific area, include those listed by Pearson (1981) (Section 5.4). English & Clay (1995:38), in their site modelling assessment for the occurrence of sites in the upper Lachlan River - Abercrombie River areas in the central tablelands, included the additional factors:

1. Access to stone material sources for use in the production of stone artefacts;
2. Seasonal availability of water, plant and animal resources and the structure of resource base;
3. The ease of which past Aboriginal groups moved across the landscape;
4. The effects of socio-cultural constraints on group movement and occupation patterns.

Due to the limited range of landform and therefore archaeological landscape systems within the survey area, the survey area was divided into only three separate and identifiable landform - archaeological landscape units. These units are defined generally by often subtle differences in vegetation, and more pronounced variation in topography and elevation. A fourth division based on existing vegetation, was also identified, but only for a preliminary level of scarred tree investigation during the survey.

The close proximity of the survey area to the Macquarie River, and location within, and along the outer margin of the 'riverine corridor', may have played a significant role in determining a potentially higher level of past Aboriginal occupation than that which would have been expected over similar landform further away from the river.
5.2.1 Ephemeral Drainage Lines, Immediate Creek Banks and Adjacent Alluvial Terraces:

The first landform unit, or land system, occurs as a combination of topographically low, and generally heavily incised, ephemeral drainage lines, their immediate creek banks, and adjacent, mainly alluvial, terraces (creek banks and terraces with slope generally less than 10%).

All ephemeral creeks within the survey area drain into the Macquarie River. There occur two major drainage lines in the survey area, the first located in the western half, which drains from the survey area's south-western boundary and the south-western high ground to the northern boundary and the topographically lower ground (approximately 1 km in length). The second un-named ephemeral creek drains parallel to and approximately 200 metres west of the survey area's eastern boundary, and also extending approximately 1 kilometre. The upper reaches of both ephemeral drainage lines extend only several hundreds of metres outside the survey area, and serve as a drainage system for the series of elevated ridge lines above. Ephemeral drainage lines and creek banks, and adjacent alluvial terraces occur over approximately 25 hectares (17.5%) of the survey area.

The first mentioned major ephemeral creek intersects with a second (also un-named) ephemeral creek, approximately 100 metres south of the survey area's northern boundary (within the survey area, see Figure 1), with both creeks then draining the remaining several hundred metres as one, to the north-east into the Macquarie River (approximately 1 km). The northern section of the major creek is heavily incised, particularly towards the point of intersection with a short section of a second creek line, and was observed to hold pools of still water at three separate locations within and immediately adjacent to the survey area (at the time of the field survey in October).

The second major drainage line within the survey area, located in the east (Figure 1), is less defined than the first, and drains from a reduced catchment area. This creek also drains into the same system as that extending from the survey area's west. The two creeks intersect approximately 50 metres outside the survey area, where they combine and complete their journey of approximately 400 metres, as one, draining into the Macquarie River.

Soils over this landform unit, within the survey area, are comprised of mainly alluvial and colluvial sediments of skeletal soil, originating from surrounding volcanic and sandstone geological formations. Soils along creek lines and adjacent alluvial terraces over the survey area are highly erodible, and extensive gully and related surface erosion were observed during the field survey.
The surface of this landform unit varies, from creek bed / and creek bank shoulders: (of gradient >10%) where a series of soil deposition and erosion processes have occurred and are ongoing, to adjacent alluvial terraces between lower hill slopes and the creek banks, where a combination of aggradation and erosion processes have occurred (slope <15°). Where gradient is the greatest and surface disturbance occurs, there also occurs a potential for the exposure of sub-soil deposits, and therefore, the potential exposure of archaeological deposits (where these deposits exist). Alluvial terrace areas closer to lower hill slopes have been subjected to a build up of eroded and weathered stone material from adjacent hill slopes. These deposits occur in the form of lag material and colluvial deposits exposed on the surface by past-commercial scale cultivation activities, i.e. ploughing etc.

Based on site distribution data for the local area, this landform unit is believed to be the most sensitive within the survey area (Figure 3).

5.2.2 Lower Hill Slopes

The second identifiable landform unit consists of low hill slopes with slope generally less than 10% and covering approximately 60 hectares (30%) of the survey area. Soils over this landform unit are comprised of highly erodable, skeletal soils originating from adjacent weathered dacite and sandstone deposits.

Whilst gradient and terrain over at least the flatter areas of this landform would have been relatively conducive to past Aboriginal occupation, there appears no reason for extensive occupation over this landform unit when the adjacent creek banks and alluvial terraces, most of which are forest free, provided all that was required for comfortable campsite location, particularly proximity to water.

This landform unit is subject to ongoing surface erosion and is considered to be low in archaeological sensitivity (Figure 3). This assessment is based upon site distribution data throughout the local area and also as a result of the extensive clearing of old-growth native timber which has occurred over this landform unit in the past.

5.2.3 Upper Hill Slopes - Hill Tops, Associated Elevate Ridge Lines

The third landform unit (or rather, archaeological landscape, because this archaeological landscape, for the purposes of this report, is a combination of several landform units), is comprised of upper hill slopes, rocky outcrops and associated hill tops and elevated ridge lines, covering approximately 105 hectares (52.5%) of the survey area. There occurs extensive scatters of weathered Dunoon Dacite rock material (of volcanic origin) over the central and eastern portion of the survey and an exposed outcrop of Ballymore Formation sandstone over a small area along the western edge of the survey area.

Soils over the third landform unit are comprised of shallow skeletal soils and are subject to an ongoing level of surface erosion.
This third land system is assessed to be low in archaeological sensitivity (Figure 3), bearing in mind that the landform units involved are the furthest from reliable water (i.e. the Macquarie River and the seasonally reliable ephemeral creek located within the survey area), have been heavily impacted by past European land use management practices, and the low incidence of sites over similar landform units in the region.

Table 1.

<table>
<thead>
<tr>
<th>Landform - Landsystem Unit</th>
<th>Vegetation</th>
<th>Site Prediction (type)</th>
<th>Available Resources</th>
<th>Stone Assemblage Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ephemeral Drainage Lijes - Associated Alleloch:: Terraces</td>
<td>Open Eucalyptus Woodland - Open Grazing</td>
<td>Seasonally occupied open campsites, scoured trees</td>
<td>Grass and tree seeds, yams, game, yabbies, core and flake tool, seed, grinding artefacts</td>
<td></td>
</tr>
<tr>
<td>Lower Hill Slopes</td>
<td>Open Eucalyptus Woodland - Open Grazing</td>
<td>Seasonally occupied open campsites, scoured trees</td>
<td>Grass and tree seeds, yams, game</td>
<td>Core and flake tool, seed, grinding artefacts</td>
</tr>
<tr>
<td>Upper Hill Slopes &amp; Hill Tops</td>
<td>Open Eucalyptus Woodland</td>
<td>Seasonally occupied open campsites, scoured trees, possibly stone artefacts</td>
<td>Grass and tree seeds, yams, and game</td>
<td>Core and flake tool, seed, grinding artefacts</td>
</tr>
</tbody>
</table>

6.0 ARCHAEOLOGICAL SURVEY

6.1 Survey Strategy

Firstly, a decision was made to cover as much of the identified survey area as possible, ensuring that coverage was effective as possible, given the constraints of time and funding, and using a combination of vehicle and on-foot surface coverage methods (Figure 5).

In consideration of the above, a further decision was made that where possible, 'total' coverage of the survey area would occur, in order to conform to the aims of the field survey described in Section 4.1, where a need was identified to determine the presence or the potential for archaeological sites to occur within the survey area. The
results of this level of investigation would also be useful to the client in determining levels and types of impact over certain areas and the requirements for appropriate Aboriginal site management (where sites occur).

However, despite total survey area coverage during the field survey, the overall level of effective surface coverage was far less than total (see Section 6.3, Table 3). Secondly, coverage of the survey area was to include a representative sample of the three identified landform units and land system units described in Section 3.6 and Table 1. The level of assessment would include investigation into site distribution, past Aboriginal landuse, and site significance. Selection of sample units was based on criteria including areas which provided high levels of surface visibility and exposure, as well as accessibility determined mainly by terrain, as well as the selection of areas appeared to have been relatively undisturbed (where such areas occurred).

A description of survey sample units, and environmental conditions is provided in Table 1. Locations of landform units and sample units is provided in Figure 2, Figure 3 respectively.

6.2 Field Recording Methods

The survey was conducted using the CaLM 1:25,000 topographic map, Eumundi Map Sheet No. 8698-3-N.

Site details, landform, and environmental conditions relating to the detectability of sites, were recorded on data sheets developed for the survey. The development of these forms was designed to facilitate the rapid documentation of basic site and environmental details, and to assist in the compilation of report-summary descriptions of the same (see Appendices). Copies of site recording forms are provided in Appendix B where they occur as field notes attached to copies of all NPWS site forms completed during the field survey.

6.3 Field Survey Methodology and Coverage Data

A total of 8 sample units were surveyed over a comprehensive representation of all three separate landform units identified within the survey area. Sample units ranged in size from 4 hectares (ha) to 101 ha (Table 3 following, and Figure 5, proceeding page 37). Survey area coverage totalled approximately 146 ha, representing approximately 73% of the survey area, whilst effective coverage was somewhat less at approximately 92.3 ha, (64.1% of the total survey area).

Site detectability varied over the survey area, and was determined by factors such as surface visibility (see Table 2, following), geomorphology, the size of the survey team and experience, background scatter, and the type of sites present (i.e. whether obstructive or unobstructive). The measurement of site detectability is difficult given the range of factors which may influence site detection, some of which are mentioned above. However, it is important to at least attempt to quantify the effectiveness of
coverage. Table 3 (page 30) provides a brief summary of survey coverage data. Effective coverage assessment can determine the interpreted accuracy of field investigation (Witter 1990b). For the purpose of the "Glenin Lee" study, a method of coverage analysis where effective coverage can be reasonably accurately calculated, was adapted from Witter (cited in Bonham 1992-50), where the following applies:

Effective Coverage = Sample Coverage (1) (2) (3) (4) (5).

where:

(1) = the area of 100% visibility

(2) = an estimate of prevailing visibility;

(3) = calculate the proportion of the area of the total sample unit that the vegetation estimate represented, i.e. if surface visibility est. at 20% = 20% of total sample unit;

(4) = above figure added to area with 100% visibility = total area with 100% visibility;

(5) = resulting figure calculated as % of sample unit giving effective coverage figure of sample unit(a).

Table 2

<table>
<thead>
<tr>
<th>Surface Visibility Assessment</th>
<th>0 - 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Nil soil visibility</td>
<td>5 x 10%</td>
</tr>
<tr>
<td>b. Occasional glimpses of sand / soil</td>
<td>20 - 50%</td>
</tr>
<tr>
<td>c. Frequent patches of bare ground</td>
<td>50 - 70%</td>
</tr>
<tr>
<td>d. Approx. 50% bare surface</td>
<td>&gt; 50% bare surface</td>
</tr>
<tr>
<td>Survey Area Landform/ Vegetation Unit</td>
<td>Total Area of Landform/ Vegetation Unit (hectares)</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Timbered Areas Across The Survey Area</td>
<td>35.00</td>
</tr>
<tr>
<td>Lugged Drainage Lines &amp; Associated Adjacent Alluvial Terraces</td>
<td>40.00</td>
</tr>
<tr>
<td>Lower Hill Slope</td>
<td>105.00</td>
</tr>
<tr>
<td>Upper Hill Slopes &amp; Hill Tops &amp; Associated Elevated Ridge Lines</td>
<td>300.00</td>
</tr>
</tbody>
</table>

Total | 200 ha. | 146 ha. | 32.5 ha. | 70% | (averaged): | 46.1% |
Initial coverage of the survey area comprised vehicle reconnaissance of the survey area perimeter to determine the boundaries, general levels of surface disturbance and visibility, landform, terrain, vegetation, and briefly assess the area for potentially sensitive landform units.

Following initial vehicle reconnaissance of the study area, preliminary site investigation was conducted over all stands of remaining old-growth timber, and isolated single trees or small clumps (conducted over an area > 180 ha.). These stands were identified and surveyed extensively for the presence of scarred tree sites, using a combination of vehicle and on-foot coverage, (where terrain allowed vehicle coverage), but employing a 'total coverage' grid system of parallel transects over all timbered areas whether surveyed by vehicle or on foot. The most densely timbered areas within the survey area occurred mainly over two landform units, including mid to upper hill slopes and associated elevated ridge lines, and secondly, over low-mid hill slopes, although at a number of separate locations in the survey area, timbered areas extended to the edge of ephemeral creek lines (third landform unit).

The inspection of both live and dead timber on the survey area involved rapid movement across the landscape, using mainly vehicle inspection, but, where difficult terrain required it, on-foot coverage occurred. This level of coverage required a level of systematic investigation, and so the area was covered with parallel transects ranging between 15 and 30 metres apart.

Two sample units were selected over elevated upper hill slopes, hill tops and associated elevated ridge lines. The largest sample unit, covered an area of approximately 195 hectares, whilst the second sample unit, located along the western boundary of the survey area, consisted of approximately 4 ha. Surface visibility was estimated at around 70% average, for selected sample units within this landform unit. A series of parallel vehicle transects were conducted by vehicle, approximately 20 metres apart, over selected sample units. Where vehicle access was restricted by terrain or vegetation, areas were covered using an on-foot, two man survey team, employing parallel transects conducted approximately 20 metres apart, (the distance between transects depending mainly upon terrain and surface visibility). Whilst inspection of old-growth timber occurred for the presence of scarred trees, observation was maintained over the ground surface for areas of bare or exposed earth and rocky outcrops, for the presence of open canopies or other less obtrusive site types. Where exposed areas occurred located amongst old-growth timber, coverage of the surface occurred employing on-foot, 10 metres apart, parallel transects and general surface observation between transects. The distance between transects depended upon terrain and surface visibility. Effective coverage over this landform unit was 79%.

Once all stands of remaining old-growth timber, areas of isolated timber, and upper hill slopes, hill tops and associated elevated ridge lines had been inspected, investigation was then carried out, on-foot, of all areas located within the most sensitive landform unit, along creek banks and adjacent alluvial terraces. Coverage of these areas included complete, 'total coverage' of extensive sample units, extending the full length of all ephemeral creek lines within the survey area, and covering an...
average width of approximately 30 metres either side of creek beds. Parallel transects were carried out approximately 10-15 metres apart over the length of the landform unit, with supplementary, general observation between transects, including a particular focus over areas of high surface visibility. Average surface visibility was estimated at around 70% over single units within this landform unit. Effective coverage over this landform unit was 22.38%.

Upon completion of vehicle and on-foot coverage of the ephemeral drainage lines and adjacent alluvial terraces, coverage was afforded to low to mid hill slopes. This level of coverage included the selection of four sample units, each approximately 9 hectares in area. Coverage of selected 5 ha. sample units comprised a combination of vehicle and on-foot transects (Table 3). Effective coverage over this landform unit was calculated at approximately 70%, whilst surface visibility was estimated at around 70% average.

6.4 Definition of Sites and Establishing Site Boundaries.

Flood (1989:286) defined a site as "a place where past human activity is identifiable". Based on the discussion of site prediction in Section 5.1, it can be seen that site types vary considerably in form and function and generally in response to a variety of cultural complexities and environmental influences. These factors affected the development of the site and the activities of the people in prehistoric times. A site can be evidence of a complex of cultural activities, e.g. a large open scatter site (of stone artefacts, cooking the hearths etc.), or a mound site. Alternatively, a site might be representative of a single, isolated occupation incident, for example a scarred tree, a small composite artefact scatter, or an isolated burial site. For the purpose of surface surveys, site boundaries are determined by the presence of Aboriginal cultural material. NPWS guidelines indicate that a site is determined by the presence of two artefacts located within 50 metres of each other. This is generally applied to open campsites and artefact scatters, whilst other site types may be determined by the presence of a single artefact (i.e. a scarred tree site) or even by the presence of a recognised significant area, with no visible artefacts (often with ceremonial or religious significance).

The extent of a site, in the case of open campsites and similar artefact scatters, is often difficult to assess due to the effects of the geomorphic processes which may have impacted a particular area and therefore its archaeological deposits. However, surface deposits of archaeological material should be considered good indicators as to the archaeological sensitivity of a specific location, and in the western region, surface deposits tend to be reliable guides to a particular area's archaeological potential.

It should be acknowledged that EIS-related surface studies do have their limitations, and where the archaeologist believes there is a potential for presence of sub-surface archaeological deposits to exist, the issue should be raised, and steps taken to accommodate that potential within a management framework. That framework might include a recommendation for further more extensive archaeological investigations or else simply taking into account the likelihood of sub-surface deposits during the
development of management recommendations. Inevitably, NPWS will determine what further management will be required under the Act, perhaps bearing in mind the consultant's findings and recommendations.

6.5 Origin Assessment of Aboriginal Scarred Trees

Scarred tree sites present a range of assessment, interpretation and management problems. Because a number of both natural and man made effects impacted old-growth timber in the past, one of the most difficult problems in scarred tree assessment is that of determining the origin of scars, whether particular scars on trees have an Aboriginal origin or else stem from a range of natural impacts.

Aboriginal scars can be found on a number of tree species within the region and study area, however, the most apparent and in most cases conclusive Aboriginal scars in the region, occur on either old-growth yellow box, fuzzy box, or silver-sal gumnut trees, with a lesser number occurring on grey box and white eucalypt pines.

Scars can occur on trees for a number of reasons, not all relating to human cultural activities, and where scars are the result of human cultural activity, not all scars necessarily relate to Aboriginal culture and yet they may be the result of Aboriginal people employed during the early 'post-contact' period as European station workers involved in related station activities. Scars can occur from a number of non-traditional causes including bark-removal from bird attack, fire, flooding, European introduced stock, rubbing and eating bark, European land clearing and ring-barking, fencing, rabbiting, farm and other machinery damage, and survey markers, to name some of the more obvious impacts. Rabbiting scars are an interesting anomaly where, during the early part of this century, particularly in the south east of the country, Aboriginal people were conducting varying levels of 'traditional' lifestyles which included the adaptation of hunting practices and diets to include the exploitation of a number of introduced plant and animal species, of which rabbits are just one. Scarred trees relating to this activity are difficult to assess for their Aboriginal origin because both Aboriginal and non Aboriginal people exploited rabbits as a significant food source, particularly during the period around the Great Depression in the 1920s-1930s, and both are known to have used steel axes to cut both possums and rabbits out of either standing or fallen, hollow trees.

Scars which generally reflect 'traditional' Aboriginal occupation over the study area are a focus of this report. In the case of scarred trees recorded during the study which are believed to be of Aboriginal origin, three categories of origin assessment have been employed. A fourth category of "definitely not" Aboriginal scars receives no further consideration in the report. Categories used in the report include the following:
6.5.1 "Possible" Aboriginal Scarred Trees

This category includes all scars which are "more than likely" a result of human cultural activities, but which are very difficult to distinguish from scars of non-Aboriginal or European origin. While the shape of scars in this category are generally irregular, the shape of these scars can often resemble the shape of more definite Aboriginal scarcing, although bark removal patterns may confuse the recorder. Scars in this category may often be found in association with scars of a more definite Aboriginal origin or other Aboriginal site types. "Possible" Aboriginal scars may or may not have axe marks visible, and where axe marks are visible, they may be the results of either a stone or steel axe. Where axe marks are visible, they are generally not consistent with recognizable Aboriginal bark removal patterns or stone axe scarcing, and quite often the height of these scars is inconsistent with a height (or shape) which it is considered would have facilitated easier and more comfortable removal of the scarred section. Prior to observation, there should be no ethnographically-historical account of the tree in relation to the local Aboriginal community.

Generally, the recorder should have considerable doubts as to the Aboriginal origin of the scar, however, the over-riding factor for inclusion in the survey, would be the scarred tree's association with other more positive Aboriginal scarred trees (although not entirely necessary the only determining factor for inclusion in a report).

6.5.2 "Probable" Aboriginal Scarred Trees

"Probable" Aboriginal scarred trees are often found in association with other more definite Aboriginal scarred trees or in association with other Aboriginal site types. These scars are generally more easily identifiable with regular scar shapes and patterns in the region, and quite often, although not necessarily, they may display axe marks. Axe marks on these scars need not necessarily resemble or be consistent with observed 'normal' bark/cambium removal in the region, but will often be the results of stone axe scarcing, although steel axe removal is not uncommon. Scars in this category also fit within height parameters which would have been conducive to comfortable bark removal, although multiple scars may be found in areas at heights which may be otherwise consider outside the normal comfort range for removal. The local Aboriginal community would have knowledge of the particular site.

Generally, the recorder may have some doubt as to the Aboriginal origin of the scar due to an absence of some of the above characteristics or for other tangible reasons.

6.5.3 "Definite" Aboriginal Scarred Trees

These scars fit the regular scar shape patterns of the area and their removal patterns can often be immediately identified with the removal of bark and/or outer cambium layers for the production of certain artefacts. Scars in this category may or may not display axe marks, but where axe marks occur, they conform to normal bark and cambium removal patterns observed in the region. Axe scarring can be either the
result of Aboriginal stone axe impact or from steel axe removal. The height of scars usually fit within a 'normal' comfort range for removal. Quite often visible! Aboriginal scars will have a known ethno-historical within the local Aboriginal community.

Generally, the observer should have no doubt from an informed, experienced viewpoint, that the scar is of Aboriginal origin.

Note: Scars should not be assessed, other than in a very broad sense, on the shape of outer bark regrowth patterns. Regrowth patterns can be extremely misleading in determining the type of implement which was removed or used the scar served. Scar shapes displayed by bark regrowth patterns can assist in vaguely identifying scar dimensions, allowing for estimated regrowth over the original scar.

6.5.4 Range of Assessment Criteria

Criteria used in the field to assess the origin of scarred / carved trees include shape (whether consistent with known removal patterns), estimated age of the tree, whether axe marks are visible or not, and what type of axe marks and the patterns of axe marks, tree species, proximity to other-scarred trees, amount of regrowth, any known Aboriginal history.

6.6 Significance Assessment

Significance assessment has occurred for all sites recorded during the field survey (see summary in Appendix 7). The assessment of an individual site's significance is determined by a number of criteria, which in their broadest terms and under NPWS Guidelines, consider the site's scientific, educational, and Aboriginal significance. However, upon analysis, these broad criteria can be further broken up into more specific criteria which could also be used in significance assessment.

Witter (1995) has identified a range of significance assessment criteria which can be applied to sites during the process of significance assessment. Witter describes these criteria as "objectifiable" and they are intended to supersede the existing criteria of scientific, educational and Aboriginal value assessment, or at least, for the present, complement them.

The broad terms of reference (or criteria) listed by Witter (1995) for the significance assessment of Aboriginal sites includes the following:

1. Identification and reconstruction of behaviour;
2. Cultural patterning; and,
3. Prehistorics.
Witter's criteria tend to fall within the Scientific Value assessment criteria previously recommended for use by NPWS in significance assessment. For the purposes of this report, both sets of criteria will be considered and where appropriate, applied.

When applying the original NPWS criteria of scientific value, educational value, and Aboriginal value, for site significance assessment, the first two can be readily assessed by an experienced archaeologist; however, the tricky way in which the Aboriginal value can be effectively assessed is with input from the local Aboriginal community, presumably to whom the material or site(s) relate. Initial significance assessment which addresses the first two values, often occurs in the field, and is generally based on assessment through comparison. In other words the "representativeness or commonness and quality" of the site being assessed, in comparison with other sites in the region or locality (or the absence of previously recorded sites in the region or locality). Assessment is also carried out, bearing in mind the actual scientific value of a site in answering research questions and the representativeness of that site in providing such information and site integrity. This level of assessment also includes scarcity of a specific site type(s) in a region.

Significance assessment, for the purposes of this report, is based on the following three assessment criteria developed for significance assessment by New South Wales National Parks and Wildlife Service, and incorporating those developed by Witter (1995):

1. Scientific Value:

Sites are assessed for their scientific value, using sub-criteria of site integrity, preservation, contents, location, uniqueness or representativeness, and the potential of the site(s) for future scientific research.

Witter (1995) has developed alternative significance assessment criteria which are, in essence, an extension of existing significant assessment criteria.

Witter (1995) uses additional criteria within a largely scientific framework. Headings used by Witter include, 'identification and reconstruction of behaviour', 'cultural patterning', and 'prehistoric', relating to past Aboriginal occupation of an area. The 'new' criteria adapted by Witter can be applied as supplementary levels of assessment when assessing a site's scientific value.

2. Educational Value:

This level of assessment can be closely linked with a site's scientific value, however, this level of assessment can also reflect a site's integrity and values as a learning tool through its visual appeal as an example of a certain site type, and clear evidence of past Aboriginal occupation over an area. The educational value of sites can vary considerably depending upon the condition of the site, (site integrity), representativeness, and location, to name several of the aspects upon which it would be assessed. Sections of the community which may place educational value to a site may include, secondary education institutions and the general education system, Aboriginal communities, the general public, etc.
3. Aboriginal Value:

The Aboriginal community places a range of values on sites. Aboriginal values can often vary from those held by the non-Aboriginal community. In some instances, the archaeological significance of a site is considered by an Aboriginal community to be a secondary consideration when assessing a site's significance. A greater emphasis may be placed by the Aboriginal community on the socio-cultural significance of a site, or else value placed upon a site for its educational value, particularly for teaching community members about the lifestyles of their ancestors, and the value of a site in providing a 'link' with living community members and their ancestors.

Based on personal experience, it appears that Aboriginal communities tend to place far greater significance on sites relating to contemporary Aboriginal heritage and historic events, for example, missions sites and fringe campsites, however, the reverence for burial sites or is almost never compromised.

7.0 SURVEY RESULTS AND SIGNIFICANCE ASSESSMENT

A total of 8 open campsite, 2 scarred tree sites and 1 isolated artefact were recorded during the "Glenn Lea" archaeological survey. Figure 4 shows the locations of all sites recorded during the field survey. Figure 5 (following) indicates the approximate locations of survey area sampling sub-units, and Appendix 3 provides a gazetteer of recorded sites. A summary of open campsite and isolated artefact finds details is provided in table form in Appendix 4, whilst data on scarred tree sites is provided in Appendix 5. Summary details on stone artefacts recorded during the field survey are included in Appendix 5, whilst a summary of Site Significance Assessment is given in Appendix 7.

For additional site location and site dimension details other than those provided in this section of the report, refer to Appendix 8 for copies of site location and site dimension sketch maps provided in NPWS Site Recording Forms.

As predicted, all recorded sites occurred in relatively close proximity to seasonally reliable water sources, i.e. the two major ephemeral creek lines located within the survey area, and within the landform unit predicted to be archaeologically sensitive. The following is a description of all sites located and documented during the current field study:
Figure 5
Survey Sample Unit Locations

Key:
1. Ephemeral Drainage: Erosion areas
2. Lower Hill Slopes
3. Upper Hill Slopes
7.1. **Open Campsites**

7.1.1 **Site Name:** GL-OS-1 (Plates)

**Location:** CR 649280E 6425510N

This open campsite is an extensive open campsite, comprised of exposed artefact scatter occurring along the eroded banks and adjacent elevated alluvial terrace of an un-named ephemeral creek line located in the western half of the survey area. The creek line extends from the south-western boundary of the survey area to a central point along the southern boundary, where it proceeds eastward towards the Macquarie River.

**Site Dimensions:**

The scatter of stone artefacts was observed to occur over an approximate area of 500 metres x 20 metres (10,000 m²) (Figure 4).

**Site Boundaries:**

For the purpose of this report, the boundaries are determined by the presence of artefacts visible upon the surface, which in turn results from the level of surface and sub-surface exposure which has occurred due to the effects of sheet and gully erosion.

The site's eastern boundary is determined by the level of apparent surface erosion caused by the effects of slope, combined with effects of vegetation removal, and the grazing of domestic stock. However, whilst the site's western boundary is similarly defined, the effects of gully erosion have been more severe and a more extensive loss of site integrity may be the result (this could be verified by sub-surface investigation).

The most northern extent of the open campsite is delineated by the presence of an existing property track and a large earthen-walled stock dam. The construction of the dam along the southern most site trajectory has effectively marked the southern-most limit of the site, with no further evidence of artefactual material located on the surface beyond the dam (on the eastern side of the creek). The eastern-most limit of the site is similarly defined by the construction of another property dam, and an internal property track, on the south-eastern side of the creek, adjacent to the "Glenn Lee" homestead. A further site is located downstream of open campsite GL-OS-1 on the steep bank of the same creek, on the eastern side of the dam, between the dam and the "Glenmore" homestead (GL-OS-2).
Site Formation and Condition:

The site was detected as an exposed stone artefact scatter located along the eroded shoulder of the elevated alluvial terrace on an unnamed ephemeral creek (Figure 1).

The site probably and to some degree surprisingly, given its distance from the Macquarie River, represents a relatively extensive occupation area, located along the immediate creek banks and associated alluvial terraces of the creek. The creek line was probably a focus of past Aboriginal groups, exploiting a seasonally reliable supply of fresh water, and possibly a range of animal and plant species which would have populated the area, at least seasonally.

The site location could be generally described as an aridizing landscape, and an indeterminate level of surface and gully erosion has resulted at the site, occurring from a range of surface disturbances, including commercial crop cultivation, the grazing of domestic stock, fence construction, the removal of timber, the construction of a property dam and the effects of internal track development. The result has been a loss of the sandy, easily erodible topsoil around the site, and therefore, a loss of site integrity due to artefact exposure and down-slope artefact movement and scatter (resulting from some or all of the previously mentioned impacts).

However, having noted that a degree of erosion is currently occurring at the site, areas along the eastern edge of the site may have been subjected to a degree of topsoil build-up resulting from erosion of steeper lower hill slopes, and could therefore be inferred to as an aridizing landform. Therefore there is a potential for sub-surface material to exist along the site’s eastern margin. In summary, whilst there may be a build up of topsoil along the eastern margin of the site, the build up is being countered by a loss of topsoil and sub-soil deposits along the site’s western edge as a result of surface and gully erosion.

Coverage:

The level of surface visibility at the time of survey was consistent with surface visibility for the whole sample unit, at around 70%, whilst effective coverage affected during site investigation was calculated at the same (70%), with total site area coverage occurring by way of on-foot parallel transects approximately 10 metres apart. Areas of exposed ground (mainly resulting from surface, sheet erosion) between transects were also inspected for the presence of artefacts.

Surface exposure occurred between patches of grass and along exposed internal vehicle track lines. In the eastern section of the site, near the "Glena Lea" homestead, an area of approximately 30 m x 10 m had eroded along the creek bank shoulder probably as a result of stock movement and the development of an internal property track across the ephemeral creek line, exposing a quantity of mainly quartz artefacts. However, this level of
exposure over the site was not common and generally restricted to the area mentioned. Although, at the southern extremity of the site, another area of surface exposure occurred as a result of internal, property track disturbance. A small scatter of artefacts was exposed by subsequent erosion which has occurred over the track area near the creek bed (erosion due to the effects of soil compaction and vegetation loss).

**Artefact Types, Numbers and Density:**

All stone artefacts, including a representative sample of stone and termite nest hearth material – heat retainers, (observed upon the surface of the site) were documented. A total of 57 stone artefacts were recorded, including 13 flakes, 11 flaked pieces, 4 cores, 25 debitage pieces, and one cyclem (broken in two sections). A representative sample of 12 sandstone, mudstone, and termite nest hearth 'stones' was also recorded, however this number was not included in the artefact count. Rather interestingly, an incomplete cyclem (broken and found as two large fragments) was documented. The artefact was located on the surface, approximately 30 metres from the site's southern extremity. This artefact was made from a soft, argillaceous sandstone, each piece measuring approximately 125 mm long x 55 mm. (Diameter at the thickest end) and 95 mm x 55 mm, respectively.

Stone artefact maximum density over the site was recorded at 5 artefacts/m², whilst average artefact density was found to be less than 1 stone-artefact / m². The presence of a relatively large quantity of stone artefacts and termite nest hearth material at the site tends to indicate that the level of occupation at the site was more than just casual visitation and that a range of activities were occurring at the site. This is further supported by the presence of a number of (approximately 40%) of the total assemblage.

**Raw Materials:**

Stone artefact raw material was comprised of quartz (59.8%), chert (28.5%), quartzite (12.3%), and silicrete (1.2%).

**Significance Assessment:**

The site is assessed to have moderate significance. This assessment is based on the site having moderate scientific value and moderate educational value. An increased level of assessment would be provided for the site should the site be found to contain relatively undisturbed sub-surface archaeological deposits, thus having the potential to reveal information on identification and reconstruction of the behaviour, cultural patterning, and prehistoric, of past Aboriginal groups in the local area and the broader region.
With regard to the site's scientific value, the site has been subject to an indeterminate level of surface disturbance, and is currently being impacted by active, sheet and gully erosion. This level of disturbance detracts from the site's integrity as an intact site, however, whilst the site is not considered an exceptional example of this particular site type, the scientific value of the site is raised slightly by the relative absence of other similar site types recorded in the local area, and the potential for adjacent areas to contain additional archaeological deposit in the form of sub-surface material (unable to be assessed during the surface investigation).

Following consultation with the Central Region Aboriginal Land Council, the site is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.1.2 Site Name: GL-OS-2(Plates)
Location: C.R. 64961E 6425499N

This exposed scatter of stone artefacts is located along an eroded, ephemeral creek bank, approximately 120 metres east of the eastern end of open campsite GL-OS-1, and on the same side of the creek (Figure 4).

Site Dimensions:

Difficulty was encountered in measuring the site due to a quantity of artefactual material found totally out of original context and impregnated in collapsing, sandy sub-soil material on the creek bank. However, the approximate site area was found to extend approximately 20 m x 5 m, (100 m²), with extent determined by the presence of visibly stone artefacts upon the surface (Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface, which in turn results from the level of surface and sub-surface exposure which has occurred due to the effects of sheet and gully erosion.

The site's eastern boundary is determined by the level of apparent surface erosion caused by the effects of slope, combined with effects of vegetation removal, and the grazing of domestic stock and gully erosion. The site's western boundary is similarly defined, with the effects of gully and sheet erosion most pronounced. The site's southern boundary is delineated by a marked absence of stone artefacts visible upon the surface, and extends some
8 m south of the heavily-eroded creek banks. The site appears to have been subjected to a far higher level of gully erosion than that which has occurred in the adjacent GL-OS-1, and it is assumed that the site boundaries have been correspondingly reduced with a loss of site integrity due to the loss of archaeological material into the creek bed. However, given the loss of site integrity due to erosion, the site does not appear to have originally been as extensive as GL-OS-1. Despite the apparent loss of site integrity due mainly to gully erosion, there is potential for sub-surface archaeological deposits to occur along the site’s southern boundary.

The most eastern and western limits of the open campsite are delineated by the absence of stone artefacts and a loss of topsoil due to gully erosion. The northern boundary is also abruptly marked by a steeply eroded gully and the creek bed. The site’s southern boundary is marked by an absence of stone artefacts visible upon the surface.

Site Formation and Conditions:

The site was detected as an exposed stone artefact scatter located along the eroded shoulder of the elevated alluvial terrace on an un-named ephemeral creek.

The site is probably an extension of open campsite GL-OS-1, with a high level of surface disturbance between the two sites responsible for a loss of site integrity and fabric, resulting in the identification of two separate sites rather than a continuum of one large site. The creek line was probably a focus of past Aboriginal groups, exploiting a seasonally reliable supply of fresh water and associated plant and animal life.

The site location could be generally described as a degrading landscape. An indeterminate level of surface and gully erosion has resulted at the site, occurring from a range of surface disturbances, including commercial crop cultivation, the grazing of domestic stock; fence construction, the removal of timber, the construction of a property dam and the effects of internal track development. The result has been a loss of the sandy, easily erodible topsoil around the site, and therefore, a loss of site integrity due to artefact exposure and slosh-slope artefact movement and scatter.

However, having stated that a degree of erosion is currently occurring at the site, areas along the southern and south-eastern edge of the site may have been subjected to a degree of topsoil build-up resulting from erosion of adjacent, steeper hill slopes. This section of the site could therefore be referred to as agrading. In summary, whilst there may be a build up of topsoil along the south-eastern margin of the site, this build up is being countered by an ongoing loss of topsoil and sub-soil deposits along the site’s western edge as a result of surface and gully erosion.
The level of surface visibility at the site is consistent with general landform unit data analysis, at around 70%, whilst effective coverage afforded during site investigation was calculated at around the same (70%). Coverage of the site area was ‘total’ in that the entire surface was inspected during the survey for the presence of stone artefacts. Due to the limited nature of the site, coverage was carried out using a zig-zagging method of on-foot coverage.

Artefact Types, Numbers and Density:

All stone artefacts observed upon the surface of the site were documented. A total of 7 stone artefacts were recorded, including 1 flake, 1 hammerstone, 1 millstone, 1 mano/pot, 1 debitage piece, and a single hearth stone. In addition, a single burnt sandstone fragment was recorded, presumably a hearth stone.

Stone artefact maximum density over the site was recorded at 2 artefacts/m², whilst average artefact density was found to be less than 1 stone artefact/m².

Raw Materials:

Stone artefact raw material was comprised of 3 quartz (43%), 2 quartzite (28%), 1 indurated mudstone (14%), 1 silcrete (14%).

Significance Assessment:

The site is afforded low-moderate significance assessment. This assessment is based on the site having low scientific value and low educational value. An increased level of assessment is provided for the site based on the potential of the site to contain relatively undisturbed sub-surface archaeological deposits, thus having the potential to reveal information on identification and reconstruction of the behaviour, cultural patterning, and prehistories, of past Aboriginal groups in the local area and the broader region.

With regard to the site’s scientific value, the site has been subject to an indeterminate but apparently high level of surface disturbance and is currently being impacted by active, sheet and gully erosion. This level of disturbance detracts from the site's integrity as an intact site; however, whilst the site is not considered an exceptional example of this particular site type, the scientific value of the site is raised slightly, by the relative absence of other similar site types recorded in the local area, and the potential for adjacent areas to contain additional archaeological deposit in the form of sub-surface material (unable to be assessed during the surface investigation).
Following consultation with the Central Region Aboriginal Land Council, this site is afforded low-moderate Aboriginal community value. The Land Council emphasised the value of the site as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.1.3 Site Name: GL-OS3 (Plates)

Location: GR. 649610E 6425584N

This open campsite is a small open artefact scatter located on a flat alluvial terrace on the northern bank and associated alluvial terrace of an un-named ephemeral creek, and situated approximately 40 metres and on the opposite side of the creek to open campsite GL-OS-2 (approximately 200 metres east of "Glen Lee" homestead) (Figure 4).

Site Dimensions:

The scatter of stone artefacts was observed to occur over an approximate area of 20 metres x 20 metres (400 m²) (Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface. However, the extent of the site was difficult to determine, given the high level of surface disturbance which has occurred, particularly as a result of commercial crop cultivation.

The site’s southern boundary is delineated by creek bank erosion, and an apparent absence of stone artefacts. The site’s northern boundary is marked by a steep hill slope and a pronounced absence of stone artefacts. The eastern and western site boundaries are identified by an absence of stone artefacts visible upon the surface.

Site Formation and Conditions:

The site was detected as an exposed stone artefact scatter located over the surface of an alluvial creek flat adjacent to an un-named ephemeral creek (Figure 4).

The site would have probably been very similar in nature (and occupation use) to other sites recorded during the survey, however, due to the effects of European land management practices, the site has virtually no remaining surface integrity as an intact deposit, although there occurs the remote...
possibility that undisturbed sub-surface archaeological deposits may exist below normal plough depth, bearing in mind that the alluvial flat may have been subject to indeterminate levels of topsoil movement both as a result of erosion, and abrasion from creek wash and adjacent hill slopes.

Coverage:

The level of surface visibility at the site at the time of survey was consistent with surface visibility for the whole sample unit, although slightly less at an estimated 20% due to recent grass cover, whilst effective coverage afforded during site investigation was calculated at the same (30%), mainly as a result of restricted surface inspection due to grass cover. Total surface coverage occurred during the field survey by way of on-foot inspection, employing a general zig-zagging coverage method as opposed to a more systematic process. This level of surface coverage was chosen due to the relatively small area of artifact scatter (and therefore site area). Surface exposure was generally limited to exposed ground between grass cover.

Artifact Types, Numbers and Density:

All stone artefacts at the site were documented during the field survey, however, a small quantity of apparently manufactured material was not documented although a sample was included. A total of 3 stone artefacts were recorded, including 1 millstone (smaller), and 2 manuport river pebbles.

Stone artefact maximum density over the site was recorded at less than 1 artefact/m². There occurs an anomaly at the site in that no flaked artefacts were observed, however, factors such as grass cover and surface disturbance may have been responsible for a possible bias in artefacts visible upon the surface.

Raw Materials:

Stone artefact raw material was comprised of 100% quartzite, river pebble material.

Significance Assessment:

The site is assessed to have low significance. This assessment is based on the site having low scientific value and low educational value.

With regard to the site's scientific value, the site has been heavily disturbed as a result of commercial crop cultivation, and a major loss in site integrity has occurred. This level of disturbance detracts from the site's integrity as an
In this site, however, whilst the site is not considered an exceptional example of this particular site type, the scientific value of the site is raised slightly, by the relative absence of other similar site types recorded in the local area, and the potential for adjacent areas to contain additional archaeological deposits of sub-surface material (unable to be assessed during the surface investigation).

Following consultation with the Central Region Aboriginal Land Council, the site is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.1.4 Site Name: GL-OS-4 (Plates 1)

Location: G.R. 650131E 6424938N

This open campsite is a relatively small open artefact scatter occurring along the eroded banks of an unnamed ephemeral creek line located in the eastern half of the survey area, approximately 200 metres west of Obley Road, and approximately 350 metres north of Morris Point Speedway. The creek line extends from the higher ground near the south-eastern boundary of the survey area to the north-easter corner, where it proceeds northward to a junction outside the survey area, with the second ephemeral creek where four other open campsites were recorded during the survey (i.e. GL-OS-1 to GL-OS-3 and GL-OS-6). From the junction of the two creeks, the creek then drains approximately 1 km eastward, to the Mosquito River (Figure 4).

Site Dimensions:

The scatter of stone artefacts was observed to occur over an approximate area of 10 metres x 10 metres (100 m²) (Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface, which in turn results from the level of surface and sub-surface exposure which has occurred due to the effects of sheet and gully erosion.

The site’s western boundary is determined by a level of surface and gully erosion along the creek bank, whilst the site’s northern and southern boundaries are similarly defined by areas of erosion and the creek bank, however the north-eastern and south-eastern margins have not been subject to the same levels of surface disturbance resulting from gully erosion, and there occurs the remote potential for sub-surface archaeological deposits to exist.
(most likely over an area immediately adjacent to visible surface material). These deposits, should they exist, would be located below normal plough depth, bearing in mind that the area has been heavily disturbed by commercial crop cultivation activities, i.e. ploughing. The site’s eastern boundary is similarly defined by the presence of visible surface artefacts, and a distinct absence of such material. The eastern edge of the site also has the potential to be more extensive if sub-surface material was found to exist.

**Site Formation and Condition:**

The site was detected as an exposed stone artefact scatter located along the generally flat, eroded alluvial and colluvial banks of an un-named ephemeral creek.

Judging by the limited number of artefacts visible upon the surface, the site probably reflects seasonal movement and short term occupation of the creek line and not the remains of a larger site, destroyed by the effects of surface and gully erosion.

Surface disturbance from crop cultivation, the movement of grazing stock, and gully erosion, have meant considerable loss of site integrity, although the eastern margin of the site is thought to have a potential for sub-surface archaeological deposits. Should sub-surface material be located at the site, it is anticipated that the extent of such deposits would be limited to within relatively close proximity to the creek line and past supplies of seasonally available water.

The reason that consideration has been given to the potential of the site to contain sub-surface deposits is based on the generally mild slope over the site area (being conducive to campsite location), and assessed moderate level of disturbance, both natural (geomorphological) and human initiated.

**Coverage:**

The level of surface visibility at the site, at the time of survey, was consistent with surface visibility for the whole sample unit and landfill unit; at around 80%, while effective coverage afforded during site investigation was calculated at the same (70%), with total site area coverage occurring by way of on-foot parallel transects approximately 10 metres apart. Areas of exposed ground (mainly resulting from surface, sheet erosion) between transects were also inspected for the presence of artefacts.

Surface exposure occurred between patches of grass and along exposed internal vehicle track lines and sheep and cattle pads (approximately 80% of site area).
Artefact Types, Numbers and Density:

All stone artefacts observed upon the surface of the site were documented. A total of 5 stone artefacts were recorded, including 2 flakes (plus a single backed blade of flake origin), 1 flaked piece, and a single piece of debitage. Stone artefact maximum density over the site was recorded at less than 1 artefact /m².

Raw Materials:

Stone artefact raw material was comprised of 3 quartz (60%) and 2 quartzite (40%).

Significance Assessment:

The site is assessed to have low significance. This assessment is based on the site having low scientific value and low educational value. A potential for an increased level of assessment is accepted for the site based on the potential of the site to contain relatively undisturbed sub-surface archaeological deposits, thus having the potential to reveal information on identification and reconstruction of the behaviour, cultural patterning, and prehistories, of past Aboriginal groups in the local area and the broader region.

With regard to the site's scientific value, the site has been subject to an indeterminate level of surface disturbance, and is currently being impacted by active, sheet and gully erosion. This level of disturbance detracts from the site's integrity as an intact site, however, whilst the site is not considered an exceptional example of this particular site type, the scientific value of the site is raised slightly, by the potential for adjacent areas to contain additional archaeological deposits in the form of sub-surface material (unable to be assessed during the surface investigation).

Following consultation with the Central Region Aboriginal Land Council, the site is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.1.5 Site Name: GL-OS-S (Plates)

Location: G.R. 650082E 6424874N

This open campsite is a relatively small open artefact scatter occurring along the eroded banks of an un-named ephemeral creek line located in the eastern half of the survey area, approximately 200 metres west of Obayy Road, and approximately 300 metres north of Morris Park Speedway. The creek line
extends from the higher ground near the south-eastern boundary of the survey area to the north-eastern corner, where it proceeds northward to a junction outside the survey area, with the second ephemeral creek, where four other open categories were recorded during the survey (i.e. GL-OS-1 to GL-OS-3 and GL-OS-6). From the junction of the two creeks, the creek then drains approximately 1 km eastward, to the Macquarie River (Figure 4).

Site Dimensions:
The scatter of stone artefacts was observed to occur over an approximate area of 15 metres x 10 metres (150 m²) (Figure 4).

Site Boundaries:
For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface, which in turn results from the level of surface and sub-surface exposure which has occurred due to the effects of sheet and gully erosion.

The site's western boundary is determined by a level of surface and gully erosion along the creek bank, whilst the site's northern and southern boundaries are similarly defined by areas of erosion and the creek bank, however the north-eastern and south-eastern margins have not been subject to the same levels of surface disturbance resulting from gully erosion, and there occurs the remote potential for sub-surface archaeological deposits to exist (most likely over an area immediately adjacent to visible surface material). These deposits, should they exist, would be located below normal plough depth, bearing in mind that the area has been heavily disturbed by commercial crop cultivation activities, i.e. ploughing. The site's eastern boundary is similarly defined by the presence of visible surface artefacts, and a distinct absence of such material. The eastern edge of the site also has the potential to be more extensive, if sub-surface material was found to exist.

Site Formation and Condition:
The site was detected as an exposed stone artefact scatter located along the generally flat, eroded alluvial and colluvial banks of an un-named ephemeral creek (Figure 4).

Judging by the limited number of artefacts visible upon the surface, the site probably reflects seasonal movement and short term occupation of the creek line and not the remains of a larger site, destroyed by the effects of surface and gully erosion.

Surface disturbance from crop cultivation, the movement of grazing stock, and gully erosion, have meant considerable loss of site integrity, although the western margin of the site is thought to have a potential for sub-surface.
archaeological deposits. Should sub-surface material be located at the site, it is anticipated that the extent of such deposits would be limited to within a relatively close proximity to the creek line and past supplies of seasonally available water.

The reason that consideration has been given to the potential of the site to contain sub-surface deposits is based on the generally mild slope over the site area, and an assessed moderate level of disturbance, both natural (geomorphological) and human initiated.

Coverage:

The level of surface visibility of the site, at the time of survey, was slightly higher than that recorded for the whole sample unit and landform unit, at around 50%, whilst effective coverage afforded during site investigation was calculated at the same (70%), with total site area coverage occurring by way of on-foot parallel transects approximately 10 metres apart. Areas of exposed ground (mainly resulting from surface, sheet erosion), between transects, were also inspected for the presence of artefacts.

Surface exposure occurred between patches of grass and along exposed internal vehicle track lines and sheep and cattle pads (approximately 80% of the site area).

Artefact Types, Numbers and Density:

All stone artefacts observed upon the surface of the site were documented. A total of 3 stone artefacts were recorded, including 1 flake, 1 flaked piece, and 3 debitage pieces. Stone artefact maximum density over the site was recorded at less than 1 artefact/m².

Raw Materials:

Stone artefact raw material was comprised of 4 quartz (80%), and 1 chert (20%).

Significance Assessment:

The site is assessed to have low significance. This assessment is based on the site having low scientific value and low educational value. A potential for an increased level of assessment is accepted for the site based on the potential of the site to contain relatively undisrupted sub-surface archaeological deposits, thus having the potential to reveal information on identification and reconstruction of the behaviour, cultural patterning, and prehistorics, of past Aboriginal groups in the local area and the broader region.
With regard to the site's scientific value, the site has been subject to a high indeterminate level of surface disturbance, and is currently being impacted by active, sheet and gully erosion. This level of disturbance detracts from the site's integrity as an intact site, however; whilst the site is not considered an exceptional example of this particular site type, the scientific value of the site is raised slightly, by the potential for adjacent areas to contain additional archaeological deposits in the form of sub-surface material (unable to be assessed during the surface investigation).

Following consultation with the Central Region Aboriginal Land Council, the site is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.1.6 Site Name: GL-OS-6 (Plates)

Location: G.R. 648878E 6425265N

This open campsite is a very small scatter of stone artefacts, situated on the western edge of an elevated alluvial/colluvial terrace of an un-named ephemeral creek. The site is located in the western half of the survey area, on an ephemeral creek, upstream, on the same creek where open campsite GL-OS-1 site occurs (on the opposite side of the creek). The site is actually located approximately 100 metres south of GL-OS-1, and an estimated 40 metres west of the creek bed. The artefacts are positioned at the foot of a colluvial slope (Figure 4).

Site Dimensions:

The scatter of stone artefacts was observed to occur over an approximate area of 5 metres x 3 metres (15 m²) (Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface...

The site's eastern boundary is determined by the absence of stone artefacts, whilst the northern, southern and western boundaries are similarly delineated. Whilst there occurs a distinctly low number of artefacts, the site has the potential to contain additional material in the form of sub-surface archaeological deposits. Unfortunately the level of past surface disturbance will most likely be a significant factor in site extent and boundaries, and the integrity of potential sub-surface deposits.
Site Formation and Condition:

The site was detected as an extremely small, stone artefact scatter, located along the western boundary of an alluvial creek flat (or terrace). The site would appear to be a southern extension of an occupation area which may have extended along a large portion of the immediate creek banks and adjacent alluvial terraces (along the western side of the creek) and opposite the extensive scatter identified in the report as GL-OS-1 (Figure 4). This view is supported by the presence of a second open campsite recorded approximately 100 metres to the north-east of GL-OS-6. This second site is referred to as GL-OS-7, and occurs as a slightly larger open campsite along the elevated creek banks (Figure 4).

However, the surface around open campsite GL-OS-6 has been subjected to an indeterminate level of surface disturbance, mainly from commercial crop cultivation and the grazing of domestic stock. As a result, the site location surface is best described as a degrading, and the site low in integrity due to a loss of intactness. The past cultural and environmental context in which the site would have occurred would have been similar to other sites recorded along the creek line.

Coverage:

The level of surface visibility at the site at the time of survey was consistent with surface visibility for the whole sample unit and landform unit, at around 70%, whilst effective coverage afforded during site investigation was also calculated at the same (70%), with total site area coverage occurring by way of on-foot zig-zagging conducted over the entire area for approximately 10000 m². Areas of exposed ground (mainly resulting from surface, sheet erosion) were also inspected for the presence of artefacts.

Surface exposure occurred between patches of grass and along exposed internal vehicle-track lines.

Artfact Types, Numbers and Density:

All stone artefacts observed upon the surface of the site were documented. A total of 3 stone artefacts were recorded, including 1 broken millstone (adapted as a producer core), 1 flaked piece, and 1 producer core.

Stone artefact maximum density over the site was recorded at less than 1 artefact/m².

Raw Materials:

Stone artefact raw material was comprised of entirely of quartzite (100%).
Significance Assessment:

The site is assessed to have low significance. This assessment is based on the site having low scientific value and low educational value. An increased level of assessment is provided for the site based on the potential of the site to contain relatively undisturbed sub-surface archaeological deposits, thus having the potential to reveal information on identification and reconstruction of the behaviour, cultural patterning, and prehistories, of past Aboriginal groups in the local area and the broader region. However, where such sub-surface deposits might exist, their integrity may too be compromised due to surface disturbance (unless they are located below normal plough depth).

Following consultation with the Central Region Aboriginal Land Council, the site, in conjunction with the suite of sites located along the creek line, is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.1.7 Site Name: GL-OS-7 (Plates)

Location: G.R. 649065E 6425392N

This open campsite is a relatively small scatter of stone artefacts, situated on the western edge of a gently sloping (<10° slope) elevated alluvial / colluvial terrace of an un-named ephemeral creek (on the opposite bank to GL-O5-1). The site is found approximately 30 metres west of the creek bed (Figure 4).

Site Dimensions:

The scatter of stone artefacts was observed to occur over an approximate area of 5 metres x 3 metres (15 m²) (see Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface.

The site's eastern boundary is determined by the absence of stone artefacts visible upon the surface, and is marked by the presence of a scarred tree site (GL-O5-1), whilst the western, northern and southern boundaries are similarly delineated, by the absence of stone artefacts visible upon the surface. Whilst there occurs a relatively low number of artefacts visible upon the surface, the
site has the potential to contain additional material in the form of sub-surface archaeological deposit. Unfortunately the level of past surface disturbance will no doubt be a significant factor in site extent and boundaries.

**Site Formation and Condition:**

The site was detected as a relatively small, stone artefact scatter, located along the western boundary of an alluvial creek flat (or terrace). The site would appear to be connected to a second surface deposit located approximately 100 metres to the south (GL-OS-6), and should more extensive investigation occur (in the form of sub-surface excavation), the site may be found to be far more extensive than that which is currently visible upon the surface. This conclusion is reached due to the apparent build-up of topsoil along an internal property fence line which cuts through the eastern edge of the site. This build-up is probably due to past cultivation practices on the property. What may also have occurred, as a result of extensive ploughing of the section of the property, is the complete disturbance of the site and re-deposition during the ploughing process, with material re-deposited on the down-slope, and out of its original context. A narrow strip of ground located between the fence line in question and the creek bed may have some potential for sub-surface archaeological deposits to remain relatively undisturbed.

In summary, the surface around open campsite GL-OS-7 has been subjected to an indeterminate level of surface disturbance, mainly from commercial crop cultivation and the grazing of domestic stock. As a result, the site location surface is best described as a degrading, and the site low in integrity due to a loss of infauna. The past cultural and environmental context in which the site would have occurred would have been similar to other sites recorded along the creek line.

**Coverage:**

The level of surface visibility at the site at the time of survey was consistent with surface visibility for the whole sample unit and landform unit, at around 70%, whilst effective coverage afforded during site investigation was also calculated at the same (70%). With total site area coverage occurring by way of soil dug-out-stripping conducted over the entire area for approximately 10,000 m² (a sample unit within a sample unit). Areas of exposed ground (mainly resulting from surface, sheet erosion) were also inspected for the presence of artefacts. Surface exposure occurred between patches of grass.
Artefact Types, Numbers and Density:

All stone artefacts observed upon the surface of the site were discontinuous. A total of 3 stone artefacts were recorded, including 2 producer-cores, and one flake.

The cores located at the site were really fine examples of producer cores. Both cores showed evidence of a number of negative flake scars, and one core was uni-platformed whilst the other was multi-platformed and rotated.

Negative flake scars present on cores at the site indicated that long 'dipper' type flakes had been removed, with one core showing signs of extensive reduction, containing a combination of plunge, hinge, and feather terminations. Stone artefact maximum density over the site was recorded at less than 1 artefact/m².

Raw Materials:

Stone artefact raw material was comprised of 2 chert artefacts (66%) and 1 silcrete artefact (33%).

Significance Assessment:

The site is assessed to have low to moderate significance. This assessment is based on the site having low scientific value and low educational value. An increased level of assessment is provided for the site based on the site containing a single scarred tree (GL-ST-1), and the potential for the site to contain relatively undisturbed sub-surface archaeological deposits (thus having the potential to reveal information on identification and reconstruction of the behaviour, cultural patterning, and prehistories, of past Aboriginal groups in the local area and the broader region). However, where such sub-surface deposits might exist, their integrity may be compromised due to surface disturbance (unless they are located below normal plough depth). With regard to the presence of the scarred tree site, whilst there occurs a spatial relationship between the open campsite and the scarred tree site (assuming that the scars are of Aboriginal origin), however, at this level of investigation there is no way of connecting the two sites temporally.

Following consultation with the Central Region Aboriginal Land Council, this site, in conjunction with the suite of sites located along the creek line, is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site, in conjunction with the surrounding sites, as an educational resource for the local Aboriginal and non-Aboriginal communities.
7.1.8 Site Name: GL-OS-S (Plate 2)

Location: C.R. 649065E 6425392N

This open campsite is a relatively extensive, but low artefact density scatter of stone artefacts, situated in the centre of a ploughed paddock, on elevated alluvial terrace, approximately 200 metres west of the "Glenlea" homestead, between the junction of two unnamed, ephemeral creeks (Figure 4).

Site Dimensions:

The scatter of stone artefacts was observed to occur over an approximate area of 50 metres x 50 metres (2,500 m²) (see Figure 4).

Site Boundaries:

For the purpose of this report, site boundaries are determined by the presence of artefacts visible upon the surface.

Whilst there occurs a relatively low number of artefacts visible upon the surface, the site has the potential to contain additional material in the form of sub-surface archaeological deposits. Unfortunately the level of past surface disturbance will no doubt be a significant factor in site extent and boundaries.

Site Formation and Condition:

The site was detected as a relatively extensive stone-artefact scatter, of low artefact density, located over an elevated alluvial creek flats (or terrace). Whilst artefact density on the surface of the site is low, considering the sensitive landform, and because of the extent of artefacts visible upon the surface, it is anticipated that sub-surface investigation may uncover additional material. However, given the level of surface and sub-surface disturbance which has occurred at the site, where shallow sub-surface material exists, the integrity of such deposits would be severely compromised. There is a possibility that deeper sub-surface deposits might occur, given the relatively stable nature of the landform unit (apart from surface disturbance) and the geomorphological processes which probably formed the landform in its present state, as an agraded landform unit.

In summary, the surface around open campsite GL-OS-S has been subjected to an indeterminate level of surface disturbance, mainly from commercial crop cultivation and the grazing of domestic stock. As a result, the site location surface is best described as a degraded, and the site low in integrity due to a loss of intactness. However, the site may have a potential for deep sub-surface deposits to occur, in relatively undisturbed condition.
The past cultural and environmental context in which the site would have occurred would have been similar to other sites recorded along the creek line.

Coverage:

The level of surface visibility at the site at the time of survey was slightly higher than the average for the rest of the survey area, due to recent cultivation and grazing down by stock. Surface visibility for the site was estimated at around 90%. Surface coverage over the site was estimated at 100%, and effective coverage afforded during site investigation was calculated at between 90% - 90%. Total site coverage obtained by way of on-foot zig-zagging conducted over the entire area for approximately 10,000 m² (a sample unit within a sample unit). Areas of exposed ground (mainly resulting from surface, sheet erosion) were also inspected for the presence of artefacts. Surface exposure occurred between patches of grass, however, no erosion was visible.

Artfact Types, Numbers and Density:

All stone artefacts observed upon the surface of the site were documented. A total of 4 stone artefacts were recorded, including 2 producer cores, 1 flake, and a maniput river pebble.

The cores located at the site were good examples of producer cores. Both cores showed evidence of a number of negative flake scars, and both cores were uni-platformed. Negative flake scars present on cores at the site indicated that long "slitter" type flakes had been removed, with one core showing signs of extensive reduction, containing a combination of plunge, hingie, and feather terminations. Stone artefact maximum density over the site was recorded at less than 1 artefact/m².

Raw Materials:

Stone artefact raw material was comprised of 3 chert artefacts (75%) and 1 quartzite artefact (25%).

Significance Assessment:

The site is assessed to have low significance. This assessment is based on the site having low scientific value and low educational value. An increased level of assessment would be provided for the site if sub-surface investigations revealed intact sub-surface deposits.
Following consultation with the Central Region Aboriginal Land Council, this site, in conjunction with the suite of sites located along the creek line, is afforded moderate Aboriginal community value. The Land Council emphasised the value of the site, in conjunction with the surrounding sites, as an educational resource for the local Aboriginal and non-Aboriginal communities.

7.2. SCARRED TREE SITES

The presence of scarred tree sites within the landform unit is consistent with site predictions for the study area and environs made in Section 5.1. The only scarred tree sites located during the archaeological survey occurs on old-growth timber, one encrustive Eucalyptus microcarpa and the second on a dead eucalypt (Plates). The following is a brief description of scarred tree sites recorded during the "Glenmore Lee" archaeological survey.

7.2.1 Site Name: GL-ST-1 (Plates)

Location:  G.R. 649065E  6425492N

The scarred tree site is located at the eastern edge of open campsite GL-OS-7, immediately adjacent to the extensive, un-painted ephemeral creek in the western half of the survey area (located approximately 3 m. from the creek bed, on the western bank) (see Figure 4).

Site Description:

Scarred tree site K-ST-1 is a standing, dead, tree stump, probably E. camaldulensis. The scar is roughly oval in shape although some what irregular, and is considered to be the 'possible' result of the removal of bark by past Aboriginal people in the area.

The scar is rated as 'possible' Aboriginal origin (see Section 6.5). More positive Aboriginal origin assessment is difficult due to the poor definition of the scar, absence of axe marks, and lack of any known Aboriginal history or specific significance. The likelihood of the scar being of Aboriginal origin is increased because of the scarred trees close proximity to an open campsite. The scar appears to be the result of both bark and outer-cambium removal.
Site Condition:

The scarred tree, a dead eucalypt, is in poor condition, remaining only as a tree stump, approximately 1.5 m. high. The actual scar is assessed to be in good condition, although there is no clear shape which can be said to be consistent with known artefact shapes from the area.

Site Dimensions:

The tree trunk is approximately 40 cm. diameter at the centre of the scar. The scar measures 20 cm. in length, 11 cm. wide at the centre of the scar, and the base of the scar is approximately 95 cm. above the ground.

Site Context:

The scarred tree occurs in extremely close association with open campsites GL-OS-7, and GL-OS-1.

Significance Assessment:

The scarred tree is given a slightly higher assessment than would perhaps be given to scarred trees in a similar poor condition due to its association with another site. A Moderate Significance Assessment is afforded to the site due to the low number of previously recorded scarred tree sites in this area of the Musquodoboit River floodplain and the representativeness of the site. The site is considered to be of low scientific value and moderate value as an educational resource (in association with the two open campsites).

Following consultation with the Central Region Aboriginal Land Council, the site is given moderate Aboriginal value, based mainly on the expressed value of the community regarding the site's educational value to the Aboriginal community.

7.2.2. Site Name:

GL-ST-2 (Plate)

Location:

G.R. 649156E 6424561N

The scarred tree site is a standing, live, grey box (E. microcarpa) and is located in the south-western corner of the survey, adjacent to the southern boundary fence, near the head of an ephemeral creek line (approximately 700 m. south of open campsites GL-OS-1 etc.). (see Figure 4).
Site Description:

Scarred tree site OL-ST-2 is a standing, live, old-growth grey box tree, situated on a gentle north-western slope, with the scar facing north. The scar is elongated in shape, and is considered to be the 'possible' result of the removal of bark by past Aboriginal people in the area.

The scar is rated as 'possible' Aboriginal origin (see Section 6.5). More positive Aboriginal origin assessment is difficult due to the poor definition of the scar, (due to bark regrowth), absence of axe marks, and lack of any known Aboriginal history or specific significance. The scar appears to be the result of bark removal only.

Site Condition:

The scarred tree, a live eucalypt, is considered to be in good condition, however, the scar has received moderate bark regrowth, covering the original scar pattern. The scar shape is thought to be reasonably consistent with similar scar shapes throughout the region.

Site Dimensions:

The tree trunk is approximately 94 cm. diameter at the centre of the scar. The scar measures 266 cm. in length, 30 cm. wide at the centre of the scar, and the base of the scar extends to ground level (most likely as a result of bark regrowth).

Site Context:

The scarred tree occurs as an isolated site, although, still in relatively close proximity to open campsites recorded during the current survey.

Significance Assessment:

A low significance assessment is afforded to the site due to the low level of Aboriginal origin assessment, low scientific value and low educational value.

Following consultation with the Central Region Aboriginal Land Council, the site is given moderate Aboriginal value, based mainly on the expressed value of the community regarding the site's educational value to the Aboriginal community.
7.3 ISOLATED ARTIFACT FINDS

One isolated artefact find, given field name GL-IF-2, was recorded during the current survey, at grid reference 649150E 6424561N (Figure 4). The reason the isolated artefact was recorded as site number (2) was because a previously recorded site, originally recorded as an isolated artefact (GL-IF-1), upon further investigation was found to be an open campsite rather than an isolated artefact find (containing >2 artefacts within 50 m. of each other).

Isolated artefact find GL-IF-2 was located on the elevated banks of an ephemeral creek, approximately 150 m. east of "Glenn Lee" homestead, on the opposite side of the creek (Figure 4). The isolated artefact, a grey-brown sandstone lower millstone, measuring 170 mm x 100 mm x 50 mm, was found on gently undulating alluvial creek flat.

8.0 DISCUSSION

The observed pattern of Aboriginal site distribution across the study area is consistent with that predicted for the region, with the greatest number of sites recorded along the banks of seasonally reliable water courses, in this case two ephemeral creeks.

Sites types located and recorded during the current archaeological investigation also correspond with Aboriginal settlement patterns described in the early European settlement history of the district, and reflect a pattern of relatively long-term occupation. The evidence of past Aboriginal occupation over the study area is also consistent with that predicted in this report for all landform units within the study area, with the greatest evidence of occupation found to occur within 1 kilometre (in this case just outside the 1 kilometre zone) of the Macquarie River.

With regard to the availability of stone resources within the survey area, it appears that the study area contains no anomalies in resource materials, apart from water. Whilst past Aboriginal people would have found the plant and animal species of the locality to be significant resources, there was no evidence located during the archaeological survey to confirm that dacite stone material deposits were exploited by past local Aboriginal people (bearing in mind the coarse nature of the material, and its unsuitability for stone artefact manufacture).

The stone artefact assemblages observed during the study indicated that water worn river pebbles provided a significant stone material source to past Aboriginal people in the locality, with approximately 33% of all stone artefacts recorded during the survey (including fire-hearth material) containing water worn cortex. There is an assumption, based on the close proximity of the Macquarie and Tallagarran Rivers to the study area, that river worn stone material was gathered from either of these two local rivers; however, further investigation is warranted to determine if indeed the Macquarie River and/or the Tallagarran River did provide this particular important resource material or whether the material was procured from an alternative source, i.e., locally exposed alluvial low deposits associated with past geological formations in the area or river sources (other than local rivers) and located some distance away.
Stone artefact assemblages observed within the study area are similar to those observed at other sites in the Dubbo area (i.e. at the site of the proposed Tullengrair River - Treg Garnage works extensions), with large quantities or proportions of quartz, chert, and quartzite flaked stone artefacts present at all sites in the current study area. Also noticeable from the results of the current "Glenn Lee" study, is the presence of many large flakes, many of which appear to be unmodified, primary flakes. This may reflect an abundance of stone material and the minimal reduction of stone material to produce suitable stone tools, or else the loss of more identifiable stone tool types from the sites as a result of geomorphological processes or past artefact collection. In addition, very few identifiable flaked stone tools fitting a specific manufactured "tool type" or regional sequence (McCarthy 1976:94-96) were observed during the study. No artefact showed definite use wear, and very few indicated evidence of secondary flaking or retouch.

A total absence of stone axes and stone seed-grinding millstones at sites during the current study may indicate the sorting of artefacts from the sites by past artefact collectors, and in fact Gresser (c. 1941) referred to large collections of artefacts which he and others had removed from sites in the locality. Some of the material collected by Gresser is known to be located in the Australian Museum in Sydney, and the location of that material, depending upon the representativeness of Gresser's collecting, may provide a more-comprehensive insight into the stone artefact assemblages of past Aboriginal people in the Dubbo area.

The presence of a single, broken, sandstone cleft stone (McCarthy 1976:66) was interesting, particularly because the consultant had not found similar artefacts located so far east from the regions which they are commonly associated, e.g. the Darling River region, etc.

With regard to significance assessment of sites recorded during the "Glenn Lee" study, no sites are considered to be scientifically significant, however, if sub-surface investigation revealed relatively undisturbed archaeological material, then a revision of the site significance would need to occur.

Whilst the scientific value of sites is consider low, the educational value of the suite of sites along both epiphratal creek lines is considered to have slightly raised value as an educational resource, to both the Aboriginal and non-Aboriginal communities, and considering the type of development proposed over the "Glenn Lee" survey area (tourism oriented) the sites may have value to certain sections of the community, as tourism resources (although no consideration of this aspect of exploitation should occur without first conducting proper consultation with NPWS and the local Aboriginal community).

Generally, the sites offer enhancement to the proposed development, and should be considered in that light. Developments of this nature, can generally accommodate the undisturbed presence (where at all possible) of archaeological sites.
5.0 CONCLUSIONS

All sites recorded during the "Glenn Lee" survey appear to be typical of others located in the local area, with one exception, that they occur along the banks of seasonally dry, ephemeral water courses. Until this survey, these landform features would not have been considered archaeologically sensitive, or at least, where occupation evidence occurred, that it would have been expected to reflect extremely short term occupation levels, and not to the extent which was found during the current study and especially that observed in the case of GLE-OS-1. Although the open campsite recorded during the survey may have some potential for scientific assessment using sub-surface investigation, that value is not known at this stage, and so therefore, significance of sites is assessed accordingly.

According to the development plan, the proposed development should not impact directly upon recorded sites (although slight adjustment may be necessary in several instances where the boundaries of proposed development overlap slightly over archaeologically sensitive areas, i.e. proposed Neighbourhood Lots 2,3, & 4, and residential lots 1,2, & 3 (or estate further archaeological investigation in the form of sub-surface testing is recommended). To ensure that development does not impact upon sites, a general buffer zone of 50 metres along both sides of all ephemeral creek lines located within the survey area (incorporating recorded sites and an allowance for archaeologically sensitive areas) has been recommended by the archaeologist. A variation to this recommendation occurs along the banks of the ephemeral drainage line located near Morris Park Speedway, in the eastern half of the proposed development. At this location, due to the existing landform, it is considered that a sensitive zone of 40 metres along either side of the creek is adequate and reasonable. This has been designed to protect both known sites, and potential, unrecorded sites, occurring in either surface or sub-surface deposits.

Notes: Variation to the buffer zones occurs over areas where sensitivity is believed to extend beyond 50 metres (see Figure 3). These areas include elevated alluvial terraces found adjacent to existing alluvial flats and drainage lines.

The provision of buffer zones and archaeologically sensitive areas as indicated by hatched in areas in Figure 3 of the report are not meant to disrupt or the development proposal, but to signal a warning that either known sites occur over these areas or else there occurs an assessed potential for sub-surface archaeological deposits to exist, and that further assessment is warranted prior to any development occurring over areas identified as sensitive.

Identified sensitive areas in Figure 3 tend to correspond with existing landform, i.e. alluvial creek flats and associated alluvial and colluvial terraces. For example, the areas identified by the developer as Lots 2 & 3 (proposed), located adjacent to Camp Road, have two distinct landform units, including alluvial creek banks and adjacent flats, and an area of elevated alluvial terrace. The sensitivity assessment over these lots is intended to extend over the alluvial creek flats, but not the elevated terrace area which immediately adjoins Camp Road. The identified sensitive area over proposed Lot 2, comprising elevated alluvial and colluvial terraces does not include the existing "Glenn Lee" farm complex area comprising sheds, yards and houses, this
area is considered to have very little archaeological potential due to past surface and sub-surface disturbance. With regard to Lot 1, the eastern half of this Lot is considered archaeologically sensitive; however, the developer has indicated that as a result of the field survey and discussion with the archaeologist, that avoidance of impact over sensitive areas will occur.

A concern was raised by the project officer from Hoymes Wheeler & Thorne Pty. Ltd. regarding the possible need, in the future, to impact upon archaeologically sensitive areas for the construction of services to the proposed development and additional stormwater diversion drains and settlement dams. Because no specific plans had been developed for these additional works within the proposed development, no assessment could be conducted as to the potential impact upon the archaeological record from these activities. However, it must be stressed that, where future plans are developed for such works, and there occurs a potential for such further development to impact upon areas assessed to be archaeologically sensitive, then a need will occur for further archaeological assessment, probably, in the form of sub-surface archaeological investigation.

With regard to impact over archaeologically sensitive areas, whilst it is desirable to avoid archaeological sites, mainly because they are a non-renewable resource (protected by the NPWS Act 1974), where the developer finds that impact is necessary, the developer will be required to satisfy NPWS (and the Consent Authority under the Environmental Planning and Assessment Act 1979) that no impact will occur, not only to surface deposits, but also to sub-surface archaeological deposits, (without first establishing whether such deposits occur, particularly over sensitive areas). The significance of potential sub-surface sites should be assessed in the same way that surface deposits are assessed. This assessment would assist in determining whether destruction of sites should be allowed to occur or not; destruction of sites would occur in the form of a Consent to Destroy (which, when considered appropriate, would be issued by the Director of National Parks and Wildlife Service).

Notes: With further regard to the management of areas assessed to be sensitive, where sub-surface investigation is conducted and reveals that no sub-surface material exists, then the level of sensitivity afforded to these areas should be re-assessed, and re-defined as low in sensitivity. Despite a change in sensitivity status, monitoring of development related excavations over areas previously assessed to be sensitive should be conducted. This would provide an additional safeguard for previously undetected archaeological deposits, and allow for proper management, particularly where the Land Council has requested salvage of surface stone material.

The developer has indicated that as a result of the archaeological survey and subsequent sensitivity assessment, a general policy of avoidance of sites will occur, and that development will not occur over sensitive landform.
10.0 SITE MANAGEMENT RECOMMENDATIONS

The consultant believes that because archaeological sites and in particular Aboriginal archaeological relics, are a non-renewable resource, then where possible, sites should not be disturbed (irrespective of significance assessment).

The following recommendations have been developed for sites recorded during the current "Glenn Lee" archaeological survey:

10.1 Recommendation 1.

There is no archaeological or anthropological reason why the proposed development should not proceed, provided the developer complies with their obligations under the NPW Act 1974, with regard to the protection of archaeological relics within the "Glenn Lee" study area.

If a Consent is granted by the Director for National Parks, for the disturbance of sites, then that Consent should only be given provided certain management conditions are incorporated into that consent:

In order for the developer to comply with the requirements of the Act and to ensure appropriate management for sites recorded during the "Glenn Lee" survey, the following recommendations have been developed:

10.2 Recommendation 2.

If at all technically possible, total avoidance of all Aboriginal sites should occur. This would require the development of protected, conservation or buffer zones around all archaeological sites.

10.3 Recommendation 3.

It is recommended that a general 50 metre buffer zone be established along all ephemeral creek lines located within the survey area (both sides of sensitive creek lines) (Figure 3), except where stated in Section 9.0. A sensitive area zone, incorporating a buffer zone, is designed to provide protection of all recorded sites and areas assessed to be archaeologically sensitive.

10.4 Recommendation 4.

It is recommended that additional sensitive areas and buffer zone areas (identified in Figure 3) also be avoided during potential development.
10.5.1 Recommendation 5. (Sub.- Surface Relics)

It is recommended that no impact should occur to identified sensitive areas without first conducting further archaeological investigation in the form of sub-surface testing (i.e. excavated test trenches) to establish whether sub-surface relics occur and if so, the extent and significance of such deposits. Such investigation should be conducted by a qualified archaeologist, and include appropriate local Aboriginal community involvement.

10.5.2

At the completion of any sub-surface investigation (where initiated) and if no sites are present, development can then proceed, however, as an added precaution, monitoring of earthworks over such areas should still occur (preferably by an archaeologist or Aboriginal community representative with appropriate archaeological or site identification skills).

10.5.3

In addition to the above, where sub-surface investigation reveals an absence of sub-surface deposits, subsequent sensitivity re-assessment should occur, within a down grading of sensitivity assessment to low sensitivity over sub-surface areas found to be sterile.

10.5.4

Should relics be uncovered during monitored earthworks, work should immediately cease at the location, and NPWS should be contacted for further direction.

10.5.5

Should relics be uncovered during sub-surface investigations, appropriate documentation of such materials should occur, including stone tools analysis and possible dating, to be followed by further significance assessment of such deposits (should they occur).

10.5.6

Should sub-surface relics occur as a result of sub-surface investigation over sensitive areas, and the developer finds that impact is still the only option over such areas, the developer will be required to apply for a Consent to Destroy (including both surface and sub-surface deposits) from the Director of NPWS.

10.5.7

Where no sub-surface relics occur as a result of sub-surface investigation, and the developer finds that impact is still necessary over surface deposits recorded by during the field survey, a Consent to Destroy will be required from the Director.
10.6 Recommendation 6.

Where avoidance of sites is an option, and where sites occur as isolates, it is recommended that 25 metre buffer zones be established around the identified site boundaries (identified in the report and possibly by subsequent on-site identification by the archaeologist). In the case of scarred tree sites, that will mean a protected area of 25 metres radius from the tree trunk.

10.7 Recommendation 7.

Should the proposed development proceed, and where the developer feels that there are no alternatives but to impact sites, application will have to be made to the Director of National Parks and Wildlife Service, for Consent to Destroy.

10.8 Recommendation 8.

Where a Consent is required, consideration should be made by the local Aboriginal community (to be contacted by the developer) for an application for a Permit to Salvage Artefacts to be incorporated into any Consent applications made to the Director.

10.9 Recommendation 9.

For the duration of development, earthworks and clearing, all sites and archaeologically sensitive landform units should be identified using either temporary fencing or flagging.

10.10 Recommendation 10.

All contractors working within the development site should be made aware by the developer, in writing, of the presence of sites, site locations, and individual contractor’s obligations under the NPW Act, 1974. A copy of such correspondence (from the developer) should be forwarded to the Regional Archaeologist, NSW NPWS Zone Office, 54 Wingewarra Street, Dubbo, NSW 2830.

10.11 Recommendation 11.

Additional archaeological investigation, where found to be necessary, shall be conducted by an archaeologist, and should involve local Aboriginal Land Council involvement.
10.12 Recommendation 12.

Where impact upon sites has been found to be necessary and a Consent to Destroy has been granted, as part of the Consent, it is recommended that all relics to be impacted, should be further documented by an archaeologist and involvement of the local Aboriginal community should occur where possible. It is anticipated that this level of assessment would require a level of rapid, subsurface investigation which could be conducted in conjunction with development related earthworks, using a blade skimming process over the surface, and appropriate documentation.


The granting of a Permit to Salvage by the Aboriginal community will depend upon the Director being satisfied that the Aboriginal community has appropriate storage facilities for the storage/display of salvaged artefacts, and will require consultation between the Director, the Aboriginal community and Australian Museum in Sydney (the designated State repository for the collection of all salvaged Aboriginal artefacts).

11.0 LEGAL REQUIREMENTS AND OBLIGATIONS

All Aboriginal relics (sites and objects), other than those made for site, are protected under the New South Wales National Parks and Wildlife Service Act 1967 (amended 1974). Aboriginal archaeological sites are a non-renewable resource, valued for the information they can provide on the lifestyles of Aboriginal people in the past, and are also valued by some Aboriginal communities who have maintained cultural links with specific sites in their 'country'. It is illegal to damage, or destroy a site or relic without the prior consent of the Director of NSW NPWS. Any such disturbance requires a permit from the Director. The Act requires that relics recovered under such a permit, come under the custody of the Australian Museum in Sydney.

In order for Aboriginal communities to have access to their cultural material recovered during development disturbance or surveys, they must first obtain the consent of the Director.

Should evidence of unrecorded sub-surface archaeological deposits be uncovered as a result of development activities, the Developer is reminded of their obligation under the above-mentioned Act, and should cease work at that particular location immediately. Should archaeological material be uncovered during development earthworks, Dharuk's Zone Office of the NPWS should be notified immediately of the discovery of any material.
REFERENCES


References (Cont'd)


Personal Communications


<table>
<thead>
<tr>
<th>Glossary of Terms</th>
<th>Definition</th>
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<tbody>
<tr>
<td><strong>Artifact</strong></td>
<td>Any object made by human agency.</td>
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<tr>
<td><strong>Assemblage</strong></td>
<td>A range of artefacts found in close association with each other.</td>
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<tr>
<td><strong>Bashed blade</strong></td>
<td>A stone artefact, blade-shaped, with one margin deliberately trimmed to provide an edge where pressure could be applied to the opposite, cutting edge.</td>
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<tr>
<td><strong>Basalt</strong></td>
<td>A fine-grained often porphyritic, darkly coloured igneous rock.</td>
</tr>
<tr>
<td><strong>Blade</strong></td>
<td>Parallel-sided flake, approximately twice as long as wide.</td>
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<tr>
<td><strong>Bora ground</strong></td>
<td>A ceremonial ground generally consisting of one or two earth - banked circles, and often connected by a “pathway”.</td>
</tr>
<tr>
<td><strong>Chert</strong></td>
<td>A fine-grained crystalline aggregate of silica.</td>
</tr>
<tr>
<td><strong>Compaction</strong></td>
<td>A term used in this report to identify the possible accumulation of once stratified archaeological deposits, the evidence of isolated occupation events (often isolated in time and place), into one large deposit at a single level, with no stratigraphy present due to erosion of the surface strata and subsequent occupation matrix below each deposit. What can occur is the accumulation of archaeological evidence of many thousands of years of occupation once separated by sand or soil deposits, dropping down to a bench layer and forming into a misleadingly single large site artefact scatter site.</td>
</tr>
<tr>
<td><strong>Conchoidal fracture</strong></td>
<td>Shell-like, bulged and curved rippled zone resulting from fracture of certain rock types.</td>
</tr>
<tr>
<td><strong>Core</strong></td>
<td>A slab of stone from which flakes of stone have been removed.</td>
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<tr>
<td><strong>Coretool</strong></td>
<td>A core with evidence of trimming and/or use wear indicating its use as an implement.</td>
</tr>
<tr>
<td><strong>Debitage</strong></td>
<td>Discarded flaked stone material, often showing no evidence of flaking, but associated with the flaking operation.</td>
</tr>
<tr>
<td><strong>Flake</strong></td>
<td>A piece of stone detached from another stone; usually removed from the core using another stone.</td>
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</tbody>
</table>
**Glossary of Terms (Cont'd)**

- **Geomorphology**: Study of the form of the earth's surface.
- **Gneiss**: A metamorphic medium to coarse grained rock, characterised by mineral banding.
- **Hammerstone**: Stone implement used to produce other stone tools and grind plant materials.
- **Hearth**: Site of a campfire. Usually indicated by presence of charcoal, burnt earth, discolouration, organic material, or stone.
- **Holocene**: Comparatively recent geological time, over past 10,000 years.
- **Jasper**: An impure opaque silica, commonly red in colour due to the presence of iron oxides in silica.
- **Midden**: An Aboriginal refuse site.
- **Millstone**: Stone artefact used for grinding seeds, fruits, foodstuffs and sometimes bone and ochre.
- **Open campsite**: A surface scatter of artefacts, usually stone.
- **Pleistocene**: Glacial epoch preceding Holocene, to approximately 2 million years.
- **Quartz**: A rock material consisting of crystalline silica SiO₂ usually white in colour.
- **Quartzite**: Metamorphosed sandstone.
- **Retouch**: Trimming of an artefact, usually stone, after it was detached from its core.
- **Sandstone**: Compacted and cemented sedimentary rocks consisting essentially of rounded grains of sand.
- **Silcrete**: A poorly defined metamorphic (?) rock of generally fine grained silicic nature occurring as silica replacement.
- **Scraper**: Stone tool manufactured from a flake and often with one or more working edges.
Glossary of Terms (Cont'd)

Stratigraphy
Superimposed layering of deposits, with older material overlain by later deposits.

Striking platform
Area on a core where a flake is detached. The detached flake carries a section of the core's striking platform on the butt end.

Use-wear
Worn or smooth area produced on the working edge of an implement resulting from the use of the implement.
PLATES
Plate 1: View of survey area landform/vegetation from western high ground looking east.

Plate 2: View of the survey area's central/eastern high ground looking east.
Plate 3: View of "Glenn Lee" farm house complex looking east from open campsite GL-OS-8.

Plate 4: View of pool near "Glenn Lee" house complex on ephemeral drainage line, looking south towards open campsite GL-OS-1.
Plate 5: A view of landform / vegetation along ephemeral drainage line in western half of survey area (at location of open campsite GI-OS-1), looking north towards "Glenn Lee" homestead.

Plate 6: View of open campsite GI-OS-1 along the banks of an ephemeral drainage line, looking north towards "Glenn Lee" house.
Plate 7: View of eroded, exposed surface of open campsite GL-QS-1 looking south from a point near the banks of an ephemeral drainagel line, immediately south of "Glenn Lee" house and farm complex.

Plate 8: Example of pink-grey quartzite core from open campsite GL-QS-1.
Plate 9: Photo of quartz flaked stone material observed at open campsite GL-OS-1.

Plate 10: Photo of river pebble, manuscript from open campsite GL-OS-1.
Plate 11: Photo of termite nest hearth stone from open campsite GL-OS-1.

Plate 12: Photo of a 'mudstone' core from open campsite GL-OS-1.
Plate 13: View of open campsite GL-OS-2 looking east along southern bank of an ephemeral drainage line, between "Glenn Lee" and "Glenmore" houses.

Plate 14: View of open campsite GI-OS-3 looking south across ephemeral drainage line. Note gully erosion along southern edge of creek bank.
Plate 15: View of open campsite GL-OS-4, looking north along eastern bank of ephemeral drainage near Morris Park Speedway and Obley Road.

Plate 16: Broken quartzite point located at open campsite GL-OS-4
Plate 17. Example of typical quartz material found at open campsite GL-OS-4, typical of material found at all "Glenn Lee" sites.

Plate 18. View of open campsite GL-OS-5 looking south towards Morri's Park Speedway.
Plate 19: View of open campsite GI-OS-7 looking east towards ephemeral drainage line in western section of survey area, and open campsite GI-OS-1 on opposite bank of creek.

Plate 20: Example of quartzite or indurated "mudstone" core from open campsite GI-OS-7.
Plate 21: View of open campsite GL-OS-8 looking south towards ephemeral drainage line and survey area central/eastern highground

Plate 22: View of scarred tree GL-ST-1 looking west towards open campsite GL-OS-7
Plate 23: View of scarred tree site GI-ST-2 looking south towards survey area's southern boundary fence.

Plate 24: View of trig station located near survey area's western boundary.
APPENDIX 1

COPY OF STATEMENT OF INVOLVEMENT IN THE "GLENN LEE" ARCHAEOLGICAL SURVEY BY CENTRAL REGION ABORIGINAL LAND COUNCIL.
2 NOVEMBER 1995

J. Kelton,
CENTRAL WEST ARCHAEOLOGICAL
AND HERITAGE SERVICES,
32 DARLING ST.
CONRA NSW 2794

TO WHOM IT MAY CONCERN

This letter is to verify that this office was consulted by Mr Jim Kelton, of Central West Archaeological & Heritage Services, on the Archaeological survey on the property "Glen Lee", Dubbo.

I personally participated in this survey, both on site and post/pre consultations, on behalf of Central Region Aboriginal Land Council, as this site is within this Council's area.

At the completion of the survey, Jim provided a brief summary of the survey and we discussed future options.

yours in unity

CECEL BEE
BRANCH MANAGER
APPENDIX 2

GAZETTEER OF PREVIOUSLY RECORDED SITES
(NPWS RECORDS)
<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
<th>Category</th>
<th>Location</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDEC17/14</td>
<td>Gazetteer of Previously Recorded Sites</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX 3

GAZETTEER OF SITES RECORDED DURING THE "GLENN LEE" ARCHAEOLOGICAL SURVEY
## APPENDIX 3

Gazetteer of Sites Recorded During The "Glenn Lee" Archaeological Survey

<table>
<thead>
<tr>
<th>Site Field Name</th>
<th>AMG Co-ordinates</th>
<th>Site Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-OS-1</td>
<td>649980  6425510</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-2</td>
<td>649610  6425490</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-3</td>
<td>649610  6425580</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-4</td>
<td>650120  6424950</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-5</td>
<td>650080  6424870</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-6</td>
<td>645870  6425260</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-7</td>
<td>649150  6425760</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-OS-8</td>
<td>649150  6425740</td>
<td>Open Campsite</td>
</tr>
<tr>
<td>GL-ST-1</td>
<td>649065  6425392</td>
<td>Scarred Tree</td>
</tr>
<tr>
<td>GL-ST-2</td>
<td>649156  6425392</td>
<td>Scarred Tree</td>
</tr>
<tr>
<td>GL-IF-2</td>
<td>649450  6425600</td>
<td>Isolated Artefact</td>
</tr>
</tbody>
</table>
APPENDIX 4

SUMMARY DETAILS OF OPEN CAMPSITES - ISOLATED ARTEFACT FINDS LOCATED DURING "GLENN LEE" ARCHAEOLOGICAL SURVEY.
### Appendix 4

**Summary Details of Open Campton & Isolated Artefact Finds Recorded During "Glenn Lee" Archaeological Survey**

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Site Type</th>
<th>Grid Ref. Easting/Northing</th>
<th>Landform Unit</th>
<th>Site Dimensions (m)</th>
<th>Site Boundary</th>
<th>Surface Visibility (%)</th>
<th>Contents</th>
<th>Artefact Density (no./m²)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-OS-1</td>
<td>Open Campsite</td>
<td>849280 8428510</td>
<td>1</td>
<td>550m x 20m (10,000 m²)</td>
<td>Visible artefacts</td>
<td>70%</td>
<td>&gt;100 stone artefacts, including quartz, chert, chert, flaked stone artefacts and sandstone and termite nest material, plus a sandstone fragment artefact</td>
<td>2/m</td>
<td>Site disturbed by cultivation, grazing stock, fencing, vehicle track, and gully erosion. Potential for sub-surface deposits.</td>
</tr>
<tr>
<td>GL-OS-2</td>
<td>Open Campsite</td>
<td>849610 8429490</td>
<td>1</td>
<td>20 m x 6 m (120 m²)</td>
<td>Visible artefacts</td>
<td>70%</td>
<td>Total of 7 stone artefacts observed on site, including 1 flake, 1 hammerstone, 1 flint, 1 transport river pebble, 1 piece of debris, and a single sandstone: hearthstone, Marri and consisting of quartz, quartzite, sandstone</td>
<td>1/m</td>
<td>Heavy disturbance due to gully erosion. Probability more extensive than visible artefacts. Potential for sub-surface investigation along southern ridge.</td>
</tr>
<tr>
<td>GL-OS-3</td>
<td>Open Campsite</td>
<td>846610 8423960</td>
<td>1</td>
<td>550m x 20m (4000 m²)</td>
<td>Visible artefacts</td>
<td>70%</td>
<td>Total of 3 river pebbles, stone artefacts recorded, however; this was only a representative sample, with an estimated 20 similar river pebbles located upon the surface at the site. Raw material mainly quartzite</td>
<td>&lt;1/m</td>
<td>Surface visibility 70%, over main artefact exposure, but little dense grass cover. Surface visibility poor over adjacent areas. Site has been subject to extensive surface disturbance, however, a potential for sub-surface deposits.</td>
</tr>
</tbody>
</table>

Key to Landform Units: 1 - Ephemeral drainage lines and associated alluvial terraces; 2 - Lower Hill Slopes; 3 - Upper Hill slopes, undervisited hill tops and edge lines.
### Appendix 4

**SUMMARY DETAILS OF OPEN CAMPSITES & ISOLATED ARTEFACT FINDS RECORDED DURING “GLEN LEE” ARCHAEOLOGICAL SURVEY (CONT’D)**

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Site Name</th>
<th>Site Type</th>
<th>Grid Ref.</th>
<th>Landform Unit</th>
<th>Site Dimensions (m)</th>
<th>Site Boundary</th>
<th>Surface Visibility (%)</th>
<th>Contents</th>
<th>Artefact density (max. / m²)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL.OS-4</td>
<td>Open Campsite</td>
<td>652130 042680</td>
<td>1 1.0 x 1.0 160 (㎡)</td>
<td>Visible artefacts</td>
<td>70%</td>
<td>Total of 3 stone artefacts recorded on site surface: includes 2 flakes, a single backed blade, a flaked piece and a whole piece of debitage. Material comprising 90% quartz, 10% quartzite.</td>
<td>1 / m</td>
<td>Site disturbed by cultivation, grazing stock, vehicles track, street and gully erosion. Potential for sub-surface deposits.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL.OS-5</td>
<td>Open Campsite</td>
<td>653280 042680</td>
<td>1 1.0 x 1.0 160 (㎡)</td>
<td>Visible artefacts</td>
<td>70%</td>
<td>Total of 3 stone artefacts recorded on site surface: includes 1 flake, 1 flaked piece and 1 debitage flaked. The dominant stone material was quartz, 80%, with chert 20%.</td>
<td>1 / m</td>
<td>Heavily disturbed site due to surface and gully erosion. Grazing stock, vehicles and crop cultivation are responsible for surface artefacts, however there exists a potential for sub-surface deposits in close proximity to the site.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key to Landform Units:** 1. - ephemeral drainage lines and associated alluvial terraces; 2. - Lower hill slopes; 3. - Upper hill slopes, and elevated hill tops and ridgelines.
<table>
<thead>
<tr>
<th>Site Name</th>
<th>Site Type</th>
<th>Landmark Feature</th>
<th>Site Dimensions (m)</th>
<th>Surface Area (ha)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>GJ-0857</td>
<td>Open Campsite</td>
<td>None</td>
<td>1.2</td>
<td>0.09</td>
<td>Site area disturbed by cultivation and spread of manure.</td>
</tr>
<tr>
<td>GJ-0858</td>
<td>Open Campsite</td>
<td>None</td>
<td>1.0</td>
<td>0.08</td>
<td>Site area disturbed by cultivation and spread of manure.</td>
</tr>
<tr>
<td>GJ-0859</td>
<td>Open Campsite</td>
<td>None</td>
<td>1.0</td>
<td>0.08</td>
<td>Site area disturbed by cultivation and spread of manure.</td>
</tr>
<tr>
<td>GJ-0860</td>
<td>Open Campsite</td>
<td>None</td>
<td>1.0</td>
<td>0.08</td>
<td>Site area disturbed by cultivation and spread of manure.</td>
</tr>
<tr>
<td>GJ-0861</td>
<td>Open Campsite</td>
<td>None</td>
<td>1.0</td>
<td>0.08</td>
<td>Site area disturbed by cultivation and spread of manure.</td>
</tr>
</tbody>
</table>

**Key to Landmark Features:**

1. **Spillway:** Spillway discharges from any type and level of activity, including industrial, residential, or agricultural activities.
2. **Silt and Edge Flow:** Silt and edge flow discharges from any type and level of activity, including industrial, residential, or agricultural activities.

**Legend:**

- **Site Area:** Site area disturbed by cultivation and spread of manure.
- **Site Surface:** Site surface disturbed by cultivation and spread of manure.
- **Site Boundary:** Site boundary disturbed by cultivation and spread of manure.
### Appendix 4

**Summary Details of Open Campsites & Isolated Archaic Findings Recorded During "Glenn Lee" Archaeological Survey (Cont'd)**

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Site Type</th>
<th>Site Ref.</th>
<th>Unit</th>
<th>Area (ha)</th>
<th>Location</th>
<th>Easting</th>
<th>Northing</th>
<th>BLG#</th>
<th>Isolated?</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

#### Key to Isolated Types
- 1 - Hypothesis drainage lines and unusual orbicular hearths
- 2 - Low + Hilltops
- 3 - Types of shell, shell middens, and sherds

- Data on maps and site plans.
- Data on plans and site plans.
- Data on plans and site plans.

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- Data on plans and site plans.
APPENDIX 5

SUMMARY DETAILS OF STONE ARTEFACTS
RECORDED DURING THE "GLENN LEE"
ARCHAEOLOGICAL SURVEY
## APPENDIX 5

### SUMMARY DETAILS OF STONE ARTEFACTS FROM OPEN CAMPSITES & ISOLATED ARTEFACT FINDS RECORDED DURING "GLENN LEW" ARCHAEOLOGICAL SURVEY

<table>
<thead>
<tr>
<th>Site</th>
<th>Artefact Type</th>
<th>Raw Material</th>
<th>Colour</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thick (mm)</th>
<th>Cortex</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-OS-1</td>
<td>Flake</td>
<td>Chert</td>
<td>Grey</td>
<td>43</td>
<td>18</td>
<td>8</td>
<td>Nil</td>
<td>Platform (bread), bulb, platform scar</td>
</tr>
<tr>
<td>Flake</td>
<td>Chert</td>
<td>Green</td>
<td>38</td>
<td>19</td>
<td>4</td>
<td>Nil</td>
<td>Platform, bipolar, 1 neg, flake scar</td>
<td></td>
</tr>
<tr>
<td>Flake (scraper)</td>
<td>Quartzite</td>
<td>Pink-brown</td>
<td>19</td>
<td>17</td>
<td>7</td>
<td>Nil</td>
<td>Bifrons (distal end missing), bulb, platform (bread), secondary flaking</td>
<td></td>
</tr>
<tr>
<td>Flake</td>
<td>Quartzite</td>
<td>Pink-red</td>
<td>28</td>
<td>20</td>
<td>6</td>
<td>Nil</td>
<td>Broken platform, flake scar, bulb, secondary flaking along distal and proximal edges</td>
<td></td>
</tr>
<tr>
<td>Flake</td>
<td>Quartzite</td>
<td>Pink-white</td>
<td>34</td>
<td>24</td>
<td>5</td>
<td>Nil</td>
<td>Broken platform, flake scar</td>
<td></td>
</tr>
<tr>
<td>Core</td>
<td>Chert</td>
<td>Grey-brown</td>
<td>82</td>
<td>78</td>
<td>43</td>
<td>5% (WW)</td>
<td>River pebble,适度, 2 platforms, 1 neg, flake scar</td>
<td></td>
</tr>
<tr>
<td>Core</td>
<td>Quartzite</td>
<td>Rasp</td>
<td>87</td>
<td>75</td>
<td>65</td>
<td>5% (WW)</td>
<td>River pebble,适度, 5 platforms, 5 neg, flake scars, Poor quality stone, heavily fractured</td>
<td></td>
</tr>
</tbody>
</table>

**Legend:** Neg. = Negative Flake Scar, WW = Cortex, river wear; Cor. = Cortex origin.
## APPENDIX 5

**SUMMARY DETAILS OF STONE ARTEFACTS FROM OPEN CAMPSITES & ISOLATED ARTEFACT FINDS RECORDED DURING "GLENN LEE" ARCHAEOLOGICAL SURVEY (CONT'D)**

<table>
<thead>
<tr>
<th>Site</th>
<th>Artefact Type</th>
<th>Raw Material</th>
<th>Colour</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thick. (mm)</th>
<th>Cortex</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT-OS-1</td>
<td>Flake</td>
<td>Chert</td>
<td>Light brown</td>
<td>24</td>
<td>18</td>
<td>10</td>
<td>50% (WW)</td>
<td>Flakes, platform (broad)</td>
</tr>
<tr>
<td></td>
<td>Flaked piece</td>
<td>Chert</td>
<td>Light brown</td>
<td>31</td>
<td>20</td>
<td>9</td>
<td>20% (WW)</td>
<td>1 neg. flake near</td>
</tr>
<tr>
<td></td>
<td>Debitage</td>
<td>Chert</td>
<td>Light brown</td>
<td>22</td>
<td>10</td>
<td>7</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Debitage</td>
<td>Chert</td>
<td>Red brown</td>
<td>24</td>
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<td>13</td>
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<td>Yellow red/brown</td>
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<td>40% (WW)</td>
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<td>Milky white</td>
<td>22</td>
<td>22</td>
<td>10</td>
<td>50% (WW) Platforms (broad), flake termination, impact point</td>
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### Appendix 5

**Summary Details of Stone Artefacts from Open Campsites & Isolated Artefact Finds Recorded During the Glenn Life Archaeological Survey (Cont'd)**

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<th>Site</th>
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<th>Width (mm)</th>
<th>Thick. (mm)</th>
<th>Cortex</th>
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<td>120</td>
<td>85</td>
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<td>Red-brown</td>
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<td>53</td>
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<td></td>
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<td>Termite nest</td>
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<td>Milky white</td>
<td>Milky white</td>
<td>35</td>
<td>20</td>
<td>11</td>
<td>Nil</td>
<td>2seg. flake scar</td>
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<tr>
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<td>Milky white</td>
<td>Milky white</td>
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<td>22</td>
<td>9</td>
<td>5% (W/W) Platform (broad), bulb, marginal, elongate termination</td>
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<td>Milky white</td>
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<td>1seg. flake scar</td>
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<td>Quartz</td>
<td>Milky white</td>
<td>Milky white</td>
<td>28</td>
<td>20</td>
<td>6</td>
<td>Nil</td>
<td>Bulb, broken platform (broad), feather termination</td>
</tr>
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<td>Quartz</td>
<td>Milky white</td>
<td>Milky white</td>
<td>28</td>
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<td>6</td>
<td>Nil</td>
<td>Bulb, deep cup, rounded scar, platform (broad), plunger termination</td>
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<tr>
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<td>Chert</td>
<td>Light brown</td>
<td>Light brown</td>
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<td>3</td>
<td>Nil</td>
<td>Platform (broad), seg. flake scar, hinge termination</td>
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APPENDIX 5

SUMMARY DETAILS OF STONE ARTIFACTS FROM OPEN CAMPSITES & ISOLATED ARTIFACT FINDS RECORDED DURING "GLENN LEE" ARCHAEOLOGICAL SURVEY (CONT'D).

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<th>Width (mm)</th>
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<th>Cortex</th>
<th>Comments</th>
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<td>Thrown piece</td>
<td>Chert</td>
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<td>45</td>
<td>20</td>
<td>10</td>
<td>20%</td>
<td>2 avg. flake scars</td>
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<td>Chert</td>
<td>Brown</td>
<td>48</td>
<td>12</td>
<td>2</td>
<td>WW</td>
<td>River pebble, large primary flake, retouch on one lateral margin</td>
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<td>Milky white</td>
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### APPENDIX 5

**Summary Details of Stone Artefacts from Open Campsites & Isolated Artefact Finds Recorded During "Glen Lee" Archaeological Survey (Cont'd)**

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<th>Width (mm)</th>
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<td>Quartz</td>
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<td></td>
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<td>55</td>
<td>Broken, proximal section (conjoins with second, mid-section located)</td>
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<tr>
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<td>70</td>
<td>50% (WB)</td>
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<td>86</td>
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<td>Red-brown</td>
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<td>(diam)</td>
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### APPENDIX 5
SUMMARY DETAILS OF STONE ARTEFACTS FROM OPEN CAVITIES & ISOLATED ARTEFACT FINDS RECORDED DURING "GLENN LEE" ARCHAEOLOGICAL SURVEY (CONT'D)

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<th>Colour</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thick. (mm)</th>
<th>Cortex</th>
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<td>Sandstone</td>
<td>Red-brown</td>
<td>110 (diam)</td>
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<td>32</td>
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<td>12</td>
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<td>Chert</td>
<td>Red-brown</td>
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<td>20</td>
<td>10</td>
<td></td>
<td>1 seg. flake scar</td>
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<td>46</td>
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<td>24</td>
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<td>River pebble, platform(2), 1 seg. flake scar</td>
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<td>Platform, 1 seg. flake scar</td>
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<td>10</td>
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<td>20% (WW)</td>
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<td>40</td>
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<td>River pebble, impact abrasion at one end</td>
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<td>Sandstone</td>
<td>Red-brown</td>
<td>35 (diam)</td>
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<td></td>
<td>Burnt</td>
</tr>
<tr>
<td></td>
<td>Flaked piece</td>
<td>Chert</td>
<td>Milky white</td>
<td>35</td>
<td>23</td>
<td>20</td>
<td></td>
<td>2 seg. flake scars</td>
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<tr>
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<td>25</td>
<td>16</td>
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<td>50% (WW)</td>
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## APPENDIX 5

### SUMMARY DETAILS OF STONE ARTEFACTS FROM OPEN CAMPSITES & ISOLATED ARTEFACT FINDS Recorded DURING "GLEN LEE" ARCHAEOLOGICAL SURVEY (CONT'D)

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<th>Artefact Type</th>
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<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thick. (mm)</th>
<th>Coarse</th>
<th>Comments</th>
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<td>100%</td>
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<td>Silcrete</td>
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<td>4%</td>
<td>100%</td>
<td>River pebble, flat surface</td>
</tr>
<tr>
<td></td>
<td>Unmodified River Pebble</td>
<td>Quartzite</td>
<td>Grey-brown</td>
<td>Not recorded</td>
<td>Not recorded</td>
<td>Not recorded</td>
<td>40%</td>
<td>River pebble, main part, broken</td>
</tr>
<tr>
<td>GL-OS-4</td>
<td>Point (backed, blade)</td>
<td>Quartzite</td>
<td>Pink-grey</td>
<td>54</td>
<td>13</td>
<td>8</td>
<td>Nil</td>
<td>One lateral margin backed and distal surface trimmed with necessary flake scars visible</td>
</tr>
<tr>
<td></td>
<td>Flaked piece</td>
<td>Quartz</td>
<td>Milky white</td>
<td>40</td>
<td>35</td>
<td>18</td>
<td>50%</td>
<td>1 seg. flake scar</td>
</tr>
<tr>
<td></td>
<td>Debrisage</td>
<td>Quartz</td>
<td>Milky white</td>
<td>40</td>
<td>13</td>
<td>12</td>
<td>Nil</td>
<td>Platform (spear), butt, 1 seg. flake scar</td>
</tr>
<tr>
<td></td>
<td>Flake</td>
<td>Quartz</td>
<td>Milky white</td>
<td>21</td>
<td>12</td>
<td>4</td>
<td>Nil</td>
<td>Platform (spear), seg. flake scar</td>
</tr>
<tr>
<td></td>
<td>Flake</td>
<td>Quartz</td>
<td>Milky white</td>
<td>25</td>
<td>14</td>
<td>4</td>
<td>Nil</td>
<td>Platform (spear), seg. flake scar</td>
</tr>
</tbody>
</table>
## APPENDIX 5

**Summary Details of Stone Artefacts from Open Campsites & Isolated Artefact Finds Recorded During 'Glenn Lee' Archaeological Survey (Cont’d)**

<table>
<thead>
<tr>
<th>Site</th>
<th>Artifactual Type</th>
<th>Raw Material</th>
<th>Colour</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thick. (mm)</th>
<th>Cortex</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-OS-5</td>
<td>Flaked piece</td>
<td>Chert</td>
<td>Grey-green</td>
<td>32</td>
<td>27</td>
<td>10</td>
<td>10% (WW)</td>
<td>2 mic. flake scars</td>
</tr>
<tr>
<td></td>
<td>Flake</td>
<td>Quartz</td>
<td>Milky white</td>
<td>26</td>
<td>24</td>
<td>6</td>
<td>Nil</td>
<td>Platform broken</td>
</tr>
<tr>
<td></td>
<td>Debitage</td>
<td>Quartz</td>
<td>Milky white</td>
<td>19</td>
<td>16</td>
<td>3</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Debitage</td>
<td>Quartz</td>
<td>Milky white</td>
<td>13</td>
<td>12</td>
<td>2</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Debitage</td>
<td>Quartz</td>
<td>Milky white</td>
<td>24</td>
<td>12</td>
<td>2</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>GL-OS-6</td>
<td>Core / Millstone (P)</td>
<td>Quartzite</td>
<td>Red-brown</td>
<td>130</td>
<td>60</td>
<td>55</td>
<td>75% (WW)</td>
<td>River Pebble, broken, 1 platform, possible flat upper millstone surface, 6 mic. flake scars</td>
</tr>
<tr>
<td></td>
<td>Core</td>
<td>Quartzite</td>
<td>Red-brown</td>
<td>82</td>
<td>55</td>
<td>55</td>
<td>60% (WW)</td>
<td>River Pebble, broken, un platform, 2 mic. Flake scars</td>
</tr>
<tr>
<td></td>
<td>Flaked piece</td>
<td>Quartzite</td>
<td>Cream</td>
<td>37</td>
<td>26</td>
<td>11</td>
<td>Nil</td>
<td>1 mic. Flake scar</td>
</tr>
<tr>
<td>GL-OS-7</td>
<td>Core</td>
<td>Chert</td>
<td>Light brown</td>
<td>81 (diam.)</td>
<td></td>
<td></td>
<td>95%</td>
<td>Uni-platform, 4 mic. flake scars</td>
</tr>
<tr>
<td></td>
<td>Flake</td>
<td>Chert</td>
<td>Light brown</td>
<td>38</td>
<td>47</td>
<td>22</td>
<td>&lt;5%</td>
<td>Bulb, platform (broad)</td>
</tr>
<tr>
<td></td>
<td>Core</td>
<td>Silicate</td>
<td>Pink</td>
<td>52 (diam.)</td>
<td></td>
<td></td>
<td>Nil</td>
<td>Related, 2 platforms, 9 mic. flake scars</td>
</tr>
</tbody>
</table>
## Appendix 5

**Summary Details of Stone Artefacts from Open Campsites & Isolated Artefact Finds Recorded During "Glenn Lee" Archaeological Survey (Cont'd)**

<table>
<thead>
<tr>
<th>Site</th>
<th>Artefact Type</th>
<th>Raw Material</th>
<th>Colour</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thick. (mm)</th>
<th>Cortex</th>
<th>Coarseness</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-OS-3</td>
<td>Core</td>
<td>Chert</td>
<td>Grey-brown</td>
<td>110</td>
<td>70</td>
<td>80</td>
<td>90% (WW)</td>
<td>River pebble, bifacial platform, 38 neg. flake scars.</td>
</tr>
<tr>
<td></td>
<td>Core</td>
<td>Chert</td>
<td>Light brown</td>
<td>90</td>
<td>60</td>
<td>50</td>
<td>80% (WW)</td>
<td>River pebble, platform, 5 neg. flake scars, oxide coated.</td>
</tr>
<tr>
<td></td>
<td>Flakes</td>
<td>Chert</td>
<td>Light brown</td>
<td>10</td>
<td>40</td>
<td>18</td>
<td>10% (WW)</td>
<td>Bulb platform (broad), 4 neg. flake scars.</td>
</tr>
<tr>
<td></td>
<td>Unmodified</td>
<td>Quartzite</td>
<td>Brown</td>
<td>120</td>
<td>75</td>
<td>70</td>
<td>100% (WW)</td>
<td>River pebble, unmodified.</td>
</tr>
<tr>
<td>GL-B-2 (no ID)</td>
<td>Millstone</td>
<td>Sandstone</td>
<td>Grey-brown</td>
<td>170</td>
<td>100</td>
<td>50</td>
<td>N/A</td>
<td>Black, bifacial, bifacial.</td>
</tr>
</tbody>
</table>

**Legend:** Neg. - Negative Flake Scar; WW - Cortex, river worn; Cor. - Corold origin
APPENDIX 6

SUMMARY DETAILS OF SCARRED TREE SITES
RECORDED DURING THE
"GLENN LEE" ARCHAEOLOGICAL SURVEY
### Appendix 6

**Summary Details of Scarred Tree Sites:**
"Glenn Lee" Archaeological Survey

<table>
<thead>
<tr>
<th>Tree</th>
<th>Scar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No.</th>
<th>Spec.</th>
<th>Cond.</th>
<th>State (D / L)</th>
<th>Trunk diam (cm)</th>
<th>Shape</th>
<th>Measurements (cm)</th>
<th>Regth. (cm)</th>
<th>Axe marks</th>
<th>Orient</th>
<th>Cond.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Euc.</td>
<td>Poor</td>
<td>D</td>
<td>40</td>
<td>Ovoid</td>
<td>20 - 11</td>
<td>95</td>
<td>2</td>
<td>Nil</td>
<td>South</td>
</tr>
<tr>
<td>2</td>
<td>Euc.</td>
<td>Good</td>
<td>L</td>
<td>94</td>
<td>Elong.</td>
<td>286</td>
<td>30</td>
<td>G</td>
<td>13-25</td>
<td>Nil</td>
</tr>
</tbody>
</table>

**Key to Scarred Tree Charts:**

- **Cond.**: Condition of scar/scarred tree
- **Spec.**: Species
- **State (D / L)**: Whether tree dead or alive
- **DIF**: Dead and fallen
- **Shape**: Scar shape
- **Elong.**: Elongated shape
- **Ovoid**: Shape
- **Ireg.**: Irregular shape
- **HAG**: Height of base of scar above ground
- **Regth.**: Amount of bark/cambium regrowth
- **Axe Marks**: Whether axe marks are visible or not
- **Orient**: Orientation of scar

**Key to Tree Species:**

- **Buc.**: Eucalyptus species
- **Em.**: Eucalyptus melliodora
- **Euc.**: Eucalyptus species
- **Euc.**: Eucalyptus microcarpa

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**PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE**

**Page 849**
Appendix 7

SUMMARY OF SITE SIGNIFICANCE ASSESSMENT
### Appendix 7

**Summary of Site Significance Assessment, "Glenn Lee" Archaeological Survey**

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Site Type</th>
<th>Integrity</th>
<th>Structure</th>
<th>Scientific Value</th>
<th>Educational Value</th>
<th>Other Value</th>
<th>Significance Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>GC-05-1</td>
<td>Open Campsite</td>
<td>Moderate Integrity due to surface disturbance (including erosion)</td>
<td>Disturbed by cultivation, grazing, and erosion; however, adjacent areas may contain relatively undisturbed sub-surface deposits</td>
<td>Moderate; representative of site type is relatively low due to limited size and poor condition</td>
<td>Low to Moderate</td>
<td>Moderate; due to limited size and poor condition</td>
<td>Low; low to moderate due to limited size and poor condition</td>
</tr>
<tr>
<td>GC-05-2</td>
<td>Open Campsite</td>
<td>Low; integrity due to surface disturbance (including erosion)</td>
<td>Disturbed by cultivation and erosion; however, adjacent areas may contain relatively undisturbed sub-surface deposits</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low to moderate; due to limited size and poor condition</td>
</tr>
<tr>
<td>GC-05-3</td>
<td>Open Campsite</td>
<td>Low due to extensive surface disturbance</td>
<td>Disturbed by cultivation and stock grazing, Potential for sub-surface deposits (i.e., gravel deposits)</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low; due to limited size and poor condition</td>
</tr>
<tr>
<td>GC-05-4</td>
<td>Open Campsite</td>
<td>Low due to high level of surface disturbance</td>
<td>Disturbed by cultivation and stock grazing, Potential for sub-surface deposits</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low; due to limited size and poor condition</td>
</tr>
<tr>
<td>GC-05-5</td>
<td>Open Campsite</td>
<td>Low due to high level of surface disturbance</td>
<td>Disturbed by cultivation and stock grazing, vehicle tracks, subsequent erosion</td>
<td>Low due to poor condition, however, the potential for sub-surface deposits may mean further assessment should deposits be found</td>
<td>Low</td>
<td>Low</td>
<td>Low; due to limited size and poor condition</td>
</tr>
</tbody>
</table>

*Note: Site types and assessments are based on specific site characteristics and potential significance.*
## Appendix 7

**Summary of Site Significance Assessment, "Glenn Lee" Archeological Survey (Cont'd)**

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Site Type</th>
<th>Integrity</th>
<th>Structure</th>
<th>Scientific Value</th>
<th>Educational Value</th>
<th>Other Value</th>
<th>Significance Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL007</td>
<td>Open Campsite</td>
<td>Low due to high level of surface disturbance</td>
<td>Disturbed by cultivation and grazing, however, there is a potential for subsurface deposits</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Aboriginal Material</td>
</tr>
<tr>
<td>GL008</td>
<td>Open Campsite</td>
<td>Low due to high level of surface disturbance</td>
<td>Disturbed by cultivation and grazing, however, there is a potential for subsurface deposits</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Aboriginal Material</td>
</tr>
<tr>
<td>GL018</td>
<td>Open Campsite</td>
<td>Low due to high level of surface disturbance</td>
<td>Subsurface structure disturbed by cultivation and grazing, but there does occur a potential for subsurface material</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Aboriginal Material</td>
</tr>
</tbody>
</table>

Low: due to poor integrity of surface deposits, however, the potential for sub-surface deposits exists, therefore assessment of significance may be necessary if sub-surface deposits were located.
## Appendix 7
### SUMMARY OF SITE SIGNIFICANCE ASSESSMENT, "GLINS LEE" ARCHAEOLOGICAL SURVEY (CONT'D)

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Site Type</th>
<th>Integrity</th>
<th>Structure</th>
<th>Representativeness</th>
<th>Scientific Value</th>
<th>Educational Value</th>
<th>Other Value</th>
<th>Significance Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL-87-1</td>
<td>Scattered</td>
<td>Compromised due to tree growth and questionable origin</td>
<td>Slight to moderate; but no definite evidence of Aboriginal origin</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Aboriginal: Moderate educational resource; moderate due to locality and Aboriginal origin assessment; shallow or absent association with other open campsites</td>
</tr>
<tr>
<td>GL-87-2</td>
<td>Scattered</td>
<td>Low due to difficulty in establishing Aboriginal origin through site</td>
<td>Slight to moderate; but lacks evidence indicating more positive Aboriginal origin. Le and marks site</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Aboriginal: Low cultural and educational value and low moderate Aboriginal value</td>
</tr>
</tbody>
</table>
APPENDIX 8

COPYIES OF NPWS SITE FORMS FOR THE "GLENN LEE" ARCHAEOLOGICAL SURVEY
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE

Page 855
<table>
<thead>
<tr>
<th>Artefact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flake</td>
<td>43 15 8</td>
<td>Chert</td>
<td>Grey</td>
<td>nil</td>
<td>Platform (brush)</td>
</tr>
<tr>
<td>Flake</td>
<td>28 20 6</td>
<td>Quartzite</td>
<td>Pink/brown</td>
<td>nil</td>
<td>Broken, flake, Platform</td>
</tr>
<tr>
<td>Core</td>
<td>31 24 5</td>
<td>Quartzite</td>
<td>Pink/white</td>
<td>nil</td>
<td>Broken, flake, Platform</td>
</tr>
<tr>
<td>Heart Stone</td>
<td>15 10 55</td>
<td>Mottled</td>
<td>Red/brown</td>
<td>nil</td>
<td>Campfire</td>
</tr>
<tr>
<td></td>
<td>12.0 7.5 45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.0 10 50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core</td>
<td>87 75 65</td>
<td>Quartzite</td>
<td>Red</td>
<td>Less than 1%</td>
<td>Splash, irregular (Poor quality stone)</td>
</tr>
<tr>
<td>Site Name/ No.</td>
<td>GL-05-1</td>
<td>Date: 13/10/95</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>---------</td>
<td>---------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artefact</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flaked Pice</td>
<td>35</td>
<td>Light Brown</td>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flake</td>
<td>30</td>
<td>Light Brown</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flaked Pice</td>
<td>29</td>
<td>Light Brown</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flake</td>
<td>22</td>
<td>Light Brown</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flake</td>
<td>20</td>
<td>Light Brown</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flake</td>
<td>15</td>
<td>Light Brown</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flake</td>
<td>24</td>
<td>Light Brown</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flaked Pice</td>
<td>31</td>
<td>Light Brown</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debitage</td>
<td>22</td>
<td>Light Brown</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debitage</td>
<td>21</td>
<td>Light Brown</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flaked Pce.</td>
<td>32</td>
<td>Light Brown</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debitage</td>
<td>21</td>
<td>Light Brown</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fists</td>
<td>115</td>
<td>Yellow/Red</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site Name / No:</td>
<td>Date: 13/10/45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>---------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Artifact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flake</td>
<td>40 27 17</td>
<td>Quartz</td>
<td>Milky White</td>
<td>40% WW</td>
<td>Rana Pebble Broken</td>
</tr>
<tr>
<td>Flake</td>
<td>22 22 10</td>
<td>Quartz</td>
<td>Milky White</td>
<td>50% WW</td>
<td>Platform</td>
</tr>
<tr>
<td>Debitge</td>
<td>12 8 2</td>
<td>Quartz</td>
<td>Milky White</td>
<td>n.d.</td>
<td>Strike, Termination</td>
</tr>
<tr>
<td>Flake</td>
<td>49 30 10</td>
<td>Chert</td>
<td>Brown</td>
<td>20%</td>
<td>2 mg Flake Sags</td>
</tr>
<tr>
<td>Flake</td>
<td>60 48 15</td>
<td>Chert</td>
<td>Brown</td>
<td>50% WW</td>
<td>Large Primary Retouch, alignment, may in Rana Pebble</td>
</tr>
<tr>
<td>Debitge</td>
<td>16 9 3 14</td>
<td>Quartz</td>
<td>Milky White</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Debitge</td>
<td>26 15 8</td>
<td>Quartz</td>
<td>Milky White</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Debitge</td>
<td>21 12 6</td>
<td>Quartz</td>
<td>Milky White</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Debitge</td>
<td>26 12 4</td>
<td>Quartz</td>
<td>Milky White</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Debitge</td>
<td>21 12 7</td>
<td>Quartz</td>
<td>Milky White</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Debitge</td>
<td>15 12 4</td>
<td>Quartz</td>
<td>Milky White</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Debitge</td>
<td>22 15 4 12</td>
<td>Quartz</td>
<td>Milky White</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Debitge</td>
<td>20 15 4 12</td>
<td>Quartz</td>
<td>Milky White</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Debitge</td>
<td>15 10 14 16</td>
<td>Quartz</td>
<td>Milky White</td>
<td>n.d.</td>
<td></td>
</tr>
<tr>
<td>Debitge</td>
<td>15 11 4 13</td>
<td>Quartz</td>
<td>Milky White</td>
<td>n.d.</td>
<td></td>
</tr>
</tbody>
</table>
## Artefact Details

**Site Name/No:** GL-05-1

<table>
<thead>
<tr>
<th>Artefact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylcon</td>
<td>25 - 55</td>
<td>Quartzite</td>
<td>White</td>
<td>-</td>
<td>Broken, Section Removal</td>
</tr>
<tr>
<td>Bone</td>
<td>45 - 55</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horn</td>
<td>30 - 90</td>
<td></td>
<td>Pink/Red</td>
<td>10%</td>
<td>3 kg flake scan</td>
</tr>
<tr>
<td>Flake</td>
<td>25 - 45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flake</td>
<td>20 - 10</td>
<td></td>
<td></td>
<td></td>
<td>1 kg flake scan</td>
</tr>
<tr>
<td>Flaked</td>
<td>50 - 45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mammal</td>
<td>50 - 70</td>
<td></td>
<td>Light brown</td>
<td>30%</td>
<td>Broken, 5 kg flake scan</td>
</tr>
<tr>
<td>Flaked</td>
<td>35 - 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flaked</td>
<td>24 - 15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flaked</td>
<td>38 - 24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Open Artefact Scatter Site

Site Name / No: C8-05-1
Grid Ref: 4259E 14D58N
Date: 12/10/99

1. Landform Unit: Arroyo Creek Flat
   (hill slope, ridge top, floodplain etc)

2. Nature of deposits: Sandy loam, gravel
   (sandy, gravelly, clay etc)

3. Erosion: - On Site:
   Sheet, Rilling, Cutty

   Environment: Open grazing

4. Site Exposure / Extent: m
   (artefacts visible)

Surface Visibility (est.): <5% 5-10% 10-20% 20-50% 50-70% 75-100%

5. Present Landuse: Grazing

6. Type of Archaeological Material Present:

7. Artefacts in situ?: No

8. Artfact Density: L M X Max

9. Total Number of artefacts:

   Estimated Number of artefacts: 50-100 100-200 <500 >500

10. Raw Material %:

11. Site complex characteristics:
    (associated hearths, knapping floors, ST's etc)
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 863
GL-08-1

Scott 4: Mixing sand and gravel
+ 2 flake

Scott 5: 3 quantity flakes
1 check flake

GR 6990.89 E
64°25'43" N.

GR 6491.26 E
64°25'42" N.

Scott 6: New "Glenm Lee" House

Scott of quantity of check flakes
+ Burned Stones scatter across treated surface.
<table>
<thead>
<tr>
<th>Site Position &amp; Environment</th>
<th>Office Use Only: NPWS Site No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Land form: a. beach/shore/super ridge/edge, etc.</td>
<td>Allocated Creek Bank</td>
</tr>
<tr>
<td>b. site aspect:</td>
<td>360°</td>
</tr>
<tr>
<td>c. slope:</td>
<td>µ°</td>
</tr>
<tr>
<td>d. mark on diagram provided or on your own sketch: the position of the site:</td>
<td></td>
</tr>
<tr>
<td>e. Describe briefly:</td>
<td></td>
</tr>
<tr>
<td>2. Local Rock Type:</td>
<td>Sandstone/Dolomite</td>
</tr>
<tr>
<td>g. Land Use/Effect:</td>
<td>Grazing</td>
</tr>
<tr>
<td>3. Resource Zone associated with site (estuarine, riverine, forest etc):</td>
<td>Un-named Creek</td>
</tr>
<tr>
<td>4. Vegetation:</td>
<td>Eucalyptus greenlandis, Open Woodland, Grazing</td>
</tr>
<tr>
<td>5. Edible plants noted:</td>
<td></td>
</tr>
<tr>
<td>6. Faunal resources (include identification)</td>
<td></td>
</tr>
<tr>
<td>7. Other exploitable resources (river pebbles, oolite etc):</td>
<td></td>
</tr>
</tbody>
</table>

**Site type:** 

**Description of Site & Contents:**

Note state of preservation of site & contents. Do NOT dig, disturb, damage site or contents.

As per Attached Sheet

**Checklist to Help:**
- Trench, width, depth, height of site, shelter, deposit, structure, element (eg. tool, scar), grooves in rock.
- Exposure: stratification, weathering, cemented-decalc, stone, charcoal, density & distribution of these, spongy types: ameliorated, infilled.
- ART: areas of surface decorated, motifs, colour, age, any pigment, technique of engraving, no. of figures, sizes, paleness.
- ORNAMENT: number & condition of bone, feather, age, sex, associated artifacts.
- TREES: number, size, dead, likely age, local, shape, position, site, patterns, are marks, regrowth.
- QUARRIES: rock type, origin, recognizable artifacts, penetrations outlined.
- OTHER SITES: eg. structures (fish traps, stone arrangements, bone mega, metal, metal, rock, holes, engraved grooves, chains, fossil sites (mollusks, marsupial, genera) etc as appropriate.

Attach sketches etc., eg. plant & section of shelter, show relation between site contents; indicate north, show scale.

Attach annotated photo(s) (stereo where useful) showing scale, particularly for artifacts.
<table>
<thead>
<tr>
<th>Item No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Landform Unit: Elevated Creek Flat (hill slope, ridge top, floodplain etc)</td>
</tr>
<tr>
<td>2.</td>
<td>Nature of deposit: Sandy / Gravelly (sandy, gravelly, clay etc)</td>
</tr>
<tr>
<td>3.</td>
<td>Erosion: On-Site: Sheet, Filling, Gulley</td>
</tr>
<tr>
<td></td>
<td>Environment: Open / Gully</td>
</tr>
<tr>
<td>4.</td>
<td>Site Exposure / Extent: 20 x 5 m, Area: m²</td>
</tr>
<tr>
<td>5.</td>
<td>Surface Visibility (est.): &lt;5% 5-10% 20-50% 50-70% 75-100%</td>
</tr>
<tr>
<td>6.</td>
<td>Present Landuse: Grass</td>
</tr>
<tr>
<td>7.</td>
<td>Type of Archaeological Material Present: Pithe</td>
</tr>
<tr>
<td>8.</td>
<td>Artifacts in situ: No (erosion occurring etc)</td>
</tr>
<tr>
<td>9.</td>
<td>Artifacts Density: ≤ 0.5 m² 1 m² 2 m² Max</td>
</tr>
<tr>
<td>10.</td>
<td>Total Number of artifacts: 10</td>
</tr>
<tr>
<td></td>
<td>Estimated Number of artifacts: 50-100 100-200 ≤500 &gt;500</td>
</tr>
<tr>
<td>11.</td>
<td>Raw Material %s: Quality</td>
</tr>
<tr>
<td></td>
<td>Site complex characteristics: (associated hearths, knapping floors, STs etc): nil</td>
</tr>
<tr>
<td>Artefact</td>
<td>Dimensions (cm)</td>
</tr>
<tr>
<td>----------</td>
<td>----------------</td>
</tr>
<tr>
<td>Millstone</td>
<td>125 100 40</td>
</tr>
<tr>
<td>Limestone headstone</td>
<td>90 80 60</td>
</tr>
<tr>
<td>Pot</td>
<td>55</td>
</tr>
<tr>
<td>Flaked Piece</td>
<td>35 25 22</td>
</tr>
<tr>
<td>Flaked Piece</td>
<td>25 16 8</td>
</tr>
<tr>
<td>Microlith</td>
<td>25 27 20</td>
</tr>
<tr>
<td>Flake</td>
<td>20 4 3</td>
</tr>
<tr>
<td>Delithic</td>
<td>16 9 8</td>
</tr>
</tbody>
</table>
### Site Position & Environment

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local rock type: Sandstone/Dolomite</td>
</tr>
<tr>
<td>Vegetation: Emergent Wetland/Grassland</td>
</tr>
<tr>
<td>Water source: Un-named creek</td>
</tr>
</tbody>
</table>

### Site Type

- Open Composite

### Description of Site & Contents

As per attached sheet.

### CHECKLIST TO HELP

- **Site Type**
- **Description**
- **Site Type**
- **Description**
- **Site Type**
- **Description**
- **Site Type**
- **Description**
- **Site Type**
- **Description**
- **Site Type**
- **Description**

### Attachments

- Sketches, plans, section of site, show relation between site contents, indicate north, show scale.
- Annotated photos (if needed) showing scale, particularly for art sites.
Open Artefact Scatter Site

Site Name/No: CH-05-2  Date: 10/1985

1. Landform Unit: Elevate Creek Flat
   (hill, slope, ridge top, floodplain etc)

2. Nature of deposit: Sandy/Gravelly
   (sandy, gravelly, clay etc)

3. Erosion - On Site:
   Sheet  Filling  Gully

   *Environment: Open Fajity

4. Site Exposure / Extent: 20 x 25 m
   Area: ------- m²

5. Surface Visibility (est.): <5%  5-10%  10-50%  50-70%  75-100%

6. Present Landuse: Gregory

7. Type of Archaeological Material Present: Fakes

8. Artifacts in situ? No
   (erosion occurring etc)

9. Artifacts Density: <1/m²  1/m² Max

10. Total Number of artifacts: 10
    Estimated Number of artifacts: 50-100  100-200  >200

11. Raw Material %:
    Quartz  Chert

12. Site complex characteristics:
    (associated hearths, knapping floors, STs etc)
### ARTEFACT DETAILS:

**Site Name / No:** GL-05-2

<table>
<thead>
<tr>
<th>Artefact</th>
<th>Dimensions (cm³)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millstone</td>
<td>125 100 40</td>
<td>Indurated mudstone</td>
<td>Red/Brown</td>
<td>15%</td>
<td>Broken, worn, scored, cortex off.</td>
</tr>
<tr>
<td>Hammerstone</td>
<td>70 80 60</td>
<td>Gneissite</td>
<td>Blue Grey</td>
<td>90%</td>
<td>None, flat surface</td>
</tr>
<tr>
<td>Axe</td>
<td>55 - -</td>
<td>B. T. Sandstone</td>
<td>Red/Brown</td>
<td>-</td>
<td>Bent</td>
</tr>
<tr>
<td>Flaked Pick</td>
<td>35 25 20</td>
<td>Quartzite</td>
<td>Milky White</td>
<td>25%</td>
<td>Two flakes seen (1)</td>
</tr>
<tr>
<td>Flaked Pick</td>
<td>25 16 8</td>
<td>Quartz</td>
<td>Milky White</td>
<td>50%</td>
<td>-</td>
</tr>
<tr>
<td>Mopstick</td>
<td>65 27 20</td>
<td>Gneissite</td>
<td>Light Brown</td>
<td>100%</td>
<td>-</td>
</tr>
<tr>
<td>Flake</td>
<td>20 14 3</td>
<td>Silcrete</td>
<td>Light Brown</td>
<td>15%</td>
<td>Plundered (tool)</td>
</tr>
<tr>
<td>Debitage</td>
<td>11 9 8</td>
<td>Quartz</td>
<td>Milky White</td>
<td>nil</td>
<td>-</td>
</tr>
</tbody>
</table>
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

ITEM NO: PDEC17/14

National Parks and Wildlife Service
Box 1997, Hurstville NSW 2220, Tel: 023) 265-4444
Standard Site Recording Form Revised 3/88

1.59,000 map sheet: READ OFFICE USE ONLY:
(NPWS Code)
[Blank]

AMG Grid reference: mE 44115168 mN
Scale of map used for grid reference: 1:100,000
Suitable & larger scale available: 1:25,000

Site name: Glenn Lee

Ownership: Western

Reason for investigation: Arch. Survey

Position no: Dublin

Photos taken? Yes

How thinly attached? 2 0

How to get to site (letter to permanent features, give best approach as site no, long roads, below area etc.)

Site located on northern bank of ephemeral, unnamed creek, opposite, zoom, east of "Glenn Lee" house.

Other sites in locality? Yes

Are sites in NPWS Register? Yes

Have any effects been removed from site? No

Site Type(s) included: Creek

Condition of site: Site is heavily disturbed, cultivated paddock.

Recommendations for management & protection (attach separate sheet if necessary)

Site recorded by:

Address/Institution:

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 875
<table>
<thead>
<tr>
<th>Item No: PDEC17/14</th>
</tr>
</thead>
</table>

### Site Position & Environment

| 1. Landform a. beach/natural slope/natural hump etc., Alluvial Creek Flat b. site aspect, SSW c. slope, nil |
|---|---|

<table>
<thead>
<tr>
<th>Site</th>
</tr>
</thead>
</table>

| 2. Local rock type, Sandstone/Peachite g. Land use/affected, Crop Cultivation |
|---|---|

<table>
<thead>
<tr>
<th>3. Resource Zone associated with site (estimate, riverline, forest etc.), Open woodland (Grey)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>4. Vegetation, Eucalyptus, Schlerophyll</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>5. Edible plants noted,</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>6. Faunal resources (include shellfish),</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>7. Other exploitable resources (river pebbles, ochre, etc.),</th>
</tr>
</thead>
</table>

### Site Type

<table>
<thead>
<tr>
<th>Open Campsite</th>
</tr>
</thead>
</table>

### Description of Site & Contents

Note: state of preservation of the site & contents. Do NOT dig, disturb, damage site or contents.

As per Attached Sheet

[Attachment: Image of site with labels and descriptions]
### Site Name / No: GH-05-2

**Date:** 13/10/1995

<table>
<thead>
<tr>
<th>Artefact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese Muller</td>
<td>60 45 40</td>
<td>Quartzite</td>
<td>Light brown</td>
<td>90%</td>
<td>Ruin Pebble - Broken</td>
</tr>
<tr>
<td>Manganese Muller</td>
<td>100 45 45</td>
<td>Quartzite</td>
<td>Light brown</td>
<td>100%</td>
<td>Flat, smooth surface</td>
</tr>
<tr>
<td>Manganese Muller</td>
<td>40</td>
<td>Quartzite</td>
<td>Greybrown</td>
<td>40%</td>
<td>Ruin Pebble - Broken</td>
</tr>
</tbody>
</table>

### Glenn Lee - Dubbo
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

ITEM NO: PDEC17/14

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 880
Open Artefact Scatter Site

Site Name / No: GL-05-14
Grid Ref.

Date: 12/10/14

1. Landform Unit: Creek Bank
   (hillslope, ridge top, floodplain etc)

2. Nature of deposit: Sandy/gravel
   (sandy, gravelly, clay etc)

3. Erosion - On Site: Sheet
   Corner
   Gully

- Environment: Open Grazing/Cultivation

4. Site Exposure / Extent: 10 x 10 m
   Area: 100 m²

5. Surface Visibility (est.): <5% 5-10% 10-25% 20-50% 50-75% 75-100%

6. Present Landuse: Grazing Crop Cultivation

7. Type of Archaeological Material Present: Stone tools

8. Artefacts in situ? No
   (erosion occurring etc)

9. Artefact Density: 1 m² Max.

10. Total Number of artefacts: 5

11. Estimated Number of artefacts: 50-100 100-200 <500 >500

12. Raw Material %: Quartz 60% Quartzite 40%

13. Site complex characteristics:
    (associated hearths, knapping flakes, GST's etc) No.
**APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL**

**ITEM NO: PDEC17/14**

---

<table>
<thead>
<tr>
<th>Artefact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point (bifacial)</td>
<td>34 x 13 x 8</td>
<td>Quenched</td>
<td>pink/yell</td>
<td>nil</td>
<td>One margin on dorsal surface trimmed</td>
</tr>
<tr>
<td>Flaked Flake</td>
<td>30 x 35 x 18</td>
<td>Quartz</td>
<td>milky white</td>
<td>50%</td>
<td>- Neg: flake scan</td>
</tr>
<tr>
<td>Dibble</td>
<td>40 x 13 x 12</td>
<td>Quartz</td>
<td>milky white</td>
<td>nil</td>
<td></td>
</tr>
<tr>
<td>Flake</td>
<td>24 x 12 x 4</td>
<td>Quartz</td>
<td>milky white</td>
<td>nil</td>
<td>Platform (dorsal) Dull Neg: flake scan</td>
</tr>
<tr>
<td>Flake</td>
<td>25 x 14 x 4</td>
<td>Quenched</td>
<td>pink</td>
<td>nil</td>
<td>Platform (dorsal) Neg: flake scan</td>
</tr>
</tbody>
</table>

---

*Site Name/No: GL-05-04*

*Date: 13/10/1995*
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

ITEM NO: PDEC17/14

National Parks and Wildlife Service
Box 1967, Kurrajong, NSW 2750. Tel: (02) 562 6444
Standard Site Recording Form

Site name: GL-05-5
Locality/property name: "Glenlee" / Obey's Camp Rd.
Report: Survey

Property/District: Comalbarina
Region: Western
Location: Dubbo

Reason for investigation:
Arch. Survey

Portion no: 236
Parishes: Dubbo

Photo taken: Yes
How many attached: 1

Site located on a western bank of an unnamed ephemeral creek, approx 600m N of speedway.

Other sites in locality: Yes
Site Type: >1000m
Scoured Mass: Open Campsite

Have a trenches been removed from site? No
When? Deposited where?

Is this important to local Aboriginals? Yes
Have contact info for address(es)

Contact person: LAC

For the proposed "Glenlee" Tourist Development
Obey's Camp Rd., Dubbo

Recall:
Surface property, amended insurance and access

Condition of site: Disturbed by internal property track and crop cultivation and erosion

Conditions for management & protection:

As per Report

Recorded by: Jim Keaton
Date: 12/01/995

Address/Institution: 37 Darley St, Cumbre 2790
**SITE POSITION & ENVIRONMENT**

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Site</td>
<td>[Diagram]</td>
</tr>
<tr>
<td>b. Site aspect</td>
<td>[Diagram]</td>
</tr>
<tr>
<td>c. Slope</td>
<td>[Diagram]</td>
</tr>
<tr>
<td>d. Local rock type</td>
<td>Sandstone/Dacite</td>
</tr>
<tr>
<td>e. Land use effect</td>
<td>Crop Cultivation</td>
</tr>
<tr>
<td>f. Distance from nearest water source</td>
<td>[Diagram]</td>
</tr>
<tr>
<td>g. Resource zone associated with site (fossiliferous, riverine, forest, etc.)</td>
<td>Open woodland</td>
</tr>
</tbody>
</table>

**Edible plants needed:**

**Fossiliferous resources (include shellfish):**

**Other exploitable resources (river pebbles, ochre, etc.):**

**Site type:** Open Campsite

**DESCRIPTION OF SITE & CONTENTS:**

- Attach sketches, etc., eg., plans & section of shelter, show relation between site contents, indicate month, show scale.
- Attach annotated photos (stereo where useful) showing scale, particularly for art sites.
Open Artefact Scatter Site

Site Name / No: GL-03-5

Date: 12/10/2015

1. Landform Unit: Creek Bank
   (hill slope, ridge top, floodplain etc)

2. Nature of deposit: Sandy gravel
   (sandy, gravelly, clay etc)

3. Erosion On Site: Sheet, Rilling, Sulky

   → Environment: Open grazing

4. Site Exposure / Extent: 15 x 10 m
   Area: 150 m²
   (artefacts visible)

5. Surface Visibility (est.): <5% 5-10% 10-20% 20-50% 50-70% 75-100%

6. Present Landuse: Grazing, Crop cultivation

7. Type of Archaeological Material Present: Stone Flakes
   flakes, sherds

8. Artifacts in situ?: No
   (erosion occurring etc)

9. Artfact Density: artifacts/m²: 1/m² Max.

10. Total Number of artifacts:
    Estimated Number of artifacts:
        50-100 100-200 ≤500 >500

11. Raw Material %: Sand 50%
    Chert 20%

12. Site complex characteristics:
    (associated hearths, knapping leavings, ST's etc)
    No.
<table>
<thead>
<tr>
<th>Artefact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaked Pea</td>
<td>32</td>
<td>Chert</td>
<td>Green/grey</td>
<td>60%</td>
<td>2 veg flakes seen</td>
</tr>
<tr>
<td>Flake Points</td>
<td>24</td>
<td>Quartz</td>
<td>Milky White</td>
<td>40%</td>
<td>Platform broken</td>
</tr>
<tr>
<td>Debitage</td>
<td>16</td>
<td>Quartz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debitage</td>
<td>12</td>
<td>Quartz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debitage</td>
<td>12</td>
<td>Quartz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debitage</td>
<td>12</td>
<td>Quartz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SITE POSITION &amp; ENVIRONMENT</td>
<td>OFFICE USE ONLY</td>
<td>VNPS please:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------</td>
<td>--------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Creek type:</td>
<td>Elevated Creek, Bank</td>
<td>2. Distance from drinking water: 30m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Land use/effect:</td>
<td>Gap Cultivation, Grazing</td>
<td>3. Resource Zone associated with site: Ephemeral Creek, Gap Woodland, Grazing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Vegetation:</td>
<td>Euc.</td>
<td>4. Faunal resources (include shellfish):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Other exploitable resources (river pebbles, ochre, etc.):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Other resources:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SITE TYPE</td>
<td>DESCRIPTION OF SITE &amp; CONTENTS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Site type</td>
<td>Open Campsite</td>
<td>Note: care of preservation of site &amp; materials. Do not dig, destroy, damage site or contents.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Artifacts located</td>
<td>As Per Attached Sheet</td>
<td>Attach sketches etc. eg. plan &amp; section of shelter, show relation between site contents, indicate north, show scale. Attach aerial photographs (where useful) showing scale, particularly for art sites.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Open Artfact Scatter Site

**Site Name / No:**  
**Grid Ref:**  

**Date:**  

### Landform Unit:
- **Elevated Creek Bank**  
  (hill slope, ridge top, floodplain etc)

### Nature of deposit:
- **Sandy loam**  
  (sandy, gravelly, clay etc)

### Erosion on Site:
- **Moderate**  
  (Sheet, Rilling, Gully)

### Environment:
- **Open grazing, cultivation**

### Site Exposure / Extent:
- 5 x 3 m  
- **Area:** 45 m²

### Surface Visibility (est.):
- 45%  
- 5-10%  
- 20-50%  
- 50-70%  
- 75-100%

### Present Landscape:
- **Grazing / cultivation**

### Type of Archaeological Material Present:
- **River Pebble**  
- **Quartzite Flake**

### Artefacts in situ?
- **No**  
- **Yes**  
  (erosion occurring etc)

### Artefact Density:
- 1 in 2 m² Max.

### Total Number of artefacts:
- **3**

#### Estimated Number of artefacts:
- 50-100  
- 100-200  
- >500

### Raw Material %:
- **Quartzite 10%**

### Site complex characteristics:
- **No**  
  (associated hearths, knapping floors, ST's etc)
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

Item No: PDEC17/14

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 892
<table>
<thead>
<tr>
<th>Artifact</th>
<th>Dimensions (mm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Core 1   | 130 x 60 x 35 | Quartzite | Red/brown | 75%        | Possible broken, possible tool |}

| Core 2   | 82 x 55 x 55 | Quartzite | Red/brown | 60%        | 2 possible reg-flake scars (broken) |

| Flaked-core 37 x 26 x 11 | Quartzite | Cream | Nil | 1 possible reg-flake scar |

Site Name/No: EK-OS-6
Date: 13-10-95

APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

ITEM NO: PDEC17/14
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE

Page 894
<table>
<thead>
<tr>
<th>SITE POSITION &amp; ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Landform: a. beach/slope/hill/slope/ridge/slop, etc.</td>
</tr>
<tr>
<td>b. site aspect: easterly &amp; sloping 10\degree</td>
</tr>
<tr>
<td>c. detail briefly:</td>
</tr>
<tr>
<td>2. Local rock type: Sandstone, Breccia</td>
</tr>
<tr>
<td>3. Land use/affected: Grazing/Cultivation</td>
</tr>
<tr>
<td>4. Vegetation: Evergreen woodland</td>
</tr>
<tr>
<td>5. Edible plant/food:</td>
</tr>
<tr>
<td>6. Faunal resources/prehistoric animals:</td>
</tr>
<tr>
<td>7. Other exploitable resources (river, pebbles, ochre, etc.):</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OFFICE USE ONLY: NPWS Site No:</th>
</tr>
</thead>
</table>

| PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE |
| Item No: PDEC17/14 |

**Site type:** Open Campsite

**DESCRIPTION OF SITE & CONTENTS:**

As for Attached Sheets

*Attach sketches etc. eg. plan & section of shelter, show relation between site & contents.*

*Indicate north, show scale. Attach aerial or photos (where useful) showing scale, particularly for art sites.*
Open Artefact Scatter Site

Site Name/No: C2-05-7
Grid Ref: 49065 E 64963 N

1. Landform Unit: Elevated creek bank
   (hill slope, ridge top, floodplain etc)

2. Nature of deposit: Gravelly Sandy Loam
   (sandy, gravelly, clay etc)

3. Erosion - On Site: Sheet - - - Rilling - - - Bully - - -
   Environment: Open Grazing/Field

4. Site Exposure / Extent: 30 x 20 m
   Area: 600 m²
   (artefacts visible)

5. Surface Visibility (est.): < 5% 5-10% 10-20% 20-30% 30-50% 50-70% 75-100%

6. Present Landuse: Grazing/Arable

7. Type of Archaeological Material Present: None

8. Artefacts in situ?: No
   (erosion occurring etc)


10. Total Number of artefacts: 3
    Estimated Number of artefacts: 50-100 100-200 <500 >500

11. Raw Material %:
    Quantity

12. Site complex characteristics:
    (associated hearths, knapping flakes, STs etc)
    Scarred Tree adjacent (Str1)
<table>
<thead>
<tr>
<th>Artefact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>80</td>
<td>Chert</td>
<td>Light brown</td>
<td>75%</td>
<td>1 platform, 4x2y flakes scars</td>
</tr>
<tr>
<td>Flake</td>
<td>38 x7 21</td>
<td>Chert</td>
<td>Lightbrown</td>
<td>&lt;5%</td>
<td>bulk platform, broad, 6x7y platform, broad, 9x7y flakes scars</td>
</tr>
<tr>
<td>Core</td>
<td>52</td>
<td>Silcrete</td>
<td>Pink</td>
<td>nil</td>
<td>2 platform, 9x7y flakes scars</td>
</tr>
</tbody>
</table>
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

ITEM NO: PDEC17/14

National Parks and Wildlife Service
Box 1997, Hurstville NSW 2220, Tel (02) 466 6444

AMG Grid reference: 6449050 mE 6445740 mN

H10K I100K I 120K

Eulomogo 8633 3-N

Coorabakh Range, Western Division

Archaeological Survey

Personnel:

Yes

Site Location:

Site located 500m north of Morrison Park

Site Type:

Open Campsites

Evidence of Activity:

Yes

Site Type(s) included:

Scattered Debris

Exposure:

Yes

Other evidence:

Scattered Debris

Additional Information:

None

Associated Reference:

None

Preparation:

No

Condition of Site:

Surface disturbance due to cultivation, grazing, and tracks.

Recommendation:

As per report

Prepared by:

J. Kelson

Date: 13/10/1995

92 Darling St

OWRA NSW
| ITEM NO: PDEC17/14 |

**APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL**

**SITE POSITION & ENVIRONMENT**

| 1. Local rock type: | Sandstone |
| 2. Distance from drinking water: | 20 m |
| 3. Resource Zone associated with site (estuarine, saline, forest, etc.): | Open Woodland |
| 4. Vegetation: | Eu. dry sclerophyll |
| 5. Edible plants noted: | |
| 6. Faunal resources (include size/taxa): | |
| 7. Other exploitable resources (river pebbles, coke, etc.): | |

**Site type:** Open Campsite

**DESCRIPTION OF SITE & CONTENTS:**

Note state of preservation of site & contents. Do NOT dig, disturb, damage site or contents.

*As Per Attached Sheet*

**CHECKLIST TO HELP:**

- length, width, depth, height of site, siting, geology, structure, elements, etc. tree, scan, ground, shillock, plan
- OPPOST: context, location, stratigraphy, preservation, bone, stone, charcoal, density
- orientation of these, stone types, artefact types
- Historic area or surface decorated, motifs, contexts, wet, dry, pigment, technique of engluining, no. of figures, sizes, plates
- Radiocarbon:
- SURVEY: number & condition of bone, position, age, sex, association artefacts
- TREES: number, size, age, size, likely age, scale; growth, patination, size, patterns, axe handles, scaphe
- QUALITY: rock type, artefacts, recognisable artefacts, percentage quantified
- OTHER: sites, etc.

Attach sketches, etc. as plan 5 sections of shelter, show relation between site contents, indicate north, show scale.

Attach annotated photos (also where useful) showing scale, particularly for art sites.
Open Artefact Scatter Site

Site Name/No: CL-05-E

Date: 13/10/95

1. Landform Unit:
   - Low Hill Slope
   (Hill slope, ridge top, floodplain etc)

2. Nature of deposit:
   - Sandy loam/gravel
   (Sandy, gravelly, clay etc)

3. Erosion:
   - Sheet
   - Gully
   - Open Gorge / Culvert

4. Site Exposure / Extent: 50 x 50 m
   Area: 2500 m²
   (Artifacts visible)

4. Surface Visibility (est.):
   - 5%  5-10%  10-20%  20-50%  50-70%  75-100%

5. Present Landuse:
   - Cultivation / Grazing

6. Type of Archaeological Material Present:
   - Isolated Artefact

7. Artefacts in situ?
   - Yes
   (erosion occurring etc)

8. Artefact Density:

9. Total Number of artefacts:
   - Estimated Number of artefacts: 50-100, 100-200, >500

10. Raw Material %:
    - Example Chart

11. Site complex characteristics:
    - Associated hearths, knapping floors, ST's etc
50 m from all creek beds or the bank.
<table>
<thead>
<tr>
<th>Artifact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>110 x 30 x 60</td>
<td>Chert</td>
<td>Grey/Green</td>
<td>90%</td>
<td>Platform, R&amp; Pebbl</td>
</tr>
<tr>
<td>Core</td>
<td>90 x 60 x 30</td>
<td>Chert</td>
<td>Light Brown</td>
<td>80%</td>
<td>10 kg Flake Share</td>
</tr>
<tr>
<td>Flake</td>
<td>70 x 40 x 18</td>
<td>Chert</td>
<td>Light Brown</td>
<td>60%</td>
<td>20 kg Flake Share</td>
</tr>
<tr>
<td>Mactrop</td>
<td>120 x 75 x 70</td>
<td>Garnet</td>
<td>Brown</td>
<td>100%</td>
<td>R&amp; Pebbl</td>
</tr>
</tbody>
</table>
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

ITEM NO: PDEC17/14

National Parks and Wildlife Service
Box 6076, Hurstville NSW 2220. Tel: (02) 565 9444

[Form]

ECNS Code: 250K

HEAD OFFICE USE ONLY:

NPWS Code:

Site types:

Amended by: [Signature]

Date: [Date]

Adresse:

Owner/Manager:

Site Name: [Site Name]

Local council name:

Region:

Section:

Arch. Survey:

Position no.:

Photos taken? Yes

How many attached?

How to get to the site (e.g. by road or walk from the nearest town)

Site located [Description]

Other sites in locality:

Are sites in NPWS Register? Yes

Site Types include:

Have artefacts been removed from site? No

When? [Date]

Deposited where?

Is site important to local Aboriginal owners? Yes

Contacted for this recording? Yes

Other information that is necessary to report on site:

Materials for recording reference sources, including any site of accompanying record:

The Proposed "Glenmore" Tourist Farm, Camp + Day Use Area,

Dubbo, NSW,

Checklist:

Surface visibility: Poor

Tree dead?

[Signature]

Date: 12/10/1995

Report:

[Signature]

Condition of site: Poor

[Signature]

Recommendations for management & protection plan?

[Signature]

Assessor/Instructor:

[Signature]

[Date]

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 904
<table>
<thead>
<tr>
<th>No.</th>
<th>Spec.</th>
<th>Cond.</th>
<th>State</th>
<th>Trunk diam. (cm)</th>
<th>Shape</th>
<th>Measurements</th>
<th>Length (cm)</th>
<th>Ass. marks</th>
<th>Orient</th>
<th>Condit</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-2</td>
<td>E. mi.</td>
<td>Good</td>
<td>Live</td>
<td>94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ST-1</td>
<td>D.</td>
<td>Poor</td>
<td>Dead</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Date: 12/10/15
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

ITEM NO: PDEC17/14

National Parks and Wildlife Service
Box 1967, Hurstville NSW 2220. Tel: 02) 536 5844
Standard Site Recording Form Revised 3/88

1:250,000 map sheet:

AMG Grid reference: 624191 150 EML

Site name: Gt St-L 2

Reason for investigation: Arch Survey

Position no: 194

Parish: Dubbo

Photos taken: Yes

How many attached:

How to get to the site:

Site located & offset from road or other site

Located near "Glenn Lee" Southern Boundary (see attached sheet)

There are no other sites in locality

Are sites in NPWS Register: No

Do you wish to remove any sites from the Register: No

When deposited:

Deposited where:

Is site important to local Aborigines: Yes

Provide contact name(s) & address(es):

Control Region: NLC, Dubbo

Are same reference sources used in identifying site:

Archaeological Survey

For Proposed "Glenn Lee" Training Farm, Booloon Conner, Obey Rd, Dubbo, NSW

Condition of site:

Poor, surface falling

Recommendations for management & protection (attach separate sheet if necessary):

As per report

Field recorded by:

Jim Kelton

Address/Institution:

92 Darling St

Cooma NSW 2649

Date: 12/10/1995

F. HEAD/OFFICE USE ONLY:

NPWS Site no:

Site types:

Accessioned by:

Date:

Data entered by:

Date:

Owner/Manager:

Address:

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 909
<table>
<thead>
<tr>
<th>ITEM NO: PDEC17/14</th>
</tr>
</thead>
</table>

**APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL**

**SITE POSITION & ENVIRONMENT**

<table>
<thead>
<tr>
<th>Site type:</th>
<th>Scarred Tree</th>
</tr>
</thead>
</table>

**DESCRIPTION OF SITE & CONTENTS.**

As per Attached Sheets.

**CHECKLIST TO HELP:**

- length, width, depth, height of site, shelter, deposits, structure, elements, edges, scars, grooves, rock.
- DEPOSITS: colour, texture, estimated depth, size, composition, contents, shell, plant, stone, charcoal, density & distribution of these, stone tools, artefact types.
- ARTIFACTS: surface decorated, motifs, designs: wet, dry, pigment,technical, engraving, no. of figures, sizes, position.
- BURNING: number, condition of bone, position, age, sex, exposed artefacts.
- TREES: number, size, dead, living age, size, shape, position, size, position, size, width, ring growth.
- QUARRIES: rock type, mineral, identifiable artefacts, percentage squared.

**OTHER SITES:**

- Structures (forts, mounds, shelter, rock art, walls, rock, etc.):
- Sites (wells, springs, springs, oases, rock art, rock walls, rock shelters, rock art, rock walls, rock shelters, rock art, rock walls, rock shelters).

**Attach/sketch, etc., eg. plan, & section of shelter, show relation between site contents, indicate north, show scale.**

**Attach photos if useful showing scale, particularly for art sites.**
### Scarred Tree Site Details

**Date:** 12/10/98

<table>
<thead>
<tr>
<th>No.</th>
<th>Spec.</th>
<th>Cond.</th>
<th>State</th>
<th>Trunk diam (cm)</th>
<th>Shape</th>
<th>Measurements (cm)</th>
<th>Reg. H (cm)</th>
<th>Ax marks</th>
<th>Orient</th>
<th>Cond.</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-1</td>
<td>MIC</td>
<td>GOOD</td>
<td>VIVE</td>
<td>94</td>
<td>TBED</td>
<td>66</td>
<td>30</td>
<td>6</td>
<td>12</td>
<td>E</td>
<td>E</td>
</tr>
</tbody>
</table>

---

**Notes:**

- ST-1: MIC, GOOD, VIVE, 94, TBED, 66, 30, 6, 12, E, E.
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

PLANNING, DEVELOPMENT AND ENVIRONMENT COMMITTEE
Page 914
APPENDIX NO: 2 - AMENDED PLANNING PROPOSAL

ITEM NO: PDEC17/14

SITE: POSITION & ENVIRONMENT

1. Land form: a. beach/hill/ridge/top, etc: Alluvial Flat
   b. site aspect: 20 degrees
   c. slope: < 10

2. Local rock type: Sandstone
   2.1 Land use/afect: Grazing, Cultivation

3. Resource Zone associated with site (estuarine, riverine, forest, etc.):
   Unnamed riparian creek
   Open woodland (grazing)

4. Vegetation: Eucalyptus schophylla

5. Edible plants noted: 

6. Faunal resources (include adrenaline):

7. Other resources (rocks, pebbles, chine, etc.):

Site type: Isolated

DESCRIPTION OF SITE & CONTENTS:

Note state of preservation of site & contents. Do NOT dig, disturb, damage site or contents.

As for Attached Sheets

CHECKLIST TO HELP:
length, width, depth, shape of site, shelter, overhang, structure, element eg. top, base, crown, sides, etc.
DEPOSIT: colour, texture, estimated depth, stratigraphy, consistency, shape, area, size, charcoal, density
6. Discard of debris, cookies, artefact type.
ARTIFACTS: number & condition of zone, position, age, sex, associated artefact.
TREES: number, site, species, life, size, shape, position, size, pattern, artefacts, regrowth.
OILS: rock type, debris, recognition artefacts, percentage, quality.

OTHERS: assistants, etc. structures (walls, traps, stones, arrangements, stone rings, art, tracer, mythology, grooves, rock holes, engraved, groove, channels, contact sites, imprints, measures, artefacts, etc., appropriate.

Attach sketches, etc. eg. plan & sections of shelter, show relation between site and contents, indicate north, show scale.
Attach annotated photos (stereo if useful) showing scale, particularly for art sites.
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Landform Unit: Alluvial Creek Flat</td>
</tr>
<tr>
<td>2.</td>
<td>Nature of deposit: Sandy</td>
</tr>
<tr>
<td>3.</td>
<td>Erosion: Open Grazing/Guttering</td>
</tr>
<tr>
<td>4.</td>
<td>Site Exposures and Extent: Area: m²</td>
</tr>
<tr>
<td>5.</td>
<td>Surface Visibility (est.): 20-50%</td>
</tr>
<tr>
<td>6.</td>
<td>Present Landuse: Grazing/ Cultivated</td>
</tr>
<tr>
<td>7.</td>
<td>Type of Archaeological Material Present:</td>
</tr>
<tr>
<td>8.</td>
<td>Artefacts in situ? No</td>
</tr>
<tr>
<td>9.</td>
<td>Artefact Density: 1 m² Max.</td>
</tr>
<tr>
<td>10.</td>
<td>Total Number of Artefacts:</td>
</tr>
<tr>
<td>11.</td>
<td>Site complex characterisation: Associated hearths, knapping floors, Bl’s etc.</td>
</tr>
</tbody>
</table>
IE-13 located approx. 70 m. north of OS-3 in Stream Creek Flat.

Glen Lee Bedrock

Glen Lee House

Stream Creek

OS-3

OS-2 (5 m from creek bed) in elevated bank.
**Site Name/No.:** GR805-4  GL-1F-2  
**Date:** 23-10-1985

<table>
<thead>
<tr>
<th>Artifact</th>
<th>Dimensions (cm)</th>
<th>Material</th>
<th>Colour</th>
<th>Cortex (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milestone</td>
<td>170 100 50</td>
<td>Sandstone</td>
<td>grey brown</td>
<td>red</td>
<td>bi-facial use, slight depression on both flat surfaces</td>
</tr>
</tbody>
</table>
PLANNING PROPOSAL
LOT 8 DP1063425
4L CAMP ROAD
DUBBO

Please find enclosed copies of amended plans for the abovementioned project. The proposed lot layout for the subject land has been amended as discussed with you, such that all dwelling envelopes are located outside an anticipated noise impact range of 55 to 65dB(A) from activities at Morris Park Motor Sport Complex.

The changes to the layout have increased lot density within the development footprint, while retaining a larger area to be offset as an environmental protection zone.

Because of the changes to the layout, Bushfire Assessment has been reviewed as outlined below:

**Bushfire Prone Land**

The subject land is partially identified as bushfire prone. The bushfire prone land is largely limited by the hilly vegetated land to the east of the site. Where dwellings are proposed on bushfire prone land, consideration must be given to the predominant vegetation, effective slope of the land, fire weather, fire intensity and building classification. These factors are used to design an appropriate asset protection zone.

The vegetation on the site, as described above, most closely conforms to a vegetation class formation of Central Western Grasslands for most proposed building sites. Where sites are located near the vegetated hilly area of the site, the vegetation classification more closely
conforms to a vegetation class formation of Dry Sclerophyll Forests with Shrubby sub formation. Proposed dwelling sites have been located downslope from the vegetated hilly land which poses the greatest risk in terms of bushfire attack. The effective slope from proposed dwelling sites in the direction of the bushfire prone land has been measured using LIDAR data, with a maximum value of 9% slope or 5.8°. All upslope vegetation is considered to have an effective slope classification of [i] or 0°. When considering downslope vegetation, all proposed dwelling sites have a predominant downslope vegetation classification of Central Western Grasslands. Effective downslopes have been measured using LIDAR data, with average downslopes of 2.5°, and maximum downslopes of 3.3°. This gives an effective downslope classification of [ii] >0 to 5° downslope vegetation.

The Dubbo area falls within the Lower Central West Plains Fire Weather Area, with a Fire Danger Index (FDI) of 80.

Planning for Bushfire Protection 2006, Appendix 2, Section 2.3 (d) states:

Grasslands of 100 metres from any boundary (subdivision) or buildings (SFPPs) do not require construction requirements in conformity with AS 3959 – 1999 or this document but requires an APZ of 10 metres for slopes <18°.

In consideration of upslope or >0°-5° downslope Dry Sclerophyll Forests with Shubby sub formation vegetation in FDI 80 areas, Table A2.5 of Planning for Bushfire Protection requires an asset protection zone of 20 respectively based on a construction level of 3. For a Level 1 construction, separation distances of 23 to 100m are required to the predominant vegetation. All lots shown on the proposed site plan in Appendix B have sufficient area to provide setbacks to boundaries of at least 20 metres.
<table>
<thead>
<tr>
<th>Proposed Lot</th>
<th>Bushfire Classification</th>
<th>Effective Slope</th>
<th>Vegetation Classification</th>
<th>APZ</th>
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<td>31 Buffer and Bushfire Prone</td>
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<td>32 Buffer and Bushfire Prone</td>
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<td>34 Buffer Zone</td>
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<td>&gt;0°-5° downslope</td>
<td>Grassland</td>
<td>10m</td>
</tr>
</tbody>
</table>
Dwelling envelopes have been shown on the proposed lot layout which provide a minimum 20 metre setback to boundaries. This enables each lot to control and manage an APZ without relying on neighbouring properties.

An APZ consists of two areas, an Inner Protection Area (IPA) and an Outer Protection Area (OPA). The OPA serves to reduce the potential length of the flames, filtering embers and reducing the likelihood of crown fire. The OPA should provide tree canopy cover of less than 30% and should have the understorey managed (mowed) to treat all shrubs and grasses on an annual basis in advance of the fire season. The IPA is critical and provides a defendable space and manages heat intensities at the building surface. The IPA should provide tree canopy cover of less than 15% and should be located greater than 2 metres from any part of the roofline of the dwelling. Garden beds of flammable shrubs are not to be located under trees and should be no closer than 10 metres from an exposed window or door. Trees should have lower limbs removed up to a height of 2 metres above the ground.

A diagram explaining asset protection zones is shown below:

If an adequate APZ is not able to be provided within the subject land, the level of construction of the dwelling will have to be increased. Bushfire mapping for the subject land can be seen below:
Planning for Bushfire Protection 2006 requires that any LEP amendment which changes the zoning and/or land use of bushfire prone land address the following items:

**Planning Principles for Rezoning to Residential Land in Bush Fire Prone Areas**

(a) Provision of a perimeter road with two way access which delineates the extent of the intended development;

(b) Provision, at the urban bushland interface, for the establishment of adequate asset protection zones for future housing;

(c) Specifying minimum residential lot depths to accommodate asset protection zones for lots on perimeter roads;

(d) Minimising the perimeter of the area of land, interfacing the hazard, which may be developed;

(e) Introduction of controls which avoid placing inappropriate developments in hazardous areas; and

(f) Introduction of controls on the placement of combustible materials in asset protection zones.

The planning proposal meets the requirements of Planning for Bushfire Protection 2006 as follows:

a) The proposed road servicing the development is a through road. Where lots are serviced by a cul-de-sac, the land is not classified as bushfire prone. In the land not classified as bushfire prone, there is a perimeter road (crown road). This crown road could be formed to provide suitable access for rural fire service vehicles. Proposed dwelling lots within the bushfire prone land are generally situated with the fire danger
areas upslope and have frontage to a fully formed and sealed proposed through road. Such access is considered adequate.
b) Adequate asset protection zones are able to be provided as outlined above.
c) All lots in the concept layout plan provided have been designed with consideration for provision of adequate asset protection zones.
d) Minimal development is proposed in land which is classified as bushfire prone. The interface between the proposed development and the hazard has been minimised by the lot design.
e) No inappropriate development is proposed on the subject land. Controls are currently in place at development application stage for bushfire hazard, requiring a Bushfire Assessment Report to be prepared and submitted to Rural Fire Service NSW with a development application for subdivision. Any dwelling proposed within bushfire prone land must meet the requirements of Planning for Bushfire Protection 2006.
f) It is possible for Council to require asset protection zones to be created on dwelling lots within bushfire prone areas. This can be done at development consent by way of a condition requiring a restriction on the use of land which ensures that the land will create and maintain an asset protection zone over the land. The possible wording for such a restriction is as follows:

Land shown as (A) on the plan must be maintained as an Asset Protection Zone for bush fire fighting purposes. The Asset Protection Zone is to be a buffer zone between a bush fire hazard and the dwelling envelope which is managed to reduce potential radiant heat levels, flame ember and smoke attack. The Asset Protection Zone should provide tree cover of less than 15% and should be located further than 2 metres from any part of the roofline of a dwelling. Garden beds of flammable shrubs are not to be located under trees and should be no closer than 10 metres to an exposed window or door. Trees should have lower limbs removed up to a height of 2 metres above the ground. Understorey vegetation should be managed (mowed) to treat all shrubs and grasses on an annual basis in advance of the fire season.

If you have any further queries please do not hesitate to contact me.

Yours faithfully,

Eric Smith
Surveyor Registered Under
The Surveying & Spatial Information Act 2002
REPORT: Proposed New Policy - Council's Response to Sick and Injured Animals not in Council's Care

AUTHOR: Manager Environmental Control
REPORT DATE: 5 December 2017
TRIM REFERENCE: ID17/2177

EXECUTIVE SUMMARY

Ranger Services provide services to the community after hours with call-outs restricted to those that are public safety emergencies such as dog attacks and stock on roads. A significant gap has been identified in relation to the response to injured animals after hours. With no RSPCA or other community organisation in the area with the capacity to respond, and local veterinary practices unable to attend sites away from their practice due to Work, Health and Safety concerns, the expectation consequently is for Council to attend and take responsibility for the animals and the associated veterinary costs, until the animal has been claimed by its owner.

There is no legislative requirement for Council to take on this responsibility and therefore the matter is proposed to be presented to Council in the form of a draft policy to seek feedback from the community as to whether it is supportive of the use of Council resources for this purpose. A draft Policy is attached here in Appendix 1.

ORGANISATIONAL VALUES

Customer Focused: This report aims to meet community expectations to ensure injured animals receive the required treatment prior to an owner being found.
Integrity: Filling this recognised gap in a service within our local government area shows that Council is showing a duty of care to the community and reducing the potential pain and suffering of our residents’ pets.
One Team: The proposed Policy extends this organisational value to our stakeholders showing that we not only work together as an organisation but as a community to achieve desired outcomes.

FINANCIAL IMPLICATIONS

Adding these services will increase Ranger overtime and veterinary costs incurred by Council. It is estimated that the additional veterinary costs could be in the order of $15,000 to $25,000 per annum above the current $38,000 veterinary costs for Shelter services. To cover the costs for the remaining 2017/2018 period, the annual Companion Animals Welfare Scheme would not be undertaken and that budget reallocated for this purpose.
POLICY IMPLICATIONS

A new Council Policy is proposed, namely, Injured Companion Animals not in Council’s Care.

RECOMMENDATION

1. That the draft Policy, ‘Injured Companion Animals not in Council’s Care’ (Appendix 1) be placed on public exhibition for a period of not less than 28 days.

2. That a further report be provided to Council for consideration following public exhibition of the draft Policy.

Debbie Archer
Manager Environmental Control
BACKGROUND

The responsibility of injured animals that are not in Council’s control is not the responsibility of Council however there is some indication that Council in the past has accepted some of this responsibility and the associated veterinary costs. Animal welfare is regulated by the Prevention of Cruelty to Animals Act, 1979 (POCTA), with the RSPCA and the Police having the relevant authority. POCTA protects the welfare of animals requiring that appropriate care be given when required by any person that has injured the animal or is in possession of the injured animal.

The Department of Local Government Circular No. 01/18 dated 13 March 2001 (Appendix 2) and correspondence from the Division of Local Government dated 20 July 2012 (Appendix 3) outline Council’s responsibilities for injured animals. Both documents indicate that Council is not responsible for an animal or associated costs until Council has been notified and the animal has been impounded.

A survey of 45 NSW councils in 2012 revealed that:

- 24.4% of councils require rangers to always attend injured companion animals after hours. The majority of these were smaller regional councils where no other services are available;
- 46.7% attend sometimes, usually when the RSPCA or the police are unable to attend, if there is a public risk or at request by a councillor or the police;
- 64.4% never cover the cost of veterinary treatment prior to the animal coming under their control;
- 73.7% responded that veterinary practices cover the cost of treatment, not council; and
- 93.3% of respondents collect stray, uninjured animals from veterinary practices if dropped off by the public.

In the former Dubbo City Council area it has historically been up to the community member that finds an injured animal to seek veterinary care and the cost of that care to be agreed on by the veterinary practice with the person or owner, with the practice undertaking their own processes to recover costs from the owner, where known. Council has until recently utilised all four Dubbo veterinary practices on a monthly roster basis to provide services to Council with a Memorandum of Understanding (MOU) and agreed fee schedule providing discounted rates for Council services.

REPORT

Relevant Legislation

Companion Animals Act 1998

- Section 6A details the general duties of councils under this Act
  
  (1) A council is required:
(a) to promote awareness within its area of the requirements of this Act with respect to the ownership of companion animals, and
(b) to take such steps as are appropriate to ensure that it is notified or otherwise made aware of the existence of all dangerous, menacing and restricted dogs (including dogs that might reasonably be considered to be the subject of a declaration under Division 1 or 6 of Part 5) that are ordinarily kept within its area.

**Prevention of Cruelty to Animals Act, 1979 (POCTA)**

Council’s responsibilities under POCTA are to provide care to any animal in Council’s control which includes animals impounded, owned or in possession of Council. Council has no legal responsibility to accept the responsibility of an injured or ill animal from another person that is not complying with their responsibilities under POCTA.

- Section 5, (3)(c) of the Act requires that a person in charge of an animal shall not fail at any time, where it is necessary for the animal to be provided with veterinary treatment, whether or not over a period of time, to provide it with that treatment. For these purposes a person in charge is defined as the owner or a person who has the animal in the person’s possession or custody, or under the person’s care, control or supervision.

- Section 14 states that the driver of a vehicle which strikes and injures an animal (other than a bird) shall not fail:

  (a) where, in consequence of the injury, pain has been inflicted upon the animal - to take reasonable steps to alleviate the pain, and
  (b) where that driver believes, or ought reasonably believe, that the animal is a domestic animal - to inform, as soon as practicable, an officer or a person in charge of the animal that the animal has been injured.

- Section 26AA details the powers of veterinary practitioners to destroy animals

  (1) Where, in the opinion of a veterinary practitioner:

    (a) an animal is so severely injured, so diseased or in such a physical condition that it is cruel to keep it alive, and
    (b) the animal is not about to be destroyed, or is about to be destroyed in a manner that will inflict unnecessary pain upon the animal,

    the veterinary practitioner may:

    (c) take possession of the animal,
    (d) remove the animal to such place as the veterinary practitioner thinks fit, and
    (e) destroy the animal, or cause it to be destroyed, in a manner that causes it to die quickly and without unnecessary pain.
The reasonable costs incurred by a veterinary practitioner in the exercise of the powers conferred upon the veterinary practitioner by subsection (1) in respect of an animal may be recovered from the owner of the animal as a debt in a court of competent jurisdiction by the veterinary practitioner.

Vet Practices Regulation 2013

- Schedule 2 - Veterinary practitioners code of professional conduct states:

  (2) Welfare of animals must be considered

  A veterinary practitioner must at all times consider the welfare of animals when practising veterinary science.

  (3) No refusal of pain relief

  (1) A veterinary practitioner must not refuse to provide relief of pain or suffering to an animal that is in his or her presence.

  (2) In this clause, relief, in relation to pain or suffering, means:

    (a) first aid treatment, or
    (b) timely referral to another veterinary practitioner, or
    (c) euthanasia,

    as appropriate.

(16) Fees for veterinary services

  A veterinary practitioner must, where it is practicable to do so and before providing veterinary services in relation to an animal, inform the person responsible for the care of the animal of:

  (a) the likely extent and outcome of the veterinary services, and
  (b) the estimated cost of those services.

The responsibility of injured animals has been continually discussed amongst Council and veterinary practitioners for many years with numerous attempts by Council’s former Companion Animals Advisory Committee to develop a clear understanding and agreement on the process and responsibilities. The issue only appears to be in relation to Companion Animals due to Council’s unrelated responsibilities to regulate and impound these under the Companion Animals Act. Council rarely receives requests to take responsibility for injured wildlife, stock or other pets (rabbits, birds, turtles, lizards, etc).
In addition to the abovementioned Circular and correspondence from the Office of Local Government (OLG), clarification was sought from LGNSW Legal Officer, Bruce McCann who conferred that the original advice provided by the OLG still stands and that it is not Council’s responsibility until the animal is in our care.

With neither Council nor veterinary practitioners ultimately responsible for injured companion animals, an acceptable resolution has never been reached. Due to the unresolved issue, all four veterinary practices recently refused to enter into the most recent Memorandum of Understanding (MOU) for services to Council with one practitioner ceasing its provision of services to Council. In an attempt to form a final position on the matter, this report presents the legal responsibilities and community expectations for Council’s consideration and possible allocation of resources in accordance with the proposed Policy, Injured Companion Animals not in Council’s Care.

Council is already experiencing an increase in these costs during business hours with the public presenting stray injured animals to a veterinary practice and Council being contacted immediately to impound the animal and authorise treatment. Where the owner is present or able to be contacted due to a microchip, a veterinary practice should contact the owner for authorisation and recover costs directly from the owner without Council’s involvement however veterinary practitioners are reluctant to do so if the owner is not a current client. Where Council is contacted, authorisation is only given for basic first aid and pain relief to allow an opportunity for the owner to be found and authorise further treatment if required. Where injuries are severe and no owner can be located, euthanasia may be authorised. A veterinary practitioner can choose to euthanize without any authorisation from Council if it is their opinion that it would be cruel to keep the animal alive.

Input was requested from local veterinary practices so that their position could be adequately detailed in this report. In order to gain this feedback it was agreed that their comments would be kept confidential. Submissions and discussions with the practices in summary detailed that injured animals are a risk to the public and are unpredictable and therefore Council Rangers that have appropriate training should be attending and taking control of these animals to negate any public safety issues. In addition, the concern is that the ‘Good Samaritan’ member of the public that may attempt to assist an injured animal is responsible for the costs of initial veterinary care which may result in animals not receiving any assistance or veterinary care, resulting in further pain and suffering. It is the vets’ view that the community expects Council to respond to these matters for the welfare of animals. One submission estimates that incidents would not exceed once per week with an annual cost of less than $25,000. It has also been suggested that should Council fail to address the issue the long standing relationship and services provided to Council is likely to be discontinued.

It is assumed that these costs account for initial first aid treatment, pain relief or euthanasia only and veterinary call-out fees where required which would be less than $500 per animal. Further basic treatment and pain relief would be authorised by Council once notified that the animal was to be impounded. Attempts are made by Council to recover veterinary fees from the owner but Ranger overtime/call-out costs are not recovered from the owner should the animal be claimed.
A high portion of stray animals are not owned by responsible pet owners however a range of circumstances can lead to responsible owners’ pets becoming unsecured also. Unfortunately, only a small percentage of injured animals are claimed, with costs of veterinary care, registration and impound fees discouraging owners from coming forward. Often those that do claim their animal are extremely grateful that their pet received treatment. Should Council take on the initial veterinary care costs, these release fees would be even higher for the owner and therefore the likelihood of the animal being claimed could be further reduced meaning that Council would bear the total cost of injured, stray animals. Current veterinary costs are approximately $38,000 per year which includes desexing of adoption animals which are fully recovered at the point of sale.

Additional concerns raised by veterinary practices include that it is becoming more difficult to retain young veterinary practitioners in Dubbo with after-hours call-outs and high euthanasia requirements becoming a disincentive for these practitioners to stay. The Work, Health and Safety issues for young practitioners responding to call-outs alone, late at night, in isolated areas with inadequate equipment is also of concern for the practitioners.

Rangers are equipped with the appropriate equipment to handle injured and aggressive animals, whereas community members are not. Injured animals may be scared and aggressive and therefore difficult to handle. After-hours rangers generally operate alone or request police support for more urgent assistance. The alternate Dubbo or Wellington Ranger can also assist when required however in the case of an injured animal the response time is likely to be too long to render the required assistance to reduce pain and suffering in a timely manner. Although most veterinary practices provide an on-call service, this does not extend to responding in the field.

On the assumption that these incidents only occur approximately once a week, the impact on ranger call-outs would result in 2-4 hours additional overtime. Being that this is after hours, there may be an impact on the rangers. Excessive call-outs can significantly impact a ranger’s ability to effectively perform their duties and therefore additional resources may be required for relief or time may be lost during normal hours if incidents are excessive.

Should Council agree to provide this additional service it is not proposed that Council take on the responsibility for any sick or injured animal that is in the possession of an owner. In this instance, the owner is to instruct the veterinary practitioner in regards to the level of care they are willing to authorise. Should financial restrictions prevent the owner from authorising the care, it is then a matter for the practitioner to negotiate the cost of treatment or to provide pain relief or euthanasia in accordance with their responsibilities under their code of professional conduct, and to recover the cost as a debt from the owner.
SUMMARY

With the absence of any other local organisation able to take on the responsibility of responding to injured animals and to prevent unnecessary suffering of injured companion animals, it will be necessary that Council allocate the required resources for ranger response and veterinary costs should the draft Policy be ultimately adopted. The proposed Policy outlines the parameters of this arrangement.

In taking on this responsibility, the concern that currently exists between Council and local vets would be reduced, veterinary services to Council could be retained, and the relationship could be strengthened. As a result, an enhanced service would be provided by Council to the Dubbo Regional Council area, and potentially, the community, giving residents peace of mind that should their animal be injured, it has the best possible chance of receiving the care it requires without delay.

Appendices:
1. Draft Policy - Injured Companion Animals not in Council’s Care/Impound
2. Correspondence from DLG dated 20 July 2012
3. DLG Circular dated 13 March 2001 - Stray and Injured Animals
COUNCIL POLICY

Injured Companion Animals not in Council’s Care/Impound

Date 22 November 2017
Council Resolution Date
Clause Number

Responsible Position Manager Environmental Control
Branch Environmental Control
Division Planning and Environment
Version 1
TRIM Reference Number
Review Period 2 years
Review Date December 2019
Consultation Executive Leadership Team 28 November 2017
Planning Development and Environment Committee 11 December 2017
Public consultation (from/to dates)

Document Revision History
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POLICY

PURPOSE
To detail the circumstances where Council will respond to incidents of injured, stray companion animals and provide veterinary treatment at Council's cost to prevent unnecessary pain and suffering to the animal.

BACKGROUND AND RELATED LEGISLATION
Council is required under the Companion Animals Act, 1998 (CAA) to raise awareness of the requirements of the Act and to be aware of the existence of all dangerous, menacing and restricted dogs within the Council area. Council does not have any legal responsibility for animals that are not yet under Council's care and control.

The responsibility of injured animals that are not in Council's control is not the responsibility of Council and this position is supported by the Office of Local Government. Animal welfare is regulated by the Prevention of Cruelty to Animals Act, 1979 (POCTA), with the RSPCA and police having the relevant authority. POCTA protects the welfare of animals requiring that appropriate care be given when required by any person that has injured the animal or is in possession of the animal.

A significant gap has been identified in relation to the response to injured companion animals, after hours in particular. With no RSPCA or other community organisation in the area with the capacity to respond, and local vets unable to attend, the expectation is that Council would take on this responsibility, including the associated veterinary costs, until an owner has claimed the animal. Costs may be recovered from the owner if the animal is claimed.

Related legislation:
- Companion Animals Act, 1998 -- Section 6A
- Prevention of Cruelty to Animals Act, 1979 -- Sections 5, 14 and 26AA
- Vet Practices Regulation -- Schedule 2, Veterinary Practitioner's Code of Professional Conduct

SCOPE
Stray companion animals may become injured by incidents such as vehicle strikes or dog attacks. POCTA requires the driver or a person in charge of an animal to seek appropriate veterinary care when required. Due to the likelihood that this person would be responsible for the associated costs, animals may suffer unnecessarily as it is possible no one may take responsibility for the animal.
This Policy aims to address this gap by allowing Council resources to be utilised for ranger attendance at these incidents. In addition, Council will cover the costs of basic treatment, pain relief or euthanasia until the owner can be contacted, the animal claimed and fees recovered.

It is not the intent of this Policy for Council to financially assist pet owners that cannot pay for urgent vet care, but instead to ensure that an animal is given appropriate care to relieve pain and suffering until the owner can be contacted and the animal claimed. Council will not assume the responsibility and cost for companion animals whose owner is present, easily identified, or where the animal is in the possession of a person responsible for its care.

Council’s responsibilities and procedures for the care of sick and injured animals under its control are not included in this Policy.

POLICY

1. Where notified, Council rangers will respond to incidents of sick or injured stray animals and authorise basic first aid, pain relief or euthanasia in accordance with a vet’s recommendations and impound the animal.

2. Costly procedures such as x-rays and surgery will not be authorised by Council and therefore euthanasia may be required if a vet considers it cruel to keep the animal alive without further treatment.

3. Council response times include during business hours and after hours by the ranger on-call where available.

4. Council will not respond or accept veterinary costs where the animal is in the possession of its owner or a person representing the owner or responsible for the animal.

5. Where a stray, sick or injured animal is presented to a vet and the person in possession cannot cover the costs of treatment, and is not the owner or responsible for the animal, Council will accept responsibility for the cost of basic first aid, pain relief or euthanasia to a maximum of $350, and impound the animal.

6. Council will not accept the surrender of sick or injured animals by their owners. Owners must comply with their responsibilities under POCTA and seek veterinary care. Failure to comply with their responsibilities, such as abandoning an animal, will result in Council reporting the matter to the RSPCA.

7. Veterinary practices are encouraged to make attempts to contact the owner of an animal (eg from a microchip) and obtain authorisation and payment for treatment without involvement from Council. Where an owner cannot be contacted, Council must be advised in accordance with the requirements of the CAA.
8. Once Council accepts responsibility for a companion animal, the animal is considered to be impounded and must not be released to the owner without Council authorisation and impound fees being paid.

RESPONSIBILITIES

Council’s Ranger and Impounding Services are responsible for enforcing and enacting this Policy.

Customers may contact Council to report an incident by calling 6801 4000.

Animals other than companion animals are not covered under this Policy. Organisations such as RSPCA, WIRES, NPWS or LLS may be able to assist.

DEFINITIONS

To assist in interpretation, the following definitions apply:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSPCA</td>
<td>Royal Society for the Prevention of Cruelty to Animals</td>
</tr>
<tr>
<td>POCTA</td>
<td>Prevention of Cruelty to Animals Act, 1979</td>
</tr>
<tr>
<td>CAA</td>
<td>Companion Animals Act, 1998</td>
</tr>
<tr>
<td>Owner</td>
<td>Each of the following persons is the owner of a companion animal: (a) the owner of the animal (in the sense of being the owner of the animal as personal property), (b) the person by whom the animal is ordinarily kept, (c) the registered owner of the animal.</td>
</tr>
<tr>
<td>WIRES</td>
<td>NSW Wildlife Information, Rescue and Education Service</td>
</tr>
<tr>
<td>NPWS</td>
<td>National Parks and Wildlife Service</td>
</tr>
<tr>
<td>LLS</td>
<td>Local Land Services</td>
</tr>
</tbody>
</table>
Dear Mr Riley,

I am writing in reply to an email of 15 June 2012 from Ms Debbie Archer, Manager Environmental Control, Dubbo City Council, about the responsibility for the care and welfare of injured or stray animals.

The Division of Local Government, Department of Premier and Cabinet administers the policy and legal framework within which NSW councils manage their companion animal responsibilities. Although it is not the Division’s role to provide legal advice to councils or members of the public, or to comment on specific circumstances, this general information is provided for your assistance.

The Companion Animals Act 1998 (the Act) requires an authorised officer who seizes an animal — or a person who finds a lost or injured animal — to deliver the animal to its owner; a council pound or an approved premises. Approved premises include any approved animal welfare organisation or a veterinary practice operated by an approved person.

When a seized or lost animal is delivered to an approved premises or a council pound, the person in charge must do their best to find out who the owner of the animal is and return the animal to that person. To help with this, an approved person may access information on the NSW Companion Animals Register.

If an animal’s owner cannot be located, the operator of an approved premises can contact the local council of the area at any time within a period of 72 hours from accepting the animal. If an animal is not claimed within 72 hours, the operator of the approved premises must arrange for the animal to be taken to a council pound.

Veterinary practices or approved persons are not authorised under the Act to otherwise re-home companion animals. Further information about approved premises is in the Guidelines for approved persons to access the NSW Companion Animals Register, which can be found on the Division of Local Government website at www.dlg.nsw.gov.au.
Councils must accept and facilitate delivery of an animal to its owner or a council pound. However, if an animal is injured and the council's pound facility is not suitable to house it, the council may arrange for the animal to be cared for by an approved premises, an animal welfare organisation or other vet as appropriate. This is a matter for individual councils to decide. Councils are not responsible for veterinary costs before an animal is delivered to a pound, unless these costs are authorised by the council.

If treatment has not been authorised by the animal's owner or a council, an approved premises may wish to establish independent procedures to recover costs from an animal's owner for any treatment administered. This may include euthanasia costs if an animal cannot be saved or a veterinary practitioner believes it is inhumane to keep the animal alive.

If the Council remains in any doubt, it may wish to seek and be guided by independent legal advice on any matters of concern.

I hope this information is of assistance.

Yours sincerely,

Ross Woodward
Chief Executive, Local Government
A Division of the Department of Premier and Cabinet
COMPANION ANIMALS - STRAY & INJURED ANIMALS
FREQUENTLY ASKED QUESTIONS

Councils, vets and members of the general public have been contacting the Department seeking information about what they should do with stray and injured animals in relation to the Companion Animals Act 1998.

A Frequently Asked Questions (FAQ) document has been prepared on this issue and is attached. Councils may use this information to inform staff dealing with companion animals enquiries or to distribute to local vets or general public seeking information on this issue. A copy of the FAQ is also located on the companion animals web page at www.dig.nsw.gov.au/companion.htm.

Councils are reminded that the following FAQ documents are also available on the companion animals web page:
* General Information
* Pet Shops & Breeders
* Working Dogs

Garry Payne
Director General
APPENDIX NO: 3 - DLG CIRCULAR DATED 13 MARCH 2001 - STRAY AND INJURED ANIMALS

Companion Animals Act - Stray & Injured Animals -

Frequently Asked Questions

First Edition February 2001

FAQ - Stray & Injured Animals  First Edition Feb 2001  page 1
CONTENTS

1. When is a dog a “stray”?
2. When is a cat a “stray”?
3. What are some examples of when a dog or a cat is not a “stray”?
4. What do I do with a stray or “seized” animal?
5. What do I do with an injured animal?
6. Do councils have to collect stray dogs and cats?
7. Do councils have to have an after hours service for stray cats and dogs?
1. **When is a dog a “stray”?**

Under the Companion Animals Act 1988 any dog which is in a place (other than where it is ordinarily kept) unaccompanied by a responsible person is a “stray”.

Any person (including a council officer) may seize a stray dog in the following circumstances as provided under the Act:
- If a dog is found in a public place and is not under the effective control of some competent person (section 13)
- If a dog is in a public place prohibited under the Act (eg children’s play area or food preparation/consumption area) (section 14)
- If seizing the dog is reasonable and necessary for the protection of any person or animal or to prevent damage to property (section 22).
- If the dog has attacked a person or animal and the dog is on property owned or occupied by the person seizing the dog. (section 18)

In addition, council officers and police have powers to seize a dog which has attacked from the owner’s property if the owner is not present and the dog cannot be adequately secured on the property (section 18).

2. **When is a cat a “stray”?**

Unlike dogs, cats are allowed to roam public places and onto private property.

Under the Companion Animals Act 1988 a cat may only be seized in the following circumstances:
- If a cat is in a public place prohibited under the Act (eg food preparation/consumption area or wildlife protection area) (section 30)
- If seizing the cat is reasonable and necessary for the protection of any person or animal (section 32).

3. **What are some examples of when a dog or a cat is a “stray”?**

- A dog which is walking along the footpath, not causing any threat to anyone, may be seized as a “stray” under section 13; a cat doing the same thing may not be seized as there is no offence under the Companion Animals Act.
- A dog which comes onto your own property and digs up the garden (damaging property) may be seized under section 22; a cat doing the same thing may not be seized as there is no offence under the Companion Animals Act (however a nuisance order could be issued).
- A dog which is on the road in the way of traffic may be seized under section 22 (as it may cause an accident resulting in either injury to persons or to itself); a cat doing the same thing may be seized under section 32 (as it may cause an accident resulting in either injury to persons or to itself).
4. What do I do with a stray or “seized” animal?

A person who seizes a dog or cat under the Companion Animals Act must cause it to be delivered as soon as possible to its owner (if the owner can be identified) or to the council pound or other authorised council officer (eg ranger) (section 62). A person who does not comply with this is guilty of an offence and may be liable for a penalty of up to $2200.

Strictly speaking, delivering an uninjured animal seized under the Companion Animals Act to a vet is an offence. However, it is acknowledged that in practice many people deliver animals to their local vet surgery because it is not practicable for them to deliver the animal to a pound (eg they can walk to the vet and may not have a car to transport the animal to the pound). In this circumstance, a vet may choose not to accept the animal (which is, strictly speaking, complying with the Companion Animals Act) and advise the person to call the council ranger or take it to the council pound. If the vet does choose to accept the animal, they do so in the same context as “any person” under the Act, and must return the animal to its owner or contact the council as soon as possible. Vets should not undertake to hold the animal and re-house it themselves – there is no legal basis for the vet to give the animal to a new owner and if the original owner should come forward at some future time a vet may find themselves subject to civil legal action.

5. What do I do with an injured animal?

Any animal which is injured is not seized under the Companion Animals Act but under the Prevention of Cruelty to Animals Act 1979 (POCTA).

POCTA provides that where a cat or dog has been injured in a vehicle accident, the driver of the vehicle is responsible for ensuring that it receives appropriate treatment to alleviate pain. The driver must also, as soon as practicable, inform the owner of the animal, or an officer of the RSPCA, AWL or a police officer (section 14).

In any circumstance where an animal is injured (for example, as the result of an attack by another animal), if a person seizes or takes charge of the animal, that person is responsible for ensuring that the animal receives any necessary veterinary treatment (section 5(3)). Where an animal is so severely injured that a vet takes possession of the animal to euthanase it, the vet may recover from the owner of the animal the reasonable costs incurred in euthanising the animal (section 26A).

If the owner for an injured animal cannot be located, under the Companion Animals Act, the council should be notified. Once the animal’s condition is stabilised and it no longer requires veterinary supervision, the animal should be transferred to the council pound. Council is not liable for any costs of treatment up to this point in time (unless of course it was council who delivered the injured animal to the vet in the first place). Nor is council under any obligation to inform the vet of the owner’s details if they succeed in locating the owner (in fact this could be a breach of privacy legislation). As a courtesy council could inform the owner that the animal was treated by a particular vet and there are outstanding costs – but there’s no obligation
to do so; and if the owner chooses to ignore this information there's nothing more a council can do.

6. Do councils have to collect stray dogs and cats?

The Companion Animals Act requires a council to accept into the pound any cat or dog which is delivered to the pound or other authorised person of the council (such as a ranger). However, the Act does not require a council to collect a "stray" animal from any public or private place. Some councils do provide this as an additional service to their community, others do not. It is a discretionary matter for the particular council to decide. Whether an individual council provides a "pick up" service for animals, and if so, in what circumstances, should be indicated in a formally adopted council management plan (this may be a specific animal management plan or be part of an environmental management plan or council's general management plan). Councils should ensure that local vets, animal welfare organisations and other relevant groups are informed of what is in their plan.

7. Do councils have to have an after hours service for stray cats and dogs?

The Companion Animals Act does not require a council to have an "after hours" service for accepting cats and dogs. Again, this is a discretionary matter for council to determine. However, the majority of local councils do have some form of general "after hours" contact for their rangers. What "after hours" arrangements council has, and when and how they operate, again should be included in a council management plan. Councils should ensure that local vets, animal welfare organisations and other relevant groups are informed of what is in their plan.