An Analysis of Surface Lithics at Calperum Station, Riverland, South Australia

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A thesis submitted in fulfilment of the requirements of the degree of Master of Archaeology and Heritage Management, Department of Archaeology, Flinders University of South Australia.

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Statement of Declaration

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature: Gemma L. Incerti
Date: 19 June 2018

Abstract

This study aims to redress a gap in knowledge relating to surface assemblages of stone artefacts in South Australia's riverine environment, and is the first in this region to involve a comparative analysis of surface lithics across earth mound, billabong and lagoon landforms as well as arid dune and lake environments. Field survey at the Calperum Station Environmental Reserve (via Renmark) examined and recorded the surface lithic record for three different landforms and landscapes, the Lake Merreti lunette, Lake Clover dune and Lake Woolpolool dune. This data was examined alongside the surface lithic record recorded by Thredgold (2017), across the Reny Island billabong precinct, Hunchee Island billabong precinct, Hunchee Creek precinct and the Ral Ral Creek East mounds.

The geomorphology and taphonomy of this dynamic environment reveals continually transforming landforms, where past and ongoing fluvial, alluvial and aeolian regimes are superimposed on former landscapes. Taphonomic processes associated with historic pastoralism have greatly impacted the Calperum Station study assemblage, and are likely the cause of the high degree of flake fragmentation observed within the lithic dataset. Land management access roads and animal activities (rabbit burrowing as well as past and current animal trampling) are a particular concern for surface disturbance and stratigraphic damage, as well as post-depositional artefact fragmentation and displacement at Calperum Station. Given the nature of the geomorphology and taphonomy within the study area, it is difficult to attribute temporal interpretations on the study assemblage without further research into local Murray River valley land system mapping and greater chronological control.

Overall, the Calperum Station surface assemblage comprised good quality raw materials, where unretouched flakes were the most common artefacts recorded across all of the varying landforms. Simple flaking strategies were employed to use raw materials and manufacture expedient flakes, while more complex manufacturing and conservation strategies were employed for higher quality materials. The general expedient use of stone materials suggests access to raw materials was such that materials need not be intensively worked or reduced. It is highly likely that the silcrete and chert seams of the Karoonda Surface, which outcrops along the nearby Murray Valley cliff lines, were extremely significant areas for raw material procurement. Cores were generally exploited until exhaustion before having been discarded; suggesting that conservation strategies were employed for the reduction of raw materials. Considering the density of surface artefacts across the varying landforms and environments, lithic scatters occurred in particularly low frequencies on the earth mound landforms, and in higher concentrations across the lunette and dune landforms of Calperum Station, possibly suggesting more intensive knapping activities occurred in these lacustrine environments.

This study of varying riverine environments and landforms in conjunction with a comparative analysis of their surface lithic record has provided archaeological insights into Indigenous landscape use and the influence of local geomorphology and taphonomy for interpretations of the archaeological surface record within Australia. This research at Calperum Station has also contributed to the broader data about stone artefacts within the Riverland district of South Australia, and the Australian Murray-Darling Basin.

Acknowledgements

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Thank you to my loving family and friends, for their unwavering support, encouragement and love.

To my Nonno, Giovanni Incerti.

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Cover page photograph: Silcrete stone artefact, Lake Merreti lunette. Photograph J. Thredgold September 2016.

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Chapter 1: Introduction

1.1 Research Description

This study adopts a geoarchaeological approach to survey and examines surface stone artefacts across varying landforms at the Calperum[1] Station Environmental Reserve (Figure 1.1). Calperum Station is located 15 km north of the town of Renmark[2], in South Australia's riverine environment, part of the immense Murray-Darling Basin (Figure 1.2). Calperum Station and Chowilla[3] Station were formerly part of the larger Bookmark[4] Station that was established for sheep and cattle grazing in 1864 (Australian Government nd). The station is situated on the traditional lands of the River Murray and Mallee Aboriginal Corporation (RMMAC) and encompasses 242,800 hectares of Murray River floodplains and semi-arid Mallee bushland (Department of the Environment 2017; *Turner v State of South Australia 2011 FCA 1312 18 November 2011*).

This study is one of several student research projects that contribute to a broader collaborative research plan initiated by Flinders University Department of Archaeology Staff and RMMAC. The broader research project has multiple aims, some of which are to investigate the myriad of ways Aboriginal people engaged with and connected to country in the context of mid to late Holocene transitions in the Murray River Valley. The objective for this research thesis is to investigate whether a comparison of surface stone artefacts from varying riverine landscapes can reveal changes in resource technologies and strategies across different environments and potentially over different periods of time. This study has gathered data from surface lithics across dune and lacustrine plains in proximity to Calperum Station lake environments, and through a

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[1] 'Calperum' possibly derived from the Erawirung word 'Kalparum', meaning 'a branch road' or 'short cut' (Tindale c.1934–c.1991).

[2] 'Renmark' potentially an anglicised version of the Erawirung word 'Rengmarko' meaning source of chert stone outcrops (Tindale c.1934–c.1991).

[3] 'Chowilla' derived from the Erawirung word 'Tjauwala' signifying 'a place of spirits and ghosts' (Tindale c.1934–c.1991).

[4] 'Bookmark' an anglicised version of the Erawirung word 'Buikmiko', meaning 'round hole' (Tindale c.1934–c.1991).

comparative technological analysis with the published research by Thredgold (2017; Thredgold et al. 2017) which examined earth mound surface lithics, will explore possible differences in economies and resource utilisation across space and possibly time.

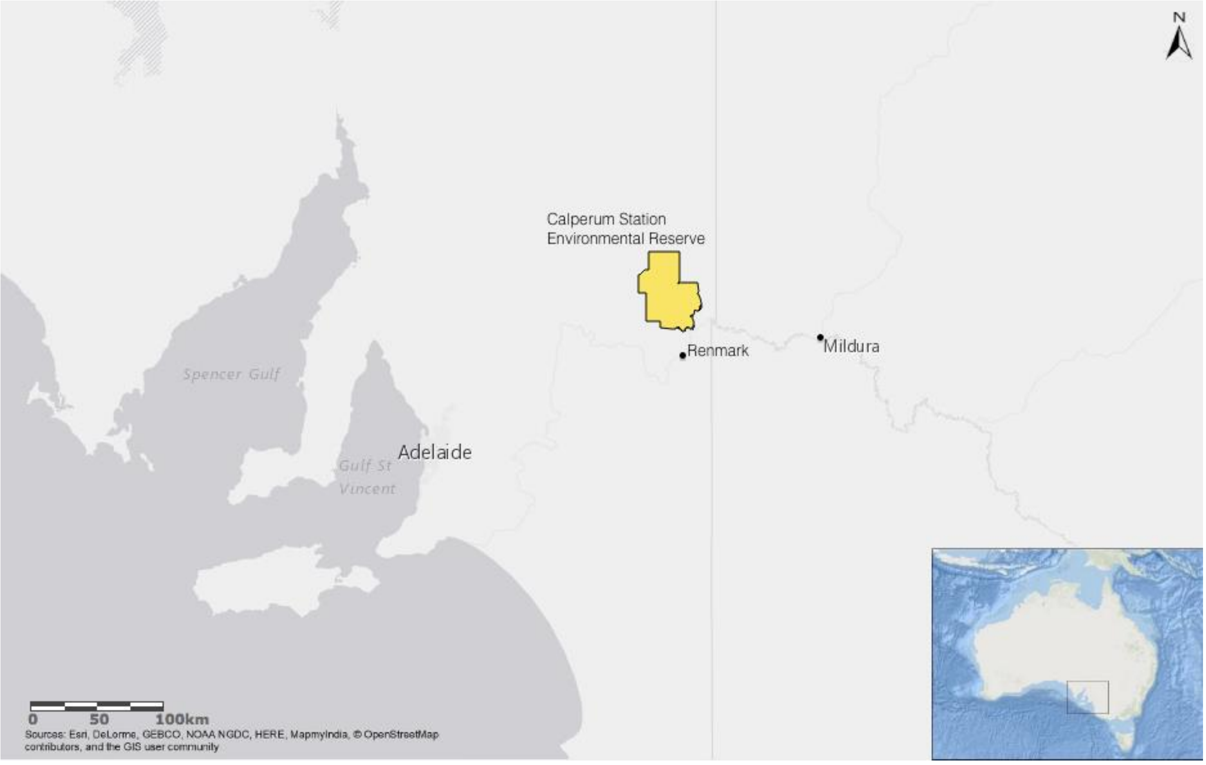

Figure 1.1 Calperum Station Environmental Reserve.

Figure 1.2 The Murray-Darling Basin and location of the Calperum study area (adapted from Murray-Darling Basin Authority 2017). *Figure removed due to copyright restrictions.*

The study area is located within a portion of the former First Peoples of the River Murray and Mallee Region native title claim area. This portion of the claim area was resolved by consent determination (see *Turner v State of South Australia 2011 FCA 1312 18 November 2011*) with the rights and interests managed by RMMAC (see Appendix 3 for detailed determination area maps). The Calperum study area lies within the boundaries of a group Tindale (1974:211) identified as Erawirung, also referred to as Jirau or Yirau by Berndt and Berndt (1993). Other descriptions of cultural boundaries also exist, however a detailed exegesis is beyond the scope of this study.

Ethnographic, historical and archaeological research reveals the Murray River territories were one of the most densely inhabited and culturally dynamic landscapes within Australia (Eyre 1845; Howitt 1904; Taplin 1879). The area of the Murray River where Calperum Station is situated, was a region of early colonial contact between local Indigenous populations and European drovers and settlers introducing cattle and sheep from New South Wales into South Australia from the 1830s (Australian Landscape Trust 2016; Bonney nd; Burke et al. 2016:148). This led to a period of brutal conflict, shootings and massacres and, in combination with the introduction of diseases, and new flora and fauna, caused a substantial decline in population, and prevented Indigenous communities from accessing their lands (Burke et al. 2016:150–153; Clarke 2009:142; Foster et al. 2001:30–43; Foster and Nettelbeck 2012:32–39). Settler and drover numbers in the area grew and Indigenous communities encountered further conflict and dispossession of land with the distribution of pastoral leases, one of the earliest in the region was Bookmark Station in 1851 (Australian Landscape Trust 2016). This property was subsequently divided into Calperum and Chowilla Stations in 1896, and Calperum Station was later sold to the Federal Government in 1993 (Australian Landscape Trust 2016).

1.2 Research Question and Aims

Using Calperum Station as a case study, this research examines the surface assemblage across varying landforms through a geoarchaeological framework and a technological lithic analysis. This approach examines the potential for variability and diversity in human behaviours, the use of stone artefacts, and practices across unique landforms that may reflect changes over time.

Primary Research Question:

> What can a comparative technological and geoarchaeological analysis of surface stone artefacts from different landforms at Calperum Station reveal about the organisation of human activities and behaviours upon and across a landscape, such as potential patterns in resource utilisation, landform-specific use of raw materials and local economies? What are the temporal complexities inherent in such an analysis?

Given the above research question, this thesis aims to:

- Survey and record surface stone artefacts at Calperum Station using technological methods to provide an insight into local resource utilisation, tool manufacture and flaking strategies and socio-economic activities.
- Examine the geomorphological and taphonomic conditions at Calperum Station and consider their impact on the lithic surface record.
- Analyse similarities, differences and trends in the surface lithic assemblage between varying Calperum landforms and environments to assess the local characteristics in the use of stone artefacts.
- Consider the temporal complexities involved with an analysis of surface lithics across variable landforms.

1.3 Project Significance

This research project is significant for several reasons. Primarily, this study is of importance to the traditional owners represented by RMMAC who supported this research on their country. This project will contribute to broader investigations in the local area examining relationships between people and environment, local economic systems and cultural change. In conjunction with several student projects and the research of Flinders University Archaeology Staff and members of RMMAC, this study provides additional research and interpretations about their country and the actions of their ancestors.

This study addresses a gap in the known archaeology of surface stone artefact analysis in South Australia's riverine environment. In conjunction with the published research of Thredgold (2017; Thredgold et al. 2017) involving an analysis of surface lithics associated with earth mounds, this study is the first in this region to conduct a comparative analysis of surface lithics across earth mound, billabong and lagoon landforms as well as arid dune and lake environments. This study will address a current gap in geoarchaeological research for this region, and contribute to a growing body of research involving archaeological assemblages and the geomorphological settings that encapsulate them. The geomorphology in this dynamic environment reflects landforms formed during the last glacial maximum through to and beyond the Pleistocene to Holocene transition, which have and continue to transform through various underlying alluvial, fluvial and aeolian processes (Bowler et al. 2006; Prendergast et al. 2009:59, 68–69). This detailed study of differing landforms and associated cultural materials will contribute archaeological insights into the potential for a nuanced relationship between landform-specific use and manufacture of stone artefacts.

Moreover, this study is important as it will add to the broader data about stone artefacts within the Murray-Darling Basin. This research will engage with discussions surrounding lithic technology, resource utilisation, and landform occupation in this dynamic riverine environment.

1.4 Research Limitations

This research project does have several limitations. Firstly, the basis for this study is an 'on-country' analysis and, as requested by traditional owners RMMAC at the time of my project, a non-invasive methodology was utilised during the field-work for this study. Dense landscape vegetation and restricted ground surface visibility made some areas difficult to survey. Vegetation removal was prohibited by community protocols and because the study area is located in a nature reserve. This study involved systematic survey methods and aimed to reduce the potential ground visibility impeding data collection.

As an 'on-country' study, all stone artefacts were recorded in the landscape during field-work. No artefacts were collected or moved from the location in which they were identified and, as such, the process of lithic recording was subject to the constraints of local field-work conditions. This included, but was not restricted to, limited time for surveys, and varying weather conditions, indeed during the principal field season for this project in September 2016, all of South Australia encountered severe storm weather. Such circumstances necessitated the use of basic and straightforward recording methods and targeted sampling strategies (see methods in Chapter Four). Nonetheless surveying was conducted thoroughly to produce comprehensive, relevant survey records, as opposed to a desired quantity of lithics recorded. Conversely, this does demonstrate that analysis was impaired by the restrictive and arbitrary nature of the data sample size, however this has been acknowledged throughout the interpretation of results.

1.5 Thesis Outline

This thesis comprises seven chapters followed by Appendices. Chapter Two provides a review of relevant archaeological research on technological approaches to lithics analysis, geoarchaeology as a methodological framework, and regional geoarchaeological studies of surface lithics and taphonomy.

Chapter Three provides an overview of the study area and descriptions for the landforms analysed by this study. This chapter provides a geomorphological context for the Calperum Station Riverland region, and discusses prior archaeological research in the study area and the Aboriginal and historical setting.

Chapter Four outlines the survey and field methodology employed for this study. This includes an outline of the lithic recording methods, descriptions of measurements and raw materials, the Flinders University ethics approval processes and the community protocols directed by RMMAC for this research.

Chapter Five presents the field results for this study from the sample of surface lithics across dune and lacustrine landforms, including summary tables for the comparative landform data.

Chapter Six presents a comparative discussion and analysis of the data recorded during this project's Calperum field surveys, and the data obtained by Thredgold (2017; Thredgold et al. 2017) across Calperum earth mound landforms. This involves an examination of variable technological lithic attributes, and a discussion of taphonomic and geomorphological processes and conditions, which impact the preservation and interpretation of the archaeological record at Calperum.

Chapter Seven provides the conclusions for this research study reflecting on the original project aims and research question, and explores the potential for future research.

Chapter 2: Literature Review – Geoarchaeology and Lithics

Introduction

This chapter will examine key geoarchaeological methods in the context of studying a surface lithic assemblage. This is closely linked to the notion of a landscape approach to archaeology, where surveys are often undertaken at more broad or regional scales within key ecological or geomorphic features and landforms. A geoarchaeological approach can facilitate strategies for survey and sampling, and offer an environmental framework to interpret survey data (Fanning et al. 2009; Goldberg and Macphail 2006). The method can develop a deeper understanding of the behavioural significance and composition of surface artefact scatters by considering the varying processes that contribute to this archaeological record (Davies et al 2016; Holdaway and Fanning 2014). This often involves an examination of assemblage characteristics, stone artefact manufacturing strategies, raw material utilisation, and artefact or landform distributional studies. Differences or changes in patterns of surface assemblages across varying landforms can reflect the organisation of human behaviours and activities upon a physical landscape and potentially illuminate general models of landscape use (Davies et al. 2016; Tumney 2011). A geoarchaeological approach considers the 'interaction of multiple natural and cultural processes' and their impact on the preservation, variability, and interpretation of the archaeological landscapes and material records (Holdaway and Fanning 2014:1; Koopman et al. 2015).

Adopting this methodological and interpretive framework for a study of surface lithics at the Calperum Station study area will support further geoarchaeological studies in the South Australian riverine environment. This chapter will outline for context two long-running studies in New South Wales at the Fowlers Gap arid zone research station, and the Willandra Lakes system where geoarchaeological methods have been applied to surface stone artefact assemblages. Embedded in an examination of geomorphology are the local and wider taphonomic processes that impact an archaeological landscape, as discussed later in this chapter.

2.1 Geoarchaeology and a Landscape Approach to Lithics Analysis

2.1.1 Landscape Geoarchaeology

The concept of landscape approaches to archaeological surveys and research grew from critiques about the concept of archaeological 'sites' (see Dunnell 1992:34; Dunnell and Dancey 1983:271; Foley 1981; Robins 1997). To examine the surface assemblage at the Calperum Station study area through a geoarchaeological approach, the term 'site' is inappropriate to convey a culturally and geomorphically dynamic landscape. Also referred to as 'non-site', 'off-site' and 'distributional' archaeology, the broader landscape framework supports studies surveying large areas and the relationship between human behaviours and the social space they took place within (Branton 2009:50–53; Dewer and McBride 1992; Ebert 1992:70; Foley 1991). As with the geoarchaeological approach, 'distributional archaeology' examines geomorphological zones, the principal surface processes occurring across these zones, and technological attributes of archaeological material to analyse the 'life-stages' of an artefact (Ebert 1992:70, 159–170).

2.1.2 A Technological Analysis of Lithics

Technological studies identify and examine the key attributes (see Chapter Four) and morphology of stone artefacts to interpret human behaviours and activities based on extensively tested principles of fracture mechanics and flake formation (Andrefsky 2005; Barton 2001:32; Bland 2012:43; Clarkson and O'Connor 2014; Cotterell and Kamminga 1987; Hiscock 1994). As opposed to examining the design and use of 'tools' and 'implements' favoured by typological approaches to lithic analysis, technological studies investigate reduction sequences, study raw material distribution and use technological attributes to characterise assemblages (Barton 2001:32; Hiscock 2007:199; Munt 2016). Some elements of a typological approach are useful for interpreting an assemblage. A number of recognisable Australian artefact 'types', based on morphology and attributes, such as 'backed artefacts', 'tulas' and 'scapers', can reveal information and strengthen interpretations about the function and use of stone artefacts (Attenbrow et al. 2009; Clarkson and O'Connor 2014; Flenniken and White 1985; Holdaway and Stern 2004). Key stone artefact 'types', commonly examined in Australian lithic assemblages, have been included in this study to enable comparisons with the interpretations and methods adopted by Thredgold (2017). Adopting both a technological methodology for examining surface lithics, and a landscape-based approach towards archaeological survey and research, can provide a more balanced interpretation of the dynamic use of landscapes and archaeological assemblages. By considering the broader lithic assemblage, this method aims to avoid the limitations of a typological approach, examining discernable attributes as opposed to an overall form, and not prematurely inferring artefact function before more detailed use-wear and residue analysis could be undertaken. Use-wear and residue analyses are presently beyond the parameters of this on-country research project.

2.1.3 Fowlers Gap Arid Zone Research Station, NSW

The most comprehensive example of a geoarchaeological approach in the Australian context is the work of the Western New South Wales Archaeological Program (WNSWAP) at the University of New South Wales Fowlers Gap Arid Zone Research Station, with extensive publications by Fanning and Holdaway (most recently revised in Holdaway and Fanning 2014; Holdaway et al. 2015). This long-term project is located on the valley floor margins of Murray River ephemeral streams, in western NSW near the south-eastern margin of the central Australian arid zone (Fanning et al. 2009:5). The ongoing project has been researching surface archaeology through detailed geomorphological studies combined with technological and distributional analysis (Fanning and Holdaway 2001; Fanning et al. 2008, 2009; Holdaway and Fanning 2008, 2014; Holdaway et al. 1998, 2005, 2015). Dating of hearths in association with detailed studies of the geomorphological context of landforms in this region has permitted relative chronologies to assess and interpret patterns in the composition of surface assemblages (Holdaway et al. 1998). Their research has demonstrated a wealth of surface and subsurface archaeological material associated with the Holocene in combination with an essentially obscured buried record (Holdaway et al. 1998). Fanning et al. (2009:25–26) assert this simply makes it appear that the archaeological record has increased in volume over the course of the Holocene. Results from Fowlers Gap suggest the preservation of the archaeological record in any one location reflects the function of landscape dynamics and geomorphological processes, with some land surfaces encountering more frequent erosional events and preserving shorter archaeological records of occupation (Fanning et al 2008:531; Holdaway et al. 2005:36). Although chronological data is not available for the Calperum Station study area presently, adopting a geoarchaeological approach to lithics can provide an interpretive framework to understand the impact of geomorphological processes across the landscape, and assess the nature of assemblage composition.

2.1.4 Willandra Lakes, NSW

The Willandra Lakes system is situated in south-west New South Wales, near the margins of the Mallee country towards the west, comprising five large interconnected lakes and fourteen smaller basins (Bowler 1998). The lakes interrupt longitudinal east-west dunes of the Mallee country, and the lake basins are characterised by transverse crescentic dunes or lunettes along the eastern margin and an abrupt cliff on the western margin (Tumney 2011). Examining the archaeological record of the Willandra Lakes systems, particularly the surface assemblages, has been a multifaceted process comprising landscape analyses, GIS (Geographical Information Systems) modelling and the mapping of local geomorphological land systems (Allen and Holdaway 2009; Allen et al. 2008; Bowler 1998; Foley et al. 2017; Hiscock and Allen 2000; Stern 2015; Tumney 2011).

The complex nature of geomorphological processes at Willandra Lakes reflects successive fluctuations of dune erosion and exposure, and sediment and artefact deposition over extended periods of time (Tumney 2011:56). Geomorphological research conducted by Bowler (1998:154; Bowler et al. 2003) has provided a framework to understand the archaeological record through the lens of environmental history, where the entirety of the Willandra Lakes system can be perceived as an archaeological landscape. Adopting a geoarchaeological landscape approach in this region enables a broader conceptualisation of the archaeological 'sites' and assemblages in the context of their geomorphic, stratigraphic, distributional and palaeolandscape histories (Tumney 2011:56).

At the Lake Mungo and Lake Mulurulu lunettes for example, erosive processes have formed wide exposures of archaeological material, elsewhere, predominantly across clay lunettes, archaeological material is restricted to chance exposures of artefactual assemblages (Allen et al. 2008:15). Recent geoarchaeological research at the Lake Mungo lunette has revealed, through technological refitting methods, that surface stone artefact assemblages are scattered across stratified sedimentary forms as opposed to refuse lag deposits of eroding landforms (Foley et al. 2017:555). Applying geoarchaeological methodology at the Willandra Lakes system has demonstrated the potential to identify variability in patterns of landscape use across this vast region.

2.2 Taphonomy and Surface Lithics

In Australia, surface lithics are the most prevalent component of the archaeological record, however principally they have not been instrumental to early archaeological accounts of Aboriginal Australian history (Holdaway et al. 1998; Holdaway et al. 2010). This is largely due to the scarcity of local stratigraphic data that can inform the surface record, an absence of well-defined 'site' boundaries, and difficulties involved in specialised lithic technological studies (Hiscock 2008; Holdaway et al. 1998; Holdaway et al. 2010). The study of taphonomy examines the processes that can affect a place or object over time (Clarkson 2007:130–134; Schiffer 1983:678–679). Examining taphonomic processes and activities can reveal a deeper understanding of the distribution of artefacts across a given landform and a broader picture of the cultural landscape they contribute to (Hiscock 1985:83–84, 1990:40–46). Taphonomic processes are likely to have impacted the surface record at the Calperum study area and will be examined below to better understand how the surface assemblage may be influenced, and inform the recording of diagnostic features during field survey.

2.2.1 Examining Surface Assemblages

Researching surface assemblages requires an understanding of landscapes that have been subject to geomorphological processes, such as erosion and weathering, for extended periods of time. Surface lithic studies have been critiqued based on the assumption they lack fine temporal resolution and are limited in what data they can provide about past human behaviours (Sullivan 1998; Wandsnider and Camilli 1992). Although surface artefacts may lack the stratigraphy of excavated artefacts, examining surface artefacts through a geoarchaeological lens, they can be considered as the uppermost layer of sediment in a stratigraphic sequence, or the 'minimum stratigraphic unit' (Holdaway et al. 2009:10). As with stratified archaeological 'sites', most surface assemblages are not representative of single 'behavioural events', rather an accumulation of behavioural activities over time (Holdaway and Fanning 2008:171). To examine the integrity of the artefact assemblages and interpret survey data, surface landscapes must be understood in terms of the long-term and contemporary taphonomic and geomorphological processes they are exposed to (Goldberg and Macphail 2006; Holdaway and Fanning 2005).

2.2.2 The Impact of Environmental Processes

Aeolian and fluvial processes across a landscape can cause erosion, deflation and sediment transportation that can move or obscure the deposition of artefacts (Fanning and Holdaway 2001; Fanning et al. 2008; Schick 1987; Schiffer 1983:679; Tumney 2011). Fanning and Holdaway (2001:681–684, see also Schick 1987:98–101) examined the propensity for stone knapping to more frequently produce small lithics, and that artefacts between 20–30 mm in size are generally removed from assemblages by fluvial activities. Petraglia and Potts (1994:231–234) contended that the absence of any artefacts with maximum dimensions smaller than 5 mm from an assemblage can indicate either that knapping did not occur at that area or water flows, even slow or moderate, have impacted the integrity of the archaeological record. At the Calperum study area, there is relatively low energy movement of floodwaters of the Murray River. The model proposed by Petraglia and Potts (1994) is unlikely to have impacted the assemblage recorded at Calperum station, although at sloping surfaces, artefacts less than 20 mm may have been shifted through fluvial activities (Fanning and Holdaway 2001:680–683, Tumney 2011:102–103). Moreover, Kibble (2008:19) has examined the impact of wind velocity on surface stone artefacts and observed displacement of artefacts with a maximum dimension of 9 mm or less in conditions with wind-speeds of 60 kph. Both fluvial and aeolian processes can cause the redistribution, transportation and accumulation of sediments. De Rose et al. (2004:247–248) modelled movement of suspended sediments carried by the Murray River and determined rates of sediment deposition across the floodplains are higher in recent history, possibly following the introduction of new land management techniques by European settlers. Although there is at present no detailed model for local geomorphology, Thredgold (2017:128–132, 134–135) proposed that human and animal grazing practices across the Calperum study area are likely to have had a significant impact on the integrity of the surface assemblage. These include human and animal trampling, artefact displacement and flake fragmentation (see Chapter Six for a detailed discussion), and the possibility of people having collected, cleared and disposed of artefacts (Thredgold 2017:128–132, 134–135).

2.2.3 The Impact of Human and Animal Activities

Both contemporary and historical human and animal activities can impact the integrity and subsequent interpretations of archaeological surface assemblages. Taphonomic processes such as the removal, reburial and redistribution of artefacts across a landscape, and the damaging of artefacts through trampling can devastate the original depositional context (Cameron et al. 1990; Douglass and Wandsnider 2012; Eren et al. 2010; Tumney 2011). Calperum Station operated under a pastoral lease predominantly for sheep grazing (see discussion in Chapter Three) suggesting trampling disturbances are expected to be significant factors in the assemblage of surface artefacts. Experimental analysis conducted by Eren et al. (2010) in the Jurreru River Valley in

South India examined the effect of trampling from goats and water buffalo across surface stone artefacts in wet and dry substrates. Results of this study revealed that in wet soils there was an overall trend of the downward displacement of artefacts into the substrate, to a maximum depth of 21 cm (Eren et al. 2010:3015–3017). Where soils were dry, there was evidence of small upward artefact displacement, and more notably, the horizontal movement of artefacts consistent with the directions of animal courses (Eren et al. 2010:3015–3019). Although the study by Eren et al. (2010) did not commonly reveal edge damage or breakage of stone artefacts, a similar study by Douglass and Wandsnider (2012) revealed high levels of flake breakage consistent with human and animal trampling over uncompacted soils. The study revealed loose, uncompacted soils produced higher instances of flake breakage when compared to varying substrates of greater soil compactness (Douglass and Wandsnider 2012:356–360). The Calperum study region likely reflects a number of the taphonomic processes that have been discussed here. The long and ongoing sequence of European human activities across the study area also indicates the potential for direct human removal and displacement of surface (and subsurface) artefacts (Midgley et al. 1998). Several cases of this occurring in the Riverland have been recorded (Casey 1973). Moreover, ongoing local land management operations of the Calperum Station Nature Reserve employ the use of 4WD vehicles and techniques in water controls for example, must be monitored to ensure that there is no damage to the integrity of archaeological assemblages and landscapes in an area where preliminary landscape mapping is in its infancy, this must be undertaken under the direction of RMMAC.

2.3 Summary

This chapter presents a discussion of the broader geoarchaeological approach that will be undertaken for this research project, in light of relevant studies that have adopted similar methods for surface lithics analysis, namely the Willandra Lakes system and the Fowlers Gap Western New South Wales Archaeological Program. This chapter also examines taphonomic processes relevant to these studies and the broader Calperum study area. The next chapter will present information about the study area, descriptions of the landforms examined, and provide a geomorphological context for the Calperum Station Riverland region.

Chapter 3: Study Area – Geomorphology and Cultural Context

Introduction

Calperum Station is situated in the South Australian Riverland region on the floodplains of the Murray River, encompassing anabranch creeks, billabongs, lagoons, lakes as well as aeolian and alluvial dunes. The Murray River landscape at Calperum Station is set within a semi-arid environment, and characterised by a distinct floodplain geomorphology, where the Murray floodplain is incised 20–30 m into the flat lying Mallee covered plain, which extends out beyond the Murray Valley margins (Bowler et al. 2006; Gill 1973:9–16; Newell et al. 2009:31). This chapter examines literature relevant to the geomorphology and fluvial context at Calperum Station through an analysis of comparable research in nearby regions of the Murray-Darling Basin. Aboriginal and historical archaeology and ethno-history for the Calperum study area, as well as previous local research that has been conducted, will be discussed as they relate to this research.

3.1 Local Geomorphology and Fluvial Context

Understanding the geomorphology of the study area for this research is essential to examining the landforms, features and access to resources across the Calperum landscape. The Murray-Darling Basin (Figure 1.2) dominates roughly one sixth of the Australian continent and reflects a history of oscillating aeolian and fluvial processes, reflected through the formation of dunefields and lunettes (Petherick et al. 2013:63; Walker and Thoms 1993:105). The Murray-Darling Basin drains rainwater and snowmelt from the inland slopes of the Great Dividing Range, through the semi-arid terrains of central and western New South Wales, north-western Victoria, and into South Australia (Pardoe 1995; Walker and Thoms 1993:104–105).

During the Palaeocene epoch, rivers flowing from the Great Dividing Range through what is now known as Lake Victoria paved the foundation for the Murray-Darling Basin (Evans 2013:1). Marine inundation of the Murray Basin deposited limestone across the deeper western regions of the basin and sandier nearer shore sediments in the east

(Bowler et al. 2006:161). This was followed by a marine regression leaving a series of strandlines. Rivers continued to course through the basin before a tectonic dam, caused by faulting uplifting the Pinnaroo Block, impeded drainage forming Lake Bungunnia around 3.5 million years ago (Bowler et al. 2006:171; Evans 2013:5; Page et al. 2009:20). Around 500,000–600,000 years ago, the dam was breached and as Lake Bungunnia regressed, the proto-Murray Valley was rapidly incised (Bowler et al. 2006:176). The cliff lines of the Murray River valley walls reveal the Blanchetown Clay unit, a late Pliocene through to Pleistocene geological formation, and reflect a sedimentary record of the relict basin depressions of Lake Bungunnia (Bowler et al. 2006:172–173; Evans 2013:3; McLaren et al. 2009:259–260; Walker and Thoms 1993:105). Below this unit are the older Loxton-Parilla Sands deposited during the earlier marine embayment in the late Miocene and early Pliocene (Bowler et al. 2006:166; Evans 2013:3; McLaren et al. 2009:259–260; Walker and Thoms 1993:105). Following the period of lake regression and valley incision, sandy sediments of the Monoman Formation filled the Murray Valley, then were subsequently covered with the infill of Coonambidgal sediments during the late Pleistocene through to the Holocene (Brown and Stephenson 1993:273; Evans 2013:8). In the eroding Loxton-Parilla Sands, the Karoonda Surface is a weathering profile, often associated with thick seams of silcrete and chert (Bowler et al. 2006:171–172; Thredgold et al. 2017:103–104, 115). Sporadic sources of silcrete and chert associated with the Karoonda Surface outcrop along the Murray Valley cliff lines locally, upstream and through to Overland Corner (Craig Westell pers. comm. 2018). In the absence of a detailed analysis of local lithic raw material sources, and, given the Mallee landscape stratigraphy is dominated by unconsolidated and semi-unconsolidated sedimentary deposits, Karoonda Surface outcrops may reflect access to local materials suitable for knapping (Gill 1973:33–34; Thredgold 2017:22–24; Thredgold et al. 2017:103; Craig Westell pers. comm. 2018).

The Murray River can also be understood in recent history through stages of: 1) Previous streams of the Pleistocene; 2) Ancestral rivers expressive of environmental transitions; and 3) Modern rivers (Gill 1973:49; Pardoe 1995:699–701). At Calperum Station, the Murray River reveals the path of the river in the two later phases. Ancestral rivers during the late Pleistocene through to the early Holocene were faster flowing and larger, vigorously altering the landscape and creating small islands from materials reworked from earlier relict landforms and intermixed with newer river sediments (Brown and Stephenson 1991:192; Pardoe 1995:699). Through to the mid-Holocene around 6000–8000 BP, in the modern stage of the river, riverine resources would have increased with warmer and slower river flows creating anabranches, lagoons, billabongs, lakes, meander scrolls and box tree plains (Brown and Stephenson 1991:192; Pardoe 1995:699–701). Lake systems in this modern stage of the Murray River are extremely variable, reliant on seasonal cycles of floodwaters to refill, providing sources of grasses and rushes for animals and people in the watery lakebed clays (Pardoe 1995:699–701).

Presently, in the region of Calperum Station, there has been no systematic geomorphic landform mapping or stratigraphic analysis, although as previously noted a study by Craig Westell has commenced to redress this gap. Nearby in the Murray River Valley region of north-western Victoria, at Ned's Corner, Prendergast et al. (2009) established a geomorphic model to examine the local characteristics of fluvial-aeolian interactions (Figure 3.1) (see also Garvey 2013, 2017). Calperum Station exists on the same floodplain complex identified in Prendergast et al.'s (2009) study and is in close proximity to their research at Ned's Corner, and has therefore been chosen as a preliminary comparative framework for this study.

Figure 3.1 Map of land system classifications at Ned's Corner, north-eastern Victoria (A) and schematic cross section (B) (Prendergast et al. 2009:57). *Figure removed due to copyright restrictions.*

The model established by Prendergast et al. (2009:57–62) proposes five land systems expressed through sedimentology, topography and vegetation, so named the 'Woorinen', 'Neds Corner', 'Lindsay', 'Mulcra Island' and 'Murray' Land Systems (see Appendix 1 for a detailed summary). The landforms examined could potentially be associated with the Mulcra Island Land System, or the Lindsay Land System (see also Jones 2016:43; Thredgold 2017; Thredgold et al. 2017). The Mulcra Island System was formed during the late Pleistocene (post 15,000 BP) by dominant fluvial processes and is characterised by billabongs, floodplains and palaeomeander scrolls (Prendergast 2009:59–60). This land system comprises sequences of mildly undulating floodplain with sediments of grey gilgai clay and grey overbank clays (Prendergast 2009:59–60). The primary vegetation (see Appendix 2 for a comprehensive map of vegetation communities) in the Mulcra Island Land System includes Black Box (*E. largiflorens*), some grasses and lignum (*Muehlenbeckia florulenta*), and Red Gums (*E. camaldulensis*) associated with billabongs (Prendergast 2009:59).

The Lindsay Land System was formed during the LGM (pre 15,000 BP) by fluvial and aeolian processes and is associated with source-bordering dunes, floodplains and palaeomeander scrolls (Prendergast 2009:59–60). Red sandy rises and mildly undulating floodplain sequences reflect dominant surface expressions of the Lindsay Land System with dark grey gilgai clay, sandy bedload and red sand sediments (Prendergast 2009:59–60). The dominant vegetation across this system includes lignum with some Black Box, and various chenopod species in relation to source-bordering dunes (Prendergast 2009:59–60).

The Murray River geomorphology reveals an extremely complex landscape, where recurrent overprinting of subsequent inundation regimes transform relict landscapes. This presents difficulties for the interpretation of local landforms and, consequently surface archaeology.

3.2 Aboriginal and Historical Cultural Setting

3.2.1 Settlement Patterns and Intensification

Patterns in settlement and mobility in the Murray-Darling River region likely reflect the natural hydrological regime (Wood et al. 2005; Wood and Westell 2010:4). The hydrological cycle as a determining factor for settlement can be expected in the

Calperum Station floodplains. Wood et al. (2005; Wood and Westell 2010:4–5) examined the archaeological record of the Chowilla anabranch system, upstream from the Calperum study area, and identified that settlements favoured more permanent bodies of water and areas bordering the river during the late summer to winter seasons, and retreated to elevated areas and floodplain margins during the summer floods. Comparable trends were recognised in the Katarapko[5]-Eckert Creek anabranch system in a report on the Katfish Reach project area, in the nearby Murray Valley Riverland region in Berri, South Australia (Wood and Westell 2010:7). Archaeological places were identified along the Katarapko-Eckert Creek anabranch system in clusters along the margins of landforms and vegetation areas, with the majority concentrated around water sources and along the boundaries of higher water levels (Wood and Westell 2010:20). Across both study regions in close proximity to Calperum, elevated areas such as sandy rises, source-bordering dunes and lunettes, often reflecting the relic meander plain of the Murray River, demonstrate the highest density of stone artefacts and archaeological markers (Wood et al. 2005:66; Wood and Westell 2010). This pattern in the distribution of archaeological locations occurs further east in neighbouring areas, discussed in greater detail in Chapter Three.

Australian archaeology has long debated whether mid-late Holocene changes, namely in the number and distribution of archaeological sites, and adaptations in local economies and technologies, were a result of transforming environments, growing social complexities or processes impacting the preservation of archaeological landscapes (Hiscock 1996, 2008; Lourandos 1980, 1983, 1985, 1997; Lourandos and Ross 1994). The ‘intensification’ model suggests these changes reflect increasing social complexity and organisation, sedentary occupation patterns, intricate exchange and alliance networks and changing site economies (Lourandos 1980:246; Lourandos 1985:385–390; Lourandos and Ross 1994:56–57). Lourandos (1983:86–87; Lourandos and Ross 1994) proposed the emergence of earth mounds during the mid-late Holocene reflected strategies to utilise marginal wetlands supporting increased sedentism and population

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[5] ‘Katarapko’ a word from the Erawirung language meaning ‘home of rock crystal’ (Tindale c.1934–c.1991).

growth. Earth mounds are a visual marker of Indigenous connections to country, potentially reflecting a wide variety of different functions over time. The composition of earth mounds can provide insights to past economies, and reflect practices of plant preparation, food production and resource management (Jones 2016:14, 29–31; Lourandos 1984:400; Martin 2006:291–293; Westell and Wood 2014:34). Earth mounds have also been considered as possible expressions of cultural landscape modification, occupied as elevated living spaces during times of floods, and spaces for social exchanges and innovation (Coutts et al. 1979:5; Jones 2016:5–14; Klaver 1998:31–34; Martin 2006:304–306). Challenging the 'intensification' model, others have suggested regional and short-term changes in social and environmental circumstances, and the adoption of risk-minimising technologies, drove alterations in settlement patterns and local economies during the mid-late Holocene (Bird and Frankel 1991:188–190; Hiscock 1994, 2008:188–189).

Aboriginal burial grounds have been commonly encountered in the sandy plains, lunettes, lacustrine plains and source-bordering dunes of the Murray-Darling Basin in south-eastern Australia (Pate 2006). Larger scale burials have been recorded across the lower and central Murray River Valley, while smaller clusters with fewer individuals have been encountered in the regions of the upper Murray and lower Darling Rivers (Pate 2006; Pardoe 1988, 1990, 1995; Littleton 1999; Littleton and Allen 2007). Larger burials, often described as cemetery landscapes, have been considered as an archaeological indication of semi-sedentary and sedentary settlement patterns and systems (Pate 1997, 2006:230–240; Pate and Owen 2014:91; Pardoe 1988, 1990, 1995). This interpretation, however, is inconclusive as many burials have not been dated and therefore cannot provide a chronology for the density of occupation and burial (Hiscock 2008:226–227). Moreover, where larger scale burials have an established chronology, there is little support for the continuous use of landscapes as burial cemeteries, such as at Lake Victoria in New South Wales, where on average only one burial per generation represents the highest estimates for total burial numbers (Hiscock 2008:226–227; Littleton and Allen 2007:283–284, 295). In the Calperum study area, burials were located at the two dune landforms where surface lithics were surveyed for this research, but were not examined or recorded (other than noting their presence) in accordance with the expressed directions and protocols of RMMAC.

3.2.2 Local Economies and Resources

Historical records, accounts and ethnographic research provide descriptions of subsistence strategies and economies along the Murray River. Berndt and Berndt (1974:41–42, 1993:85–95, 104) examined the lower region of the Murray River in South Australia, studying personal accounts and detailed socio-economic practices such as the management of resources and division of labour, including technologies such as earth ovens, canoes, and animal and fishing traps. The Murray River sustained resources including animals, birds, fish, crustaceans, molluscs, reeds and rooted plants (Pretty 1977). *Typha* spp., for example, was consistently available and utilised as a fibre rich food staple and a source for equipment used for food procurement, such as baskets, basket fish traps, nets and mats in the Coorong and Lower South Australian Lakes region (Angas 1847:54–58, 89–90; Beveridge 1883:41–42, Eyre 1845 Vol. II:269, 311; Taplin 1879:18–19, 29, 52; see also Jones et al. 2017). Ethnographic accounts in the Lower Murray River Valley, reveal that the bulk of large game was caught by men who often consumed their catches immediately after hunting (Angas 1847:54; Berndt and Berndt 1993:76–77; Eyre 1845 Vol II:29). In this same region women have been described hunting smaller game, collecting vegetables and plant foods, and having been responsible for preparing larger game to share (Angas 1847:54; Berndt and Berndt 1993:76–77; Eyre 1845 Vol II:291). It is however important to keep in mind the androcentric lens in which ethnographic commentary about women was written (Bird 1993; Dobres 1995; Gero 1991).

Stable carbon and nitrogen isotope analyses of human skeletal remains located in burials from the Coorong, Swanport and Roonka Flat archaeological sites in South Australia revealed variation in dietary economies across the different locations in the mid and Lower Murray (Pate 1997:112–113, 2006:232–240; Pate and Owen 2014:91–92). At Roonka Flat, approximately 100 km south-west of the town of Renmark, burial remains indicated adolescents consumed larger portions of terrestrial animals compared to both male and female adults (Pate and Owen 2014). South of Roonka Flat, towards the coast, the diets of females and youth at Swanport reflected a higher proportion of aquatic foods (shellfish and plants) (Pate and Owen 2014). In the Coorong region of coastal South Australia, marine foods were identified as a staple to the diet for the whole population (Pate and Owen 2014). Pate and Owen (2014) contend their research on remains at Roonka Flat reflected patterns of growing sedentary behaviours and territoriality amongst the Murray River populations, and demonstrated the organisation of discrete biogeographical zones.

As previously discussed, geomorphological processes producing unconsolidated and semi-consolidated sediments produced an environment lacking in suitable siliceous stone for knapping (Thredgold 2017:22–24; Thredgold et al. 2017:103–104, 115). An exception is local silcrete, principally associated with the Karoonda Surface of the Blanchetown Clay unit (Brown and Stephenson 1991:315–316; Gill 1973:33). The Karoonda Surface is found close to the modern surface and recurrently exposed in the Chowilla area, close to the Calperum study region (Brown and Stephenson 1991:164). These silcrete outcrops were quarried along the Murray River cliffs and exploited for subsistence economies.

3.3 Study Area Descriptions

The landforms examined both during field survey and for comparative purposes are described below (see also Figure 3.2). The landforms surveyed and recorded for the purposes of this thesis include Lake Merreti[6] lunette, Lake Clover dune and Lake Woolpolool[7] dune. These three landforms were selected by Flinders University staff leading the broader Calperum Station research project to both contribute to the

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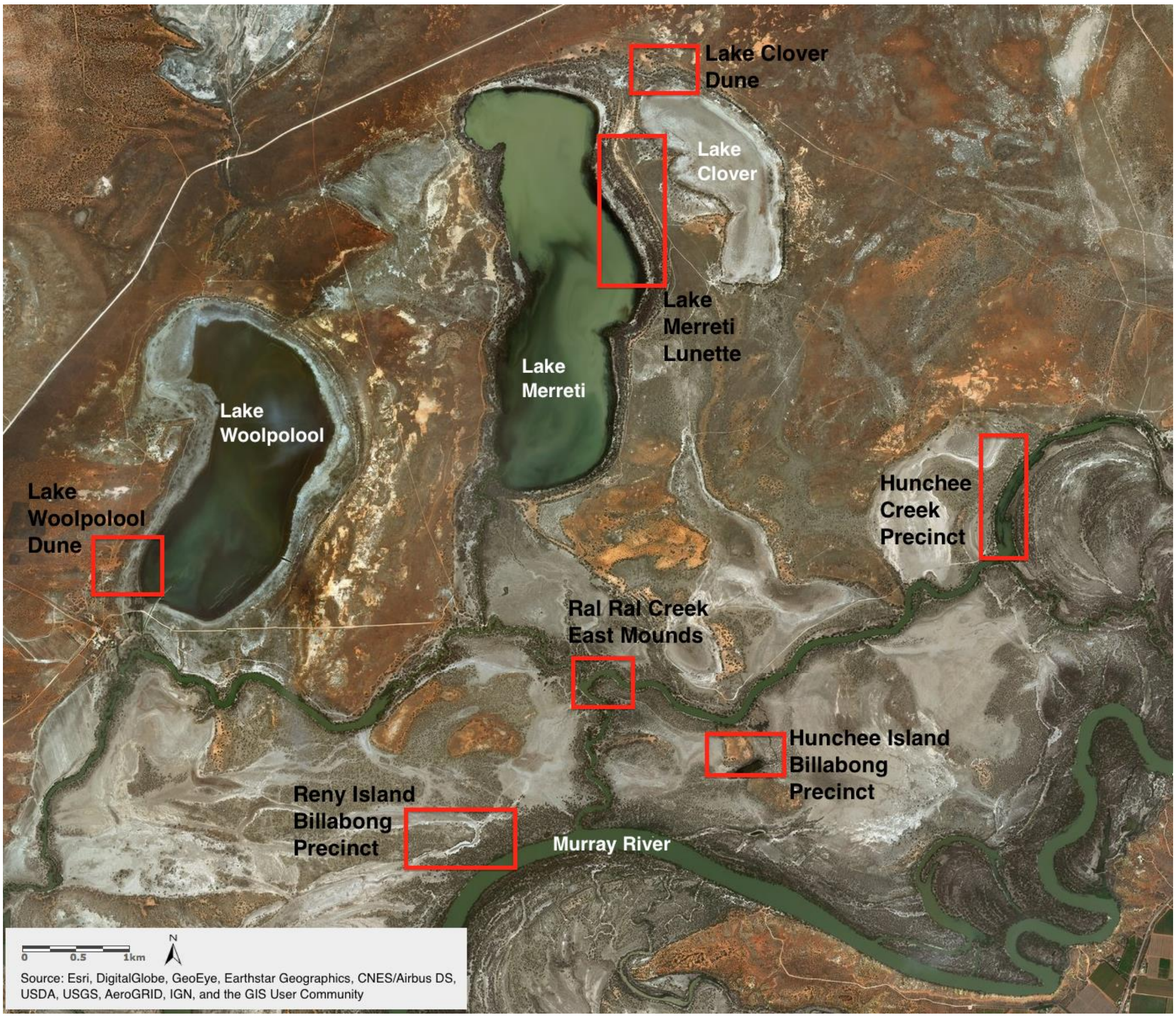
[6] ‘Merreti’ derived from the local Indigenous language meaning ‘a pool of water’ (Manning 1990:202). The late Mr Tom Mullins, who spoke the local Aboriginal language, once told Art Hisgrove Lake Merreti was pronounced Lake ‘Mershee’ by the local Aboriginal people (Linn 1995).

[7] ‘Woolpolool’ a word from the local Indigenous language said to mean ‘a place of mud like milk’ (Manning 1990:345).

growing data recorded and examined in this region, and to address a gap in field research at these lacustrine landforms. The landforms examined for a comparative geoarchaeological analysis have been recorded and examined by Thredgold (2017; Thredgold et al. 2017) and Jones (2016), a summary of their research is provided in Section 3.4. The comparative landforms include Reny Island billabong precinct, Hunchee Island billabong precinct, Hunchee Creek precinct, and Ral Ral[8] Creek east mounds. The landforms of the study area are represented in Figure 3.2.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 3.2 Map of the Calperum Station study areas. 9

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[8] 'Ral Ral' possibly named after a prominent member of a local Aboriginal group in the district (Manning 1990:259).

[9] Only the general study area zones, and not the specific survey locations, are represented on this map as requested by RMMAC.

3.3.1 Lake Merreti Lunette

The Lake Merreti lunette/source-bordering dune is situated on the central eastern margin of the Lake Merreti wetland (Figure 3.3). Now a permanent freshwater lake, under natural conditions the lake was a temporary wetland, subject to variable water levels and intermittent drying periods according to fluctuations in the flow of the Murray River (Steggles and Tucker 2003:10, 17). Changes in lake hydrology were the direct result of Murray River regulation initiatives put in place from the late 1920s until the mid 1990s, until management procedures were re-directed towards a more ecological focus (Steggles and Tucker 2003:17). The Lake Merreti wetland is one of the largest regulated freshwater wetlands in the lower Murray River, and is supplied with water from the Ral Ral Creek anabranch (Steggles and Tucker 2003:18). The Lake Merreti lunette is a landform consistent with the interpretation of relict terrace surfaces in western Victoria described by Prendergast et al. (2009:58–59), likely formed during the later phase of the Last Glacial Maximum (LGM) less than 18,000 BP (see also Gill 1973:14–15). However, it must be noted that a separate and concurrent project by student Craig Westell is attempting to refine our understanding of these terraces, examining C^{14} samples collected from archaeological context to consider the development of the Lake Merreti system and the timing of the Lake Merreti lunette. As such, the Prendergast et al. (2009) interpretations used in this thesis may be updated in the future.

The lunette is comprised fine to medium grained sand, moderately oxidised in areas of higher elevation but generally a pale yellow to white colour across the landform in lower areas. Visibility of artefacts across this landform is good with little obstruction by local vegetation. Vegetation comprises mixed chenopod and samphire low shrubland such as river saltbush (*Atriplex rhagodioides*) chenopod shrubland, and Black Box (*Eucalyptus largiflorens*) woodlands, in varying degrees of tree health (Newell et al. 2009). The western margin of the lunette is bordered by a land management access road (see further discussion in Section 4.2.1 and Figure 4.1)

3.3.2 Lake Clover Dune

The Lake Clover dune examined during field survey is located on the north-eastern margin of the Lake Clover wetland. Lake Clover is an intermittent freshwater lake that has been largely in an unregulated drying cycle since the mid 1990s (Newell et al. 2009:40; Steggles and Tucker 2003). In periods where Lake Merreti has exceeded carrying capacity at water levels of approximately 18 m AHD (Australian Height Datum) and river flow rates of approximately 80,000 ML/day, water flows beyond to the Lake Clover wetland (Steggles and Tucker 2003:19). Low chenopod shrubland and Black Box woodlands in varying degrees of tree health, dominate the vegetation surrounding the dune. The dune is a fine-grained blowout with an elevated eroding hearth feature on the eastern margin and good artefact visibility. Several burials in differing states of erosion are spread across the dune landform[10]. Along the southern side of Lake Clover dune, a land management access road (running East-West) divides the landform (see further discussion in Section 4.2.2 and Figure 4.2). Land management practices have also involved the introduction of foreign cobbles in this portion of the dune to reinforce the road for vehicles.

As with the Lake Merreti lunette, relict floodplains and palaeomeander scrolls formed Lake Clover dune during the LGM, prior to 15,000 BP (Gill 1973:14–15; Prendergast et al. 2009:58–59). While multiple phases of lunette and dune development initially during the LGM formed the lacustrine environments, these were followed by more recent deflation episodes, hollowing the dune, reworking an older landscape into a newer dune (Bowler et al. 2006). As is the case across the varying Calperum Station landforms, Lake Clover dune reflects a landscape continually transformed, where various underlying alluvial, fluvial and aeolian processes are morphing the landform and environment.

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[10] All burials across the Calperum Station study areas were, however, strictly avoided when recording lithics, and all RMMAC cultural protocols were adhered to.

3.3.3 Lake Woolpolool Dune

The Lake Woolpolool dune is situated on the south-western margin of the Lake Woolpolool wetland. Lake Woolpolool is a saline brackish lake, salinised in the 1950s from land management practices and now under a limited management regime of seasonal flooding and drying (Newell et al. 2009:39; Steggles and Tucker 2003). As is the case with Lake Clover, Lake Woolpolool also obtains excess water flows from nearby Lake Merreti when maximum carrying capacity and river flow rates are high (Steggles and Tucker 2003:19). Vegetation includes mixed chenopod and samphire low shrubland, with Black Box woodland and tree litter from trees that have died. The Lake Woolpolool dune is an erosional surface of medium-grained reddish oxidised sands likely formed during the LGM prior to 15,000 BP, by relict paths of the Murray River (Gill 1973:14–15; Prendergast et al. 2009:58–59). Woorinen formation East-West trending linear dunes extend into the western edges of the Murray River floodplain to the margins of Lake Woolpolool, and reflect floodplain transgressions during the height of the LGM (Lomax et al. 2011:724, 731–732). Lake Woolpolool dune is likely a source-bordering dune, sitting amidst Woorinen formation dune ridges (Lomax et al. 2011; Prendergast et al. 2009). Surface artefact visibility is good as the artefacts observed sit in the depressions of the eroding surface, with the dune forming a boundary around hearth features. Scatters of shell fragments are interspersed amongst the surface artefacts and several burials that are in varying states of erosion across the dune landform.

3.3.4 Reny Island Billabong Precinct

Located in close proximity to the modern course of the Murray River, the Reny Island billabong reflects a small relict palaeochannel, continually impacted by successive inundation regimes, in a complex environment where underlying processes are superimposed over former landscapes (Jones 2016; Thredgold 2017; Thredgold et al. 2017). Consistent with the surfaces studied by Prendergast et al. (2009:58–59) in western Victoria, the relict palaeochannel likely formed the billabong during the late

Pleistocene (approximately post 15,000 BP). The billabong retains water through contemporary management practices, with a pump located at the northern point of the lagoon. Fluctuations in water supply for the lagoon were observed by the author and recorded by Thredgold (2017:9; Thredgold et al. 2017) during periods of field-work, where the billabong held water in September 2015, and was dry in April 2016. Several earth mounds (many with surfaces covered by *Mesembryanthemum* spp.) are in close proximity to the billabong as well as a small shell midden and scar tree (Jones 2016:68). Vegetation along the southern margin of the billabong near the Murray River includes Black Box and some river Red Gum (*E. camaldulensis*) woodland, saltbush and lignum shrubland and nitre bush (*Nitraria billardierei*). The remaining areas meeting the edge of the billabong are relatively sparsely vegetated in comparison, largely comprising round-leaf pigface (or rounded noon-flower) (*Disphyma crassifolium*).

3.3.5 Hunchee Island Billabong Precinct

The Hunchee Island billabong mounds are located near a lagoon on the northern side of the billabong and are subject to periodic flooding (Jones 2016; Thredgold 2017; Thredgold et al. 2017). Grey sediments surround the lagoon, which intersect an elevated red sandy rise where the mounds were positioned on the eastern margin. This elevated rise is possibly a sand ridge developed as a levee and crevasse splay, where the lagoon would be formed in a crevasse channel associated with a prior LGM channel (Craig Westell pers. comm. 2018). This elevated sandy rise could meet the geomorphological classifications of the Lindsay Land (formed during the LGM, between 24,000–14,000 BP, see Prendergast et al. 2009:5–60), however also further reflects a landscape continually transforming through subsequent flooding regimes. Vegetation surrounding the lagoon includes lignum and saltbush chenopod shrubland intermixed with Black Box trees.

3.3.6 Hunchee Creek Precinct

The Hunchee Creek mounds are situated on the north-western margin of the eastern end of Hunchee Creek, in a landscape which experiences periodic flooding episodes that have and continue to transform the local landforms (Jones 2016; Thredgold 2017; Thredgold et al. 2017). The precinct reflects a prior LGM channel transformed into an oxbow after meander cut-off (Craig Westell pers. comm. 2018). Vegetation along this bank of the creek includes Black Box and river Red Gum woodland, mixed with lignum and saltbush chenopod shrubland. Sediments include light fine-grained sands and grey gilgai clay. Water levels in the Hunchee Creek are maintained through contemporary management practices including a system of sluices.

3.3.7 Ral Ral Creek East Mounds

The Ral Ral Creek east mounds are located on Hunchee Island across an active floodplain south of the Hunchee and Ral Ral Creek anabranch intersection (Jones 2016; Thredgold 2017; Thredgold et al. 2017). Located on sediments of grey gilgai clay, dominant vegetation includes river Red Gum and Black Box woodland, lignum and saltbush chenopod shrubland. The mounds and surrounding areas encompassed both open and thickly vegetated sections; densely vegetated areas have significant tree litter from dead woodland species.

3.4 Prior Research in the Study Area

As previously noted, research in the Calperum study area had been relatively limited prior to the commencement of the Flinders University Archaeology and RMMAC research project. Under this broader project, several Flinders University student research studies have been instigated, with two completed Masters theses currently available and concomitant publications (Jones et al. 2017; Thredgold et al. 2017); an analysis of Indigenous earth mounds (Jones 2016) and surface lithics associated with earth mounds (Thredgold 2017), and Student projects involving geophysical techniques, analysis of scarred trees and an examination of the Murray River corridor landscape have also been initiated but have not yet been completed.

In the boundaries of Chowilla Station, adjacent to the research study area of Calperum Station, it was proposed in the early 1970s to construct a dam at a point of the Murray River near the meeting of the South Australian, New South Wales and Victorian borders (Gill 1973:1). Geological, environmental and archaeological salvage surveys were conducted by the National Museum of Victoria to investigate this area prior to its potential inundation (Gill 1973; Casey 1973). Gill (1973) and Casey (1973:209–215) conducted salvage surveys of stone artefacts across the planned Chowilla Dam region. Retouched and ground artefacts collected by Casey (1973:209–212) were described in detail (see Table 3.1 for a summary) while unretouched flakes and flake fragments collected were deemed 'of little significance except as evidence of the presence of Aborigines' and not recorded in detail. A description of raw materials or the landforms on which they were collected from was not included in Casey's (1973:209) account of salvaged stone artefacts. Outside of this study and the work of Thredgold (2017; Thredgold et al. 2017–see discussion below), there is little publically accessible commentary regarding stone artefacts in this region.

Table 3.1 Summary of artefacts collected and recorded from the proposed Chowilla Dam Impact Area (Casey 1973:209).

Artefact type	Number	Additional Notes Recorded
Adze	39	Two are similar to tulas. Many are worn down into slug form. Width ranges from 20–40 mm with average width of 32mm. Several highly patinated.
Side scrapers	2	Discoidal and other types absent.
Retouched flakes and fragments	15	
Utilised flakes	4	Edge damage chipping observed.
Highbacked elongate uniface implements	5	Four are of quartzite and one is sandstone. Length ranges from 90–130 mm. All are approximately 50 mm wide.
Uniface choppers	4	
Horsehoof cores	7	Do not appear to have been used as choppers.
Unidirectional cores	8	
Multidirectional cores	12	
Hammerstones	6	
Mill stones	25	Nine lower and 16 upper. Fragments and whole included.
Mortars	15	With saucer-shaped hollows. Four demonstrate anvil damage.
Pestles or pounding stones	11	All elongated. Three with hammer damage.

Through the examination of information held by the South Australian Government's Aboriginal Affair and Reconciliation Division, and with the permission of RMMAC, Caldwell (2014) produced an unpublished preliminary analysis of recorded Indigenous archaeology within the Calperum Nature Reserve. Caldwell (2014) identified inland and floodplain environments with campsites, burials, scarred trees and quarries. Access to this research was restricted during the completion of this thesis.

Jones (2016; Jones et al. 2017:20) examined the archaeological record at Calperum Station through an analysis of the distribution of earth mounds across the floodplain. The research sought to test whether the Indigenous oven mounds at Calperum represented adaptions to environmental changes in the Murray-Darling Basin during the late Holocene (Jones 2016:6; Jones et al. 2017). Jones (2016:110; Jones et al. 2017:24–28) compiled chronological and morphological datasets for the broader Murray-Darling Basin environment to compare with the sample of 27 earth mounds recorded during surveys at Calperum Station. Jones (2016:112; Jones et al. 2017) determined that oven mounds at Calperum Station reflected an association between distribution and plant resource utilisation across the floodplain to maximise use of these resources over the changing annual flood cycle. The oven mound landforms analysed by Jones (2016; Jones et al. 2017) are relevant to this study to provide context for the local geomorphology and a detailed analysis of economies and behaviours across the Calperum landscape.

Thredgold (2017) analysed the surface lithics associated with the Calperum Station anthropogenic earth mounds recorded by Jones (2016), to determine local activities and earth mound functions, and examined the local taphonomic record (see Section 3.1 for a description of landforms examined). Thredgold (2017:119) recorded 195 stone artefacts across 14 mounds and their immediate vicinities, and examined their broader context in the study of lithics and earth mounds in the Murray-Darling Basin. This assemblage was comprised mostly of unretouched unmodified flakes with only the occasional example of grindstones and retouched flakes and that only a small quantity of artefacts were observed on the surface of mounds (Thredgold 2017:141). Thredgold (2017:140) proposed that earth mound landforms on the Calperum floodplain were single activity sites, with uniform knapping strategies and activities connected to food and fibre processing with little inter- and intrasite variability. The analysis of lithics and conclusions drawn by Thredgold (2017) are examined for comparative purposes in greater detail in the discussion chapter (Chapter Six) of this thesis.

3.5 Summary

This chapter provided an overview of the pre-contact Calperum study area. An analysis of relevant geomorphological literature, ethnographic and historical research, reflects an active and dynamic riverine environment producing rich resources for local economies during a period of complex patterns in settlement. The methods adopted for this analysis of surface lithics are presented in the next chapter.

Chapter 4: Methods

Introduction

Chapter Four outlines the methods adopted by this study for survey at Calperum Station. This chapter outlines the community and ethics approval, the survey procedures and the recording process employed. This includes a discussion of the raw materials encountered during field-work, the attributes recorded and the reasoning behind their analysis.

4.1 Ethics Approval

This research project stems from a broader archaeological study into past and contemporary connections to country led by Flinders University and the River Murray and Mallee Aboriginal Corporation (RMMAC). RMMAC administer the native title rights for the Traditional Owners of the South Australian Riverland. Flinders University Social and Behavioural Research Ethics Committee (SBREC) granted approval to the larger Calperum Station Research Project in 2014, under project number 6618. Updates on this project were provided to RMMAC directors during the course of the research

The discipline of archaeology in Australia has encountered criticism for practices which have failed to acknowledge, support, and seek consent from Traditional Owners and Indigenous communities in the determination, authorship and agency over decisions regarding their country (Langford 1983:2; Roberts et al. 2005; Russell 2004). There has been a shift away from these earlier practices evident in the Australian Archaeological Association's (AAA) present code of ethics, which establishes principles of mutual respect, informed consent, Indigenous approaches to interpretation, negotiation and agreement (Australian Archaeological Association 2017).

This study was designed as an 'on-country' surface analysis in observance and adherence of the expressed protocols and intentions of RMMAC. RMMAC representatives participated and directed cultural protocols during research field-work.

A key factor in the permission to conduct this study is that all knowledge is to be kept by the local RMMAC community, RMMAC will retain all survey and analysis data, and information pertaining to the precise location of archaeological artefacts and places will generally be restricted from publication and distribution.

4.2 Survey Methods

The field-work for this research project was conducted from 26th September to 30th September 2016 as a part of the Flinders University 2016 'Archaeological Field Methods' postgraduate topic. Reconnaissance field-trips conducted in April 2016 by Flinders University Archaeology staff, RMMAC, and various Masters students researching the Calperum study area, involved preliminary surveys to select the landforms for examination by this research project. Joanne Thredgold assisted with field survey and recording across all days where field-work was undertaken and provided the camera used for field photography (Canon EOS 350D camera with a Sigma 20-700 lens). Due to extremely severe storms at Calperum Station (and throughout the State of South Australia) impacting safe access to and working conditions at survey locations, no field surveys were conducted on the 29th September.

Given this project involved the survey and analysis of surface archaeological materials, a geoarchaeological approach was adopted to assess and examine the complexities and issues involved with surface studies in this area of the Murray River landscape. A geoarchaeological approach towards archaeological research is defined by Holdaway and Fanning (2014:1) as:

> The means to move away from such single dimensional characterisations of either the environment or culture and, instead to consider the interaction of multiple processes, both natural and cultural, operating over different temporal and spatial scales.

As there was no systematic geomorphic landform mapping or stratigraphic analysis available for examination during this research study, where evident, observations of taphonomic processes were recorded during field survey. This included notes on contemporary surface disturbances, and the recording of attributes such as flake fragmentation, to better interpret the various influences on the preservation of archaeological artefacts and landscapes. This survey data, in conjunction with relevant research into the dynamic geomorphology of the broader Murray River Valley, provided for a discussion of the issues and complexities involved with the study of the surface record of a landscape that is particularly influenced by underlying processes.

Due to the extensive size of the surveyed areas, non-randomised sampling techniques were employed to target concentrations of surface material and to provide a suitable dataset for each location. This approach was also adopted in consultation with Flinders University Archaeology staff, with the objective of assessing the areas with a greater density of artefacts visible on the surface record, and to comply with time constraints restricting the ability to record the landforms in their entirety.

4.2.1 Lake Merreti Lunette

A baseline was positioned along the lunette lateral margin (north-south) with a 100 m open reel tape. Beginning at 10 m on the baseline, a transect was arranged to a width of 2 m, with a maximum length running to the opposing lateral margin boundary of the dune. This process was repeated at the 20 m, 30 m, 40 m, 50 m, 60 m, 70 m, 80 m and 90 m intersections on the baseline. Artefacts were identified and marked with pin flags by approximately 15 students as well as Jo Thredgold and myself. A total of nine transects were prepared with artefacts present and recorded in transects one to seven (see Appendix 4). The transect dimensions were as follows: transects one to five were 2 m by approximately 15 m, transects six and seven were 2 m by approximately 10 m, and transects eight and nine were 2 m by approximately 5 m. The area surveyed was approximately 210 m^2.

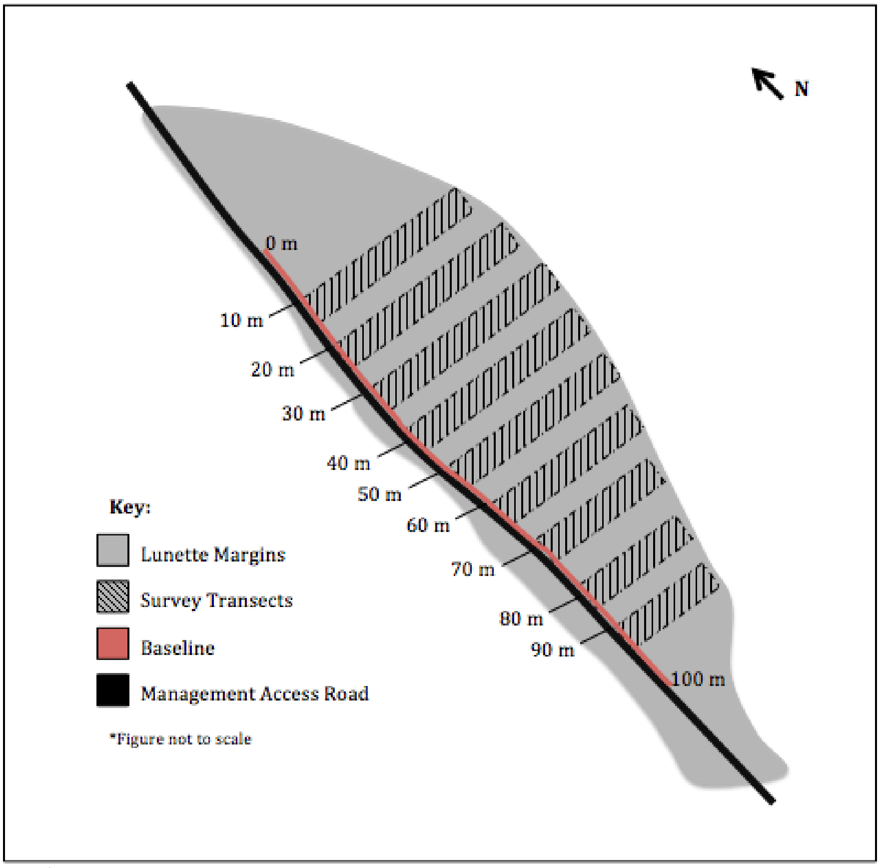

Figure 4.1 Lake Merreti lunette field survey plan.

4.2.2 Lake Clover Dune

The crescentic shaped blowout had an unsealed management access road running in a north-south direction through the dune (Figure 4.2). On the eastern margin of the dune, parallel to the access road, a hearth feature was eroding. A baseline was arranged with a 100 m open reel tape at the central point of the exposed hearth, running the length of the dune until intersecting the access road. A transect was laid perpendicular to the baseline, from 0 to 2 m (on the baseline) with an approximate length of 40 m. The area surveyed was approximately 80 m^2. Artefacts were identified and marked with pin flags by two students as well as Jo Thredgold and myself.

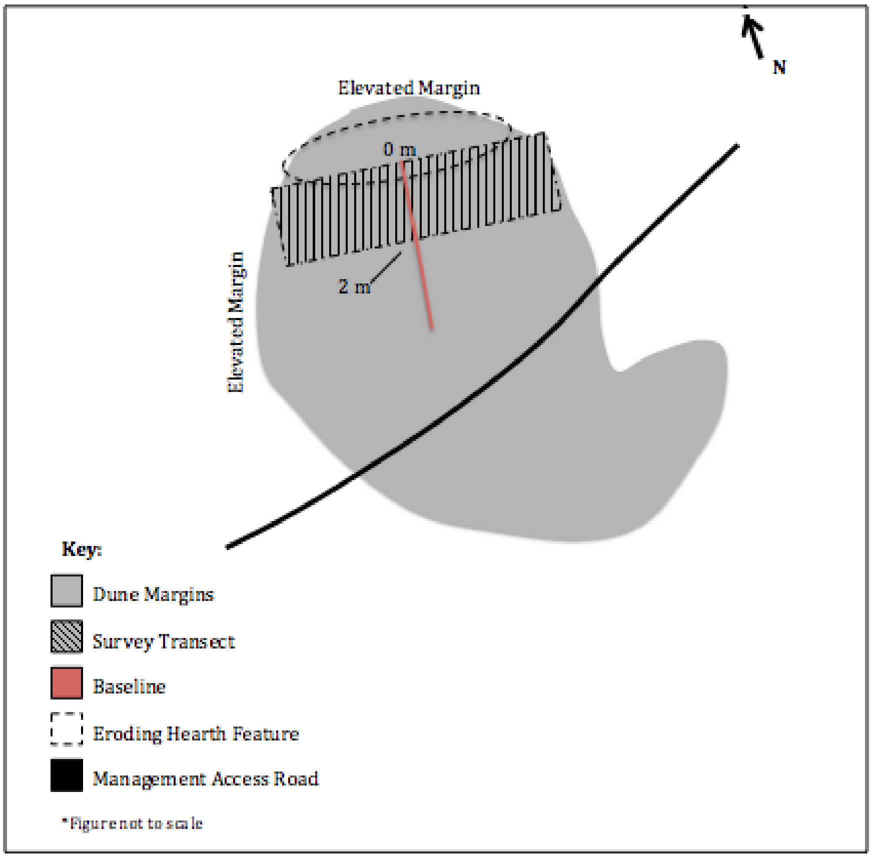

Figure 4.2 Lake Clover dune field survey plan.

4.2.3 Lake Woolpolool Dune

The northern margin of the dune has an elevated plain (in an east-west direction), perpendicular to an unsealed management access road running in a north-south direction (Figure 4.3). The highest density of visible surface artefacts was west of the access road, and a baseline was arranged with a 100 m open reel tape, running north-south from the centre point of the elevated plain. A transect was laid to a width of 2 m away from the baseline, which was 20 m in length. The area surveyed was 40 m^2. Artefacts were identified and marked with pin flags by Jo Thredgold and myself.

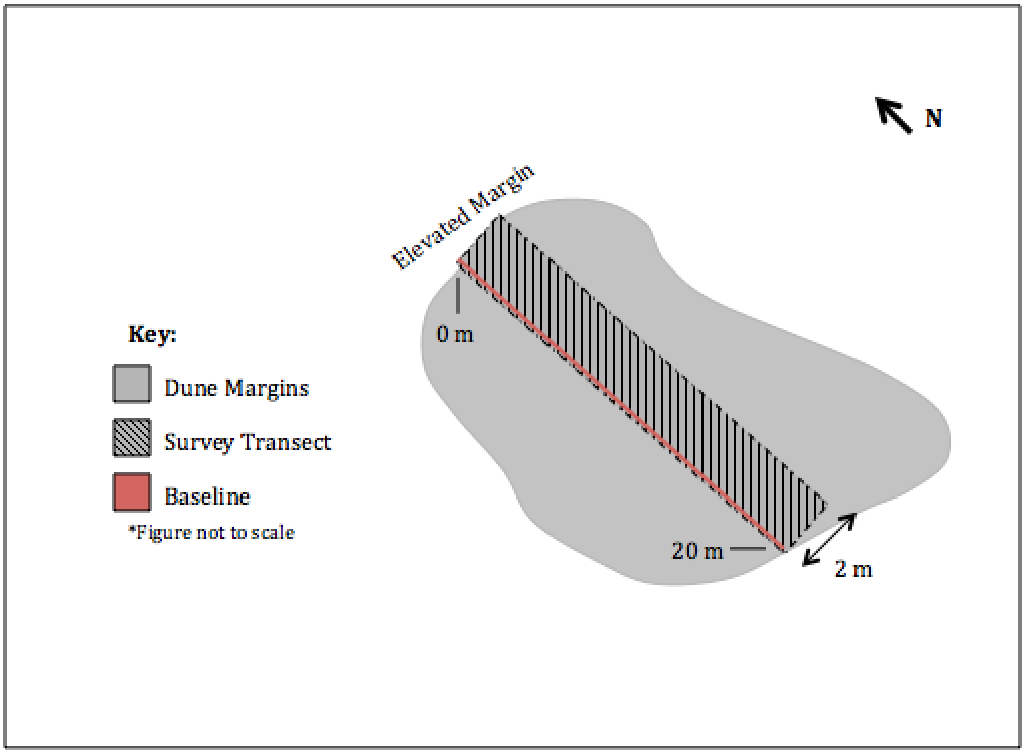

Figure 4.3 Lake Woolpolool dune field survey plan.

4.3 Stone Artefact Analysis

The stone artefact characteristics were recorded through the ArcMap geospatial processing program, a component of the Esri (Environmental Systems Research Institute) ArcGIS suite. ArcMap was utilised for this research program, as it is the surveying program employed by the broader Calperum research project. This program was loaded onto a LG Nexus X5 tablet, which could record the date, location and attributes of stone artefacts remotely. Data was reviewed and backed up at the conclusion of each field day and checked for errors.

The following recording scheme was designed to meet three goals. Firstly, to produce a systematic detailed selection of attributes that could be implemented for surveying Calperum station beyond this immediate research program, as part of future field-work for the broader Flinders University and RMMAC research project. Secondly, attributes were also chosen for comparative and interpretive purposes with the recording system implemented by Thredgold (2017) to produce a relative dataset for the Calperum study area, and to enable a comparison and examination of artefact densities across the varying landforms. Thirdly, this recording scheme was devised to address the question and aims posed by this research study, and were based on a technological approach to lithics analysis (Andrefsky 2005; Clarkson and O'Connor 2006; Holdaway and Stern 2004).

4.3.1 General Stone Artefact Attributes

Artefact ID: The artefacts were designated an identifying number for recording and analysis purposes (Example GI204). The artefact ID indicates the recorder 'GI' (author's initials) to distinguish data from other recordings undertaken during the field season. This is followed by either '0', '1', or '2', indicating one of the three survey locations and a nominal designated to an individual artefact at that particular location.

Raw Material type: Raw material selections included silcrete, chert, quartzite, quartz, sandstone and 'other'. The choice of raw material impacts the process of manufacturing stone artefacts, often known as 'fracture mechanics' (Andrefsky 2005:24–30; Cotterell and Kamminga 1987:678–679). Materials that are isotropic and homogenous were favoured in producing stone artefacts as they can be more easily controlled with replicable results by tool-makers or knappers (Andrefsky 2005:24–30; Cotterell and Kamminga 1987:678–679). Identifying raw material type can also provide information as to the location of stone resources across the landscape and cultural interactions though trading networks (Andrefsky 2005:42).

1. 'Silcrete': Silcrete (Figure 4.4) is a siliceous sedimentary rock, consisting of quartz grains in a matrix of amorphous or fine-grained silica (Hutton et al. 1972). Silcrete is hard, brittle and conducive to conchoidal fractures, and can occur in a variety of colours such as red, brown, grey and blue (Rapp 2009:56–57). This material is available in proximity to the study area in the Karoonda Surface (Gill 1973:33).

Figure 4.4 Examples of silcrete flakes (a. and b.) and a silcrete core (c.) from the study area.

2. 'Chert': Chert (Figure 4.5) is an isotropic, brittle and siliceous sedimentary rock, highly conducive to conchoidal fracturing (Rapp 2009:76–79). Chert is abundant in many Australian lithic assemblages and can occur in a variety of colours including white, grey, brown, amber, red, sandy-yellow and blue to name a few (Shafer 2008:1583). Chert consists of micro- or cryptocrystalline quartz of approximately equidmensional crystals (Rapp 2009:76). Chert can form as nodules in limestone and was likely sourced from the Murray River cliffs (Grist 1995:36; Tindale 1974:211).

Figure 4.5 Examples of chert flakes from the study area (a. complete flake, b. hinge termination, c. medial flake).

3. 'Quartz': Quartz is a mineral often found in colours of white 'milky' vein quartz, opaque and rose quartz (Grist 1995). Quartz is not as simple to knap with veined flaws interrupting the fracture path. Quartz is not known locally in the study region and most likely was traded in (Grist 1995).

Raw Material Colour: Artefact colours were recorded by visual observation and aided the process of raw material identification. Artefact colour was recorded with the assistance of Jo Thredgold (2017) to be consistent with the approach adopted for her research.

Raw Material Additional Comments: Additional observations, including raw material quality and grain size (Figure 4.6), were recorded. Variation in grain size can help in the process of raw material identification and can be an indicator as to the access to quality knapping materials (Andrefsky 2005:59). Finer grained or amorphous materials are better suited to produce conchoidal fractures and a desired replicable knapping result (Clarkson and O'Connor 2014:192). Grain size was assessed through visual observation with the aid of a hand lens and in consultation with Jo Thredgold (2017) to aid comparative descriptions of both datasets.

Figure 4.6 Examples of silcrete flakes from the study area with varying grain size.

Artefact Weight: Digital scales measured individual artefact weight to the nearest gram. Measuring the quantity of artefacts in a debitage assemblage (the by-products or non-formal components of flaking processes) can sometimes be misleading if post-depositional processes are not taken into consideration (Andrefsky 2005:83). Arefact weight is often a more reliable indicator to determine the stages of material reduction, manufacture and mobility (Clarkson and O'Connor 2014:164–165; Kuhn 1995:25; Shott 1994:80–81).

Heat Damage: Any indication of heat damage on artefacts was recorded. In some cases raw material can undergo heat treatment to alter the composition of the stone to be more malleable and effective for knapping (Clarkson and O'Connor 2014:167; Domanski et al. 1994:199). Pot-lid scarring, colour alteration and a shiny, greasy lustre are commonly, but not exclusively, features of heat-treated stone materials (Clarkson and O'Connor 2014:167). Assessing deliberate heat treatment as opposed to unintentional heat damage can be difficult to distinguish, therefore artefacts with apparent heat damage must be carefully examined in relation to the assemblage and landscape (Clarkson and O'Connor 2014:167).

Artefact Technological Attributes: Artefacts were recorded under the classifications 'flake', 'core' and 'other' (see below) with relative attributes for each classification specified in detail below. These three general classification groupings were implemented in the recording forms to provide a uniform template for recording lithics in the broader Flinders University and RMMAC led research studies running concurrently and subsequent to this research project.

4.3.2 Flaked Stone Artefacts

1. Flake Type: 'Unretouched flake' ('URTF') or 'Retouched Flake' ('RTF'). A flake is a sharp-edged piece of stone removed from a rock through the application of force by percussion or pressure (Holdaway and Stern 2004:42). 'Retouch' refers to the process of removing small adjacent flakes (resulting in negative flake scars) from the edge of the original larger flake to alter the shape or edge angle (Holdaway and Stern 2004:33).
2. Flake Completeness: Recording the completeness of a flake can give a more accurate indication as to the density of artefacts across a landscape or within an assemblage, taking into account the potential for either breakage during production or post-depositional damage (Andrefsky 2005:82–83). The classifications for flake completeness (Figure 4.7) are listed below.

i. ‘Complete’: Flake in intact with the presence of a platform and/or ‘point of force application’ (‘PFA’), termination and ventral surface.
ii. ‘Margin Missing’: A flake has part of the margin broken or missing, the platform and/or ‘PFA’ and termination are present.
iii. ‘Marginal Fragment’: A flake has no platform and/or ‘PFA’, no termination and only a section of the flake’s margin remains intact.
iv. ‘Longitudinal Cone Split’ (Left ‘LCSL’ or right ‘LCSR’): A longitudinal fracture in a flake with a hertzian initiation. The flake is either the left or right fragment.
v. ‘Proximal Fragment’: A broken flake with the platform and/or ‘PFA’ intact and no termination.
vi. ‘Medial Fragment’: A broken flake with distinguishable dorsal and ventral surfaces, and no evidence of termination, platform of ‘PFA’.
vii. ‘Distal Fragment’: A broken flake with the termination intact and no platform or ‘PFA’.

Figure 4.7 Illustration of flake completeness (adapted from Hiscock 2002:253). *Figure removed due to copyright restrictions.*

3. Length, Width, Thickness Measurement: The length, width and thickness measurements were recorded with digital Vernier callipers to the nearest millimetre. Examining the size of a flake can assist in determining the stages of flake reduction and provide information involving the use and distribution of lithics across a landscape (Holdaway and Stern 2004:135–136). Measurements were recorded under the following conventions (Andrefsky 2005:99–102; Holdaway and Stern 2004:37–42):
    i. 'Length': For complete flakes and broken flakes that can be orientated, following the percussion axis, length was measured from the PFA to the termination. For broken flakes that cannot be orientated and retouched artefacts, maximum length was recorded.
    ii. 'Width': For complete flakes and broken flakes that can be orientated, width was measured perpendicular to the percussion length at the mid-point of the length dimension. For broken flakes that cannot be orientated and retouched artefacts, maximum width was recorded.
    iii. 'Thickness': For complete flakes and broken flakes that can be orientated, thickness was measured perpendicular to the artefact width, at the intersection of length and width dimensions. For broken flakes that cannot be orientated and retouched artefacts, maximum thickness was recorded.
4. Platform Surface: The shape and surface of flake platforms can assist with understanding the reduction stages of artefact production and manufacturing strategies employed (Andrefsky 2003:90). Platform surface was recorded by the following classifications (Andrefsky 2005:94–97; Holdaway and Stern 2004:119–120):
    i. 'Cortical': The platform was cortex and the platform surface had not been further modified.
    ii. 'Shattered': The platform surface has been damaged to the extent where attributes cannot be recorded.
    iii. 'Single': The platform was shaped through the prior removal of a single flake (a 'flat platform').
    iv. 'Multiple': The platform comprises multiple negative flake surfaces.

    v. ‘Facetted’: The platform reflects three or more negative flake scars initiated from the dorsal surface across the flake platform.
    vi. ‘Focalised’: The platform surface does not extend horizontally beyond the edges of the PFA.
5. Platform Width and Thickness: Platform width and thickness were recorded with digital Vernier callipers to the nearest millimetre. Platform width was recorded as the maximum distance from one side margin on the platform to the other (Holdaway and Stern 2004:124–125). Platform thickness is perpendicular to the platform width, measuring the distance between the ventral and dorsal surfaces (Holdaway and Stern 2004:124–125). Platform width and thickness can be indicators as to the reduction process during flake manufacture (Andrefsky 2005:90).
6. Flake Initiation: Flake initiation will be recorded as either ‘hertzian’, ‘wedging’ or ‘bending’ (Figure 4.8). Medial and distal flakes, some retouched flakes and those with extensively damaged initiations will be recorded as ‘none’.
    i. ‘Hertzian Fracture’: A flake with a hertzian initiation (also referred to as ‘conchoidal fractures’) will feature a ‘ring crack’ (PFA) that forms a hertzian cone, and a bulb of percussion, produced as the force travels through the core to shape the flake (Holdaway and Stern 2004:34).
    ii. ‘Bending Fracture’: Bending fractures are most common where the edge angles are acute, do not produce a bulb of percussion and feature a crescentic shaped platform (Holdaway and Stern 2004:34). The platform will feature a pronounced lip and a ‘waist’ (or constriction) immediately below (Cotterell and Kamminga 1987:689).
    iii. ‘Wedging Fracture’: Wedging initiations are most common in bipolar flaking where the core is placed on an anvil and struck with force through a hammerstone (Cotterell and Kamminga 1987:685). Wedging initiations often demonstrate that multiple strikes of force have been applied to the core to remove the flake, reflected in the formation of small cracks prior to the flake formation (Holdaway and Stern 2004:34).

Figure 4.8 Illustration of flake initiation (adapted from Cotterell and Kamminga 1987:684). *Figure removed due to copyright restrictions.*

7. Artefact Termination: Terminations (Figure 4.9) can provide information about the application of force during the knapping process and how the flake was removed from the core (Andrefsky 2005:88–89). Artefact terminations were recorded under the following conventions (Andrefsky 2005:20; Cotterell and Kamminga 1987:699–701):
   i. ‘Feather’: The force of the fracture produces a smooth, thin ‘feathered’ termination with an acute angle.
   ii. ‘Step’: A step termination is formed when the force changes direction abruptly and results in a breakage from the core at roughly a right angle
   iii. ‘Hinge’: Hinge terminations are the result of a change in force direction where an acute angle produces curved hook-shaped lip.
   iv. ‘Outrepasse’: Also known as a ‘plunge’ termination, is similar to hinge terminations however force is redirected in the opposite direction curving back towards the core.
   v. ‘None’: Where the termination is absent in the case of a broken flake or a retouched flake.

Figure 4.9 Illustration of flake termination types (adapted from Andrefsky 2005:21). *Figure removed due to copyright restrictions.*

8. Dorsal Cortex Coverage: Cortex present on the distal surface of the flake was recorded as an estimated percentage of '0', '<50', '>50' or '100' (Holdaway and Stern 2004:144). Examining the presence of remaining cortex on the dorsal surface can provide information as to the use of raw materials across a specific landscape, the process of core reduction and the manufacture of flakes (Andrefsky 2005:103–104; Dibble et al. 2005:545).
9. Dorsal Scar Count: Designated '0', '1', '2' or '3'. A dorsal surface with indistinguishable scars or completely covered in cortex were recorded as '0' (Andrefsky 2005:108–109). Negative scars present on the dorsal surface were recorded as a dorsal scar count of '1', '2', or where flakes demonstrated three or more negative scars, '3' (Andrefsky 2005:108–109). Dorsal scars can assist in understanding the reduction sequence (Andrefsky 2005:106).
10. Dorsal Scar Direction: The dorsal scar direction reflects a relationship between the orientation of the dorsal scar and the ventral surface of the flake (Holdaway and Stern 2005:146). Dorsal scars represent prior flake removals from preceding platforms and by examining scar directions, can demonstrate core rotation during manufacturing processes (Holdaway and Douglass 2012:112). The classifications for dorsal scar direction include: 'none', 'indeterminate', 'same', 'opposite', 'oblique',

‘same and opposite’, ‘same and oblique’, ‘opposite and oblique’ and ‘same opposite and oblique’ (Thredgold 2017:74). Dorsal scar directions can reflect practices of core rotation and reduction strategies, potentially linked to attempts to conserve raw material (Holdaway and Stern 2004:148).

11. Overhang Removal: The presence of overhang removal was recorded as either ‘yes’ or ‘no’. Overhang removal is recognised as small scars on the flake’s dorsal surface that indicate material had been removed from the platform prior to the detachment of the flake from the core (Holdaway and Stern 2004:145). Overhang removal suggests conservation practices were employed by the knapper to prevent unwillingly damaging the core and to extend the quantity of flakes that can be removed (Clarkson and O’Connor 2014:158–159). Eliminating unnecessary material left behind on the core from previous flake removals produces a more desirable platform angle for future flakes (Clarkson and O’Connor 2014:178; Dibble and Rezek 2009:1951).
12. Edge Damage: Where edge damage was observed, it was recorded as ‘yes’, ‘no’ or ‘unknown’. Edge damage on a flake can be distinguished from retouch by the macroscopic negative scars, too small to have been created by a hammer, and often distributed irregularly (Holdaway and Stern 2004:167; Lerner et al. 2007; Shea 1987). Although edge damage can occur during flake use, as the lithics examined in this study were surface scatters, there is a higher possibility of edge damage due to taphonomic processes such as post-depositional trampling or surface weathering (Clarkson and O’Connor 2014:175).

The following additional attributes were recorded for ‘retouched flaked artefacts’:

1. Retouched flake type: Recording retouched flakes may indicate the technologies and activities performed across a specific landscape (Holdaway and Stern 2005:226). The following retouched flake types reflect those commonly examined in Australian lithic typologies (Flenniken and White 1985:142–148; Holdaway and Stern 2005:227–266):

    i. ‘Backed Artefact’: A flake that features steep retouch (either unidirectional or bidirectional) usually, but not exclusively, to one margin of the flake to ‘back’ or blunt the edge. This form of flake retouching is believed to enable the process of hafting.
    ii. ‘Scraper’: Flakes that demonstrate one or more edges of continuous retouch. Scrapers are often distinguished exclusively in terms of their edge morphology.
    iii. ‘Point’: Artefacts where either one or both lateral margins on a flake have been retouched and meet to form a point.
    iv. ‘Burin’: One or more triangular scars along the flake’s margin meet to form a chiselled edge, produced through the removal of ‘burin spalls’ (small flakes). A burin with one triangular scar has been made by truncating one end of the flake to create a new platform to detach the burin spall. For a burin where two triangular scars meet, the preceding scar has been utilised as a platform to remove the latter.
    v. ‘Tula Adze’: Where a flake has a particularly pronounced bulb of percussion and a wide platform, retouch originating from the ventral surface at the distal end reshapes the original flake to produce a tula adze. Tula adzes are often repeatedly re-sharpened, and at the end of this resharpening sequence, will take the form of a ‘tula adze slug’ (so called by it’s resemblance to a slug).
    vi. ‘Amorphous’: Amorphous retouched flakes demonstrate modified margins however have no common analytical morphological attributes.

2. Retouch Location: Where possible, retouch location was recorded for both the dorsal and ventral surfaces through a quadrant method (Figure 4.10), dividing the artefact into four sections (Holdaway and Stern 2004:147). On the dorsal surface, recording the flake margins in a clockwise direction and beginning with ‘1’ at the flake platform, retouch location was recorded as ‘1’, ‘2’, ‘3’ and ‘4’ (Andrefsky 2005:167). The ventral surface was recorded using the same method, labelled instead as ‘a’, ‘b’, ‘c’ and ‘d’, where ‘a’ was the flake platform. Retouch location can assist in identifying retouched flake type and activities linked to the use of the flake (Holdaway and Stern 2004:157–158).

Figure 4.10 Illustration of retouch location quadrant method. Flake retouch located in 2, 3, a, c, d. (adapted from Andrefsky 2005:167, 174). *Figure removed due to copyright restrictions.*

4.3.3 Stone Cores

A core (Figure 4.11) is understood as a nucleus of homogenous rock where flakes have been detached from its surface (Andrefsky 2005:14). A core has no ventral surface and will demonstrate one or more negative flake scars from previous removals (Holdaway and Stern 2004:37). One exception is the example of a flake that has been utilised as a core. A flake will have a ventral surface, and where negative scars can be distinguished from those on a retouched flake, can be exploited as a core to produce new flakes (Holdaway and Stern 2004:179).

Figure 4.11 Examples of chert cores from the study area.

1. Core Type: Core type was recorded under the following classifications; unidirectional, bidirectional, multidirectional, bifacial or bipolar, and can reveal the reduction sequence of raw materials, and possibly reflect strategies involved with resource utilisation (Holdaway and Stern 2004:180, 194). The term 'bipolar' refers to a specific technique of removing flakes from a core and is not exclusive; hence a core can be 'bipolar bidirectional' for example (Andrefsky 2005:16).
    i. 'Unidirectional': Unidirectional cores have flake scars that indicate flakes have been removed from a single striking platform in one direction. 'Blade cores' are a prominent example of unidirectional cores where long flakes have been removed, however unidirectional cores have also been observed where shorter negative flake scars are present (Andrefsky 2005:15–16).
    ii. 'Bidirectional': Bidirectional cores have two opposing platforms with flakes struck from each, hence negative flake scars travelling in opposite directions.
    iii. 'Multidirectional': Flakes have been removed from two or more platforms in several directions without clear orientation.
    iv. 'Bifacial': Bifacial cores feature a single platform where flakes from two different faces of the core have been removed.
    v. 'Bipolar': A bipolar core indicates that the core has been positioned on an anvil while the hammer has applied force to remove a flake. Bipolar cores are often smaller in size than freehand cores and can indicate strategies to maximise the potential for reduction of raw material (Andrefsky 2005:153).

2. Number of Core Platforms: Core platform counts were determined by both the visible platforms still present on the core, and those which could be reconstructed by orientating negative flake scars (Holdaway and Stern 2004:193). The sum of platforms reflect the minimum number of core rotations, and can also indicate that the knapper may have been eliminating undesirable features from the core such as former step or hinge terminations, cracks or voids (Clarkson and O'Connor 2014:161).
3. Length, Width, Thickness Measurements: Core measurements were recorded with digital Vernier callipers to the nearest millimetre. The core is orientated with the principal flaking surface facing towards the recorder and the principal flaking platform at the top. Length is taken from this position; width and thickness are recorded perpendicular to core length at the midpoint (Holdaway and Stern 2004:189). In conjunction with other core attributes, core measurements can reflect reasons as to why a core may not have been further reduced (Holdaway and Stern 2004:188).
4. Complete Negative Scar Length and Relative Platform Type: Recording the length of complete negative scars can demonstrate the size of flakes removed in the final stages of core reduction (Holdaway and Stern 2004:188). Relative platform types can suggest the degree to which platform preparation was undertaken to remove the flake from the core (Holdaway and Stern 2004:191).
    i. Complete Negative Scar Length: Where possible, the maximum lengths of the two longest complete negative scars were recorded. In cases where only one complete scar was observed, the field entry for second complete negative scar was left blank.
    ii. Complete Negative Scar Platform Type: Where complete negative scars have been documented, the associated platform type was recorded as 'cortex', 'negative scar' or 'indeterminate'.
5. Additional Comments: Observations as to the presence of any 'core problems' such as cracks, voids, inclusions, uneven texture and crushed surfaces were noted (Clarkson and O'Connor 2014:160). Such features on a core can alter and redirect the delivery of force from a hammerstone through the core and reduce the ability to

control the fracture path of the flake (Clarkson and O'Connor 2014:160). Where crushing is observed on a cores surface, it is likely that the core could be bipolar, having rested on an anvil to remove flakes (Clarkson and O'Connor 2014:158).

4.3.4 Stone Other

The category of 'other' was utilised for all other stone artefacts that do not meet the classifications for 'flaked stone artefact' or 'stone core'.

1. Artefact Type: Artefact types for this classification include, but are not exclusive to grindstones, anvils, hammer stones and non-diagnostic shatter.
2. Worked Areas and/or Evidence of Use: Where possible, observations as to the potential artefact use was recorded, for example a hammerstone with pitting at only one end or evidence of damage on an anvil.
3. Length, Width, Thickness Measurements: For all artefacts recorded under this classification, maximum length, width and thickness measurements were recorded.
4. Manuport or Non-diagnostic shatter: Where stones do not demonstrate attributes of having been culturally modified but have been likely been transported to the area by human agency as they are not naturally occurring in the study area (Hiscock 2009).

4.4 Summary

The methods adopted for this study have been designed to address the aims outlined in Chapter One, and have been based on broadly accepted conventions for technological lithics analysis, in conjunction with a geoarchaeological interpretive framework for the analysis of surface archaeological materials (Andrefsky 2005; Clarkson and O'Connor 2006; Cotterell and Kaminga 1987; Holdaway and Fanning 2014; Holdaway and Stern 2004). The research methods meet ethical requirements for the Traditional Owners RMMAC and the Flinders University Social and Behavioural Research Ethics Committee.

Chapter 5: Results

Introduction

This chapter firstly presents the data from the field survey conducted for this study at Lake Merreti lunette, Lake Clover dune and Lake Woolpolool dune, in Sections 5.1 to 5.6, so as to thoroughly and comprehensively outline the new data recorded by this study. This includes a discussion of technological attributes of the stone artefact assemblage, and markers of taphonomic processes (see Figure 4.1) observed during field survey (which alongside earlier examinations of local geomorphology, see Chapter Three, will inform geoarchaeological discussions in later chapters). Section 5.7 systematically presents the comparative dataset recorded by Thredgold (2017) at the Reny Island billabong precinct, Hunchee Island billabong precinct, Hunchee Creek precinct and the Ral Ral Creek east mounds.

5.1 Stone Artefact Assemblage Summaries

The results for the overall numbers of stone artefacts recorded during field survey are presented in Table 5.1. A total of 157 artefacts were recorded and the majority were unretouched flakes (55%). The numbers of complete to broken unretouched flakes were somewhat comparable, 55% and 45% respectively. Including retouched flakes in a measurement of complete to broken flakes reveals 58% were complete and 42% broken. Examining both retouched and unretouched flakes, retouched flakes were relatively uncommon representing only 5% of flaked artefacts analysed.

Table 5.1 Summary of assemblage recorded from field survey 'sites'.

Artefact type	**Total**	**Complete**	**Broken**
Unretouched Flakes	88	48 (55%)	40 (45%)
Retouched Flakes	5	4 (80%)	1 (20%)
Cores	8	8 (100%)	0
Heat Shatter	39	-	-
Non-Diagnostic Shatter	13	-	-
Hammerstone	2	0	2 (100%)
Manuport	2	-	-
Total	157	60 (58%)	43 (42%)

5.1.1 Lake Merreti Lunette

There were a total of 71 stone artefacts recorded at the Lake Merreti lunette (Table 5.2), 45% of the total field survey assemblage. Silcrete was the most dominant raw material recorded, comprising 73% of the 'site' assemblage.

Table 5.2 Summary of assemblage recorded from Lake Merreti lunette.

Artefact type	**Total**	**Chert**	**Silcrete**	**Calcrete**
Unretouched Flakes	28	11 (39%)	17 (61%)	0
Retouched Flakes	3	3 (100%)	0	0
Cores	3	1 (33%)	2 (67%)	0
Heat Shatter	29	0	28 (97%)	1 (3%)
Non-Diagnostic Shatter	4	2 (50%)	2 (50%)	0
Hammerstone	2	0	2 (100%)	0
Manuport	1	0	0	1 (100%)

5.1.2 Lake Clover Dune

There were a total of 60 stone artefacts recorded at the Lake Clover dune (Table 5.3), 38% of the total field survey assemblage. Silcrete reflected 68% of the raw material at Lake Clover dune, and 63% of the total cores recorded in the total field survey assemblage were recorded here. One unretouched broken silcrete flake had evidence of having been affected by heat exhibiting a small pot lid mark.

Table 5.3 Summary of assemblage recorded from Lake Clover dune.

Artefact type	**Total**	**Chert**	**Silcrete**	**Quartz**
Unretouched Flakes	42	11 (26%)	31 (74%)	0
Retouched Flakes	1	0	1 (100%)	0
Cores	5	3 (60%)	1 (20%)	1 (20%)
Heat Shatter	4	1 (25%)	3 (75%)	0
Non-Diagnostic Shatter	8	3 (38%)	5 (62%)	0
Hammerstone	0	0	0	0
Manuport	0	0	0	0

5.1.3 Lake Woolpolool Dune

There were a total of 26 stone artefacts recorded at the Lake Woolpolool dune (Table 5.4), 17% of the total field survey assemblage. Silcrete was the most common raw material at the Lake Woolpolool dune, representing 54% of the assemblage.

Table 5.4 Summary of assemblage recorded from Lake Woolpolool dune.

Artefact type	Total	Chert	Silcrete	Quartz
Unretouched Flakes	18	5 (28%)	11 (61%)	2 (11%)
Retouched Flakes	1	1	0	0
Cores	0	0	0	0
Heat Shatter	6	4 (67%)	2 (33%)	0
Non-Diagnostic Shatter	0	0	0	0
Hammerstone	0	0	0	0
Manuport	1	0	1 (100%)	0

5.2 Raw Materials

The dominant raw material by quantity recorded for the total field survey assemblage (Figure 5.1), excluding non-diagnostic shatter, heat shatter and non-artefactual manuports, is silcrete reflecting 63% of the raw materials. Chert represents 34% and quartz represents 3% of the total recorded field survey assemblage. Examining the weight in grams of the field survey assemblage (Figure 5.2), silcrete is still the dominant material, 78%, compared to chert 20% and quartz 2%.

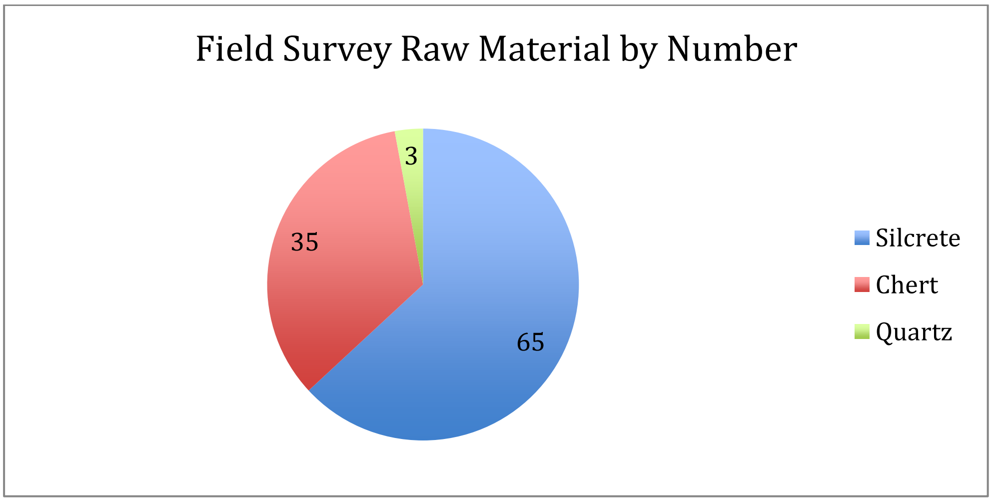

Figure 5.1 Field survey raw material by number.

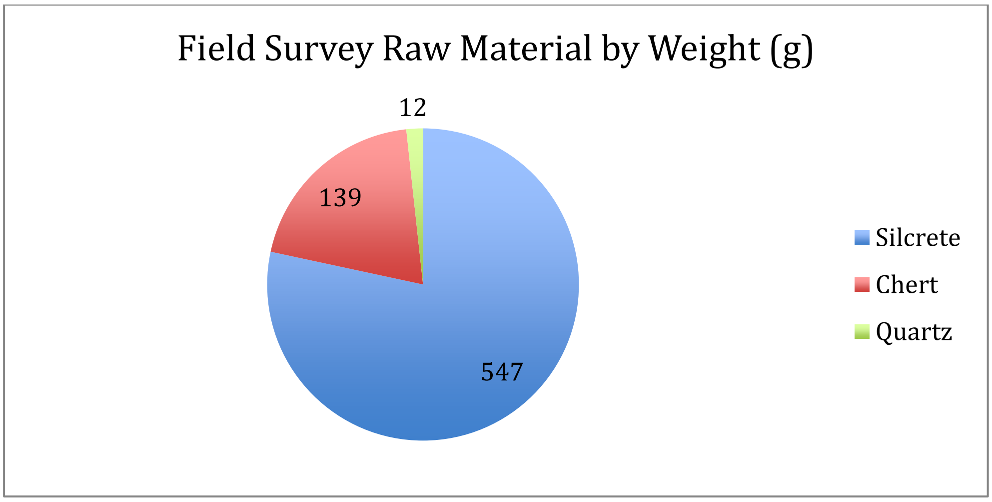

Figure 5.2 Field survey raw material by weight (g).

There were eight cores recorded during field surveys, located at the Lake Merreti lunette and the Lake Clover dune. There was not a large difference in raw materials for cores, 50% chert (n=4), 38% silcrete (n=3) and 12% quartz (n=1).

Considering the quantity of flaked artefacts alone (Figure 5.3) reduces the field survey assemblage to 93 flaked artefacts. Of the quantity of flaked artefacts, silcrete represents 65%, chert 33%, and quartz 2% of the assemblage. Analysing the weight of flaked artefacts (Figure 5.4), silcrete dominates the assemblage representing 80% compared to chert 19% and quartz 1%.

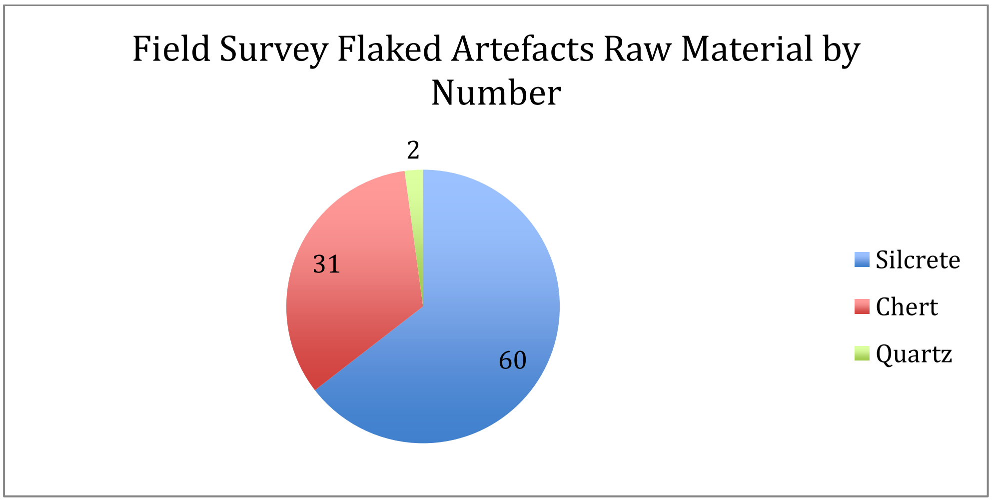

Figure 5.3 Field survey flaked artefacts raw material by number.

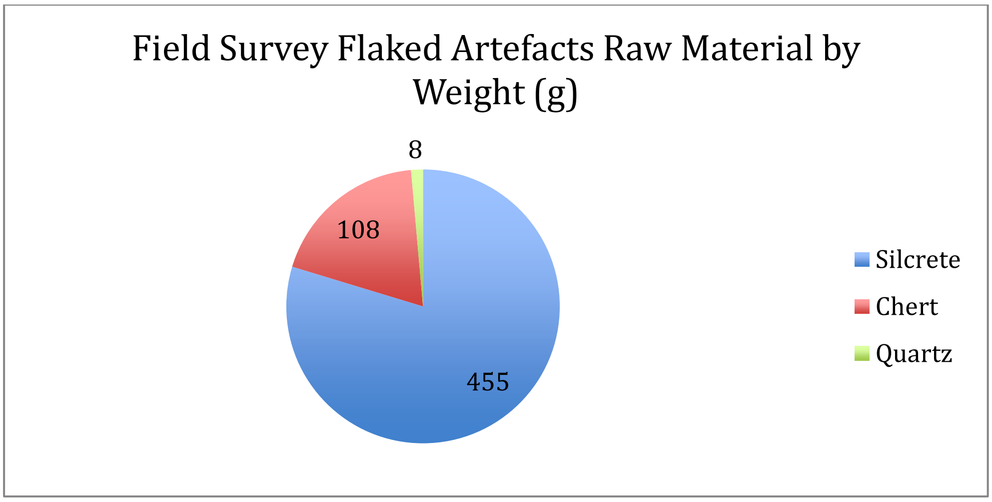

Figure 5.4 Field survey flaked artefacts raw material by weight (g).

The quality of raw material was variable across the field survey (Figure 5.5). Examining the unretouched flakes, retouched flakes and cores, the raw material comments were revised to fine-grained (includes artefacts described as very fine and fine), medium-grained and coarse-grained (includes artefacts described as coarse and very coarse).

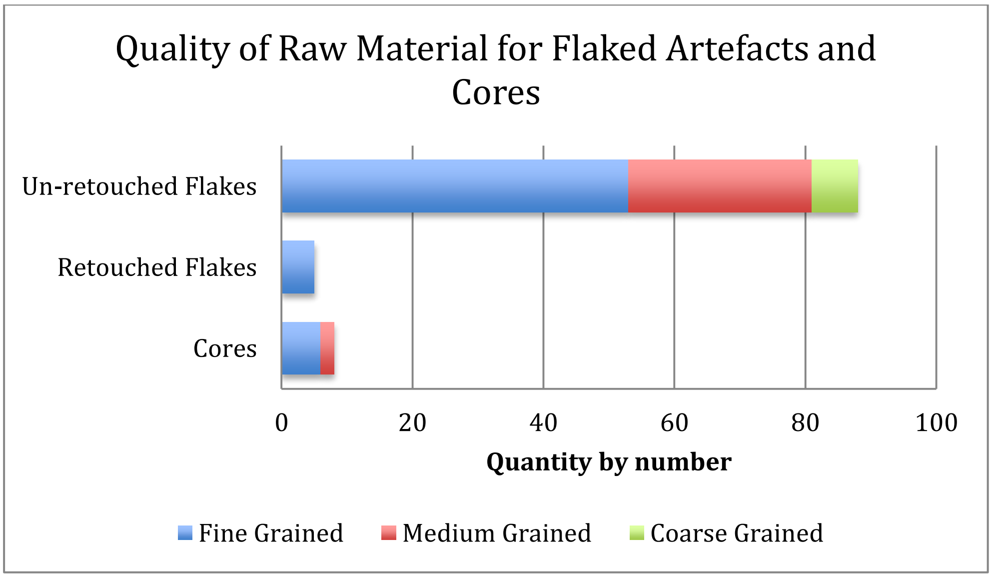

Figure 5.5 Quality of raw material for field survey flaked artefacts and cores.

Overall, fine-grained materials were most common, reflecting 62% of the flakes and cores recorded during field survey. Fine-grained materials were recorded in both chert and silcrete materials with little noticeable distinction. Of the fine-grained flaked artefacts recorded, 49% were silcrete and 51% were chert. Silcrete flaked artefacts were most commonly recorded as fine-grained (54%) compared to medium-grained (33%) and coarse-grained (16%).

Coarse-grained artefacts were only found in unretouched flakes and represent 7% of the raw material quality for flaked artefacts and cores. For non-diagnostic shatter and heat shatter stones, silcrete was the most common material recorded, reflecting 79% of these stones, compared to 21% recorded as chert. For the silcrete non-diagnostic shatter and heat shatter stones recorded in this study, coarse-grained (42%) and medium-grained (42%) silcrete materials dominated the record. Only 16% of silcrete non-diagnostic shatter and heat shatter stones were recorded as fine-grained materials recorded.

5.3 Flake Attributes

5.3.1 Flake Dimensions

Examining the dimensions for unretouched flakes (n=88) recorded during field surveys, the average flake length was 19.35 mm, the average width 16.86 mm, and the average thickness was 5.10 mm. Excluding one outlier with a length of 117 mm and width of 110 mm, the general distribution of unretouched flakes (n=87) can be observed in Figure 5.6.

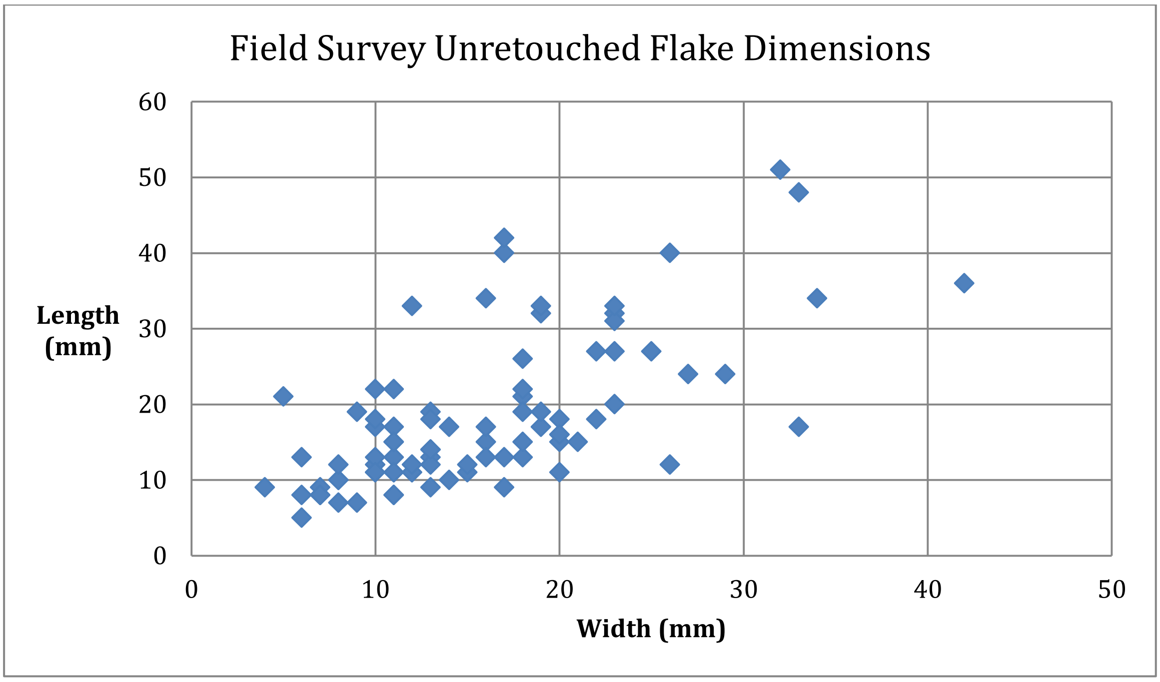

Figure 5.6 Field survey unretouched flake dimensions.

Exploring the relationship between raw material and unretouched flake dimensions, on average silcrete flakes were larger than chert flakes (Figure 5.7 and Figure 5.8). Excluding one silcrete outlier with a length of 117 mm and width of 110 mm, the average length for silcrete unretouched flakes (n=59) was 20.32 mm with an average width of 16.68 mm. Including the outlier, there was a marginal increase in silcrete average dimensions to with an average length of 21.93 mm and an average width of 18.23 mm.

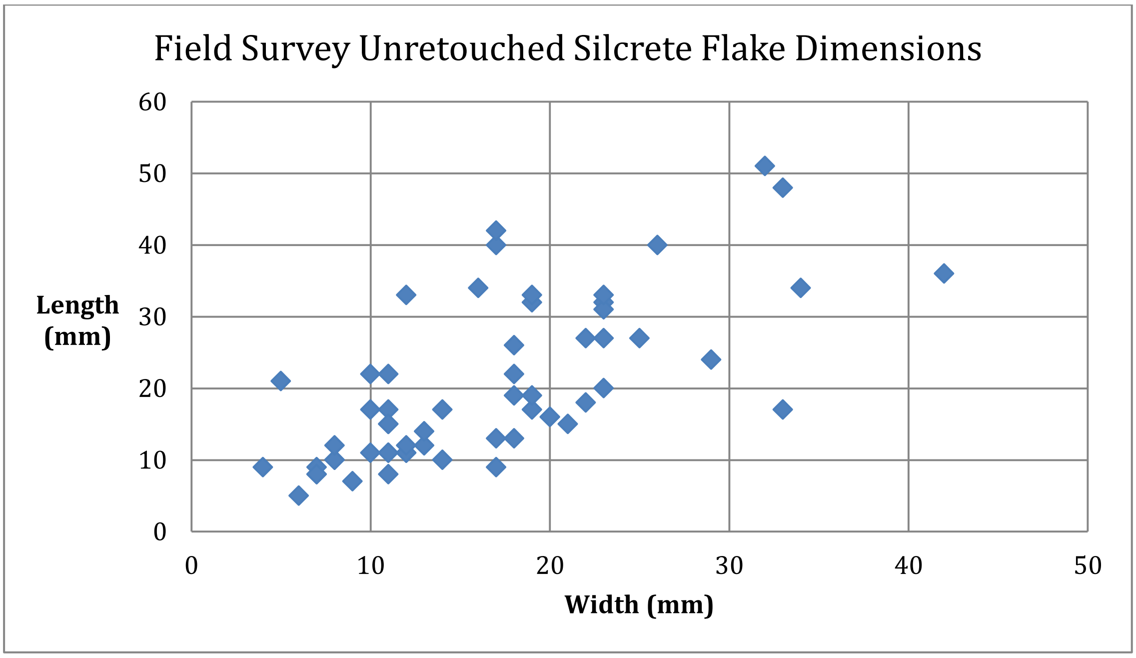

Figure 5.7 Field survey unretouched silcrete flake dimensions.

For unretouched chert flakes (n=26) there was less variability in the range of dimensions for the field survey assemblage (Figure 5.8). The average length was 13.81 mm with an average width of 13.77 mm.

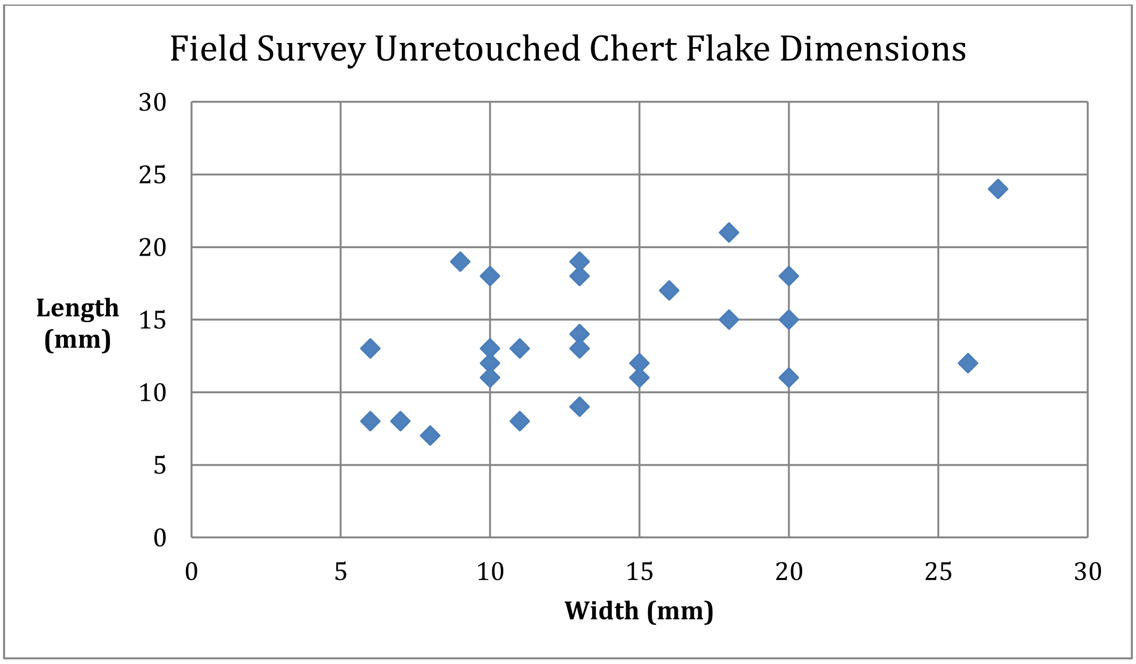

Figure 5.8 Field survey unretouched chert flake dimensions.

Two unretouched quartz flakes were recorded during field survey. The average length was 14 mm with an average width of 16 mm.

5.3.2 Flake Completeness

Table 5.1 presents the quantity of complete and broken stone artefacts in relation to artefact type. Considering the connection between raw material and flaked artefact completeness, Table 5.5 demonstrates complete flakes were slightly more common within the field survey assemblage. Flake completeness levels were comparably elevated for raw materials, particularly silcrete (55% complete flakes) and chert (58% complete flakes).

Table 5.5 Complete and broken flaked artefacts by raw material.

Raw Material type	**Number of Artefacts**	**Number of Complete Flakes**	**Number of Broken Flakes**
All Flaked Materials	93	52 (56%)	41 (44%)
Silcrete	61	33 (54%)	28 (46%)
Chert	30	18 (60%)	12 (40%)
Quartz	2	1 (50%)	1 (50%)

Figures 5.9 and 5.10 exhibit the connection between complete and broken unretouched flake dimensions in the field survey data. Excluding one outlier, a complete unretouched flake with a length of 117 mm and width of 110 mm, the general distribution of complete unretouched flakes (n=48) can been examined below. The average length of complete unretouched flakes was 20.06 mm, and the average width 17 mm. Including the outlier in this assessment; there is a marginal increase in average length to 22.08 mm and average width to 18.94 mm.

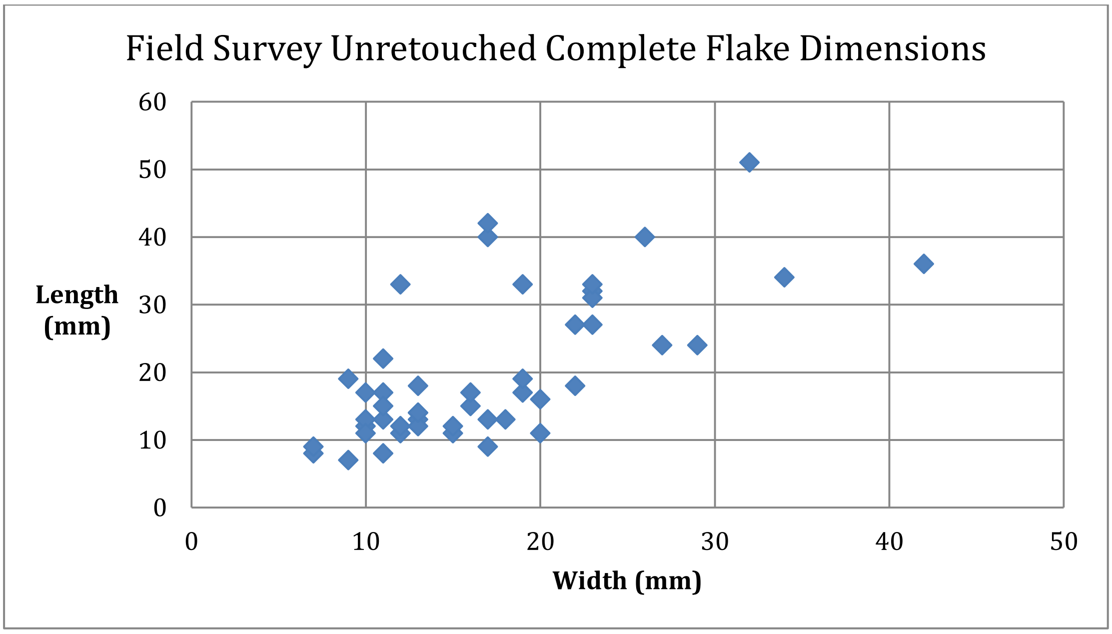

Figure 5.9 Field survey unretouched complete flake dimensions.

Examining the distribution of broken unretouched flakes (n=40), the average length was 16.08 mm and the average width 14.35 mm. Although broken flakes reflect 43% of the field survey assemblage (Table 5.5), the overall reduction in average size for broken compared to complete flakes was marginal.

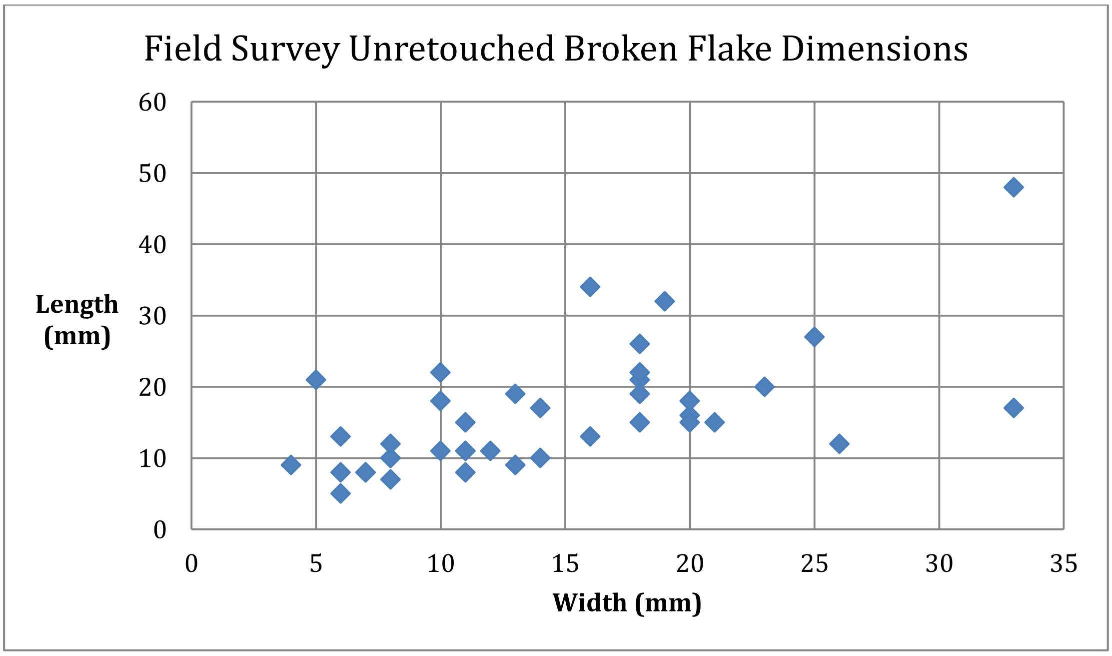

Figure 5.10 Field survey unretouched broken flake dimensions.

Of the unretouched flakes (n= 88) recorded during field survey, and considering raw material and flake completeness, all three raw materials reflect relatively common results (Table 5.6). Unretouched chert flakes had the most notable difference with relatively more complete flakes (58%) compared to broken flakes (42%).

Table 5.6 Complete and broken unretouched flaked artefacts by raw material.

Raw Material type	**Number of Artefacts**	**Number of Complete Flakes**	**Number of Broken Flakes**
Silcrete	60	32 (53%)	28 (47%)
Chert	26	15 (58%)	11 (42%)
Quartz	2	1 (50%)	1 (50%)

Table 5.7 indicates the connection between the average width of complete and broken unretouched flaked artefacts recorded during field surveys, alongside their raw materials. The most notable observation is with unretouched silcrete flakes, where those with a comparatively large width were more commonly a complete flake, and the average width for complete silcrete flakes was 5.91 mm compared to 4.93 mm for broken silcrete flakes.

Table 5.7 Average width dimensions for complete and broken unretouched flaked artefacts by raw material.

Raw Material type	**Number of Artefacts**	**Average Width of Complete Flakes**	**Average Width of Broken Flakes**
Silcrete	60	5.91 mm	4.93 mm
Chert	26	4.4 mm	4.36 mm
Quartz	2	3 mm	4 mm

5.3.3 Dorsal Scars

Dorsal scar information was recorded on 24 unretouched flaked artefacts (Figure 5.11); retouched artefacts with dorsal information were not encountered. The majority were complete flakes (92%, n=22), and there was one proximal and one distal flake with dorsal information recorded. Of the 10 chert flakes, three indicated some core rotation while seven had dorsal scars travelling in the same direction as the flake. Five of the 13 silcrete flakes showed evidence of core rotation compared to eight that had dorsal scars travelling in the same direction as the flake.

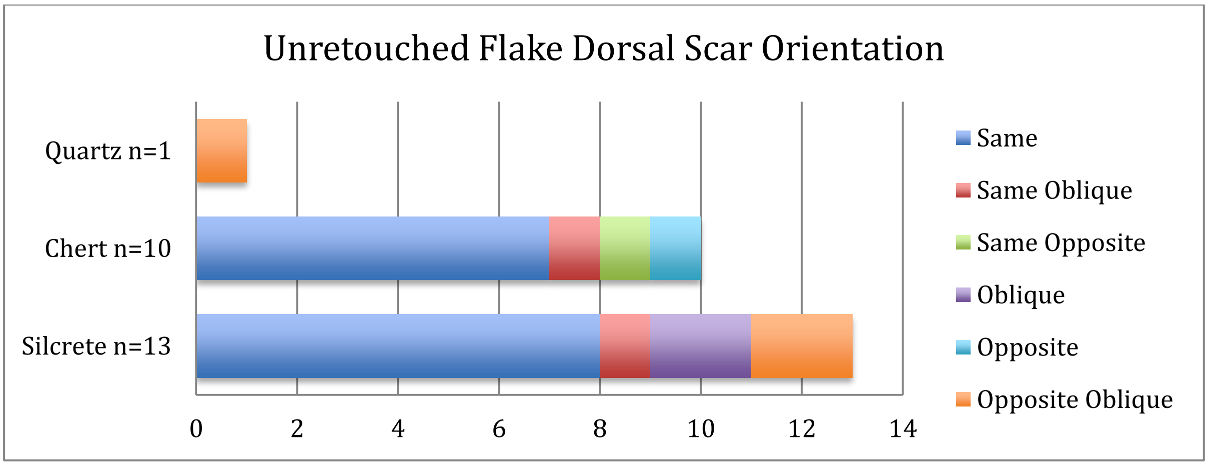

Figure 5.11 Unretouched flake dorsal scar direction.

Raw material quality was measured against dorsal scar orientation to analyse whether there were any observable features (Figure 5.12). Silcrete, chert and quartz raw material qualities for unretouched flakes with dorsal information were organised into groupings of fine-grained (includes artefacts described as very fine and fine), medium-grained and coarse-grained (includes artefacts described as very coarse). While the quality of raw material can impact the strategies employed to produce a desirable flake (Andrefsky 2005:59; Clarkson and O'Connor 2014:192), fine-grained and medium-grained flaked artefacts with dorsal information generally reflected comparable diversity in dorsal scar orientation. The majority of flakes demonstrated dorsal scars travelling in the same direction as the flake.

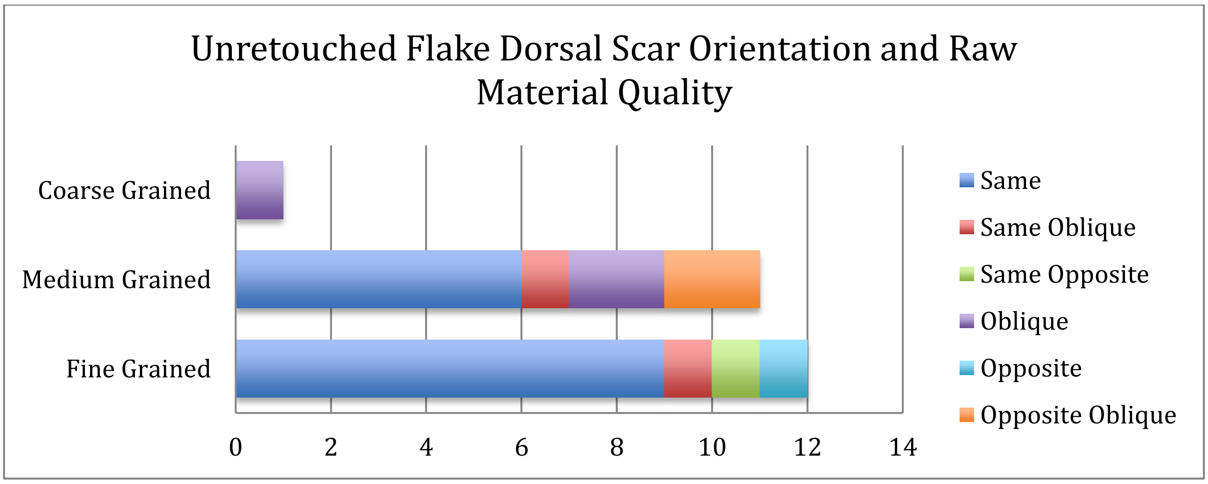

Figure 5.12 Unretouched flake dorsal scar direction and raw material quality.

5.3.4 Retouched Flakes

Retouched flakes (Table 5.8) were uncommon in the field survey assemblage, representing only 5% (n=5) of the flaked stone artefacts recorded. All retouched flakes were noted to be of fine-grained raw material quality and chert was the more common material for retouched flakes over silcrete. All examples of retouched flakes had amorphous retouch, two flakes had consistent retouch on all margins. Retouched flake length varied between 9 mm and 31 mm with an average of 18.2 mm. The average length of complete retouched flakes was 15.75 mm.

Table 5.8 Retouched flakes: Raw material, material quality, completeness and length.

Raw Material	**Raw Material Quality**	**Complete or Broken Flake**	**Flake Length (mm)**
Chert	Fine-grained	Complete flake	9
Chert	Fine-grained	Complete flake	31
Chert	Fine-grained	Complete flake	13
Silcrete	Fine-grained	Complete flake	10
Chert	Fine-grained	Longitudinal cone split left	28

5.3.5 Cone Split Flakes

Of the total retouched and unretouched flakes recorded (n=93), 16% (n=15) were longitudinal cone split (LCS) flakes (Table 5.9). LCS right flakes were more common representing 73% (n=11) of the field survey record. Dorsal cortex was uncommon, and only recorded on three LCS flakes. Overall, LCS flakes were found in finer-grained to medium-grained raw materials, and more commonly in silcrete flakes, 87% compared to 13% in chert.

Table 5.9 Longitudinal Cone Split (LCS) flakes: Raw material, material quality, length and weight.

Flake type	**Raw Material**	**Raw Material Quality**	**Length (mm)**	**Weight (g)**
LCS left	Silcrete	Medium-grained	27	6
LCS right	Silcrete	Coarse-grained	34	4
LCS left	Silcrete	Coarse-grained	19	2
LCS right	Silcrete	Medium-grained	8	1
LCS left	Silcrete	Fine-grained	8	1
LCS right	Silcrete	Fine-grained	9	1
LCS right	Silcrete	Fine-grained	11	5
LCS right	Silcrete	Fine-grained	11	5
LCS left	Silcrete	Fine-grained	10	6
LCS right	Silcrete	Fine-grained	15	8
LCS right	Silcrete	Medium-grained	48	20
LCS left	Silcrete	Medium-grained	26	2
LCS right^a	Silcrete	Fine-grained	21	4
LCS left*^b	Chert	Fine-grained	28	3
LCS right^c	Chert	Fine-grained	18	9

* Retouched Flake ^Dorsal Cortex Present

a Dorsal Cortex = 1–50% b Dorsal Cortex = 51–99% c Dorsal Cortex = 1–50%

5.3.6 Platform Attributes and Preparation

Of the retouched and unretouched flaked artefacts recorded during field surveys (n=93), 44 had measureable platform details (three retouched flakes and 41 unretouched flakes). Silcrete flakes had an average platform width of 18.78 mm and average platform thickness of 4.85 mm (Figure 5.13).

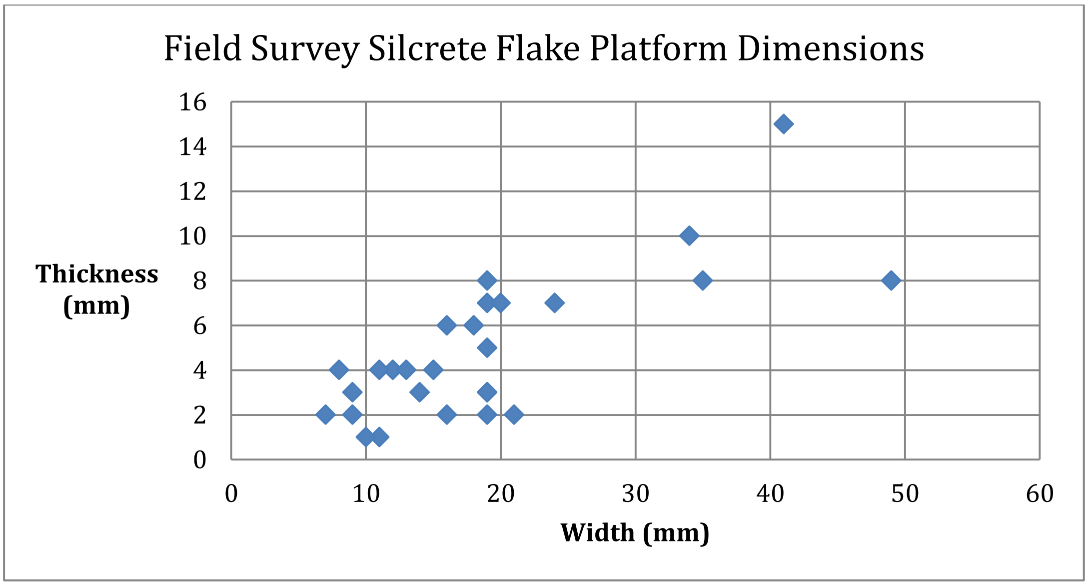

Figure 5.13 Field survey silcrete flake platform dimensions.

Overall unretouched and retouched chert flakes recorded during field survey were smaller in average dimensions than those in silcrete. Chert flake platforms had an average width of 12.13 mm and an average thickness of 4.13 mm (Figure 5.14). The small dimensions for chert flake platforms are consistent with the overall smaller width of chert flakes recorded during field survey (see Section 5.3.1).

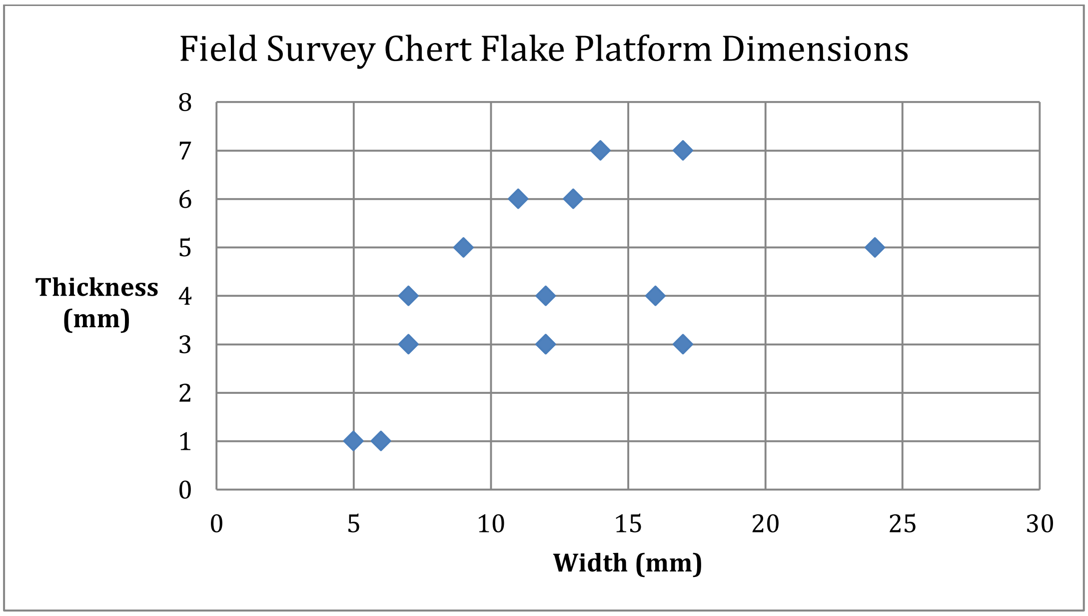

Figure 5.14 Field survey chert flake platform dimensions.

Of the two quartz flakes recorded during field surveys, both had platform measurements available. For quartz flakes, the average platform width was 5.5 mm and the average platform thickness was 2 mm. The small platform dimensions reflect the overall nature of small quartz flake dimensions encountered during field survey (see Section 5.3.1) and the rarity of this raw material in the assemblage.

Examining the platform surface for unretouched and retouched flakes (n=93) recorded during field survey, 44 flakes had discernible surface classifications. Three retouched flakes revealed platform surface data, two chert flakes and one silcrete flake all with multiple surface platforms. One unretouched quartz flake was recorded to have a shattered platform. The most common platform surface across all raw materials was single fracture platforms representing 41% of those with surface classifications (n=44). Cortical platform surfaces (Figure 5.15) were only recorded on silcrete flakes and reflect 20% of the silcrete surfaces with classifications (n=34).

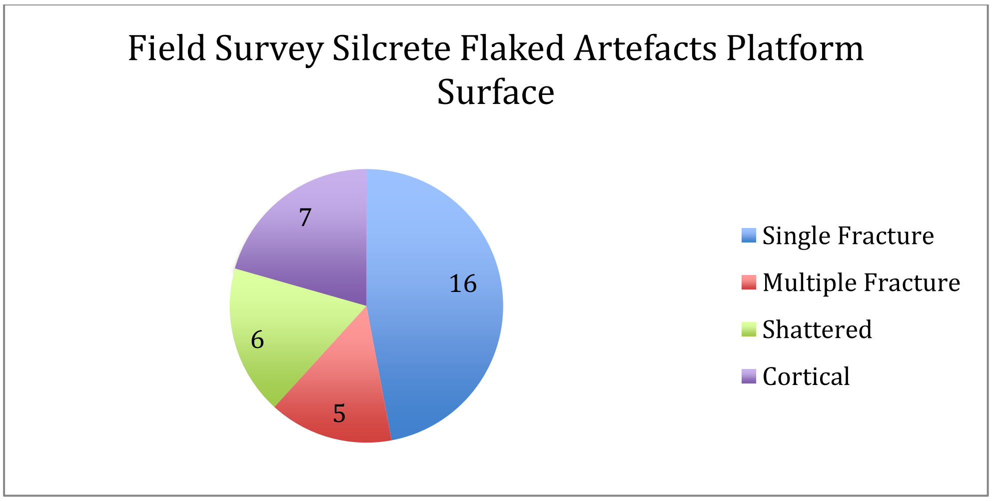

Figure 5.15 Field survey silcrete flaked artefacts platform surface.

Chert flakes recorded had diversity in platform surface in comparison to silcrete flakes. As with silcrete flakes, the most common platform surface was single fracture platforms (Figure 5.16). One-third of chert flakes were recorded to have shattered platforms.

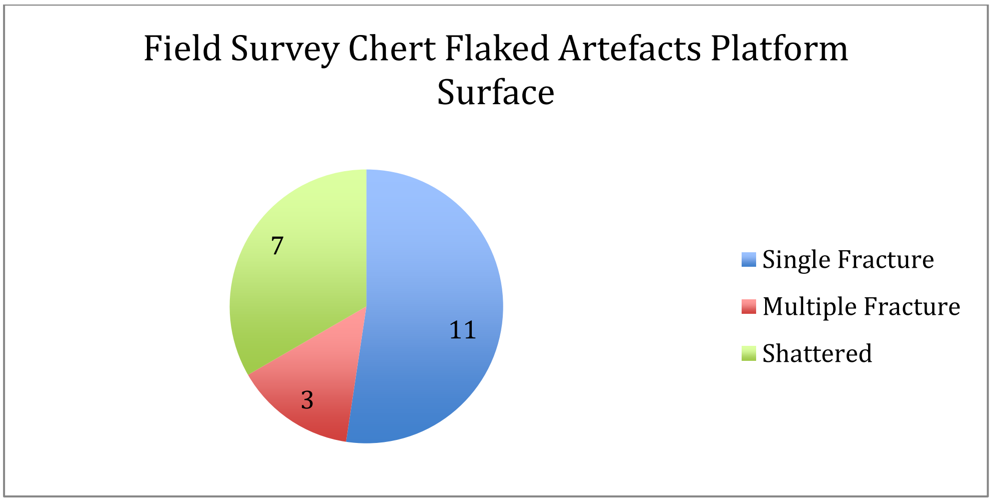

Figure 5.16 Field Survey chert flaked artefacts platform surface.

Overhang removal was recorded during field survey as an approach to understanding platform preparation. Only 12 unretouched and retouched flakes had evidence of this feature, equal numbers in silcrete and chert. Of these flakes, overhang removal was identified on two, one silcrete unretouched flake with multiple platform surfaces, and one chert unretouched flake with a single fracture surface.

5.4 Cortex in the Assemblage

The presence of remaining cortex was recorded on flaked and core artefacts (n=101) in the field survey assemblage (with the exclusion of non-artefactual artefacts, heat shatter, two broken hammer stones and two manuports). Of the unretouched and retouched flake artefacts recorded during field survey (n=93), 77% of flakes had no dorsal cortex present (Figure 5.17). The majority (91%) of flake artefacts had less than 50% dorsal cortex.

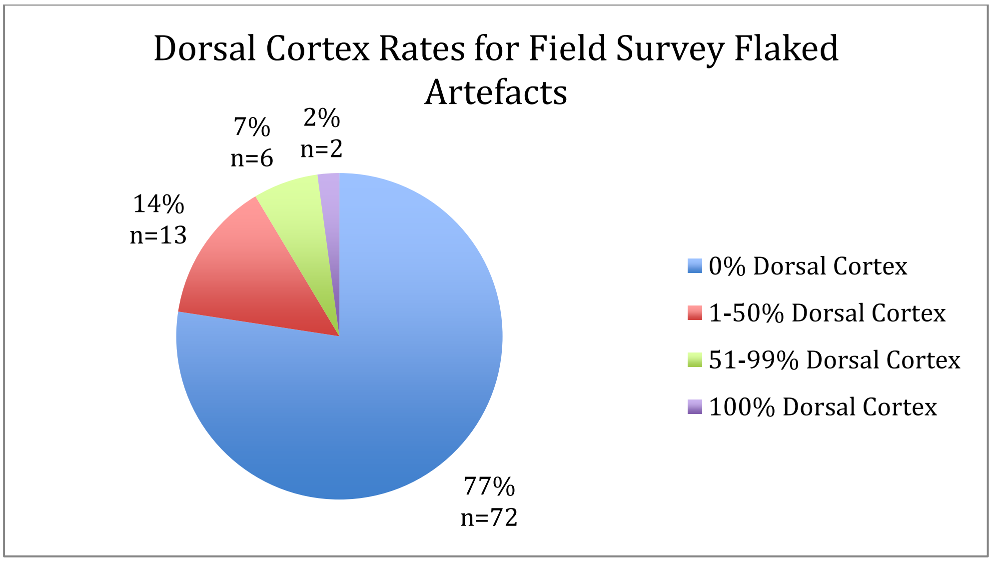

Figure 5.17 Dorsal cortex rates for field survey flaked artefacts.

Of the core artefacts recorded during field surveys (n=8), no cores had remaining cortex values greater than 50% (Figure 5.18). Cortex was also present on the platform surface of seven silcrete flakes (see Figure 5.15), representing 20% of silcrete flakes where platform surface information was available (n=34).

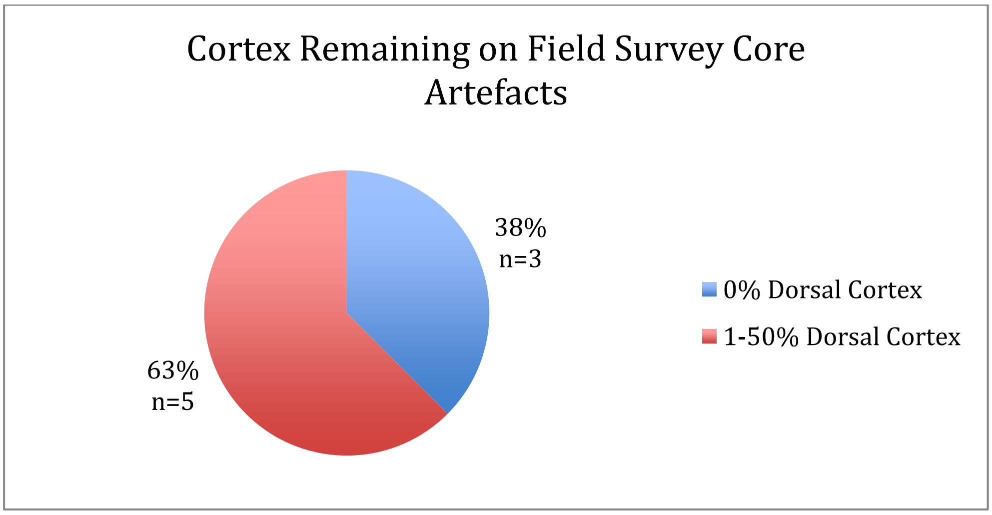

Figure 5.18 Cortex remaining on field survey core artefacts.

5.5 Core Attributes

There were eight cores recorded during field surveys, 50% of which were chert cores, 38% silcrete, and 12% quartz. Figure 5.5 (see also Table 5.10) indicates 75% of cores recorded during field survey were fine-grained. Core types were varied, bipolar unidirectional (n=2), bipolar multidirectional (n=2) and bidirectional (n=2) were recorded in equal numbers (Table 5.10). Multidirectional (n=1) and bipolar bidirectional (n=1) were less frequent in the core assemblage.

Table 5.10 Field survey core attributes: Raw material, material quality, weight and core problems.

Raw Material	Raw Material Quality	Core Type	Core Weight (g)	Core Problems
Silcrete	Fine-grained	Bipolar unidirectional	2	
Silcrete	Medium-grain	Bipolar multidirectional	79	Uneven texture, voids
Silcrete	Fine-grained	Bidirectional	11	
Chert	Fine-grained	Multidirectional	15	
Chert	Fine-grained	Bipolar multidirectional	2	
Chert	Fine-grained	Bipolar unidirectional	3	
Chert	Fine-grained	Bidirectional	11	Uneven texture, voids, cortex
Quartz	Medium-grained	Bipolar bidirectional	4	

The combined total measurement for core weight (n=8) was 127 g (Figure 5.19 and Figure 5.20). Considering all core artefacts recorded during field survey, silcrete is the most dominant material in the assemblage with a combined total weight of 92 g. One silcrete bipolar multidirectional core was an outlier for weight measurements with a weight of 79 g. Figure 5.20 portrays the weights for core artefacts excluding this outlier (n=7). In doing so, chert is evident as the dominant material both in quantity of cores recorded and core weight.

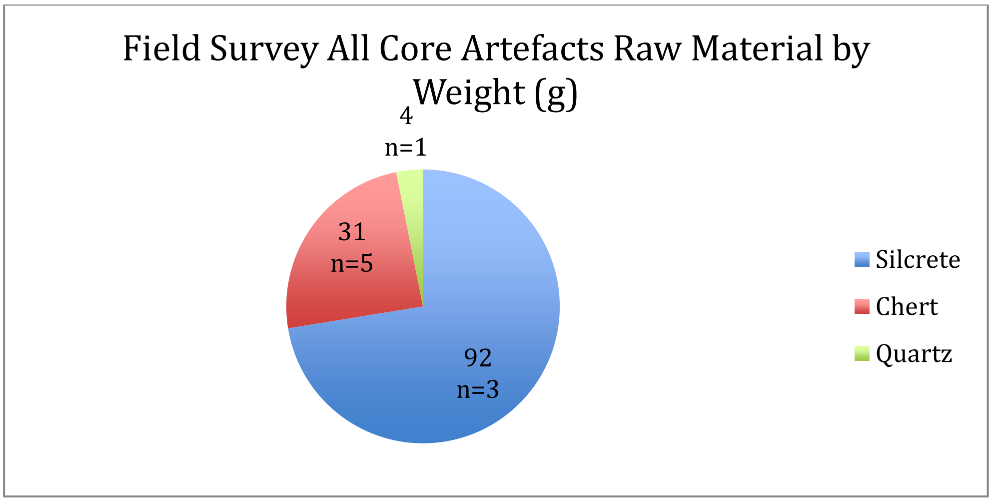

Figure 5.19 Field survey all core artefacts raw material by weight (g).

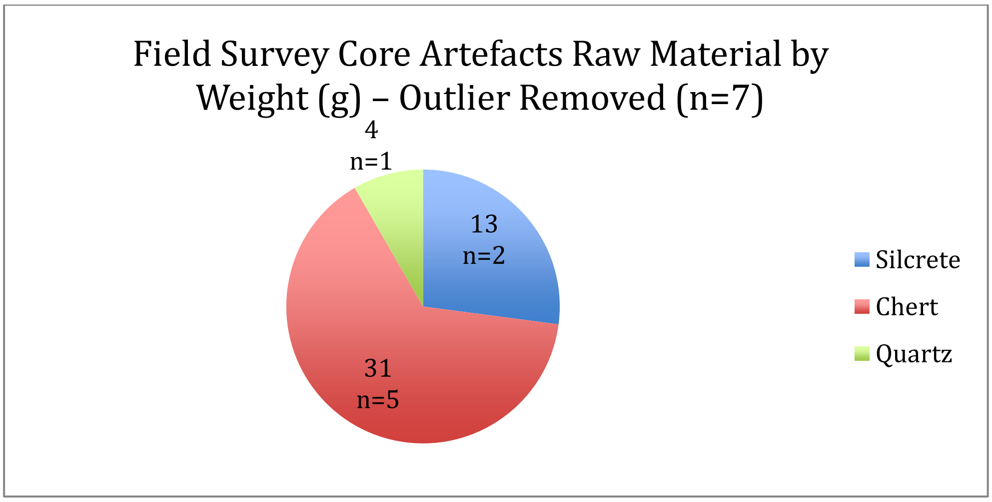

Figure 5.20 Field survey core artefacts raw material by weight (g)–outlier removed (n=7).

The dimensions for cores recorded during field survey (n=8) are presented in Figure 5.21. Cores were typically less than 30 mm in length and less than 20 mm in width. The average core length is 26.63 mm and the average width is 22 mm.

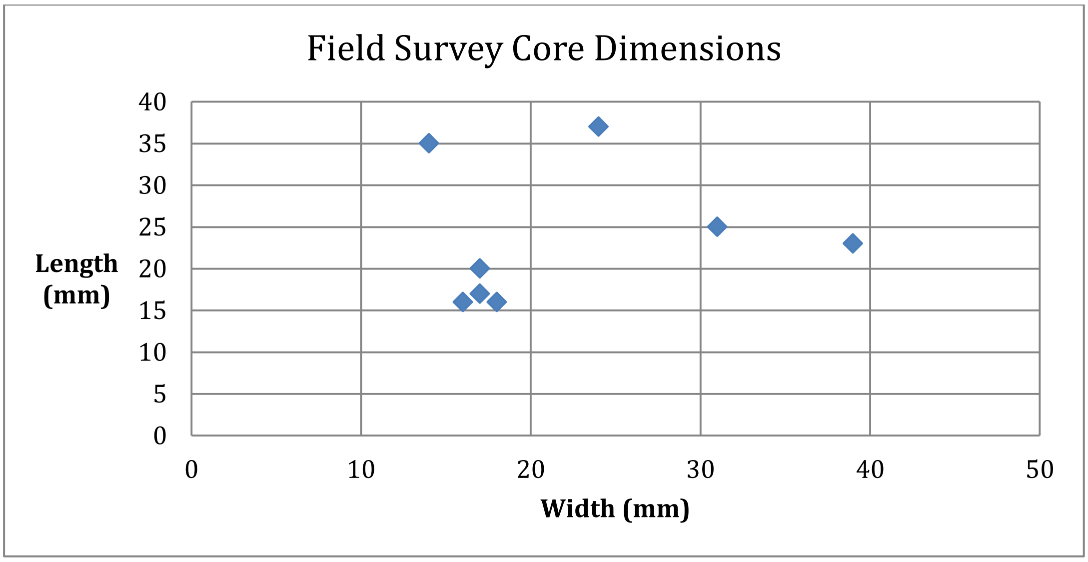

Figure 5.21 Field survey core dimensions.

Considering the length of cores and the negative scar lengths, generally, cores were longer than the negative scars remaining on them (Figure 5.22). Of the eight cores recorded, four had more than one measureable negative scar length. The average length for negative scar one was 15.38 mm and the average length for negative scar two was 11.25 mm. The core length and scar lengths are relatively comparable across the silcrete, chert and quartz materials, however silcrete reflects a slight inclination towards smaller negative scars relative to the length of cores.

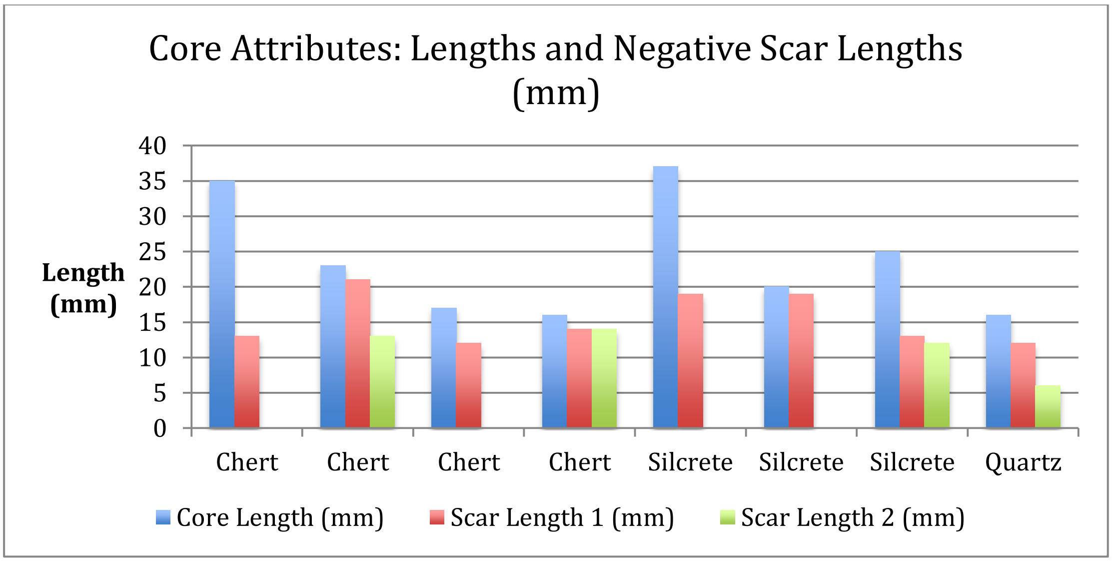

Figure 5.22 Core attributes: Lengths and negative scar lengths (mm).

Figure 5.23 demonstrates the average core length and average negative scar length on cores, in all raw materials, to the average lengths for unretouched flakes recorded during field survey (excluding one silcrete outlier with a length of 117 mm). Cores in each raw material were larger than the unretouched flakes in the corresponding raw materials. Of the three raw materials recorded during field survey, chert unretouched flakes and negative core scars were most comparable in length with flakes measuring an average of 13.8 mm and negative scars an average of 14.5 mm.

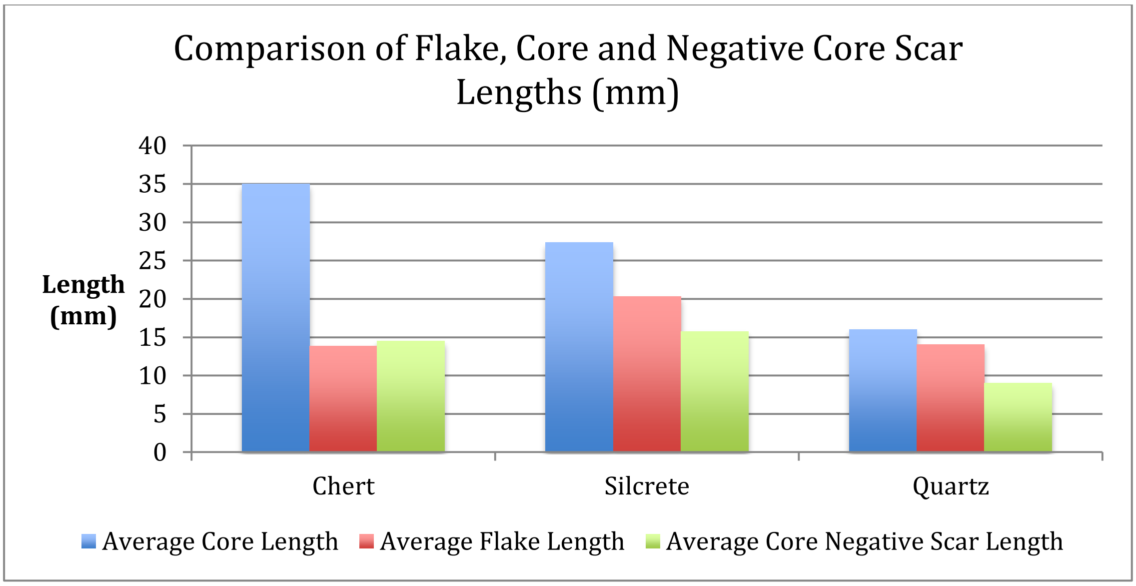

Figure 5.23 Comparison of flake, core and negative core scar lengths (mm).

5.6 Evidence of Cultural and Natural Landform Processes

5.6.1 Contemporary Surface Disturbances

A prominent contemporary disturbance to the Lake Merreti lunette and Lake Clover dune landforms is the presence of station management access roads in close proximity to the landforms (Figure 5.24 and Figure 5.25). At the Lake Merreti lunette the road runs along the lateral margin of the landform, running north south. Stone artefacts were observed during field survey lying both directly on the road and in the immediate vicinity. The baseline was set approximately 1 m back from the road in an attempt to avoid recording material that had been damaged from vehicle activities. At the Lake Clover dune landform, the road runs immediately through the western side of the dune. Artefacts were observed lying directly on the road and along the road fringes. The Lake Clover dune transect was set up along an exposed hearth feature and ran the length of the dune until meeting the edge of the road. Artefacts located on the road were not recorded due to the high level of disturbance and probable damage.

Figure 5.24 Station management access road at the Lake Merreti lunette, facing north. Photograph J. Thredgold, September 2016.

Figure 5.25 Station management access road at the Lake Clover dune, facing northwest. Photograph J. Thredgold, September 2016.

5.6.2 Flake Fragmentation

Examining broken unretouched flakes (n=40) recorded during field survey (Figure 5.26), longitudinal cone split flakes (35%) and distal flakes (27%) were the most commonly recorded.

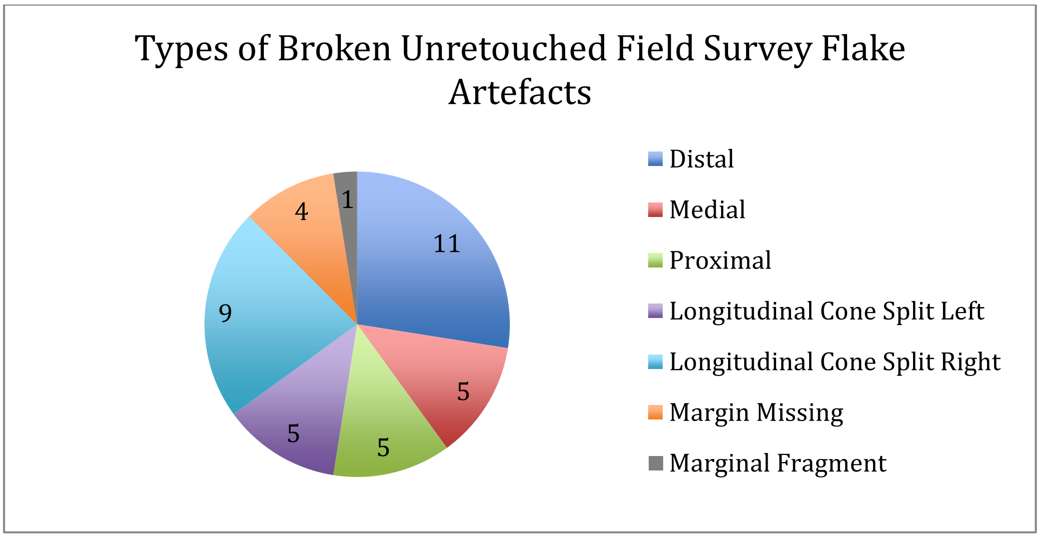

Figure 5.26 Types of broken unretouched field survey flake artefacts.

Considering the quality of raw material and the quantity of complete and broken unretouched flake artefacts recorded during field survey (Figure 5.27), 64% of broken unretouched flakes were of a fine-grained material.

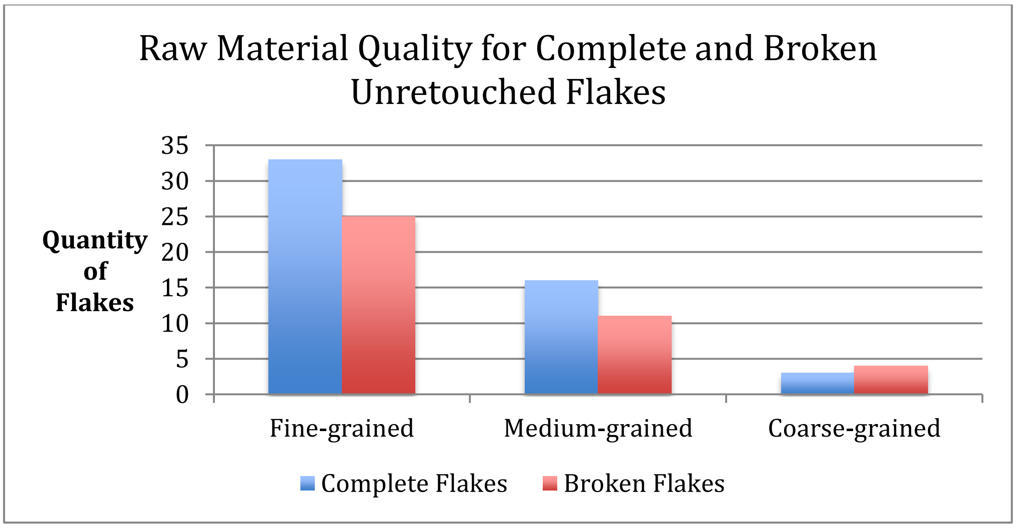

Figure 5.27 Raw material quality for complete and broken unretouched flakes.

Examining edge damage across the field survey assemblage, only 11 (12%) of the 93 recorded flakes demonstrated edge damage. Of the 11 edge damaged flakes, only one was a retouched chert flake and the remaining ten were unretouched. Figure 5.28

demonstrates the edge damaged flakes by raw material and the proportions of complete and broken flakes. No quartz flakes were recorded with edge damage.

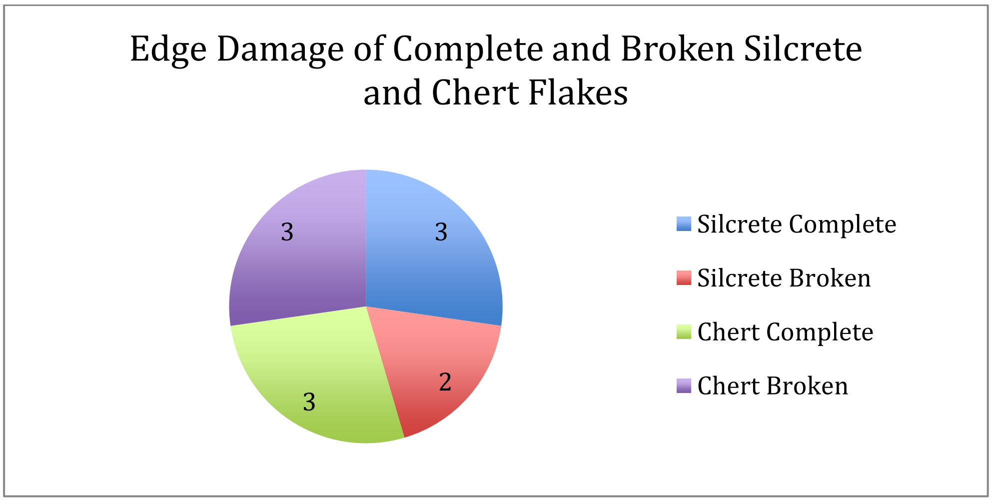

Figure 5.28 Edge damage of complete and broken silcrete and chert flakes.

5.6.3 Fluvial Processes

In lithics analyses designed to consider the mark of fluvial processes across a landform, studies have asserted that artefacts with dimensions smaller than 20 mm are likely to be subject to fluvial disturbance, removing them from the assemblage (Hiscock 1985; Fanning and Holdaway 2001:681–683; Petraglia and Potts 1994:231; Schick 1987; Tumney 2011:102–105). During field surveys, 103 artefacts (flakes, cores and hammerstone fragments) have measurements for length and width. Of the 103 artefacts, 47% (n=48) had both length and width measurements less than 20 mm. This would indicate that fluvial processes have had little impact of assemblage displacement.

5.6.4 Heat Shattered Stones and Heat Affected Stone Artefacts

Heat shattered stones recorded during field survey were considered to be stone fragments which exhibited crenated fractures from excessive heating or cooling, where there was also no evidence of conchoidal fractures across the fracture surfaces or further diagnostic information (Clarkson and O'Connor 2014:167; Domanski et al. 1994). Of the nine survey transects recorded at the Lake Merreti lunette (see Chapter Four), heat shatter was only recorded for the first two transects. In the first two transects, 53 stone artefacts and heat shatter fragments were recorded, of this subset, 51% were heat shattered stones (n=27). The decision was made to cease recording heat shattered stone (with no other diagnostic features) at the Lake Merreti lunette due to time constraints. Of the 27 recorded heat shatter fragments at this landform, silcrete was the dominant raw material (n=26), with one calcrete fragment recorded, and all materials had been described as either medium, coarse or very coarse-grained. Heat shattered stone fragments were recorded at both the Lake Clover and Lake Woolpolool dune landforms in much lower quantities (n=10) and were found to be both in silcrete (n=5) and chert (n=5) materials.

Where heat damage was observed on stone artefacts, notes were made in the general recording comments. Pot-lidding (heat spalling), crazing and crenated fractures were noted as attributes of heat damage to stone artefacts (Domanski et al. 1994:199). Only two unretouched fine-grained broken silcrete flakes, recorded during field survey were observed to have been affected by heat. No complete flakes or stone cores demonstrated signs of heat damage.

5.7 Comparative Lithic Dataset

This section will introduce the assemblage data recorded by Thredgold (2017; see also Thredgold et al. 2017), utilised for comparative purposes by this research project to examine surface lithics across varying landforms through a geoarchaeological approach. The study areas surveyed by Thredgold (2017:7–14) have been described in Chapter Three. This section will present a summary (Table 5.11) of the comparative assemblage artefact types and locations, while more detailed technological attributes will be discussed and analysed alongside the field survey data in Chapter Six.

Table 5.11 Summary of comparative lithics assemblage (adapted from Thredgold 2017:85).

Artefact type	Total	Complete	Broken
Unretouched Flakes	101	26 (26%)	75 (74%)
Retouched Flakes	10	6 (60%)	4 (40%)
Cores	12	12 (100%)	0
Heat Shatter	50	-	-
Non-Diagnostic Shatter	18*	-	-
Flaked Piece^	3	-	-
Hammerstone/Grindstone	1	0	1 (100%)
Complete and Broken Artefacts	124	44 (35%)	80 (65%)

* Total count for Non-Diagnostic Shatter includes 1 artefact classified by Thredgold (2017:85) as 'ONA' (other non-artefactual stone).

^Flaked Piece (FP) artefacts were observed by Thredgold (2017:64) and are described as artefacts where it is unclear if they are a flake, core or retouched flake.

5.7.1 Reny Island Billabong Precinct

Thredgold (2017:80) surveyed five anthropogenic earth mounds at the Reny Island billabong precinct and recorded stone artefacts across three (Reny Island billabong earth mound four, five and six). Surface visibility across these three mounds and their surrounding 10 m buffer zones was relatively poor at <40%, impacting the visibility of artefacts. Few artefacts were recorded in association with the earth mounds (seven unretouched flakes, one retouched flake and one core). The majority were observed during survey of all margins of the Reny Island billabong. Table 5.12 presents a summary of the Reny Island billabong precinct assemblage.

Table 5.12 Summary of assemblage from Reny Island billabong precinct (adapted from Thredgold 2017:80–81).

Artefact type	Total	Chert	Silcrete	Quartz	Limestone	Sandstone
Unretouched Flakes	80	36 (45%)	44 (55%)	0	0	0
Retouched Flakes	9	3 (33%)	5 (56%)	1 (11%)	0	0
Cores	10	5 (50%)	5 (50%)	0	0	0
Heat Shatter	23	1 (4%)	14 (61%)	0	7 (31%)	1 (4%)
Non-Diagnostic Shatter	15	5 (33%)	9 (60%)	1 (7%)	0	0
Flaked Piece	2	1 (50%)	1 (50%)	0	0	0
Hammerstone /Grindstone	1	0	1 (100%)	0	0	0

5.7.2 Hunchee Island Billabong Precinct

Jones (2016) recorded four mounds at the Hunchee Island billabong. Thredgold (2017:82) surveyed two mounds along the northern side of the billabong, with artefacts observed at one mound (Hunchee Island billabong earth mound 16) with surface visibility at 30%. Only one unretouched chert flake was recorded from the earth mound with the remaining artefacts deriving from survey of the northern margin of the Hunchee Island billabong (a sandy rise where the mounds were located). Rabbit burrowing activity was recorded at both mounds surveyed by Thredgold (2017). Table 5.13 presents a summary of the Hunchee Island billabong precinct assemblage.

Table 5.13 Summary of assemblage from Hunchee Island billabong precinct (adapted from Thredgold 2017:81–82).

Artefact type	Total	Chert	Silcrete
Unretouched Flakes	5	3 (60%)	2 (40%)
Retouched Flakes	-	-	-
Cores	-	-	-
Heat Shatter	5	2 (40%)	3 (60%)
Non-Diagnostic Shatter	-	-	-
Flaked Piece	-	-	-
Hammerstone/Grindstone	-	-	-

5.7.3 Hunchee Creek Precinct

The Hunchee Creek precinct featured 11 mounds recorded by Jones (2016). Thredgold (2017) surveyed four mounds (and a surrounding 10 m buffer zone) for artefacts (Hunchee Creek North earth mounds 20, 21, 22 and 23), including the creek margin alongside the track between mounds 22 and 23. Surface visibility during survey was poor, <50% at Hunchee Creek North earth mounds 20 and 21, and <30% Hunchee Creek North earth mounds 22 and 23 (Thredgold 2017:83–84). Along the creek margin track, visibility was 'variable to good' (Thredgold 2017:84). In comparison to the other study areas examined, more artefacts were observed in association with the mounds in the Hunchee Creek precinct. Table 5.14 presents a summary of the Hunchee Creek precinct assemblage.

Table 5.14 Summary of assemblage from Hunchee Creek precinct (adapted from Thredgold 2017:82–84).

Artefact type	**Total**	**Chert**	**Silcrete**
Unretouched Flakes	15	12 (80%)	3 (20%)
Retouched Flakes	1	1 (100%)	0
Cores	2	2 (100%)	0
Heat Shatter	17	3 (18%)	14 (82%)
Non-Diagnostic Shatter	3	0	3* (100%)
Flaked Piece	1	1 (100%)	0
Hammerstone/Grindstone	-	-	-

*Includes one silcrete artefact recorded by Thredgold (2017:84) as 'other non-artefactual' (ONA).

5.7.4 Ral Ral Creek East Mounds

Jones (2016) observed three mounds at Ral Ral Creek with artefacts surveyed and recorded at two mounds by Thredgold (2017). A total of nine artefacts were recorded, located on and within a 10 m buffer zone of the mound. Surface visibility was variable due to vegetation growth, recorded as <70% at Ral Ral Creek earth mound 12, and <30% at Ral Ral Creek earth mound 14 (Thredgold 2017:84). Table 5.15 presents a summary of the Ral Ral Creek east mounds assemblage.

Table 5.15 Summary of assemblage from Ral Ral Creek east mounds (adapted from Thredgold 2017:84).

Artefact type	**Total**	**Chert**	**Silcrete**
Unretouched Flakes	4	2 (50%)	2 (50%)
Retouched Flakes	-	-	-
Cores	-	-	-
Heat Shatter	5	1 (20%)	4 (80%)
Non-Diagnostic Shatter	-	-	-
Flaked Piece	-	-	-
Hammerstone/Grindstone	-	-	-

5.7.5 Density of Comparative Lithic Scatters

Table 5.16 provides a summary of the relative densities in the artefacts recorded across the lacustrine, earth mounds, creeks and billabong landforms of the Calperum Station study area. There were a total of 14 earth mounds recorded by Thredgold (2017, Thredgold et al. 2017) alongside the survey of billabong and creek margins. Table 5.16 reflects the measurements recorded by Jones (2016) based on the outer mound dimensions, plus a 10 m surrounding margin (Thredgold 2017:79–84). Small numbers of artefacts were located on the earth mound landforms, of the 14 earth mounds recorded, 11 had artefacts within the 10 m marginal boundaries (Thredgold 2017:79). Considering the quantity of artefacts recorded per landform, overall the lacustrine environments reflect a higher density of lithic materials, however, the largest quantity of artefacts recorded in one area was on the Reny Island billabong margins (Thredgold 2017:79–81). Variations in the densities of surface artefacts across landforms could likely reflect a palimpsest assemblage, where archaeological materials represent an accumulation of cultural activities over time, impacted by varying temporal and spatial landform conditions. Surface visibility across the earth mounds, creeks and billabong landforms varied significantly due to vegetation and leaf litter, and ranged between less than 70% ground surface visibility at the Ral Ral Creek East mounds to 30% ground surface visibility across the Hunchee Island billabong precinct (Thredgold 2017:79–84). Surface visibility was not a concern across the lacustrine landforms surveyed.

Given the vast size of Lake Merreti lunette, it was not possible to record the landform in its entirety, therefore nine transects were prepared off a baseline that ran the length of the lunette. Artefacts were present and recorded in transects one to seven (see Figure 4.1), and transect two recorded the highest number of artefacts, representing 68% (n=48) of those recorded for the Lake Merreti lunette (n=71). Heat shatter was recorded in transect one and two at the Lake Merreti lunette, however the decision was made during field survey to stop recording heat shatter beyond these two transects given weather and time constraints and the desire to focus on recording flake and core artefacts. It is likely that transects three to nine could have revealed higher quantities of lithics across the landform were field surveys not hampered by poor weather conditions and time restraints. As with the recording of Lake Merreti lunette, transects were prepared for Lake Clover dune and Lake Woolpolool dune due to their large size and field-work constraints. Overall, the survey of the Calperum lacustrine environments covered smaller areas (m^2) in comparison to the areas (m^2) surveyed across earth mounds, creeks and billabong landforms, however the Calperum Station study assemblage indicates lithic scatters occurred in greater densities at Lake Merreti lunette, Lake Clover dune and Lake Woolpolool dune. Of the lacustrine landforms surveyed, Lake Clover dune has the highest density of lithic materials with 60 artefacts recorded in a single transect of approximately 80 m^2 (see Table 5.16).

Table 5.16 Summary of landform artefact densities across the comparative lithics assemblage (earth mound survey data adapted from Thredgold 2017:79–84).

Calperum Landform	**Total number of stone artefacts surveyed**	**Area Surveyed (m)**	**Area Surveyed (m^2)**
Lake Merreti lunette	71	Transects 1–5, 2x~15 Transects 6–7, 2x~10 Transects 8–9, 2x~5	~ 210 m^2
Lake Clover dune	60	1 transect, 2x40	~ 80 m^2
Lake Woolpolool dune	26	1 transect, 2x20	40 m^2
Reny Island billabong – Earth mound 4	3	11x11	121 m^2
Reny Island billabong – Earth mound 5	2	9x9	81 m^2
Reny Island billabong – Earth mound 6	2	10x7	70 m^2
Reny Island billabong – Natural levy edge occupation area	2	23x23	529 m^2
Reny Island billabong margins	130	Data not available	Data not available
Hunchee Island billabong – Earth mound 16	1	10x10	100 m^2
Hunchee Island billabong northern margin	4	Data not available	Data not available
Hunchee Creek North – Earth mound 20	6	20x14	280 m^2
Hunchee Creek North – Earth mound 21	5	40x23	920 m^2
Hunchee Creek North – Earth mound 22	8	25x25	625 m^2
Hunchee Creek North – Earth Mound 23	15	22x22	484 m^2
Hunchee Creek North track between Hunchee Creek North earth mounds 22 and 23	5	Data not available	Data not available
Ral Ral Creek East – Earth mound 12	4	15x15	225 m^2
Ral Ral Creek East – Earth mound 14	5	20x20	400 m^2

5.8 Summary

A total of 157 stone artefacts were recorded during field survey for this research project. Thredgold (2017) recorded a total of 195 stone artefacts, which have been introduced in Section 5.7 and will be examined for comparative analysis in greater detail in the next chapter. Thus far the overall Calperum Station surface lithic assemblage reflects clear inclination toward unretouched flakes with silcrete and chert the most dominant raw materials for the region. Chapter Six will contextualise and discuss in greater detail the results presented in this chapter.

Chapter 6: Discussion

Introduction

This chapter discusses and examines the results presented in Chapter 5 alongside the comparative lithic dataset, recorded by Thredgold (2017). This chapter analyses the broader Calperum Station study assemblage and generates information about the surface stone artefact record at Calperum Station in light of the methods undertaken in this study. The preliminary sections will contextualise the stone artefact assemblage, followed by a discussion of local geomorphology and taphonomic conditions and the impact they have on the integrity of the surface record.

6.1 Stone Artefact Assemblage

This study examined the surface stone artefact assemblage of seven landforms, likely representative of an accumulative lithic record shaped by geomorphological conditions over variable time spans (after Holdaway and Fanning 2005; 2008). The combined stone artefact assemblage examined in this chapter comprises a total of 352 stone artefacts, 157 recorded by the author during field surveys and 195 recorded by Thredgold (2017). Flaked artefacts were dominant in the study assemblage, reflecting 58% of the stone artefacts recorded. Unretouched flakes represented the majority of stone artefacts across all landforms, 93% of flakes recorded were unretouched. Westell and Wood (2014:53) and Thredgold (2017:119) contend that flaked artefacts associated with earth mounds across Calperum Station were nearly entirely unretouched, to which this study would add that the same data proves true for the assemblage studied on sandy dune and lunette formations.

6.1.1 Raw Materials

Silcrete was markedly the most commonly utilised raw material across all landforms in the Calperum Station study area. In the sandy dune and lunette landforms, examining the number of artefacts revealed that there was an obvious dominance in the use of silcrete material (Figures 5.1 and 5.2). For the earth mounds, creeks and billabong landforms of Calperum Station, there was a more even division of raw materials with the numbers of artefacts demonstrating 53% silcrete and 46% chert (Thredgold 2017:86; Thredgold et al. 2017:111–113). Considering the weight of raw materials in the assemblage across all landforms, the preference of silcrete, as opposed to any other material, was thus evident. Unretouched flake dimensions showed little difference between landforms with flakes commonly less than 30 mm in length and 25 mm in width (Thredgold et al. 2017:111–113). Silcrete flakes were, however, generally larger in dimensions when compared to chert flakes, and silcrete cores were mostly larger in size than those recorded in chert. In the absence of an analysis of raw material local sources, at a rudimentary level it can be suggested that parent cores were larger in silcrete over chert, while silcrete may have either been more readily available as a raw material, or was preferentially selected as a knapping material.

Stone does not occur naturally on the landforms examined in the Calperum Station study area and would therefore also reflect a minimum distance of raw material transportation across the broader landscape. Quartz was extremely scarce in the study assemblage. One core was recorded at the Lake Clover Dune (Table 5.3), two unretouched flakes at the Lake Woolpolool Dune (Table 5.4), and two artefacts at the Reny Island billabong precinct, an amorphously retouched flake and a non-diagnostic artefact (Table 5.12). Quartz can be an important raw material for ceremonial purposes and for composite weaponry and tools in Australia, however due to its infrequency in the study area it is difficult to draw any conclusions as to landform-specific quartz activities or indeed if quartz materials were used for such purposes in this region (Angas 1847:93; Eyre 1845:306–309; Grist 1995:10–11, 57). Unlike other raw materials, quartz sources have thus far not been identified in the Riverland region, which may also possibly account for the low quantity of quartz artefacts in the assemblage (Thredgold 2017:23). Moreover, given quartz materials are not found in the local geology, their presence in the Calperum Station study assemblage likely reflects a much greater raw material procurement distance.

Based on an examination of the raw materials within the Calperum Station study lithic assemblage, the data would suggest the consistent use of such resources over varying landscapes and possibly time by people living across this region. The analysis of flake and core reduction sequences and the infrequent number of retouched artefacts within the assemblage (see further discussion below) suggests access to raw materials was such that materials need not be intensively worked and reduced. Although a regional study of raw material sources suitable for knapping has not yet been conducted, given the expedient use of stone materials, the silcrete and chert seams of the Karoonda Surface which outcrop along the Murray Valley cliff lines are likely to have been extremely significant areas for raw material procurement (Thredgold 2017: 22–23; Thredgold et al. 2017:103). Within the Loxton-Parilla Sands, the Karoonda Surface is a weathering profile that sits close to the modern ground surface and is often exposed within the Calperum and neighbouring Chowilla area, Overland Corner and beyond the South Australian and Victorian borders (Bowler et al. 2006:171; Brown and Stephenson 1991:164; Thredgold et al. 2017:103; Craig Westell pers. comm. 2018). Access to discrete Karoonda Surface outcrops could have thus provided for expedient and opportunistic local resource utilisation, while a smaller number of larger-scale quarries may have seen more intensive raw material use and may suggest the ability to travel within a larger territory to acquire raw materials (Bowler et al. 2006). The Berribee quarry in the Victorian Riverland and the Marndelbuik[11] quarry in the South Australian Riverland are two notable examples where chert and silcrete materials could have been sourced more intensely given both areas feature thick profiles of these raw materials (Gill; 1973:33; Grist 1995:22, 28, 35–36; Thredgold et al. 2017:103).

6.1.2 Cores and Flake Lengths

Cores were relatively uncommon across the study area, representing only 6% of the total stone artefact assemblage. A total of 20 cores were recorded, 12 in chert, seven in silcrete and one in quartz. Irrespective of raw material, the majority of cores were

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[11] Alternatively 'Mernsdellbuick', an Erawirung word meaning 'flint hole' and also known as Spring Cart Gully (Tindale c.1934–c.1991).

smaller than 40 mm in both length and width. Chert cores were more commonly smaller in size when compared to silcrete cores. This could reflect the ease of chert flaking properties, the possibility that chert cores were more intensively reduced, or the access to smaller quantities of chert parent nodules across the broader landscape, however the present sample is too small to decisively draw such conclusions (see also Thredgold et al. 2017). The single quartz core, as discussed previously (Section 6.1.1), was not found in association with any of the quartz flakes recorded, and was comparable in size to the smallest chert cores, further highlighting the scarcity of this raw material in the study area.

Across the lacustrine landforms of the lunette and dunes, on average, the length measurements for complete flakes were relatively comparable to the recorded lengths of negative core scars. This data could possibly suggest that flakes across these lacustrine landforms were removed from the core towards the end of the core reduction sequence (Holdaway and Stern 2004:82–86). Across the earth mounds, creeks and billabong landforms of Calperum Station, the negative scars on silcrete cores were mostly larger than the length of complete flakes, suggesting silcrete cores in these areas were likely in an early stage of reduction (Thredgold 2017:97). The negative scars on chert cores across the earth mounds, creeks and billabong landforms were more comparable to the cores recorded over the lacustrine landforms. The scar lengths and complete flake lengths were generally similar in size, indicating that across these landforms, chert cores were also at a later stage of reduction or flaked till they were expended. The data recorded from cores and flake lengths could reflect strategies of raw material conservation and planning such as provisioning (Kuhn 1995; Mackay 2005). Following Kuhn's (1995:22–23; MacKay 2005:97) model, chert cores could potentially reflect 'individual technological provisioning' where chert was part of transportable toolkit, discarded only in the final stages of reduction. Alternatively, silcrete cores, particularly those that indicate discard prior to maximum reduction, could reflect that this material was utilised as necessary on a given landform and revisited to provide flakes when necessary (Kuhn 1995:24).

6.1.3 Cortex in the Assemblage

Overall, cortex was not commonly recorded in the stone artefact assemblage. For cores, 60% were observed with no cortical surfaces, with the remaining demonstrating less than 50% cortex coverage (Thredgold 2017:98). Although the low proportions of cortex in the assemblage cause difficulties for identifying characteristics of the parent material, where cortex was recorded, chert materials commonly demonstrated white or pale grey cortex, chalky in nature while the silcrete cortex material appeared to grade from sandstone to silcrete (Thredgold 2017). Examining flake and core artefacts, the proportion of cortex nonetheless remains low with 77% of these artefacts recorded with no cortex coverage. Cortex rates were comparable across all varying landforms with no evidence of obvious differences despite the variable contexts.

Low rates of cortex in an assemblage have often been interpreted as reflecting raw material transportation, where materials are acquired from a distant source away from the study area, and cortex is removed and discarded during early stages of reduction (Clarkson 2007:83; Dibble 2005; Doelman et al. 2001:29; Douglass et al. 2008:520–523). Examining stone artefacts at Lake Mungo in the Willandra Lakes, New South Wales, Tumney (2011:168) observed low levels of overall cortex in the assemblage and determined that either initial core reduction was likely to have occurred elsewhere or the presence of cortex at the source of raw material was rare. In the semi-arid Fowlers Gap Arid Research Zone of New South Wales, research revealed low ratios of cortex in the overall assemblages, suggesting high degrees of flake movement and the transportation of raw materials across considerable distances from their original sources and locations of early manufacturing (Douglas et al. 2008:520–521; Holdaway and Douglas 2012: 113–114; Holdaway et al. 2015:61).

Alternatively, low rates of cortex in an assemblage and higher quantities of small cores and stone artefacts could also possibly be indicative of small to medium sized nodules of raw material resulting in low levels of cortex being introduced into the study area (Douglass et al. 2008:523). It is difficult to determine which model would best explain the lack of cortex across the Calperum study area without also conducting analysis of assemblages closer to possible quarry sources of raw materials. In the absence of this, the analysis of Grist (1995:64–67) at the nearby Berribee Quarries, while not directly examining the types of cortex or size of raw material nodules, demonstrated no consistent patterns of distance decay in cores found across inland and up-river transects. Moreover, tendencies towards comparatively small core and flake sizes are relatively common in the Murray-Darling Basin. In the Central Murrumbidgee Riverine Plain of New South Wales, Klaver (1998:203) found small quartz pebbles produced small artefacts with larger proportions of cortex in the assemblages. At Lake Boort in northwest Victoria, Johnston (2004:55–56) revealed small cores infrequently displayed identifiable cortex reflecting low concentrations of cortex overall. Martin (2006:130, 218) in the Hay Plain of South Australia, observed the use of imported small nodules as a source of stone raw materials, producing large quantities of small cores and artefacts.

For Calperum Station, the assemblage analysed in this study only represents a small portion of the overall archaeological landscape. While it is conceivable cortex ratios could be higher in surface scatters in other areas of Calperum Station, given this study examines variable landforms separated by some distance, it is probable that high levels of cortex are uncommon in the study area. Beyond this conclusion, it is necessary to develop an understanding of local quarry sources before it can be determined if raw materials were introduced to Calperum in small nodules with little cortex or if early reduction occurred at some distance from the study area. Further, research into modelling the local geomorphology, in conjunction with an examination of small-scale local sources of silcrete and chart such as the Karoonda Surface outcrops, and larger more intensely utilised quarries, could provide a greater understanding of raw material procurement and relative strategies for resource utilisation.

6.1.4 Approaches to Flake Manufacture and Core Reduction

Platform widths and thicknesses were mostly comparable across the assemblage analysed from all landforms in the study area. Of the four quartz flakes recorded, only two had intact platforms. Consistent with the general small size of quartz artefacts, the average platform dimensions available for quartz flakes (width = 5.5 mm, thickness = 2 mm) were smaller than those found on silcrete and chert flakes. Overall there was an inclination towards smaller chert platform dimensions when compared to those of silcrete. Across the lacustrine landforms, platform dimensions were relatively homogenous with silcrete platform width and thickness measurements consistent with expectations drawn from the overall larger dimensions of silcrete flakes. These results are in line with general principles of platform dimensions where a larger platform width will increase the overall mass of a flake, and an increase in platform thickness will generally result in a longer flake length (Pelcin 1997:752; Schott et al. 2000:890). Across the earth mounds, creeks and billabong landforms, chert platforms had a slightly larger range of thickness measurements (where measurements ranged between 0.83 mm and 13.15 mm), compared to the data for chert platform thickness measurements of the lacustrine landforms (where measurements ranged between 1 mm and 7 mm). The broader range in the platform thickness measurement for chert flakes could correlate to the surface morphology of chert cores, where, in an attempt to produce longer flakes, it would be necessary to increase platform thickness (Pelcin 1997:752; Thredgold 2017:122). Considering the differences in chert platform thickness across the varying landforms, it is possible that the knapper sought to produce larger chert flakes across the earth mounds, creeks and billabong landforms than those flakes over the lacustrine landforms. An increased sample size would assist in determining whether the patterns in platform thickness measurements are indeed a demonstrable feature between varying landforms.

Methods of platform preparation were largely uncommon in the Calperum study area. Where flake platforms were intact, the most common platform surface across all landforms were single surface platforms, likely to reflect the negative surface of a prior flake removal. Following single surface platforms, the next most commonly encountered platform surfaces were shattered platforms, highlighting the rarity of more complex forms of platform preparation in the study area. Across lacustrine landforms, chert flakes revealed less diversity in platform surfaces compared to silcrete platforms, while across the earth mounds, creeks and billabong landforms, chert flakes demonstrated greater complexity in platform surfaces (Thredgold 2017:101–102). This could indicate that chert cores were more intensively worked across the earth mounds, creeks and billabong landforms compared to chert and silcrete flakes elsewhere in the study area. It is possible that chert cores were discarded in the more final stages of reduction across the earth mounds, creeks and billabong landforms, where silcrete cores were surplus materials, knapped when necessary and generally abandoned prior to exhaustion (MacKay 2005:95–97; Kuhn 1995:23–27).

Another approach to platform preparation, in the form of overhang removal, was observed in the study area with eight flakes demonstrating this strategy. While generally uncommon in the Calperum Station assemblage, overhang removal was more frequently encountered across the earth mounds, creeks and billabong landforms, with six of the eight examples occurring in these areas (Thredgold 2017:103). Chert platforms were more likely to reflect overhang removal reflecting 88% of platforms with overhang removal compared to 12% in silcrete. The single silcrete platform with overhang removal was recorded as a fine-grained material, indicating that across all landforms, this strategy was only implemented on finer-grained materials. This suggests a preference towards conserving fine-grained raw materials, particularly across the across the earth mounds, creeks and billabong landforms where they may have been more exclusively required. Half of all platforms with overhang removal were observed on multiple platform surfaces further suggesting this method was infrequently practiced in the study area (Thredgold 2017:103).

Examining the dorsal scars on a flake can indicate methods that have been employed to manage the reduction of a core (Clarkson and O'Connor 2014). Dorsal scars on silcrete flakes suggest minimal core rotation on silcrete cores across all landforms. Chert cores, however, appear to have been treated differently across the Calperum study area, with a greater indication of core rotation across the earth mounds, creeks and billabong landforms compared to those at lacustrine landforms. Equally, bipolar chert cores were greatest in frequency across the earth mounds, creeks and billabong landforms, representing 71% of chert core types recorded across these landforms (Thredgold 2017:98). The higher frequency of bipolar flaking of chert cores across these landforms and overall rotation of chert cores indicates technological strategies to maximise the use of this raw material (Clarkson and O'Connor 2014:178–181). Moreover, it is possible that this reflects technological practices of producing and working with more fine-grained chert lithics, distinctive to the earth mounds, creeks and billabong landforms of the Calperum Station study area.

Although silcrete core rotation was generally low, in the lunette and dune assemblage, silcrete flakes indicated slightly more diversity in dorsal scar direction, contrasting the assemblage recorded across the earth mounds, creeks and billabong landforms, (Thredgold 2017:104). This could suggest the employment of technological conservation practices for silcrete materials was somewhat greater across the lacustrine landforms (Holdaway and Stern 2004:148). One quartz flake from the Lake Woolpolool dune exhibited core rotation with the dorsal scar direction recorded as opposite and oblique (Figure 5.11). The quality of raw material can alter strategies employed to produce a desirable flake (Andrefsky 2005:59; Clarkson and O'Connor 2014:192). At lacustrine environments, both fine-grained and medium-grained flaked artefacts with dorsal information generally reflected comparable diversity in dorsal scar orientation (Figure 5.12). Conversely, across the earth mounds, creeks and billabong landforms, dorsal scar direction reveals finer-grained materials were subjected to higher degrees of core rotation as a strategy for flake manufacture (Thredgold 2017:105). Overall, the majority of flakes across the Calperum study area, regardless of raw material, demonstrated that unidirectional flake manufacture was most common, with minimal employment of core rotation.

Cone split flakes are usually considered to reflect early stages of core reduction and are often deemed to be knapping debitage (Doelman 2005:56). In the Calperum study area, longitudinally cone split (LCS) flakes were observed in similar quantities across all environments with a total of 33 LCS flakes recorded. They were highest in number in the vicinity of the Reny Island billabong, and the Lake Clover dune landforms

(Thredgold 2017:106–107). Across the earth mounds, creeks and billabong landforms there was a higher proportion of cortex observed in LCS flakes, 50% (the majority LCS right flakes), compared to those recorded at lacustrine landforms, 20% (the majority LCS right flakes) (Thredgold 2017:106–107). Where cortical platforms were present on flakes recorded across the earth mounds, creeks and billabong landforms, it was more common for them to be found on LCS flakes (five out of seven cortical platform flaked artefacts). Alternatively, across lacustrine landforms, cortical platforms on flakes were less likely to occur on LCS flakes (one out of seven cortical platform flaked artefacts).

It could be suggested that the lacustrine landforms were either situated further away from sources to raw materials or were not areas where the early stages of core reduction were executed. While possible, it cannot be presumed that given the higher degree of cortex observed in LCS flakes across the earth mounds, creeks and billabong landforms, particularly Reny Island billabong, that these areas were closer to raw material sources or indeed places where early stages of core reduction occurred. Though the chert knapping floor identified within the study area was located in proximity to the Reny Island billabong (approximately 50 m away in a nearby scald), only one LCS flake was located in this subset in association with the chert parent core and other debitage (Thredgold 2017:123–124). This was the only knapping floor identified between both this study and the comparative research undertaken by Thredgold (2017). Moreover, across all study areas, LCS right flakes were more common in the assemblage, representing 76% of LCS flakes compared to 24% for LCS left flakes. This result is surprising, as it would be expected that both right and left LCS flakes would be equally present, particularly as the stone artefacts have been recorded across varying landforms located at some distance from one another. Moreover, if LCS flakes are to reflect early stages of stone knapping, it would be more common to find even distribution of left and right LCS flakes. The assemblage indicates it was possible LCS left flakes may have either been selectively removed, or knapping occurred away from the study areas and LCS right flakes were preferentially introduced to the landforms. A third explanation could be that human and animal trampling caused the fragmentation, removal or loss of LCS left flakes by chance.

6.1.5 Retouched Flakes, Ground and Hammerstone Artefacts

Retouched flakes were uncommon in the Calperum study area assemblage, reflecting only 4% (n=15) of the 352 stone artefacts recorded. The majority of retouched flakes had amorphous retouch and one-third of retouched flakes had consistent retouch around all margins (Thredgold 2017:107). Only one retouched flake resembled a formal artefact type, an adze flake (of high quality chert material) located in the vicinity of the Reny Island billabong (Thredgold 2017:107–108). This retouched flake was classified as an adze flake as it demonstrated steep and invasive retouch at 90°, reduced to the edge of one platform, across the distal and left margins (Holdaway and Stern 2004:258–259; Thredgold 2017:107). Adzes are commonly considered composite tools used throughout the Holocene into recent times and are often linked to harvesting and woodworking activities, suggesting it is possible such pursuits took place in proximity to the billabong where the adze was recorded (Doelman and Cochrane 2012; Holdaway and Stern 2004:252; McCarthy 1967:27–28; Thredgold 2017:75–76, 124–125; Veth et al. 2011). However, if such activities were common across this landform, higher quantities of adze discard in the assemblage would be expected. The rarity of formal types of retouched stone artefacts is not unexpected as they are generally uncommon at archaeological locations in the Murray-Darling Basin (Balme and Beck 1996:40; Coutts and Witter 1977:62–66; Coutts et al. 1979:57; Gill 1973:89; Klaver 1998:217; Westell and Wood 2014:53).

Hammerstones were not commonly observed in the Calperum study area assemblage, only two broken silcrete hammerstone fragments were recorded, both located at the Lake Merreti dune (Table 5.2). Hammerstones are well known for use in the manufacture of stone artefacts, and the hammerstone fragments at the Lake Merreti dune may have been used for knapping activities in the lacustrine environments (Clarkson and O'Connor 2014). Both fragments were medium to coarse-grained materials with one displaying a band of crushing or pitting, evidence of use of percussion techniques (Holdaway and Stern 2004:8–9, 11–12). The second fragment was noted as possibly displaying a grinding surface, although this observation was not conclusive.

Multiple uses for larger rocks, such as hammerstones, grindstones and anvils, are common where strategies of raw material conservation are employed (Casey 1973:209; Smith et al. 2015:72). One distinct grindstone fragment was recorded in the Calperum study area assemblage, a rounded silcrete cobble, demonstrating grinding on two surfaces, and scarring patterns (pitting, crushing and incipient cones) consistent with hammer and anvil use (Thredgold 2017:107). Grindstones are usually interpreted (on the basis of archaeological and ethnographic analysis) to be associated with food processing tasks, such as seed processing, fibrous root and vegetable processing, pulverizing animal materials (usually bone and cartilage), meat pulping and cracking bones to remove marrow (Odell 2001:57; Gorecki et al. 1997:142; Smith et al. 2015:75–76). In other non-food related activities, grindstones were also utilised for activities such as grinding ochre, sharpening or smoothing stone and wooden tools, and preparing bush tobacco and resin (Gorecki et al. 1997:142; Smith 1985:24).

With the multipurpose grindstone fragment located in proximity to the Reny Island billabong, it is possible that both knapping and food processing activities may have occurred in this area. The lack of larger quantities of hammerstones, grindstones or anvils in the study area may indicate transportation of these artefacts to other locations, or as the often larger artefacts were more visible across the landscape, could reflect practices of human artefact collecting over the years of European pastoral activities in the area (Casey 1973:209; Midgley et al. 1998:229–230). Indeed, it is known that the South Australian Museum collection includes a number of these artefacts (which are currently being studied by Craig Westell).

6.1.6 Comparing Lithic Scatter Densities Across Calperum Station

As previously discussed, the Calperum Station study assemblage is largely dominated by small, unretouched chert and silcrete flakes. Considering the potential for variability in resource utilisation at the varying lacustrine landscapes and across the earth mounds, creeks and billabong landforms, the assemblage indicates relatively uniform knapping strategies intended to maximise the output of raw materials (Thredgold et al. 2017). Where a strong point of difference in the assemblage has been revealed is in relation to the relative density of lithic scatters across the varying landforms.

The earth mound landforms located near Reny Island billabong, Hunchee Island billabong, Hunchee Creek north and Ral Ral Creek east had very low numbers of artefacts located on the mound surfaces, only two mounds were recorded to have artefacts directly on them, and this was only five stone artefacts (Thredgold 2017:79–84). Of the 14 earth mounds surveyed by Thredgold (2017:79; Thredgold et al. 2017:110), 11 earth mounds recorded 33 stone artefacts either on the mound or within 10 m of the earth mound margins. The 11 earth mounds reflect 3306 m^2 of surveyed landforms, a survey area vastly larger than the approximately 330 m^2 of surveyed lacustrine landforms (see Table 5.16).

Given the combined lacustrine lunette and dune landforms recorded a total of 127 stone artefacts across the survey area, this data would at a preliminary level suggest that the lacustrine environments were areas of more intensive knapping activities. Lake Clover dune reflected the highest density of artefacts scatters amongst the lacustrine landforms, with 60 stone artefacts recorded within an approximately 80 m^2 survey area (Table 5.16). Of the lacustrine environments surveyed by this study, Lake Clover dune had a higher degree of surrounding vegetation, where the dune margins were the dominated by low chenopod shrubland and Black Box woodlands vegetation. This could perhaps have contributed to a higher degree of surface artefact preservation at Lake Clover dune, where the dense layer of vegetation may have shielded the dune from the more extreme underlying Murray River Valley erosional processes, and the infiltration of grazing animals during periods of pastoral activities (Bowler et al. 2006:165; de Rose et al. 2004:248; Thredgold et al. 2017:103–105).

The impact of underlying geomorphological processes is particularly important to examine the relative differences in lithic scatter densities across the varying study area landforms of Calperum Station. The low quantity of lithic material located on or immediately near the earth mounds could be suggested to reflect that these environments were exposed to higher levels of fluvial disturbance and subsequent artefact displacement, however this is not supported by the assemblage data that is dominated by large quantities of small stone artefacts (see discussion in Section 6.2.3). Moreover, survey of the Reny Island billabong margins revealed high quantities of surface stone artefacts, 130 recorded in this area, despite the local fluvial geomorphology indicating the area is continually impacted by successive inundation regimes (Jones 2016; Thredgold 2017).

The study assemblage also reveals flake fragmentation rates were largely similar across the varying lacustrine landforms, earth mounds, creeks and billabong landforms (see discussion in Section 6.2.4). The study assemblage recorded 45% of unretouched flakes were broken across the lacustrine environments, compared to 55% of the unretouched flakes across the earth mounds, creeks and billabong landforms (Thredgold 2017:88). This suggests post-depositional taphonomic processes, particularly trampling associated with pastoral activities, rather than local knapping strategies, are likely to explain the high degrees of flake fragmentation within the study assemblage. Overall, examining the differences in the density of lithic scatters across the varying Calperum Station study area landforms, the study assemblage reveals flaked artefacts were produced through relatively uniform knapping strategies across the varying landforms. These knapping strategies sought to maximise resource utilisation, however given that retouched artefacts were uncommon across all of the study area landforms, it is likely raw materials were located from nearby sources where stone material resources could also be used expediently. The higher degree of lithic scatters across the lacustrine landforms at a rudimentary level alludes to ongoing underlying geomorphological processes that have impacted the preservation of surface artefacts across Calperum Station, as well as perhaps a higher frequency of knapping activities occurring across the lacustrine landforms. Given the relatively small size of the comparative Calperum

Station study assemblage, further lithic studies in this area could provide for the opportunity to assess in greater detail the specific activities undertaken across these varying landforms.

6.2 Geomorphology and Taphonomic Processes

6.2.1 Dynamic Geomorphology and Temporal Complexities

Adopting a geoarchaeological approach for an analysis of surface lithics across varying landforms highlights the complexities involved with the preservation of archaeological materials and environments, and the inherent impact of geomorphological processes on temporal interpretations of archaeological landscapes. The local geomorphology of the Murray Valley reveals an extremely complex landscape, where ongoing underlying processes are continually superimposing upon relict landscapes (Bowler et al. 2006; Evans 2013; Jones 2016; Prendergast et al. 2009; Thredgold 2017). The overlapping and persistent transformations of Murray River landforms through various fluvial, alluvial and aeolian processes can contextualise the difficulties associated with projecting temporal scales on both the landforms themselves and their surface archaeological materials.

Calperum Station is situated within the western margins of the Murray River floodplain and the local area is commonly inundated by floodwaters, particularly across the earth mounds, creeks and billabong landforms examined in this study. In the Riverland region of the Murray River, sedimentary studies examining the Quaternary elevated Murray Valley ridges reveal high amounts of clay, suggesting low velocity long term sinuous channels, and laterally migrating channels (Brown and Stephenson 1991; Gill 1973:4; Prendergast et al. 2009:6, 59, 66; Thredgold et al. 2017:105). Likewise, suspended silt and clay in the modern sediment load suggests contemporary river flows are also low energy (Brown and Stephenson 1991; Gill 1973:6–9; Thredgold et al. 2017:105). Despite periods of frequent flooding at Calperum Station and beyond in the wider Riverland region, given the generally low velocity flow of the Murray River it is less likely that alluvial or fluvial processes have caused significant spatial disturbance of the archaeological record (see further discussion in Section 6.2.3).

Research examining the movement of fine suspended sediments suggests higher degrees of sediment accumulation in the Murray floodplain region, particularly in more recent times where historic grazing practices activated soil deposition processes (de Rose et al. 2004:248; Thredgold et al. 2017:105). Conversely, aeolian erosional processes also occur throughout the Calperum study area however they are a little more difficult to measure (Newall et al. 2009:166–167; Thredgold et al. 2017:105). Former pastoral activities in conjunction with the underlying Murray Darling Basin erosional regimes have impacted, and continue to impact, the interpretation of landform morphologies, particularly where activities such as vegetation clearing practices and animal grazing have altered current soil salinity levels and limit natural plant regrowth in several places (Newall et al. 2009:167; Rose et al. 2004:248; Thredgold et al. 2017:103–105). The nature of a continually modifying landscape, where multiple geomorphic processes are reworking and transforming the landforms, emphasises the temporal complexities involved in a study of surface artefacts in this region, where oscillating erosional and depositional processes subsequently bury archaeological materials and potentially expose lag deposits or deflation episodes (Bowler et al. 2006:165; de Rose et al. 2004:248; Thredgold et al. 2017:103–105).

6.2.2 Contemporary Surface Disturbances

Landform disturbances through contemporary management practices were most apparent across the lacustrine environments (see Figures 5.24 and 5.25). At the Lake Merreti lunette and Lake Clover dune, Calperum station management access roads were observed as the most obvious threat to the integrity of the surface assemblage. The management roads at the Lake Merreti lunette (see Figure 4.1 and Figure 5.24) were increasingly encroaching upon the western margin of the lunette and artefacts were observed, although not recorded in the survey assemblage due to damage, located on the path of the management road. At the Lake Clover dune, the station management access road is most concerning (see Figure 4.2 and Figure 5.25), running directly through the western portion of the dune. Surface, and potentially subsurface, cultural material has been damaged from vehicle activities and the integrity of the archaeological materials further impaired through the introduction of cobbles on the road surface to strengthen the path over the dune sands. As with the Lake Merreti lunette, artefacts located on the road were not recorded due to the high level of disturbance.

Contemporary land management practices were less imposing across the earth mounds, creeks and billabong landforms (Thredgold 2017:9, 108–116). The most prominent example of land management across these landforms was the presence of a water pump at the northern tip of the Reny Island billabong, designed to artificially maintain water levels (Thredgold 2017:9). Thredgold (2017:9, 108–109) witnessed the billabong both carrying water (September 2015) and completely dry (April 2016), however no direct impact on the integrity of the surface assemblage through use of the water pump was observed. Furthermore, species of animals, particularly rabbits and Brown Hare have been introduced in the area, causing particular constraints upon native flora and fauna and impacting the local archaeology (Newall et al. 2009:94–95). Rabbit burrowing has caused surface disturbance (and predictably stratigraphic damage) on earth mounds located within the Hunchee Island billabong precinct (Jones 2016:75; Thredgold 2017:81). Further animal disturbances are discussed in Section 6.2.4.

6.2.3 Fluvial Processes

Considering the potential impact of fluvial taphonomic processes across the Calperum study area, analysis of the surface stone artefacts would indicate disturbance had been minimal. Research has demonstrated that artefacts with dimensions smaller than 20 mm are likely to be subject to fluvial disturbance, and removed from surface assemblages (Hiscock 1985; Fanning and Holdaway 2001:681–683; Petraglia and Potts 1994:231; Schick 1987; Tumney 2011:102–105). Of the stone artefacts recorded across the Calperum study area, 230 artefacts (flakes, cores, hammerstone and grindstone fragments) had length and width measurements documented. More than half (54% or n=124) of this subset of artefacts had both length and width dimensions measuring less than 20 mm. At the lacustrine landforms, this figure was slightly lower. A total of 103 artefacts had length and width measurements recorded, with 47% (n=48) of those less than 20 mm. Across the earth mounds, creeks and billabong landforms, a total of 127 artefacts had length and width measurements documented, and 60% (n=76) of those measured less than 20 mm (Thredgold 2017:115).

Given artefacts less than 20 mm represent large percentages in the individual and combined assemblage, fluvial processes as a factor for surface disturbance and artefact displacement are considered to have been high across the study area. This result would also indicate that a substantial portion of the surface record across the varying landforms reflects artefacts that are not in situ (Petraglia and Potts 1994:233). This would further indicate that either knapping is unlikely to have occurred in these areas, or any remains of these activities has been disturbed and displaced fluvial processes. An exception is the chert knapping floor recorded by Thredgold (2017:123–124) located east of the northern tip of Reny Island Billabong. Although this was not recorded in great detail, this knapping floor was identified approximately 50 m away from the billabong in a nearby scald (likely subject to processes of erosion) and indicates knapping activities in this area likely occurred some distance from the immediate margins of the billabong.

6.2.4 Flake Fragmentation and Surface Trampling

Overall, flake fragmentation across the Calperum study assemblage was relatively high, with 51% (n=120) of the recorded 237 unretouched flakes, documented as broken (Thredgold 2017:88). It is possible that the earth mounds, creeks and billabong landforms are subject to higher degrees of post-depositional taphonomic processes, as a higher overall percentage of broken flakes were recorded in these areas, 55%, compared to 44% (see Table 5.1) across the lacustrine landforms (Thredgold 2017:88). Higher quantities of broken silcrete flakes were recorded at the lacustrine landforms, 46% compared to 40% broken chert flakes (Table 5.1), however this is likely to reflect the larger number of silcrete flakes in the assemblage at these landforms, with silcrete flakes comprising approximately two-thirds of this assemblage. Alternatively, broken chert flakes marginally outnumbered broken silcrete flakes across the earth mounds, creeks and billabong landforms, 73% to 69% respectively (Thredgold 2017:88).

A study conducted by Amick and Mauldin (1997:20–21) suggested the quality of raw materials correlates to the rate of flake breakage during knapping. Amick and Mauldin (1997:20–21) found more coarsely grained raw materials have a higher frequency of flake breakage compared to finer grained raw materials. Interestingly, in the Calperum study area, fine-grained raw materials demonstrated higher quantities of flake fragmentation, with 64% of broken flakes at the lacustrine landforms recorded as fine-grained, and 71% fine-grained broken flakes across the earth mounds, creeks and billabong landforms (Thredgold 2017:112). This data suggests flake fragmentation in the Calperum study area is unlikely to have been the result of knapping processes, and is proposed to have been caused by other mechanisms.

Studies examining the effect of varying sedimentary surfaces on the post-depositional fragmentation of stone artefacts indicate loose and uncompacted soils are more likely to facilitate artefact breakage compared to the more compacted and indurated substrates (Douglass and Wandsnider 2012:356; Eren et al. 2010). The large majority of surface artefacts recorded across the Calperum study area were located on sandy substrates. In similar sandy substrate experimental conditions, Eren et al. (2010:3018) examined the impact of animal trampling (goats) in both wet and dry conditions, and found generally low rates of flake fragmentation. The low rates of flake fragmentation were caused by the lack of other hard surfaces or gravels in the sandy substrate, and the generally low density of surface artefacts, which limited the interaction of rock materials causing fragmentation (Eren et al 2010:3021–3020).

Animal surface disturbances through trampling were particularly notable at and in the vicinity of the Reny Island billabong, with evidence of deeply set footprints (mostly emu and kangaroo) observed on the billabong bed and along the billabong margins (Thredgold 2017:108–109; Thredgold et al. 2017:103). The footprints were pressed into the sandy and loam substrates, potentially causing downward displacement of surface materials and high rates of artefact breakage. The numerous footprints at this location reflect the high concentration of animals visiting the billabong when it is in a period of stable water supply. The Reny Island billabong is characterised by grey gilgai clay, which formed substantial deep cracks during oscillating dry periods (gilgai clays were also observed at the Hunchee Creek precinct and the Ral Ral Creek east mounds, although surface cracks were less substantial in these areas). The potential for surface artefacts to fall amongst the large cracks, in conjunction with high proportions of animal and human trampling activities at the Reny Island billabong precinct, and possibly the reburial of surface material through flooding-related sedimentary build-up, could account for the lack of surface artefacts on the billabong bed (Douglass and Wandsnider 2012; Eren et al. 2010).

6.2.5 Heat Shattered Stone and Heat Affected Artefacts

Heat affected stone fragments were recorded as either heat shattered stone or heat damaged artefacts. Heat shattered stones were those that appeared to be non-artefactual, having been transported to the Calperum study area yet exhibiting no evidence of conchoidal fractures across the fracture surfaces. The majority of heat shattered stone fragments across all landforms were observed to be of medium to very coarse-grained raw materials (Thredgold 2017:115–116). The majority of heat shattered stone fragments were observed away from predictable sources of heat, such as use in the earth mounds (Thredgold 2017:131). While heat shattered stone fragments could possibly have been used as heat retainers in other cooking or non-cooking practices, no stone artefacts, heat affected or otherwise, were recorded in direct relation to hearths; including the Lake Woolpolool dune where the survey transect was positioned along the margin of an eroding hearth feature (see Figure 4.3), or the Lake Merreti lunette, where heat shattered stone fragments were observed in greatest density. It is possible that the seemingly isolated heat shattered stone artefacts are the result of local bushfires, however this is also further evidence of a disturbed and displaced surface record (Pargeter and Bradfield 2012:244–246).

As with the heat shattered stone fragments, the vast majority of heat damaged stone artefacts across the Calperum study area were not located in association with hearth features, and located greater than 10 m away from the boundaries of the earth mound landforms (Thredgold 2017:131–132). These artefacts could have similarly been potentially exposed to displacement through human and animal trampling, or may have been impacted by post-depositional natural bushfires, although this difficult to determine. At this stage, it is difficult to conclusively determine how heat affected artefacts came to be reflected in the Calperum study assemblage.

6.3 Summary

The stone artefact surface assemblage of the Calperum study area is composed of predominantly small and frequently broken unretouched flakes, mostly smaller than 20 mm in dimensions and of good quality raw materials for flake manufacture. The analysis presented by this chapter indicates that surface stone artefacts were generally manufactured across variable landforms for specific local functions, possibly for a variety of food processing activities (Binford and O'Connell 1984; Kamminga 1982; Westell and Wood 2014:48). The taphonomic and geomorphic processes examined in this chapter indicate high levels of artefact and landform disturbance, which have, and are likely to continue to cause artefact fragmentation and displacement, and further highlight the underlying interactions between cultural and environmental processes and the complexities involved with temporal interpretations in this landscape. The following chapter will expand on the conclusions drawn from the analysis in this chapter.

Chapter 7: Conclusions

This research project was initiated to contribute to the broader collaborative research project at Calperum Station between Flinders University and the River Murray and Mallee Aboriginal Corporation (RMMAC). This study sought to consider whether a comparison of surface stone artefacts from potentially varying temporal riverine landscapes could reveal changes in resource technologies and strategies across different environments. Field survey examined and recorded the surface lithic record for three different landforms and landscapes, the Lake Merreti lunette, Lake Clover dune, and Lake Woolpolool dune. This data was then examined alongside the surface lithic record recorded by Thredgold (2017), across the Reny Island billabong precinct, Hunchee Island billabong precinct, Hunchee Creek precinct, and the Ral Ral Reek East mounds. The discussion presented in Chapter 6 is summarised below in relation to the aims and primary research question of this thesis, followed by a consideration of future research directions.

The primary research question asks:

> What can a comparative technological and geoarchaeological analysis of surface stone artefacts from variable landforms at Calperum Station reveal about the organisation of human activities and behaviours upon and across a landscape, such as potential patterns in resource utilisation, landform-specific use of raw materials and local economies? What are the temporal complexities inherent in such an analysis?

To address this, the following conclusions have been divided into two key discussions below.

- What insights into local resource utilisation, tool manufacture and flaking strategies, and economic activities does this research study provide? What can be inferred from the results of this study in resolution to the organisation of human activities and behaviours upon and across a landscape?

At Calperum Station, across all landforms examined for this research project, silcrete was the most commonly utilised raw material both in weight and quantity of stone artefacts. There was a greater use of silcrete across the lacustrine dune and lunette formations, silcrete representing 63% of raw materials at these landforms compared to 53% at the earth mounds, creeks and billabong landforms. The overall surface stone artefact assemblage comprised good quality raw materials.

Cores were not encountered in great quantities across the Calperum Station earth mounds, creeks, billabong, and lacustrine landforms examined by this study, representing only 6% of the total stone artefact assemblage. Cores were present at the Lake Merreti lunette, Lake Clover dune, Reny Island billabong, and Hunchee Creek precinct. Although the debris associated with knapping locations was generally absent from the data examined in this study, given the presence of greatly exhausted chert cores, proportionately larger silcrete cores, and longitudinally cone split flakes, the study data would suggest knapping activities likely occurred close to or in the vicinity of these areas (Doelman 2005:56). Longitudinally cone split flakes were recorded in their highest frequency in the proximity of the Reny Island billabong, and the Lake Clover dune landforms, and a knapping floor was recorded approximately 50 m away from the Reny Island billabong at a nearby scald (Thredgold 2017:123–124).

The data recorded from cores and flake lengths of the Calperum Station surface assemblage reflects strategies of raw material conservation and planning (Kuhn 1995; Mackay 2005). Chert cores were generally smaller than silcrete cores and reflected a greater degree of core reduction, indicating they were generally exploited until exhaustion before having been discarded. This mirrors the overall measurements for flake lengths, where chert flake lengths were smaller overall, ranging between 7–24 mm compared to a range of 5–51 mm for silcrete. Chert materials were utilised differently across the Calperum study area. The earth mounds, creeks and billabong landforms examined by this study demonstrated higher degrees of chert core rotation, a greater frequency of bipolar chert cores, indicating the adoption of technological manufacturing practices to maximise the use of this raw material across these landforms (Clarkson and

O’Connor 2014:178–181). Additionally, across the earth mounds, creeks and billabong landforms, chert flakes demonstrated a greater diversity in platform surfaces, than those chert flakes recorded across the lacustrine landforms. Although strategies of platform preparation were not common in the Calperum study area, considering chert platform surfaces, the data reveals chert materials were more intensively utilised across the earth mounds, creeks and billabong landforms compared to chert and silcrete materials elsewhere in the study area.

Finer-grained silcrete and chert materials were subjected to higher degrees of core rotation to increase the yield of flakes manufactured (Andrefsky 2005; Pelcin 1997). Data recorded for the direction of dorsal scars on flakes reflect slightly more variety on silcrete flakes across the lacustrine lunette and dune assemblage compared to dorsal scars recorded across the earth mounds, creeks and billabong landforms. This suggests conservation practices and strategies for raw material reduction may have been exercised for the preservation of silcrete materials across the lacustrine landforms (Holdaway and Stern 2004:148). Given the consideration of local utilisation of the Karoonda Surface siliceous outcrops along the cliff ridges of the Murray Valley, this could suggest silcrete raw materials were procured at a greater distance from the lacustrine landforms. Further studies involving geomorphological landform mapping and local raw material sources could provide a deeper understanding as to practices of resource utilisation and local economies.

Cortex was not a common feature of the Calperum Station surface assemblage (Thredgold 2017:98). Despite the variable landforms, there is no discernable pattern between the location of surface stone artefacts and the presence of cortex. Only 40% of cores in the assemblage were observed to retain cortical surfaces, all of which demonstrated between the ranges of 1–50% cortex coverage, and 77% of flake and core artefacts across all study areas recorded no cortex coverage. The low rates of cortex in the assemblage can reflect practices of transporting raw materials, where the cortical surface of the raw material has been discarded at another location during early stages of reduction, or cortex at the source of raw material was uncommon given raw material outcrops occurred in smaller sizes (Clarkson 2007:83; Dibble 2005; Douglass et al. 2008:520–523; Tumney 2011). Further, research into the sources of raw materials utilised at Calperum Station is necessary before cortical reduction and raw material transportation can be appropriately assessed in any detail.

It is possible that the lacustrine lunette and dune landforms of Calperum Station were areas where flakes were removed from the core at a later stage in the core reduction sequence. Considering the relationship between negative core scar lengths alongside the lengths of complete flakes, on average the length measurements were generally comparable between flakes and cores (Holdaway and Stern 2004:82–86). Across the earth mounds, creeks and billabong landforms, for silcrete cores, the negative core scars were generally larger than the length of complete silcrete flakes, which could suggest silcrete cores were utilised in these areas at an earlier stage of reduction (Thredgold 2017:97).

The vast majority of the Calperum Station surface assemblage comprised unretouched flakes (93% of recorded flakes were unretouched). Consistent with Thredgold's (2017:120, 133, 139–140) findings, that the employment of simple flaking strategies were likely sufficient to utilise raw materials and manufacture expedient flakes, with more complex manufacturing and conservation strategies employed for higher quality materials.

Lithic scatters occurred in higher densities across the lacustrine lunette and dune landforms of Calperum Station, and in particularly low frequencies on the earth mound landforms (Thredgold 2017:79–84). This can be understood as a result of several possible circumstances. It is possible that higher densities of lithic scatters in the lacustrine environments were the result of more intensive knapping activities. This is particularly notable at Lake Clover dune, where the assemblage reveals the highest density of artefacts scatters, 60 stone artefacts recorded within an approximately 80 m^2 survey area. The impact of underlying geomorphological processes could also explain the variation in lithic scatter densities between the Calperum Station study areas. Given the low quantity of lithic material located on or immediately near the earth mounds, this could suggest these landforms were exposed to higher levels of fluvial disturbance and subsequent artefact displacement. Although fluvial processes have potentially altered the preservation of stone artefacts across the Calperum Station surface record, fluvial surface disturbance in relation to artefact displacement is generally believed to be low (see further discussion below). Similarly, although the study assemblage reveals flake fragmentation to be particularly high, flake fragmentation rates were largely similar across the varying lacustrine, earth mounds, creeks and billabong landforms, and are likely the result of post-depositional taphonomic processes rather than local knapping strategies (see further discussion below). The data provided by the study assemblage therefore suggests, while influenced by the local geomorphology and taphonomic processes, given the larger density of lithic scatters, it is likely that lithic activities occurred in greater frequency or intensity across the lacustrine landforms.

- What is the impact of geomorphological and taphonomic conditions on the lithic surface record at Calperum and what are the temporal complexities involved with an analysis of surface lithics across variable landforms?

Contemporary taphonomic conditions impacting varying landforms have caused significant disturbances to the integrity of the archaeological record at Calperum Station. Land management practices specifically the Calperum Station management access roads, were observed to have caused the greatest disturbance across the lacustrine environments. At Lake Merreti lunette, surface artefacts had been damaged by a management road, which is increasingly encroaching upon the western margin of the lunette (see Figure 4.1). Likewise, at Lake Clover dune, the station management access road runs directly through the western portion of the dune landform, and introduced cobbles have been liberally scattered to strengthen the pathway of the road (see Figure 4.2). Encountering the poorly located access roads was unexpected and consequently stone artefacts directly compromised by them were excluded from the study assemblage. Such practices can cause a high degree of artefact displacement and destruction, and continue to undermine the preservation of the archaeological surface record.

At the Reny Island billabong, the most prominent example of contemporary land management practices is a water pump located at the northern tip of the billabong that artificially maintains water levels (Thredgold 2017:9). While land management practices across the across the earth mounds, creeks and billabong landforms were less imposing, a higher degree of animal disturbance was observed in these areas, particularly in the case of wild rabbits burrowing. Introduced rabbit species burrowing habits raise strong concerns about the both the displacement of surface lithics and stratigraphic damage (Newall et al. 2009:94–95). Rabbit burrowing was particularly evident on earth mounds located within the Hunchee Island billabong precinct (Jones 2016:75; Thredgold 2017:81). Further animal disturbances (particularly at Reny Island billabong), namely deeply set animal footprints, are likely to have caused the downward displacement of surface materials, and contribute to artefact breakage (Thredgold 2017:108–109).

A prominent marker of taphonomic disturbance can be measured by the degree of flake fragmentation. In the Calperum Station study assemblage, flake fragmentation was reasonably high with 51% of unretouched flakes recorded as broken. Studies indicate surface lithics are particularly susceptible to post-depositional fragmentation when situated upon loose and uncompacted sedimentary surfaces (Douglass and Wandsnider 2012:356; Eren et al. 2010). The majority of the surface artefacts within the Calperum Station study assemblage, unsurprisingly, were located on sandy substrates. Fine-grained raw materials reflected higher quantities of flake fragmentation across all landforms, 64% of broken flakes across lacustrine landforms were recorded as fine-grained, and 71% across the earth mounds, creeks and billabong landforms (Thredgold 2017:112). Flake fragmentation at Calperum Station is unlikely to have been caused by knapping practices, rather the pastoral history of the station, historic and ongoing human and animal activities, including contemporary management practices in its use an environmental reserve, are likely be responsible for the high degree of artefact damage.

Given the locations of the study areas for this research project and their proximity to permanent or semi-permanent water sources, it is feasible that fluvial processes have impacted the integrity of the surface record. Research indicates artefacts with dimensions smaller than 20 mm are likely subject to displacement by water movements, however the majority of stone artefacts (54%) within the Calperum study area assemblage were recorded with both length and width dimensions measuring fewer than 20 mm (Hiscock 1985; Fanning and Holdaway 2001:681–683; Petraglia and Potts 1994:231; Schick 1987; Tumney 2011:102–105). While this may indicate fluvial surface disturbance across the study areas has been low, across all landforms no artefacts were recorded with measurements smaller than 5 mm. This could indicate some degree of fluvial disturbance, however it may also suggest that knapping did not occur in these areas, or artefacts were too small to be visible during field survey conditions, particularly areas of dense vegetation and sandy substrates (Petraglia and Potts 1994:233).

In this analysis of surface stone artefacts in the Calperum Station study area, the local Murray River Valley geomorphology and taphonomy has highlighted the inherent complexities involved with temporal interpretations of this dynamic landscape. The Murray River floodplain generates a 'taphonomic nightmare' for archaeological surface studies and geochronological analysis, and spawns an intricate maze of morphing landforms where past and ongoing fluvial, alluvial and aeolian regimes are superimposed on former landscapes (Craig Westell pers. comm. 2018). It is difficult to attribute relative ages between the surface lithics and varying landforms at Calperum station given the local geomorphology. The lacustrine environments examined by this study are likely late LGM landforms experiencing multiple intermixing phases of lunette and dune development processes, as well as contemporary taphonomic stresses involving ongoing station management access roads (Bowler et al. 2006; Prendergast et al. 2009). Likewise, across the earth mounds (likely Holocene in age), creeks and billabong landforms are overlapping processes of relict LGM Murray River channels and cut-off meanders forming the Hunchee Creek oxbow, the billabongs of Hunchee Island and Reny Island, and their surrounding environments (Jones 2016; Thredgold 2017; Craig Westell pers. comm. 2018). This research study has highlighted the importance of a geoarchaeological approach to examining the interactions between cultural and natural processes over varying temporal and spatial scales (Holdaway and Fanning 2014:1). The separate and concurrent study by Craig Westell and the broader Calperum Station research project involving C^{14} dating will provide further clarity as to the temporal interpretations of the landforms examined by this study, and refine our current understanding of the local Calperum Station landform systems and taphonomic profile.

This research study provides an insight into the archaeology of surface stone artefact analysis in South Australia's inland riverine environment, and redresses the previous gap in comparative lithic research in this area, examining variable lacustrine dune and lunette landforms, creeks, billabongs and earth mound environments. Considering the potential for a nuanced relationship between landform-specific use and manufacture of stone artefacts, this study contributes to the broader body of data for lithics analysis within the Murray-Darling Basin.

Calperum Station and the unique landscape of South Australia's riverine environment, provides extensive opportunities for further archaeological research. Beyond the scope of this present research project, studies involving geomorphic mapping, raw material sources and archaeological excavations could provide further clarity to the myriad of ways Aboriginal people engaged with and connected to country, and build upon the research and conclusions drawn in this study for the South Australian riverine environment.

Geomorphic landform mapping, in conjunction with the collection of samples for radiocarbon dating, will provide a more comprehensive chronological framework for this region of South Australia's riverine and will improve our understanding of the local characteristics of fluvial-aeolian interactions, and the manner in which they influence the formation and preservation of the archaeological record. The broader collaborative research project initiated by Flinders University Department of Archaeology Staff and RMMAC have now commenced the collection of samples for C^{14} assessment, however they were not available before the completion of this lithic study.

A survey and analysis of areas of local lithic raw material sources would assist to inform the direction of future stone artefact research in the South Australian riverine. This could also provide further resolution to the local Calperum study assemblage examined in this thesis, contributing to an understanding of the degree of remaining cortex, the size of parent materials, resource transportation and trading networks.

Furthermore, excavations at Calperum Station could strengthen geomorphological research with the potential for stratigraphic analysis to reveal information about local geomorphology and taphonomic conditions. Taphonomic processes have, and continue to, influence the archaeological record in the Calperum study area. Excavations have the potential to yield new information about artefact densities, local knapping activities, and the degree in which taphonomic disturbances have undermined the integrity of the surface archaeological record, such as in areas where animal and human trampling and fluvial processes have occurred. Similarly, excavations of earth mounds could provide a greater understanding as to the local activities occurring in these areas, the degree of taphonomic disturbance across these landforms, and their deeper relationship to stone artefacts found either in proximity to, on the surface of or indeed within the subsurface of the earth mounds.

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Appendices

Appendix 1

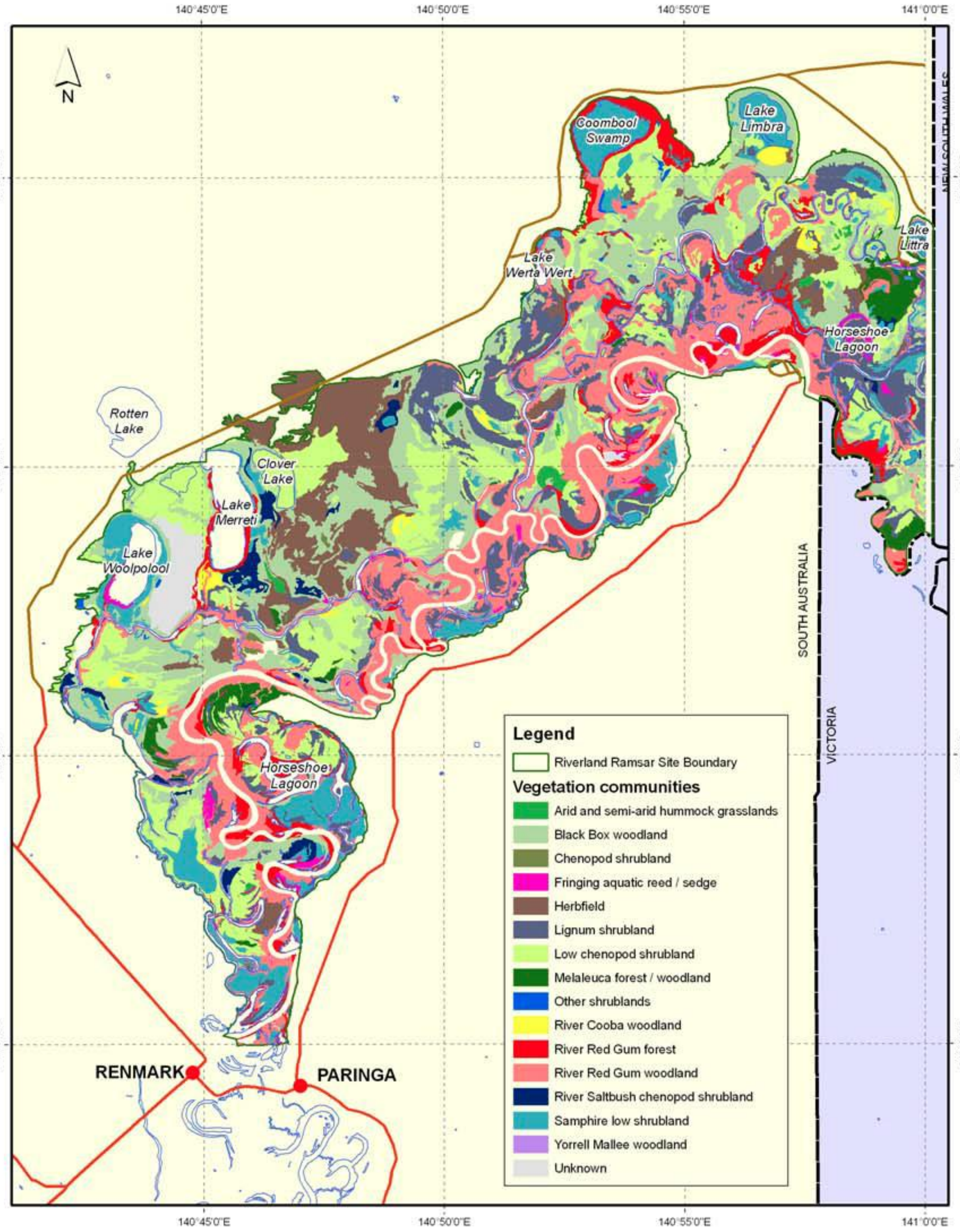
Summary table of Ned's Corner Landform Systems (from Prendergast et al. 2009:59).

Land System	Land Units	Dominant Process	Surface Expression	Sediments	Soils / Degree Of Pedogenesis	Dominant Vegetation	Archaeology	Age
Murray Land System	floodplain, billabongs and river channels	fluvial	mildly undulating surface with some flooding channels	compacted light grey medium clay	very little soil development	River Red Gum	surface scatters of artefacts	Holocene (~10 ka to present)
Mulcra Island Land System	floodplain and palaeomeander scrolls	fluvial	mildly undulating channel floodplain sequences	medium grey gilgai clay	mild pedal development	Black Box with some grasses and Lignum	midden deposits on floodplain surface	Late Pleistocene, (post 15 ka)
	billabongs	fluvial	arcuate depression, sometimes filled with water	fine medium grey overbank clays	mild pedal development	Black Box and Red Gum	not observed	Late Pleistocene (post 15 ka)
Lindsay Land System	floodplain and palaeomeander scrolls	fluvial	mildly undulating channel floodplain sequences	dark grey gilgai clay and sandy bedload	mild pedal development	Lignum with some Black Box	not observed	LGM (Pre 15 ka)
	LLS source-bordering dunes	aeolian	red sandy rises	fine to medium, well-sorted red sand	carbonate pedogenesis below 30 cm	various Chenopod species	middens, stone artefacts, burials and hearths	LGM (Pre 15 ka)
Neds Corner Land System	floodplain and palaeochannels	fluvial	predominantly flat surface	fine red silty sand	secondary carbonate, duplex soils	Chenopod shrubland	hearth stones and stone artefacts on surface	> 40 ka
	NCLS Source-bordering dunes	aeolian	irregularly shaped sandy rises	fine, well-sorted red brown sand	clay cutan development. carbonate at depth	Blue Bush, Old Man Saltbush	middens, burials hearth stones and stone artefacts on surface	> 40 ka
	lunette lakes	aeolian/ lacustrine	ovoid depressions, 4-5 m below surrounding plains flanked by arcuate dunes on eastern margins	pelletal clay, gypseous grey-brown sandy clay	some carbonate and gypsum. weak pedal development	Blue Bush, Dillon Bush, native grasses	grinding stones, hearth stones, burials and stone artefacts on surface	LGM? (~20 ka?)
Woorinen Land System	linear dunes and swales	aeolian	regular rises with rounded crests	fine red brown sand	paleosols and carbonate development	Mallee eucalypts	not observed	active throughout last and previous glacial cycles

Appendix 2

Riverland Ramsar site vegetation communities map (from Newell et al. 2009:74).

Riverland Ramsar Site - Vegetation Communities



Produced by: Ecos Environmenal Consulting
Compiled: T Clark
Location: Murraylands Region
Data Sources: Dept. for Environment and Heritage
Date: 20 March 2008

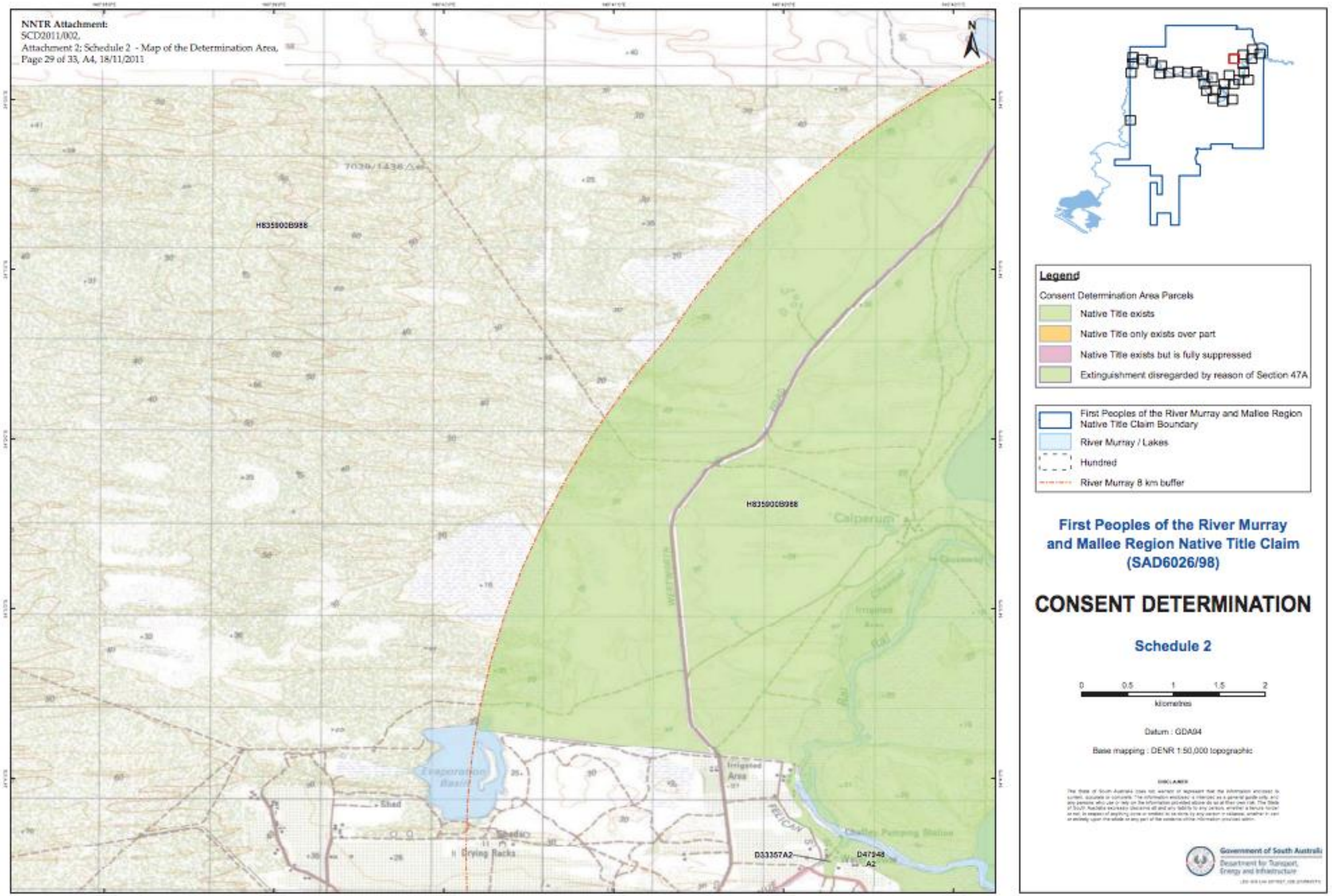
Projection: Tranverse Metacor
Datum: Geocentric Datum of Australia, 1994
Grid: Map Grid of Australia, Zone 54

0 1 2 3 4 5
Kilometres

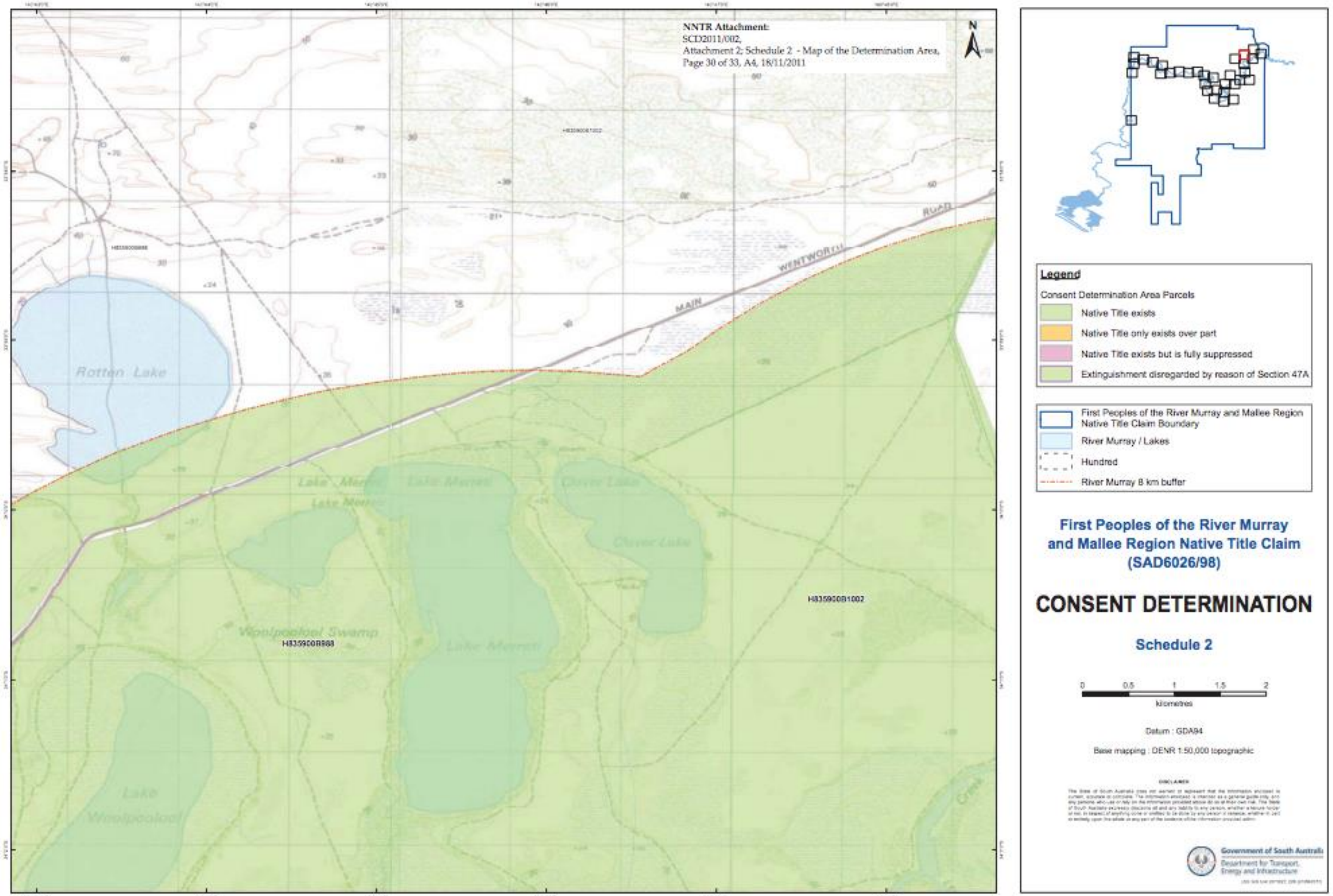
Appendix 3

Maps of the native title determination area for the First Peoples of the River Murray and Mallee Region associated with Calperum research study area (National Native Title Tribunal 2017).

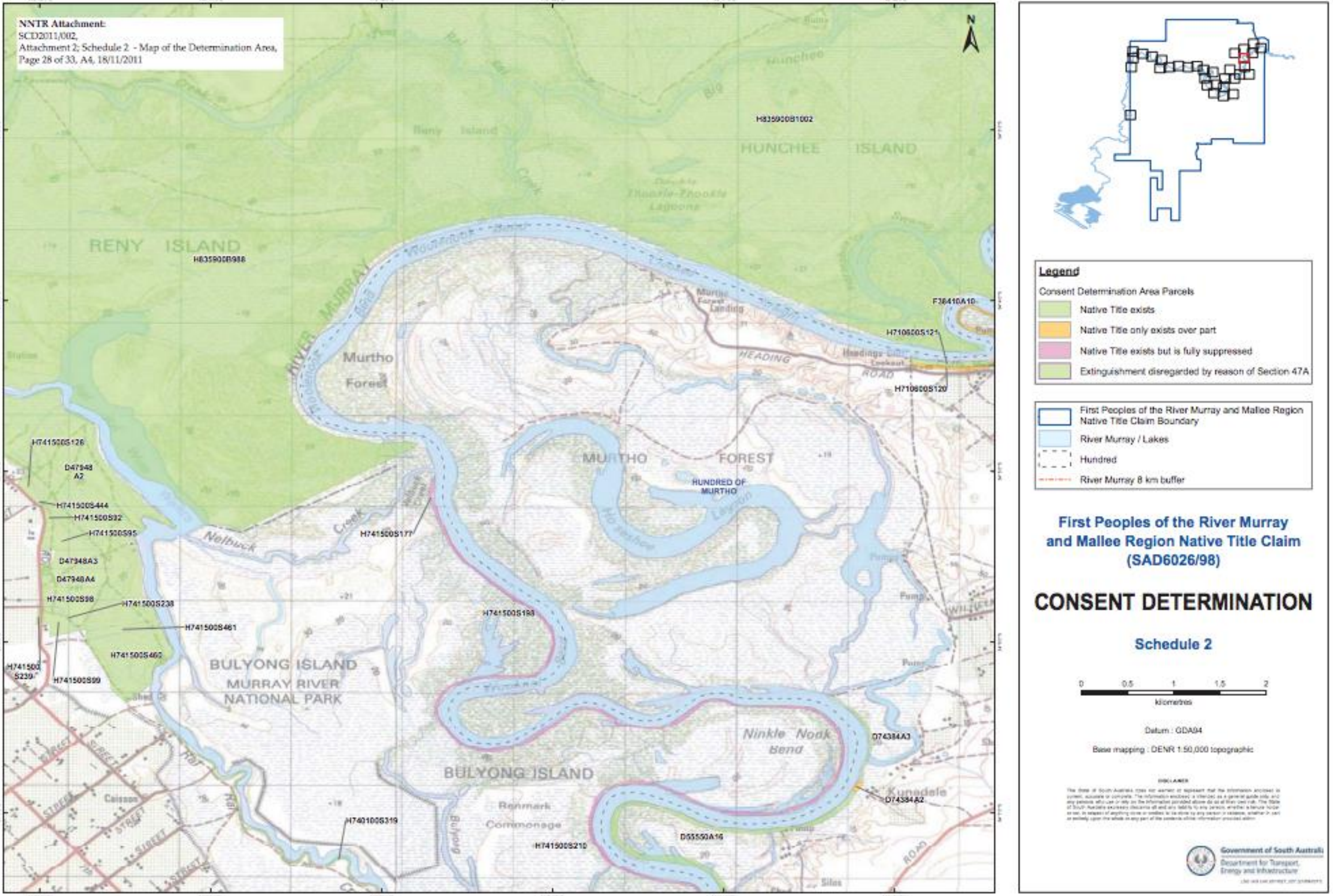
1) – Native Title determination area ‘2011027_ 29’ (National Native Title Tribunal 2017).



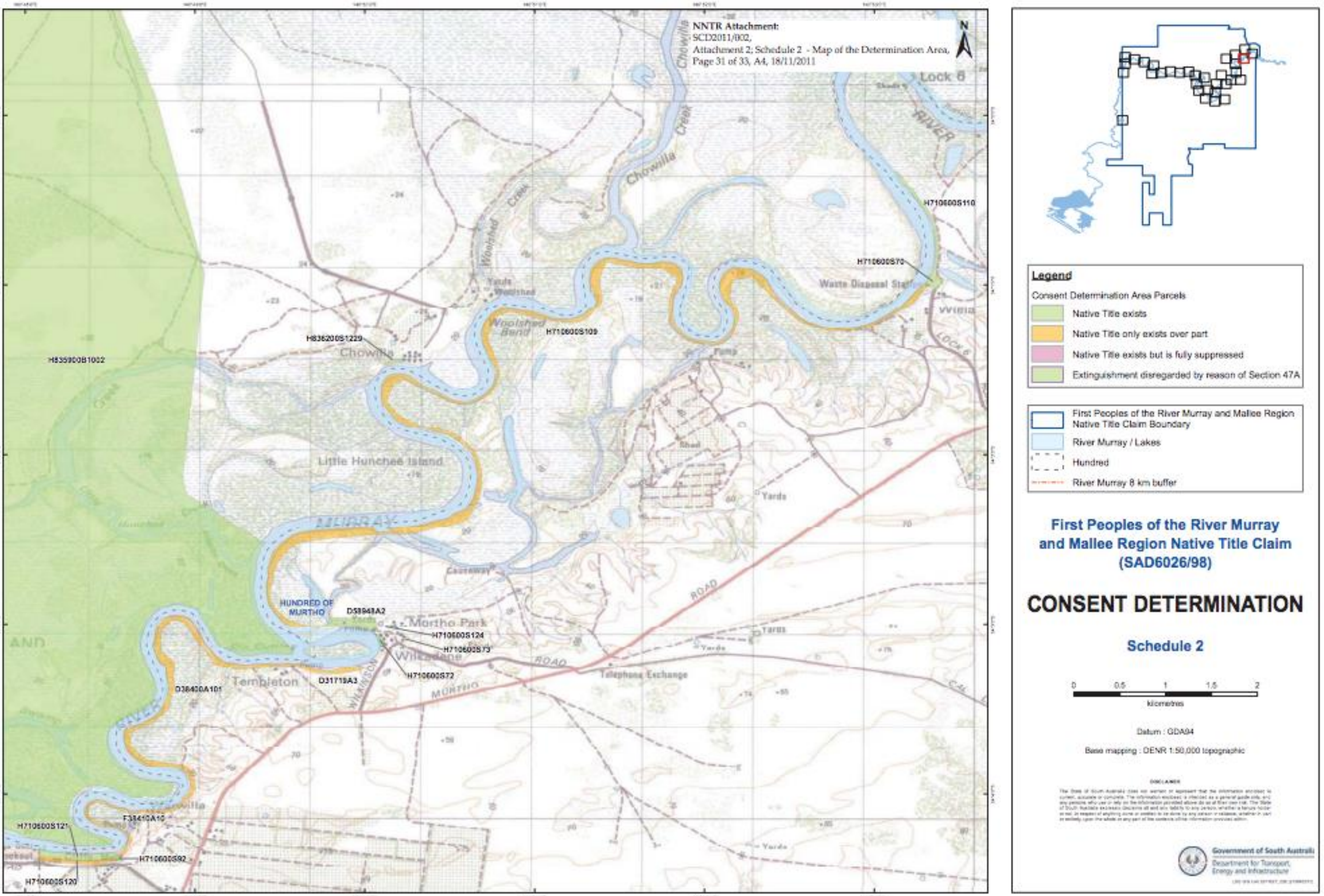
2) – Native Title determination area ‘2011027_ 30’ (National Native Title Tribunal 2017).



3) – Native Title determination area '2011027_ 228' (National Native Title Tribunal 2017).



4) – Native Title determination area '2011027_ 31' (National Native Title Tribunal 2017).



Appendix 4

Raw field data collected during Calperum field survey (September 2016).

1) – Stone Flakes

Date	Field ID	Material	Colour	Raw Material_ Desc.	Complete or broken	Type	Length _mm	Width _mm	Thick _mm	Plat_ width	Plat_ thick _mm	Term_type	Dorsal_ cortex_ %	Dorsal _scar_ count	General Comments	Weight	Overhang _removal	Initiation _type	Plat_ surface	Dorsal_ scar_ direction	Edge_ Damage	RTF_type	Retouch _quad	Advanced_comments
26/09/16	GI002	Chert	Banded brown to cream	Fine grained	Complete flake	Retouched Flake	9	19	5	17	3	Missing termination	0%	2		7	No	Hertzian	Multiple	None apparent	No	Amorphous	2,3,4	Retouch from ventral to the dorsal
26/09/16	GI003	Chert	Brown	Medium grain	Marginal fragment	Un-retouched Flake	19	13	4			Feather termination	1-50%	0	Margin missing	1	No	Hertzian			No			No platform
26/09/16	GI004	Chert	White	Medium grain	Complete flake	Un-retouched Flake	12	10	2	7	3	Feather termination	0%	3	White with yellow bits inside	1		Hertzian	Single fracture	Same but oblique	No			
26/09/16	GI005	Silcrete	Brown	Fine grained	Complete flake	Un-retouched Flake	51	32	11				0%		Type: flaked piece, Max. width length thickness taken	15	No							
26/09/16	GI008	Silcrete	Yellow	Fine grained	Distal Flake	Un-retouched Flake	16	20	3			Feather termination	0%		Platform missing	1		Hertzian			Yes			
26/09/16	GI010	Silcrete	Pale pink	Coarse material	Medial Flake	Un-retouched Flake	17	33	5				0%			3					No			
27/09/16	GI073	Chert	Dark brown and red	Medium grain	Distal Flake	Un-retouched Flake	12	26	7			Feather termination	51-99%			2								
27/09/16	GI074	Chert	Caramel	Medium grain	Complete flake	Un-retouched Flake	14	13	15	14	7	Feather termination	0%	3		1	No	Hertzian	Single fracture	Same direction	Yes			Edge damage in 3 and 4 (lower left margin)
27/09/16	GI075	Silcrete	Caramel brown	Medium grain	Complete flake	Un-retouched Flake	27	23	11	15	4	Feather termination	1-50%	4	Platform complete, voids	6	No	Hertzian	Single fracture	Opposite but oblique	Yes			Dorsal scar from relic platform. edge damage on all of left and distal, q3 and 4
27/09/16	GI076	Silcrete	Caramel brown	Fine grained	Complete flake	Un-retouched Flake	24	29	7	34	10	Feather termination	1-50%		Dorsal scars indeterminate, negative scars and separate removals, cherty silcrete	5	Yes	Hertzian	Multiple		Yes			Overhang removal. Edge damage on boundary of 1 and 2
27/09/16	GI077	Chert	Dark red	Fine grained	Distal Flake	Un-retouched Flake	9	13	5			Feather termination	0%		Indeterminate dorsal scars, too small to tell	6					Yes			Edge damage in q3
27/09/16	GI079	Chert	Caramel	Fine grained	Proximal	Un-retouched Flake	18	20	3	7	4		0%	0		1	No	Hertzian	Single fracture		Yes			Edge damage ventral to dorsal
27/09/16	GI080	Chert	Caramel	Fine grained	Complete flake	Retouched Flake	31	13	10				1-50%		Platform too small to record,	3		Hertzian				Amorphous	1,2,3,4	
27/09/16	GI016	Silcrete	Pale pink grey	Coarse medium grains	Medial Flake	Un-retouched Flake	17	14	3			Feather termination	0%	2	Can't tell dorsal scar direction	1		Hertzian		Ind.				

Date	Field ID	Material	Colour	Raw Material_ Desc.	Complete or broken	Type	Length _mm	Width _mm	Thick _mm	Plat_ width	Plat_ thick _mm	Term_type	Dorsal_ cortex_ %	Dorsal _scar_ count	General Comments	Weight	Overhang _removal	Initiation _type	Plat_ surface	Dorsal_ scar_ direction	Edge_ Damage	RTF_type	Retouch _quad	Advanced_comments
27/09/16	GI017	Silcrete	Pink grey	Medium grains	Medial Flake	Un-retouched Flake	10	14	2				0%		Dorsal scars indeterminate	3								
27/09/16	GI018	Silcrete	Brown	Coarse grain	Complete flake	Un-retouched Flake	40	26	8	24	7	Feather termination	0%	2	GI017 also in images	8	Unknown	Hertzian	Single fracture	Ind.	Unknown			No platform preparation, material too coarse to see
27/09/16	GI019	Silcrete	Light grey	Medium grains with large inclusions	Distal Flake	Un-retouched Flake	32	19	4			Feather termination	51-99%	1		2				Ind. i	No			
27/09/16	GI022	Silcrete	Light brown	Coarse grain	Complete flake	Un-retouched Flake	32	23	5	19	7	Feather termination	0%	0	Single flat piece on dorsal, 1 dorsal scar	4	Unknown	Hertzian	Single fracture	Ind.	Unknown			
27/09/16	GI030	Silcrete	Pink purple	Medium coarse grain	Lgtdl cone split left	Un-retouched Flake	27	25	8			Feather termination	0%			6	Unknown	Hertzian						
27/09/16	GI034	Silcrete	Pale pink	Very coarse	Lgtdl cone split right	Un-retouched Flake	34	16	7			Feather termination	0%		Very coarse material uneven grain size	4		Hertzian						
27/09/16	GI037	Silcrete	Golden yellow	Very fine grains with crystal inclusions	Distal Flake	Un-retouched Flake	11	12	5			Hinge Termination	0%			6					Unknown			
27/09/16	GI046	Silcrete	Yellow	Very fine grain	Distal Flake	Un-retouched Flake	11	10	2			Feather termination	0%			3								
27/09/16	GI047	Silcrete	Yellow	Very fine grains	Complete flake	Un-retouched Flake	18	22	4	19	3	Hinge Termination	1-50%	1	Long hinge termination the length of the flake	2		Hertzian	Single fracture	Same direction	No			
27/09/16	GI054	Chert	Caramel brown	Fine grained	Complete flake	Un-retouched Flake	19	9	4			Hinge Termination	0%	3		6	Unknown	Hertzian	Shattered	Same direction	Yes			Edge damage continuous, right platform and margin
27/09/16	GI055	Chert	Caramel brown	Fine grained	Medial Flake	Un-retouched Flake	21	18	6				100%			2								
27/09/16	GI056	Chert	Red	Fine grained	Proximal	Un-retouched Flake	8	6	6			Missing termination	0%			1			Shattered					

Date	Field ID	Material	Colour	Raw Material_ Desc.	Complete or broken	Type	Length _mm	Width _mm	Thick _mm	Plat_ width	Plat_ thick _mm	Term_type	Dorsal_ cortex_ %	Dorsal _scar_ count	General Comments	Weight	Overhang _removal	Initiation _type	Plat_ surface	Dorsal_ scar_ direction	Edge_ Damage	RTF_type	Retouch _quad	Advanced_comments
27/09/16	GI057	Silcrete	brown mustard	medium grain	Margin Missing	Un-retouched Flake	22	18	5	12	4	Feather termination	0%		Direction of impact hits and results in a feather term but is missing margin	2		Hertzian	Single fracture		Yes			
27/09/16	GI058	Chert	Caramel	Fine grained	Complete flake	Un-retouched Flake	24	27	6			Step Termination	51-99%	1	Uneven cortex	3			Shattered	Same direction				
27/09/16	GI059	Chert	Cream caramel	Fine grained	Distal Flake	Un-retouched Flake	7	8	3			Feather termination	0%			2								
27/09/16	GI060	Chert	Brown	Fine grained	Complete flake	Retouched Flake	13	25	10	24	5		0%			2		Hertzian	Multiple		Yes	Amorphous	All	All areas retouched.
27/09/16	GI072	Silcrete	Grey brown	Very coarse	Lgtdl cone split left	Un-retouched Flake	19	18	7			Feather termination				2								
28/09/16	GI100	Chert	Cream	Fine grained	Complete flake	Un-retouched Flake	8	7	1	5	1	Feather termination	0%	2		1		Bending	Single fracture	Same direction				
28/09/16	GI101	Silcrete	Cream	Very fine grain	Complete flake	Un-retouched Flake	9	7	1			Feather termination	0%			1			Shattered					
28/09/16	GI103	Silcrete	Brown red	Very coarse	Complete flake	Un-retouched Flake	117	110	27	49	8	Feather termination	1-50%	1		201		Hertzian		Oblique direction				Indeterminate platform too coarse
28/09/16	GI104	Silcrete	Cream	Very fine	Proximal	Un-retouched Flake	10	8	2	8	4	Missing termination	0%			2		Bending	Single fracture					
28/09/16	GI105	Silcrete	Cream	Fine grained	Complete flake	Un-retouched Flake	13	18	2			Step Termination	0%			4		Hertzian	Shattered					
28/09/16	GI107	Silcrete	Cream	Fine grained	Distal Flake	Un-retouched Flake	8	11	4			Feather termination	0%		Cherty silcrete	3								
28/09/16	GI108	Silcrete	Sandy yellow	Medium grain	Lgtdl cone split right	Un-retouched Flake	8	7	2			Feather termination	0%			1								
28/09/16	GI109	Chert	Caramel	Fine grained	Margin Missing	Un-retouched Flake	13	6	1			Feather termination	0%			1			Shattered					
28/09/16	GI110	Chert	Grey brown	Fine grained	Proximal	Un-retouched Flake	15	18	2				0%			9		Hertzian	Shattered					
28/09/16	GI111	Silcrete	Cream	Fine grained	Complete flake	Un-retouched Flake	7	9	3	9	2	Feather termination	0%			1		Hertzian	Single fracture					

Date	Field ID	Material	Colour	Raw Material_ Desc.	Complete or broken	Type	Length _mm	Width _mm	Thick _mm	Plat_ width	Plat_ thick _mm	Term_type	Dorsal_ cortex_ %	Dorsal _scar_ count	General Comments	Weight	Overhang _removal	Initiation _type	Plat_ surface	Dorsal_ scar_ direction	Edge_ Damage	RTF_type	Retouch _quad	Advanced_comments
28/09/16	GI112	Chert	Mushroom brown	Fine grained	Complete flake	Un-retouched Flake	13	10	4			Feather termination	0%			1		Hertzian	Shattered					
28/09/16	GI113	Chert	Dark mushroom brown	Fine grained	Complete flake	Un-retouched Flake	13	13	2	16	4	Feather termination	100%			6		Hertzian	Cortical surface					
28/09/16	GI115	Chert	Dark mushroom brown	Fine grained	Complete flake	Un-retouched Flake	8	11	4	13	6	Feather termination	0%			6		Bending	Single fracture		Yes			Edge damage in Q3. Possible snap from scraper as blunt on dorsal
28/09/16	GI116	Chert	Dark mushroom	Fine grained	Complete flake	Un-retouched Flake	13	11	2	6	1	Feather termination	0%	3		3	Yes	Hertzian	Single fracture	Same but opposite				Overhang on dorsal side
28/09/16	GI117	Silcrete	Brown cream	Fine grained	Complete flake	Un-retouched Flake	17	19	7	20	7	Feather termination	0%			2		Hertzian	Single fracture					
28/09/16	GI118	Silcrete	White	Fine grained	Complete flake	Un-retouched Flake	11	12	3	9	3	Step termination	0%	2		2		Hertzian	Single fracture	Same direction				
28/09/16	GI119	Silcrete	Orange	Medium grain	Complete flake	Un-retouched Flake	13	17	2	11	1	Feather termination	0%			5		Hertzian	Single fracture					
28/09/16	GI120	Silcrete	White pink	Medium grain	Complete flake	Un-retouched Flake	17	11	2	7	2	Feather termination	0%			4		Hertzian	Single fracture					
28/09/16	GI121	Silcrete	Cream yellow	Fine grained	Lgtdl cone split left	Un-retouched Flake	8	7	3			Hinge termination	0%			1		Hertzian						
28/09/16	GI123	Silcrete	Orange cream	Fine grained	Lgtdl cone split right	Un-retouched Flake	9	4	2			Feather termination	0%			1		Hertzian						
28/09/16	GI125	Silcrete	Orange	Fine grained	Complete flake	Un-retouched Flake	12	12	3	16	6	Hinge termination	0%			6		Hertzian	Multiple					Small amount of cortex on dorsal
28/09/16	GI128	Chert	Mushroom brown	Fine grained	Complete flake	Un-retouched Flake	11	15	4	12	4	Feather termination	0%			6		Hertzian	Single fracture					
28/09/16	GI120	Silcrete	Cream	Fine grained	Complete flake	Un-retouched Flake	12	13	4	13	4	Feather termination	0%			4		Hertzian	Cortical surface					
28/09/16	GI130	Silcrete	Caramel white	Fine grained	Complete flake	Un-retouched Flake	17	10	4			Feather termination	0%			4		Bending	Shattered					Complete flake with shattered platform. Missing margin from platform but visible bending initiation

Date	Field ID	Material	Colour	Raw Material_ Desc.	Complete or broken	Type	Length _mm	Width _mm	Thick _mm	Plat_ width	Plat_ thick _mm	Term_type	Dorsal_ cortex_ %	Dorsal _scar_ count	General Comments	Weight	Overhang _removal	Initiation _type	Plat_ surface	Dorsal_ scar_ direction	Edge_ Damage	RTF_type	Retouch _quad	Advanced_comments
28/09/16	GI133	Silcrete	Red	Very fine grain	Lgtdl cone split right	Un-retouched Flake	11	11	3			Feather termination	0%			5			Cortical surface					
28/09/16	GI134	Chert	Orange caramel	Fine grained	Complete flake	Un-retouched Flake	11	10	5	12	3	Feather termination	0%	1		5		Bending	Single fracture	Same direction				Distal end of larger flake similar to earlier ref to potential scraper
28/09/16	GI135	Silcrete	Light murky brown	Very fine	Complete flake	Retouched Flake	10	14	7	18	6	Feather termination	0%			1		Hertzian	Multiple			Amorphous	2,3	
28/09/16	GI136	Silcrete	Brown	Medium grain	Complete flake	Un-retouched Flake	15	11	2	11	4	Feather termination	0%			4		Hertzian	Single fracture					
28/09/16	GI133	Silcrete	Red	Very fine grain	Lgtdl cone split right	Un-retouched Flake	11	11	3			Feather termination	0%			5			Cortical surface					
28/09/16	GI139	Silcrete	Cream	Rough margin but very fine grain	Margin Missing	Un-retouched Flake	15	21	5			Feather termination	0%		Heat affected, small heat pock	5		Hertzian	Shattered					
28/09/16	GI140	Silcrete	Cream	Fine grained	Lgtdl cone split left	Un-retouched Flake	10	8	7			Hinge termination	0%			6		Hertzian						
28/09/16	GI141	Silcrete	Dark orange	Very fine	Lgtdl cone split right	Un-retouched Flake	15	11	5			Feather termination	0%			8		Hertzian						Proximal longitudinal cone split right
28/09/16	GI142	Silcrete	Brown	Medium grain	Lgtdl cone split right	Un-retouched Flake	48	33	18			Feather termination	0%			20								
28/09/16	GI146	Silcrete	Mustard brown	Medium grain	Complete flake	Un-retouched Flake	31	23	9			Feather termination	0%			4		Hertzian	Shattered					
28/09/16	GI147	Silcrete	Light brown	Medium to coarse grain	Complete flake	Un-retouched Flake	19	19	5	21	2	Step termination	0%	1		1		Hertzian	Multiple	Same direction				
28/09/16	GI148	Silcrete	Cream yellow	Fine grained	Complete flake	Un-retouched Flake	14	13	3			Step termination	0%			3		Hertzian	Shattered					
28/09/16	GI149	Silcrete	Dark caramel brown	Fine grained	Distal Flake	Un-retouched Flake	5	6	2			Hinge termination	0%			2								

Date	Field ID	Material	Colour	Raw Material_ Desc.	Complete or broken	Type	Length _mm	Width _mm	Thick _mm	Plat_ width	Plat_ thick _mm	Term_type	Dorsal_ cortex_ %	Dorsal _scar_ count	General Comments	Weight	Overhang _removal	Initiation _type	Plat_ surface	Dorsal_ scar_ direction	Edge_ Damage	RTF_type	Retouch _quad	Advanced_comments
28/09/16	GI150	Chert	Caramel brown	Fine grained	Complete flake	Un-retouched Flake	11	20	5	17	7	Feather termination	51-99%	1		1		Hertzian	Single fracture	Same direction				
28/09/16	GI151	Silcrete	Brown	Medium grain	Complete flake	Un-retouched Flake	36	42	9	35	8	Feather termination	1-50%	1		14		Hertzian	Single fracture	Same direction	No			
28/09/16	GI152	Silcrete	Brown	Medium	Lgtdl cone split left	Un-retouched Flake	26	18	8			Feather termination	0%			2		Hertzian						
28/09/16	GI155	Silcrete	Caramel	Fine grained	Margin Missing	Un-retouched Flake	22	10	8			Missing termination	0%		Platform missing hence initiation unclear	3					Yes			Snapped off the end of a scraper. Heat affected
28/09/16	GI157	Silcrete	Caramel	Fine grained	Complete flake	Un-retouched Flake	22	11	2			Feather termination	0%			6		Hertzian	Shattered					
28/09/16	GI159	Silcrete	Cream caramel	Fine grained	Complete flake	Un-retouched Flake	33	12	7	19	5	Feather termination	0%			3		Hertzian	Multiple		Yes			Edge damage on Q4 vent to dorsal
30/09/16	GI200	Silcrete	Yellow orange	Medium grain	Complete flake	Un-retouched Flake	33	23	8	14	3	Feather termination	1-50%	4		6		Hertzian	Single fracture	Oblique direction				
30/09/16	GI201	Quartz	White	Medium grain	Complete flake	Un-retouched Flake	15	16	3	2	1	Feather termination	0%			7		Hertzian			No			Focalised platform.
30/09/16	GI203	Silcrete	Caramel orange	Fine grained	Complete flake	Un-retouched Flake	27	22	6			Feather termination	0%	2		2		Hertzian	Shattered	Same but oblique				
30/09/16	GI204	Silcrete	Yellow gold	Medium grain	Medial Flake	Un-retouched Flake	20	23	8			Feather termination	0%			4								
30/09/16	GI206	Silcrete	Dark red	Medium grain	Complete flake	Un-retouched Flake	9	17	3	16	2	Feather termination	0%	1		8		Hertzian		Same direction				
30/09/16	GI208	Silcrete	Yellow cream	Fine grained	Lgtdl cone split right	Un-retouched Flake	21	5	3			Feather termination	1-50%			4		Hertzian						
30/09/16	GI210	Silcrete	Caramel	Fine grained	Complete flake	Un-retouched Flake	40	17	8	19	8	Feather termination	1-50%			6		Hertzian	Cortical surface					Redirecting flake or relic platform
30/09/16	GI213	Chert	Mushroom	Fine grained	Complete flake	Un-retouched Flake	18	13	5	9	5	Feather termination	0%			6		Hertzian	Single fracture		Yes			Edge damage in Q3 and Q4
30/09/16	GI214	Silcrete	Tan light brown	Medium grain	Complete flake	Un-retouched Flake	42	17	7	19	2	Feather termination	0%	2		6		Hertzian	Single fracture	Same direction				

Date	Field ID	Material	Colour	Raw Material_ Desc.	Complete or broken	Type	Length _mm	Width _mm	Thick _mm	Plat_ width	Plat_ thick _mm	Term_type	Dorsal_ cortex_ %	Dorsal _scar_ count	General Comments	Weight	Overhang _removal	Initiation _type	Plat_ surface	Dorsal_ scar_ direction	Edge_ Damage	RTF_type	Retouch _quad	Advanced_comments
30/09/16	GI216	Chert	Dark brown red	Fine grained	Lgtdl cone split left	Retouched Flake	28	19	10			Feather termination	51-99%			3		Hertzian			Yes	Amorphous	B	Edge damage on dorsal retouch onto ventral
30/09/16	GI218	Silcrete	Yellow gold	Fine grained	Distal Flake	Un-retouched Flake	12	8	2			Feather termination	0%	2						Same direction				2
30/09/16	GI219	Silcrete	Tan brown	Medium grain	Complete flake	Un-retouched Flake	34	34	7	41	15	Feather termination	1-50%	2		13		Hertzian		Opposite but oblique				Relic platform created new/current flake platform
30/09/16	GI220	Quartz	White	Medium grain	Proximal	Un-retouched Flake	13	16	4	9	3		0%	1		1		Hertzian	Single fracture	Oblique direction				
30/09/16	GI221	Chert	Dark reddish brown	Fine grained	Complete flake	Un-retouched Flake	17	16	3	12	3	Feather termination	0%	1		8		Hertzian	Cortical surface	Same direction				
30/09/16	GI222	Silcrete	Light brown	Medium grain	Complete flake	Un-retouched Flake	33	19	6	10	1	Step Termination	0%			3		Hertzian	Single fracture					
30/09/16	GI224	Chert	Red brown	Fine grained	Lgtdl cone split right	Un-retouched Flake	18	10	4			Feather termination	1-50%			9		Hertzian						
30/09/16	GI225	Chert	Cream	Fine grained	Distal Flake	Un-retouched Flake	15	20	7			Feather termination	0%			1								
30/09/16	GI226	Silcrete	Red brown	Medium grain	Complete flake	Un-retouched Flake	16	20	6	19	3	Feather termination	51-99%	1		1		Hertzian	Cortical surface	Same direction				
30/09/16	GI227	Chert	Dark red	Fine grained	Complete flake	Un-retouched Flake	12	15	4	11	6	Plunging termination	1-50%	1		2		Hertzian	Multiple	Opposite direction				Dorsal has scar with hinge termination

2) – Stone Cores

Date	Field ID	Material	Colour	Raw Material_ Desc.	Complete Artefact	Type	Length _mm	Width _mm	Thick _mm	Core_ platform_ count	Plat_1_ Type	Scar_1_ Length_ mm	Plat_2 _type	Scar_2_ Length_ mm	Core_problems	Remaining_ cortical_ surface_ percent	General_comments	Weight_g
27/09/16	GI078	Chert	Caramel brown with black cortex	Fine grained	Complete	Bidirectional	35	14	20	2	Cortical surface	13			Voids, uneven surface, cortex	0%	Fine grained	11
27/09/16	GI013	Silcrete	Caramel yellow	Very fine grained with crystalline inclusions	Complete	Bipolar unidirectional	20	17	9	1	Indeterminate	19				1-50%	Small amount of cortex, shattered platform	2
27/09/16	GI048	Silcrete	Blue yellow	Fine to medium grain	Complete	Bipolar multidirectional	25	31	19	3	Indeterminate	13	Negative scar	12	Uneven texture, void, change in texture runs throughout	1-50%	Platform 2 is the same surface as platform 1.	79
28/09/16	GI102	Quartz	White	Medium grained	Complete	Bipolar bidirectional	16	18	12	2	Negative scar	12	Negative scar	6		0%	Both scars from same platform	4
28/09/16	GI122	Chert	Cream caramel	Fine grained	Complete	Multidirectional	23	39	23	3	Indeterminate	21	Negative scar	13		0%	Scar 1 platform is a ridge	15
28/09/16	GI131	Chert	Orange	Fine grained	Complete	Bipolar multidirectional	17	17	10	3	Indeterminate	12				1-50%	1 complete scar	2
28/09/16	GI144	Chert	Caramel chocolate brown	Fine grained	Complete	Bipolar unidirectional	16	16	10	1	Negative scar	14	Negative scar	14		1-50%	No evidence of crushing	3
28/09/16	GI154	Silcrete	White cream	Fine grained	Complete	Bidirectional	37	24	22	2	Cortical surface	19				1-50%	Core with relic bulb	11

2) – Stone Other

Date	FieldID	Material	Colour	Raw_Material_Desc.	Type	Completeness	Length_mm	Width_mm	Thick_mm	Cortex Remaining	Primary_use	General_comments	Weight
26/09/16	GI001	Silcrete	Grey	Coarse	Heat shatter							Present across landform. Landform type: lunette	2
26/09/16	GI006	Silcrete	Purple	Coarse	Heat shatter								19
26/09/16	GI007	Silcrete	Blue	Medium grain with red inclusions	Heat shatter								38
26/09/16	GI009	Silcrete	Blue	Medium grain	Heat shatter								13
26/09/16	GI011	Silcrete	Purple	Very coarse grains	Heat shatter								7
26/09/16	GI012	Silcrete	Grey	Coarse	Heat shatter								6
26/09/16	GI014	Silcrete	Dark blue with pale pink edges	Medium grain	Heat shatter								4
27/09/16	GI081	Chert	Caramel brown		Non diagnostic shatter								3
27/09/16	GI015	Any other please describe	Pale yellow	Calcrete	Heat shatter								7
27/09/16		Any other please describe	Grey	Calcrete	Manuport								3
27/09/16	GI020	Silcrete	Grey purple	medium grain	Heat shatter								4
27/09/16	GI023	Silcrete	Purple grey	Coarse	Heat shatter								3
27/09/16	GI024	Silcrete	Purple grey	Coarse	Heat shatter								5
27/09/16	GI025	Silcrete	Dark blue and grey with red band		Heat shatter								9
27/09/16	GI026	Silcrete	Dark red	Medium grain	Heat shatter								3
27/09/16	GI027	Silcrete	Pale sandy orange	Very coarse grain	Hammerstone	Broken	28	32	18	0%	Hammerstone	Dimensions are max dimensions. Fragment of hammerstone. Evidence of crushing impact from hammer strike - band of crushing	13
27/09/16	GI028	Silcrete	Dark blue grey	Even medium grain	Heat shatter								3
27/09/16	GI029	Silcrete	Purple	Medium coarse grain	Heat shatter								2
27/09/16	GI031	Silcrete	Grey	Coarse	Heat shatter								2
27/09/16	GI032	Silcrete	Dark red purple	Very coarse	Heat shatter								2
27/09/16	GI033	Silcrete	Grey	Coarse grain	Heat shatter								9
27/09/16	GI035	Silcrete	Dark grey	Medium grain	Heat shatter								2
27/09/16	GI038	Silcrete	Pink	Very coarse grain	Non diagnostic shatter								4
27/09/16	GI039	Silcrete	Grey	Medium coarse grains	Heat shatter								7
27/09/16	GI041	Silcrete	Blue	Medium grain	Non diagnostic shatter								8
27/09/16	GI042	Silcrete	White	Very coarse	Heat shatter								5
27/09/16	GI043	Silcrete	Pink	Medium grain	Heat shatter								3
27/09/16	GI044	Silcrete	Grey	Medium grain	Heat shatter								1
27/09/16	GI045	Silcrete	Grey	Medium grain	Heat shatter								19
27/09/16	GI049	Silcrete	Grey	Very coarse	Heat shatter								1

Date	FieldID	Material	Colour	RawMaterial_Desc.	Type	Complete	Length	Width_	Thick_mm	Cortex Remaining	Primary_use	General_comments	Weight
27/09/16	GI050	Silcrete	Grey	Very coarse	Heat shatter								8
27/09/16	GI051	Silcrete	Grey	Very coarse grain	Heat shatter								17
27/09/16	GI052	Silcrete	Purple	Medium grain	Heat shatter								8
27/09/16	GI053	Silcrete	Grey	Medium grain	Heat shatter								5
27/09/16	GI061	Silcrete	Grey		Hammerstone	Broken	58	52	31		Hammerstone	Band of brown inside. Possible grinding surface. Maximum dimensions taken	51
27/09/16	GI071	Chert	White	Chalcedony, repatination	Non diagnostic shatter								2
28/09/16	GI106	Silcrete	Cream	Cherty silcrete	Heat shatter								6
28/09/16	GI114	Chert	Dark mushroom		Non diagnostic shatter								4
28/09/16	GI124	Chert	Orange		Heat shatter								1
28/09/16	GI126	Silcrete	Pink yellow		Heat shatter								2
28/09/16	GI127	Silcrete	Caramel mushroom		Heat shatter								7
28/09/16	GI132	Silcrete	Dark orange	Cherty silcrete	Non diagnostic shatter								1
28/09/16	GI138	Silcrete	Yellow cream	Cherty silcrete	Non diagnostic shatter								6
28/09/16	GI143	Silcrete	Pink red	Medium grain	Non diagnostic shatter								6
28/09/16	GI145	Silcrete	Cream white	Cherty silcrete	Non diagnostic shatter								3
28/09/16	GI153	Chert	Dark caramel brown		Non diagnostic shatter								7
28/09/16		Silcrete	Cream caramel white	Coarse to medium	Non diagnostic shatter								5
28/09/16	GI158	Chert	Brown with cream cortex		Non diagnostic shatter					100%		100% dorsal cortex	5
28/09/16	GI160	Silcrete	Mustard brown	Fine to medium grain	Non diagnostic shatter								2
28/09/16	GI202	Silcrete	Pink red		Manuport								8
28/09/16	GI205	Any other please describe	Golden yellow	Ochre	Ochre fragment								1
30/09/16	GI207	Any other please describe	Golden yellow	Ochre	Ochre fragment							Image 293 also contains ochre from GI205	1
30/09/16	GI209	Silcrete	Grey purple	Very coarse	Heat shatter								33
30/09/16	GI211	Chert	Mushroom		Heat shatter							Close proximity to GI209 heat shatter	1
30/09/16	GI212	Chert	Mushroom		Heat shatter								1
30/09/16	GI215	Chert	Mushroom		Heat shatter								4
30/09/16	GI217	Chert	Mushroom		Heat shatter								6
30/09/16	GI223	Silcrete	Cream	Cherty silcrete	Heat shatter								1