APPENDIX 1

STATUTORY AND POLICY CONTEXT

Environmental Protection and Biodiversity Conservation Act 1999

The scope and coverage of the Act is wide and far-reaching. The objectives of the Act include: the protection of the environment, especially those aspects of national significance; to promote the conservation of biodiversity and ecologically sustainable development; and to recognise the role of indigenous people and their knowledge in realising these aims.

The Act makes it a criminal offence to undertake actions having a significant impact on any matter of national environmental significance (NES) without the approval of the Environment Minister. Actions which have, may have or are likely to have a relevant impact on a matter of NES may be taken only:

- In accordance with an assessment bilateral agreement (which may accredit a State approval process) or a declaration (which may accredit another Commonwealth approval process); and

- With the approval of the Environment Minister under Part 9 of the Act. An action that requires this Commonwealth approval is called a 'controlled action'.

Matters of national environmental significance (NES) are defined as:

- A place listed on the National Heritage List;

- World heritage values within declared World Heritage Properties (section 12(1));

- Ramsar wetlands of international importance (s16(1));

- Nationally threatened species and communities (s18);

- Migratory species protected under international agreements (s20);

- Nuclear actions;

- The Commonwealth marine environment (generally outside 3 nautical miles from the coast) (s23(1&2));

- Any additional matters specified by regulation (following consultation with the States) (s25); and

- Commonwealth action (s28).

In addition, the Act makes it a criminal offence to take on Commonwealth land an action that has, will have, or is likely to have a significant impact on the environment (section 26(1)). A similar prohibition (without approval) operates in respect of actions taken outside of Commonwealth land, if it has, or is likely to have a significant impact on the environment on Commonwealth land (s26(2)). Section 28, in general, requires that the Commonwealth (or its agencies) must gain approval (unless otherwise excluded from this provision), prior to conducting actions which has, will, or is likely to have a significant impact on the environment inside or outside the Australian jurisdiction.

The Act adopts a broad definition of the environment that is inclusive of cultural heritage values. In particular, the 'environment' is defined to include the social, economic and cultural aspects of ecosystems, natural and physical resources, and the qualities and characteristics of locations; places and areas (s528).

The Act allows for several means by which a controlled action can be assessed, including an accredited assessment process, a public environment report, an environmental impact statement, and a public inquiry (Part 8).

Section 68 imposes an obligation on a proponent proposing to take an action that it considers to be a controlled action, to refer it to the Environment Minister for approval.

As the Moorebank IMT project has the potential to impact matters of NES under the EPBC Act, the proposed action was referred to and accepted by SEWPaC as a controlled action, to be assessed by preparation of an Environmental Impact Statement (EIS). SEWPaC released guidelines for the content of a draft EIS for this project (2011/6086), which require the EIS to meet the following in relation to heritage:

- identify, describe and map places or items of indigenous cultural value; and
- describe the impacts the proposed action would have on indigenous cultural values including the continuing practice of traditional beliefs and access to sites.

Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and its regulations, schedules and associated guidelines require that environmental impacts are considered in land use planning and decision making. Environmental impacts include cultural heritage assessment. Division 4.1 of Part 4 of the EP&A Act establishes an assessment and approval regime for projects deemed to be State Significant Development (SSD). Division 4.1 applies to development that is considered to be SSD by either a State Environmental Planning Policy (SEPP) or a Ministerial Order published in the Government Gazette (under Section 89C of the EP&A Act).

Under Section 89D of the EP&A Act, the Minister is the consent authority for SSD. Section 23 of the EP&A Act enables the Minister to delegate the consent authority function to the Planning Assessment Commission, the Director-General or to any

APPENDIX 2

DETAILED METHODOLOGY

Research Design and Proposed Methodology

Archaeological Test Excavation Program Aboriginal Heritage

Moorebank Intermodal Terminal

Navin Officer Heritage Consultants *11 October 2012*

The Purpose of this Submission

The purpose of this document is to provide to registered Aboriginal parties, for review and comment, a research design and proposed methodology for the conduct of archaeological subsurface testing at two Aboriginal archaeological sites (MA1 & MA5), three potential archaeological deposits (PAD1, PAD2 and MPAD1) and three sample areas within landforms of differing predicted archaeological sensitivity, all within the Moorebank Defence precinct.

The review forms part of the Aboriginal consultation procedure required by the NSW Office of Environment and Heritage (OEH) (DEC 2005, DECCW 2010). In addition, the Director General's Environmental Assessment Requirements for the Moorebank Intermodal Terminal project (SSD – 5066) specify that the research designs and methodologies proposed for any physical archaeological works to be undertaken as part of initial heritage assessments should be reviewed by: the Department of Planning and Infrastructure (DP&I), the Office of Environment and Heritage (Environmental Protection Authority), and the Heritage Council of New South Wales. This submission is made on behalf of the Moorebank Project Office and the Commonwealth Government (Department of Finance and Deregulation).

Registered Aboriginal parties were invited to provide comments and suggestions back to NOHC or Parsons Brinckerhoff by Thursday 11th October 2012. Four written responses were received during the review period and a site meeting was held on 26th September with the registered Aboriginal parties to discuss the project and the proposed excavation methodology. No requests for changes to the methodology have been received as the result of this consultation process. No changes were made to this methodology following the consultation with the registered Aboriginal parties.

Background to Submission

In May 2010 the Australian Government tasked the Department of Finance and Deregulation to conduct a Feasibility Study into the potential development of an intermodal terminal (IMT) at Moorebank in south western Sydney. The IMT site is currently occupied by the Department of Defence including the School of Military Engineering (SME) to the west of Moorebank Avenue. The Government has determined that SME will relocate to new purpose-built facilities at the nearby Holsworthy Barracks with the move complete by the end of 2014.

Navin Officer Heritage Consultants Pty Ltd (NOHC) was commissioned in 2010 by Parsons Brinckerhoff to undertake a cultural heritage assessment for the Moorebank Defence precinct on behalf of the Commonwealth Government (Department of Finance and Deregulation).

The results of interim heritage studies conducted to date, including the results of surface archaeological field survey (conducted in 2010) and a review of potential development constraints, have been documented in two preliminary reports:

- A scoping report which presented a summary of known and potential constraints based on a desktop review (NOHC 2011); and
- A report on existing Aboriginal and European Heritage (CDFD Aug 2011) which supported a Preliminary Project Environmental Overview (CDFD 2011)

  There are currently site access restrictions in place on the Liverpool City Council (LCC) land which have prevented field survey, however a desktop assessment has been undertaken of the LCC land.

Aboriginal participation and consultation conducted to date includes the registration of Aboriginal parties, the preparation and review of an archaeological survey methodology, and the field survey participation of representatives from two selected registered Aboriginal parties. The assessment of site significance in the preliminary reports has been limited to scientific criteria, pending the continuation of the Aboriginal consultation program for the EIS assessment.

An outline of Aboriginal consultation and participation to date is provided in Attachment A.

In April 2012 the Australian Government committed to development of the Moorebank Intermodal Terminal (IMT) Project after reviewing the findings of a detailed business case for the facility (CDFD Feb. 2012). The project is subject to planning approval with an Environmental Impact Statement due to be displayed late in 2012 to enable public feedback. Both Federal and NSW planning approval are being sought.

The Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) has determined that Moorebank IMT Project is a Controlled Action requiring the development of an EIS for assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).* The Commonwealth has lodged a submission under the EPBC Act and elected to make a submission under Part 4.1 of the New South Wales *Environmental Planning and Assessment Act 1979* (EP&A Act). Pursuant to the provisions of S 83(B) of the EP&A Act, a staged development application is proposed. This application is for a Stage 1 development application for the entire IMT. A staged development application sets out the concept proposals for the development of a site for which detailed proposals for separate parts of the site are to be the subject of subsequent development applications.

In February 2012, the NSW Department of Planning and Infrastructure (DPI) issued Director General's Requirements (DGRs) that are the State equivalent of the SEWPaC requirements.

The DGRs state that the EIS must include an assessment of impacts on Aboriginal heritage. Where impacts to Aboriginal heritage are identified the assessment shall:

- Outline the proposed mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the measures) generally consistent with the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC 2005);

- Be undertaken by a suitably qualified heritage consultant(s);
- Demonstrate effective consultation with Aboriginal communities in determining and assessing impacts and developing and selecting options and mitigation measures (including the final proposed measures); and
- Demonstrate that an appropriate archaeological assessment methodology, including research design (where relevant), has been undertaken to guide physical archaeological test excavations of areas of potential archaeological deposits. The full spatial extent and significance of any archaeological evidence shall be established and results of excavations are to be included.

The NOHC 2010 field survey program identified eight Aboriginal sites (MA1 – 8), one potential archaeological deposit (MAPAD1), and three sensitive landform zones within the project area.

The potential archaeological deposit (MAPAD1) consists of the banks and surrounds of a natural lake basin, now probably overlain with fill. The three archaeologically sensitive landforms are defined as the riparian corridor of the Georges River, the riparian corridors of tributary drainage lines (each consisting of 100m either side of the banks), and the edge and upslope fringing 100m of a continuous Tertiary aged terrace formation.

The recorded sites consist of three isolated surface artefacts (MA1, 2 & 3), two surface artefact scatters, each with three visible artefacts (MA4 & 5), and three scarred trees with a possible Aboriginal origin (MA6, 7 & 8). The 'possible' status of the tree scarring is based on an assessment that a natural or European origin is considered to be at least equally possible based on the scar characteristics. Pertinent to this assessment is the long history of European military activity across the area which could also have caused tree scars.

In 2011, Archaeological & Heritage Management Solutions Pty Ltd (AHMS) conducted an archaeological assessment of a proposed rail corridor situated across the far southern portion of the Moorebank IMT project area, for the Sydney Intermodal Terminal Alliance (AHMS 2012). This assessment recorded two surface Aboriginal stone artefacts in the general area of site MA1 (artefacts 5 & 6), and defined two potential archaeological deposits which roughly correspond to relevant portions of the sensitive terrace and riparian landforms identified in the NOHC survey.

The sites, PADs and areas of sensitivity, identified in the 2011 NOHC and 2012 AHMS assessments form the subject of this test excavation proposal. This further phase of investigation and assessment is required to determine the nature and significance of potentially occurring subsurface archaeological deposits, and allow for effective consultation with the Aboriginal community. This will form part of the cultural heritage component of the forthcoming Environmental Impact Statement for the Moorebank IMT project. The conduct and results of the investigation will be documented in the EIS report.

In preparing this methodology, ongoing consultation has occurred between the project team (comprising the Department of Finance and Deregulation (the proponent), environmental consultants Parsons Brinckerhoff and NOHC), DPI and the NSW Office of Environment and Heritage. Following this consultation, this methodology has been drafted, and proposes the following approach and assumptions to the investigations:

- A combination of mechanical and hand excavation techniques would be undertaken, provided that areas of predicted high archaeological potential be excavated, at least in the first instance, by hand;
- A flexible field methodology, allowing for modification of excavation techniques and the number and placement of pits is preferable to a rigid or prescriptive methodology[1].
- Mechanical excavation would be an acceptable means of removing fill that overlies suspected or known archaeological deposits;
- Mechanical excavation in areas of predicted low archaeological potential would be acceptable provided that test results are continuously monitored and a change to by-hand excavation would be triggered in the event that significant[2] archaeological deposits are encountered;

- Mechanical excavation would also be an allowable means of inspecting deposits at depth where:
    - It is thought possible that archaeological deposits could occur below a depth at which the conduct of by-hand excavation would be unsafe;
    - information is sought on the nature and extent of deposits below clay (this should only be undertaken at representative pit locations where there is no evidence of significant archaeological deposits in the upper layers;
- Not all Aboriginal sites or landforms necessarily need to be tested. Testing should focus on representative locations and areas of lesser disturbance;
- It would be useful to give consideration to testing, at least one area of predicted low archaeological potential, in an area of minimal or lesser disturbance;
- The size and spacing of test pits needs to achieve a balance between site disturbance through excavation and information recovery at a level commensurate with the excavation aims;
- 0.5 x 1.0 m pits at a spacing of 25 m would be acceptable provided that there is provision for the conduct of additional pits at closer intervals if further information is necessary to address research questions at a given site; and

The Moorebank IMT Project Area

The Project site is Commonwealth-owned land currently occupied by the Department of Defence (Figure 1). It is approximately 220 hectares in size, located within the suburb of Moorebank within the City of Liverpool Local Government Area approximately 30 kilometres south-west of the Sydney Central Business District. The Project site is generally defined as the land bounded by the Georges River to the west, Moorebank Avenue to the east, the M5 Motorway and ABB Medium Voltage Production facility to the north and the East Hills Railway line to the south.

The Project requires additional supporting infrastructure external to the Project site including the development of a rail crossing of the Georges River connecting to the Southern Sydney Freight Line (SSFL). This infrastructure would require some development on land currently owned by Liverpool City Council.

A Staged Assessment Process

> This methodology deals primarily with the Commonwealth owned land portion of the project site. As mentioned there are currently site access restrictions in place on the LCC land which have prevented field survey.

It is proposed that the current EIS and planning approval application (Stage 1) will focus primarily on detailed assessments on the Commonwealth owned land and that subsequent staged applications will address the LCC land in greater detail.

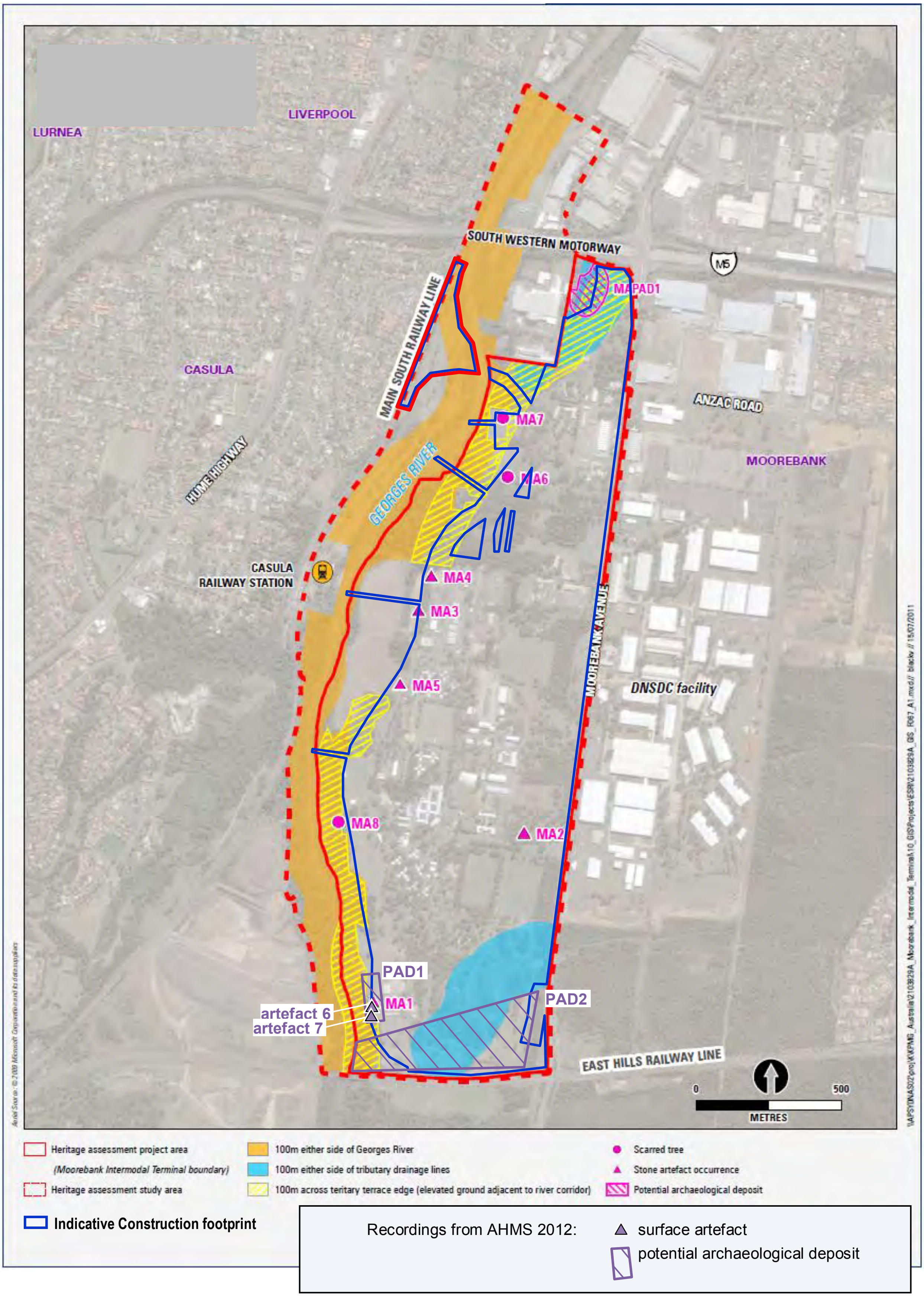


Figure 1 Location of all Aboriginal heritage recordings (pink and purple) and areas of archaeological sensitivity (yellow hatch, orange and blue shading) within the project area (red outline), relative to indicative construction footprint of the development (blue outline) (after Figure 4.1 in CDFD Aug 2011, p29). Note that the areas of archaeological sensitivity do not include areas of major landsurface disturbance, as indicated by past or present vegetation clearance and building development (refer also Figure 18).

Heritage Recordings and those Selected for Test Excavation

Eight Aboriginal archaeological sites have been recorded in the Moorebank IMT project area. These consist of five artefact occurrences, and three scarred trees of possible Aboriginal origin. Of the five artefact occurrences, three occur in highly disturbed contexts and do not provide effective contexts for a test excavation program (MA2, 3, & 4). The remaining two sites (MA1 and MA5) have been selected for test excavation. In addition, all identified potential archaeological deposits (PADs) will be subject to testing (MAPAD1, PAD1 and PAD2), and the predicted archaeological sensitivity of the differing landforms across the project area will be tested in three representative sample areas. This section provides a description of all the artefact occurrences, the PADs and the sensitive landform categories.

The location of all recordings, relative to the indicative construction footprint of the Moorebank IMT development is shown in Figure 1.

Site MA1 (including ‘Artefact 5’ and ‘Artefact 6’ (AHMS 2012))

Map Grid Reference: 307309.624002 (GDA)

This recording consists of three surface artefacts recorded on or adjacent to an approximately 90m interval of roadway. The roadway runs parallel to the edge of an elevated terrace formation. One artefact was recorded in 2010 (NOHC 2011) and two further artefacts were recorded in 2011 (AHMS 2012).

The first recording was a single surface artefact in 2010, exposed on the shoulder of a road and situated on the edge of an elevated terrace (around 3-5m high), adjacent to the entrance to the Initial Employment Training Squadron building. The area was noted to be extensively disturbed by earth works, importation of fill and gravel, and the installation of underground services. The incidence of ground surface exposures was around 5%, with visibility in the exposures around 40%.

The artefact was a microblade core and displayed an area of adhering cement to its surface. It was considered possible that the item had been imported to its current location within building materials or fill.

1. Banded grey-brown fine grained metamorphic sedimentary rock, microblade core, 21 x 19 x 12mm

Figure 2 MA1 looking north, in 2010 (artefact by foreground bag)

Two further artefacts were recorded in this location by AHMS in 2011 (AHMS 2012:87):

Artefact 5. Consisted of a red silcrete possible flaked piece, found on a sandy exposure, west of the road in survey Transect 3;

Artefact 6. Consisted of a poor quality grey chert/silcrete possible medial flake, fond on a sandy exposure, west of the road in survey Transect 3.

Transect 3 of the AHMS survey consisted of an area of 1.4 hectares, with 98 to 10% exposure visibility and an effective coverage of 10% (AHMS 2012:84). Based on the artefact finds and the landform type, AHMS identified a potential archaeological deposit on the terrace surface in the area of the finds (PAD1).

This PAD recording corresponds to the Tertiary terrace archaeologically sensitive landform identified in NOHC (2011).

MA2

Map Grid Reference: 307826.6240593 (GDA)

This recording consists of a single artefact situated in a shallow scald within mown grass north of entry gates and inspection post in SME. The area has been previously subject to vegetation clearance, agricultural development, grading, soil removal and construction of surface drainage.

The incidence of ground surface exposures was around 20%, with visibility in the exposures around 25%

This is a possible artefact (use fragment), with most surfaces displaying natural fractures, with the exception of one possible platform edge with bifacial flaking.

1. Banded grey fine grained metamorphic sedimentary rock, possible artefact, 31 x 32 x 13mm

Figure 3 MA2 looking south-east

Figure 4 Possible artefact at MA2 (side view)

Figure 5 Possible artefact at MA2 (other side view)

Figure 6 Possible artefact at MA2 (edge view)

MA3

Map Grid Reference: 307456.6241375 (GDA)

This recording consist of a lone artefact located at the base of the cut and graded tertiary terrace edge and is approximately 300m south of MA 4. The area has been extensively disturbed from Defence related earthworks and excavations.

The incidence of ground surface exposures was around 95%, with visibility in the exposures around 85%

Many introduced gravels are present in the vicinity of the artefact, above and upslope of which lies a narrow vegetated margin of original soil with archaeological potential.

1. Banded grey-grey green rhyolite multi-platform core, at least 4 platforms, 5% cortex, 40 x 28 x 13mm

Figure 7 MA3 looking south-east

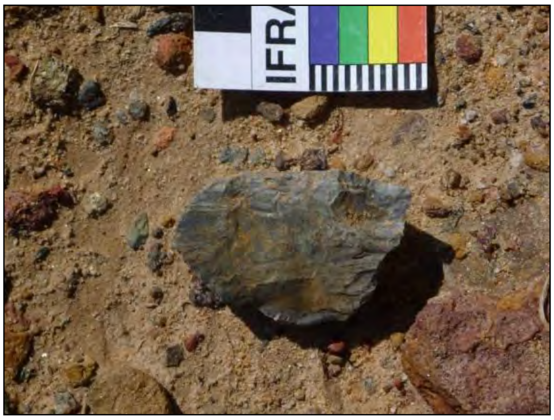


Figure 8 Artefact at MA3 (side view)

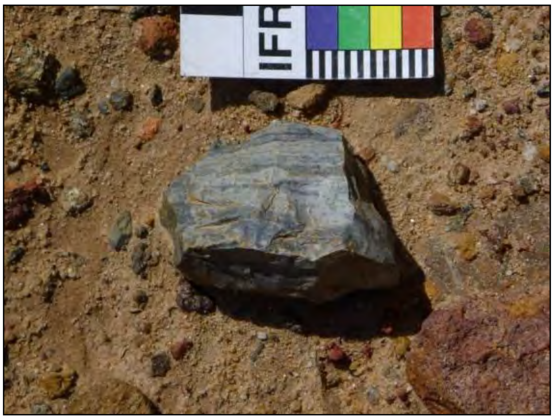


Figure 9 Artefact at MA3 (other side view)

MA4

Map Grid Reference: 307489.6241489 (GDA)

This recording is a low density artefact scatter of three artefacts exposed on the edge of a tertiary terrace and situated on a gravelled dirt track sloping down onto river flats ("dirt pans") below. The edge of the terrace is highly disturbed due to excavation and landscaping to form a uniform slope and straightened edge.

The incidence of ground surface exposures was around 80%, with visibility in the (track) exposures around 75%.

1. Red silcrete multi-platform core with at least 3 platforms, 39 x 35 x 30mm
2. Red to light red quartzite bipolar flake, 45% alluvial pebble cortex, 44 x 30 x 14mm
3. Light yellow patinated fine grained tuff steep edge concave scraper, secondary retouch along 75% of margin, remnant platform edge evident, 23 x 31 x 10mm

Figure 10 MA4 looking east, note elevated terrace and modified embankment.

Figure 11 Artefacts at MA4 (side view)

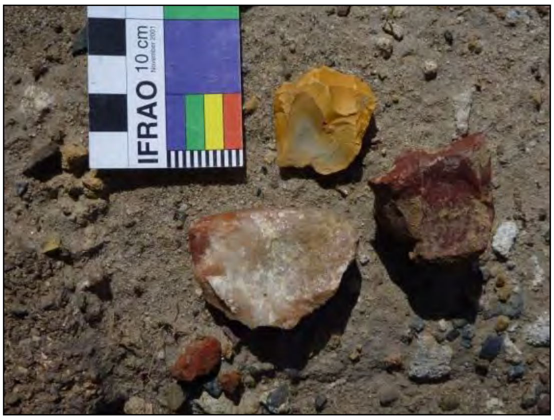


Figure 12 Artefacts at MA4 (other side view)

MA5

Map Grid Reference: 307396.6241118 (GDA)

This recording consists of 3 artefacts situated on the high side of an artificially benched slope atop the tertiary terrace, and is adjacent to the lower lying dirt pan. The three artefacts were found in area measuring 25 x 5m.

The incidence of ground surface exposures was around 15%, with visibility in the exposures around 85%

1. Yellow-brown broken flake, approximately 40% cortex, proximal end missing, 30 x 16 x 5mm.
2. Yellow-brown silcrete flake, focal platform, 18 x 12 x 3mm
3. Light brown fine grained metamorphic rock (tuff?), some modern edge damage, 10 x 7 x 1mm.

Figure 13 MA5 looking south along edge of terrace

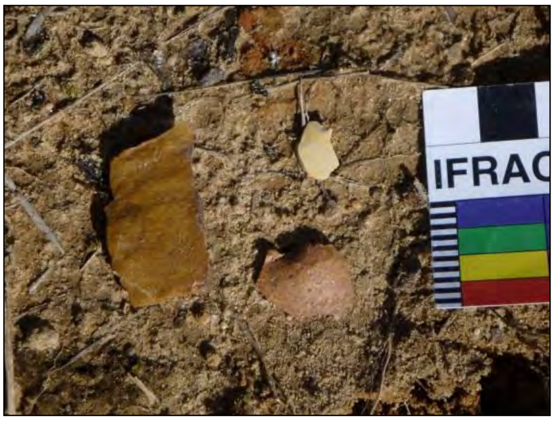


Figure 14 Artefacts at MA5 (side view)

Figure 15 Artefacts at MA5 (other side view)

MAPAD1

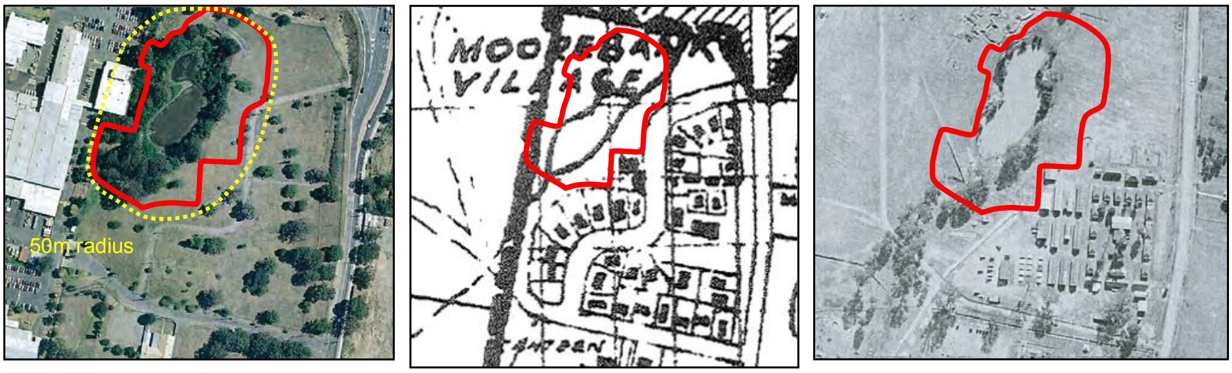
Map Grid References (GDA): Approximate perimeter points

308063.6242558
308116.6242453
308029.6242336
307958.6242360
307965.6242432
307995.6242430
308009.6242506

This recording consists of the banks and a fringing 50m radius around a natural lake basin situated in the far northern portion of the project area. The lake basin is situated in the upper reaches of an unnamed first order tributary which drains to the northeast. The proximity of this freshwater lake to the riparian corridor of the Georges River (350m to the west), which may have been estuarine at this point in prehistory, provides a strong basis for predicting evidence of past Aboriginal occupation along its original banks and surrounds.

The banks of the lake are now steep sided and are suggestive of the dumping and encroachment of landfill. This may have occurred as a result of successive Defence related development of the land to the east and south of the basin, and more recent commercial development on the lake's western side (Figure 16).

Figure 17 presents a comparison of aerial photography of the MAPAD1 area and associated drainage system from 1943 and 2008 (from www.six.nsw.gov.au). It is clear from the catchment comparison that the subject lake is now the last remaining relatively unmodified basin from the local Georges River flood plain, which originally included at least 6 lakes or anabranches.



2008
(from www.six.nsw.gov.au)

1958
(1958 topographic map, Moorebank Holsworthy Area CEN938d 1/9/57, Amended 22/4/58 (Aust War Mem'l 123, Item 493))

1943
(from www.six.nsw.gov.au)

Figure 16 A comparison of aerial photography and mapping across the MAPAD1 area, from 1943, 1958 and 2008, showing the remnant nature of the PAD and the boundary (red) relative to past ground disturbance.

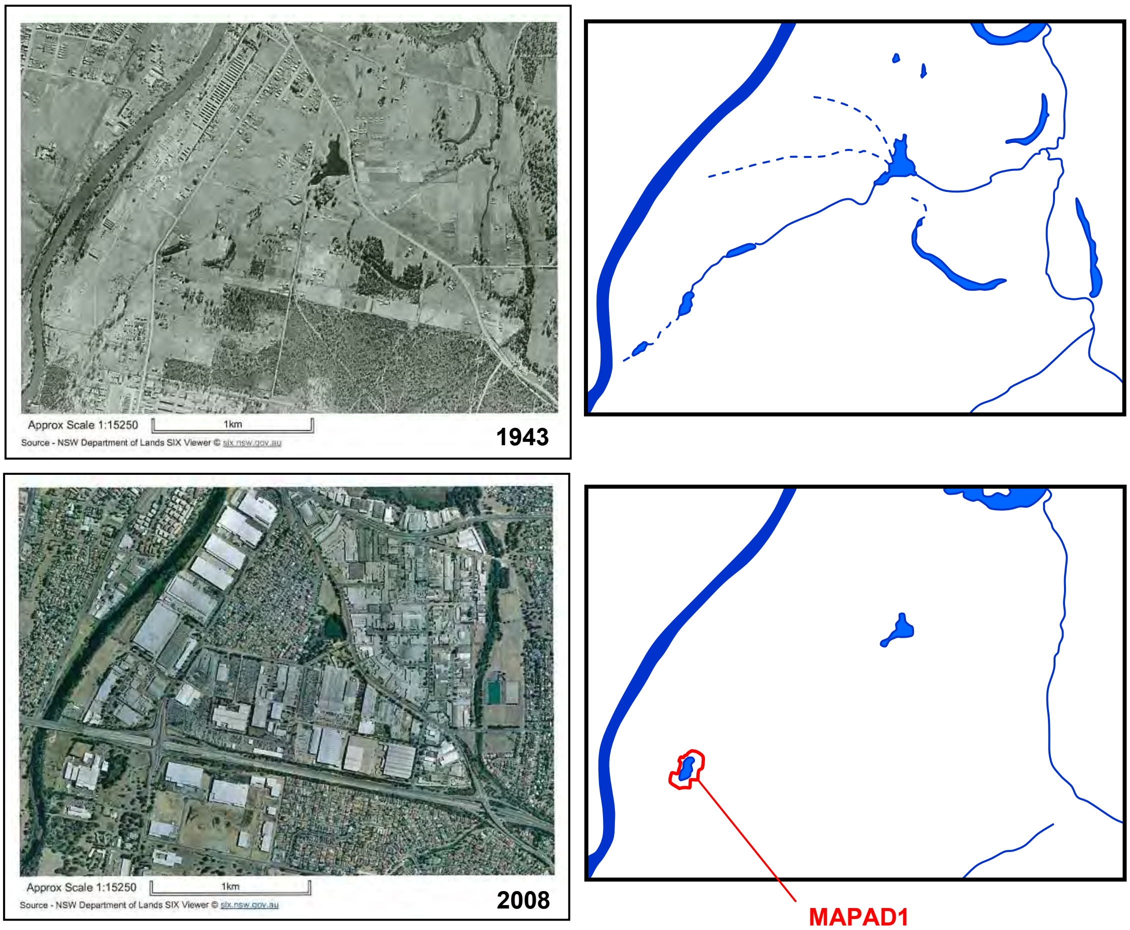


Figure 17 A comparison of aerial photography and mapping across the MAPAD1 area, from 1943 and 2008 showing the location of MAPAD1 relative to the pre-urban and contemporary surface drainage network.

PAD1

Map Grid References (GDA): Approximate perimeter points — *307319.6239944*, *307276.6239941*, *307255.6240103*, *307309.6240111*

This potential archaeological deposit was defined by AHMS (2012), based on the landform, the presence of intact soil profile and the presence of artefacts 5 and 6 (AHMS 2012:76). It is described as a:

> River terrace running along the eastern side of the Georges River; largely undisturbed; vegetation cleared; eroding; grassy with exposures; 10% ground surface visibility. (AHMS 2012:87).

As such, this recording forms part of the archaeologically sensitive Tertiary terrace landform identified by NOHC (2011). An assessment of an isolated surface artefact by NOHC in 2011 indicated extensive ground disturbance in the area of the find from road works, importation of fill and underground services.

PAD2

Map Grid References (GDA): Approximate perimeter points *307864.6240004*
307824.6239767
307213.6239765
307235.6239858

This potential archaeological deposit was defined by AHMS (2012), based on the areas elevation above the terrace, the relatively low level of disturbance (despite its context within a golf course), and the presence of an intact soil profile. It was considered to have moderate archaeological potential (AHMS 2012:77).

It is defined as:

> 'Golf course between Anzac Creek and East Hills Rail Line; grassy but possibly some original soil profile, scattered large Eucalypts; 15% ground surface visibility; no artefacts identified on surface' (AHMS 2012:87).

This recording primarily includes three archaeologically sensitive landforms identified by NOHC (2011): the Georges River riparian corridor, the adjacent Tertiary terrace, and the riparian zone surrounding Anzac Creek, a first order tributary.

Archaeologically Sensitive Landforms

Following a review of previous local archaeological assessments, site location models (Boot 1990 & 1992, Dallas & Steele 2004, Dames and Moore 1996, NOHC 1997), geomorphological, and landuse characteristics, the NOHC preliminary assessments identified three archaeologically sensitive landforms. These are described below and illustrated in Figure 2 and Attachment C. The identification of these zones represents a refinement of previous work conducted by Dallas and Steele (2004). The sensitive areas were defined by plotting predicted archaeological potential based on landform variables, and then excluding grossly or substantially disturbed land surfaces (Figure 18, refer also Attachment C).

The three archaeologically sensitive landforms are defined as:

- The Georges River Riparian Corridor – 100 m either side of the Georges River (inclusive of the 1890s eastern riverbank configuration);
- Minor Tributary Riparian Zones – 100 m either side of tributary drainage lines (inclusive of the pre-European drainage alignment, as best determined from historical mapping and 1943 aerial photography); and
- The elevated slopes and riverside margin of a locally elevated Tertiary alluvial terrace edge situated adjacent to the Georges River – zone 100 m wide. (NOHC 2011:14)

The predicted sensitivity of these landforms is based on a generalised site location model which postulates that the majority of sites occur on locally elevated, well-drained and low gradient ground, located in relative proximity to a fresh or estuarine water source (and that a majority of sites, and most larger sites, occur within 100 m of a fresh or estuarine water source).

The likely incidence of Aboriginal sites along the Georges River riparian corridor could be expected to be relatively high given its value in prehistory as a source of food, camping locations, raw materials and fresh water (the tidal limit is now situated at the Liverpool Weir, 1.3 km downstream). This expectation should, however, be moderated by factors which are known to obscure or destroy sites along fluvial corridors, notably, the scouring of archaeological deposits during flood events and their concealment by the deposition of flood born sediments.

Given the upper catchment context, and therefore low stream order of the tributary streamlines in the study area (both drain to the northeast and away from the river), the intermittent nature of these water sources limits the potential occurrence of adjacent sites to small and transient campsites with corresponding low incidences of artefact discard. This expectation can be qualified by an appreciation that:

- natural swamp or lake basins (some of which are shown on these tributaries in historical mapping and 1943 aerial photography (Figure 17)); may have afforded greater water permanence, and

- such streams may have represented the only fresh water near the river prior to the construction of the Liverpool Weir, when the tidal limit in the Georges River may have extended into or upstream of the study area.

The two classifications, being PAD and archaeologically sensitive landform, relate to different scales of predicted potential for archaeological deposits. Archaeologically Sensitive Landforms use a broad scale of identification, typically covering many hectares or square kilometres and are based on the predictive analysis of landform traits, such as geomorphological origin, local elevation and distance to water. The boundaries of a landform classification may be approximate or indicative. The landform classification may not take into consideration micro-topographic variations, or localised areas of low potential (due to disturbance or natural topographic variation). For this reason, it would be inaccurate to classify a sensitive landform as a PAD. A variable proportion of any identified sensitive landform may not have appreciable archaeological potential.

A deposit classification (i.e. a PAD) is a small scale identification, typically covering areas less than a hectare. Its identification will include reference to the characteristics of a specific location (rather than only generalised landform characteristics), and is likely to reflect micro-topographic traits and avoid areas of low potential due to disturbance. The boundaries of a PAD are likely to be definable at a small scale, and be specific to localise traits and reflect localised landuse impacts.

The two potential archaeological deposits identified by AHMS are encompassed by the archaeologically sensitive landforms identified in the current assessment.

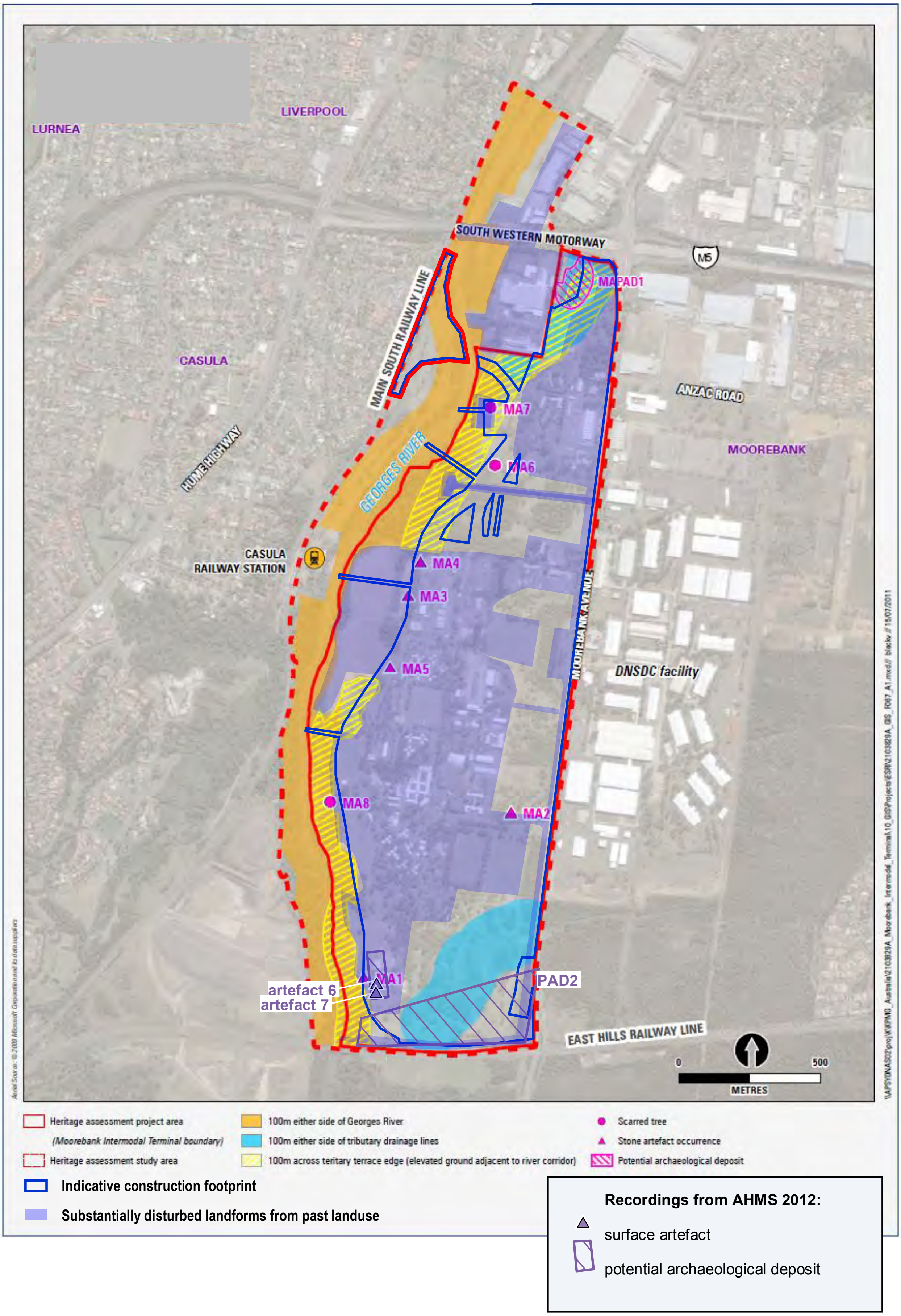


Figure 18 Substantially Disturbed Landforms from past landuse
(following on from Dallas & Steele 2004 and NOHC 1997, 2010)

Objectives and Research Questions

The primary objectives of the proposed test excavation program are to:

- Conduct an investigation of sufficient scope, to gain a representative sample of the likely archaeological resource present at the test locations;
- Determine the nature and significance of any Aboriginal archaeological evidence within the test locations;
- Where necessary, determine appropriate strategies for the management of cultural heritage values related to any confirmed archaeological evidence, relative to the proposed Moorebank IMT development.

The test excavation program will be directed at the following research questions:

- How can the anticipated development impact of the Moorebank IMT project on any significant Aboriginal heritage values be effectively avoided or mitigated?
- What do the test results indicate about the past Aboriginal occupation of the project area and the Sydney region?
- How do the test results compare with other local and regional archaeological results and models?
- Does the subsurface archaeological resource accurately reflect the predictions on which the sensitive landform mapping is based?
- Based on the test excavation results, how can the local predictive model be refined or corrected?

Excavation Methodology

Two excavation methodologies are proposed:

- Mechanical test pit excavation using backhoe/excavator; and
- By-hand test pit excavation.

It is proposed to employ the mechanical test pit methodology in all test locations where the predicted archaeological potential is no greater than low (MA1 & PAD1, MA5 and representative sample location 3). This may be a site-specific assessment based primarily on disturbance levels and may run contrary to the relevant landform sensitivity rating.

The mechanical method will be suspended and a by-hand excavation methodology adopted if and when circumstances are encountered that warrant more controlled excavation. In the event that one or more of the following Aboriginal cultural features is potentially indicated by visible evidence on the land surface or during machine excavation, then the machine methodology will be suspended and a by-hand excavation methodology will be conducted in the area of the find:

- *In situ* bone material relating to Aboriginal occupation;
- The remains of a hearth in a relatively undisturbed condition;
- A lithic flaking floor in a relatively undisturbed condition;
- An arrangement of stones (showing evidence of deliberate placement by a human agency) in a relatively undisturbed condition;
- A disposal pit or post hole in a relatively undisturbed condition;

- A dense layer or lens of cultural material which could be potentially damaged/fragmented by a mechanical excavation method; or
- A deposit containing artefacts which displays well preserved fine scale stratigraphy which probably relates to cultural episodes or phases.

The term *undisturbed condition* in this context is defined as:

Archaeological material evidence which can be reliably interpreted to be in a context, arrangement or position, which is substantially unchanged since the human behaviour that resulted in its current context, arrangement or position.

It is proposed to employ the by-hand excavation methodology for all test pits in areas of predicted moderate to high archaeological sensitivity (MAPAD1, PAD2 & minor tributary Riparian zone, and representative sample locations 1 and 2). At MAPAD1, where there is evidence to indicate that there may be a substantial amount of fill overlying suspected archaeological deposits, machinery will be used to remove any fill and establish a safe surface for hand excavation of intact deposits. Machinery will also be used in vegetated test locations to clear the area prior to excavation and in instances where archaeological deposits, or suspected deposits, continue at depths in excess of 1.5 m (i.e. where OH&S concerns preclude further excavation by hand). In the latter case, if any of the triggers for cessation of machine excavation (outlined above) were encountered below 1.5 m, then further excavation in that pit would be suspended or the pit walls modified to allow safe by-hand excavation.

Excavation by Backhoe/Excavator

The following excavation methodology will be followed. This methodology may be subject to change depending on factors encountered in the field that have not been anticipated.

1. Mark out and record the required location of mechanical excavation pits.

2. Excavate pit.

Pits will be excavated by backhoe or excavator using, as a preferred set-up, a straight-edged toothless bucket 1000 mm in width. In the event that a straight edged bucket becomes unusable in compact or gravelly sediments, a toothed bucket will be employed, of similar or smaller width than the bucket used for the above spits. The intended depth interval for each spit will normally be 10 cm, but this may vary depending on the nature of the deposit and intended total depth of the pit. The actual depth interval achieved for each spit is dependent on the skill of the operator and the consistency and type of sediments encountered. As a consequence, spit intervals and the consistency across a spit excavation will tend to vary. Pits will have a potential final length of around 2 m to 4 m, depending on the final depth achieved, and the nature of the deposits.

The following excavation sequence will be followed (refer Figure 18):

- Excavation of spit one along an interval averaging 1.5 to 2.0 m in length
- Following the removal of spoil from each spit, a 5-10 cm strip may be removed from one side of the pit. This would be done where there is a potential risk of significant contamination from material dropping from previous and upper spit levels. The strip would be removed to ensure that the backhoe bucket does not contact the pit sides during the next spit excavation, therefore minimising potential contamination from upper levels.
- Following the removal of spoil from each spit, loose surface material or other unwanted sediment may be removed prior to the commencement of the following spit excavation.
- Excavation of spit 2 (and all subsequent spits), beginning approximately 50-150 mm from the far end of the previous spit, and ending before the near end of the pit is encountered. This is done in order to create a 'clean' end-wall and to prevent contamination from loose sediments at the ends of the pit.

- Following spit 2 (and after all subsequent spits), the near end of the pit will be extended by up to 300 mm in order to remove any fallen sediment from upper levels and to provide a 'clean' end point for the backhoe bucket.

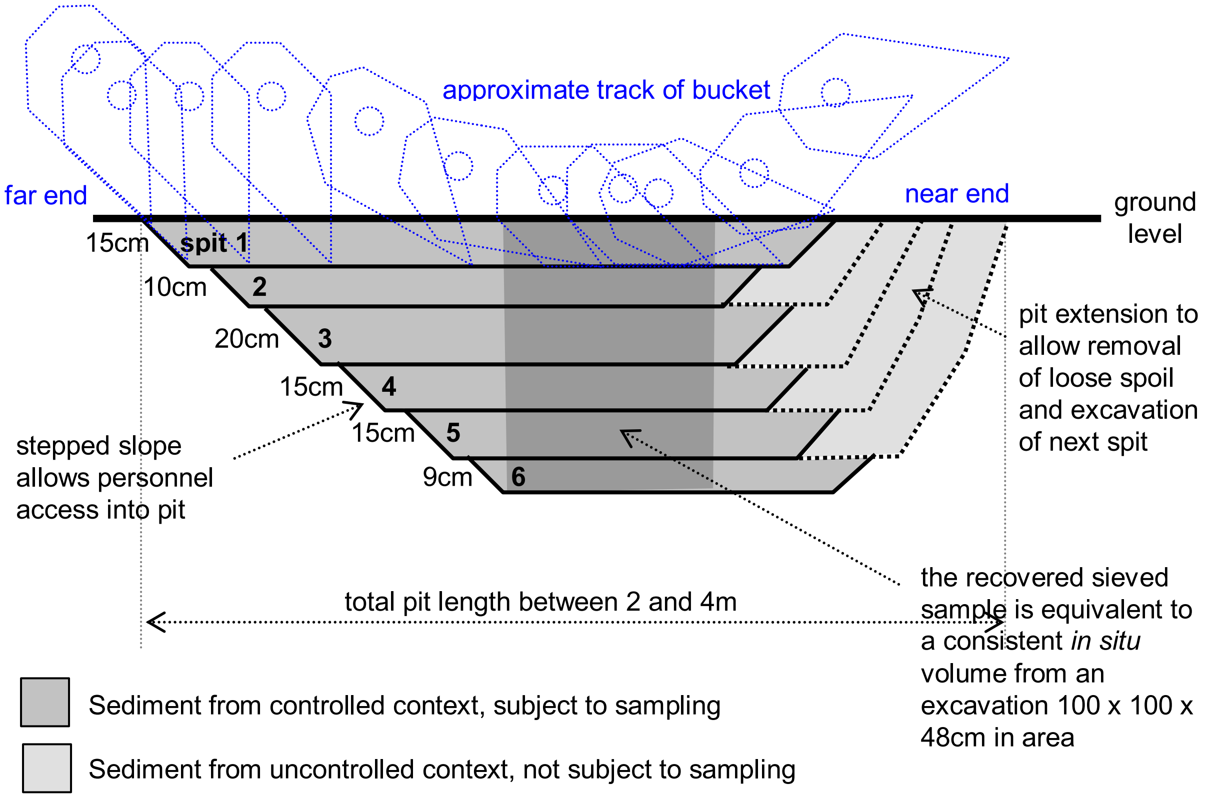


Figure 18 Indicative pit profile (not to scale) showing sampling methodology and sequence for mechanical pit excavation

- Following each spit excavation, a consistent sample of the excavated sediment will be recovered for sieving. The size of the recovered sample will vary according to the depth of the spit so that the volume is equivalent to the *in situ* deposit which would be recovered from an excavation area of 100 x 48 cm^3. These varying sample sizes are shown in the Table 1 below. In the case of a spit with the preferred depth interval of 15 cm, the sample size would be 8 x 10 litre buckets.

Table 1 sample size of sediment recovered from each spit relative to spit depth

average depth interval across spit	no. of 10 lt buckets*	loose volume (litres)	equivalent *in situ* volume (litres)
2.5cm	1.3	13.3	12
5cm	2.7	26.7	24
7.5cm	4.0	40.0	36
10cm	5.3	53.3	48
12.5cm	6.6	66.6	60
15cm	8.0	80.0	72

average depth interval across spit	no. of 10 lt buckets*	loose volume (litres)	equivalent *in situ* volume (litres)
17.5cm	9.3	93.3	84
20cm	10.7	106.6	96
22.5cm	12	120.0	108
25cm	13.3	133.3	120

**Multiply spit depth (cm) by 0.535 to get no. of required 10 lt buckets*

- The material for sieving will preferentially be taken from the middle of the backhoe/excavator bucket, prior to the emptying of the bucket. This minimises the potential for contamination from sediments falling to lower levels from the pit sides. All material remaining in the bucket after recovery of the sample for sieving (if any) will be set aside in a separate pile.

- A larger sample for sieving may be recovered from this separate pile, if an in-field assessment of results indicates that a larger sample would be beneficial.

- Excavation of each test pit will cease according to an on-site appreciation of testing requirements. In most cases, excavation will cease when dense clay, or bed rock is encountered.

All sieving will be conducted with the aid of pressurised water from a water truck or an appropriate environmental source. All material will be sieved through 4 x 4 mm mesh, with the use of a top 10 x 10 mm mesh when required by the presence of large gravels.

All identified or suspected cultural material recovered from sieving will be retained, bagged and labelled. Materials which offer the potential for radiometric or other forms of dating may also be sampled, bagged and removed, where these relate to cultural or key stratigraphic features. In addition, samples of sediment may be taken for the purposes of palaeo-environmental analysis. A reference collection of natural gravels may be collected to aid in lithic interpretation, where appropriate.

3. Representative pits (i.e. one or two pits) at each test location may also be excavated beyond the top of the clay horizon in order to check the nature of deposits below. Excavation beyond clay may necessitate stepping out or battering the sides of the pit, given that this would mean disturbance to a broader area, this type of excavation would only be undertaken at pits where the recovered artefact incidence is between 0-5 per metre square. Excavation beyond clay would be done primarily to inspect the soil profile at depth. Depending upon the nature of these deposits, a decision would be made in the field regarding the merits of sieving such deposits (e.g. dense clay with no evidence to suggest the presence of archaeological evidence would not be sieved, deposits suspected to be palaeosols would be sieved).

4. Following cessation of excavation, the soil profile and characteristics will be described and checked with the separately documented incremental spit descriptions. PH measurements may be taken from representative pits at various locations in the profile.

5. All pits will be backfilled with the remaining excavated and sieved spoil. Where necessary, clean material will be sourced separately to allow backfilling of pits.

At MAPAD1, there is evidence of a possible cap of fill over the predicted archaeological deposit. In order to avoid unnecessary by-hand excavation through disturbed materials, the following procedure will be followed:

A mechanical or hand powered auger (drill diameter <300mm) will be used to test the depth of suspected fill at appropriate locations along the test transect(s). Auger locations will be selected according to an on-ground assessment of the micro-topography. Based on the auger results, any substantial fill layer at test pit locations will be excavated using mechanical excavation. This excavation will be monitored by the on-site archaeologist and will cease when the change from fill to natural deposits is observed. Fill excavation will be undertaken in 10 cm spits so that the detection of this soil transition can be carefully monitored. The fill material may not be subject to sieving

A mechanical excavator or bob cat will also be used to clear vegetation at test pit locations that are heavily overgrown such as by Lantana and similar plants. A whipper snipper/slasher may also be used for this purpose.

Excavation by hand

The following excavation methodology will be followed for hand excavated pits (This methodology may be subject to change.

1. Mark out and record pit locations.

2. Excavate hand-dug pit.

   Half metre (50 cm x 100 cm) pits will be excavated using standard by-hand archaeological methodologies including vertical and horizontal recording of spit levels and sedimentary, cultural and stratigraphic features.

   We anticipate that pits will have a maximum depth of one metre.

   Indicative pit intervals will be 10 cm, but will be reduced to 5 cm or less where intact stratigraphy is encountered or suspected.

   Excavation will cease according to an on-site appreciation of the vertical extent of the archaeological deposit.

   All unattended open pits will be fenced, and warning signs posted at all active works sites to advise pedestrians of hazards

3. All excavated archaeological deposit will be sieved with the aid of pressurised water from a water truck. All material will be sieved through 4 x 4 mm mesh, with use of a top 10 x 10 mm mesh where appropriate. All identified or suspected cultural material recovered from sieving will be retained, bagged and labelled.

4. All pits will be backfilled with the remaining excavated and sieved spoil.

In the event that hand excavation pits indicate substantial evidence of a deposit of low or nil archaeological potential (such as from disturbance), mechanical excavation will be employed for the remainder of test pits along that transect, subject to the triggers for hand excavation already outlined.

Figure 19 Example of excavation conducted by an excavator

Figure 20 Selection and transporting of excavated deposit

Figure 21 Wet sieving of excavated deposit at a sieve station

Figure 22 Example of mechanically excavated pit, note ramped and safe pit access and good section exposure

Location and Scope of Test Excavation Pits

Archaeological test excavation is proposed within the following landscape categories and combinations, where direct impact from the Moorebank IMT development is anticipated (Table 2):

- Tertiary terrace edge: MA5;
- Tertiary terrace edge and Georges River riparian zone: MA1 & PAD1, representative sample locations 1 and 2;
- Natural lake basin within a minor tributary riparian zone (adjacent to tertiary terrace edge): MAPAD1;
- Minor tributary riparian zone: PAD2;
- Tertiary terrace away from (riverside) edge (i.e. an area of predicted no archaeological sensitivity): representative sample location 3.

Three areas have been selected for archaeological subsurface testing outside of known sites and PADs. These areas provide a sample of the archaeological sensitivity categories (including the nul hypothesis) and have been selected to test the model within areas of lesser disturbance. These areas are described as representative sample areas 1-3:

- Representative sample area 1 is on the edge of the tertiary terrace and the Georges River basin and is located in a relatively undisturbed context.

- Representative sample area 2 is on the tertiary terrace edge and in a relatively undisturbed context.

- Representative sample area 3 is on the tertiary terrace away from its edge and any riparian zones. The area represents an area of predicted low archaeological potential in an area of minimal disturbance.

Wherever possible, test pits will be arranged in straight line transects and situated within the anticipated development footprint (the area subject to direct construction impact). The distance between test pits on transects will normally be 25 m (or 50 m across PAD2), except in the following circumstances:

- Where the avoidance of an erosional or other disturbance feature requires a one-off larger or smaller interval;
- An on-site appreciation of landform and archaeological potential indicates that a larger or smaller interval is necessary; or
- An in-field assessment of initial test pit results supports the conduct of additional (contingency) test pits at closer intervals or outside of a formal transect configuration.

It should be noted that transect placement and alignment has been guided not only by initial field assessments of archaeological potential, but also subsequent information from Defence regarding land use. For instance at MA1, the transect of proposed test pits curves to the west in order to avoid an area of recent disturbance (Figure 24). At representative sample location 1, testing will not be conducted at the far western end (Figure 26), immediately adjacent the river, as this area corresponds to where known chlorinated solvent impacts (TCE) are present in groundwater (gauged at approximately 5.2 m BGL), making the area potentially unsafe for excavation activities at this time.

The placement and alignment of test transect across PAD2 (Figure 25 - area currently used as a golf course) have also been modified in order to target areas of minimal disturbance and to minimise safety concerns and/or interruptions for golf course users.

Indicative locations of test pits are shown in Figures 18 – 28. Table 2 summarises the indicative number of test pits proposed at each test location

Where a proposed test pit falls within an area of:

- large stone cobbles or tors (with maximum linear dimensions greater than 300 mm);
- outcropping bedrock;
- highly disturbed or eroded ground; and/or
- substantial vegetation (with stem diameter of 500 mm or greater); and/or
- Ecologically Endangered Communities,

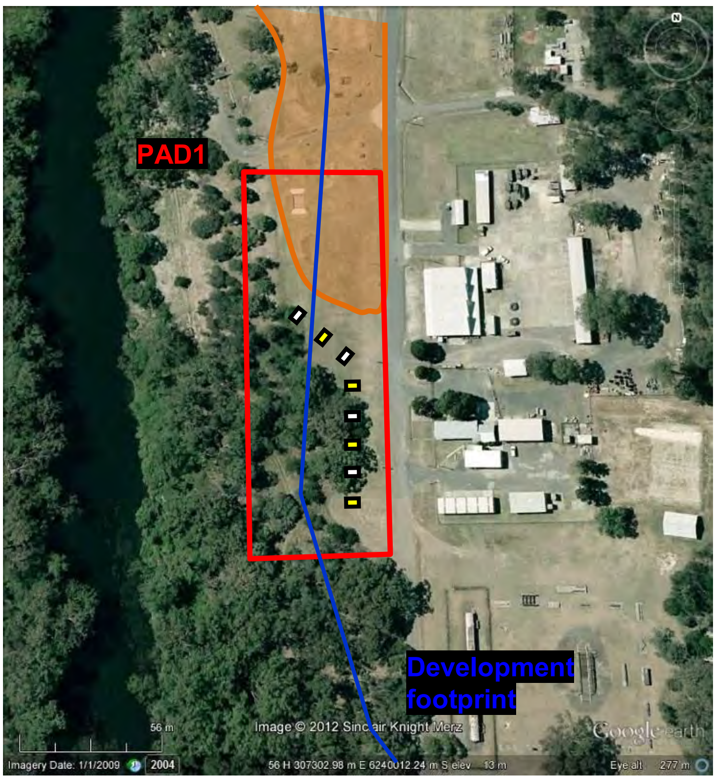
then the location of the test pit will be amended to the nearest location which avoids the constraint/s listed above.

Excavation and or spoil processing, may cease, or not be attempted, in any particular area where qualified advice indicates there may be a potential health risk or hazard to field workers. Examples include contaminated ground (such as from asbestos or hydrocarbons) and unexploded ordnance. As a health precaution, no excavation will be conducted in test pits once the water table, or other substantial ground water source, is encountered.

Table 2 Predicted Archaeological Potential and Indicative Number of Test Pits for Each Location

Site Name	Landform	Within archaeologically sensitive landform (y/n)	Degree of disturbance	Consequential rating of predicted archaeological potential	Proposed Subsurface testing Methodology	No. Test pits	Contingency No. Test pits
MA1 & PAD1	edge of tertiary terrace	Y	at least moderately disturbed	low	machine, or by hand where and if warranted	4	4
MA2	landform not identified as archaeologically sensitive	N	at least moderately disturbed	low	N/A	-	-
MA3 & 4	tertiary terrace	Y	highly disturbed	low	N/A	-	-
MA5	tertiary terrace	Y	at least moderately disturbed	low	machine, or by hand where and if warranted	7	6
MAPAD1	tertiary terrace and natural lake basin	Y	Potential for low degree of disturbance under fill	moderate-high	machine for excavation of fill, then by-hand unless otherwise warranted	8	11
PAD2 & minor trib. Riparian zone	minor tributary riparian zone	Y	at least low degree of disturbance outside of golf course developed areas such as fairways and landscaping	moderate	by-hand initially, then by machine or hand as determined from results	22	17

Site Name	Landform	Within archaeologically sensitive landform (y/n)	Degree of disturbance	Consequential rating of predicted archaeological potential	Proposed Subsurface testing Methodology	No. Test pits	Contingency No. Test pits
Representative Sample Location 1	tertiary terrace and Georges River riparian zone	Y	relatively undisturbed but some areas with fill and industrial contamination	moderate	by-hand initially, then by machine or hand as determined from results	5	4
Representative Sample Location 2	tertiary terrace	Y	relatively undisturbed but some areas impacted by former sewerage treatment works	moderate	by-hand initially, then by machine or hand as determined from results	7	6
Representative Sample Location 3	tertiary terrace, away from edge and riparian zone	N	relatively undisturbed some areas impacted by defence training works	nil	Machine, or by hand where and if warranted	7	6
Total						60	54

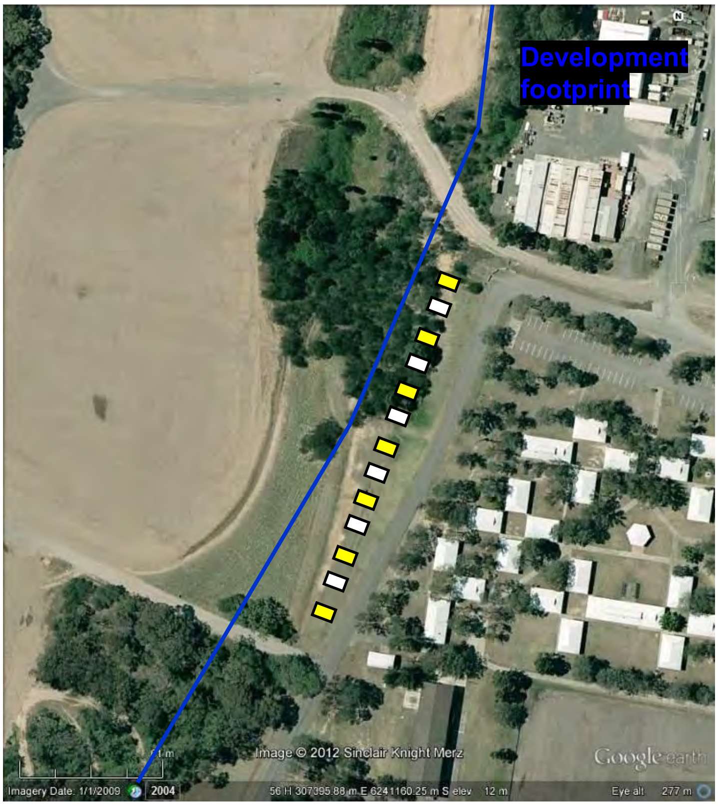


MA1 & PAD1

4 pits (yellow), 25 m apart – contingency for 4 additional pits (white)

(2009 image: Google Earth Pro)

Traverse modified to avoid recent disturbance and development in area:

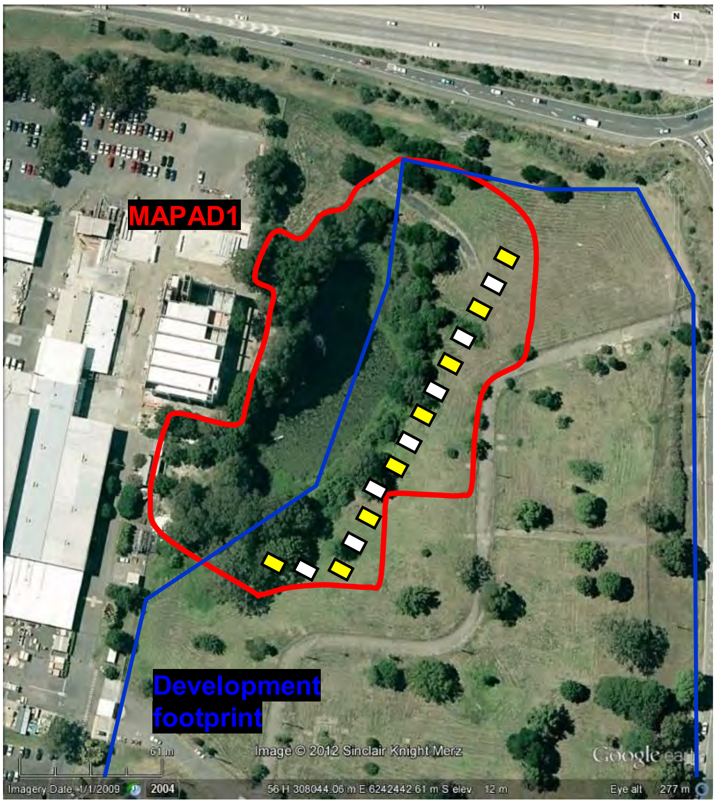


MA5

(occurs within terrace landform) 7 pits (yellow), 25m apart – contingency for 6 additional pits (white)

(2009 image: Google Earth Pro)

Figure 24 Indicative location of test pits at sites MA1 & PAD1 and MA5

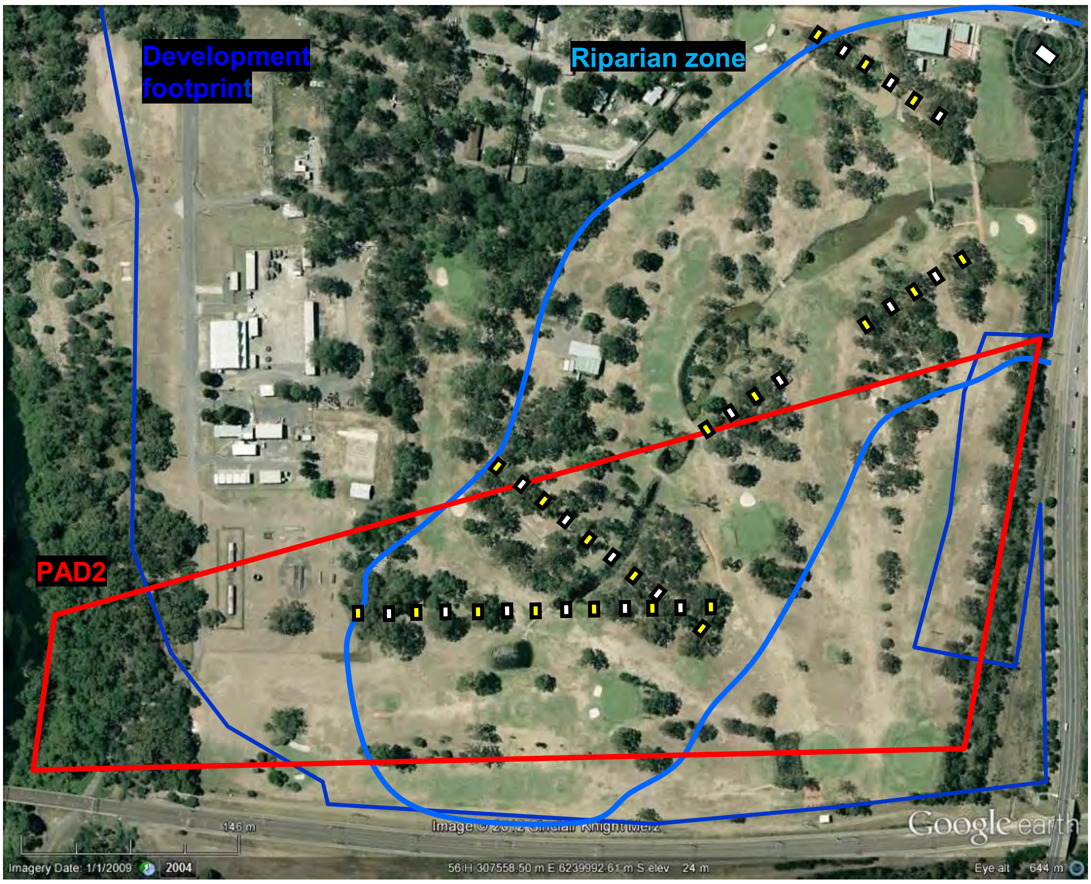


MAPAD1

(occurs within terrace landform)

8 pits (yellow), 25m apart with contingency for an additional 11 (7 at closer intervals and 4 pits at selected locations), depending on results

(2009 image: Google Earth Pro)



PAD2 & minor tributary riparian zone

22 pits (yellow) at 25 m intervals on 5 transects - contingency for an additional 17 pits (white).

(2009 image: Google Earth Pro)

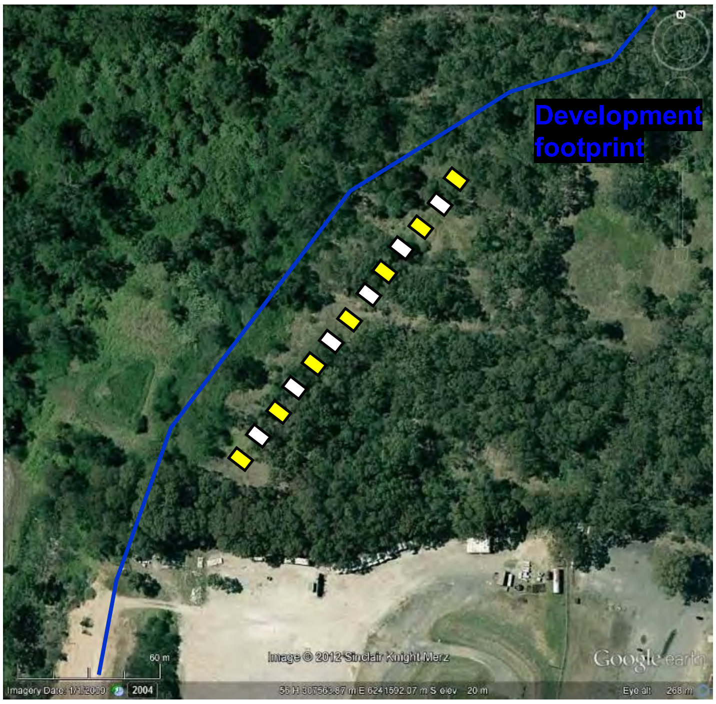
Figure 25 Indicative location of test pits at MAPAD1 and PAD2

Representative sample area 1

5 pits (yellow), 25m apart – contingency for an additional 4 pits (white)

Note avoidance of contaminated ground but remaining within area of proposed impacts

(2009 image: Google Earth Pro)

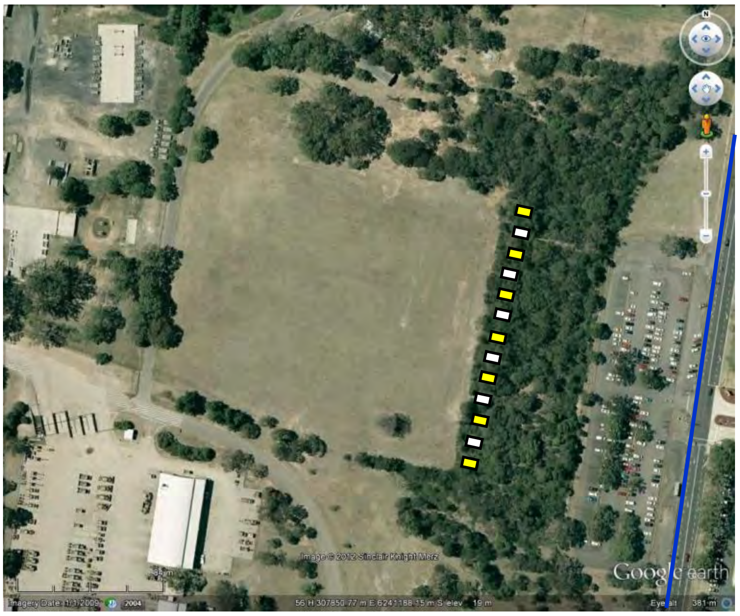


Representative sample area 2

7 pits (yellow), 25m apart – contingency for an additional 6 pits (white)

(2009 image: Google Earth Pro)

Figure 26 Indicative location of test pits at representative sample areas 1 and 2



Representative sample area 3

7 pits (yellow), 25m apart – contingency for an additional 7 pits (white)

(2009 image: Google Earth Pro)

Figure 27 Indicative location of test pits at representative sample areas 3

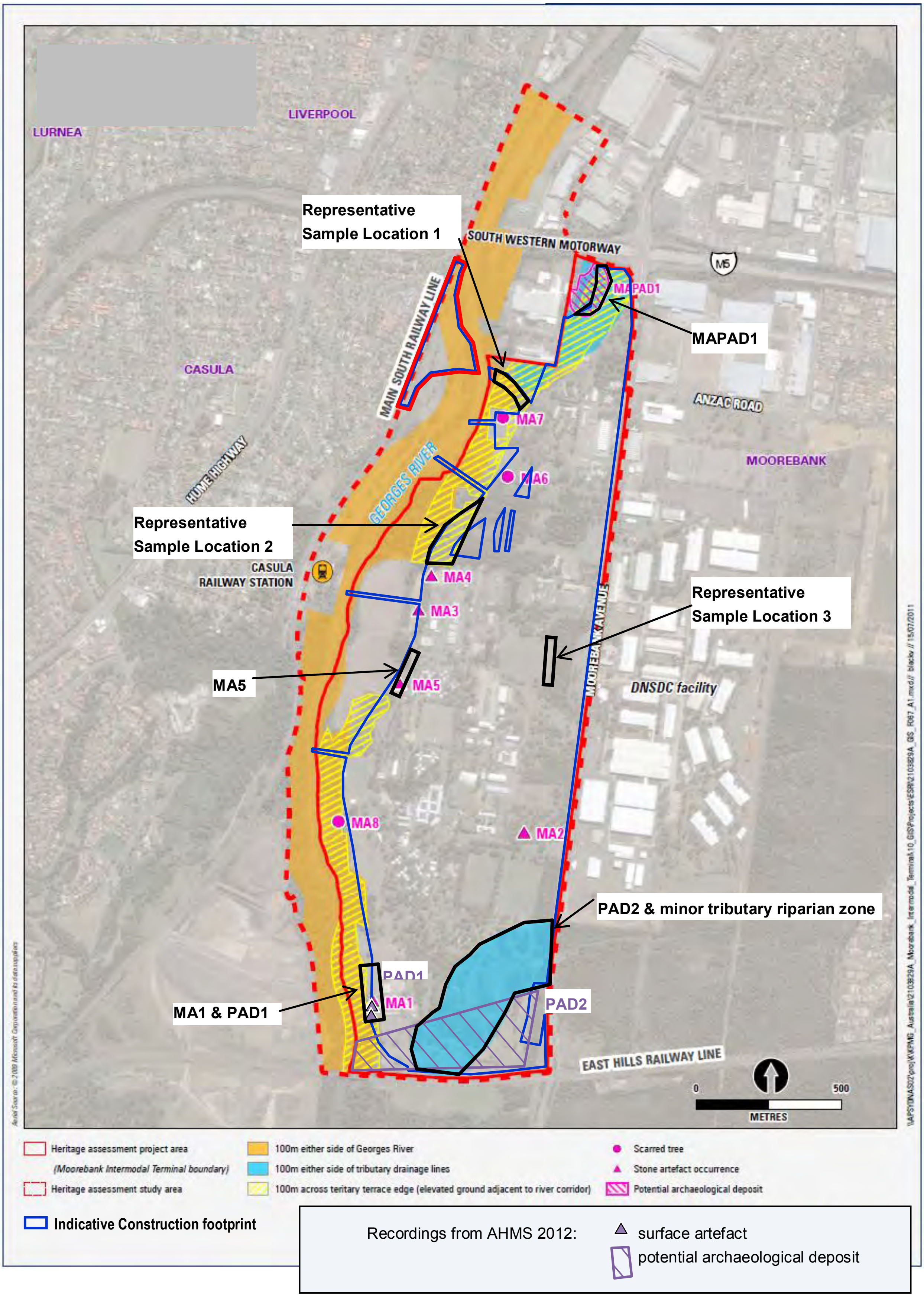


Figure 28 Location of all subsurface testing areas

Justification for the use of Mechanical Excavation

The proposed test excavation methodology for the program for the Moorebank project includes a mechanical excavation methodology that uses an excavator or backhoe to undertake the excavation work.

This methodology is proposed as it provides the best fit approach to the archaeological testing within areas of low archaeological potential. The aims of the test excavation program are to assess the presence or absence of Archaeological deposits in the study area and to determine what strategies, if any, are needed to mitigate the impact of the proposal on those deposits.

Mechanical excavation is by far the most effective means for testing large scale areas and addressing landscape based theory and predictive modelling as it can excavate and process ground quickly, thus allowing a maximum number and the greatest spread of samples within a limited period of time.

The mechanical excavation methodology provides a compromise sampling method that allows for speed and a maximum number, and spread, of samples, at the cost of lesser vertical control (compared to a hand excavation methodology), some potential for contamination, and the sacrifice of some excavated material which is mixed and remains untested.

The negative elements of this compromise are considered to be justifiable when considered as part of an overall risk/benefit assessment:

- Most deposits subject to mechanical testing are in open contexts and the artefacts encountered typically occur in low or moderate incidences and found to have little or no vertical integrity. In these contexts, the lesser vertical control and the untested excavated material associated with mechanical methodologies amounts to a minimal loss of information.

- Most tested deposits are defined according to varying scales of landform unit (such as spur crests, creek and river banks, dunes, terrace margins etc.) and typically extend across hectares. The proportion of these deposits subject to archaeological testing is typically less than 0.01%. In this context the information losses inherent in the methodology remain minimal.

The subsurface testing program at Moorebank will be concerned within broad landscape features and low-density artefact occurrences, both of which can be effectively tested using the mechanical excavation approach. The hand excavation provision will allow for the investigation of more significant features in a more controlled manner.

Registered Aboriginal Party Participation in Field Work

The proponent is committed to providing an opportunity to the representatives of registered Aboriginal parties to participate in the conduct of the test excavation program.

It is proposed that each registered Aboriginal party which seeks to participate in the field program, submit an application, demonstrating experience and field qualifications. The selection of field participants would be made by the proponent. Representation would be limited to one person per successful registered party application.

Protocol to be followed in the Event that Suspected Human Remains are Encountered

In the event that suspected human remains are encountered during any of the test excavation methodologies proposed, the protocol presented in Attachment B will be followed.

Environmental Safeguards

Minimal vegetation will be removed to facilitate the testing program.

All pits will be backfilled after completion of excavations at each location.

Sediment barriers will be set up around sieve stations to contain the spread and deposition of water-borne sediment. Sieve stations will be established in locations and managed so that surface run-off water does not reach the open water of creeks, rivers, lakes or swamps. A kit suitable for the containment of spillage of fuel for the water pump will be kept on site during the operations.

Analysis of Artefacts

All lithic items will be examined in detail by a lithic specialist Dr Chris Clarkson (or other qualified lithic specialist, depending on availability), using a low-power binocular microscope and incident illumination and/or hand lens. Descriptive recording of collected material will be to a level concomitant with the stated aims of the investigation, and the number of artefacts/type of material recovered.

The primary aim of the analysis of the lithic items retrieved from the test locations will be to assist in the assessment of the significance of the sites/deposits and to identify appropriate management strategies.

Raw material type will be recorded for each stone artefact. Attributes for each artefact in the assemblage will be entered into a relational database and digital photographs may be taken of selected artefacts, where appropriate. Information for each specimen recorded in the analysis will be provided in a final report Appendix.

Four basic variables will be recorded for each lithic item:

- size class, in one centimetre units;
- weight, as measured with an ISCO balance (precision of ±0.005 grams). Lithic item weights of less than 0.01 grams are accorded this nominal value;
- stone material type or category. To the extent possible, specific stone types will be identified, including colour and fabric characteristics. Some stone materials cannot be identified with confidence, even when magnified and viewed under reflected light. Such materials will be described as 'unidentified stone type';
- lithic item type or category (with further details entered into the comments section of the database);

Observations about notable technological attributes and other pertinent data such as specific characteristics of the stone material, any evidence of use-wear and potential tool-use residues, will also be recorded.

Report Preparation

The conduct and findings of the test excavation program will be documented in a cultural heritage assessment report which will form part of the EIS. The report will detail the methodology, background research, artefact analysis, results, assessment of significance, procedures for the management of sites and details of further archaeological investigations and /or salvage measures. Information received from registered Aboriginal parties will also be documented in the report except where identified as restricted or unsuitable for publication.

When completed, a draft of the cultural heritage assessment report will be provided to registered Aboriginal parties for comment. These comments, and any registered Aboriginal party heritage assessments, will then be addressed and incorporated into the final report.

The report will be consistent with reporting standards and guidelines as specified by the NSW Office of Environment and Heritage.

Care and Management of Recovered Artefacts

After examination and measurement, all recovered artefacts will be stored individually in standard resealable plastic bags. These containers would be labelled in permanent black pen with the item's unique identification number (where generated and appropriate), and/or details of its provenance within the excavation (as appropriate).

Following completion of the analysis of the recovered artefacts, it is proposed that all Aboriginal objects be repositioned back into the landscape (‘returned to country’) within reserved open space, in as close a position (as is feasible and safe) to their original find locations. The manner, format and containment of the artefact repositioning would be subject to agreement by the registered Aboriginal parties.

All locations of repositioned artefacts would be recorded on appropriate OEH forms and lodged with the AHIMS, administered by OEH.

In the event that the registered Aboriginal parties resolve to retain some (or all of the artefacts) in the care and custody of one or more individuals or organisations, then this would be subject to the approval of a Care Agreement by the OEH.

In the event that there is no agreement or consensus by the registered Aboriginal parties regarding the long term management of the recovered artefacts, then an application will be made to the Australian Museum (Sydney) for lodgement of the collection. If this application is rejected, then a management solution will be finalised through negotiation between the Moorebank Project Office, Department of Defence, OEH and the registered Aboriginal parties.

Aboriginal Consultation Process Regarding this Methodology

A draft version of this methodology was sent to all registered Aboriginal parties (RAPs) on the 13th September 2012 with a 28 day period for comment ending on 11th October 2012.

A site visit was held with the RAPs on the 26th September 2012. The site visit included a presentation on the project and proposed methodology and a tour of sites and areas that are proposed to be tested. All registered parties were represented at the site visit except for the Banyadjaminga organisation.

See Attachment A for a full description of the consultation process to date.

Comments on the methodology have been received from:

- Cubbitch Barta Native Title Claimants Aboriginal Corporation (CBNTCAC);
- Darug Aboriginal Landcare Incorporated (DALI);
- Darug Custodian Aboriginal Corporation (DCAC); and
- Darug Aboriginal Cultural Heritage Assessments (DACHA).

DALI, DCAC and DACHA all are in of support of the methodology (see Attachment A). CBNTCAC raised several matters regarding the methodology, however these matters were all addressed in the course of the site visit and a subsequent telephone conversation with Nicola Hayes (NOHC) on the 27th September 2012. CBNTCAC supports the methodology as presented.

No requests for changes to the test excavation methodology have been received from any of the registered Aboriginal parties.

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Attachment A

Outline of Aboriginal participation and consultation to date

Section removed, detailed in main report above.

Attachment B

Protocol to be followed in the event of that suspected human remains are encountered

Section removed, replaced by Appendix 10.

Attachment C

Additional Mapping

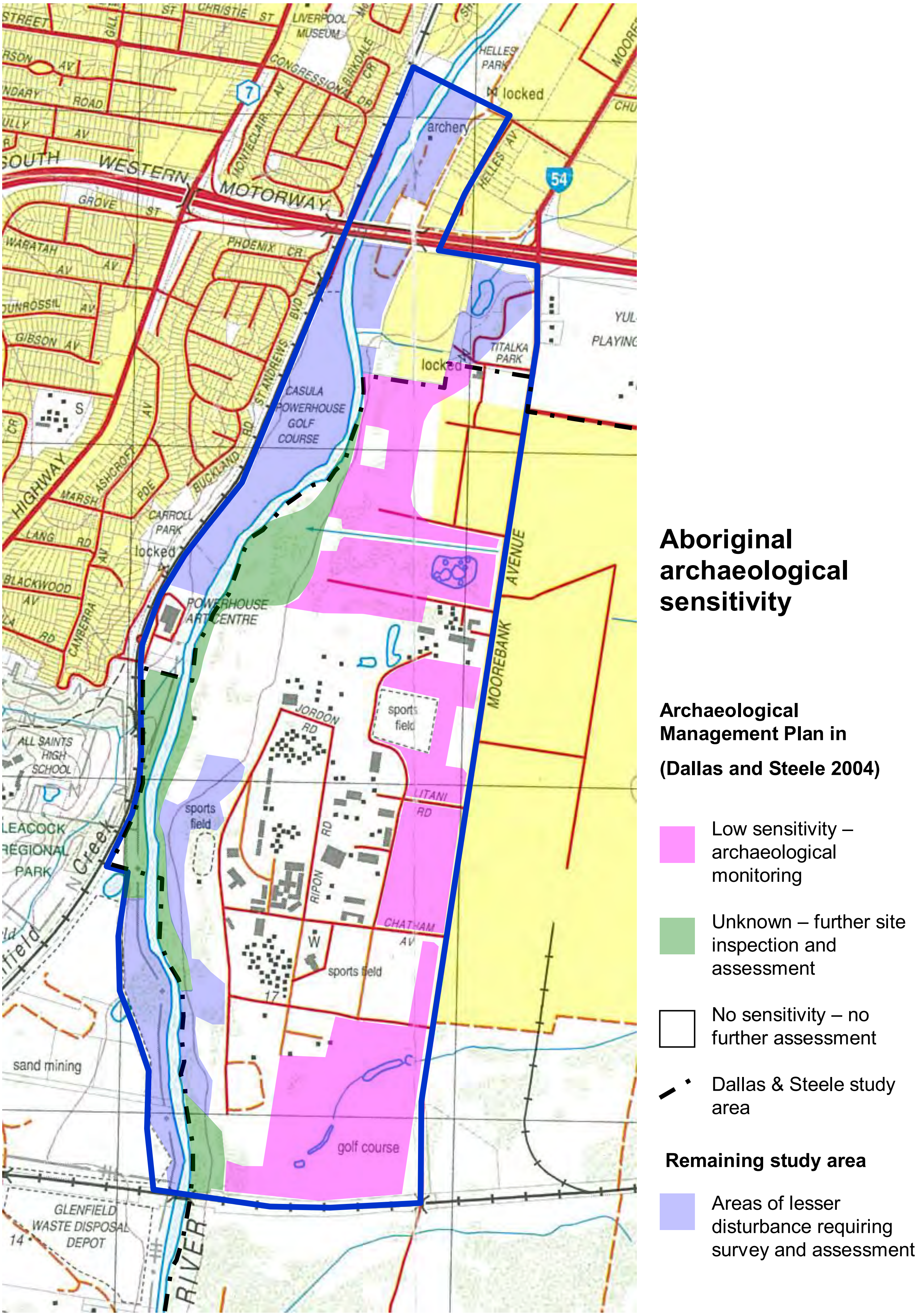

Figure C1 Aboriginal archaeological sensitivity as determined by Dallas and Steele in 2004 prior to the conduct of the Moorebank IMT project assessment (note: this graphic is from a draft interim report).

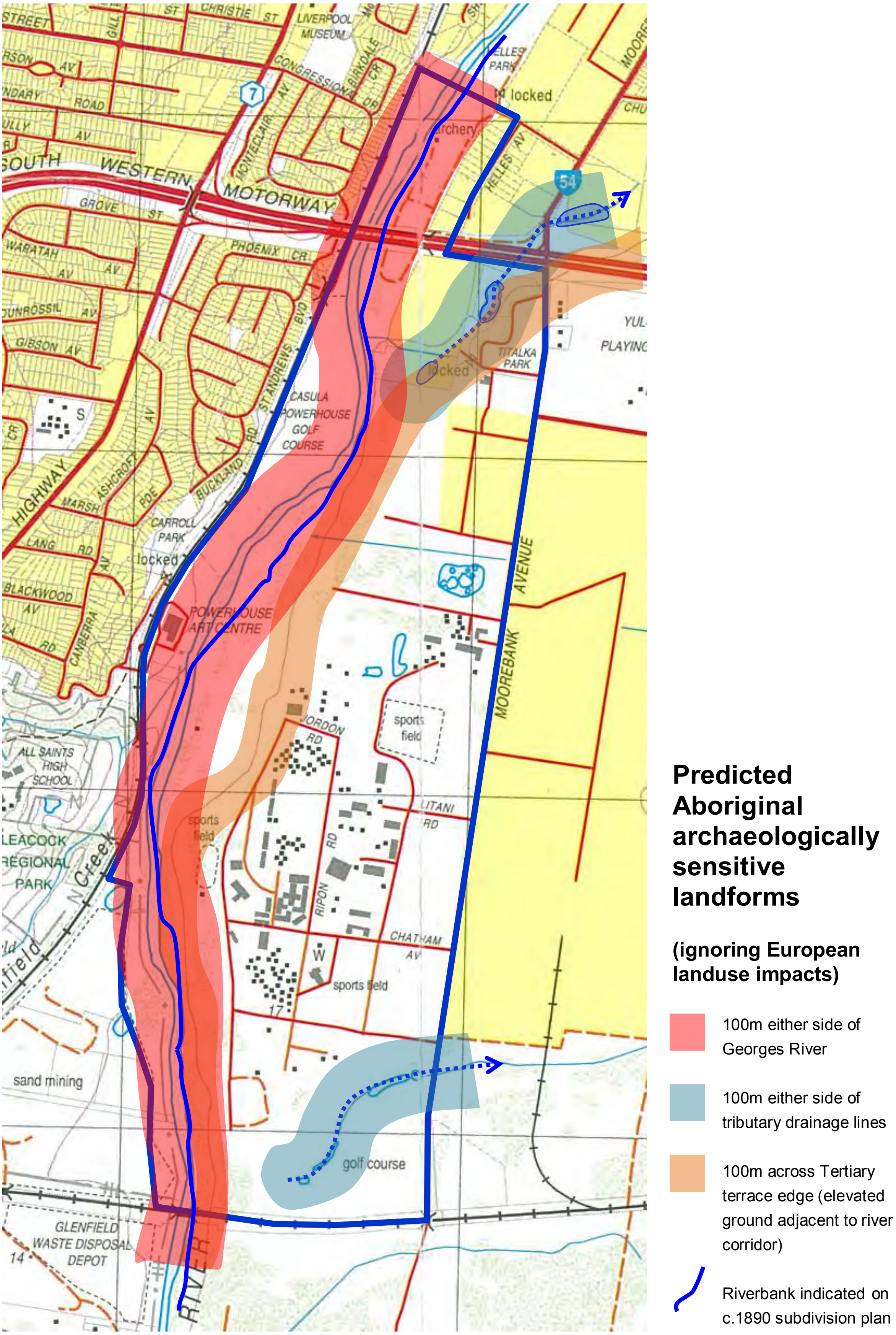

Figure C2 Aboriginal archaeological sensitive landforms based on predictive modelling and ignoring the impact of subsequent European landuse. (note: this graphic is from a draft interim report).

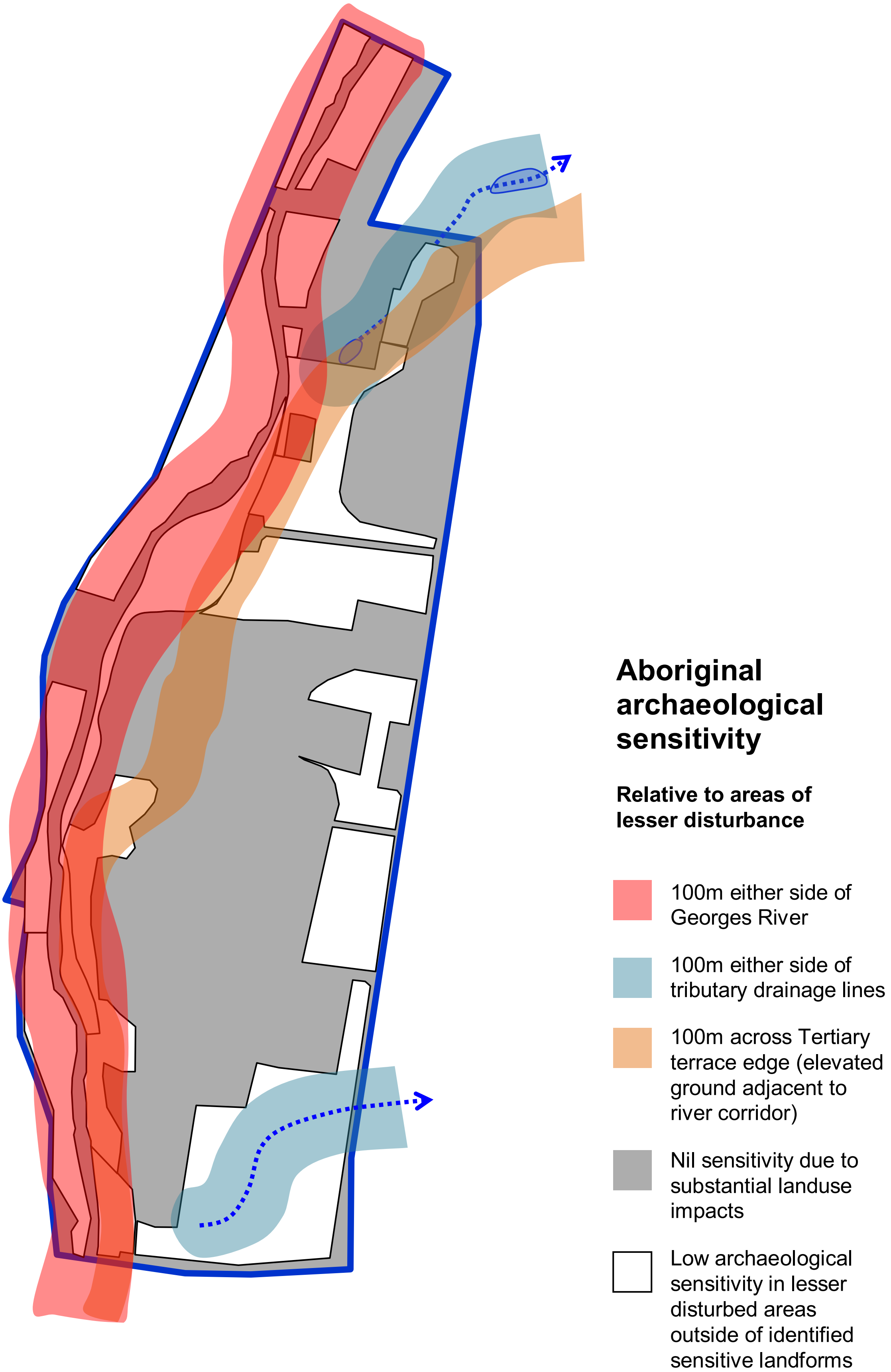

Figure C3 Aboriginal archaeological sensitive landforms compared with areas of substantial and lesser landuse disturbance. This figure illustrates the derivation of the zones shown in Figures 1 and 2. (note: this graphic is from a draft interim report).

APPENDIX 3

GEOMORPHOLOGY REPORT

Stratigraphy and Archaeological Interpretation - Test Excavations at Moorebank Intermodal Terminal site, Sydney, NSW

Draft Report for Navin Officer Heritage Consultants
Draft version dated: November 2012

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Executive Summary

This short report describes stratigraphy examined at seven test pits as part of Archaeological Test Excavation Program being conducted by Navin Officer Heritage Consultants within the Moorebank Defence Precinct. Testing was completed in October – November 2012. The report describes and interprets the stratigraphy and deposits encountered during testing. Interpretation is based on close field examination of sections exposed during the field testing program. Test pits were excavated by combinations of hand and machine excavation.

Key issues addressed in the report are the likely depositional origin of the deposits encountered, their integrity and likely age, the potential of the deposits for preserving archaeological materials and attributes of possible cultural and natural heritage significance.

Implications of the observations and interpretations are outlined. Options for future investigation and mitigation ahead of project implementation are briefly considered.

Future salvage may need to address issues of chronology. Deposits and especially soil horizons, encountered are likely to be later Pleistocene and Holocene age (and so overlapping with the period since human arrival in Australia around 55+/- 5ka BP). These soil horizons and sediments are superimposed on the regolith present on the Tertiary terrace surfaces across the study area. Some sequences may be intrinsically important as natural heritage archives of the environmental history of this part of the Sydney Basin, and the Georges River catchment. The deposit sequences (and their age) will need to be considered *in tandem* with archaeological evidence of use of the area (from artifact and features evidence) in order to confer any special values in the vicinity of infrastructure impacts viewed from the perspective of assessing archaeological significance.

Artefacts located within the upper sand and silty sand cappings at Moorebank may represent discard by Aboriginal people occupying the area throughout the period since the fluvial and aeolian deposits were originally deposited, including the very recent past. This means that even though a sequence of deposits (eg deep sands) may date to pre-10,000 years BP in age archaeological artefacts located within the units may be much younger. Two reliable dating techniques could be applied to the sediments at Moorebank. Radiocarbon dating (^{14}C) on charcoals or Optically Stimulated Luminescence (OSL) dating on single quartz sand grains could be used on the sediments observed. However, with both techniques, great care would be needed to ensure ages generated were reliable estimates of artefacts lodged in the deposits. This would require demonstration of processual association; not just stratigraphic co-association.

Techniques which assist in establishing association should be built into any dating program if salvage is undertaken.

Much of the land surface of the study area, and the broader precinct, has been extensively modified by landscaping and dumping of fill. Disturbance of this kind was easily identifiable in test pits and stratigraphy beneath the fill is often undisturbed. The undisturbed soils – while truncated – retain soil horizons indicative of pre-European landforms, events and palaeoecology associated in some locations with archaeological artefacts. This study has identified *in situ* and clean soil horizons in many of the sensitive landform units, along with some archaeological sites.

It is concluded that, pending the analysis of artefacts recovered during testing, the deposits show potential heritage significance. This may justify limited salvage in target areas, ahead of development. The view that evidence of surface disturbance (from landscaping) automatically precludes any significance remaining in underlying deposits is not a recommended stance – based on sections examined.

The geomorphology, hydrology and wetland habitats of the Georges River seen today close to the study site are probably poor analogues for the river floodplain at European contact or earlier (Nanson et al. 2003). This is important when interpreting features seen in the test pits, and for generally understanding the archaeological record of this area in terms of past environments contemporary with the archaeological evidence.

The sediments seen in the river today reflect disturbance throughout the catchment since the 1830s. Massive mobilization of both sandy and silt-rich sediments has occurred from upper tributary catchments to estuary (Gale et al. 2004; Howarth 2002).

Past and present sediment environments (and sources) in the river are directly relevant to the archaeological record of the study area in at least three ways i) they illustrate the dynamic nature of the contemporary fluvial environments of the George River as a baseline against which to compare the historic and prehistoric floodplain settings and ecology ii) they represent sediments sources which may have episodically contributed to the stratigraphy across the study area during extreme floods and by wind (aeolian) action and iii) the sedimentary environments reflect and may record the range of floodplain habitats available to Aboriginal people in the past as resources. Over late Pleistocene to Holocene timescales sediment availability may have exerted strong controls on the deposition of source-bordering sand accumulations on the lower river terraces, and up onto the river bluffs overlooking the floodplain. Dust inputs to soil stratigraphy on the floodplain bluff and plateau edge may also be significant.

The Georges River catchment has the capacity to flood to very high levels in the lower reaches. Precise maximum flood datums and relationships to flood history have not been researched for this short report. However, maximum historic flood levels will be relevant to the interpretation of archaeology and deposits across this area. Maximum historic floods will only indicate minimum likely flows during the Quaternary and Holocene (Maddocks 2001). High magnitude - low frequency megafloods and climate effects on river discharge will determine prehistoric flood heights. River damming from trees may also be significant factors in determining anabranch formation.

The sampled locations lie on the eastern side of the river. The SW-NE alignment of Anzac Creek and minor tributaries may be important indicators of past hydrological regime and its influence on sediment and soils across the study area.

The sites investigated are located on low dissected plateau where the orientations and occurrence of minor creeks drain to the NE. The long term landform evolution on the edge of the Woronora Plateau and ramp links to regional tectonism (see Brown 2000; Ollier and Pain 1996). The plateau edge around Moorebank is inset within the major recurve of the Georges River where it turns from its northerly entrenched gorge alignment round to the east and into the SE –E alignment draining into the estuarine reach. The plateau surface is mapped as Tertiary alluvium. Palaeochannel and overbank deposits of both Tertiary and Quaternary age are likely to occur across the area. Some Holocene and historic drainage (eg the minor creek and recent "chain-of-ponds" topography may be aligned and superimposed on earlier palaeochannels). Surface anabranches and ponds in the area eg at the MAPAD1 area may track such palaeogeography.

It is not established whether Holocene mega-floods could overtop the lower plateau margins and flow into the anabranches and ponds. The relatively fresh stratigraphy seen at Pad 1 Pit 3 may well relate to lower slope trimming and flood deposition of either Historic or prehistoric age. Historic floods are recorded to above the estimated 100 year flood return level of 9 -10m AHD at Liverpool – the 1873 flood reached 11-12m AHD (Maddocks 2001). 500 -1000 year flood recurrence levels could be much higher. Some archaeological assessments have suggested high flood levels may have impacted on archaeological preservation (see AHMS 2012).

Aeolian accession of sands and silts from exposed flood deposits in the Georges River channel and tributaries are likely to be an important contributing soil forming agent, and a process weathered alluvial units, and soils developed on alluvium of Quaternary or even Tertiary age may be compositionally similar to saprolites, or mixtures of saprolite and alluvium of Tertiary age.

Soils and Regolith Mapping

The 1:100,000 Penrith Soils Landscape Series is the main source of information – ascribing soils in the area to the Berkshire Park Soil Group (Bannerman and Hazleton 1990). This soils landscape unit is characterized as forming on alluvium, often on elevated terraces and comprising shallow clayey sand soils, with frequent ironstone pisoliths. Mottling is common. The Berkshire Park Soils landscape is mapped on the Penrith Sheet as developed on Tertiary terraces.

Soil Landscape Mapping usually correlates with pre-determined bedrock mapping and alluvial terrace age. If parts of the terrace deposits at Moorebank were re-assigned a Pleistocene age the soil mapping unit would be logically re-assigned to the South Creek Soils Landscapes unit[1].

Soil Landscape Mapping does not provide an especially useful basis for archaeological predictive purposes. Primacy should always be given to primary field observations – especially if the stratigraphy or sediment needs dating. Examination of geotechnical logs from the study area would be a useful input to managing future Heritage assessment and strategies.

Field Observations

Detailed records of the sequences were made in the field. Recording comprised detailed section drawing, photography and pH testing of units, and examination of sections and inclusions. Reference sediment sampling of drawn sections was undertaken prior to backfilling. Further methods statements, along with the full archived records, are presented at Appendix 1. Here basic summary descriptions and interpretations are presented. The test pit locations investigated in detail are listed (Table 1).

All test pits examined were between 50cm and 100cm deep, sections were cleaned before being described.

Observation conditions were excellent, with light sun or slightly overcast conditions. Soils were damp to slightly damp when freshly cleaned. One artefact – a broken red silcrete flake – was located during section description at 28cm depth in the SW end of the east-facing (west) section of Test Pit 7 at MA5.

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1 When using such sources for archaeological investigations/heritage management purposes it should be remembered that primary goal of the NSW Soil Landscape mapping lies in soil conservation and management. Soil landscapes are conceived as areas of land which have recognizable and specifiable topographies and that may be presented on maps and described by concise statements (Northcote 1979). The mapping does not investigate or re-consider deposit ages or the time periods over which soil attributes may have developed on either sediments developed by bedrock weathering *in situ*, or soils developed on previously transported sediments eg alluvium or colluvium.

Archaeological Test Excavation Program – Moorebank Intermodal Terminal
Report for Navin Officer Heritage Consultants

Test Pit	Date of observation	GPS log	Depth	Deposit sequence	Interpretation and Significance
PAD 2 Pit 9	1.11.2012	0307574E 6239944N	0-100cm	Made ground (15-20cm) over *in situ* undisturbed bleached sands A2 (E) horizons and Bhs "coffee rock" and concretionary gravels. Shale saprolite expected below test depth. Check geotechnical data for bedrock depths.	*In situ* sequence below 20cm may contain archaeology (eg to 50cm). Soils reflect and inform regarding past hydrological conditions and drainage – prehistoric lower slope wetland margin predicted. Limited variation/correlations between TPs suggest areal stripping of fill to reveal area suitable for salvage excavation would be possible if warranted by artefacts found during testing.
PAD 2 Pit 10	1.11.2012	0307596E 6239930N	0-100cm	Made ground (20cm) over in situ undisturbed A2 (E) and Bh and Bhs + concretionary gravels.	*In situ* sequence below 20cm may contain archaeology (eg to 50cm). Soils reflect and inform narratives of past hydrological conditions and drainage – prehistoric lower slope wetland margin predicted as at Pit 9. Salvage excavation would be possible if warranted by artefacts found during testing.
PAD 1 Pit 4	1.11.2012	0308079E 6242441N	0-100cm	Weak horizons in deep sand sequence – likely Holocene alluvium and with possible aeolian inputs. Bedrock not expected close to BOS.	Well preserved (recent) bioturbation features – probably historic over deep sands – absence of pedogenesis suggests much of sequence may be late Holocene and/or reworked/flood lain. Archaeology possible to base of sequence. Indications of recent European activation/colluviation in upper 30/35cm. Settler and late prehistoric land use narrative probably archived in sequence.
PAD 1 Pit 3	1.11.2012	0308090E 6242461N	0-100cm	0-32cm dump fill over clean contact onto well preserved deep A1/A2 sands and weakly illuvial B horizons at base	Holocene alluvium expected – possibly very recent - assocated with flooding. Wetland marginal environments and sediments contributing from upslope (tillage/colluvium). Settler and late prehistoric land use narrative probably archived in sequence.
MA5 Pit 6	2.11.2012	0307394E 6241093N	0-100cm	0-10cm compacted fill over shallow sharp truncation over preserved A1 and shallow A2 sands. Bedrock expected close to BOS.	Pedogenically mature horizons relatively intact and sufficiently deep to be worth salvaging if high density artefacts located. Overlooking floodplain – high archaeological significance possible where truncation by earthmoving minimized.
MA5 Pit 7	2.11.2012	0307390E 6241082N	0-100cm	0-15/22cm locally truncated – but relatively undisturbed conformable sands, over incipient B horizons at base of section.	Moderate to well developed soil horizons consistent with valley margin situation over shale saprolite. Area has high potential for salvage – despite localized truncation. Position of artefacts likely to be dispersed within Unit II as bioturbation/mixing within unit has been high.
MA5 Pit 10	2.11.2012	0307402E 6241131N	0-100cm	Thin fill over very sharp truncated surface of E horizon / A2 profile. Unmixed subsoil profile through most of section.	Much upper sequence including horizons likely to contain archaeology missing. Thin sequence reflects leveling of landform on valley edge.

Table 1 Summary of NOHC Test Pits examined in detail.

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General properties of the deposits across the study area

The observed soil profiles investigated are consistent with the geological mapping for the area, namely as Tertiary alluvial terrace landscapes.

Relatively deep sandy soils occur over most of the area. The soils show pedogenic properties and horizon development in patterns consistent with elevation and the geomorphological surfaces and landforms on which they occur. Bleached horizons are common in the soils across the area – equivalent to an A2 horizon or E horizon definition (Butt et al. 2005). The bleached horizons overlie less permeable clayey subsoils or incipient pans. Shale saprock is suspected below levels excavated in test pits at some locations (Test Pit 7 and 10 in MA5). The soils are all variants of podzols with variable albic bleaching and coarsening in A2 or E horizons.

Locally bleached horizons are underlain by well developed "coffee rock" iron-humate cemented structures in some test pits (PASD 2 Pits 9 and 10). It would be unwise to assume these soil formation horizons are age-indicative as complex relationships (spanning late Holocene to Quaternary or older timescales) have been proven in shallow (1.0-1.5m deep) Podzol sequences within visually simple E and Bhs horizons (Field and Humphreys 2002).

All test pits showed evidence of recent disturbance in the upper parts of the profiles observed. The study area has sustained substantial modifications by spreading of fill across the surface and modifications of slope (grading). This has been noted in previous evaluations and geotechnical investigations in the area (AHMS 2012; Steele and Dallas 2001). Stratigraphy in the test pits confirms combinations of:

- Truncation and removal of upper soil units – especially Ao and A1 sand profiles.
- Additions and spreading of subsoils across the area onto a) truncated profiles and b) by plastering onto locally intact soil profiles. The added fill units vary from shaley clayey subsoils to clastic sandstone gravels and very poorly sorted (diamictic) dumps. Some fills are clean. Others are full of age-diagnostic debris and refuse. Depths of fill are typically 10cm-30cm.
- Deliberate infilling by dumping around margins of wetter depressions and former channels
- Use of machines to cut and truncate soils profiles and also to compress and overconsolidate sediments as made-ground.

The heritage implications of the observed disturbance are a) soil horizons likely to contain archaeology are locally removed and reworked b) *in situ* archaeology and associated undisturbed soils exist in undisturbed A1 horizons and also in near surface situations where fill has been plastered over landsurfaces c) surface observations of artefacts will be minimal (underestimate true archaeological distributions) due to fill cover and d) surface occurrences of artefacts may be unreliable as spatial and quantitative indicators of where archaeological materials occur preserved across the landscape.

The extent of fill makes subsurface archaeological preservation very difficult to predict. Some significant palaeotopography (eg small dunes, channels, soaklines and ponds) may be removed or buried.

Conversely, most fill is very easily identified in section or in plan. Normally the contact of fill onto underlying *in situ* soils is sharp, obvious and well preserved. The unmixed nature of many of these sharp truncated interfaces indicates their relatively recent age. If archaeological salvage excavation is justified – quick removal of overburden fill, by machine, down to levels at which salvage excavation can commence will be a practicable quick option.

These observations indicate:

- testing subsurface is the only viable method of detecting *in situ* archaeological materials across much of the area.
- the remaining soil horizons provide good indications of where former intact historic and prehistoric surfaces remain, and also indicate where most topsoils are removed (ie the completeness of the sequence can be read).

In area MA5 the pits showed progressive deeper truncation of the former soil sequence northwards. This is consistent with leveling and may indicate removal of former topography eg. as source bordering sand bodies along the terrace margin. The three test pits suggested the most preserved sequence lies in the south of the test pit transect.

Bedrock was not observed. However, clayey subsoils and locally shaley clasts within subsoils were observed, consistent with Ashfield Shale geology at depth. In PAD 2 and MA5 shale saprolite is expected < 1.0m below observed base of sections (BOS). Geotechnical data would usefully be investigated to test these predictions.

The stratigraphic sections seen during field excavation and recording show that soils and deposit sequence preservation across the areas of investigation is patchy, highly variable and difficult to predict. Present and previous land use, development and ongoing geomorphic processes such as minor sheet-flooding, rilling, revegetation together with rejuvenated soil development are transforming remnants of older soil profiles and deposits. These processes are capable of being either locally destructive or protective of preserved heritage values.

Evidence of disturbance, made ground, soil profile truncation, sediment translocation and dumping was ubiquitous. However, there is also evidence of *in situ* weathered A1, A2 (E) and B horizons close to surface, and locally evidence of very well preserved soil structures (especially hydromorphic features) which must relate to ground conditions from earlier (pre 20th century) of historic or prehistoric age close to surface.

Archaeological significance of the deposits

The majority of the stratigraphic sequences are variants of podzols. Hydromorphic properties suggest poor drainage and depths to saprolite and bedrock are important factors in determining soil properties throughout the area. Some soils may indicate proximity to wetlands in the past – ie indicate past local habitats and resources available to prehistoric human populations. Observations of catenary (lateral) soil developments along transects would help validate such interpretations.

During any salvage activity – trench excavation to expose sequences would be advantageous ahead of total destruction of the deposit sequence by development. This would only be appropriate after sampling for archaeological finds, and where any options for preservation <u>in situ</u> are definitely precluded.

All soils observed have sufficiently deep sandy subsoil units to act as very efficient traps in A1 and A2 parts of the profile for discarded artefacts. Bioturbation and upcasting of sediments in these soils is likely to "spread" artefacts vertically through, and potentially deep within, the sequence. The depth distribution of artefacts may not be archaeologically meaningful – incipient "stone lines" of artifact rich zones may result. Historic ploughing may have exacerbated such movement tendencies. Activations of down-slope movements of sandy silts was interpreted at pits in the PAD1 area.

The deposits and soils horizons developed on them do represent relatively stable environments as land surfaces overlooking the floodplain of the Georges River. Dating will be possible on these quartz rich sands. For dating techniques like OSL to be effective and reliable, close consideration should first be given to the process and soil formation histories of the target deposits. Micromorphological investigations may assist in reaching this goal (Davidson and Simpson 2001; Kemp 1985).

The archaeological significance of the deposits is evaluated provisionally as moderate to locally high based on the capacity of the observed sequences:

- to preserve soil histories and information on past environments (especially around ponds and water courses)
- to preserve discarded materials within the stratigraphy at depth
- to preserve features (cuts, burn out features)
- the quartzose sand and charcoal observed - which can be used to produce age-estimates
- observations of artefacts subsurface

The significance of the terrain units is archaeologically reduced by extensive landscaping and surface modification. However, while reducing significance, it does not remove all heritage values as soil subhorizons preserve intact at most points observed.

It will be prudent , appropriate and effective to remove all fills by machine to expose unimpacted in situ surfaces before commencing salvage excavations if required.

Recommendations

These observations support the NOHC approach of targeting sensitive landforms. Sufficient sequence preservation is demonstrated to advise further salvage *where and if* significant number of artefacts (or archaeological features) co-occur with *in situ* undisturbed soil units beneath fill – even if truncated. It is also noted that fill is so extensively plastered across the landscape (and so frequently is composed of subsoils likely to be archaeologically sterile) that any surface observations of artefacts are surprising and must poorly represent/ reflect pre-European site distributions across the landscape both quantitatively and spatially. Some surface artefacts are likely to be relocated by landscape modifications. Precedence should be given to artefacts reliably recovered from beneath fill if archaeological conservation or salvage areas are to be defined (eg Pit 7 MA5).

It is quite possible much higher frequencies of artefacts remain undiscovered by surface survey beneath the fills.

It is recommended:

- That limited salvage is considered /undertaken where significant numbers of artefacts have been identified in the immediate sub-fill soil units.

- Consideration is given to back-stripping fill around such areas eg over 5m x 5m areas to then investigate whether artefacts are visible beneatrh truncated interfaces.

- That where total destruction of soils sequences is anticpated some trenches are dug and recorded to archive the information preserved in soils sequences.

- That as a precursor to any salvage investigations being undertaken geotechnical data (eg on depth to saprock) is reviewed in all areas of interest. Soils sequences observed here in this limited study, seem to indicate the three-dimensional topography and architectures of underlying saprock surfaces may be good indicators of where overlying archaeological sequence may be least disturbed.

- OSL, TL or radiocarbon dating should not be undertaken unless the macro and micro-properties of the sand sequences are first assessed. These types of sequences are known to represent challenges for dating (Field and Humphries 2002) and great care is required to produce archaeologically meaningful results. Developing chronologies from these soil development and sediment sequences are scientifically important objectives (eg to calibrate megaflood levels) but must be conducted prudently.

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APPENDIX 1

STRATIGRAPHIC LOGS AND DESCRIPTIONS FROM TEST PITS (TPs) AT THE NAVIN OFFICER HERITAGE CONSULTANT TEST EXCAVATION PROGRAM - MOOREBANK INTERMODAL TERMINAL SITE, LIVERPOOL, NSW.

The logs and descriptions of the Test Pits provide an archive record of the stratigraphy observed. Terminology used follows published standards and methodologies used internationally for archaeological soils and stratigraphy (see Courty *et al.* 1989; Davidson and Simpson 2001) and for Quaternary sediments and soils (Gale and Hoare 1991; Kemp 1985). Where conflicts exist with Australian soil systems and taxonomy, inclusive regolith methodology and terminology are preferred (see Ollier and Pain 1996) over other soil landscape approaches.

Where geotechnical borehole data are interpreted, or off-site geotechnical data linked to archaeological site stratigraphy, the methods are as outlined by Bates *et al.* (2000) and Barham *et al.* (1996).

Description focuses on sedimentological trends through and between units, and on the nature of the stratigraphic boundaries (interfaces) between units as aids to *sequence* or *deposit unit* interpretation. Descriptive terminology is kept distinct and separate from interpretation. Descriptions form the site archive – interpretations should always be revisable (Barham and Macphail 1995).

Some points of importance in assessing archaeological values and significance are typed in bold (eg. **buried soil Ao profile**).

Test pits were dug nominally to 100cm depth. Test pit stratigraphy was logged in detail for 7 test pits (see Appendix 1).

Stratigraphic descriptions include visual estimates of particle size sorting, grading (ie vertical changes in the modal particle size up and down the profiles) and occasionally trends in grading are identified eg. terms like 'fining-upwards' may be used. When the term *massive* is used it means an absence of stratification or structure within the deposit (Fritz and Moore 1988). Boundaries observed between visually or texturally different deposit units were defined in terms of how sharp or gradual they were ie. in terms of boundary distinctiveness (sharp, clear gradual) and also boundary form (wavy, undulating etc.) see Courty *et al.* (1989). Evidence for mixing or movement of sediment across boundaries was also noted.

Pit 9 PAD 2 **GPS 0307574E 6239944N** **NOHC Moorebank IT**	**Depth**		**Stratigraphy**
	0 – 15cm	Made ground Units Ia-Ic	Weakly developed thin Ao horizon and rootlet zone (0-5cm) overlying hard-setting very poorly sorted gritty sandy silty (locally clayey) sands 10YR 7/1 light grey and minor gravels.Compressed and over consolidated. Occasional shale clasts 50-80mm subangular. Grey silty infill to very sharp bioturbation burrows (recent) indicating upcast of sediment from underlying unit. Occasional patches of red stained clays and sandy clays (not in section = imported fill). Locally packed and deformed/stretched lenses of red stained sandy clay (deformed by strain = machine packed and graded fill. Very sharp, planar basal contact at 13-15cm. Medium lateral tree roots extensive along the sharp interface. Contact is mostly unbioturbated – suggesting recent age. Inferred sudden burial with minor surface truncation and then packing down of overlying fill. Burial of previous "active" lower profiles of remnant A1 and complete A2 profiles. No *in situ* archaeology possible in this unit unless of very recent historic age
PIT 9 Upper 13-15cm of dumped poorly sorted fill unconformably overlying truncated but *in situ* A2 and Bh horizons (coffee rock) at 50-70cm and nodular concretionary gravels 65-70cm capping firm mottled clayey sands (80-100cm)	15-40cm	Units IIa – IIc Grey grading to very pale grey (bleached E horizon) silty sands (buried former lower topsoils)	IIa - Grey (2.5Y 6/1) medium silty fine sands to medium silty sands, slightly hard setting with occ-frequent 5-10mm angular charcoal fragments in matrix, and as dispersed lenses – particularly 20-25cm depth (residual buried A1?). Decreasing staining and organics (IIb) with depth. Clean – minimal mixing of overlying fill. Very well sorted silty fine sands –grey (2.5Y 5/1) mottled and bioturbated with infills to root tubes. Occ dispersed charcoal <5mm grading - at 25cm - to IIC v.fine silty sands - v.occ. charcoal slightly hard setting
	40-55/60cm	Unit III Bleached sands –	10YR 7/2 light grey very well sorted slightly soft hard setting fine to very fine sands with silts. Homogenous, Little structure (massive) or intrusive material - E horizon overlying residual concreted and fissured illuvial Bhs)
	55/60cm -70-76/80cm	Unit IV Humate cemented sands with well developed "coffee rock" blocks	Humate and iron cemented sands with well developed block structure and fissures through unit. Humate and sequioxide cemented very dark grey brown crusts to blocks, some fibrous rootlets (relic) and rootlets ghost structures. Locally red-brown 5YR 5/6 yellowish red) sands. Concretionary block structures developed on fine sands Undulating and irregular gradational contact 70/76cm
PIT 9 Hardened and fissured blocky (unit IV) Bh sands as "coffee rock" below base of bleached massive sands (unit III)	70-76/80cm to 100/105 cm *BOS = 105cm*	Unit V concretionary nodular fine gravels over Unit VI firm locally mottled clayey silty sands	Unit V yellowish concretionary nodular 10-30mm fine-medium gravel (loose) supported in fine sandy silt and fine sands- occ modern live roots persist. Grades into Unit VI yellowish-brown firm to v. frim well sorted – mod. sorted mottled yellow sands with clayey (cutans) infilling to pores in sand matrix – patches of larger mottling 10YR 5/8 to 10YR 7/6.

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PAD 2 Pit 10 **GPS 0307596 E 6239930N** **NOHC Moorebank IT**	**Depth**		**Stratigraphy**
 Pit 10 located at base of slope, near drainage line and swale on golf course perimeter	0-3/5cm	0-3/5cm developing soil on dumped fill	<5cm of weakly developed Ao as thin sandy cap to very compact hard setting fill.
	3/5cm to 12-18cm	Unit I Imported shaley subsoils – poorly mixed and over-loaded and consolidated by machines as fill/made ground. Largely plastered over *in situ* landsurface on inclined very sharp contact	Heteregenous mix of shale clasts, clays and sands. Clasts variable up to 70x 20mm typically 50 x 30mm with *in situ* "squeeze'deformation of clayey sand ball clasts. Local shear planes developed. Mix of pure grey sand lenses and patches of white sands and clayey sands and red-stained heavily mottled clayey sands. Note admixture of grey (reduced) and red (oxidized) lumps of fill – pH not equilibrial. Interpretation: landscaping by dumping and machine spreading and overconsolidation of fill comprising subsoils derived from Waianamatta Shales areas. Very sharp – contact inclined (sloping east-west) unconformable contact – little mixing across interface.
	12/18cm to 20-30cm	Unit II Fine sands	Very fine to fine sands with charcoal flecking. Sparse but consistent charcoal throughout. Dipping west, occasional lenses of charcoal – frequent modern live tree roots on upper contact and to 25cm. Friable - not hard setting. Variable to diffuse transition and dipping contact at base.
	30-52/55cm	Unit IIIa	Damp very homogenous bleached well sorted fine to medium silty sands. 2.5Y 5/1. Locally coarser with occ. grits. Interpreted as well developed bleached deep E horizon (A2). 52-55cm gradational contact.
	52/55-60cm	Unit IIIb	Fine to slightly silty humate stained sands to 5YR 3/2 reddish brown.
Thick weakly graded and compacted poorly sorted diamict Unit I (fill) from surface to 15-20cm depth at Pit 10. Indicates recent landscaping by machines dumping and landscaping imported fill derived from shale subsoil and saprolite-rich sources.	60-70/80cm and 80-100cm	Unit IV and V	Unit IV Fissuring to upper concreted surface of sandrock blocky structure with occ. modern roots – well defined hard crust to the fissured surface. Variable 7.5YR 5/6 to 7.5YR 3/2 locally 5YR 3/2. Possible reactivation of buried palaoefeatures by recent profile shallowing(?). Unit V humic stained sands 80-100cm 2.5 6/3 light yellow brown to 10YR 6/3. At BOS variable mottled and cemented clayey sands (Unit VI) discontinous at base > pallid.

PAD 1 Pit 4 **GPS 0308079N 6242441N** **NOHC Moorebank IT**	**Depth**		**Stratigraphy**
	0- 5/10cm	Recently disturbed topsoils	Locally truncated cut features to 10cm with infill of burnt clay exotic to sequence.within shallow weak Ao organic stained sands. Weakly developed topsoil.
	5/10cm to 30/35cm	Organic stained medium sands	10YR 6/4 (damp) medium to wells sorted to mixed medium sorted sands grading with depth to 7.5YR 5/2 occasionally mottled or patch from disturbance /mixing. Diffuse gradational contact at base as undulating transition into underlying sands.
			Occasional patches of charcoal on lower interface
Relatively undifferentiated deep sand profile at Pit 4. Possible overprinting of lower bleached units from 35-50cm – rejuvenation of profile at depth? 	30/35cm to 90cm		From 30/35cm very well sorted medium sands grading to very fine to medium sands 10YR 6/4 to 10YR 6/6 as fining upwards sequence from about 60cm . Sands >consolidated and very well mixed with some grits and paler (E horizon) around 60-80cm – srained and possibly re-activated with organics from above (evidence of removal of upper profile/ shallowing of sequence?) Very well mixed sands at base – limited pedogenesis.
Pit 4 – N-facing (south) section of pit (SE on left) Steep dipping contact with charcoal- rich brown sands (5YR 3/1 and 5YR 3/2) medium well sorted sands as fill and possible buried A1 horizons (infill to 30-32cm) interpreted as evidence of tree burn out features. Mixed upper profiles and underlying organic buried topsoils may indicate ploughing and addition to soil profile by downslope creep and wash.	90- 100cm		Gradational change to 10YR 7/6 well sorted sands with very occasional sandy soft concretionary nodules 23-30mm rounded with silty sand cores. Matrix supported and dispersed. At base silty sands and very slightly clayey with weak mottling. 10YR 5/6 mottled on 2.5Y 7/6 and 2.5Y 7/4. Still soft and unconsolidated.

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PAD 1 Pit 3 **GPS 0308090E 6242461N** **NOHC Moorebank IT**	**Depth**		**Stratigraphy**
PAD 1 Pit 3 Stone block in upper 30cm of stratigraphy on NE corner of Pit 3. Also cable and pipe fragments. Recent fill unit overlain by poorly sorted v dark grey-brown sands (10YR 4/2) without clastic debris (wash from upslope in field). . 	0 -10-15cm	Overland wash and recent makeup to datum on lower edge of field	Organic stained very poorly sorted fine to coarse sands and silts 10YR organic stained. Damp to moist medium to dark brown (10YR 3/1) (sandy loam) clayey silts and sands. Sharp lower contact – some small scale bioturbation. Infrequent very recent European debris - loose sands
Grey stained sands underlying sharp unmixed contact at 30-32cm depth – hiatus 	15-30/32cm	Dumped fill and rubbish – rapid dumping into edge upslope margin of poorly drained area.	Very poorly sorted (diamictic) matrix supported rubble including stone blocks, broken glass from beer bottles, sewer pipe fragments and plastic cable. Voids prevalent, unfilled locally. Numerous gravel clasts 20-40mm no preferred orientation in clasts and gravels. Very sharp unmixed undulating planar interface at the base of unit. European late C20th debris dump
	30/32cm to 40/45cm	Well sorted subsoil sands	Sharp contact onto well sorted clean medium sands with some silt (10YR 8/2 to 10YR 6/2)
	40/45cm to 85/90cm	Well sorted slightly coarse friable medium sands Mostly structureless and bleached	Massive structureless medium sands with very occ coarse sand thoughout. Locally bleached. Slightly hard setting. Patchy infills of dispersed fine charcoal rich grey sands (root burn outs) as intrusive wedges in unit
	90-100/105 cm	weakly illuvial B horizon mottled sands	10YR 6/6/ 10YR 6/8 medium sands very well sorted with very occasionl sandy silty concretionary nodules – very dispersed., Mottled sands > weakly cemented and over-consolidated at extreme BOS (100-105cm)

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MA5 Pit 6 **GPS 0307394E 6241093N** **NOHC Moorebank IT**	**Depth**		**Stratigraphy**
	0 – 10cm	Made ground – variable across pit from upslope to down-slope	Unit I - Coarse packed sandstone clastic gravel – over consolidated and with minor injection features (wet load) with machine cut planar cuts locally at base and partings from shear (lateral) – unbioturbated (very recent) – locally possibly conformable or with only minor erosion truncation of underlying organic stained sands . Very sharp lower contact – locally appears conformable suggesting burial of previous Ao topsoil surface *without truncation* at some points in section
			Fill – compacted – sometimes burnt clay at lower interface
Pedogenically mature shallow A1 and subsoil,sequence, with organic overprinting in upper A2 overlying a consolidated mottled clayey subsoil – pit located at slope break on edge of plateau overlooking Georges River.	10-20/25cm	Preserved A1 horizon	Unit II - mixed grey-brown sands – locally with small dispersed charcoal flecked and occasional coarse sands + grits (2-3mm) > with depth very well mixed – diffuse boundary at base grading (see photo below left) into
	20/25cm to 50cm		Unit III – moderately sorted medium gritty sands slightly hard setting – coarse sands and grits dispersed within the sands 2-3mm. Gradual undulating transition at base from 50-54cm into mottling
MA5 Pit 6 Detail of sandstone clastic gravel rubble fill with compression and minor injection features (machine landscaping with wet sediment) overlying burnt clayey thin unit and well preserved organic stained top soil sands on planar (intact?) contact.	50cm - 74cm (BOS) to 75cm	BOS = 75cm	Pale yellow sands with Fe mottles within medium sorted sands – becoming slightly clayey silty at base with > mottling – very stiff silty clayey red mottled and blue-grey silts in the east side of the trench in base of section.

MA5 PIT 7 **GPS 0307390E 6241082N** **NOHC Moorebank IT**	**Depth**		**Stratigraphy**
	0- 20/22cm	Unit I locally disturbed Ao and A1 fine silty sands	Localised cut and fill in surface lens scrapes – sharp basal contacts – into 10YR 5/2 grayish brown organic stained silty sands gtrading to very light gray 10YR 7/1 – with surface rootlet layer and gradual transition along well bioturbated transition into..
	20/22cm to 50/55cm	Unit II Hard setting bleached moderately sorted grey sands A2 (E horizon)	Highly bioturbated homogenous bleached moderately sorted sands, with rounded 2-3mm very fine quartzose grits throughout. Well defined silty fill to vertical burrow features within sands. Very pale grey 10YR 7/1 to 10 YR 7/2 Gradual transition (gradational) at base into zone of Fe stained patches and occ. Fe stained concreted bioturbation traces 30 x 20 x 3mm broken red silcrete flake in section at 28cm depth
	50/55cm to 78/82cm	Unit III bleached sands E to B horizon transitional	Medium sorted bleached gritty sands (>grit with depth) > silty and very slightly clayey with depth –compact - occ modern live rootlets to 60-70cm
MA5 Pit 7 - Well developed horizons in sands – and overprinting of former bleached E horizons by organics from above. 	78/82cm to 90/92cm	Unit IV Mottled moderately sorted medium sands	Zone of very dark brown patch mottling at top of unit – in fine silty sands (better sorted) > 2.5Y 6/6 pale olive yellow sands with local mottling to 10YR 5/6 and some black staining and spotting (manganese) - illuvial clays >
MA5 Pit 7 – silcrete broken flake at 28cm in section (left of scale) in undisturbed bleached sands of Unit II - note disturbance to upper 10cm of section but not gradational change frombase of Unit I into Unit II	90/92cm to 100cm	Unit V stiff clayey mottled sands BOS = 100cm	Very stiff to hard clayey and silty sands. Mottling red (10R 4/6) and patchy with matrix of 5BG 4/1 to 10B 5/1 bluish grey sandy clay. Poorly sorted sands medium to coarse sands – clay content high (moulds. Likely saprolite mix from shale bedrocks (?)

MA5 PIT 10 **GPS 0307402E 6241131N** **NOHC Moorebank IT**	**Depth**		**Stratigraphy**
 MA5 Pit10 Gravel fill unconformably overlying subsoil sequence (bleached E horizons) over mottled clays – sequence only 50cm deep. Much of upper pedosequence missing. Sequence is a reactivated and truncated A2 profile with B horizons at base.	0-10/12cm	Poorly to moderately sorted compacted fill on truncated surface (sand soil sequence removal)	Very compact blocky clayey and clastic medium gravels – FILL. Matrix supported. Unit sits on slightly undulating planar very sharp interface – cut surface, Clasts to 40-50mm typically, occ to 70mm. Some minor compression features. 2.5Y 7/6 (yellow) and inclusions as patches to 10YR 6/8.
			Recent dumped and compressed clastic gravel fill.
	10/12cm 30cm -		Very sharp – mostly unbioturbated interface above – into hard setting bleached light grey (2.5Y 7/2) medium to slightly coarse quartzose gritty sands. Frequent 2-3mm pellets in sands. Intrusive silty fills into recent burrow intrusions in upper 20cm of unit are unmixed into unit. Interpreted as recent down- mixing of fines from overlying fill via burrows/roots into otherwise undisturbed E horizon subsoil – which is reactivating now overlying units removed and fill emplaced. Deep upper sand sequence interpreted as removed by landscaping prior to fill deposition. Subsoils now closer to surface than previously (prior to landscaping).
	30-40/45cm	Unmixed original subsoil horizon	Grades into moderately sorted gritty very light grey sands with frequent 2-3mm pellets and quartz grains – hard setting Sharp undulating transition 40/45cm
	40/45cm to 50/52cm BOS	Subsoil clays	. Clayey red-stained and locally mottled very stiff sandy silty clays and clayey sands locally blue grey and gleyed
	BOS = 50-52cm		

APPENDIX 4

LITHICS ANALYSIS

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Aims

Descriptive recording and analysis of recovered artefacts aimed to determine the following:

- Quantity of stone, by counts;
- Suspected origin of the stone (whether from quarries where the rock is in place, or dispersed along riverbeds);
- Identification of the artefacts;
- Interpretation of finished implements among the artefacts, including function of the implements and what they indicate about how the makers lived;
- Patterns in spatial and chronological distributions of the artefacts;
- Archaeological research potential

Approaches to Australian Stone Artefact Studies

There are three key questions that are relevant for examining Australian stone artefact assemblages:

- What technologies were present during the Holocene?
- What changes occurred?
- Why did these changes take place?

It is usually the case in most situations with prehistoric remains that stone artefacts are always better preserved in the archaeological record than organic matter. In Australian ethno-historic records there are references to stone artefacts but few detailed descriptions of manufacturing, utilisation and discard processes that occurred. In fact most of the Australian Aboriginal material culture recorded during the time after European contact was made from organic material, for example boomerangs, digging sticks, carrying items, bags, nets, fishing lines and hooks, spears etc.

Since the 1970's, stone artefact analysis has gone through some fundamental changes. Archaeologists are moving away from a typological analysis of stone artefacts and have begun to use a technological perspective in their analysis. Within stone technological analysis there are many terms which hold certain connotations when used. For example ***industry*** when used has undertones of being a chronological marker, an ethnic pattern or a set mental template of ideas. There are three main artefact analysis approaches used in Australian Archaeology.

A ***typological approach*** can include a mixture of different analytical attributes, including functional types (e.g. adzes), technological types (e.g. cores), ethno-taxons (tulas), and descriptive types. This approach is one of the most widely used in Australian archaeology and commonly concentrates on stone ***tools***.

Tool or "thing *designed* to help or enable the hand(s) to apply force", is commonly used for artefacts that fall into the categories just described, or refers to artefacts that have some form of use-wear. Anything else was commonly referred to as ***debitage***.

A ***Functional approach*** that utilises microwear analysis and replication experiments depending on the problems pursued.

A ***technological approach*** is artefact holistic and takes into account every step of the artefact manufacturing process from procurement to discard. This includes logistics of stone procurement, core preparation, flaking properties of stone, assemblage formation, mechanics of stone fracture, which is sometimes through replication and so on.

These three methods of archaeological analysis are either conducted separately or in a combination. A trend towards technological and functional analysis has been taken in studying Australian prehistoric stone artefacts to answer research questions that cannot be dealt with through purely typological approaches.

There are two main changes in stone technology are currently believed to have occurred during the last 10,000 years that are important for Australian archaeology. The first is the spread of artefact types, ground stone axes and flaked stone adzes through all or most of the continent. The second is the addition of a number of new forms of retouched artefacts. There is some evidence that these changes occurred concurrently in southern Australian at about the same time (Hiscock 2010).

Backed Artefacts and Points

Changes in the stone artefact assemblage in Australian prehistory was first recognised in 1930 when Hale and Tindale excavated Devon Downs rockshelter on the lower Murray River and found stratified variability in stone and bone artefacts. Further recognition of these changes was made by McCarthy and later D.J. Mulvaney. This later led Gould to coining the term "Australian small tool tradition" for the new forms and this was widely adopted. However there are still a number of new forms, most of which display formally identifiable patterns, the dating of both their commencement and disappearance and the description of their economic and sociological importance. According to Mulvaney the small tool tradition was defined by the development of blade tool production along with some pressure and percussion flaking primarily to make a variety of points and backed artefacts. Johnson sees that the difference the small tool tradition and earlier traditions as consisting in a general reduction in artefact size, more controlled flaking with core preparation the greater use of fine grained raw materials and the introduction of new more formally and functionally specialised tool types.

Backed Artefacts

These are thin blades or flakes, usually triangular in cross-section, mostly 1-5 cm in length with abrupt, blunting retouch along part or all of one side. Within this group there have been a number of different forms that have been recognised, including Bondi points, Woakwine points, and geometric microliths of various shapes which can be generally defined as assymetrical and geometric. It is inferred they may have been used in "death" spears like examples from the 19th century which had small quartz flakes inserted into resin on a spear shaft. Bondi points have been assumed to be a product of a blade technology. There are no technological reasons that Bondi points are the result of a specific blade industry. If Bondi points were part of a blade technology then the results should show that there are many blades during their use and few after their decline, however this is not the case as blades are still part of the assemblage after Bondi points decline. A recent article by Hiscock and Attenbrow has slammed the use of the term "backed blade". They advocate that this terminology has too many misconceptions and now researchers have to explain the "backed blades" they are analysing are not really blades but flakes. Therefore Hiscock and Attenbrow advocate that they are labelled as **backed artefacts**.

Elouera

These tools might well be described as large and crudely backed artefacts, shaped like a segment of an orange. They are usually 3-8 cm long with a mean length being nearer the lower end of the range. One margin of the segment is unretouched and this thin edge is sometimes use-polished. The definition of the tool has not been precise as McCarthy refers to scraper-trimming on the thick edge and Mulvaney and Johann Kamminga say it carries blunting retouch. The presence of use-polish has sometimes been used as a defining characteristic. This artefact type can be more appropriately called a retouched flake and would not use this type description often.

Points

These are made on flakes, often triangular in cross section, usually leaf shaped in form, with width being about one third the length. Both unifacial and bifacial forms occur, and within both these broad groups there is secondary trimming and shaping ranges from fully covering the surface to occurring on one margin only. Among unifacial points a distinction has been drawn between *pirri* points and *lelira* "blades" on the basis of the function of the latter in the 19th century and on the relative lengths, *lelira* being defined as longer than 6 cm. Technologically I see that there is not much difference between the two unifacial points other than large points and small points. Among bifacial points the main distinction

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between types is between plain edge from serrated edge or Kimberley points. Kimberley points are generally 2-10 cm in length with surface slaking by percussion or pressure.

Distribution of Retouched Artefact Types

The distribution of the various artefact forms is not a coincidence. The two different forms of backed artefacts, geometric and assymetrical are found indifferent parts of Australia with slight overlaps in areas. The assymetrical backed artefacts are generally found along the eastern coast of Australia. Geometric blades are found in other regions of Australia. Neither occur in the top end of the NT. This may reflect that there are two different functions occurring. The distribution of the Elouera has been less well described. These artefact types are reported from most parts of Australia but usually in small numbers. The areas where large samples have been found include the central coast and highlands of NSW. They are purported to exist from sites in Arnhem Land NT, but they should be defined as retouched flakes. Eloueras occur only in association with backed artefact industries and not subsequent to back blades.

Points display a very different distribution to backed artefacts. Generally unifacial examples occur in a broad band across Australia, although precise boundaries have not been established. Unifacial points are found throughout the tropical north. Bifacial points have a distinct distribution essentially to the tropical north, the Kimberley's and the top end of the Northern Territory. Occasionally trimming of the proximal end of points occurs on unifacial points in the southern areas of Australia which can be defined technically as bifacial flaking, both the ventral and dorsal surfaces. Kimberley points are mainly restricted to the Kimberley region of Western Australia and were traded over much of the surrounding regions to central Australia and western Queensland. Therefore the general pattern is below this line (OHT) only unifacial points, above this line both bifacial and unifacial. Generally this is then same line for backed artefacts as well.

The appearance of backed artefacts marks a change in the way people used their existing technology and represents an intellectual shift in the way they used stone artefact technologies. Therefore backed artefacts are not just a new separate innovation but a continuation and regularisation of reworking stone through retouching. The date at which these changes occur are thought to be oldest in the south east corner of Australia. Since the early 1960's, radiocarbon dates for the start of the small tool tradition have suggested both that its elements appeared at about the same time and that their spread across the continent occurred in less than a 1000 years. Conversely there has been evidence that the dates suggest that the appearance of these new forms was erratic within any region. Therefore there has been much argument within the archaeological community about the antiquity of backed artefacts and points.

Backed Artefacts as an Australian invention.

Johnson rejected this model with the use of taphonomic processes to discount the antiquity of backed artefacts and that they had moved into the lower levels of sites. For example two sites in NSW, one at Burrill Lake has a date for the backed artefacts of 5320 BP and Curracurrang has a date of 2865 BP. Johnson's explanation for this is that post depositional processes, ie disturbance caused the blades to move downwards. Johnson believed that the backed artefacts were introduced from elsewhere and not an internal adaptation by prehistoric Australians but an external adaptation. Phillip Hughes disagreed with Johnson's interpretation of Currarong 1 as he noted that the deposit had a high degree of stratigraphic integrity and there were not a large number of backed artefacts in the deposit above the 4800-7000 level to have acted as a reservoir of material to move to lower levels.

Regardless of the precise dating of these retouched artefacts, these artefact types have been lumped together under the one umbrella of the small tool tradition. This has been viewed traditionally that all stone artefact types came from a single origin and appear at the same time, tulas, backed artefacts, points etc in a single "package". The hypothesis has been made that this was an introduced technological revolution that came to Australia. Gould named it the "small tool tradition" after a similar stone artefact assemblages from the artic of northern America where there was an introduction of blade technology. There is growing doubt about the usefulness of such a concept of the "small tool tradition". The geographical distribution for each type of artefact is vastly more complex than it first appears. The uncertainty about dating of the different types of artefact types and reluctance to accept older dates. Also there is uncertainty about the ill defined functional relationships between different types. The overall "package" idea does not fit with the distribution of dates and artefact types across the continent.

Methodology for Stone Artefact Analysis

Stone Artefact Identification

A requirement for successful archaeological projects involves the accurate identification of archaeological materials. Since the identification of stone artefacts is basic to the accurate recognition and measurement of the archaeological record it is imperative that people undertaking archaeological surveys be able to differentiate between natural objects and artefacts. Principles of artefact identification employed in this survey follow those recommended by Hiscock (1984) and further discussed in Holdaway and Stern (2004).

Each time sufficient force is placed on the surface of an isotropic rock it will fracture into two pieces. The fragment that has been struck contains the ring-crack, where fracture was initiated, and is called the flake. The flake is usually the smaller of the two pieces of stone. The larger fragment, from which the flake has been removed, is called the core. On both the flake and the core the surface that is struck is called the platform. Flakes are identified by the distinctive surface created when they are removed from the core. The classification of artefacts in this survey was based on identifiable characteristics outlined by Hiscock (1984, 1989). For an object to be classed as a flaked artefact, it needed to possess one or more of the following characteristics:

- a positive or negative ring crack;
- a distinct positive or negative bulb of percussion;
- a definite eraillure scar in an appropriate position beneath a platform; and
- remnants of flake scars (dorsal scars and ridges).

These characteristics indicate the application of an external force to a core. Artefact morphologies will be described by using the four types of artefacts as defined by Hiscock (1984:128-129):

- Flake: Flakes exhibits a set of characteristics that indicate they have been struck off a core. The most indicative characteristics are ring-cracks, which show where the hammer hit the core. The ventral surface may also be deformed in particular ways, for example a bulb or eraillure scar.
- Core: A piece of stone with one or more negative flake scars, but no positive flake scars.

- Retouched Flake: A flake that has had flakes removed from it, identified by flake scars on or deriving from the ventral surface.
- Flaked Piece: This is a chipped artefact which cannot be classified as a flake, core, or retouched flake. This category is used only when an artefact was definitely chipped but could not be placed in another group.

Other artefacts and implement types that have been identified in the region are listed below following characteristics as outlined by McCarthy (1976), Cundy (1989), Kamminga (1982) and Holdaway and Stern (2004) include:

- Unifacial Points are flakes that have been retouched along the margins from one surface (either dorsal or ventral) to give or enhance its pointed shape. These unifacial points are sometimes symmetrical or leaf shaped.
- Grindstones are characterised by a worn and abraded surface(s). The surface may either have concave depression or a convex surface.
- Pounders are characterised by abraded and pitted surfaces on the margin of the stone from processing plant foods and shellfish rather than used as hammerstones for stone tool working.
- Hammerstones show use wear on the surface in the forms of abrasion, pitting and edge fracturing with some negative scarring.

The table below lists the attributes recorded for artefacts located within the study area. Certain attributes were not recorded for some artefacts, depending on their type and breakage.

Table 1 Attributes of recorded artefacts characteristics.

ATTRIBUTE	CHARACTERISTICS RECORDED
Type	flake, retouched flake, core, flaked piece, unifacial point, axe, grindstone
Raw material	tuff, quartz, dolerite, chert, quartzite, fine grained sedimentary rock, glass, porcelain
Breakage	(recorded for flakes), complete, proximal, distal, medial, longitudinal cone split
Weight	weight of artefact in grams
Length	measured from proximal to distal ends of artefact
Width	measured at widest point of artefact at right angles to the axis prom the proximal to the distal end of the artefact
Thickness	measured from the ventral surface to the dorsal surface
Platform width	width of the platform on the proximal end of flakes
Platform Thickness	thickness of the platform on the proximal end of flakes
Cortex	presence or absence
Overhang removal	presence or absence
Platform faceting	presence or absence
Flake termination	feather, step, hinge, outrepasse
Heat treatment	potlid, crenated, crazed

Raw Material Identification

Certain stone raw materials are chosen over others for manufacture of stone tools. The identification of these stone raw materials is an important factor in the recording of archaeological sites. Distinguishing between raw material types is useful in the interpretation of stone tool technologies and past Indigenous settlement and mobility patterns. Definitions of different stone raw material types commonly found in northern Australia can be found below:

- **Quartz**: is a crystalline form of silica, colourless to white in colour, with a vitreous lustre and hardness of seven. It exhibits a conchoidal fracture and is extremely resistant to weathering. Although having an internal trigonal crystallography, quartz crystals exhibit no recognised or predictable cleavage plane that would affect fracture path. It forms in either tabular or sheet-like veins that intrude by lithostatic pressure into pre-existing joints or newly developed joints in the bedrock. These

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veins form from hydrothermal and magmatic fluids released during syn- or post metamorphic and igneous periods. The resultant veins may vary in width from a few millimetres to a metre or more (Thorpe & Brown 1990:16). Quartz is one of the most frequently encountered raw materials for stone implements in the Australian archaeological record (Cotterell & Kamminga 1990) and in the Darwin region.

- **Chert**: is a microcrystalline sedimentary rock composed of primarily of quartz (chalcedony SiO_2). Chert has a microcrystalline granular texture, but rarely exhibits banding or translucency, thus often forming dull opaque masses. Usually chert has appreciable quantities of impurities, including water, with lustres ranging from earthy to sub-glassy to matte. Chert is also often tinted by ochre or haematite. Chert forms as the result of precipitation of silica bearing solutions in massive form or in nodules. Chert is frequently found in limestone, where microfossils such as radiolarians are often evident under a hand lens. (Pough 1988:270; Mottana et al 1978:245)
- **Indurated Mudstone**: consists of a mixture of clay minerals, together with detrital quartz, feldspar, and mica. Iron oxides are also often present. Mudstone is a very fine grained rock, and the grains cannot be seen with the naked eye. It shares many characteristics with shale and may contain fossils, though it has less well defined lamination compared to shale (Pellant 1992:232)
- **Quartzite**: Formed by metamorphism of sandstone. Since quartz grains, large or small, hot to cold, are about the same, heating and squeezing does little to sandstone except make a very hard rock. With deep burial and cementation, the sand grains eventually become so tightly welded that any fracture breaks across the grains instead of around, as in loosely bound surfaces of a sandstone. Quartzite is amongst the hardest and most resistant of all rocks. They show the same colours as sandstones: brown, yellow, grey, reddish, or white. Resistant to weathering, hard and brittle, outcrops lack the mellow rounding of sculptured sandstone or the fluting of soluble limestone, so they are not too hard to recognize (Pough 1988:34).
- **Siltstone**: By definition, siltstone is a fine grained sedimentary rock. It usually contains more quartz than either mudstones or shales. Siltstones are commonly laminated, due to variations in grain size. Organic content or amounts of calcium carbonate. The individual rock fragments and mineral grains in siltstone are too

small to be visible to the naked eye (Pellant 1992:232). Post-depositional lithification of siltstone, such as silicification and/or laterisation, is often termed porcellanite (Langford-Smith, 1978:3).

- **Dolerite**: A mafic intrusive rock, similar in composition to, but finer-grained than, gabbro.
- **Tuff**: This is a geological formation composed of compressed volcanic ash. Commonly this formation is interpreted as a rock consisting of a layer or layers of lava particles blown from a volcano. A fine tuff is often called volcanic ash and a coarse tuff is called breccia .

Quartz Artefact Identification

Since the 1970's, stone artefact analysis has gone through some fundamental changes. Archaeologists are moving away from a typological analysis of stone artefacts towards a technological perspective. Within stone technological analysis there are many terms which hold certain connotations when used. For example industry when used has undertones of being a chronological marker, an ethnic pattern, or a set mental template of ideas. The three main approaches for artefact analysis in Australian Archaeology are typology, functional and technological. These three methods of archaeological analysis are either conducted separately or in a combination.

A trend away from typological to technological and functional analysis has been taken in studying quartz, mainly because the standard typological approach became inappropriate due to the nature of quartz. There have been many key studies of quartz artefact technologies undertaken Hiscock , and Witter in New South Wales, and Bird and Schwede have investigated quartz assemblages in the south west of Western Australia. There are three main conclusions that have been found by these quartz studies.

- Due to the nature of quartz fracture patterns, identification of knapped quartz from naturally fracturing quartz is particularly difficult. It is a partial disclaimer at the start of any study on quartz.
- There is recognition that internal stresses, fracture planes and incipient cracks affect quartz flaking properties.

- The third conclusion reached by most of these studies is that there are very small numbers of formal implement types made on quartz. However each study reported high incidences of bipolar cores.

Sullivan found that it was difficult to see on quartz the traditional features for recognising artefacts and implements. She used a classification system with a list of characteristics; concavity, convexity, convincing bulb, convincing negative bulb, shattering, ripples, striking platform, small flake scars, bruising and battering. Sullivan concluded that the form of quartz artefacts are not entirely dependent on raw material, and is more likely to be dependent on culture, but alludes that the amount of cracking exhibited by the core/stone would affect knapping. Hiscock expanded on the quartz structure and variety and basically set the standard for quartz identification. In a study on a quartz assemblage Hiscock, identified two structural variables relevant to fracture propagation;

- Presence, size and definition of crystal structures
- Presence of lines and stress and incipient fracture planes.

When fracture/splitting takes place along incipient planes, the "classic" Hertzian fracture characteristics will often be subdued or absent. Therefore Hiscock suggested that a different analytical system be used for quartz artefacts. With the presence of quartz fracture planes it is important to look at points of impact from the hammer striking the core instead of bulb features. These would be point of force application, ringcrack features and areas of crushing. Also ventral characteristics such as greater variety of surface deformation, errailure scars and radial striations could be apparent.

Therefore, the analytical framework for quartz artefacts has been developed from previous research and from observations by the consultant in the field. Researchers in the past have had access to laboratory equipment such as microscopes and all recommend that this is the best way to proceed with quartz analysis. This is not always possible to achieve this level of identification in the field. Therefore instead of using a micro-analytical approach as others have, this project utilises a macro-analytical approach. This macro-analytical approach utilises the characteristics identifiable with the naked eye or a hand lens. The important considerations of a macro-analytical approach are listed here;

- Quartz artefacts are generally difficult to identify and need a more rigorous identification system than normally required.

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- Quartz can be conchoidally flaked and artefacts can show typical Hertzian characteristics from flaking. However this is not the case all the time. Different features have to be looked for when these "traditional" characteristics are not entirely present. By using the naked eye and perhaps a hand held lens the following characteristics should be identifiable;
- When the presence of fracture planes and incipient cracks are detected, then look for points of impact from the hammer striking the core instead of bulb features - PFA, ring crack, and areas of crushing
- Ventral characteristics such as greater variety of surface deformation, errailure scars and radial striations should be looked for.
- Other characteristics can be determined from individual quartz sources by studying structural composition (e.g. fracture planes, crystal formation). Data about these features can aid the identification of artefactual quartz from non-artefactual quartz.
- Certain types of quartz may be preferred over more opaque quartz and vice versa. A correlation may exist between frequency and size of fracture planes, translucency, and densities of quartz flakes on sites.

By using this framework to identify quartz artefacts, problems of artefact and site identification should be overcome by using normal site definitions of artefact density and area.

RESULTS

The chart below illustrates the variety of archaeological materials recovered from the excavation trenches. Excavations within the project area recovered a total of 358 Indigenous stone artefacts. Stone artefacts were recovered from three sites, MA1, MA5, and MA PAD1, from a total of 22 excavation trenches. Other Indigenous archaeological materials included a single contact flaked artefact made on porcelain. Historic archaeological materials consisting of metal fragments, potsherds, and glass shards illustrate the proximity of the 19th Century activities in the project area.

Stone artefacts consisted of flakes, cores, retouched flakes, flake pieces, backed artefacts, utilised flakes, and hammerstone fragments. Figure 1 below illustrates the distribution of stone artefact types in the assemblage. The majority of the assemblage consists of stone flakes (n = 226) and flake pieces (n = 73). Cores accounted for a smaller proportion of the overall assemblage (n = 12). Formal tool types such as backed artefacts (n = 10), and other flaked tools including utilised flakes (n = 9) and retouched flakes (n = 22) comprise a small percentage of the assemblage. Grindstone fragments consist of 6 pieces.

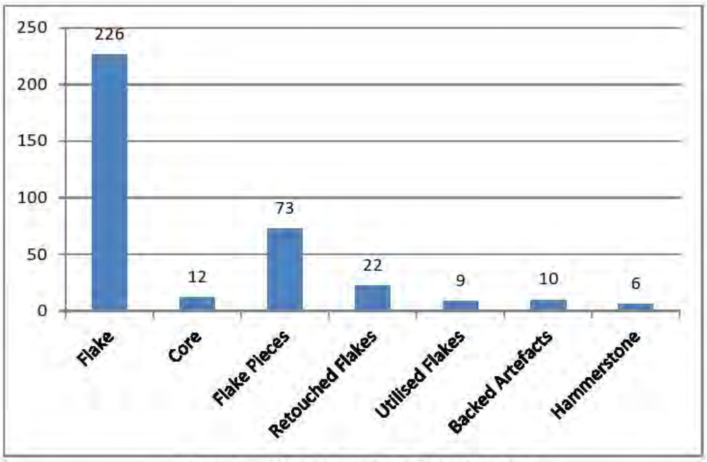

Figure 1. Total Artefact Distribution

Raw Materials

A total of 13 different stone raw material types were identified in the Moorebank assemblage. Stone raw materials encountered in the project area include quartz, chert, quartzite, silcrete, tuff, basalt, limestone, indurated mudstone, siltstone, fine grained

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igneous (FGI), and fine grained sedimentary (FGS). Figure 2 below illustrates the stone raw material distribution of the total artefact assemblage. Silcrete is the dominant raw material type within the assemblage consisting of 54.46% of the total collection (n = 195). Quartzite (15.36%) and quartz (13.96%), are the next most common raw material types in the assemblage. Only minor occurrences of chert, tuff, basalt, limestone, indurated mudstone, siltstone, fine grained igneous (FGI), and fine grained sedimentary (FGS) are found in the assemblage.

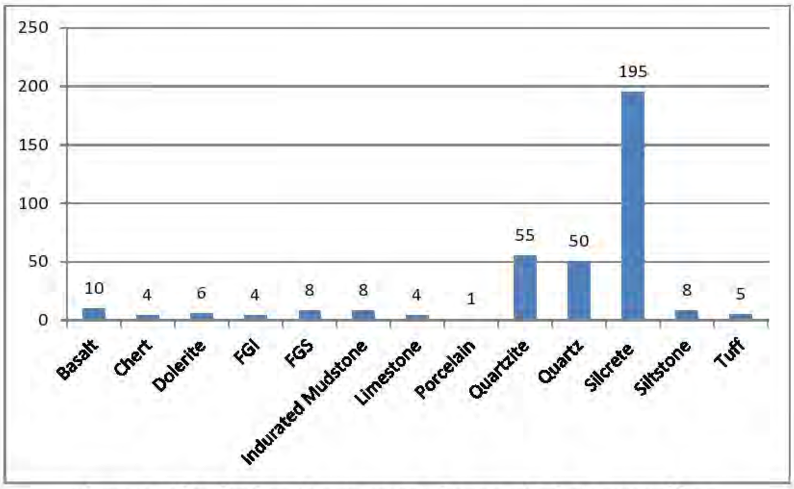

Figure 2. Distribution of raw material types of whole assemblage

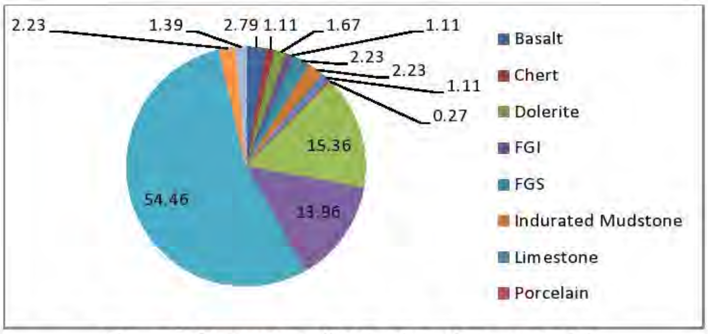

Figure 3. Percentage distribution of raw materials

Attenbrow (2006:279) defines quartzite raw material including meta-quartzite, orthoquartzite, indurated sandstone and possibly some coarse-grained silcrete which reflects the difficulty of identification and diversity of this raw material occurring in the

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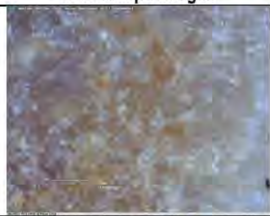
Sydney basin region. It was difficult at times to distinguish between silcrete and quartzite within the Moorebank assemblage even under 200x magnification.

Table 2. Raw Material Types identified within the artefact assemblage

Type	Colour	Description	Microscope Images
Quartzite	Reddish colour	Interlocking quartz grains from quartz sandstone, very fine grained sediment, poorly sorted, quartz grains ranging from 0.01mm to 0.25mm in size. Suspended in recrystallised quartz grain matrix which can be variable in grain texture. Iron rich sandstone.	
Fine Grained Igneous	Greyish to light grey colour	Possibly a very fine grain basalt. Quartz inclusions less than 1mm. Micah inclusions less than 0.2mm.	
Silcrete	Variable. Reddish to white matrix	High density of very fine quartz grains suspended in very fine silica context matrix. Quartz grains poorly sorted but compact. Matrix varies in colour from white to pink, to dark red. Distance between grains goes from 0 to approximately 0.2mm. Quartz grains range in size from .05mm to 0.4mm in size. Some examples have quartz grains .09mm to 1mm in size. Grains poorly sorted. Densely set in white matrix.	
Indurated mudstone	Grey	Extremely fine grain. Uniform material. No visible inclusions. In some cases, banded.	
Siltstone	Ranges from White-Yellow-Red	Very fine grained siltstone. Grains are <0.1mm in size.	

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Type	Colour	Description	Microscope Images
Fine Grained Siliceous (FGS)	Mostly light grey to reddish white	A very fine grained crypto-crystalline material of sedimentary origin that has undergone some metamorphic change	
Basalt	Dark Grey	A fine grained rock with a variety of inclusions.	

The table below illustrates the distribution of artefact types by raw material type. Very few formal implement types were recovered from the Moorebank assemblage. Formal tools and utilised flakes were generally made on exotic raw materials. Backed artefacts are made only on silcrete. The majority of the cores are also made on silcrete (94%). Noticeably absent are any implements associated with grinding activity, although some dolerite may have had ground surfaces (discussed later). Some fragments of the assemblage notably the igneous materials, had some signs of use as pounding or hammerstones.

Table 3. Total assemblage distributed by raw materials and artefact types

Raw Material	Backed Artefact	Core	Flake	Flake Piece	Retouched Flake	Utilised Flake	HS
Basalt	0	0	4	0	0	0	0
Chert	0	1	3	0	0	0	0
Dolerite	0	0	3	1	0	0	2
FGI	0	0	2	0	0	0	1
FGS	0	0	3	2	1	2	0
Indurated Mudstone	0		3	1	2	2	
Limestone	0	0	0	4	0	0	0
Porcelain	0	0	0	0	0	1	0
Quartzite	0	2	34	16	3	0	0
Quartz	0	1	26	18	4	0	1
Silcrete	10	7	138	27	10	3	0
Siltstone	0	0	6	1	0	1	0
Tuff	0	0	3	2	0	0	0

HS = Hammerstone

Reduction

The majority of the flaked artefact assemblage possessed feather terminations (n = 181; 88.7%). Other termination types consisting of hinge (7.3%), step (1.4%), and outrépassé (2.45%) were recorded on the flaked artefact assemblage. The majority of the flaked artefacts were made on silcrete, quartzite, and quartz. The high proportion of feather terminations present on the assemblage suggests a careful reduction and curation strategy was employed on the available stone resources.

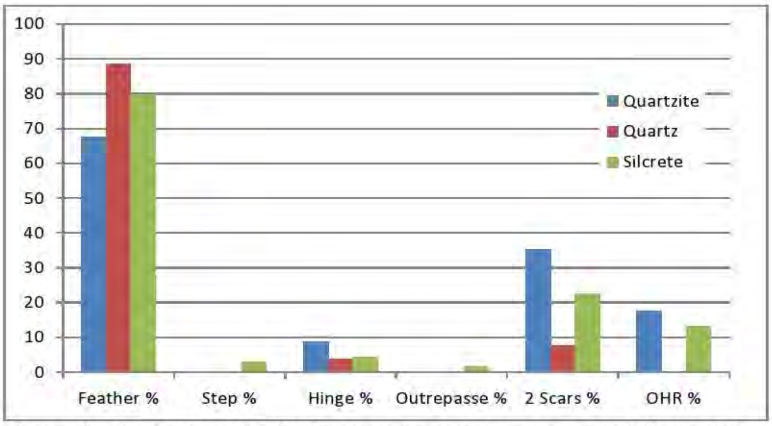

Figure 4. Distribution of flake features in quartzite, quartz and silcrete flake assemblages

Features relating to the platform of flaked artefacts were recorded including the presence of cortex, whether the platform surface was flat or contained multiple scars, or had overhang removal and platform faceting. Overall, single scar platform surfaces tended to be present on 64.48% of the assemblage, followed by multiple scars (28.9%) and cortex (6.5%). The high proportion of multiple scars and no cortex on the platform surface is indicative of careful curation of cores to produce good striking platforms. The total assemblage tended to have low levels of overhang removal (n = 38; 16.8%) and noted only on two flakes (0.8%). Low levels of overhang removal and platform faceting on the Moorebank artefact assemblage may reflect the nature of the raw material source material.

Low levels of overhang removal and faceting general occur if the material being knapped are from pebble or cobble stone sources rather than larger blocky outcrops of stone.

The majority of the stone artefact assemblage had no cortex (85.7%). The following graph illustrates the presence and absence of cortex on the raw material types found in the Moorebank assemblage. It shows that major raw materials, quartzite, silcrete, and quartz have the least percentage of cortex. The majority of the artefacts made on these raw material types are found to be in the tertiary decortication stage. The other raw materials present had higher proportions of cortex present than the three major raw materials. This may be a reflection of the distance to these raw materials to the site, however, it is probably more likely to be a factor of the sample size of the assemblage.

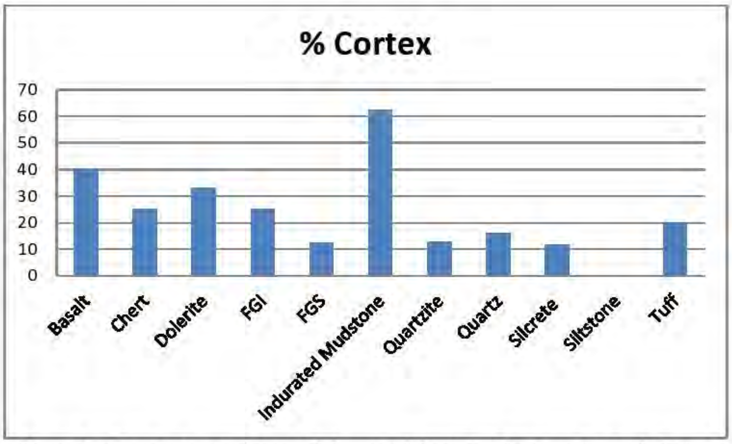

Figure 5. Percentage of assemblages with cortex by raw material type

Quartz is traditionally considered a difficult raw material to knap. However in the Moorebank assemblage, the care and precision in preparing cores and striking platforms is reflected by preparation of the flake platform. Platform cortex accounts for only 16% of the flake assemblage.

The physical properties of quartz have been noted by other researchers to behave in ways different to other conchoidally fracturing stone (Schwede 1990; Hiscock ; Bird1985). The low percentage of step and hinge terminations also suggests that the quartz raw material available in the area is of reasonably good quality with lower proportions of incipient fractures and cleavage planes that would normally be encountered in quartz outcrops. Another factor to consider is the type of flake the knapper was attempting to produce. Small, square, sharp quartz flakes are predominantly produced at this locale utilising small quartz cobbles. Therefore knapping of this raw material does not require large amounts of force and calls for more controlled knapping techniques.

Breakage

Breakage within the Moorebank assemblage was recorded on flaked artefacts. The graph below illustrates complete flakes consist of 43.57% of the flake assemblage. Breakage is found on 56.37% with no clear breakage dominating the assemblage. Distal and proximal breakage comprises 19% of all breakage types. Breakage can reflect issues relating to the properties of the raw material, the knapping process, and taphonomic issues occurring at an archaeological site. Higher levels of artefact breakage would be expected should the archaeological deposits have been subjected to post-depositional disturbance. The level of breakage found in this assemblage most likely reflects the nature of the raw materials being used, knapping, and discard processes.

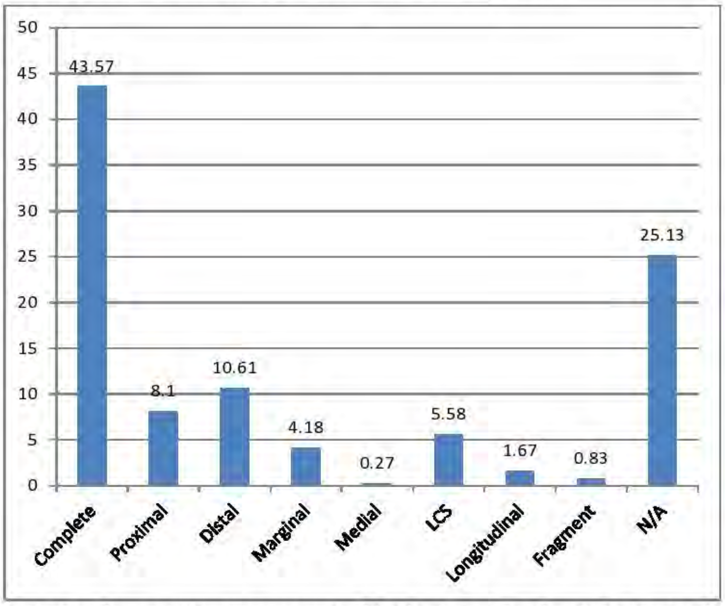

Figure 6. Breakage patterns represented in the Moorebank artefact assemblage

Size characteristics

The Moorebank artefact assemblage tended to consist of relatively small artefact size class with the entire assemblage less than 100mm in length as illustrated in the graph below. A distinct clustering of artefact size occurs in the less than 20mm length category. A general uniform size trend line can be seen in the following graph. Only a small number of artefacts fall outside of 50mm in size.

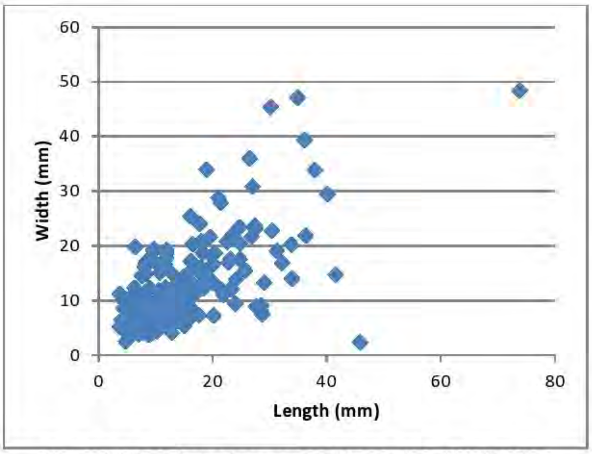

Figure 7. Total artefact assemblage size distribution

The silcrete, quartzite, and quartz flake populations all tend to cluster in the 20mm x 20mm size class as illustrated in the graphs below. The uniform size of all raw material types may reflect a uniform flaking strategy being employed in the Moorebank locality.

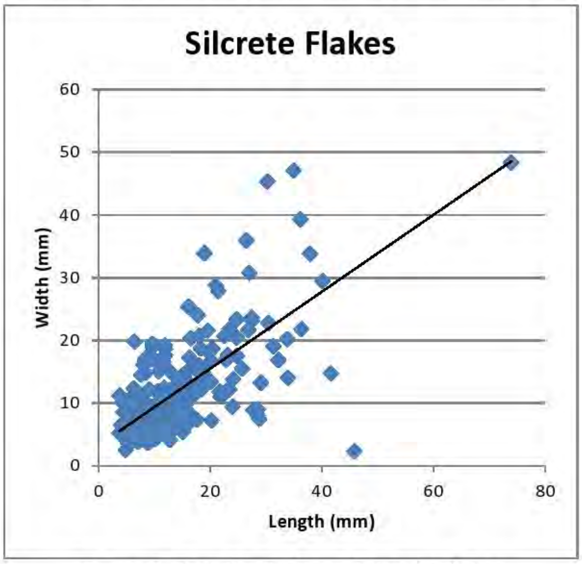

Figure 8. Size distribution of silcrete flakes

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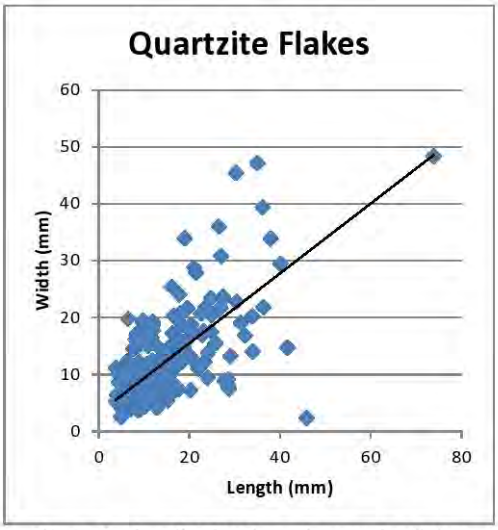

Figure 9. Size distribution of quartzite flakes

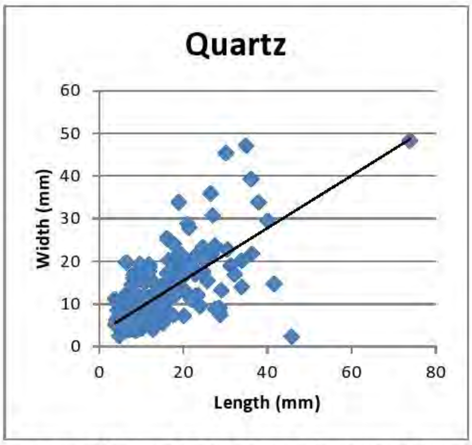

Figure 10. Size distribution of quartz flakes

The size of the stone artefact found in the Moorebank assemblage may be influenced not only by raw material rationing and distance from source, but would also seem to be arising as a result of the pebble and cobble raw material source. Drawing on the crack and flaw propagation technique promoted by Witter, quartz artefacts are generally limited in size by the incipient flaws and cracks found in quartz. Conchoidal fracture properties are readily identifiable on the majority of the Bellarine quartz assemblage. Therefore, the flaws

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and cracks in the Moorebank quartz are sufficiently spaced to allow a functional flaked assemblage to be knapped that is generally less than 20mm in length or width.

Figure 11. Artefact identification characteristics on a quartz flake

Utilised Flakes, Backed Artefacts, and Use Wear

Use wear was noted on 25 artefacts within the artefact assemblage. These artefacts consisted of 9 utilised flakes made on indurated mudstone, FGS, silcrete, siltstone, and a porcelain flake.

Figure 12, Usewear on an utilised flake

A total of 10 backed artefacts were recorded, all made on silcrete.

Discussion

Hiscock suggested that distinctions between raw material types can indicate differences in fracture properties and therefore probably differences in technology and manufacture, use, and amount of transportation. Hiscock investigated quartz bipolar technologies in Kakadu National Park where the premise that bipolar knapping is considered to be advantageous when mobility is low, and the relative abundance of bipolar cores may therefore be a measure of residential mobility. Hiscock demonstrated the nature of residential mobility of the South Alligator River sites through bipolar core densities. This model presumes that sites with low levels of residential mobility would have higher percentages of bipolar cores as people are reworking stone even when the source is nearby. Sites representative of low levels of occupation would have lower percentages of bipolar cores. Bipolar flaking was only present on 7 artefacts (1.95%) and there were no bipolar cores recorded from the Moorebank assemblage. The large proportion of a uniform flake assemblage may be indicative that the Moorebank area was occupied by Indigenous people on a higher residential mobility basis.

Bird undertook a major regional study that dealt mainly with coastal and inland artefact assemblages. This study area was split into a coastal region and an inland region and was focussed on determining the usefulness of an economic approach for understanding surface archaeological sites and for integrating different types of archaeological data. Of particular interest was the increase of quartz bipolar cores in Inland assemblages and with a subsequent decrease on the Coast. Chert bipolar cores increase from 2.9% on Coastal sites to 19.8% on the Inland Sites. The polarised distribution might be readily explained by raw material rationing behaviour, as chert is available on the coast and not inland. Quartz, however, is readily available in both regions with the inland region displaying a higher percentage of quartz bipolar cores. Hiscock's model would suggest the high proportion of bipolar cores in the inland assemblages would suggest a lower level of residential mobility. It would appear that the coastal region had a higher level of residential mobility to take advantage of changing resources. This may also be the case for the Moorebank assemblage where higher levels of residential mobility where necessary to exploit coastal resources.

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Database

Site Details:	ID; SITE; PIT#; SPIT; DATE
TECHNOLOGICAL CLASS:	Flake; retouched flake, core, flake piece, hammerstone, backed artefact, utilised flake (displays usewear)
RAW MATERIAL Silcrete:	QTZE (quartzite); Quartz; FGI (fine grained igneous); Basalt; (FGS) Fine grained siliceous; Ind Mud (Indurated Mudstone); Limestone; Dolerite; Tuff
BREAKAGE 1	Proximal; Distal; Marginal; Medial; LCS (Longitudinal cone split)
BREAKAGE 2	If another breakage present
BIPOLAR	Presence/Absence; evidence of bipolar flaking
HEAT TREATMENT	Presence/Absence; Potlid, crazing, crenation
USEWEAR	Presence/Absence
CORE #Platforms	Number of striking platforms on a core
TERMINATION	Feather, Hinge, Step, Outrépassé
CORTEX %	Estimate of the percentage of cortex on the ventral surface
CORTEX % Platform	Estimate of percentage cortex on the platform surface
2 SCARS PLAT:	Presence/Absence; 2 or more negative flake scars on the platform surface
OHR:	Presence/Absence; Overhang removal
Platform Facet:	Faceting on the platform surface of flakes
Measurements:	Weight, Length, Width, Thick, Platform Width, Platform Thick

Appendix 1 MA1 Artefact Attributes

ID	PIT#	SPIT	TECHNOLOGICAL CLASS	RAW MATERIAL	BREAKAGE	BIPOLAR	HEAT TREATMENT	USEWEAR	TERMINATION	CORTEX %	CORTEX % Platform	2+ SCARS PLAT	OHR
MA1PIT1SPIT3/1	1	3	Flake	Quartz	Complete	N	N	N	Feather	0	0	N	N
MA1PIT1SPIT4/1	1	4	Flake	Siltstone	Complete	N	N	N	Hinge	0	0	N	Y
MA1PIT2SPIT2/1	2	2	Flake	Siltstone	Complete	N	N	N	Feather	0	0	N	N
MA1PIT2SPIT2/2	2	2	Flake Piece	Siltstone	N/A	N	N	N	N/A	0	N/A	N/A	N/A
MA1PIT3SPIT4/1	3	4	Flake	Siltstone	Complete	N	N	N	Feather	0	0	N	N
MA1PIT3SPIT5/1	3	5	Utilised Flake	Siltstone	Proximal	N	Y	Y	Feather	0	N/A	N/A	N/A
MA1PIT3SPIT5/2	3	5	Flake	Silcrete	Complete	N	N	N	Feather	0	0	N	N
MA1PIT4SPIT2/1	4	2	Flake	Siltstone	Complete	N	N	N	Feather	0	0	N	N

Appendix 2 MA1 Artefact Metrical Characteristics

ID	PIT#	SPIT	TECHNOLOGICAL CLASS	RAW MATERIAL	Weight	Length	Width	Thick	Platform Width	Platform Thick
MA1PIT1SPIT3/1	1	3	Flake	Quartz	0.05	4.5	4.97	0.83	3.73	0.8
MA1PIT1SPIT4/1	1	4	Flake	Siltstone	0.3	14.93	11.81	2.65	7.3	2.02
MA1PIT2SPIT2/1	2	2	Flake	Siltstone	0.4	11.76	12.38	3.6	4.13	1.03
MA1PIT2SPIT2/2	2	2	Flake Piece	Siltstone	0.2	11.63	11.26	3.75		
MA1PIT3SPIT4/1	3	4	Flake	Siltstone	0.05	6.25	5.35	1.04	4.3	1.04
MA1PIT3SPIT5/1	3	5	Utilised Flake	Siltstone	2.8	24.09	13.79	12.8		
MA1PIT3SPIT5/2	3	5	Flake	Silcrete	0.05	8.81	6.52	2.77	6.27	2.78
MA1PIT4SPIT2/1	4	2	Flake	Siltstone	0.05	6.74	7.22	1.27	6.51	0.74

Appendix 3 MSRA1 Artefact Attributes

ID	PIT	SPIT	TECHNOLOGICAL CLASS	RAW MATERIAL	BREAKAGE	BIPOLAR	HEAT TREATED	USE WEAR	TERMINATION	CORTEX %	CORTEX % Platform	2+ SCARS PLAT	OHR
MRSA1PIT2SPIT1/1	2	1	Backed Artefact	Silcrete	Complete	N	N	N	N/A	0	N/A	N/A	N/A
MRSA1PIT2SPIT1/2	2	1	Flake Piece	Silcrete	N/A	N	N	N	N/A	0	N/A	N/A	N/A
MRSA1PIT2SPIT1/3	2	1	Flake `	Silcrete	Complete	N	N	N	Feather	0	0	Y	N
MRSA1PIT2SPIT2/1	2	2	Flake	QTZE	Proximal	N	N	N	Feather	0	N/A	N/A	N/A
MRSA1PIT2SPIT2/2	2	2	Flake	Silcrete	Distal	N	N	N	N/A	0	0	N	N
MRSA1PIT2SPIT2/3	2	2	Flake	Silcrete	Complete	N	N	N	Feather	0	0	N	N
MRSA1PIT2SPIT2/4	2	2	Flake	Silcrete	Complete	N	N	N	Feather	0	0	N	N
MRSA1PIT3SPIT1/1	3	1	Retouched Flake	Silcrete	N/A	N	N	N	N/A	80	0	N	N
MRSA1PIT3SPIT1/2	3	1	Flake	Quartz	Distal	N	N	N	N/A	0	0	N	N
MRSA1PIT4SPIT2/1	4	2	Flake Piece	Silcrete	N/A	N	N	N	N/A	0	N/A	N/A	N/A
MRSA1PIT4SPIT4/1	4	4	Flake	Silcrete	Complete	N	N	N	Feather	0	0	N	N
MRSA1PIT4SPIT5/1	4	5	Flake	Silcrete	Complete	N	N	N	Feather	0	0	N	N
MRSA1PIT4SPIT5/2	4	5	Flake	Quartz	Complete	N	N	N	Feather	0	0	Y	N
MRSA1PIT5SPIT1/1	5	1	Core	Quartz	N/A	N	N	N	N/A	45	N/A	N/A	N/A
MRSA1PIT5SPIT6/1	5	6	Flake	Silcrete	Complete	N	N	N	Feather	0	0	N	N
MRSA1PIT5SPIT7/1	5	7	Flake	Silcrete	Complete	N	N	N	Feather	0	0	N	N

Appendix 4 MSRA1 Artefact Metrical Attributes

ID	PIT#	SPIT	TECHNOLOGICAL CLASS	RAW MATERIAL	Weight	Length	Width	Thick	Platform Width	Platform Thick
MRSA1PIT2SPIT1/1	2	1	Backed Artefact	Silcrete	0.5	19.07	6.83	3.5		
MRSA1PIT2SPIT1/2	2	1	Flake Piece	Silcrete	1	20.81	9.1	5.53		
MRSA1PIT2SPIT1/3	2	1	Flake `	Silcrete	0.4	17.98	11.27	4.66		
MRSA1PIT2SPIT2/1	2	2	Flake	QTZE	0.05	11.2	5.12	1.4		
MRSA1PIT2SPIT2/2	2	2	Flake	Silcrete	0.3	12.66	7.01	3.04	4.87	2.93
MRSA1PIT2SPIT2/3	2	2	Flake	Silcrete	0.05	5.84	7.62	1.56	5.8	1.6

ID	PIT#	SPIT	TECHNOLOGICAL CLASS	RAW MATERIAL	Weight	Length	Width	Thick	Platform Width	Platform Thick
MRSA1PIT2SPIT2/4	2	2	Flake	Silcrete	0.05	3.34	5.59	0.97	3.05	0.97
MRSA1PIT3SPIT1/1	3	1	Retouched Flake	Silcrete	2.7	22.5	23.24	5.7	6.84	3.14
MRSA1PIT3SPIT1/2	3	1	Flake	Quartz	0.1	9.22	3.8	2.78	3.8	2.7
MRSA1PIT4SPIT2/1	4	2	Flake Piece	Silcrete	0.05	7.03	3.35	1.87		
MRSA1PIT4SPIT4/1	4	4	Flake	Silcrete	0.05	7.31	6.48	1.68	4.4	1.08
MRSA1PIT4SPIT5/1	4	5	Flake	Silcrete	0.05	6.47	8	2.12	3.41	1.65
MRSA1PIT4SPIT5/2	4	5	Flake	Quartz	0.1	8.37	9.99	2.46	5.75	2.56
MRSA1PIT5SPIT1/1	5	1	Core	Quartz	0.4	8.33	11.9	3.79		
MRSA1PIT5SPIT6/1	5	6	Flake	Silcrete	0.05	5.3	4.16	1.32	4.05	1.04
MRSA1PIT5SPIT7/1	5	7	Flake	Silcrete	0.05	6.73	4.87	1.29	4.1	1.07