

# LITHIC ARTEFACT DISTRIBUTION

## in the Rouse Hill Development Area, Cumberland Plain, New South Wales

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### Abstract

For several years systematic test excavations have been conducted in the open landscape of the Rouse Hill Development Area (RHDA), as part of development impact mitigation projects. Data on artefact distribution and density from these projects are combined here to identify patterns which might signal Aboriginal people's preferences for artefact discard in their landscape. Topographic and stream order variables correlate with artefact density and distribution. High artefact density concentrations may have resulted from larger numbers of artefact discard activities and/or from intensive stone flaking. Highest artefact densities occur on terraces and lower slopes associated with 4<sup>th</sup> and 2<sup>nd</sup> order streams, especially 50–100m from 4<sup>th</sup> order streams. Upper slopes have sparse discontinuous artefact distributions but artefacts are still found in these landscape settings. As artefacts are found in all tested areas and site boundaries are not identified, most of the RHDA could be regarded as a cultural landscape.

### Introduction

This paper discusses the nature of artefact distribution in the open landscape of the Rouse Hill Development Area (RHDA) on the Cumberland Plain in northwest Sydney (Figures 1-2). Much Australian, and more specifically Sydney, literature has been concerned with the vertical distribution and changing densities of stone artefacts through time (e.g. Attenbrow 2004; Hiscock and Attenbrow 2005; McDonald 2008) but there have been few published analyses of the spatial distributions of lithic artefacts across open landscapes in Australia (cf. Holdaway *et al.* 1998). While rockshelter locations encourage the accumulation of cultural materials over time, their bounded nature often concentrates these materials in confined areas. In open landscapes people camped in innumerable configurations, discarding cultural materials in the many places they occupied, visited or travelled through.

Variations in numbers of artefacts and artefact density in the landscape could have been related to the nature of flaking activities, how often activities were conducted, and how often artefacts were removed and transported to other areas. Larger numbers of artefacts, occurring as higher artefact densities, could have resulted from (1) large numbers of people conducting many small-scale flaking and discard episodes, (2) small numbers of people conducting small-scale flaking and discard episodes over long periods of time, and/or (3) a small number of intensive flaking activities during which many flakes were struck from cores (White 1999). Our discussions here focus on the identification of landscape patterns of artefact discard, which probably

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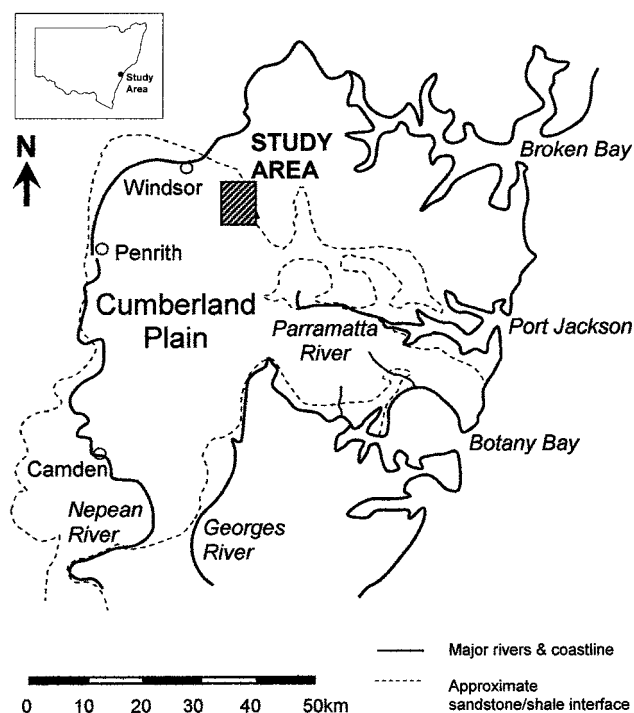


Figure 1 Location of the Rouse Hill study area.

resulted from long-term trends in occupation. We recognise that landscapes also had social and symbolic dimensions for people (e.g. Bruck and Goodman 1999; van Dommelen 1999), and some locations with unusually high or low artefact densities may represent the influence of non-environmental (social and/or symbolic) factors.

Holdaway *et al.* (1998) discuss the difficulties of conducting research on open artefact scatters which normally lack stratigraphy, could be extensive without clear boundaries, and have few features to distinguish groups of artefacts, and whose identification may be controlled by exposure and visibility related to ground surface conditions. The Western New South Wales Archaeological Project (WNSWAP) developed methods for conducting an archaeology of an open landscape. In that region large numbers of artefacts and occasional hearths occur on extensive eroded land surfaces and it was possible to record thousands of artefacts during surface survey (Doelman *et al.* 2001; Holdaway *et al.* 1998). However, on the Cumberland Plain most of the archaeology is buried and different methods are needed to identify and assess it.

On the Cumberland Plain stone artefacts are the most common type of archaeological evidence. From the 1970s occasional artefacts were identified by ground surface survey and in the 1980s a number of studies sought to understand the relationship between the surface archaeology and its

environment (e.g. Fletcher-Jones 1985; Kohen 1986; Smith 1989). Smith (1989) predicted that sites would be found on all topographic units, including ridge tops, slopes, creek banks and flats, but that half of all sites would be clustered around water, and most within 50m of water. She further predicted that site densities would be high around stone sources, frequent around permanent water, and near temporary water where stone sources were present. High site densities would also be present in sedge communities, more in open forest than in woodland areas, and larger numbers of sites would be found in areas of good ground visibility (Smith 1989).

These earlier studies based on survey found few sites with more than 50 surface artefacts. In the early 1990s, test excavations in the RHDA demonstrated the presence of large numbers of stone artefacts in areas where none was seen on the surface (McDonald *et al.* 1994). This work demonstrated that, in this region, surface survey was inadequate to identify and assess the archaeology because soils were largely aggrading and most of the artefacts were buried. McDonald (1996) advocated a strategic approach to management, which perceived the archaeological landscape as a meaningful management concept, in contrast to the previous relics-based approach. Variables such as stream size and proximity to lithic raw materials were thought to have influenced people's settlement patterns and artefact discard, while geomorphology and modern land-use influenced the survival of archaeological evidence. The conservation of representative landscapes was seen as the driving force behind this management approach, while the salvage of landscapes which could not be conserved was requisite to understanding the archaeology of the region.

Since 1999, Jo McDonald Cultural Heritage Management Pty Ltd (JMCD CHM) has conducted extensive dispersed testing and open area excavations across the RHDA. Systematic dispersed test excavations have provided comparative information on artefact distribution over large areas while area excavations salvaged artefact concentrations, investigated intrasite spatial distributions, and provided statistically useful artefact samples for detailed analysis.

### The RHDA

The Rouse Hill Development Area (RHDA) is located towards the northern edge of the Wianamatta Shale-based Cumberland Plain, near its interface with Hawkesbury Sandstone formation geology. This area was once covered in Cumberland Plain Woodland, with taller forest in the vicinity of larger streams on the sandstone/shale interface. The main geoarchaeological consequences of the underlying Wianamatta Formation geology are:

- Low relief landforms with well-developed and high density drainage networks. Water sources were relatively common, with both ephemeral and permanent streams and ponds forming significant elements in the prehistoric landscapes.
- Poor soils precluded significant intensive agricultural use of the area. This natural low fertility assisted in the preservation of natural woodland, promoted pastoral land-use and minimised the effects of land disturbance from clearance and agriculture in some areas. There was thus a high potential for *in situ* undisturbed preservation of near-surface archaeological evidence.

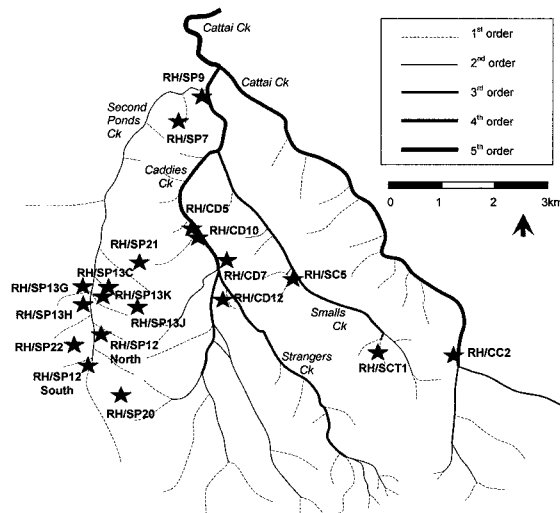


Figure 2 Location of tested areas within the Rouse Hill development area.

The soils produced from the weathering of these rocks were inherently fine-grained with high proportions of fine sands and silts in the A horizon soil over clay-rich subsoils. The active soil zone is shallow, typically <10–30cm with a sharp contact with subsoil clays. Shallow soils limit archaeological assemblages to the near-surface zone. The consequences of this are significant, when surveying archaeological sites, when designing field sampling and salvage methods, and subsequently assessing overall site significance (JMCD CHM 2005a:14–15).

Geomorphological studies have been a regular component of the archaeological investigations, as there was limited evidence to indicate the antiquity of soil formation, and processes of soil erosion and/or deposition within the RHDA. Soils in the RHDA are generally aggrading and has this led to the burial and survival of the archaeological record. Geomorphological investigations (led by Tony Barham, Australian National University) in the Second Ponds Creek valley have provided the best indication of how that landscape may have changed over time (JMCD CHM 2005a).

Second Ponds Creek is a 2<sup>nd</sup> order stream, draining ridges and upper slopes on Bringelly Shale and lower slopes on Ashfield Shale. Quaternary alluvium occurs along the valley floor. The sediments at and around one site (RH/SP12 South) provide the following stratigraphic sequence. Basal stream gravels (ironstone) are present, which from their large size indicate a higher water flow than existed at any time during the Holocene. The deposition of these gravels has not been directly dated, and may have pre-dated Aboriginal occupation of the region. A terrace of fine sand, silt and clay was deposited on these gravels. Charcoal from a pond of a palaeochannel, which had filled with sediment, was dated to 8536±53BP (Wk-16231). This context indicates that fine sediments from the adjacent slopes were deposited along the valley floor, a stream of chain-of-ponds form developed, then sediment (and charcoal) continued to be deposited to fill the stream channel in the early Holocene. In turn, this indicates that sediments were eroded from adjacent slopes, probably towards the end of the late Pleistocene and into the early Holocene. The pond continued to be filled with sediments and an A horizon soil subsequently developed on this. The A horizon soil contains substantial archaeological evidence (RH/SP12 South). The oldest age determination for Aboriginal

occupation is dated to 3351±40BP (Wk-16227), indicating that the terrace surface had formed by this time. Only minimal sedimentation occurred on the terrace during the mid-to-late Holocene, suggesting reduced soil erosion from the adjacent hillslopes (JMCD CHM 2005a).

Some other evidence for change in sedimentation rates on lower slopes and terraces is available at other sites in the RHDA. At RH/SP13C on a lower slope, charcoal in sediment infill along a 1<sup>st</sup> order tributary is dated to 11,387±78 BP (Wk-16233), indicating sediment deposition towards the end of the late Pleistocene (JMCD CHM 2005a). On nearby Caddies and Smalls Creeks, at RH/CD7 and RH/SC5, sediments accumulated on lower slopes below sandstone benches (JMCD CHM 2002b, 2007). Sediments from these two sites contained stratified lithic assemblages which are technologically similar to late Pleistocene/early Holocene assemblages from the Parramatta sand body (JMCD CHM 2005c). At RH/CD7 and RH/SC5 sediments from higher slopes were deposited on lower slopes concurrent with late Pleistocene/early Holocene occupation. At RH/CC2 a terrace contained a similar lithic sequence (JMCD CHM 2005b). At this site the terrace was occupied by Aboriginal people, followed by renewed sedimentation, and then the terrace was reoccupied sometime in the mid-to-late Holocene. Geomorphic evidence suggests some slope instability during the late Pleistocene/early Holocene and increased slope stability within the last few thousand years.

Analysis of artefact distribution in this paper has found that artefact densities tend to be lower on upper slopes and higher on lower slopes and terraces. A possible explanation for this distribution is that sediments and artefacts could have been eroded from hillslopes and been redeposited on lower slopes. If this was the case, artefact distribution on hillslopes should have correlated with soil depth; shallow soils potentially being locations from which sediments and artefacts had been stripped, with deeper soils potentially being locations of sediment and artefact accumulation. Correlation analyses are conducted for two hill slope areas within the Second Ponds Creek valley – RH/SP13C from which the late Pleistocene age determination for stream fill was obtained, and RH/SP22 located on the slope above RH/SP12 South. These two sites show no correlation between artefact density and soil depth (RH/SP13C:  $\rho=+0.040$ ,  $n=42$ ; RH/SP22:  $\rho=+0.199$ ,  $n=33$ ), indicating that artefact density and distribution on hill slopes was not related simply to soil stripping or accumulation.

The available evidence suggests that the RHDA landscape has not been static and unchanging, but experienced changes in water flow, erosion and sedimentation during the late Pleistocene/early Holocene. Soils have tended to be aggrading across the RHDA during the last few thousand years or so. The aggrading nature of soils during the late Holocene (and in earlier times in some locations) means that much of the landscape is sufficiently stable to identify trends in Aboriginal occupation of the RHDA during the late Holocene. Creek flat landforms, which are by definition flood-affected, are possible exceptions to this statement.

In this study all reported archaeological samples are from areas which were targeted for their good potential for relatively intact archaeological deposit (PAD). Geomorphic considerations and aerial photograph interpretation were used as part of the selection criteria, and while many of these areas had been cleared

(pre-1947) none was known to have been cultivated. Many of the excavated areas had been assessed as worthy of conservation, but due to the various development scenarios, this was not possible and these areas were instead salvaged as mitigation against development impacts.

## Testing and Analysis Methods

All the test excavations discussed here were carried out by JMCD CHM (1999, 2002a, 2002b, 2004, 2005a, 2005b, 2006a, 2007, 2008). While attempts were made to sample representative landscape settings, the nature of consulting work and the extent and focus of modern land disturbance has meant that some landscape settings have been less well sampled. For all the projects considered here the same systematic test excavation methods were used, under the direction of JM, enabling direct comparison of the results. Areas were tested by excavation of 1m x 1m test squares at regular intervals on 15–20m grids; more closely spaced test squares are excluded from the present dataset. Excavated soils were wet sieved through 2mm or 3mm mesh: to account for minor variations in mesh, artefacts less than 5mm in size are excluded from the current data. All lithics recovered during these projects were analysed by one person (BW) and only those items which met technical criteria as artefacts are counted here (Baker 1996; Cotterell and Kamminga 1987; Holdaway and Stern 2004; Speth 1972). Heat shatters and non diagnostic items, often resulting from post-discard artefact breakage, are excluded from these discussions although these were recorded during the original studies. We did not more closely consider the issue of artefact breakage (Hiscock 2002) by converting the artefact counts into ‘minimum numbers of artefacts’ because the excavation of dispersed 1m x 1m test squares will have intercepted occasional artefacts from diverse lithic discard activities, rather than entire assemblages from individual flaking episodes. Open area excavations were undertaken at most of the tested locations, retrieving complete assemblages. These assemblages are not discussed here, as these focused on higher density locations and/or unusual artefact loci, which may not have been comparable in this current discussion of landscape.

The database used here consists of 4429 artefacts from 631 dispersed test squares, excavated at 19 sample areas, together with variables relating to stream order, distance from water, landform, aspect, geology and distance from known silcrete sources. Artefact distribution is analysed by considering the numbers of artefacts occurring in each test square. This is done by counting the number of (1m x 1m) test squares which each have 0 artefacts, 1–5 artefacts, 6–10 artefacts, 11–20 artefacts, 21–50 artefacts, 51–100 artefacts, and more than 100 artefacts (Table 1). For some analyses it was necessary to combine categories to provide statistically useful numbers of test squares. Chi-square tests of statistical significance were conducted on the numbers of test squares with specified artefact counts and the results are summarised (Table 2). We also calculated the range and mean of the artefact distribution for each analysis.

It should be noted that the testing methods provide an *indication* of artefact distribution in various landscape contexts, rather than an exact account, as open area excavations have shown that higher artefact densities occur in most landscapes. That is, dispersed testing does not indicate the full range of artefact densities which are present, but provides systematic samples of the general presence and distribution of artefacts.

## Results

Most of the test squares have few artefacts: one-third (36%) has no artefacts, and another third (35%) has only 1-5 artefacts (Table 1). Less than 1% of the test squares has more than 100 artefacts. Most of the test squares intercept low density and/or discontinuous artefact scatters.

### Stream Order

Water supply is often thought to be a significant factor influencing peoples' land-use strategies. Large and/or permanent water supplies may have supported large numbers of people and/or long periods of occupation while small and/or ephemeral water supplies may have been able to support only small numbers of people and/or transient occupation (e.g. Veth 1993). Stream order is used here to indicate water supply, given hydrological changes to the landscape as a result of modern land-use. The stream order method identifies the smallest tributary stream as 1<sup>st</sup> order, two 1<sup>st</sup> order streams join to form a 2<sup>nd</sup> order stream, two 2<sup>nd</sup> order streams join to form a 3<sup>rd</sup> order stream, two 3<sup>rd</sup> order streams join to form a 4<sup>th</sup> order stream, and so on (McDonald and Mitchell 1994, after Schrever 1966 and Strahler 1952).

Artefact distribution varies significantly with stream order (Tables 2-3). Two-thirds of test squares in 1<sup>st</sup> order landscapes have zero artefacts and the mean density is just 1 artefact/m<sup>2</sup>; 1<sup>st</sup> order landscapes have low average artefact density and sparse artefact distributions. 2<sup>nd</sup> and 4<sup>th</sup> order landscapes have fewer test squares with zero artefacts indicating more continuous artefact

distributions. 4<sup>th</sup> order landscapes have the highest proportion of higher density test squares. Mean artefact density is higher in 4<sup>th</sup> order landscapes (14 artefacts/m<sup>2</sup>) than in 2<sup>nd</sup> order landscapes (about 7 artefacts/m<sup>2</sup>). Too few test squares were excavated in 3<sup>rd</sup> order landscapes to make comparisons. As predicted, the data on artefact distribution and mean artefact density suggest that water supply was an important factor influencing Aboriginal land-use and habitation patterns in the RHDA.

### Landform

A fairly simple landform classification is utilised here, based loosely on McDonald *et al.* (1998). 'Creek flats' are flood plains with flat to very gently inclined surfaces, adjacent to streams. 'Terraces' are former flood plains but no longer frequently flooded and occur at higher elevations than flats. 'Ridges' occur at the tops of slopes, forming watersheds. 'Hill slopes' are roughly subdivided into lower, middle and upper to describe their relative position in valleys. Lower slopes comprise the lower third of slopes above valley floors, mid-slopes comprise the middle third of valley slopes between valley floors and ridge tops, and upper slopes comprise the upper third of slopes below ridge tops.

Artefact distribution varies significantly with landform (Table 2, Table 4). Mean artefact density is lowest on upper slopes and ridge tops, where nearly 75% of test squares have no artefacts. Artefact density tends to increase towards lower positions in valleys, with increasing densities on mid-slopes and lower slopes. Mean artefact density is highest on terraces,

**Table 1** Summary data on test squares and artefact distribution.

	Number of Artefacts in Each Test Square							Total Test Squares	Total Artefacts	Range	Mean
	0	1-5	6-10	11-20	21-50	51-100	>100				
# of Test Squares	230	224	66	53	43	10	5	631	4429	0-176	7
% Frequency Test Squares	36.4	35.5	10.5	8.4	6.8	1.6	0.8	100	-	-	-

**Table 2** Results of chi-square tests of significance.

Analysis	Table	Chi-square=	df=	Significance Level
Stream order	3	214.618	8	0.001
Landform	4	236.536	16	0.001
Lower slopes & stream order	5	77.917	8	0.001
Mid-slopes & stream order	6	0.398	2	Not significant
Distance from 1st order streams	7	1.635	2	Not significant
Distance from 2nd order streams	8	13.871	6	0.05
Distance from 4th order streams	9	17.444	8	0.05
Aspect on upper slopes 1st order streams	10	1.363	2	Not significant
Aspect on lower slopes 4th order streams	11	9.414	3	0.05
Distance from known silcrete sources	12	126.261	6	0.001
2nd order streams & distance from silcrete sources	13	0.922	3	Not significant

**Table 3** Artefact distribution in relation to stream order. Table shows numbers of test squares with specified numbers of artefacts.

Stream Order	Number of Artefacts in Each Test Square					Total Test Squares	Total Artefacts	Range Artefacts/ Test Square	Mean Artefacts/ Test Square
	0	1-5	6-10	11-20	>20				
1 <sup>st</sup>	175	78	4	2	-	259	179	0-17	0.7
2 <sup>nd</sup>	29	78	20	21	13	161	1,042	0-82	6.5
4 <sup>th</sup>	25	60	27	25	32	169	2,344	0-176	13.9

where fewer than 10% of test squares have no artefacts, and nearly one-third of test squares have more than 20 artefacts. Artefact densities tend to be fairly low on creek flats, with overall distribution similar to that on mid-slopes. As creek flats are flooded from time-to-time artefacts may have been lost by erosion, or these landforms may not have been preferred for occupation.

Sufficient test squares were excavated on lower and mid-slopes to be able to consider whether artefact distribution varies in relation to both landform and stream order in combination (Tables 5-6). Artefact distribution on lower slopes varies significantly with stream order but this is not the case for mid-slopes where artefact distribution is similar for both 2<sup>nd</sup> and 4<sup>th</sup> order streams. Artefact discard activities were increasingly concentrated on lower slopes as water supply increased in quantity and/or permanency. This increased concentration of activity in the lower parts of valleys is not translated into increased discard activity in the hillier landscapes surrounding larger streams.

### Distance from Water

Proximity to water was previously thought to be a primary determinant of site location on the Cumberland Plain (e.g. Smith 1989). Distance from water is considered here in relation to stream order.

In 1<sup>st</sup> order landscapes, there is no significant difference in artefact distribution with distance from water (Table 2, Table 7). In 2<sup>nd</sup> order landscapes, artefact density is highest within 50m of water and declines with increasing distance from water (Tables

2, 8). In 4<sup>th</sup> order landscapes, artefact density is highest 51–100m from water, lower closer to water and declines with increasing distance more than 100m from water (Tables 2, 9).

Previous studies on the Cumberland Plain indicated that 'sites' would be clustered within 50m of water (e.g. Smith 1989). The present analysis has shown that highest mean artefact density within 50m of water occurs only in relation to 2<sup>nd</sup> order streams; 51–100m from water may have been a more important distance for 4<sup>th</sup> order streams. There may have been various reasons why artefact discard activities were often conducted slightly further away from larger creeks – to allow animals to drink, to occupy elevated landforms which tended to occur further from water, to catch a cool breeze on a hot summer day etc. The clustering based on surface manifestations (Smith 1989) was most likely due to erosion and exposure of artefact-bearing sediments close to streams, where sheet wash and gullying exposed artefact bearing soils. The presence of surface exposures close to streams has thus biased the results of surface survey used for predictive modelling.

### Aspect

The orientation of open land surfaces may have influenced peoples' choices of artefact discard locations: north-facing slopes tend to be drier and provide shelter from colder southeast or southwest winds (Fletcher-Jones 1985:60-63). Slopes facing northeast receive morning sun in winter and are sheltered from hot afternoon sun in summer. While most previous investigations of aspect in Sydney focussed on rockshelter sites (Attenbrow 2004; Fletcher-Jones 1985; Hawthorne 1982) this

**Table 4** Artefact distribution in relation to landform. Table shows numbers of test squares.

Landform	Number of Artefacts in Each Test Square					Total Test Squares	Total Artefacts	Range Artefacts/ Test Square	Mean Artefacts/ Test Square
	0	1-5	6-10	11-20	>20				
Creek flat	12	24	9	3	1	49	188	0-21	3.8
Terrace	6	25	17	15	29	92	1911	0-165	20.8
Lower slope	63	84	29	31	23	230	1924	0-176	8.4
Mid-slope	24	47	10	4	5	90	346	0-35	3.8
Upper slope & ridge top	125	44	1	–	–	170	60	0-6	0.4

**Table 5** Artefact distribution on lower slopes in relation to stream order. Table shows numbers of test squares.

Landform	Stream Order	Number of Artefacts in Each Test Square					Total test Squares	Total Artefacts	Range Artefacts/ Test Square	Mean Artefacts/ Test Square
		0	1-5	6-10	11-20	>20				
Lower slope	1 <sup>st</sup>	50	34	3	2	–	89	119	0-17	1.3
	2 <sup>nd</sup>	7	25	7	12	5	56	423	0-33	7.6
	4 <sup>th</sup>	5	21	10	13	14	63	1116	0-176	17.7

**Table 6** Artefact distribution on mid-slopes in relation to stream order. Table shows numbers of test squares.

Landform	Stream Order	Number of Artefacts in Each Test Square			Total Test Squares	Total Artefacts	Range Artefacts/ Test Square	Mean Artefacts/ Test Square
		0	1-5	>5				
Mid-slope	2 <sup>nd</sup>	14	31	12	57	228	0-35	4.0
	4 <sup>th</sup>	10	16	7	33	118	0-22	3.6

level of choice is worth investigating for the Cumberland Plain, where the open woodland vegetation was described at contact as being ‘like an open parkland’ (Tench [1793] 1961).

The main streams in the RHDA drain northwards and much of the available land surface faces east, north and west. Consequently, the largest numbers of test squares have been excavated in landscapes facing east, northeast and west. None was excavated in areas facing south. To ascertain whether aspect might have influenced artefact discard activity it is necessary to control for stream order and landform as we have already demonstrated that these factors strongly influence artefact distribution. Suitable data are available only for upper slopes associated with 1<sup>st</sup> order streams and lower slopes associated with 4<sup>th</sup> order streams.

On lower slopes associated with 4<sup>th</sup> order streams artefact densities are higher on slopes facing north and northeast than on slopes facing west (Table 10). However, artefact distribution does not vary significantly with aspect on upper slopes (Table 2, Table 11). Additional testing of various landscape settings will be useful to investigate the influence of aspect on artefact discard (e.g. 2<sup>nd</sup> order landscapes facing west). The available data suggest that aspect may have had some influence on the location of artefact discard activities in the lower parts of valleys, such as the siting of residential occupation to take advantage of consistent factors such as rising and setting sun and dominant wind direction. In upper valley landscapes peoples’ choices of locations for artefact discard activities may have been influenced more by day-to-day variations in weather conditions, personal preferences, access to resources etc.

**Geology**

Geology defines landforms and drainage, influences habitat formation and provides different resources, such as sandstone

suitable for grinding, and diversity of plant resources. Surface geology also provides the sediments and geochemical environments which allow the preservation of lithic artefacts (JMcD CHM 2007). Within the RHDA, the Wianamatta group of shales forms an undulating topography, and overlies Hawkesbury sandstone which is exposed on some lower slopes and along larger streams as platforms, low ledges, boulders and (rarely) rockshelters.

To assess the influence of geology on artefact distribution sufficient numbers of test squares sampling differing geologies are needed in otherwise similar landscape settings. Unfortunately all 4<sup>th</sup> order stream samples have been located on the sandstone-shale interface, while no 2<sup>nd</sup> order streams, and only one 1<sup>st</sup> order stream, on the sandstone-shale interface have been sampled. The single 1<sup>st</sup> order sample on a lower slope on the sandstone-shale interface has a mean density of 3 artefacts/m<sup>2</sup> which is higher than the mean density of 1 artefacts/m<sup>2</sup> for lower slopes on shale associated with 1<sup>st</sup> order streams. Additional testing is needed to investigate the influence of geology on artefact discard.

**Distance to Silcrete Sources**

Silcrete is the predominant artefact lithology in the RHDA, with silicified tuff predominant in only a few stratigraphically deeper assemblages which are technologically similar to late Pleistocene or early Holocene assemblages from Parramatta (JMcD CHM 2005b, 2005c, 2007). Natural sources of usable silcrete occur in the Colebee Release area at Plumpton Ridge (JMcD CHM 2006b) and near Crown Street, Riverstone (Corkill 1999), west and northwest respectively of the RHDA. Numerous studies elsewhere have shown the effects of increasing distance from stone sources on attributes of lithic assemblages, as people used various strategies to conserve available lithic supplies when distant from quarries – ‘distance-decay’ theory (e.g. Barry

**Table 7** Artefact distribution with distance from 1<sup>st</sup> order streams. Table shows numbers of test squares.

Stream Order	Distance from Water (m)	Number of Artefacts in Each Test Square		Total Test Squares	Total Artefacts	Range Artefacts/ Test Square	Mean Artefacts/ Test Square
		0	1-17				
1 <sup>st</sup>	<50	61	29	90	63	0-10	0.7
	51-100	65	37	102	96	0-17	0.9
	>100	49	18	67	20	0-3	0.3

**Table 8** Artefact distribution with distance from 2<sup>nd</sup> order streams. Table shows numbers of test squares.

Stream Order	Distance from Water (m)	Number of Artefacts in Each Test Square				Total Test Squares	Total Artefacts	Range Artefacts/ Test Square	Mean Artefacts/ Test Square
		0	1-5	6-10	>10				
2 <sup>nd</sup>	<50	5	15	6	15	41	449	0-82	11.0
	51-100	8	31	7	13	59	356	0-28	6.0
	>100	16	32	7	6	61	237	0-35	3.9

**Table 9** Artefact distribution with distance from 4<sup>th</sup> order streams. Table shows numbers of test squares.

Stream Order	Distance from Water (m)	Number of Artefacts in Each Test Square					Total Test Squares	Total Artefacts	Range Artefacts/ Test Square	Mean Artefacts/ Test Square
		0	1-5	6-10	11-20	>20				
4 <sup>th</sup>	<50	6	20	14	10	7	57	549	0-64	9.6
	51-100	5	14	6	10	15	50	1,290	0-176	25.8
	>100	14	26	7	5	10	62	252	0-86	13.3

2005; Byrne 1980; McNiven 1993). One conservation strategy could have been to discard fewer artefacts, therefore resulting in lower artefact densities with increasing distance from known lithic sources.

In the RHDA the current analyses show that artefact discard tended to increase with increasing distance from known silcrete sources – the opposite trend to that predicted by ‘distance-decay’ theory (Table 12). In the RHDA, the hydrology is such that larger streams are more distant from silcrete sources than some smaller streams. Thus, most of the test squares associated with 4<sup>th</sup> order streams are 6km or more from known silcrete sources, while most of the test squares associated with 1<sup>st</sup> and 2<sup>nd</sup> order streams are closer to known silcrete sources. Sufficient numbers of test squares for analysis were excavated in areas associated with 2<sup>nd</sup> order streams 4km to 5km and 5km to 6km from known silcrete sources (Table 13). The more distant sample has a slightly lower mean density than the closer sample but the difference is not statistically significant (Table 2). It appears that distance to known silcrete sources had little influence on artefact discard rates over the distances considered here; or that other closer silcrete sources were used which have not yet been identified.

#### Variation between Tested Areas

The above analyses describe general trends relating artefact distribution to landscape variables. However, some tested areas

with similar landscape settings have higher artefact densities than others (Figure 3). RH/CC2 has the highest mean artefact density, and most test squares have moderate and high artefact densities, unmatched by any other sample considered here. This terrace location may have been favoured for its association with a large stream (4<sup>th</sup> order), at the sandstone-shale interface which may have provided more diverse resources. Long-term occupation and favourable geomorphic processes may also have contributed to high artefact densities, as the deposits here retain stratified evidence of an early assemblage dominated by silicified tuff overlain by a more recent assemblage dominated by silcrete. Conversely, the lower slope sample from RH/CD7 has similar stratified features but has a lower artefact density. There may have been some landscape factors critical to artefact density and distribution that we have not yet identified, or particular places may have been favoured for other social, religious or traditional reasons.

Other notable samples with relatively high artefact densities also occur on the lower slopes of RH/SP9 and RH/CD5 and on terraces at RH/CD12 and RH/SP12 South. The lower slopes at RH/SP9 and RH/CD5 would have provided elevated land surfaces with northerly and northeasterly aspects. The terrace at RH/SP12 South would also have been sheltered by the hill to the west. RH/CD12 was located adjacent to an extensive area of alluvium which may have included permanent water holes and swamp habitats.

**Table 10** Artefact distribution with aspect on lower slopes associated with 4<sup>th</sup> order streams. Table shows numbers of test squares.

Stream Order	Aspect on Lower Slopes	Number of Artefacts in Each Test Square				Total Test Squares	Total Artefacts	Range Artefacts/ Test Square	Mean Artefacts/ Test Square
		0-5	6-10	11-20	>20				
4 <sup>th</sup>	North & Northeast	10	1	5	10	26	668	0-176	25.7
	West	16	9	8	4	37	448	0-86	12.1

**Table 11** Artefact distribution with aspect on upper slopes associated with 1<sup>st</sup> order streams. Table shows numbers of test squares.

Stream Order	Aspect on Upper Slopes	Number of Artefacts in Each Test Square		Total Test Squares	Total Artefacts	Range Artefacts/ Test Square	Mean Artefacts/ Test Square
		0	1-6				
1 <sup>st</sup>	Northeast	20	11	31	12	0-2	0.4
	Northwest	59	20	79	24	0-3	0.3
	West	13	5	18	11	0-6	0.6

**Table 12** Artefact distribution with distance from known silcrete sources. Table shows numbers of test squares.

Distance to Known Silcrete Sources	Number of Artefacts in Each Test Square			Total Test Squares	Total Artefacts	Range Artefacts/ Test Square	Mean Artefacts/ Test Square
	0	1-5	>5				
4-5km	23	25	17	65	381	0-82	5.9
5-6km	179	128	48	355	1081	0-140	3.0
6-7km	23	63	92	178	2234	0-176	12.6
>7km	5	8	20	33	733	0-165	22.2

**Table 13** Artefact distribution in 2<sup>nd</sup> order landscapes with distance from known silcrete sources. Table shows numbers of test squares.

Stream Order	Distance to Known Silcrete Sources	Number of Artefacts in Each Test Square				Total Test Squares	Total Artefacts	Range Artefacts/ Test Square	Mean Artefacts/ Test Square
		0	1-5	6-10	>10				
2 <sup>nd</sup>	4-5km	10	21	5	11	47	370	0-82	7.9
	5-6km	19	57	15	23	114	672	0-35	5.9

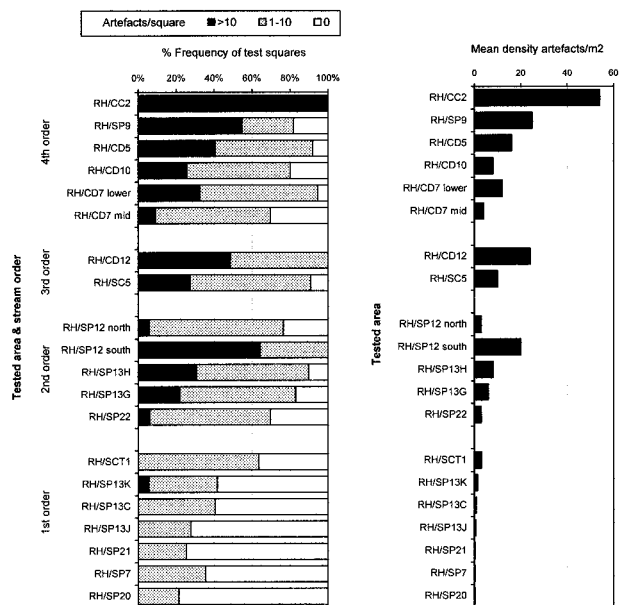


Figure 3 Artefact distribution and mean density at tested areas.

For 1<sup>st</sup> order streams, RH/SCT1 has a relatively high mean artefact density and fewer empty test squares than other 1<sup>st</sup> order samples. More numerous artefact discard activities may have been carried out here because of this area’s location on a lower slope, with a northeasterly aspect and presence of sandstone-shale interface.

Discussion

The present analyses indicate that stream order and landform were important factors influencing artefact density and distribution, and consequently how Aboriginal people utilised the Rouse Hill landscape. The analyses supported Smith’s (1989) general predictions in that artefacts are found on all topographic units and areas associated with larger streams tend to have higher artefact densities than do smaller streams. However, landform also strongly influenced artefact distribution, and in some landscape settings artefact density is highest 50–100m from water. Contrary to earlier occupation models, creek flats have fairly low artefact densities, possibly because they were low-lying and less well-drained and/or because flooding may have removed some artefacts. Artefacts were found in all tested areas and most of the RHDA could be regarded as an extensive cultural landscape, exhibiting variation in artefact density and distribution.

Factors influencing artefact density include (1) stream order, with higher order streams tending to have higher artefact densities and more continuous distributions than lower order streams; (2) landform, with higher densities occurring on terraces and lower slopes, and with sparse discontinuous scatters on upper slopes; (3) aspect on lower slopes associated with larger streams, with higher artefact densities occurring on landscapes facing north and northeast; and (4) distance from water, with higher artefact densities occurring 51–100m from 4<sup>th</sup> order streams, and within 50m of 2<sup>nd</sup> order streams. Proximity to the sandstone-shale interface may have influenced artefact distribution and density but this cannot be assessed with the available data. Distance from known silcrete sources does not appear to have influenced artefact distribution. The identified trends indicate that people

preferred slightly elevated, well-drained locations in the lower parts of valleys; such locations would have been drier, received winter sun and been sheltered from southerly and southwesterly winds. Locations away from immediate creek banks may have been preferred because they were elevated and well-drained, to avoid mosquitoes, to allow animals to drink, and/or to accommodate the spatial requirements of residential groups allowing all members access to water (Koettig 1976).

Most 1<sup>st</sup> order landscapes have very low mean artefact densities, a predominance of test squares with zero artefact counts, and test squares with more than 10 artefacts are rare. The available data indicate that distance from water and aspect does not affect artefact distribution here. Open area excavations in 1<sup>st</sup> order landscapes revealed activity locations with higher artefact counts (62 artefacts/m<sup>2</sup> on RH/SP13K), but such artefact densities appear to be uncommon.

Most 2<sup>nd</sup> and higher order landscapes have higher artefact densities, higher maximum densities and more continuous artefact distributions (fewer test squares with zero counts), suggesting a threshold between 1<sup>st</sup> order landscapes and those associated with more reliable streams. It is notable that mid-slopes (the middle third of valley slopes between valley floor and ridge top) associated with 2<sup>nd</sup> and higher order streams have higher artefact densities and more continuous distributions than any of the 1<sup>st</sup> order landscapes considered here (compare Tables 5 and 6). To the extent that ‘types’ of archaeological landscapes could be distinguished, it would seem that landscapes associated with ephemeral water supplies could be distinguished from landscapes associated with more substantial and/or permanent water supply (i.e. higher order streams).

While these analyses reveal general trends in landscape use, there are individual areas which vary from these, having either exceptionally high or low artefact densities; for example, the terraces associated with a 4<sup>th</sup> order stream at RH/CD5 and RH/CD10 have much lower artefact densities than the terrace at RH/CC2. Other factors which we have not yet identified, and which are archaeologically difficult to ascertain such as family tradition or personal preferences, may also have influenced the selection of particular places for artefact discard.

In the RHDA the artefact distributions do not form bounded sites but landscapes have higher and lower densities relative to landscape variables and to other (as yet untested) factors. The unbounded nature of most archaeological distributions has previously been noted by Foley (1981), Bruck and Goodman (1999) and van Dommelen (1999). In their review of settlement archaeology Bruck and Goodman (1999) note that because ‘sites’ were not bounded entities they could not be distinguished from the landscape around them or from other types of sites within that landscape. They point out that different kinds of activity, such as domestic tasks or tool production, might have been carried out in many different contexts and in different landscape settings, not confined to residential bases or industrial areas. They also point out that cosmological beliefs and social meanings may have influenced site selection along with the distributions of economic or other resources (Bruck and Goodman 1999).

Foley (1981) predicts that archaeological materials should be spatially ‘continuous’ across landscapes, with variations in artefact density. He suggests that such distributions should arise because of the long-term accumulation of artefacts from human activities,

which were conducted in many different locations across a home-range with unevenly distributed resources, and as affected by post-discard processes. Foley acknowledges that ethnographic studies of hunter-gatherers indicate some variety in site types across any home-range, potentially including residential bases, peripheral activity areas, transitory camps, look-out points and so on (e.g. Binford 1980). But over long periods of time, residential mobility and variety in the placement of activities would have led to residential bases and other activity areas being sited in many different locations across a large area (Foley 1981).

Artefact distribution in the RHDA may have resulted from such a variety of factors. There are definable trends relating to water supply, landform, distance from water and aspect. But artefacts, sometimes as sparse distributions, occur in many locations and the entire landscape appears to have been cultural. High density artefact concentrations, which may have been related to intensive backed artefact production, also occur in many different landscape settings in relation to 2<sup>nd</sup> and higher order streams.

We conclude that the entire RHDA was a cultural landscape, that different kinds of lithic activities were conducted across it, and that some locations were particularly favoured for artefact discard. This resulted in low and moderate density scatters, varying in their continuity or sparseness, and with occasional high density concentrations which also varied in their size and frequency. Trends in artefact density and distribution indicate large-scale and long-term patterns in the use of this cultural landscape. Short-term models of settlement organisation that incorporated terms such as 'residential base' or 'transitory camp' were not sufficient to account for these artefact distributions.

As a result of the large-scale testing carried out using a consistent methodology we have a systematic dataset which allows objective measurement and comparison of artefact density and distribution within the RHDA. This study has not been affected by the range of taphonomic factors which affect the study of spatial and chronological site distribution in eroded landscapes (e.g. Holdaway *et al.* 1998), since the data are retrieved from relatively intact soil horizons. Future studies may be able to assess the influence of lithic outcrops, unusual habitats or high areas with good views, by comparing newly tested areas with the RHDA data. It would also be possible to conduct regional studies of artefact density and distribution by comparing the RHDA data with other parts of the Cumberland Plain and beyond.

### Management Implications

Artefacts were found in all tested areas, in landscapes which have been assessed as 'PADs', being areas with good to high potential for intact archaeological deposits (cf. Corkill 2007; Czastka 2007; McDonald 2007). A paradigm shift in the State's management regime may be appropriate, to afford automatic protection to landscapes defined as PADs until it is demonstrated that artefacts are absent or that lands are too disturbed to warrant heritage intervention.

Several kinds of landscape settings within the RHDA have not as yet been well sampled; being 3<sup>rd</sup> order streams generally, westerly and southerly aspects, upper slopes in relation to 2<sup>nd</sup> and higher order streams, and ridge tops. These landscapes should be targeted for future investigation as the opportunities arise.

Riparian corridors 40m wide are often incorporated into development designs, providing opportunities for heritage

conservation. While our analyses indicate that artefacts are likely to be present within these riparian corridors, most of the region's archaeology is located beyond these ecologically defined 'conservation outcomes'. Analysis of RHDA data suggests that artefact distributions within different project areas need to be considered early in the planning stage of new development proposals, in conjunction with previous land-use impact assessment (McDonald 1996), to assist in identifying archaeologically significant landscapes which should be set aside for conservation. While such predictions would still need to be ground-truthed by excavation, the early opportunity to flag more sensitive areas should improve heritage management outcomes.

A methodological implication of these findings is that archaeological excavation carried out to detect and assess archaeological materials, needs to employ methods at a sufficiently large-scale to address the potential for diversity in artefact distributions.

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