



# Preliminary (Environmental) Site Investigation

## Canberra Brickworks

For: Land Development Agency

18 February 2014

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## EXECUTIVE SUMMARY

SMEC Australia Pty Ltd (SMEC) was engaged by the LDA to undertake a Preliminary Geotechnical and Environmental Site Investigation (PSI) at the Canberra Brickworks, ACT (the Site). This report presents the findings of the Environmental Investigation undertaken at the Site.

The purpose of this PSI was to provide preliminary Site contamination data for the information of the LDA regarding the contamination status of the Site. Assessment of the suitability of the site for any particular development would then be subject to the outcomes of a future Detailed Site Assessment (DSI).

The available historical data indicate the northern portion of the Site has been used as brickworks since the early 1900's. A disused quarry is located adjacent (east) and a demolished workers accommodation is located adjacent (south) to the brickworks. The remainder of the Site (southern areas) was formerly grazing land which has been developed to include road infrastructure (Cotter Road, Adelaide Avenue and Yarra Glen).

Parts of the brickworks are currently leased by Thor's Hammer a wood recycling business, the potential for contamination attributed to current land uses is considered low.

A total of 28 test pits were advanced across the Site and 42 samples submitted for laboratory analysis to evaluate contaminants of concern.

Fill material was logged at 18 of the 28 test pit locations. Dependent on the sample location the fill materials were observed to comprise:

- **Brickworks and Quarry:** brick waste, ash, quarry cuttings (shale) with traces of anthropogenic inclusions (glass, metal and bitumen) to the practical limit of excavation of 3 metres below ground level (mbgl). The nature and extent of fill beyond 3mbgl is unknown;
- **Surrounding Areas:** sandy to silty clay, probable reworked natural soils, generally encountered at shallow depths less than 1 mbgl; and
- **Adjacent Cotter Rd (TP02):** silty cobbles to gravelly sand with traces of brick and bitumen, refusal on concrete 2 mbgl, the nature of fill is expected to be attributed to the construction of the adjacent road, however the extent of fill is unknown.

Natural soils were logged to comprise soft brown silty topsoils underlain by medium to stiff red-brown silty clays and clays. Natural soils graded to weathered red brown residual soils (silty clays and clay) and were underlain by shale, dacite, siltstone or sandstone bedrock. Strength and weathering of the bedrock material varied across the Site and was logged between depths of 0.17 and 1.9 mbgl.

All analyte concentrations in natural and fill samples submitted for analysis were less than the adopted (human health based and ecological) assessment criteria. In particular, it was noted that polycyclic aromatic hydrocarbon (PAH) concentrations in fill containing coal ash (which are often associated with PAH contamination) were below assessment criteria and typically below laboratory detection limits.

It should be noted, however, that the sampling densities adopted during this preliminary assessment were below though that would typically be adopted during a detailed site investigation (DSI) and the full depth of fill in the quarry has not been investigated.

Based on our review of previous reports and existing data SMEC relating to the Site a total of 32 areas of environmental concern (AEC) were identified at the site. Potential risks to human health and

the environment associated with each AEC were considered, supported by data from the limited supplemental soil sampling and analysis conducted by SMEC as part of this preliminary investigation. On this basis preliminary information reviewed to date 28 of the 32 identified AECs were qualitatively assessed be of low risk with no further investigation or limited further investigation recommended.

Generally, based on the limited soil data collected during this PSI, the site ecological and human health risks associated with brickworks, quarry and the former workers accommodation areas of the site are considered moderate to low. The remainder of the Site (the Southern Areas) typically comprised of natural soils grading to weathered bedrock. Soil analytical results returned concentrations of contaminants less than the adopted assessment criteria, the potential for contamination is therefore considered low.

Although no potential source of groundwater contamination was identified during this investigation, no groundwater testing or assessment groundwater conditions at the Site have been made.

The results of this primary investigation are not sufficient to assess the suitability of the site for a specific planned land use. It is recommended that, once detailed plans indicating the proposed land use(s) across the Site have been developed that a detailed site investigation (DSI) be undertaken to assess the suitability of the site for the planned land use(s). Typically a Site Audit Report (SAR) and Site Audit Statement (SAS) regarding the suitability of the Site would be required by the approving authority and an ACT EPA accredited Site Contamination Auditor would be engaged to independently review the DSI and any subsequent remedial works as supported by the ACT EPA.

# 1 INTRODUCTION

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## 1.1 General

SMEC Australia Pty Ltd (SMEC) was engaged by the LDA to undertake a Preliminary Geotechnical and Environmental Site Investigation (PSI) at the Canberra Brickworks, ACT (the Site). This report summarises the work conducted and the results of the Environmental Investigation including the findings from the historical information review, field observations and analytical data from analysis of soil samples collected between the 9<sup>th</sup> and 11<sup>th</sup> of September 2013. The results of the geotechnical investigation are presented in a separate geotechnical report.

The location of the Site is presented in Figure 1 and the Site layout and features are presented in Figure 2 and Figure 2a (**Appendix A**). Features of the Site include a former brickworks, former quarry, and former workers accommodation with open grassland to the south. A draft masterplan has been prepared by the LDA for the redevelopment of the Site. The proposed redevelopment of the Site will include medium density residential and commercial land use. A copy of the draft masterplan provided in **Appendix B**, which shows proposed building height limitations and park land areas (West Bridge Park and the Quarry Park).

At the time this report was prepared it was also understood that the former brickworks area would likely be redeveloped for commercial use, preserving some of the existing buildings. The remainder of the Site would be redeveloped to include a mix of high, medium and low density land use with park lands (West Bridge Park and the Quarry Park).

## 1.2 Project Objectives

The purpose of this (environmental) PSI was to provide preliminary Site contamination data for the information of the LDA regarding the contamination status of the Site. Assessment of the suitability of the site for any particular development would then be subject to the outcomes of a future Detailed (environmental) Site Assessment (DSI).

## 1.3 Limitations

The findings in this report are based on the desk top scope and limited soil testing. SMEC prepared this report for the exclusive use of the LDA for the purposes specified and performed services in a manner consistent with the level of care and expertise ordinarily exercised by members of the environmental consulting profession. No other warranties, expressed or implied, are made or intended.

The Conclusions in this report were based on site observations and other information obtained by SMEC, and on the assumption that these data were representative and reliable. These conclusions must be read in conjunction with the assumptions and uncertainties included in the report. Conditions may vary over time and therefore the timing of the activities of the report should be considered in the use of any information provided herein.

This report is issued on the condition that it will not be altered, amended or abbreviated, issued in part or issued incomplete without our prior approval. We accept no responsibility for any loss, damage or consequence that may arise from breaches of this condition.

## 1.4 Scope of Works

The following scope of work was undertaken to meet the objectives of the PSI.

- Review of available background data including:
  - Previous environmental and heritage reports;
  - Historical aerial photography;
  - Available geology and hydrogeology maps;
  - Dangerous Goods Search;
  - Groundwater Bore Search; and
  - An Environmental and Sustainable Development (ESDD) Contaminated Land Search.
- Inspection of the Site to identify potential sources and indicators of contamination;
- Completion of 28 test pit's to a maximum depth of 3mbgl across the Site and collection of soil samples to evaluate concentrations of contaminants of concern;
- Submission of collected soil samples for laboratory analysis to National Association of Testing Authorities (NATA) accredited laboratories; and
- Preparation of this PSI report, discussing the historical data, field methodologies, analytical results, identified areas of environmental concern (AECs) and preliminary findings.

SMEC notes that the scope of the PSI was prepared to identify the AECs present at the Site with limited soil sample collection undertaken in conjunction with the geotechnical investigation (presented under a separate cover). The assessment of groundwater was therefore outside the scope of the PSI.

Furthermore the sampling design and densities were not derived from the endorsed ACT EPA guidelines (**Section 1.5** below) and are not to be relied upon for the assessment of site suitability for the proposed land use.

## 1.5 Published Guidelines and Framework

This PSI report has been prepared in accordance with the requirements of the guidelines endorsed by the ACT Environment Protection Authority (EPA) as contained in the ACT EPA (2009) Contaminated Sites Environment Protection Policy (EPP):

- ACT Environmental Protection Authority (EPA), 2009. Contaminated Sites Environmental Protection Policy;
- Environment Protection Act, 1997;
- Environment Protection Regulation, 2005;
- National Environment Protection Council (NEPC), 1999 – National Environmental Protection (Assessment of Site Contamination) Measure (Amended 2013) – “the ASC NEPM”;
- NSW EPA, 2000 (reprinted 2011), Guidelines for Consultants Reporting on Contaminated Sites; and

- Standards Australia, 2005 – AS 4482.1: Guide to the investigation and sampling of potentially contaminated soils: Part 1 – Non-volatile and semi volatile compounds.

## 1.6 Data Quality Objectives

The seven step Data Quality Objective (DQO) process for this PSI has been adopted in accordance with the ASC NEPM. The DQO process is a seven step process to assist the development of sampling programs that produce data of sufficient reliability to support the decision making process. The DQOs established for the PSI are presented in **Appendix C**.

## 1.7 Abbreviations

This section includes an alphabetical list of abbreviations used in this report:

ACT	Australian Capital Territory
ACM	Asbestos Containing Material
AST	Above Ground Storage Tank
BTEX	Benzene, toluene, ethyl benzene and xylenes
DECCEW	Department of the Environment, Climate Change, Energy, and Water
EPA	Environment Protection Authority
EPU	Environment Protection Unit (part of Territory and Municipal Services)
HM	Generally, arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc
LOR	Limit of reporting
mbgl	Metres below ground level
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection (Site Contamination) Measure
NSW	New South Wales
OCP	Organochlorine Pesticides
OPP	Organophosphorus pesticides
PSI	Preliminary Site Investigation
PAH	Polycyclic Aromatic Hydrocarbons
SMEC	SMEC Australia Pty Ltd
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
UST	Underground Storage Tank

## 2 SITE SETTING

### 2.1 Site Definition and Land Zoning

The Site definition and land zoning is summarised below in Table 2.1:

Table 2-1 Site Definition and Land Zoning

Detail	Description
Block and Section	Yarralumla Block 1, 7, and 20 Section 102, Yarralumla Block 3 Section 94, Yarralumla Block 2 Section 103, Yarralumla Block 1 Section 113 and Curtin: Block 1 Section 123
Part Block and Section	Yarralumla Block 1 Section 127, Yarralumla Block 7 Section 121, Deakin: Block 4 Section 65, and Deakin: Block 1 Section 75
Land Zoning	RZ1: Suburban CZ6: Leisure and Accommodation; PRZ2: Restricted Access Recreation Zone PRZ1: Urban Open Space Des: Designated
Area m <sup>2</sup> (approximate)	45,239 m

The land use zones noted above were assessed using the ACT Planning and Land Authority ACTmapi online mapping tool (<http://www.actmapi.act.gov.au/>).

### 2.2 Surrounding Land Uses

The surrounding land uses are summarised below:

- North: Low density residential, a Uniting Church is also located adjacent to Denman St in the north eastern portion of the Site. Further north is the Royal Canberra Golf Course followed by the Yarralumla Nursery (1200 m) and Lake Burley Griffin (1800m);
- South: Open urban space, followed by roads (Dudley St, Cotter Rd and Yarra Glen). Further afield Deakin offices are located to the south east and open space to the south west;
- West: Royal Canberra Golf Course. Lake Burley Griffin is located 630 m to the northwest; and
- East: Residential, Suburb of Yarralumla.

### 2.3 Current Land Use

The current uses of the Site are summarised below:

- Canberra Brickworks: Leased by Thor's Hammer a wood recycler (further detail provided in **Section 3.5**);
- South eastern portion of the Site used for public recreation and vehicle parking; and
- Roads (Dudley St, Cotter Rd and Yarra Glen) and tracks (pedestrian and bicycle use).

The remainder areas of the Site included open grasslands, forest and open urban space.

## 2.4 Site Description

The Site covers an approximate area of 45 ha, features of the Site include a former brickworks, quarry, and a workers accommodation with open grassland to the south. For ease of reporting, discussion of the Site will be divided by these features, the features are also depicted in Figure 2, **Appendix A**.

A description of the Site features is provided below:

### Former Brickworks

The Canberra Brickworks is located adjacent to the suburb of Yarralumla and the Royal Canberra Golf Course. Access to the brickworks is via Denman St adjacent south. The brickworks were operational between 1913 and 1976 and are currently used by Thor's Hammer, a wood recycling business.

Remnant buildings include, 6 kilns, 4 stackhouses, office building and amenities, 3 machinery sheds, workshops, boiler house, a substation, a power house (prior to 1915 was powered by a steam donkey engine), storage sheds and other minor buildings.

Demolished features include temporary kilns (south east), two explosive stores (180 m south and 130 m west respectively), a forklift shed (west), clay storage shed (quarry) and a weatherboard house (quarry).

### Former Workers Accommodation

The former Workers Accommodation is located south of the brickworks; it comprises several demolished buildings with a former railway corridor to the west and south. The extent of the former buildings unknown, inspection of this portion of the Site was limited by overgrown grass and woody weed species (blackberries).

### Quarry

The quarry is a large levelled grassed area with several exposed natural limestone and shale bedrock features. The area contains an unknown amount of fill used to level the quarry and to form several large mounds located in the northern and western portions of the area. An artificial lake was also present in the northern portion of the quarry.

### Southern Areas

The Southern Areas of the Site is comprised of planted tree groves (predominately pine trees) and open grasslands with several major roads (Dudley St, Cotter Rd and Yarra Glen) bisecting the Site east to west.

The area includes the Yarralumla and Deakin Open Space as shown in Figure 2, **Appendix A**.

## 2.5 Proposed Land Use(s)

SMEC have been provided with a draft 'Canberra Brickworks and Environs Master Plan' dated 2013 and is included in **Appendix B**. SMEC understands that the former brickworks area would likely be redeveloped for commercial use, preserving some of the existing buildings for adaptive reuse.

The remainder of the Site (the former workers accommodation, quarry and southern area) is to be redeveloped to include a mix of high, medium and low density land use with park lands (West Bridge Park and the Quarry Park).

## 2.6 Topography and Drainage

A traffic report prepared by SMEC entitled 'Canberra Brickworks and Environs Options & Evaluation Report Update' dated 17 December 2013 identified a total of five catchments in the Site; the catchments and anticipated surface water flow is shown in Figure 2c, **Appendix A**.

A summary of the topological and drainage characteristics of the Site in relation to the catchments is provided below:

### Catchments 1, 2, 3 and 4

The Southern Areas of the Site generally slope to the southwest, south, and southeast. The topography of this area has been modified to include the Cotter Road and Yarra Glen/Adelaide Avenue. Surface water flow has been mapped to generally flow south towards Yarralumla Creek which discharges into the Molonglo River.

### Catchment 3

The brickworks, located adjacent west to the former quarry, is approximately 3m lower than the quarry with the quarry (having been backfilled) to an unknown depth below the natural surface on the north eastern site boundary, as shown in Figure 2c, **Appendix A**.

It is expected that most surface water entering the quarry would either infiltrate fill material or drain towards the artificial lake. A drain located in the north western portion of the quarry suggests at least some water drains to the brickworks area.

The brickworks contain drainage infrastructure (including roof level guttering and surface open concrete lined, open stormwater drains) which are likely to receive majority of surface water in the area, possibly including the quarry and former workers accommodation.

The final discharge point is towards the Royal Canberra Golf Course, although water captured in the brickworks drainage infrastructure is likely to enter the municipal stormwater system, the discharge point is unknown.

## 2.7 Vegetation

The vegetation of the Site was characterised by areas of tree plantings (pine and deciduous trees) and open grassland (native and modified grassland). Areas within the former brickworks, former quarry and former workers accommodation contained dense grass and woody weed species (blackberry bush) with pine trees.

The vegetation appeared to be in good health with no obvious signs of stress.

## 2.8 Regional Geology

The Canberra Brickworks quarry form one of Canberra's most important and oldest geological 'monuments'. The quarry derive their geological importance from being the type locality of the Yarralumla formation, a sequence of tuffaceous siltstone, sandstone and limestone deposited in the Silurian Period, 425 Million Years ago.

The Yarralumla formation is the only fossiliferous, marine unit within the extensive volcanic marker horizon in determining the stratigraphy of the volcanic rocks, and through its fossil fauna, provides evidence of the age of these volcanics.

A significant portion of the site has been excavated to provide raw materials for brickmaking (clay). Excess raw materials from the quarry have been combined with brick offcuts to fill site areas and to create mounds around the Site. There was no specific geotechnical information for the site available for this study.

## 2.9 Regional Hydrogeology

In the Canberra region, groundwater occurs in fractured rock aquifers and in unconsolidated sand in thin alluvial and colluvial aquifers. Yields of bores in fractured rock aquifers are in the range 0.1-5l/s and higher yields are obtained in closely jointed rocks along fault zones.

Groundwater salinity is generally less than 2000 mg/L TDS and largely determined by complex geology and recharge conditions. The depth to groundwater in the Canberra region generally ranges from about 2 to 20m from the surface and is dependent on the underlying geology.

### ACT ESDD Groundwater Bore Search

A search of the Environment and Sustainable Development Department (ESDD) Groundwater Bore database indicated that 3 registered abstraction and one investigation/monitoring groundwater were located within a 2 km radius of the Site. No groundwater bores were located within the Site, a copy of the search and a map depicting the location of the bores is presented in **Appendix D**.

Table 2-2 Groundwater Bore Search

Bore ID	Purpose	Construction Date	Total Depth (m)	Static Water Level (m)
WU36	Private (abstraction)	Unknown	43	35
WU105	Private (abstraction)	Unknown		
WU609	Private (abstraction)	Unknown		
Woden3	Investigation	Unknown		

## 3 SITE HISTORY AND BACKGROUND DATA

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### 3.1 Previous Investigations

SMEC has reviewed two conservation plans (Lester Firth & Associates and Lovell Chen) and six environmental reports (Connell & Wagner and Robson's).

The plans and reports reviewed as part of the PSI are listed below:

- Lester Firth & Associates Pty Ltd (June 1986), Old Canberra Brickworks, Conservation Plan, June 1986;
- Connell & Wagner (February 2001), Brickworks Contamination Report, Appendix F;
- Robson Laboratories Pty Ltd (October 2006), Environmental Investigation Audit, Yarralumla Brickworks Block 1 Section 102 Yarralumla, Canberra Central, ACT;
- Robson Laboratories Pty Ltd (March 2006), Survey to Determine the Extent and Condition of Hazardous Building Material at Yarralumla Brickworks, Yarralumla ACT;
- Lovell, Chen – Architects & Heritage Consultants (March 2010), Conservation Management Plan – Canberra Brickworks, Denman Street, Yarralumla, Canberra;
- Robson Environmental Pty Ltd (May 2010), Review of Past Site Works and Indicative Costings for Further Assessment and Remediation, Yarralumla Brickworks, Yarralumla, ACT;
- Robson Environmental Pty Ltd (October 2010), Hazardous Material Survey & Management, Denman St Yarralumla Brickworks, Yarralumla ACT; and
- Robson Environmental Pty Ltd (February 2012), Hazardous Material Survey & Management, Yarralumla Brickworks, Yarralumla ACT.

The reports generally pertain to the Canberra Brickworks located within the northern portion of the Site. A summary of the reports is provided in the following sections.

#### 3.1.1 Lester Firth (1986)

Lester Firth Associates prepared a Conservation Plan for the Canberra Brickworks; the purpose of the plan was to outline conservation policies and management options for the brickworks.

The plan reports on the history of the Canberra Brickworks until its closure in 1976. A series of chorological layout plans are presented in the report, a review of the plans is provided below, copies of each plan can be found in **Appendix E**.

**1911:** Plan depicts rural character of the Canberra Brickworks. The Site is surrounded by fenced paddocks, Yarralumla creek is identified to the south and Molonglo River to the north. An unnamed road is located adjacent and south of the brickworks.

**1916:** The first four (4) kilns and associated workshop were located approximately 100 m southeast of the brickworks office building (refer **Appendix E**). The kilns were used sometime between 1913 and 1916 to make the initial bricks used to establish the brickworks. At this time the brickworks comprised a machine shed (with attached blacksmiths shop), office, power house, Staffordshire kiln and a fan house with a stack. A tram line is identified connecting the brickworks to the quarry.

It is noted that the power house was driven by a steam driven donkey engine (likely coal fired) until the Kingston Powerhouse was commissioned in 1915.

**1920s:** Hardy patent kiln and fan house with stack constructed. A tile making plant installed south of the machine shed. The plan reports that joinery shop, mechanical and electrical workshops were operated briefly for one year.

A 3'6" (1027 mm) narrow gauge steam hauled locomotive rail network installed to service Parliament House, the Kingston Powerhouse and Canberra Hotel. The railway was removed and timber was used for firing kilns due to the economic depression. Prior to the railway, bricks were likely transported in wagons pulled by a steam driven tractor.

**1950s:** Post war growth included the establishment of the brickworks workers accommodation, crusher/pan houses, workshops and machine bays. Two temporary downdraft and one Hardy patent kiln with stack were also constructed.

The workers accommodation comprised two sleeping quarters, kitchen and mess hall, several huts and a latrine (toilet) block.

Carpenters shed was constructed approximately 50 m south east of the office and power house.

A diagrammatic representation of the brick making process (1960) is presented in the plan (refer **Appendix E**).

**1960-70s:** Three downdraft kilns with stack, forklift shed, oil storage, and extrusion plant were constructed.

The carpenters shed was removed between 1963/1969, the building was replaced with a carpark.

A weighbridge also used to weigh imported material during the 1960s. A concrete pit remains but has been filled.

In 1967 the ACT Health Services found the accommodation to be in '*a state of disrepair, and the area littered with all kinds of rubbish*'. In 1970 attempts were made to dispose of the brickworks workers accommodation, although foundations and building demolition remain visible today.

The brickworks were closed in 1976. All reusable material was relocated to the new Mitchell Brickworks Site.

**1976-84:** The brickworks were purchased by private developer A.R Marr Pty Ltd, it was envisaged that the brickworks and surrounding area would be redeveloped as a major tourist complex with associated housing.

The quarry area was to become 'quarry gardens' works included land filling, installation of the 'reflection lake' and 'outer quarry' was levelled and grassed to install a 300 mm railway.

Several storage sheds including a Model Railway Workshop were located adjacent to the wall separating the brickworks and quarry. The Model Railway Workshop was formerly used for the storage of coal/oil.

A.R Marr Pty Ltd was put into provisional liquidation and the Commonwealth government regained the lease.

Fill was identified in the A.R Marr Pty Ltd plan as being a development constraint (Lester and Firth, **Section 3.4.3**) in the following areas:

- Western Open Space: area was used for dumping brick waste including over burnt brick, broken material, rubble and dust/other unspecified waste from the kilns. The location and volume of fill were unspecified; and
- Quarry Zone; area contains areas of reject brick fill; the location and volume of fill were unspecified.

### 3.1.2 Connell and Wagner (February 2001)

Connell and Wagner completed a Phase 1 assessment for the Old Canberra Brickworks which was included as an appendix to a Development Control Plan also prepared by Connell and Wagner.

The assessment included a desktop study, site inspection and an interview of personal involved with the operation of the brickworks.

The Phase 1 data identified the following Areas of Environmental Concern (AEC):

- Coal and Oil Bunkers. Location initially used for the storage of coal;
- 1000L underground storage tank (UST) in the forklift area. The status of the UST at this time was unknown;
- Model Railway Workshop. Location initially used for above ground storage for coal and later oil;
- Septic Tank;
- Blacksmiths shop; and
- Explosives Storage Area.

The Phase 1 concluded that the main sources of contamination at the site are attributed to the brickmaking activities (1913 to 1976) including the onsite storage of fuels, oils and possibly explosives. Connell and Wagner also identified the areas of fill sourced from materials within the Site.

The report concluded that the identified AEC's would require further assessment, remediation and validation (as required) in accordance with Environment ACT requirements.

### 3.1.3 Robson Laboratories (October 2006)

Robson Laboratories completed a report entitled, "Environmental Investigation – Audit Report" detailing the results of soil testing targeting of specific facilities within the Yarralumla Brickworks Complex, Yarralumla ACT. The purpose of the investigation was to assess the potential environmental impact arising from former uses at each facility. The facilities targeted also include AEC identified by Connell and Wagner (2001) and are summarised below:

#### Brickworks

- Explosive Store;
- Asbestos dump;
- Forklift Shed;
- Coal and Oil Storage Area;
- Kiln Sand; and

- General Areas.

#### **Quarry Area (West)**

- Machine and Blacksmith Shop Area;
- Quarry Tailing Dump Areas; and
- General Areas.

A contaminated land search undertaken through Environment ACT Environment Protection Unit (EPU) indicated the site is recorded on the database as potentially contaminated.

The EPU supported the recommendations of the Connell and Wagner stating '*it would oppose any change in land use from brickworks until the site is assessed and independently audited by a contaminated land auditor*'.

The key findings of the investigation are summarised below:

- Fill was identified across the site and was observed to comprise bricks, clay and slag.
- TPH exceedances were reported at a sample location proximal to the Machine Bay 3. The exceedance was attributed to temporary fuel storage at this location.
- A single lead exceedance was reported in a surface sample of sands adjacent to the kiln. The source of the impact was unclear, but was considered attributed to the glaze used in brick making.

Robson recommended that an appropriate environmental assessment be designed once the future land use is confirmed. The assessment may include further investigations and/or remedial work of the AEC's identified.

#### **3.1.4 Robson Laboratories (March 2006)**

Robson Laboratories in March 2006 completed a report entitled, "Survey to Determine the Extent and Condition of Hazardous Building Materials at Yarralumla Brickworks", this was a non-destructive survey and sampling was therefore limited to accessible materials. The objective of this report was to give a detailed list of hazardous materials that were identified and included the following:

- Friable asbestos;
- Bonded asbestos;
- Lead-paint;
- Synthetic mineral fibre; and
- PCB capacitors to fluorescent light fittings

Areas excluded from the inspection (due to access) included:

- Asbestos pipe lagging set into masonry walls;
- Wall Cavities – original asbestos sheeting, debris and insulation ;
- Areas which contain inaccessible building rubble;
- Plant equipment – asbestos gaskets;

- Subterranean areas and asbestos sheet fragment packers; and
- Hot water heaters – asbestos beneath Synthetic Mineral Fibre Insulation

Based on the site survey and analytical results, Robson recommended the following:

- Structures should be removed as soon as practicable (e.g. top level Kiln 2).
- Other structures which are in poor condition should be removed by an ACT licensed asbestos removalist as soon as practicable (e.g. external wall sheets of the building atop Kiln 3, corrugated roof sheet on building A3).
- Dumped material on the western end of the site would need to be removed prior to any further site development due to contamination.
- Lead paint identified on the windows frames of the top floor of the former canteen building is in poor condition and should be removed or encapsulated to prevent further deterioration.
- All the Synthetic mineral fibre should be removed as soon as practicable as asbestos waste.
- If it is decided to demolish or excavate the exclusion areas, care should be taken to determine the existence of asbestos. If asbestos is located, all works must cease and an ACT licensed asbestos removalist should be contacted immediately to remove this material prior to completion of the job.

### **3.1.5 Lovell, Chen – Architects & Heritage Consultants (March 2010)**

Lovell and Chen prepared a Conservation Management Plan (CMP) for the Canberra Brickworks, the CMP built upon previously undertaken by Lester Firth (1986) and provides a more recent and detailed account of the history of the brickworks.

One of the main objectives of this Management Plan is to support a sensitive approach to potential future change and the implementation of an adaptive reuse and redevelopment strategy that is both feasible and will support the long-term conservation of the core heritage values of the place.

The Management Plan includes:

- The Process of Brickmaking;
- History and Physical Analysis;
- Assessment of Significance; and
- Conservation Policy and Management Plan.

This Plan highlights facilities, which could have environmental impact on the site:

- Quarry;
- The power house (concrete floor);
- Coal storage shed (later model railway storage shed);
- Demolished structures: (the location of some is unclear):
  - clay storage shed;
  - carpenter's shed;

- oil/fuel and coal bunkers (onsite and offsite);
- weighbridge;
- forklift shed;
- temporary kilns;
- brickworks workers accommodation (includes Hostel and Camps);
- explosives store; and
- a weatherboard cottage.

The CMP concludes with the recommendation that these sites should be investigated as part of a broader archaeological assessment of the site and abutting land.

### **3.1.6 Robson Laboratories (May 2010)**

Robson Laboratories in May 2012 prepared a proposal entitled "Review of Past Site Works and Indicative Costing's for Further Assessment and Remediation".

The proposal refers to an environmental assessment report titled Robson (2006) *Remediation Action Plan (Draft), Asbestos Dump, Yarralumla Brickworks, Block 1 Section 102 Yarralumla, Canberra Central ACT* (Robson report reference 3144\_CL\_RAP\_20061109, dated November 2006). The summary stated:

*In 2006, Robson prepared an environmental assessment report titled Robson (2006) Remediation Action Plan (Draft), Asbestos Dump, Yarralumla Brickworks, Block 1 Section 102 Yarralumla, Canberra Central ACT (Robson report reference 3144\_CL\_RAP\_20061109, dated November 2006). The Remediation Action Plan (RAP) was prepared so as to facilitate the safe and effective removal of all waste from the asbestos dump area so that the waste no longer poses a risk to human health or the natural environment.*

*Three broad phases of work were proposed for the remediation of the asbestos dump including:*

- *Vegetation removal, including prior organisation of work permits and preparation of a Sediment and Erosion Control Plan and a Project Health and Safety Plan;*
- *Removal of hazardous materials and recyclable wastes, including waste classification and validation of the remediated area; and*
- *Site reinstatement, including importing validated fill material and revegetation.*

Limited remedial works of the asbestos dump area were subsequently undertaken by Robson in June and July 2007, with approximately 50m<sup>3</sup> of asbestos waste being removed from the site. Remedial works were ceased when:

*A 'Prohibition Notice' was served by a delegate of the ACT Planning and Land Authority (ACTPLA) on the grounds that the excavation work was being undertaken without development approval. At the time that work ceased it was assessed that potentially 500m<sup>3</sup> of asbestos waste remained in the dump area.*

### 3.1.7 Robson Environmental (October 2010)

Robson in October 2010 completed a report entitled, "Hazardous Material Survey and Management Plan". The objective of this report was to assure the occupants of Yarralumla Brickworks the highest standards of occupational health and safety in relation to hazardous materials. The survey involved a visual inspection non-destructive and non-intrusive in nature of accessible, representative materials, therefore limited to the following areas:

- Interior and exterior of the building;
- Roof, amenities and immediate surrounding land; and
- UST filler points and breather vents (near kiln 1).

The survey did not include the inspection or assessment of the following areas:

- Subterranean areas (e.g. infill/soil);
- Concealed cavities; and
- Formwork and subterranean electrical cable ducts and water pipe ducts.

The key findings of hazardous materials were:

- Asbestos (friable, bonded);
- Lead paint;
- Synthetic mineral fibre;
- Polychlorinated Biphenyls (PCB);
- Ozone Depleting Substances (ODS); and
- Aboveground Storage Tank (near Machinery Shed 3) and Underground Storage Tank (near Kiln 1).
  - Note that, the AST and UST identified by Robsons (2010) were not sighted during the fieldwork component of the PSI.

The key recommendations of this report were:

- All Asbestos Containing Material should be removed by an ACT licensed Asbestos Removalist. Also, the area where this material was found should be cleaned by this removalist.
- All SMF, Lead Paint, PBC and ODS contaminated related material should be removed using effective control procedures and disposed in accordance with the ACT regulatory authorities.
- As access to some areas was not permitted, it should be presumed that any similar materials located in these areas could be contaminated until proven otherwise.
- In terms of the Underground Storage Tank, further investigation is required to establish whether or not is still in place and its condition.

### 3.1.8 Robson Environmental (February 2012)

Robson Laboratories in February 2012 completed a second report entitled, "Hazardous Material Survey and Management Plan" at the Canberra Brickworks. The objective of this report was to present the findings of a Hazardous Material Survey conducted at Canberra Brickworks, Yarralumla. Also, ensures that the safe removal of hazardous materials must be undertaken by appropriately licensed and skilled personnel prior to the demolition of the premises. The survey undertaken at Canberra Brickworks involved a visual inspection non-destructive and non-intrusive in nature of accessible, representative materials, therefore limited to the following areas:

- Interior and exterior of the building
- Roof, amenities and immediate surrounding land.
- UST filler points and breather vents.

The key findings were the same as previous reports, with a more specific report in terms of identification of the hazardous materials, location and the actions which have to be taken in order to eliminate the hazard.

## 3.2 Historical Aerial Photographs

Historical aerial photographs were obtained and reviewed to investigate the former land uses and development at the site. Aerial photographs dated between 1951 and 2012 were obtained and reviewed.

The historical aerial photographs are presented in Figure 3a to 3k, **Appendix A**. Remnant features still visible today are presented in Figures 2 and 2a, **Appendix A**.

Table 3-1 Historical Aerial Photography

Year	Site Description
Figure 3a 1951 Run 2 Print 5102	<p>The Site: Quarry, Power House, Staffordshire Kiln (Kiln 1), Fan House and Chimney Stack for Kiln 1, Offices, Hardy Patent Kiln (Kiln 2), Fan House and Chimney Stack for kiln 2, Amenities Block also present.</p> <p>There are some visible buildings and sheds surrounded by trees east, north and south (Workers Accommodation) of the Site.</p> <p>The railway line and several roads are visible including Denman St.</p> <p>Several unnamed roads leading to the brickworks, quarry and the former workers accommodation are also visible in the imagery.</p> <p>The Surrounding Area: to the north trees/orchids associated with early arboretum works including the Westbourne Woods to the west. Development of Yarralumla suburb to the east and vacant land to the south also observed.</p>
Figure 3b 1958 Run 7 Print 5060	<p>The Site: presence of new buildings. A third kiln has been established on the Site (Hardy patent Kiln), Chimney stack for Kiln 3, Machine Bays (I, II and III), Workshop building, Crusher Houses and the Elevator/Conveyor.</p> <p>Additional structures observed at the former brickworks workers accommodation, the quarry has also been expanded.</p> <p>Shed like structure observed west of the brickworks and north of the railway line, possible location of the explosives store.</p>

Year	Site Description
	<p>Small building south and east of the brickworks, probable location of the Carpenters Shed. Exposed soils observed further south and east of this location.</p> <p>The Surrounding Area: further development of the surrounding areas.</p>
<p>Figure 3c 1968 Run 9 Print 8708</p>	<p>The Site: a large shed has been built on the west of Power House and became the Downdrafts Kilns (Kilns 4-6). The railway line is starting to be overgrown with vegetation. The quarrying activity is more evident. Appears to be some stockpiling of material west of the quarry. Clay storage shed observed in the quarry area Area of exposed soil south east of the brickworks previously noted (1968) remain, purpose is unclear however the area may have be used for the storage of materials. Cleared area 50m south east of the Power House, location of a former carpenter's workshop appears to be used as a carpark. Plantings of trees in the southern portion of the Site evident. Rows of trees also planted south adjacent to Denman St. Earthworks associated with the Cotter Road and Yarra Glen overpass observed.</p> <p>The Surrounding Area: further development of Yarralumla to the east, establishment of the Royal Canberra Golf Course to the west and the suburb Curtin to the south. Some buildings have been established north of the Site. Lake Burley Griffin has been filled.</p>
<p>Figure 3d 1978 Run 15 Print 49</p>	<p>The Site: removal of clay storage shed, workers accommodation buildings, forklift shed and several other buildings. The quarry appears to have been also been filled. Extrusion plant has been constructed. Disturbed soils observed in the north western portion of the Site, this is the location of the current asbestos dump. Cleared area south east of brickworks (noted 1958 and 1968) appears to be used for stockpiling. The vegetation around the former railway corridor and brickworks workers accommodation increased. The railway corridor is barely visible in the image.</p> <p>The Surrounding Area: Consistent with 1968. Cotter Road and Yarra Glen overpass construction completed. CSIRO School of Forestry established (NE of the site).</p>
<p>Figure 3e 1988 Run 15 Print 6251</p>	<p>The Site: roofing material of the kilns and workshops has been upgraded. Tracks observed in the quarry, the carpark (formerly the carpenter's workshop) is disused and overgrown with grass. Former workers accommodation and railway corridor completed overgrown with vegetation.</p> <p>The Surrounding Area: No significant changes, housing constructed to the northern and eastern boundary of the Site</p>
<p>Figure 3f 1998 Run 5 Print 0137</p>	<p>The Site: asbestos dump appears covered with vegetation. Quarry area grassed with the reestablishment of trees. Some minor tracks (pedestrian) appear to bisect the central areas of the Site.</p> <p>The Surrounding Area: No significant changes.</p>
<p>Figure 3h 2012 Aerial Imagery</p>	<p>No significant changes from previous years.</p>

Year	Site Description
ACTmapi	

A review of the available aerial photographs indicates the Site has a history of industrial land use associated with the operation of the brickworks between 1913 and 1976. Some features of the brickworks have been demolished since its closure. The review did not provide any data pertaining to the depth of the quarry or the nature and/or extent of filling activities.

With the exception of the construction of road infrastructure, the southern portions of the Site remain largely unchanged.

### 3.3 ACT ESDD Contaminated Land Search

A search of the Environment and Sustainable Development Department (ESDD) Contaminated Land Search database indicated that following blocks were recorded on the ACT EPA contaminated sites management database:

**Blocks 1, 7 and 20 Yarralumla Canberra Central** (the brickworks, quarry and the former workers accommodation areas)

The search identified the presence of an abandoned commercial brickworks. The EPA have reviewed and gave their support to the recommendations made in the Phase 1 assessment report prepared by Connell and Wagner (2001). The Phase 1 recommended that further investigation, validation and remediation would be required.

The EPA stated '*it would oppose any change in land use from brickworks until the site is assessed and independently audited by a contaminated land auditor*'.

The search also indicated the block may contain fuel storage facilities and asbestos containing materials. Worksafe ACT should be contacted regarding the status of any fuel storage facilities and asbestos abatement plans.

The search indicated that a draft remediation action plan for the remediation of identified asbestos material in soil was received by the EPA in 2007. The RAP was not available at the time this PSI report was prepared, the area subject to remediation has identified as an area of environmental concern in this PSI and shown on Figure **Figure 2a, Appendix A**.

**Block 4 Deakin Canberra Central** (the Southern Area)

The block is not reported on the EPA's contaminated sites management database or geographic information system.

Records indicate the block is occupied by public playing field and that playing fields have (in the past) been associated with contamination due to the application of chemicals for the control of weeds and pests. The storage of herbicides/pesticides may also have occurred at the block. There is potential for uncontrolled fill to also be present at public playing fields.

Copies of the ACT ESDD Contaminated Land Search results are provided in **Appendix F**.

### 3.4 Dangerous Goods Records Search

A search of the Dangerous Goods Act 1975 and Dangerous Substances Act 2004 maintained by Worksafe ACT did not indicate the presence of any stored dangerous goods or underground storage tanks (USTs).

The search indicated that tanks containing diesel less than 50 000 litres were not required to be licensed with Worksafe. A copy of the search is provided in **Appendix G**.

### 3.5 Site Inspection

#### 3.5.1 Visual Observations

An inspection of the Site was undertaken by SMEC during the fieldwork component of the PSI. The purpose of the inspection was to identify areas of environmental concern. Photographs taken during the Site inspection are included in **Appendix H**.

Observations made during the inspection are summarised below:

#### **Brickworks**

Large portions of the brickworks were occupied by Thor's Hammer a wood recycling business (Photo 1, **Appendix H**) and were used for the storage of bulk wood supplies, it is understood that artists also utilise some workshop spaces at the brickworks. Thor's Hammer and the artists were observed to be operating in Machine Bay 1 and the Workshop (Figure 2a, **Appendix A**), other areas of the brickworks (both sealed and unsealed) were used for wood storage as shown in Figure 2b, **Appendix A**.

An inspection of the chemical storage areas used by Thor's Hammer and artists was undertaken by SMEC on 12/2/2014. The chemicals stored at the brickworks included varnishes, wood finishes, paints, oils and hydraulic fluid (for wood working machinery). These chemicals were kept in a lockable shipping container and steel storage cabinets, good housekeeping was observed with no staining evident. These storage areas were typically located in Machine Bay 1 (Figure 2a, **Appendix A**) on a sealed concrete surface.

Remnant buildings associated with the operation of the brickworks were observed to be in various conditions ranging from good to some buildings showing signs of disrepair. (Photo 2, **Appendix H**).

A hazardous material assessment was outside the scope of this PSI; however a brief inspection generally indicated good housekeeping with no obvious staining or visible waste observed. Robson Environmental Pty Ltd has prepared several hazardous material surveys for the brickworks (March 2006, October 2010 and February 2012) a summary of these reports is provided in **Section 3.1** of this PSI.

External areas comprised gravelled vehicular tracks, grassed and concreted areas. The condition of concrete varied presumable based on the age of construction. Occasional fragments of potential ACM were observed during the Site inspection of the brickworks and quarry areas.

A network of concrete drains was observed around the building; although generally dry, some sheen was observed in drains around Machine Shed 1 (Photo 3, **Appendix H**). The source of the sheen is unknown but is likely oily wash from the nearby workshop. The drains are likely to receive wash from the former operation of the brickworks and the current use of the workshops. It is expected that the infrastructure drains to the local stormwater system.

Remnant structures of the former crusher plants were noted, some rusted oil drums (labelled 'lubrication oil') were observed in this area (Photo 4, **Appendix H**), no staining and/or odours were observed. Inspection of this area (and others) was limited by the presence of dense woody weed species (blackberries).

General areas around the machinery sheds were littered with empty drums, scrap metal and other waste materials (Photo 5, **Appendix H**). No obvious signs of ACM, staining and/or odours were noted during the inspection.

A disused oil pressure/storage tank was identified at the rear of Machine Shed 3 (Photo 6, **Appendix H**). It was located adjacent to the concrete footings of removed plant machinery. No odours or staining were observed however Robson (2006) identified TPH impact at nearby at location BH14.

Historical data indicated the presence of a 1000 L petrol UST between the former forklift shed and Fan House 2. A visual inspection did not identify any vent pipes, dispensing pumps, concrete pads or remote filling points. The base of the former building was littered bricks and demolition waste (no observed ACM) limiting the inspection.

The asbestos dump was contained within a fenced exclusion area which prevented access. The area was also observed to be overgrown with weed species which prevented inspection of surface soils. A septic tank servicing the brickworks is also located in the fenced exclusion area. It is considered likely that the septic tank is still connected to the brickworks and possibly the former workers accommodation.

## Quarry

The quarry was observed to comprise levelled grassed areas, natural limestone and shale knolls, and several fill mounds. The original depth of quarry is unknown and has been backfilled to level approximately 3 m higher than the ground level within the adjacent former brickworks (Figure 2c, **Appendix A**).

The artificial lake located in the northern portion of the quarry was observed to be dry and appeared to have been formed from a shallow (approximately 1 m) depression. The base of the lake appeared to be bedrock with shale outcroppings, the walls of the lake appeared to be constructed from reworked soils.

Two large fill mounds comprising reworked natural soils, brick waste and excess quarried rock. Fragments of potential ACM were observed in the northern fill mound (Photo 7, **Appendix H**).

It is expected that surface water in the quarry would either infiltrate fill material or drain towards the artificial lake. A surface drain was observed in the north western portion of the quarry that drained to the brickworks, Figure 2c **Appendix A**. The exact purpose of the drain is unknown but may have been constructed for the following:

- To redirect surface water (from the north and north east) away from the quarry (towards the brickworks) to protect mining activities; and/or
- To receive the overflow from the artificial lake.

Once discharged to the brickworks surface water either infiltrate sub-surface materials (probable fill material) or flow towards the brickworks drainage infrastructure.

Surface fragments of potential ACM were also observed in the southern portion of the quarry, the potential ACM appeared to be associated with gravelly fill comprising crushed brick and concrete used to construct the track.

### Former Workers Accommodation

Several demolished brick buildings and footings were observed in the former workers accommodation (Photo 8, **Appendix H**). The demolition waste generally comprised bricks, metal and concrete, occasional fragments of potential ACM were also observed.

The exact location and extent of the former building could not be established during the inspection due the presence of overgrown grass and woody weeds. The approximate location of the former buildings identified from a review of the available reports (**Section 3.1**) is provided in Figure 2b, **Appendix A**.

An interceptor type structure (Photo 9, **Appendix H**) adjacent to a demolished building (likely location of the former kitchen/mess hall) indicates that underground services/structures are still likely to be present. The interceptor likely received grease and fats from the kitchen/ mess hall operations, no odours and/or staining was observed. It is probable that the interceptor drains to the brickworks, and then subsequently the local stormwater system.

An abandoned vehicle (Photo 10, **Appendix H**), dumped materials (wood, metal and general waste), a fridge and multiple mounds were observed in the area, a detailed inspection of these features was limited by dense vegetation.

The railway corridor(s) was observed to be bare, with no remnant infrastructure (railway lines or treated wooden sleepers).

A cleared area with patches of asphalt was observed adjacent to the workers accommodation, no mounding or dumped materials were identified. The purpose of the area is unclear but may have been used for storage of materials.

### Southern Areas

The Southern Areas of the Site were observed to comprise tree plantings (pine species) and open grasslands with several major roads (Dudley St, Cotter Rd and Adelaide Avenue) that bisect the Site east to west. It is considered probable that this fill was imported to meet the designed Cotter road grade.

Plantings of deciduous trees were observed north adjacent to Denham St and west near the Royal Golf Course. Slashing and mulching activities in the western portion of the area were noted during the PSI.

The available historical data (Lester and Firth, 1986) indicated that the southern areas of the Site were denoted as "Gibbes Paddock" and was likely used for grazing as part of the larger Yarralumla property. The potential for contamination from grazing practices is considered low. A grove of trees was also observed adjacent south to Denham St in the central portion of the Site.

Since then several tree groves (predominately pine) have been planted throughout the central and southern areas of the Site, as shown in Figure 2, **Appendix A**. The trees appeared to be in good health with no obvious signs of stress.

Remnant portions of the railway corridor were observed in the western portion of the area. No ballast or other infrastructure was noted during the inspection; it is likely that the rail line and sleepers rested on the site's soils.

Two concrete lined pits were located adjacent to remnants of an unnamed vehicle track (currently used by pedestrians and cyclists). Some broken tiles and glass bottles observed at the base of the pits, which appeared otherwise empty (Photo 11 and Photo 12, **Appendix H**). The purpose of the pits was unclear; however, it was considered likely that they were used to retain stormwater run-off from

the adjacent unnamed road. The potential exist for possible impacts from spills/leaks from vehicles (formerly using the track) and wash form the surrounding area.

A diffuse waste pile was identified in the south east portion of the Site adjacent Yarra Glen (city bound). The pile comprised mostly bricks, metal, and general waste and was estimated to be around 10 m<sup>3</sup> in total volume (Photo 13 **Appendix H**). Several fragments of potential ACM were also identified in and around the pile.

### 3.5.2 Interview with Thors Hammer

On the 12 February 2014, SMEC undertook an interview with Mr Thor Diesendorf the proprietor of the Thors Hammer since 1984 regarding his knowledge of historical or recent potentially contaminating activities. A summary of the interview is provided below:

- Mr Diesendorf was not aware of any contaminating activities to have occurred at the brickworks during the operation of Thor's Hammer, however some vandalism (spray painting) had been noted;
- It was highly unlikely that any treated woods have been stored or used as part of the business given the regulations around the reuse of these materials (arsenic (copper chrome arsenate), creosote and/or OCP treated timbers); and
- Mr Diesendorf did however indicate that small amounts of creosote treated timber and painted (potentially lead based) timber could have been reused over the years.

General woodworking chemicals were kept on the premises this included, varnishes, finishes and paints. Some oils and hydraulic fluids were kept for maintenance of the woodworking machinery (lathes, wood saws etc). These chemicals were kept in a lockable shipping container and steel storage cabinets, good housekeeping was observed with no staining evident.

## 3.6 History Summary

**1913-1976:** A review of the available site history and background data indicated that the northern portion of the Site has a history of industrial land use centred around the operation of the Canberra Brickworks from 1913 until its closure in 1976.

**1976 -1984:** Since its closure, there has been one attempt to redevelop the brickworks by A.R Marr Pty Ltd. It was envisaged that the brickworks and surrounding area would be redeveloped as a major tourist complex with associated housing. A artificial lake, and a model railway was constructed in the quarry at this time. Several storage sheds including a Model Railway Workshop were located adjacent to the wall separating the brickworks and quarry. The Model Railway Workshop was formerly used for the storage of coal/oil. The locations of these features are presented in Figure 2b and 2c, **Appendix A**.

**1984-Current:** Areas of the brickworks are currently leased by Thor's Hammer a wood recycler and local artists. Given the limited available historical data since the closure of the brickworks (1976 to Current) there is the potential for dumping (illegal or legal) and/or vandalism to have occurred.

The remainder of the Site is comprised of open grassland, forests and several major roads.

**Previous Environmental Investigations:** Two limited environmental investigations have been undertaken by Connell and Wagner (2001) and Robson Environmental Pty Ltd (2006). Robson completed 21 boreholes across the brickworks and quarry, as no GPS data was provided the approximate borehole locations of the investigation are provided in Figure 4, **Appendix A**.

The inclusion of the Robson (2006) data is not considered to add a significant amount of certainty/data for future assessments given:

- The lack of GPS coordinates for the boreholes (this would add uncertainty);
- The age of reported data, as the condition of the site may have changed since the publication of the report.

### 3.7 Contaminants of Potential Concern

The historical data review completed by SMEC has identified the following contaminants of concern (CoPC) that may be present at the Site.

Table 3-2.6 Contaminants of Concern

CoPC	Context
Asbestos Containing Material (ACM), Asbestos Fines (AF) and Fibrous Asbestos (FA)	Asbestos cement materials present (sheet, conduits, flooring tiles etc) in Site buildings. May be present in fill material containing demolition waste from former buildings. Asbestos also may have used in vehicle and locomotive (light rail and trams) brake pads used during operation of the brickworks.  Asbestos is also present in the asbestos material dump area.
Benzene, toluene, ethylbenzene, xylenes (BTEX)	Volatile organic compounds (VOC) present in petroleum based fuels, oils and solvents. May be present in solvents, paint strippers and rubber cements. Potential for former use associated with the operation of the workshops and/or former carpenters shed.
Creosote	Wood –tar or coal-tar creosote used for wood preservation. It is toxic to fungi, insects, marine borers and is a water repellent and it's typically applied to pilings, telephone poles, power line poles and fence posts.  Storage of creosote treated woods may have been associated with operation of Thors Hammer.  Contains variable percentages of aromatic hydrocarbons (PAH and BTEX) and phenols.
Explosives	Potential for nitrogenous organic explosives (TNT etc.) to have been stored and used to advance the quarry. Given the uncertainty around the specific explosives, analysis of a broad suite of explosives compounds may be necessary.  Potential for metals (e.g. mercury fulminate) to have been used as detonators.
Metals and Heavy Metals (HM)	Potential for elevated natural occurring metal concentrations in Site soils.  Anthropogenic impacts may be associated workshop activities (machinery maintenance/servicing and welding), deterioration of metallic objects, pesticides, herbicides (arsenic) and general industrial practices.  Elevated metal concentrations may be present in fill associated with practices described above.
Nutrients	Discharge of nutrient rich wastewater into unsaturated soil above the water

CoPC	Context
(fixed nitrogen (all forms), phosphorus, and faecal coliforms)	<p>table. Transport of wastewater can occur via surface water flow and infiltration.</p> <p>Potential for nutrient impacts arising from the septic tank located at the brickworks. The septic tank is first show in the 1954 site plan (Lester and Firth 1986) with a long history of use (+50 years).</p>
Herbicides and Pesticides including: Organochlorine Pesticides (OCP), Organophosphorus Pesticides (OPP)	<p>OCPs are persistent and bioaccumulation in the environment formerly used as pest control to crops, livestock and buildings. OPPs used since the banning of OCP in Australia.</p> <p>Potentially used in building footings, rail corridor and across the Site for pest control. Can be present in uncontrolled fill.</p>
Oil and Grease	<p>Oil and grease present fuels, motor oils, lubricating oil, hydraulic oil, animal-derived fats and cooking oil. Human and ecological toxicity varies between types of oil and grease. Contains various hydrocarbons that can pose a range of health risks. Typically insoluble in water.</p> <p>Likely used to operate and maintain machinery at the brickworks, potential impacts to soils and receiving water bodies.</p>
Phenols	<p>Phenol is generally synthesized as a manufacturing chemical, primarily used as a resin and in the production of plastic and synthetic materials. May occur naturally as a constituent of coal tar and decomposing organic material.</p> <p>Potentially used in workshops, may be present in uncontrolled fill.</p>
Polychlorinated biphenyls (PCB)	<p>PCBs were formerly used a coolants and insulating fluids for electrical transformers, and capacitors.</p> <p>Robson (2006, 2010 and 2012) identified the presence of PCB containing material in the existing buildings of the brickworks.</p>
Polycyclic aromatic hydrocarbons (PAH)	<p>Can occur naturally in crude oil, coal and incompetently burnt carbon materials (wood, coal, diesel etc) and ash. Used in the production of bitumen and asphalt material, can be present in fill of unknown origin.</p>
Petroleum hydrocarbons (TPH)	<p>Present in fuels (petrol, diesel, and kerosene) solvents and oils. Potential for TPH impacts sourced from the operation of the brickworks (workshops, machinery, USTs), spills from vehicles and in uncontrolled fill.</p>

### 3.8 Areas of Environmental Concern

Based on the Site history review and field observations the following AECs identified at the Site are summarised below in Table 3.3.

Table 3-3 Areas of Environmental Concern

AEC	Description	Comments
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AEC	Description	Comments
1	Waste Fill (locations where fill is present )	<p>Likely contained to the brickworks and quarry. Fill in these area was observed to comprise reworked natural soils, brick waste, ash waste, bitumen, demolition waste often with other anthropogenic inclusions (including metal, concrete, wood but not plastic).</p> <p>Potential for TPH, BTEX, PAH, Phenols, PCB, HM, Herbicides, Pesticides and Asbestos impacts in soil. Potential for contaminants to leach to the groundwater.</p>
<b>Former Brickworks</b>		
2	Recycled Timber Storage (Thor's Hammer)	<p>Parts of the brickworks are currently used for the storage of recycled (possibly treated) timber associated with the operation of Thor's Hammer. Potential for to metal impacts leaching from treated timbers.</p> <p>Potential for HM, creosote and Pesticide impacts in soils.</p>
3	UST(s) Forklift Shed (former)	<p>Historical data indicates a 1000 L petrol UST was located between the former forklift shed and adjacent fan house (Fan House 2).</p> <p>Robson (October 2010) reported the presence of UST filling points and breather vents near Kiln 1. A small empty above ground storage tank was also identified near Machinery Shed 3. These features were not identified during the PSI; further investigation is recommended to determine the presence and condition of the storage tanks discussed above.</p> <p>Potential for TPH, BTEX and lead impact in soils and/or groundwater.</p> <p>Potential for TPH, BTEX, PAH, HM and asbestos impacts in the soils at and/or near the former forklift shed.</p>
4	Stackhouse(s)	<p>Ash waste from combustion of wood, coal and oils. Potential for PAH impact in ash waste present in uncontrolled fill across the brickworks and quarry.</p> <p>Storage of coal material observed adjacent to Fan House 2.</p> <p>Potential PAHs impacts in and around stackhouses and coal storage areas. Potential for contaminants to leach to the groundwater.</p>
5	Explosive Store (former)	<p>The former explosives store (160 m west of the Power House) was assessed in this PSI and by Robson (2006).</p> <p>Potential for impacts from explosive compounds impacts in shallow soils. Potential for contaminants to leach to the groundwater.</p>
6	Machinery Shed(s)	<p>Includes blacksmith's workshop attached to Machine Shed 1. Possible spills and leaks from use of oils and solvents. Deteriorating metal waste present in and around the workshops.</p> <p>Leaks and spills likely to wash towards surrounding soils and/or into surrounding drainage infrastructure.</p> <p>Potential for TPH, BTEX, Oil, Grease, PAH, Phenols and HM impacts in soil, surface and groundwater.</p>

AEC	Description	Comments
7	Operation of Crusher and Refinery Plant(s)	<p>Potential for hydrocarbon impacts from spills and leaks from machinery used for crushing and transporting of raw material. A diagrammatic representation of the brick making process (1960) is presented in <b>Appendix E</b>.</p> <p>Robson (2006) reported elevated concentrations of TPH at sample location BH14 in this general area.</p> <p>Potential for TPH, Oil, Grease, BTEX and PAH impacts in soil and/or groundwater.</p>
8	Coal/Oil Storage Facility(ies)	<p>An aerial image in the Lovell Chen CMP (page 168) indicates the presence of 2 large above ground storage tanks at the building most recently used as the Model Railway Shed during the A.R Marr lease of the Site (1976 to 1984). It is currently an unsealed empty shed.</p> <p>Another former coal/storage facility was identified by Robson (2006), it was observed to be a remnant steel structure, the surrounding area was observed to be sealed (concrete) with no obvious signs of staining/and or odours.</p> <p>Potential for TPH, BTEX and PAH impacts in soil and/or groundwater.</p>
9	Kiln Sand	<p>Potential lead contamination. Historical data recorded an elevated concentration of lead (770mg/Kg) in a Kiln sand sample. Likely restricted to within the kilns but potentially deposited through fill material within the brickworks and quarry.</p> <p>Potential for HM impacts.</p>
10	Asbestos Dump	<p>ACM material and fill dumped west of the brickworks, observed to be contained within an exclusion fence and overgrown with dense woody weed species (blackberry bushes). Estimated to be 500 m<sup>3</sup> (Robson 2010).</p> <p>SMEC understands that the Robson Environmental Pty Ltd have prepared and will be implementing a Remediation Action Plan for the asbestos dump. The remedial area is show in Figure 2a, <b>Appendix A</b>.</p> <p>Potential for TPH, BTEX, PAH, Phenols, PCB, HM, Herbicide, Pesticide and Asbestos impacts in soil. Potential for contaminants to leach to the groundwater.</p>
11	Septic Tank	<p>Robson (2006) identified the septic tank as an AEC. The septic tank servicing the brickworks is located in the asbestos dump fenced exclusion area and was not inspected as part of the PSI.</p> <p>Nutrients, (phosphate and or nitrate / nitrite impact to groundwater), HM and faecal coliform impacts to soil and groundwater.</p>
12	Carpenters Workshop (former)	<p>Possible spills/leaks associated with workshop activities (use of oils, solvents and/or resins). Demolition waste may contain ACM.</p> <p>Potential for TPH, BTEX, PAH, Phenols and Asbestos impacts in soils.</p>
13	Former Kiln(s)	<p>Possible presence of demolition waste containing ash, kiln sand, and ACM.</p> <p>Potential for HM and Asbestos impacts in soils.</p>

AEC	Description	Comments
14	Fill Mound(s)	<p>Two fill mounds were identified immediately south of the quarry fence. A detailed inspection of the mounds was limited by the presence of grass.</p> <p>The mounds may contain demolition waste from nearby former structures (temporary kilns and the carpenters shed).</p> <p>Potential for TPH, BTEX, PAH, Phenols, PCB, HM, Herbicides and Pesticides and Asbestos impacts in soil. Potential for contaminants to leach to the groundwater.</p>
15	Weighbridge (former)	<p>Former weighbridge used to weigh imported raw materials, Lester Firth &amp; Associates (1986) report the concrete pit as remaining and has since been filled with material of unknown origin.</p> <p>Potential for TPH, BTEX, PAH, Phenols, PCB, HM, Herbicide, Pesticide and Asbestos impacts in soil.</p>
16	Power House and Underground Conduits	<p>Constructed 1915-1916, also referred to as the Power Station (Lovell Chen 2010) was used to breakdown the high voltage supply from the Kingston Power House.</p> <p>The Power House distributed power across the Site via underground electrical conduits (1916 Historical Plan, <b>Appendix E</b>).</p> <p>PCBs and Asbestos materials potentially to have been used in the Power House, potential for impacts to nearby soils. The underground electrical conduits are also potentially constructed of Asbestos materials.</p>
17	Boiler House and adjoining Substation (former)	<p>Constructed in 1971 to service the adjacent brick extrusion plant increasing the brick production capacity. Only operational for 5 years. All internal infrastructures have since been removed. It is unknown if the boiler was fuel (wood, coal or oil) or electricity driven.</p> <p>Potential for PCB, TPH, PAH and Asbestos impacts in soil.</p>
<b>Former Quarry</b>		
18	Fill Mound(s)	<p>At least two large fill mounds within the quarry were identified; it is likely the mounds are comprised of reworked soils, brick waste and quarry overburden. Fragments of ACM were observed in the northern fill mound.</p> <p>Potential for TPH, BTEX, PAH, Phenols, PCB, HM, Herbicide, Pesticide and Asbestos impacts in soil. Potential for contaminants to leach to the groundwater.</p>
19	Clay Storage Shed (former)	<p>Shed structure used to store clay. TP23 targeted this location; fill was logged to a depth of 1.5 mbgl and comprised sandy clays and silts with gravels, bricks and shale pieces.</p> <p>Potential for Asbestos impacts in soil.</p>
20	Weatherboard Cottage (former)	<p>Located approximately 20 m east of Crusher 3 (Lester Firth and Associates). A coal store and stable were attached to the cottage, demolished prior to the 1920s.</p>

AEC	Description	Comments
		Potential for PAH and Asbestos impacts in soil.
<b>Brickworks Workers Accommodation</b>		
21	Workers Accommodation (former) – General Areas and Former Buildings	<p>Area included camps and later the workers accommodation (both demolished). Several demolished brick buildings and footings were observed in the former brickworks workers accommodation. The demolition waste generally comprised bricks, metal and concrete, occasional fragments of ACM were also observed.</p> <p>Several small fill mounds were also identified in the general area; inspection of the mounds was limited by the presence of grass cover.</p> <p>Detailed inspection of the area was negated by the presence of grass and woody weed species, potential for unidentified building footprints, fill and dumped materials. Potential for fill of unknown origin to be present throughout the former workers accommodation.</p> <p>The approximate historical location of the former building is provided in Figure 2b, <b>Appendix A</b>. Assessment of AEC 19 should include the location of these former buildings.</p> <p>Potential for TPH, BTEX, PAH, Phenols, PCB, HM, Herbicide, Pesticide and Asbestos impacts in soil. Potential for contaminants to leach to the groundwater.</p>
22	Interceptor Pit	<p>A triple interceptor type structure identified adjacent north to the former kitchen/mess hall building likely to receive oils, domestic chemicals and food wastes.</p> <p>Potential for TPH, PAH, Oil, Grease and Phenol impacts in soil.</p> <p>Potential for contaminants to leach to the groundwater.</p>
23	Abandoned Vehicle	<p>An abandoned vehicle overgrown with woody weed species was identified, potential for hydrocarbon impacts and heavy metal impacts (deterioration of metals).</p> <p>Potential for TPH, BTEX, PAH and HM impacts in soil.</p> <p>Potential for contaminants to leach to the groundwater.</p>
24	Dumping Area	<p>Area of dumped materials including wood, rusted metal containers, a tar drum, electric fuse box and general waste (plastic, wood and metal pieces). Possible location of a former building.</p> <p>Potential for TPH, BTEX, PAH, PCB, Phenols and Asbestos impacts.</p> <p>Potential for contaminants to leach to the groundwater.</p>
25	Scrap Metal Stockpile	<p>Stockpile approximately 10m x 8m, volume difficult to determine inspection limited by woody weeds. Observed to contain reworked soils, sheet metal, bricks and an old fridge.</p> <p>Potential for TPH, BTEX, PAH, Phenols, PCB, HM, and Asbestos impacts in soil.</p>
26	Fill Mound	<p>A large stockpile 50m<sup>3</sup> observed adjacent to brickworks boundary fence. Observed to comprise reworked soils, rusted metal (sheets and pipes), concrete and bricks.</p> <p>Potential for TPH, BTEX, PAH, Phenols, PCB, HM, Herbicide, Pesticide and Asbestos impacts</p>

AEC	Description	Comments
		<p>in soil.</p> <p>Potential for contaminants to leach to the groundwater.</p>
27	Cleared Area	<p>Large cleared area with patches of asphalt was observed adjacent to the workers accommodation, no mounding or dumped materials were identified. The purpose of the area is unclear but is identifiable on historical plans since the 1920s; more recent uses may include the storage of materials.</p> <p>Fill was logged to a depth of 0.5 mbgl and comprised sandy clay with gravels, glass and bitumen.</p> <p>Potential for TPH, BTEX, PAH, and HM impacts in soil.</p>
28	Explosive Store (former)	<p>Lester Firth &amp; Associates reported that the original explosives store was located 180 m south of the current Power House, and was later relocated 160 m west of the Power House.</p> <p>Potential for impacts from explosive compounds in soils and/or groundwater.</p>
<b>Southern Areas</b>		
29	Rail Corridor	<p>Former railway corridor used to transport bricks to parts of Canberra. Historical data also indicated temporary tramways were operated inside the quarry. Contamination may include treated timber sleepers (pesticides), asbestos from brake pads and vegetation control (in corridor).</p> <p>Potential for Herbicide, HM and Asbestos impacts in soil.</p>
30	Vehicle Tracks (site wide)	<p>The Site contains multiple vehicle tracks (current and historical). Potential for hydrocarbon impacts from oil/fuel spills and leaks. Assessment should include areas likely to receive wash (drains, low points etc).</p> <p>Potential for TPH, BTEX and PAH impacts in soil.</p>
31	Waste Pile	<p>A small waste pile (around 10 m<sup>3</sup>) was identified near Adelaide Avenue. Material comprised bricks, metal, and general waste (plastics and cardboard). Several fragments of potential ACM were identified at this location.</p> <p>Potential for TPH, BTEX, PAH, Phenols, PCB, HM, Herbicide, Pesticide and Asbestos impacts in soil. Potential for contaminants to leach to the groundwater.</p>
32	Fill (Road)	<p>Fill materials comprising silty cobbles to gravelly sand with traces of brick and bitumen was logged at TP02 until refusal at 2.0 mbgl on a large piece of concrete. The nature and extent of fill is unknown but is likely attributed to filling required meet the design grade of the Cotter rd and Yarra Glen overpass.</p> <p>Potential for TPH, BTEX, PAH, Phenols, PCB, HM, Herbicide, Pesticide and Asbestos impacts in soil. Potential for contaminants to leach to the groundwater.</p>

## 4 CONCEPTUAL SITE MODEL

### 4.1 Conceptual Site Model

A Preliminary Conceptual Site Model (CSM) has been developed to integrate the:

- I. Contaminants of Concern (historical data review, **Section 3.6**);
- II. Potential Source(s) of Contamination (AECs, **Section 3.7**);
- III. Potential Pathway(s) of Contamination transport and exposure; and
- IV. Potential Receptor(s) of Contamination (past, present and future ecological/human receptors).

The CSM for the Site is summarised below in **Table 4.1**.

Table 4-1 Conceptual Site Model

Potential Source (current and former)	Pathway (preferential and exposure)	Receptors (past, present and future)
AEC 1, 4, and 8. Ash waste associated with operation of brickworks, likely restricted to fill (PAH impacts)	Direct Exposure. Leaching of contaminants to groundwater.	(past, present) Site Workers (d, in) (future) Residential Site Occupiers (d, in) (past, present) Sub-surface soil and/or groundwater ecology (d, in, phy)
AEC 7 Machinery used to crush, refine and produce bricks. (Heavy Metal and Hydrocarbon based impacts).	Direct Exposure. Migration of dissolved contaminants through Surface and/ or Groundwater. Vapour migration and inhalation.	(past, present) Site Workers (d, in) (future) Residential Site Occupiers (d, in) (past, present) Sub-surface soil and/or groundwater ecology (d, in, phy)
AEC 4 Explosive Store(s) (TPH, BTEX and volatile organic compounds)	Direct Exposure. Migration of dissolved contaminants through Surface and/ or Groundwater. Vapour migration and inhalation.	(past, present) Site Workers (d, in) (future) Residential Site Occupiers (d, in) (past, present) Sub-surface soil ecology (d, in, phy)
AEC 1, 6, 10, 12-21, 24, 26, 29-32. ACM in fill materials and Site buildings. (ACM, FA and FA impacts)	Migration of airborne fibres generated by disturbance of ACM, or asbestos impacted soils.	(past, present) Site Workers (inh) (future) Residential Site Occupiers (inh)
AEC 23 and 30 Spills and/or leaks of fuels oils from vehicles and mobile machinery. (TPH, BTEX, PAH, Phenols and Heavy Metal impacts)	Direct Exposure. Migration of dissolved contaminants through Surface and/ or Groundwater. Vapour migration and inhalation.	(past, present) Site Workers (d, in) (future) Residential Site Occupiers (d, in) (past, present) Sub-surface soil and/or groundwater ecology (d, in, phy)
AEC 2, 6, 8 and 12 Workshop spills and/or leaks of fuels, oils and solvents etc. (TPH, BTEX, PAH, Phenols and Heavy Metal impacts)	Direct Exposure. Migration of dissolved contaminants through Surface and/ or Groundwater. Vapour migration and inhalation.	(past, present) Site Workers (d, in) (future) Residential Site Occupiers (d, in) (past, present) Sub-surface soil and/or groundwater ecology (d, in, phy)

AEC 1, 10, 14, 15, 18, 26, 29 and 31 Pesticide use (building footprints, rail corridor and former agricultural land) (Heavy Metal, OCP and OPP impacts)	Direct Exposure. Migration of persistent contaminants via Surface and/ or Groundwater.	(past, present) Site Visitors (d, in) (future) Residential Site Occupiers (d, in) (past, present) Sub-surface soil ecology (d, in, phy)
AEC 1, 10, 14, 15, 18, 26, 31 and 32 Uncontrolled Fill (TPH, BTEX, PAH, Phenols, PCB, HM, Herbicides and Pesticides and Asbestos impacts)	Direct Exposure. Migration of dissolved contaminants through Surface and/ or Groundwater. Vapour migration and inhalation.	(past, present) Site Workers (d, in) (future) Residential Site Occupiers (d, in) (past, present) Sub-surface soil ecology (d, in, phy)
AEC 3, AEC 7, AEC 8, AEC 17 Storage of fuels and oil (TPH, BTEX, PAH and lead impacts)	Direct Exposure. Migration of dissolved contaminants through Surface and/ or Groundwater. Vapour migration and inhalation.	(past, present) Site Workers (d, in) (future) Residential Site Occupiers (d, in) (past, present) Sub-surface soil and/or groundwater ecology (d, in, phy)

**Notes: exposure**

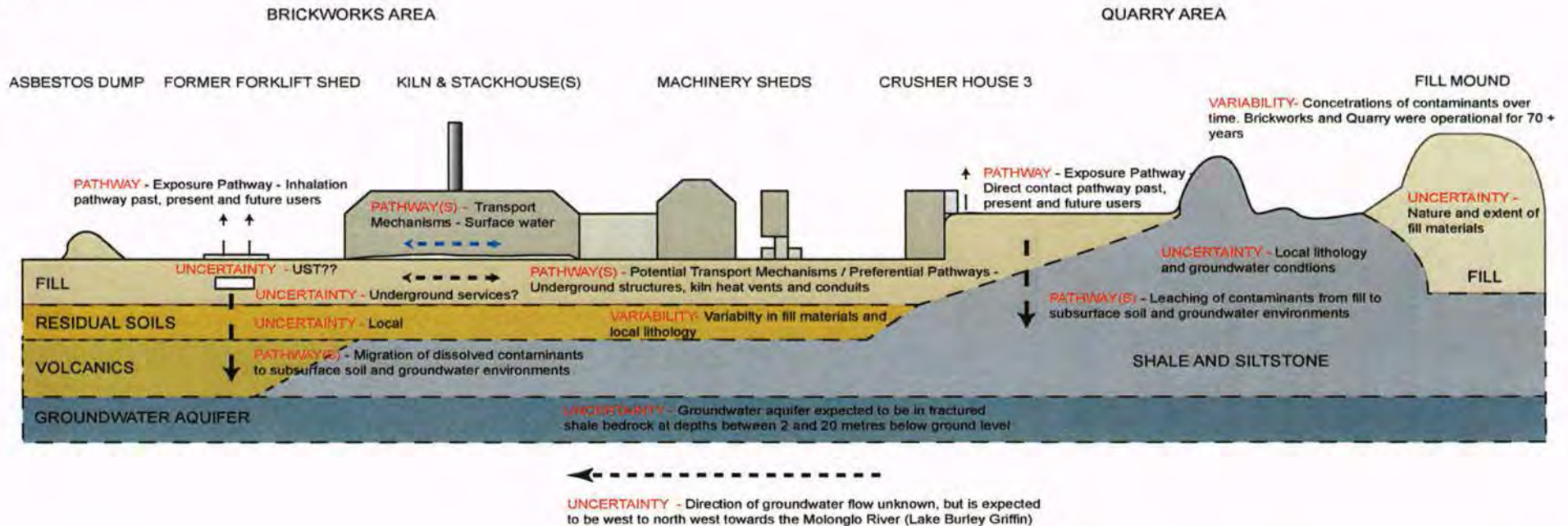
d = dermal      inh = inhalation      in = ingestion      ex = explosion      phy = roots

## 4.2 Graphical CSM

A graphical CSM of a typical section through the brickworks and quarry (east to west) illustrating some of the potential transport mechanisms, preferential pathways and data gaps identified in the PSI is provided below. Uncertainties indicated on the CSM indicate areas of uncertainty where additional information may be obtained during a future DSI. Variability indicated in the CSM may require additional data to meet DSI DQOs.

### Conceptual Site Model

N.T.S  
Not To Scale



## 4.3 Data Gaps

Subsurface conditions (soil, sediment and groundwater) can be complex and heterogeneous with many unknown geologic interactions that may affect the movement and/or concentrations of potential contaminants. This uncertainty is increased by the lack of sufficient field testing (logging of soil conditions, collection of samples and the evaluation of the concentrations of potential contaminants) to adequately assess the Site. Some of these uncertainties and variability's are identified in the Graphical CSM show above in **Section 4.2**.

Further assessment(s) are recommended to reduce the degree of uncertainty; the data gaps identified should be targeted to yield a greater understanding of the assessment area.

## 5 SITE ASSESSMENT CRITERIA

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### 5.1 Soil Assessment Criteria

The PSI was conducted with reference to with the current assessment guidelines endorsed by the ACT Environment Protection Authority (EPA) which include the following guidelines:

- ACT EPA, 2009. Contaminated Sites Environment Protection Policy;
- Environment Protection Act, 1997;
- Environment Protection Regulation, 2005;
- NEPC Amended 2013. National Environmental Protection Measure Assessment of Site Contamination (ASC NEPM); and
- NSW EPA, 2000, Guidelines for Consultants Reporting on Contaminated Sites.

The application of these guidelines is summarised below.

### 5.2 Health Based Investigation Levels (HILs)

Health based soil Investigation Levels (HILs) are provided in the CSM NEPM for metal and inorganic contaminants for a range of exposure settings, based on the current or proposed/approved use(s) of the land, including:

- Residential A (HIL A): Residential with gardens and accessible soil (home-grown produce contributing less than 10% fruit and vegetable intake; no poultry), including children's day care centres, kindergartens, preschools and primary schools.
- Residential B (HIL B): Residential with minimal access to soil; includes dwellings with fully and permanently paved yard space such as including high-rise buildings and apartments.
- Recreational C (HIL C): Public open space such as parks, playgrounds, playing fields, secondary schools and footpaths.
- Commercial/Industrial D (HIL D): Commercial/ industrial, includes premises such as shops, offices, factories and industrial sites.

Conservatively, residential (HIL A) concentrations have been adopted as screening levels for all results from the limited soil sampling conducted as part of this preliminary investigation. Further consideration of the local exposure scenarios (e.g. commercial or open space use) or site specific risk assessment would be appropriate during any detailed investigation and when redevelopment land use plans are available.

### 5.3 Ecological Investigation Levels (EILs)

The EILs provided in the CSM NEPM relate to the protection of terrestrial ecosystems and are generally applicable to contaminants in the top 2 m of the soil at finished/ground level which corresponds to the root and habitation zone of species. EILs relevant to gardens and low density residential land use have been adopted for the whole site.

Calculation of some EILs also requires measurement of soil pH and cation exchange capacity (CAC), where this is the case we have assumed typical values for the soil types observed. If soil

concentrations exceed these, indicative, EILs further consideration of local soil / fill conditions and specific biota to be supported by the soil/ fill (e.g. tree plantings) may be warranted when detailed redevelopment plans are available.

## 5.4 Health Screening Levels (HSLs)

Health Screening Levels (HSLs) are provided in the amended NEPM for petroleum hydrocarbon compounds using the same land use settings as those prescribed by the HILs for Metal and in Organic Contaminants, however the values for Residential A and B are combined in the HSL tables as they are based on the same exposure conditions for vapour inhalation pathways. The HSLs include additional consideration of soil texture and depth to source to determine appropriate soil, groundwater and soil vapour criteria for the exposure scenario. The Site's soils are predominately clay based. However given the porous nature of fill materials (brick waste and unconsolidated fill) present at the brickworks and quarry, a sand soil profile has been adopted conservatively.

## 5.5 Asbestos Containing Materials (ACM)

Materials containing asbestos on the surface or within the fill are considered to be potentially contaminated and therefore require assessment and remediation in accordance with the ACT EPA endorsed Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia (WA Department of Health, 2009).

The purpose of the PSI was to identify the presence/absence of asbestos in Site soils, as such the adopted field sampling and laboratory analytical methodology did not meet the requirements of the ACT EPA endorsed WA guidelines.

## 5.6 Aesthetic Considerations

Auditor guidelines require the consideration of soil aesthetics. For the purposes of this preliminary investigation any soils with discoloured or that are affected by odours or containing foreign materials have been noted for consideration at the appropriate stage of the contamination assessment / audit process.

## 5.7 Adopted Assessment Criteria

The soil analytical results were compared (conservatively) to low density residential land use criteria as summarised below in **Table 5.7**:

Table 5.7 – Adopted Assessment Criteria

Adopted Criteria	CoC
NEPM (amended 2013) HIL A	Metals, PAH, Phenols, OCP, OPP, PCB
NEPM (amended 2013) HSL A & B, 0 to <1m, Sand	BTEX, TPH
NEPM (amended 2013) EIL	DDT, Naphthalene, Metals (as, pb, cu, ni, zn)
Presence/Absence	Asbestos

The soil analytical results are compared to the adopted assessment criteria in Table 1, **Appendix I**.

## 6 SAMPLING PLAN AND METHODOLOGY

### 6.1 Soil Sampling Rationale

A limited program of geotechnical and environmental test pitting was conducted at the Site to provide preliminary geotechnical data for future development within the Site (TP01 to TP13); environmental samples were collected at these locations to assess general site soil conditions.

The remainder of the sampling locations were targeted to either confirm previous soil data or to fill data gaps to better inform the recommendations outlined in this PSI. The sampling location plan is presented in Figure 4, **Appendix A**.

It is also noted the sampling locations were placed to minimise impacts on the critically endangered Golden Sun Moth (GSM) population in the Southern Area of the Site. The GSM populations are shown in Figure 2a, **Appendix A**.

A summary of the sampling plan is provided below in **Table 6.1**.

Table 6-1 Sampling Plan

Test Pit Location	Targeted AEC	Comment
TP01 to TP13, excluding TP12	General Site / AEC 1 Waste Fill	General Site coverage – to describe general site subsurface conditions including identification of filled areas
TP12 and TP14	AEC 29 Rail Corridor	Targeted – to assess impacts associated with treated timber sleepers (pesticides), asbestos from brake pads and vegetation control (in corridor)
TP15 to TP17	Targeted: AEC 21 Brickworks Workers Accommodation (former) – General Areas	General coverage Brickworks Workers Accommodation (former) – to describe subsurface conditions including the nature and extent of filled areas
TP18	Targeted: Grove of Deciduous Trees / Open Space Areas	Targeted – to assess the potential former use of pesticides
TP19	Targeted: AEC 5 Explosives Store	Targeted – to assess impacts from storage of explosive compounds
TP20	Targeted: AEC 2 General Areas - Recycled Timber Holding Yard	Targeted – to assess potential metal impacts leaching from treated timbers
TP21	Targeted: AEC 3 UST near Forklift Shed (former)	Targeted– to describe subsurface conditions including indications of hydrocarbon impacts (odours and/or staining)
TP22	Targeted: Robson Laboratories BH14 / AEC 7 Operation of Crusher and Refinery Plant(s)	Targeted – to describe subsurface conditions including indications of hydrocarbon impacts identified by Robson (2006)
TP23, TP24, TP26, TP27 and TP28	Targeted: AEC 1 Waste Fill and AEC 19 Clay Storage Shed (former)	General coverage Quarry area – to describe subsurface conditions including the nature and extent of fill
TP25	Targeted: AEC 18 Fill Mound(s)	Targeted – to describe nature of mounded materials

## **6.2 Assessment Methodology**

### **6.2.1 Service Clearance**

Test pit locations were cleared for the presence of underground services by a Telstra accredited plant location contractor referencing utility plans obtained through a Dial Before (DBYD) You Dig search.

### **6.2.2 Test Pitting**

Test pitting activities were undertaken between the 9 and 11 September 2013 using an 8 tonne excavator. Test pits were advanced to either refusal (on bedrock) or until the maximum investigation depth of 3 mbgl.

Sub surface conditions were logged in accordance with the Unified Soil Classification System (USCS); test pit logs are included in **Appendix J**.

### **6.2.3 Soil Sample Collection**

Soil samples were collected directly from the bulk undisturbed soil from the centre of the excavator bucket. A new disposable nitrile gloves was used for each sample depth and location. The soil sample was directly placed into laboratory supplied sample jars by a nitrile gloved hand. Samples were collected at nominal depths of 0.0, 0.5, 1.0, 2.0 and 3.0 mbgl and intervals of 100 mm.

Actual sample depths from each test pit was modified to target each type of material present areas of suspected contamination (staining, odour and/or fill).

### **6.2.4 Sample Storage and Handling**

#### **Soil Samples**

Soil sample were placed into 250 ml glass jars with Teflon lined lids supplied by SGS Laboratories. The jars were completely filled with soil (so there was minimal to zero headspace), labelled with the job number, date, time, sampler and unique sampling point identification.

The soil jars, once filled with sample, were immediately placed in an ice-filled esky to keep the samples below a temperature of approximately 4°C. A chain of custody (CoC) form was filled in with the sample names, sampling date and required analyses. This documentation and the samples were then sent to the laboratory for analysis, within the prescribed analyte holding times

### **6.2.5 Decontamination**

No reusable sampling equipment was utilised in the investigation. Decontamination and the collection of rinsate blanks were not required.

### **6.2.6 Quality Control samples**

Field QC samples included field replicate samples (duplicates and triplicates), field blanks, trip blanks and trip spikes. A detailed account of the QA/QC program adopted for the PSI can be found in **Appendix K**.

### **6.2.7 GPS**

The GPS coordinates of each test pit were recorded on SMEC field sheets and provided below in Table 6.2.

Table 6-2 GPS Coordinates UTM 55

Test Pit	X Coordinate	Y Coordinate
1	689767	6090210
2	689948	6090023
3	690043	6090013
4	690271	6089946
5	690313	6089784
6	690410	6089820
7	690472	6089844
8	690564	6089879
9	690469	6090000
10	690579	6090051
11	690247	6090052
12	690044	6090134
13	689959	6090229
14	689871	6090319
15	689890	6090442
16	689910	6090388
17	690017	6090363
18	690215	6090246
19	689822	6090537
20	689930	6090474
21	689908	6090610
22	690015	6090615
23	690053	6090548
24	690113	6090541
25	690142	6090461
26	690109	6090581
27	690137	6090729
28	690208	6090566

## 7 QUALITY ASSURANCE/QUALITY CONTROL

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### 7.1 Field and Laboratory QA/QC

A summary of the Field and Laboratory QA/QC is provided in **Appendix K**.

### 7.2 Summary QA/QC Assessment

Assessment of the field and laboratory QA/QC indicate that the accuracy and precision of the analysis was satisfactory and constitute an appropriate reflection of soil conditions and are suitably reliable for the objectives of the PSI.

## 8 RESULTS

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### 8.1 Subsurface Conditions

The subsurface conditions encountered during the PSI are summarised in the following sections, test pit logs can be found in **Appendix J**.

#### 8.1.1 Fill Materials

Fill was encountered at 18 test pit locations across the Site and was typically logged to comprise Fill reworked natural sandy to silty clays. Ash waste likely sourced from the operation of the brickworks (combustion of wood and coal) was identified in fill at both the brickworks and quarry. The presence of ash if fill is further discussed in **Section 9.1** and **9.4**.

With the exception of test pits TP23 to TP28 in the quarry area and TP02 fill generally terminated at depths less than a 1 mbgl. Deeper fill comprising brick waste, ash, quarry cuttings (shale) with traces of anthropogenic inclusions (glass, metal and bitumen) was identified in TP 25 and TP28 within the quarry area to the maximum investigation (and the limit of the excavator) depth of 3 mbgl.

At test pit location TP02 fill logged to comprise silty cobbles to gravelly sand with traces of brick and bitumen. The test pit terminated at 2 mbgl due to refusal on a large piece of concrete, a piece of pipe was also identified at this depth. The source of the fill is unknown but is likely attributed to filling to meet the design grade of the Cotter road.

#### 8.1.2 Natural Soils

Natural soils were generally comprised soft brown silty topsoils underlain by medium to stiff red-brown silty clays and clays. Variable components of sand, cobbles and weathered rock (shale and siltstone) were also logged.

Natural soils ranged from silts to clays with variable components of sand and weathered rock (shale, ironstone and was typically encountered between depths of 0.0 and 1.0 mbgl.

#### 8.1.3 Residual Soils and Bedrock

Natural soils graded to weathered red brown residual soils (silty clays and clay) and were underlain by shale, dacite, siltstone or sandstone bedrock. Strength and weathering of the bedrock material varied across the Site. With the exception of TP03, TP23 and TP28 (terminated in fill) bedrock was typically logged between depths of 0.17 and 1.9 mbgl.

### 8.2 Soil Analytical Results

Soil analytical results are compared to the adopted assessment criteria and can be found in **Appendix I**.

With the exception of TRH, Metals and PAH concentrations all samples submitted for laboratory analysis returned concentrations of analytes below the laboratory LOR and therefore the adopted assessment criteria. Copies of the laboratory certificates are provided in **Appendix L**.

A summary of the results is provided below:

TRH

Concentrations of TRH C<sub>10</sub>-C<sub>40</sub> (120 mg/kg) above the laboratory LOR of 110 mg/kg were reported in sample TP26-2.0. The sample location comprised of fill material containing brick waste, metal and bitumen.

#### **PAH**

Phenanthrene (0.1 mg/kg) was detected at sample TP22-0.5 marginally above the laboratory LOR of <0.1 mg/kg. The sample location comprised of fill material containing brick waste, ash and bitumen.

#### **Metals**

Concentrations of metals were below the adopted assessment criteria in all soil samples submitted for analysis.

#### **Asbestos**

The presence of asbestos was not identified in any of the fill samples submitted for analysis.

#### **PCB**

Concentrations of PCBs were below the adopted assessment criteria in all soil samples submitted for analysis.

#### **BTEX**

Concentrations of BTEX were below the adopted assessment criteria in all soil samples submitted for analysis.

#### **OCP/OPP**

Concentrations of OCP/OPP were below the adopted assessment criteria in all soil samples submitted for analysis.

#### **Phenols**

Concentrations of Phenols were below the adopted assessment criteria in all soil samples submitted for analysis.

#### **Explosives**

Explosive compounds were not detected in sample TP19-0.0 targeting AEC 5.

## 9 DISCUSSION & RECOMMENDATIONS

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The Site history data indicates the potential for contamination to be present; a discussion of the history review, field and laboratory data is provided below.

### 9.1 AEC 1 – Waste Fill

#### Fill Materials

Likely contained to the brickworks and quarry areas of the Site, as shown in Figure 2a, 4 and 5, **Appendix A**.

The nature and extent of fill material at the brickworks and quarry is unknown, observational data indicate the material comprised reworked natural materials (silts, clays and shale) with variable amounts of brick (or tile) waste, ash and anthropogenic inclusions (including metal, concrete and wood). Although not observed in fill, occasional surface fragments of potential ACM were noted at both the brickworks and quarry.

The presence of ash in waste fill is discussed in **Section 9.4**.

Fill extended beyond the maximum investigation depth of 3.0 mbgl at test pits TP25, 26 and 28 (quarry area). The available historical data did not indicate the depth of the quarry nor the nature of filling activities. TP24 located approximately 10 m south east of TP26 was terminated on shale bedrock at 0.5m bgl, indicating the presence and depth of fill is variable across the quarry.

At test pit location TP02, fill was logged to comprise silty cobbles to gravelly sand with traces of brick and bitumen. The test pit terminated at 2 mbgl due to refusal on a concrete slab, a pipe was also identified at this depth. The source of the fill is unknown but is likely attributed to filling to meet the design grade of the Cotter road.

The limited available soil analytical data suggests that the encountered fill materials contain low concentrations of metals, TRH and PAHs.

Given the uncertainty around the nature and extent of fill at the Site further investigation is recommended.

### 9.2 AEC 2 –Recycled Timber Storage

#### Storage of recycled timbers

Various areas of the brickworks are currently used for the storage of recycled timber materials. The exact volume and extent of materials stored is unknown but is restricted to the brickworks area of the Site, as shown in Figure 2a, 4 and 5, **Appendix A**.

In an interview, the business owner Mr Thor Diesenford stated that it was unlikely that any of the stored wood (past or present) was treated given the regulations around the reuse of these materials (arsenic and/or OCP treated timbers). However it was possible that some creosote treated and/or painted (potentially lead based) timber have been reused during the twenty years the business has been operational.

TP20 targeted an accessible area used for the storage of wood (potentially treated) materials by Thor's Hammer. Gravel and clay fill was logged to a depth of 0.27 mbgl and was underlain by moderately weathered siltstone.

Elevated concentrations of metals were not detected in the surface soil sample submitted for analysis.

The potential for contamination is considered low. No further investigation is recommended.

### **9.3 AEC 3 – Fuel Storage**

TP21 targeted the potential location of a 1000L petrol UST identified by the historical data between the former forklift shed and Fan House 2. Fill materials were logged to comprise silty cobbles with brick and tile waste, ash, coal and bitumen. No UST or associated infrastructure were identified, nor were any staining or hydrocarbon odours observed. Given the (relative) small size of the UST it possibly remains in-situ.

Robson (October 2010) reported the presence of UST (filling point and breather vents) near Kiln 1 and a small empty above ground storage tank near Machinery Shed 3. These features were not identified during the PSI.

Further investigation is recommended to determine the presence and condition of any fuels storage tanks at the Site.

### **9.4 AEC 4 – Stackhouse(s)**

Four stackhouses were observed to be present at the brickworks, they have been used to burn coal, wood and later oil. Variable amounts of ash waste was observed to be present inside the firing chamber in each stackhouse. Stored coal was observed adjacent to Fan House 2, and was presumably used to fire Stackhouse 3.

#### **Ash Waste in Fill**

Ash waste was identified in the PSI either as a discernible layer or mixed in Waste Fill (AEC 1) within both the brickworks and quarry (TP12, TP21, TP22, TP25 and TP26).

The low detected concentration of PAHs indicate the ash material is benign, this may be related to the stackhouses operating at high temperatures resulting in the complete combustion of carbon based (coal and wood) fuels, however the ash layer was often variable (both partially and heavily combusted)

Given the uncertainty around the nature and extent of ash waste at the Site further assessment is recommended. The assessment should include the stackhouse(s) and coal storage facility(ies) which were not targeted as part of the PSI.

### **9.5 AEC 5 –Explosives Store 1**

A building footprint comprising concrete tiles (around 30 cm x 30 cm) was targeted (TP19) as the potential base of the explosives store. No odours or staining were observed beneath the building footprint, underlying soils graded to natural clays at a depth of 0.3 mbgl. Several surface fragments of ACM were observed in the general area.

Sample TP19-0.0 was submitted to evaluate concentrations of explosives. Laboratory analysis did not detect any explosive compounds in the submitted sample.

Remnant features of the building were not easily identifiable during the PSI and the disposition of the explosive store and level of control of explosives (potential for spill) is not known. Explosive residues may occur away from the sampled location further investigation is recommended.

## 9.6 AEC 6 – Machinery Sheds

A brief inspection of the machinery sheds was completed as part of the PSI. The sheds were observed to be used for the storage of wood materials (Thor's Hammer) and remnant machinery from former operations. No staining was observed on the floors which were sealed (concrete), however some sheen was observed in surface water drains around Machine Shed 1.

General areas around the machinery sheds were littered with empty drums, scrap metal and other waste materials. No obvious signs of staining and/or odours were noted during the inspection.

Further investigation of the machinery sheds including surrounding areas is recommended.

## 9.7 AEC 7 – Operation of Crusher and Refinery Plant(s)

Robson (2006) completed a limited intrusive investigation at the brickworks. The soil data identified TPH at 10 550 mg/kg (C<sub>6</sub> to C<sub>36</sub>) in a soils sample collected from (Robson) borehole location BH14 (to the rear of Machine Shed 3 at a depth of 0.5-0.7 mbgl. An oil pressure/storage was identified near the north eastern corner of Machine Shed 3 suggesting oils may have also been used and/or stored in the area.

Several test pits including TP22 were advanced in this area to investigate the potential for hydrocarbon contamination of soil. Fill materials were encountered which generally comprised sandy clays with angular shale gravels, ash, bitumen and bricks. Field observations and soil analytical data did not indicate the presence of hydrocarbon impacted soils

It is possible that the TPH impact (identified in one sample by Robson) was related to an isolated spill of oil (long chain hydrocarbon fractions) associated with plant machinery (removed) previously used during the crushing, conveying and refining of raw materials from the quarry to Machine Shed 3. A diagrammatic representation of the brick making process is presented in **Appendix E** (1960).

## 9.8 AEC 8 – Coal/Oil Storage Facility(ies)

Historical information and aerial imagery presented in the Lovell and Chen CMP (page 168) identified the presence of two large above ground storage tanks at the Model Railway Shed. At the time of the PSI it was observed to be an unsealed and empty shed. No odours or staining were observed.

Robson (2006) identified an additional coal storage facility north of Machine Shed 3. SMEC observed to be a remnant steel structure, the surrounding area was observed to be sealed (concrete) with no obvious signs of staining and/or odours. It is likely that there are smaller stores of coal within the brickworks as observed near Fan House 2.

The potential for contamination arising from the storage of coal/oil is considered low to moderate, however further investigation is recommended in areas identified as used for the storage of oils.

## 9.9 AEC 9 – Kiln Sand

Kilns sands are likely to be present in Kilns 1 to 6 as shown in Figure 2a (**Appendix A**). There is potential of kilns sands to present in demolition waste associated with AEC 12 (former Kilns).

Robson (2006) reported elevated concentrations of lead (770 mg/kg) in a sample collected from kiln sand. Robson stated '*The source of the lead may be from the glaze and not be specifically from the kiln sands (sand on the floor of the kilns)*'.

The investigation of kiln sands did not form part of SMEC's scope for this investigation.

Further investigation to assess the source and presence of metal impacts in kilns sand is recommended.

## 9.10 AEC 10 – Asbestos Dump

Robson (2006-2012) identified the presence of asbestos in the building structures of the brickworks. A asbestos dump in the western portion of the brickworks was also identified by Robsons (2006).

A review of previous reports suggests that Robson's completed some remedial work and have prepared a Remediation Action Plan (RAP) for the dump estimated to be 500 m<sup>3</sup>. SMEC have not sighted the RAP or any assessment reports relating to the dump.

- The LDA have advised SMEC that Robson Environmental is managing the remediation of the asbestos dump. The remediation area is shown in **Figure 2a, Appendix A**. This area was bound by a security exclusion fence and was not investigated during this PSI.

### Asbestos in Waste Fill (AEC 1)

Asbestos was not identified in fill material encountered in this PSI, however surface fragments of ACM sheeting were observed at several locations across the brickworks, former workers accommodation, and quarry.

Given the volume of waste fill across the brickworks, former workers accommodation and quarry; SMEC recommends further investigation to determine the presence (or absence) of asbestos in fill materials.

## 9.11 AEC 11 – Septic Tank

Historical data indicates the septic tank is located in the western portion of the brickworks area. Inspection of the septic tank was not completed as part of the PSI due to a security fence excluding access to this area (and the asbestos dump, AEC 10).

Further investigation to assess potential impacts in soil and/or groundwater is recommended.

## 9.12 AEC 12 – Carpenters Workshop

Historical data identified the presence a carpenter's workshop south east of the brickworks. No identifiable remnants of the former building were observed during the PSI.

The contamination status of the building footprint and surrounding area is unknown, further investigation is recommended.

## 9.13 AEC 13 –Former Kilns

Historical data identified the presence of additional former kilns south east of the brickworks. No signs of these kilns were identified during the PSI.

The contamination status of the building footprint and surrounding area is unknown, further investigation is recommended.

## 9.14 AEC 14 - Fill Mounds

Two fill mounds were identified immediately south of the quarry fence. A detailed inspection of the mounds was limited by the presence of grass. The mounds may contain demolition waste from nearby former structures AEC 11 and AEC 12 (carpenters workshop and former kilns respectively).

Further investigation to evaluate potential contamination associated with the fill mounds is recommended.

## 9.15 AEC 15 – Weighbridge (former)

Former weighbridge used to weigh imported raw materials, Lester Firth & Associates (1986) report the concrete pit as remaining and has since been filled with material of unknown origin (likely consistent with AEC 1 – Waste Fill) .

This feature was not identified in the PSI, and indicative location is provided in Figure 2a, **Appendix A**.

Potential for impacts associated with AEC 1, further investigation is recommended.

## 9.16 AEC 16 – Power House

The Power House building was used since 1915 to breakdown high voltage power supplied from the Kingston Power House. The electricity was then distributed across the Site.

A review of the 1916 historical plan (**Appendix E**) indicates that at least some of the electricity was distributed across the Site in underground electrical conduits. It is probable that these conduits were constructed of ACM.

The Power House buildings were not inspected as part of the PSI. There is potential for PCBs and/or ACM to be present in the building and in the surrounding soils.

Further investigation assessment is recommended.

## 9.17 AEC 17 – Boiler House and adjoining Substation

The Boiler House and adjoining Substation were constructed to service the brick extrusion plant and were briefly operated for approximated 5 years (1971 to 1976). All internal infrastructures have since been removed from the buildings. It is unknown if the boiler was fuel (wood, coal or oil) or electricity driven.

The potential for contamination at this location is considered low given the brief operation period (5 years) and the removal of potential sources of contamination (transformers used in the substation, operation of the boiler etc). However given the age of the building(s) they are likely constructed of ACM.

The potential for t contamination at this AEC is considered low, although further investigation may be considered to verify this.

## 9.18 AEC 18 – Fill Mound(s)

Two large fill mounds were also identified in the quarry area; the purpose of the mounds is unclear but may have been related to directing rain water away from the quarry pit. Observational data indicate the material comprised reworked natural materials (silts, clays and shale) with variable amounts of

brick waste, ash and anthropogenic inclusions (including metal). Fragments of ACM were observed in the northern fill mound.

The limited available soil analytical data suggests that fill used to create the mounds contain low concentrations of metals, TRH and PAHs. Given the uncertainty around the nature and extent of fill at contained in the mounds further investigation is recommended.

### **9.19 AEC 19 – Clay Storage Shed (former)**

Test pit TP23 was advanced into a small mound of fill proximal to the footprint of the Clay Storage Shed. Fill was logged to 1.6 mbgl and comprised sandy silts to sandy clays with coarse angular gravels (fresh siltstone), bricks and bitumen. The fill material was underlain by slightly weathered siltstone bedrock.

The available soil analytical data from TP23 indicate the fill waste contained concentrations of TRH, PAH and metals less than the adopted assessment criteria.

The potential for contamination at this location sourced from the Clay Storage Shed is considered low, no further investigation is recommended.

### **9.20 AEC 20 – Former Weatherboard Cottage**

A weatherboard cottage with attached stable and coal storage (demolished 1920s) was identified by Lester Firth and Associates (1986). Remnant features of the building and/or attached structures were not observed during the PSI.

The potential for contamination is considered low, no further investigation recommended.

### **9.21 AEC 21 – Former Workers Accommodation**

The workers accommodation was observed to contain several demolished brick buildings and footings. The demolition waste generally comprised bricks, metal and concrete, occasional fragments of ACM were also observed.

Test Pit TP15 and TP16 were advanced in the general areas of the workers accommodation. Fill materials were only logged at TP15 to a depth of 1.0 mbgl and were comprised of reworked natural soil (silts) with traces of brick, glass and charcoal.

It is probable that the area contains pockets of fill containing demolition waste from the former workers accommodation building(s). The limited soil analytical data from TP15 and TP16 did not identify concentrations of contaminants greater than the adopted assessment criteria. Further assessment to determine the nature and extent of fill in the workers accommodation area is recommended.

### **9.22 AEC 22 – Interceptor Pit**

A triple interceptor type structure identified adjacent north to a demolished building thought to have been the kitchen/mess hall (Figure 2b, **Appendix A**). The interceptor likely received grease and fats from the kitchen/ mess hall operations, no odours and/or staining was observed.

The pit may have also received petroleum based oils and domestic chemicals.

The potential for contamination is considered low, further investigation may be considered to verify this.

### **9.23 AEC 23 – Abandoned Vehicle**

An abandoned vehicle overgrown with woody weeds (Blackberries) was identified during the PSI. A detailed inspection was limited by the presence of vegetation, however given the age of the vehicle it has likely been abandoned for over 20 years. No staining and/or odours were observed at the time of the PSI.

The potential for contamination sourced from the abandoned vehicle is considered low, further investigation may be considered to verify this.

### **9.24 AEC 24 – Dumping Area**

Area of dumped materials including wood, rusted metal containers, a tar drum, electric fuse box and general waste (plastic, wood and metal pieces). No staining and/or odours were observed at the time of the PSI.

The potential for contamination is considered to be low to moderate, further investigation is recommended.

### **9.25 AEC 25 – Scrap Metal Stockpile**

Stockpile approximately 10m x 8m, volume difficult to determine inspection limited by woody weeds. Observed to contain reworked soils, sheet metal, bricks and an old fridge. It is probable that the scrap metal originated from the former workers accommodation.

Given the uncertainty around the nature and extent of fill at this location further investigation is recommended.

### **9.26 AEC 26 – Fill Mound**

A large stockpile 50m<sup>3</sup> observed adjacent to brickworks boundary fence. Observed to comprise reworked soils, rusted metal (sheets and pipes), concrete and bricks. The source of the fill mound is unknown but may have been created during the demolition of the former workers accommodation.

Given the uncertainty around the nature and extent of fill at this location further investigation is recommended.

### **9.27 AEC 27 – Cleared Area**

A large cleared area with patches of asphalt was observed adjacent to the brickworks workers accommodation, no mounding or dumped materials were identified. The purpose of the area is unclear but is identifiable on historical plans since the 1920s; more recent uses may include the storage of materials.

Fill was logged to a depth of 0.5 mbgl and comprised sandy clay with gravels, glass and bitumen. Soil analytical results at this location were less than the adopted assessment criteria.

Historical aerial photographs indicate activities in this have been undertaken since the 1950's. Given the long and undocumented historical use of the area further investigation is recommended.

## 9.28 AEC 28 – Explosives Store 2

Lester Firth & Associates (1986) reported that the original explosives store was located 180 m south of the current Power House, and was later relocated 160 m west of the Power House (AEC 5).

Remnant features of the building were not identifiable during the PSI. Potential for explosive CoPC to be present in soils, further investigation is recommended.

## 9.29 AEC 29 – Rail Corridor

A rail corridor was observed in the western portion of the Site and was noted to be free of remnant infrastructure (ballast, track or sleepers).

Test Pit TP12 and TP14 were advanced within the corridor; fill was logged to maximum depth of 0.8 mbgl and comprised reworked natural soils (silts and clays). Fill layers were generally underlain by either residual soils (silty clay) and bedrock (siltstone). Analytical results at these sample locations were less than the adopted assessment criteria.

The available historical data indicate the rail line was only briefly used in the 1920s before being dismantled and wooden sleepers used to fire the stackhouses.

The potential for contamination in the rail corridor is considered low, although further investigation may be considered to verify this.

## 9.30 AEC 30 – Vehicle Tracks (site wide)

The Site contains multiple tracks (both current and former) with a long history of vehicular usage. The current (roads, streets, avenues) and former (denoted by a dashed blue line) vehicle tracks are shown in Figure 5, **Appendix A**.

There is potential for impacts arising from spills and leaks which are likely to accumulate in areas that receive wash (drains, low points and other drainage features).

The potential for contamination is considered low to moderate, further investigation is recommended.

## 9.31 AEC 31 – Waste Pile

A small waste pile (around 10 m<sup>3</sup>) comprising bricks, metal, general waste (plastics and cardboard) and several fragments of potential ACM was identified near Adelaide Avenue. The material appeared to have been dumped.

It is recommended that the asbestos dump be assessed and disposed offsite in accordance with ACT EPA requirements.

## 9.32 AEC 32 – Fill (Road)

Fill comprising silty cobbles to gravelly sand with traces of brick and bitumen was logged at sample location TP02. The test pit terminated at 2 mbgl due to refusal on a large piece of concrete, a piece pipe was also identified at this depth. Soil analytical results at this location were less than the adopted assessment criteria.

Given the uncertainty around the nature and extent of fill at this location further investigation is recommended.

## 10 CONCLUSIONS

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SMEC completed a Preliminary Site Investigation (PSI) at the Site to provide preliminary contamination data for potential purchasers (and developers) of the Site. Key findings include:

The available historical data indicate the northern portion of the Site has been used as brickworks since the early 1900's. Remnant buildings include, 6 kilns, 4 stackhouses, office building and amenities, 3 machinery sheds, workshops, boiler house, a substation, a power house (prior to 1915 was powered by a steam donkey engine), storage sheds and other minor buildings. A disused quarry is located adjacent (east) to the brickworks is also present at the Site.

Demolished features include temporary kilns (south east), two explosive stores (180 m south and 130 m west respectively), a forklift shed (west), clay storage shed (quarry) and a weatherboard house (quarry). Significant amounts of filling across the brickworks and quarry is evident and is poorly documented.

Parts of the brickworks are currently leased by Thor's Hammer a wood recycling business, the potential for contamination due to current land uses is considered low. The remainder of the Site was formerly grazing land which has been developed to include road infrastructure (Cotter Road, Adelaide Avenue and Yarra Glen).

A total of 28 test pits were advanced across the Site and 42 samples submitted for laboratory analysis to evaluate contaminants of concern. The purpose of the sampling plan was to provide preliminary geotechnical and environmental data for the Site.

Fill material was logged at 18 of the 28 test pit locations. Dependent on the sample location the fill materials were observed to comprise:

- **Brickworks and Quarry:** brick waste, ash, quarry cuttings (shale) with traces of anthropogenic inclusions (glass, metal and bitumen) to a maximum depth of 3 mbgl, the nature and extent of fill is unknown;
- **Surrounding Areas:** sandy to silty clay, probable reworked natural soils, generally encountered at shallow depths less than 1 mbgl; and
- **Adjacent Cotter Rd:** silty cobbles to gravelly sand with traces of brick and bitumen, refusal on concrete 2 mbgl, the nature and extent of fill is unknown.

Whilst the preliminary data did not identify contamination in the above fill materials, the nature and extent of fill materials is unknown. Remediation may also be considered for aesthetic reasons.

Natural soils were logged to comprise soft brown silty topsoils underlain by medium to stiff red-brown silty clays and clays. Natural soils graded to weathered red brown residual soils (silty clays and clay) and were underlain by shale, dacite, siltstone or sandstone bedrock. Strength and weathering of the bedrock material varied across the Site and was logged between depths of 0.17 and 1.9 mbgl.

All analyte concentrations in natural and fill samples submitted for analysis were less than the adopted (human health based and ecological) assessment criteria. In particular, it was noted that polycyclic aromatic hydrocarbon (PAH) concentrations in fill containing coal ash (which are often associated with PAH contamination) were below assessment criteria and typically below laboratory detection limits.

It should be noted, however, that the sampling densities adopted during this preliminary assessment were below though that would typically be adopted during a detailed site investigation (DSI) and the full depth of fill in the quarry has not been investigated.

Based on the our review of previous reports and exiting data SMEC relating to the Site a total of 32 areas of environmental concern (AEC) were identified at the site. Potential risks to human health and the environment associated with each AEC were considered, supported by data from the limited supplemental soil sampling and analysis conducted by SMEC as part of this preliminary investigation. On this basis preliminary information reviewed to date 28 of the 32 identified AECs were qualitatively assessed be of low risk with no further investigation or limited further investigation recommended.

Generally, based on the limited soil data collected during this PSI, the site ecological and human health risks associated with brickworks, quarry and the former workers accommodation areas of the site are considered moderate to low. The remainder of the Site (the Southern Areas) typically comprised of natural soils grading to weathered bedrock. Soil analytical results returned concentrations of contaminants less than the adopted assessment criteria, the potential for contamination is therefore considered low.

Although no potential source of groundwater contamination was identified during this investigation, no groundwater testing or assessment groundwater conditions at the site has been made.

The results of this primary investigation are not sufficient to assess the suitability of the site for a specific planned land use. It is recommended that, once detailed plans indicating the proposed land use(s) across the Site have been developed that a detailed site investigation (DSI) be undertaken to assess the suitability of the site for the planned land use(s). Typically a Site Audit Report (SAR) and Site Audit Statement (SAS) regarding the suitability of the Site would be required by the approving authority and an ACT EPA accredited Site Contamination Auditor would be engaged to independently review the DSI and any subsequent remedial works as supported by the ACT EPA.

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## APPENDIX A: FIGURES

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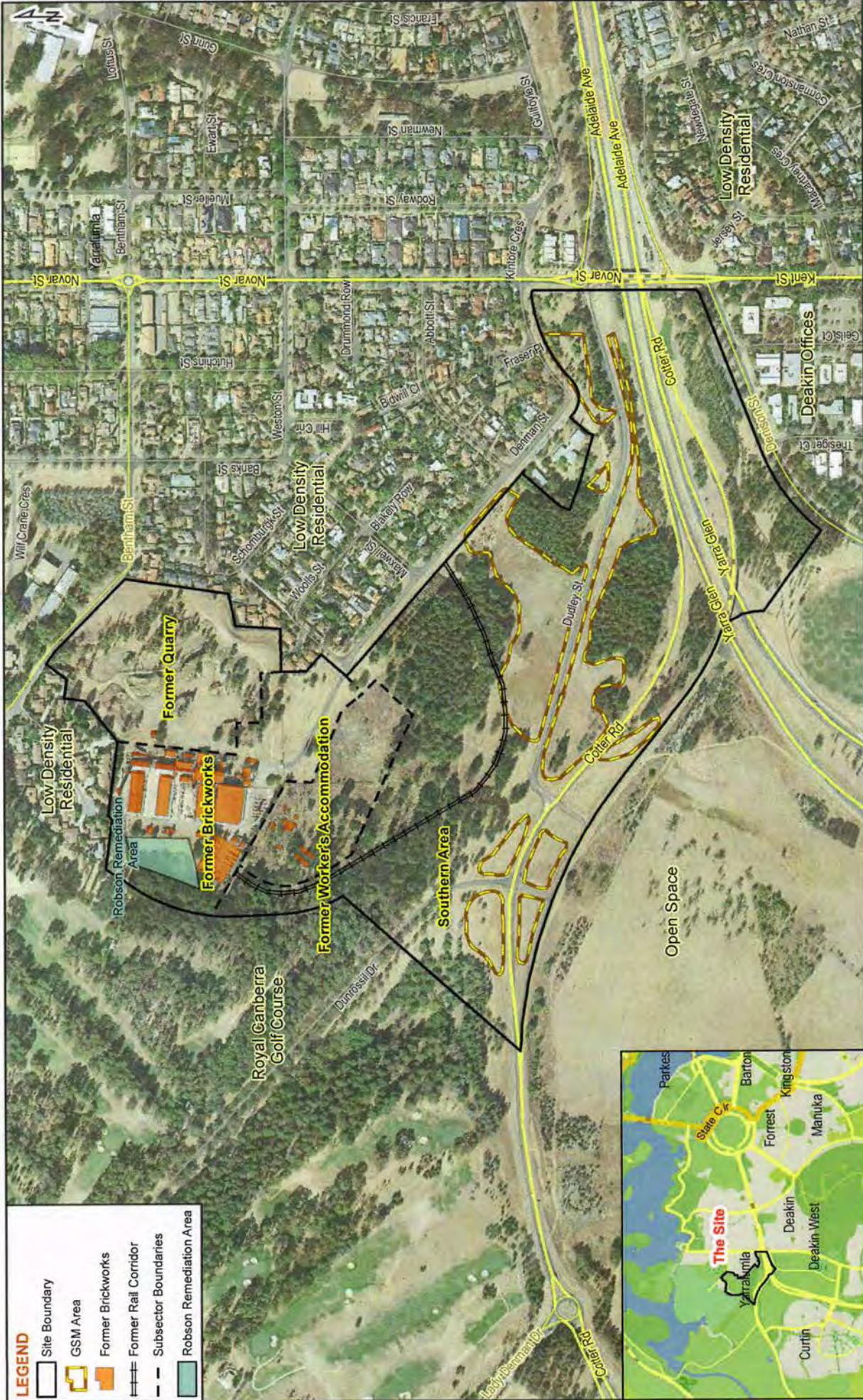
**LEGEND**  
 Site Boundary

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<b>DATE</b>	17/02/2014
<b>FIGURE TITLE</b>	Site Location
<b>FIGURE NO.</b>	1
<b>PROJECT NO.</b>	3002369
<b>PROJECT TITLE</b>	Canberra Brickworks Preliminary Site Investigation
<b>COORDINATE SYSTEM</b>	ACT Grid 1966
<b>PAGE SIZE</b>	A4
<b>SOURCES</b>	Imagery © Bing Maps, Imagery © Roadnet
<b>CREATED BY</b>	J. Seng

**DATE** 17/02/2014  
**FIGURE TITLE** Site Location  
**FIGURE NO.** 1  
**PROJECT NO.** 3002369  
**PROJECT TITLE** Canberra Brickworks Preliminary Site Investigation  
**COORDINATE SYSTEM** ACT Grid 1966  
**PAGE SIZE** A4  
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Location: X:\PROJECT\3002369\_Yarralumia\_Brickworks\_Site\_Investigation\6.2\_Figures\_and\_Results\Figures\2.1\_GSV\_Figure\_1.mxd



**LEGEND**

[Black outline]	Site Boundary
[Yellow outline]	GSM Area
[Orange outline]	Former Brickworks
[Double line]	Former Rail Corridor
[Dashed line]	Subsector Boundaries
[Green outline]	Robson Remediation Area



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	<p>DATE: 17/02/2014</p> <p>FIGURE TITLE: Site Layout</p> <p>PROJECT NO.: 30002369</p> <p>PROJECT TITLE: Canberra Brickworks Preliminary Site Investigation</p>
<p>PAGE SIZE: A4</p> <p>COORDINATE SYSTEM: ACT Grid 1966</p> <p>FIGURE TITLE: Site Layout</p>	<p>DATE: 17/02/2014</p> <p>FIGURE TITLE: Site Layout</p> <p>PROJECT NO.: 30002369</p> <p>PROJECT TITLE: Canberra Brickworks Preliminary Site Investigation</p>
<p>CREATED BY: J. Seng</p> <p>SOURCES: Imagery © Bing Maps, Imagery © Roadnet</p>	<p>DATE: 17/02/2014</p> <p>FIGURE TITLE: Site Layout</p> <p>PROJECT NO.: 30002369</p> <p>PROJECT TITLE: Canberra Brickworks Preliminary Site Investigation</p>

Location: X:\PROJ\30002369 Yarralumla Brickworks Site Investigation\Deliverables\Figures and Plans\Figure 2a - Layout.mxd

42



ID	Description
2	Concrete Retaining Wall
3	Power House
4	Staffordshire Kiln (Kiln 1)
5	Fan House for Kiln 1 (Fanhouse 1)
6	Chimney Stack for Kiln 1 (Stackhouse 2)
7	Offices
8	Hardy patent Kiln (Kiln 2)
9	Fan House for Kiln 2 (Fanhouse 2)
10	Chimney Stack for Kiln 2 (Stackhouse 3)
11	Amenities Block
12	Hardy Patent Kiln (Kiln 3)
13	Chimney Stack for Kiln 3 (Stackhouse 4)
14	Machine Bay I for Kiln 1
16	Machine Bay III for Kiln 3
15	Machine Bay II for Kiln 2
17	Workshop
18	Small Crusher House (Crusher House 1)
19	Larger Crusher House (White Pan Room / Crusher House II)
20	Primary Crusher House (Crusher House III)
21	Elevator / Conveyor
22	Down draft Kilns (Kiln 4 - 6)
23	Down draft Kiln Control Room
24	Chimney Stack for Kilns 4 - 6 (Stackhouse 1)
25	Toilet Block
26	Amenities Block
27	Substation / Control Room
28	Boiler House
29	Ancillary Storage Building
30	Remnant of Extrusion Plant (Concrete Pad)
31	Ancillary Storage Building
32	Storage Shed
33	Model Railway Workshop
34	Model Railway Storage Shed
35	Forklift Shed (Former)
36	Weightbridge (Former)
37	Sleeping Quarters 2
38	Sleeping Quarters 2
39	Hut
40	Hut
41	Hut
42	Hut
43	Latrine
44	Kitchen and Mess Hall

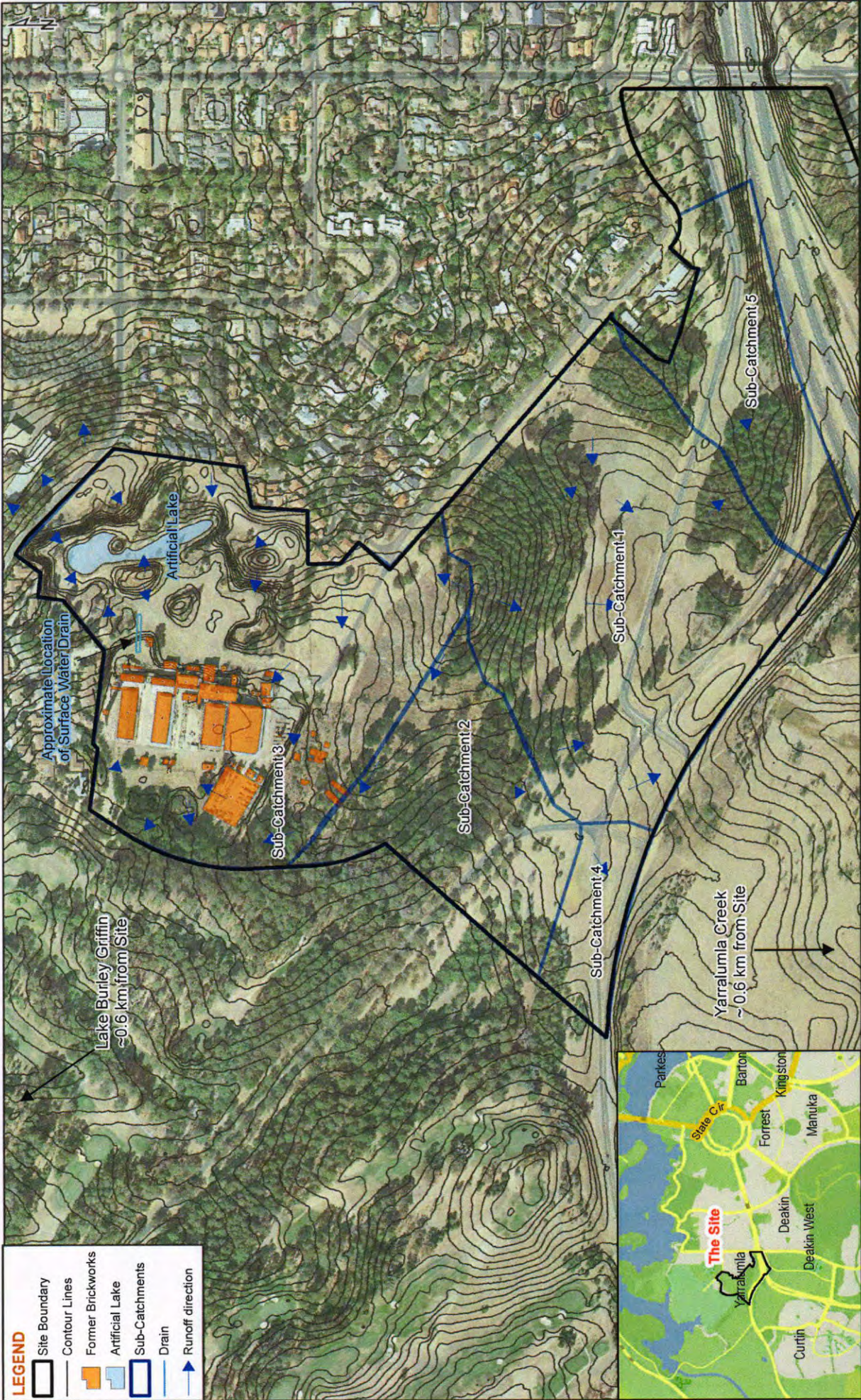
**LEGEND**

	Site Boundary
	Former Brickworks
	Timber Storage
	Sealed Ground Surface
	Unsealed Ground Surface

<b>FIG. NO.</b> 2b	<b>FIGURE TITLE</b> Former Canberra Brickworks Features	<b>DATE</b> 17/02/2014	<b>PAGE SIZE</b> A4	<b>COORDINATE SYSTEM</b> ACT Grid 1966
<b>PROJECT NO.</b> 3002369	<b>PROJECT TITLE</b> Canberra Brickworks Preliminary Site Investigation	<b>CREATED BY</b> J. Seng	<b>SOURCES</b> Imagery © BingMaps, Imagery © Roadnet	

Location: X:\PROJECT\3002369\Canberra Brickworks Site Investigation\DWG\2 Figures and Results\Figure 2b - brickworks features.mxd

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LEGEND	
	Site Boundary
	Contour Lines
	Former Brickworks
	Artificial Lake
	Sub-Catchments
	Drain
	Runoff direction

FIG NO.	FIGURE TITLE	DATE	PAGE SIZE	COORDINATE SYSTEM
2c	Topography, Sub-Catchments and Drainage	17/02/2014	A4	ACT Grid 1986
PROJECT NO. 3002369	PROJECT TITLE Canberra Brickworks Preliminary Site Investigation	CREATED BY J. Seng	SOURCES Imagery © BingMaps, Imagery © Roadnet	



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Location: X:\PROJECT\13002369\_Yarralumla Brickworks Site Investigation\8\_Delivery\2.1\_FIG\Figure 2c - Catchment Top and Drainage.mxd

15751



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 The Site

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**DATE**  
3/10/2013

**COORDINATE SYSTEM**  
ACT Grid 1966

**PAGE SIZE**  
A4

**SOURCES**  
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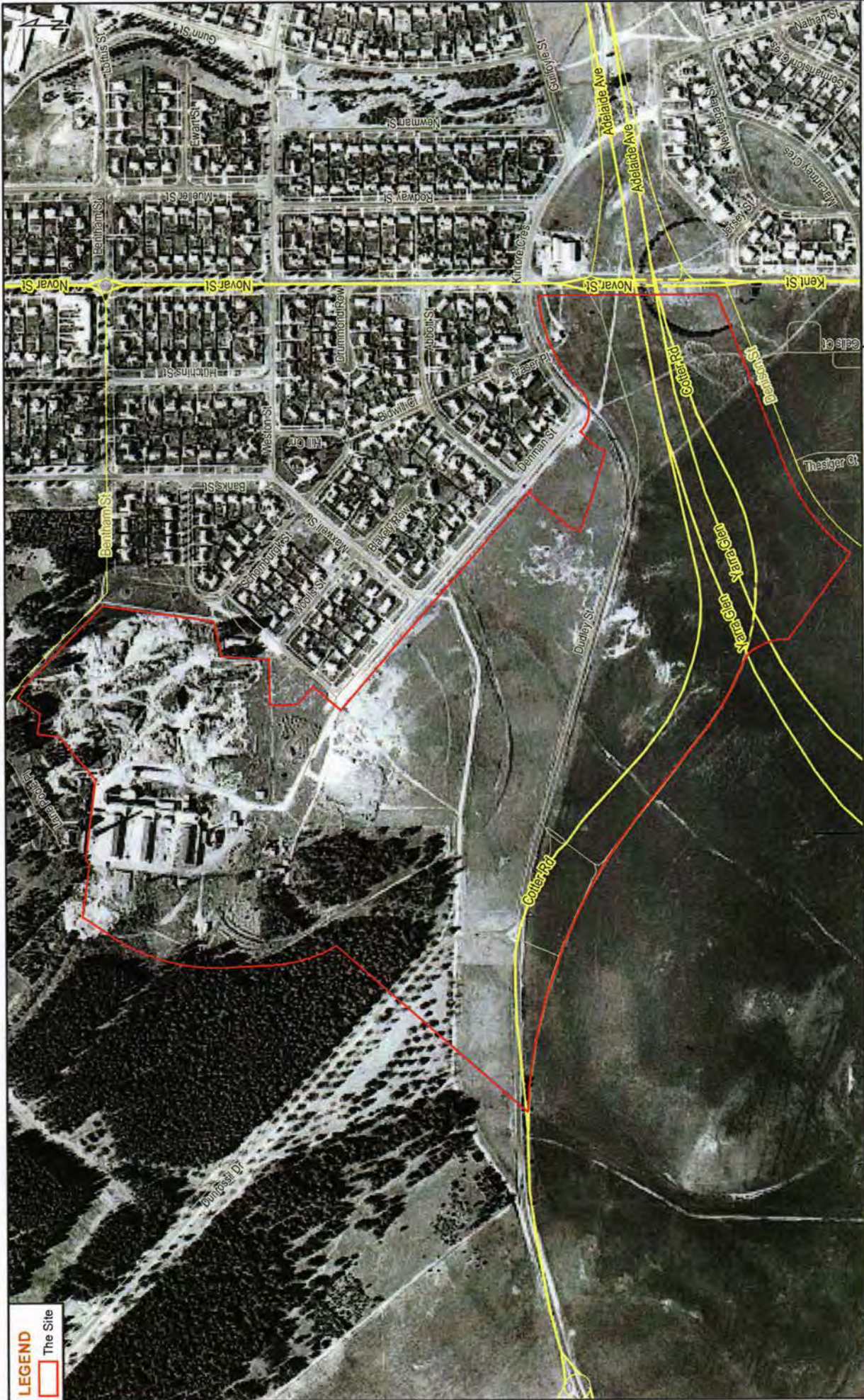
**FIG NO.**  
3a

**FIGURE TITLE**  
Historical Aerial Photograph - 1951

**PROJECT NO.**  
3002369

**PROJECT TITLE**  
Cambera Brickworks Preliminary Site Investigation

Location: X:\PROJECTS\3002369\Yarrabubba Brickworks Site Investigation\08\Delivery\2\ Figures and Results\Tab\04\_3.1 GIS\Figure 3a.mxd



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<b>DATE</b>	3/10/2013	<b>PAGE SIZE</b>	A4
<b>FIGURE TITLE</b>	Historical Aerial Photograph - 1958	<b>COORDINATE SYSTEM</b>	ACT Grid 1966
<b>PROJECT NO.</b>	3002369	<b>SOURCES</b>	Imagery © ACT/Mapi, Imagery © Roadnet
<b>PROJECT TITLE</b>	Canberra Brickworks Preliminary Site Investigation	<b>CREATED BY</b>	J. Seng

Location: X:\P10\6013002369\Veranda\_Brickworks\_Site\_Investigation\Delivery\6.2\_Figures\_and\_Revcat\_Table\6.2.1\_GIS\Figure\_3.mxd



**LEGEND**  
 The Site

<p><b>FIG NO.</b> 3c</p>	<p><b>FIGURE TITLE</b> Historical Aerial Photograph - 1988</p>	<p><b>DATE</b> 3/10/2013</p>	<p><b>COORDINATE SYSTEM</b> ACT Grid 1986</p>	<p><b>PAGE SIZE</b> A4</p>	<p><b>CREATED BY</b> J. Seng</p>
<p><b>PROJECT NO.</b> 3002369</p>	<p><b>PROJECT TITLE</b> Camberra Brickworks Preliminary Site Investigation</p>	<p><b>SOURCES</b> Imagery © ACTMapi, Imagery © Roadnet</p>	<p>© SMEC Australia Pty Ltd 2013.          All Rights Reserved          Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date, SMEC does not warrant or represent that the information contained on this map is free from error or omission. Any use of this map is at the user's own risk. Please verify the accuracy of all information prior to using it. This map is not a design document.</p>		



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**FIG NO.** 3d  
**FIGURE TITLE** Historical Aerial Photograph - 1978  
**PROJECT NO.** 3002369  
**PROJECT TITLE** Canberra Brickworks Preliminary Site Investigation  
**DATE** 3/10/2013  
**PAGE SIZE** A4  
**COORDINATE SYSTEM** ACT Grid 1966  
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**FIG NO.** 3d  
**FIGURE TITLE** Historical Aerial Photograph - 1978  
**PROJECT NO.** 3002369  
**PROJECT TITLE** Canberra Brickworks Preliminary Site Investigation  
**DATE** 3/10/2013  
**PAGE SIZE** A4  
**COORDINATE SYSTEM** ACT Grid 1966  
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<b>FIG NO.</b> 3F	<b>FIGURE TITLE</b> Historical Aerial Photograph - 1988	<b>DATE</b> 3/70/2013	<b>COORDINATE SYSTEM</b> ACT Grid 1966
<b>PROJECT NO.</b> 3002369	<b>PROJECT TITLE</b> Canberra Brickworks Preliminary Site Investigation	<b>PAGE SIZE</b> A4	<b>SOURCES</b> Imagery © ACTMapi. Imagery © Roadnet

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<p><b>FIG NO.</b> 3g</p>	<p><b>FIGURE TITLE</b> Historical Aerial Photograph - 2009</p>	<p><b>DATE</b> 3/10/2013</p>	<p><b>FIGURE SIZE</b> A4</p>	<p><b>COORDINATE SYSTEM</b> ACT Grid 1986</p>
<p><b>PROJECT NO.</b> 3002369</p>	<p><b>PROJECT TITLE</b> Cambera Brickworks Preliminary Site Investigation</p>	<p><b>SOURCES</b> Imagery © ACTMapi; Imagery © Roadnet</p>	<p><b>CREATED BY</b> J. Seng</p>	<p><b>SMC</b>  <small>© SMC Australia Pty Ltd 2013. All Rights Reserved.          Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, the user should be aware that the information contained on this map is from other or alternative sources and no warranty is given that the information is correct. Please verify the accuracy of all information prior to using it. This map is not a design document.</small></p>



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<p><b>SOURCES</b> Imagery © ACTMapi, Imagery © Roadnet</p>		<p><b>PROJECT NO.</b> 3002369</p> <p><b>PROJECT TITLE</b> Canberra Brickworks Preliminary Site Investigation</p> <p><small>Location: X:\PROJECT\3002369\Varalamb, Brickworks Site Investigation\Deliverables\2 Figures and Plans\Tab\Tab02_2.1_G3H_gure_3.mxd</small></p>				

0247



- LEGEND**
- Site Boundary
  - Former Brickworks
  - Former Rail Corridor
  - Subsector Boundaries
  - Test Pit Locations (SMEC 2013)
  - Approximate BH Locations (Robson 2006)



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<p><b>COORDINATE SYSTEM</b> ACT Grid 1986</p> <p><b>PAGE SIZE</b> A4</p> <p><b>DATE</b> 17/02/2014</p> <p><b>FIGURE TITLE</b> Test Pit and Borehole Locations</p>	<p><b>COORDINATE SYSTEM</b> ACT Grid 1986</p> <p><b>PAGE SIZE</b> A4</p> <p><b>DATE</b> 17/02/2014</p> <p><b>FIGURE TITLE</b> Test Pit and Borehole Locations</p>	<p><b>FIG NO.</b> 4</p> <p><b>PROJECT NO.</b> 3002369</p> <p><b>PROJECT TITLE</b> Yarralumla Brickworks Environmental Investigation</p>
<p><b>CREATED BY</b> J. Seng</p> <p><b>SOURCES</b> imagery © Bing Maps, Imagery © Roadnet</p>	<p><b>CREATED BY</b> J. Seng</p> <p><b>SOURCES</b> imagery © Bing Maps, Imagery © Roadnet</p>	<p><b>CREATED BY</b> J. Seng</p> <p><b>SOURCES</b> imagery © Bing Maps, Imagery © Roadnet</p>



**LEGEND**

- Site Boundary
- Areas of Environmental Concern (AEC)
- Subsector Boundaries
- Former Rail Corridor
- Historical Tracks (AEC 30)
- Current Tracks and Roads (AEC 30)
- Recycled Timber Storage (Thor's Hammer) (AEC 2)

Note: AEC 1 (Waste Fill) is located within the whole Former Brickworks, Former Quarry and Former Worker Accommodation Subsectors

FIG NO.	FIGURE TITLE	DATE	PAGE SIZE	COORDINATE SYSTEM
5	Areas of Environmental Concern	17/02/2014	A3	ACT Grid 1986
PROJECT NO.	PROJECT TITLE	CREATED BY	SOURCES	
3002369	Canberra Brickworks Preliminary Site Investigation	J. Seng	Imagery © Bing Maps, Imagery © Roadnet	

AEC Description
1 Waste Fill
Former Brickworks
2 Recycled Timber Storage (Thor's Hammer)
3 UST(s) and FOMIT Shed (former)
4 Stockhouse(s)
5 Explosive Store (former)
6 Machinery Shed(s)
7 Operation of Crusher and Refinery Plant(s)
8 Coal/Oil Storage Facility (ies)
9 Kiln Sand
10 Asbestos Dump
11 Septic Tank
12 Carpenters Workshop (former)
13 Former Kiln(s)
14 Fill Mound(s)
15 Weightbridge (former)
16 Power House and Underground Conduits
17 Boiler House and adjoining Substation (former)
Former Quarry
18 Fill Mound(s)
19 Clay Storage Shed (former)
20 Weatherboard Cottage (former)
Brickworks Workers Accommodation
21 Workers Accommodation (former) - General Areas and Former Buildings
22 Interceptor Pit
23 Abandoned Vehicle
24 Dumping Area
25 Scrap Metal Stockpile
26 Fill Mound
27 Cleared Area
28 Explosive Store (former)
Southern Areas
29 Rail Corridor
30 Vehicle Tracks (site wide)
31 Waste Pile
32 Fill (Road)

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Scale: 0 35 70 140 Meters  
 1:6,000

Scale bar and north arrow.



## APPENDIX B: DRAFT MASTERPLAN

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- Legend**
- Study Area Boundary
  - - - Future Stage Boundary
  - Key Buildings

- Built Form Height**
- 3 storey maximum
  - 4 storey maximum
  - 6 storey maximum
  - 8 storey maximum
- Proposed built form heights are also marked in numbers (x)



**CANBERRA BRICKWORKS AND ENVIRONS  
MASTER PLAN**

## APPENDIX C: DATA QUALITY OBJECTIVES

---

# DATA QUALITY OBJECTIVES

---

## Data Quality Objectives

The Data Quality Objective (DQO) process for this project has been derived from the NSW DEC (2006) "Guidelines for the NSW Site Auditor Scheme (2<sup>nd</sup> Edition)" and the NEPM (1999) "Guideline on Data Collection, Sample Design and Reporting". The DQO process is a seven step process to assist the development of sampling programs that support the decision making process.

### Step 1: State the Problem

#### Problem Definition

At present there is limited data on the contamination status of the Site. A review of available historical data indicates there is potential for significant contamination to be present.

#### The Planning Team

This team has been selected to work together through the seven steps of the project DQO process. The size of the planning team reflects the complexity of the project, however as the DQO Process is iterative, team members may be added to address areas of expertise not initially considered.

#### Decision Makers and Stakeholders

- LDA Project Manager: Gary Travis
- SMEC Project Manager: Peter Hicks
- SMEC Senior Environmental Scientist: Nathalie O'Toole
- SMEC Environmental Scientist: John O'Brien

#### Stakeholders

Stakeholders are individuals and organisations that are directly affected by a decision, interested in a problem, and want to be involved, offer input, or seek information. The involvement of stakeholders early on in the DQO process can provide a forum for communication as well as foster trust in the decision making process. At this stage it is envisaged that communication is limited to LDA staff and individuals directly involved in the project. Future communication and consultation may include the following stakeholders:

- Current users of the Site (Thor's Hammer);
- ACT Environment Protection Authority (EPA); and
- Yarralumla Residents Association.

## Step 2 : Identify the Decision

The purpose of this step is to define the decision statement that the study will attempt to resolve, based on the problem stated above in Step 1. The Principal Study Question can therefore be summarised as:

*To assess the potential risks posed by contamination and obtain sufficient data to allow the development of strategies to remediate and/or manage the contamination to an end land use that is suitable for the proposed redevelopment.*

Project Decisions include:

- Do the Site soils and/or groundwater contain concentrations of contaminants of concern (CoC) above the ACT EPA endorsed assessment criteria for the current and proposed land use;
- Do current concentrations of contaminants pose a human health or ecological risk to the receptors of concern;
- Determine the pathways of exposure for human and ecological receptors;
- Is there sufficient data to develop the scope for further investigation or remedial strategies; and
- Can the Site be made suitable for the proposed future land use.

## Step 3: Identify the Inputs to the Decision

### Introduction

The primary inputs required to be measured by the PSI sampling program are:

- Identify and undertake limited assessment of the areas of environmental concern;
- Assess in greater detail the current site conditions (i.e. topography, hydrogeology) and their potential to influence the migration of contamination;
- Aesthetic impacts in residual surface and deeper soils caused by contamination, including staining, odours and visible asbestos;
- Determine preliminary data on the background quality of soils at the Site;
- Use of appropriate sampling techniques to obtain representative samples from the Site;
- Use of NATA accredited laboratories for selected analysis of sampled medium (soil, surface water, groundwater)
- Determine the migration potential of contamination (if any) at the Site;
- Determine the type and location of contamination;
- ACT Environment Protection Authority and National Environment Protection Measures (NEPM) endorsed adopted site assessment criteria; and
- ACT Environment Protection Authority endorsed site investigation and environmental guidelines.

- The following sections more specifically identify the DQOs associated with key fieldwork components of the assessment.

## **DQO Decision Inputs**

### **Purpose & Required Information**

The purpose of the intrusive investigation works is to visually inspect subsoils and to obtain samples of soils and groundwater for chemical analysis.

Fieldwork information requirements are:

- Maps of the Areas of Environmental Concern;
- Logs of the soil profile;
- Information on the nature of materials encountered during works;
- Photographic logs of Site conditions and features; and
- Collection of representative soil samples in accordance with ACT Environment Protection Authority endorsed criteria, for chemical analysis at NATA accredited laboratories.

### **Information Sources**

The grid based sampling plan was designed to provide preliminary geotechnical data for future development within the Site (TP01 to TP14); environmental samples were collected at these locations to assess for background soil conditions. The sampling plan is presented in Figure 4 **Appendix A**.

The remainder of the sampling locations were targeted to either confirm previous soil data or to fill data gaps to better inform the recommendations outlined in this PSI.

### **Determining the Action Level**

Field screening of soil samples, based upon:

- Visual or olfactory evidence of contamination.

## **Step 4: Define the Study Boundaries**

The study boundaries include spatial and temporal boundaries of the site, including potential receptors of concern. The "Study Boundaries" have been divided into the following descriptors:

- Target population (subsurface boundaries to include fill, residual soils and bedrock);
- Geographic boundaries (the Site boundary as presented in Table 1 **Appendix A**); and
- Temporal boundaries.

### **Target Population**

The target population for this study comprises the environmental samples of:

- Surface and subsurface soils.

The decision makers will base assessment and management decisions on information gained from these target populations.

The conditions of these populations [soils] will be compared to the adopted site assessment criteria to determine the response to the Principal Study Question.

### **Geographic Boundaries**

The geographic boundaries of the data collection and decision making process for this project are shown in Figure 1 **Appendix A**.

### **Temporal Boundaries**

The temporal boundaries included in the decision making process are based the persistence of potential contaminants of concern in the environment and the mobility of potential soil contamination. Metals and PAH are considered to be persistent contaminants, with potential impacts occurring over time scales of 10 years or more.

## **Step 5: Decision Rules**

As the PSI has been developed to provide preliminary contamination data, the following key drivers and relevant decision rules that will be applied in the decision making process:

- Assess the need for further investigation at the Site to assess the identified areas of environmental concern;
- The risk to current and future users of the Site; and
- Potential impacts to offsite receptors (water bodies)

The analytical and field data generated through the PIS sampling program will be compared to the adopted site assessment, and the decision rules become:

- If contaminant concentrations in soils are greater than adopted soil investigation levels then consider further investigation;
- If contaminant concentrations in soils are less than adopted soil investigation levels then consider the data gaps, further investigation may still be recommended;
- If aesthetic issues (i.e. visible waste material) remain then consider further remediation works.

## **Step 6: Tolerable Limits On Decision Errors**

The Tolerable Limits of Decision Errors establish the Data Quality Indicators (DQIs), by which the data collected during the limited Phase 2 ESA sampling program is measured. The DQIs are summarised as follows:

### **Data representativeness:**

- Use of appropriately trained field personnel to collect data and investigate site conditions. Careful soil logging to confirm nature and depth of impact has been removed and residual impacts documented.

### **Documentation and Data completeness:**

- Site conditions properly described;
- Sample locations to be properly described and recorded on field notes/logs;

- Field records are appropriately completed;
- Completion of calibration results, chain of custody documentation, laboratory reports from National Association of Testing Authorities registered laboratories;
- Collection of representative samples from each identified area of environmental concern. Locations are recorded to enable relocation at the completion of the project;
- Samples are tested for appropriate Contaminants of Concern (CoC). Field parameters (as required) including olfactory assessment.

#### **Data Comparability:**

- Appropriate techniques are used for sample handling (including sampling, storage and transport);
- Use of NATA accredited test methods in primary laboratory using NEPM procedures;
- Use of NATA accredited test methods in check/secondary laboratory using NEPM procedures.
- Precision and accuracy for sampling and analysis:
- Blind duplicates to be collected at a rate of 1:20 and analysed in the primary laboratory;
- Triplicate samples to be collected at a rate of 1:20 and analysed by the check/secondary laboratory;
- Relative Percentage Differences (RPDs) for inorganic analytes to be less than 30%;
- RPDs for organic analytes to be less than 50%;
- Acceptable quality of field blanks, trip blanks and trip spikes; and
- Acceptable data quality control results by the laboratories are achieved.

### **Step 7: Optimisation Of The Data Collection Process**

The grid based sampling plan was designed to provide preliminary geotechnical data for future development within the Site; environmental samples were collected at these locations to assess for background soil conditions. The sampling plan is presented in Figure 4 **Appendix A**. The remainder of the sampling locations were targeted to either confirm previous soil data or to fill data gaps to better inform the recommendations outlined in this PSI.

The investigation was undertaken in general accordance with the initial sampling plan, slight changes to the locations were made during the fieldwork component of the PSI based on observational data to:

- Ensure a dynamic sampling plan that allowed flexibility to locate test pits based on the proposed design and field observations;
- Targeting sampling at the most significant areas of environmental concern at the Site.

It is noted that the PSI was to provide preliminary contamination data and all identified areas of environmental concern were not targeted as part of the investigation.

## **APPENDIX D: GROUNDWATER BORE SEARCH**

---



**ACT**  
Government

Environment and  
Sustainable Development

Mr John O'Brien  
SMEC  
Email: john.o'brien@smec.com

Dear Mr O'Brien

I refer to your application for a groundwater bore search with a 2 km buffer zone of Block 1 Section 102 Yarralumla. There are three (3) privately managed groundwater abstraction bores registered under the *Water Resources Act 2007* within the search area

Bore Number	Construction Date	Depth of Bore	Static Water Level
WU36	Unknown	43m	35m
WU105	Unknown	Unknown	Unknown
WU609	Unknown	Unknown	Unknown

There is also one (1) investigation or monitoring bores ('Woden3') within the 2km buffer, and a fourth groundwater abstraction bore (WU611) just outside of the search area. No further information is available for either 'Woden3' or WU611.

Please note that this search does not include bores associated with contaminated sites. If you require more information please contact Contaminated Sites (Environment Protection Authority) on 132281.

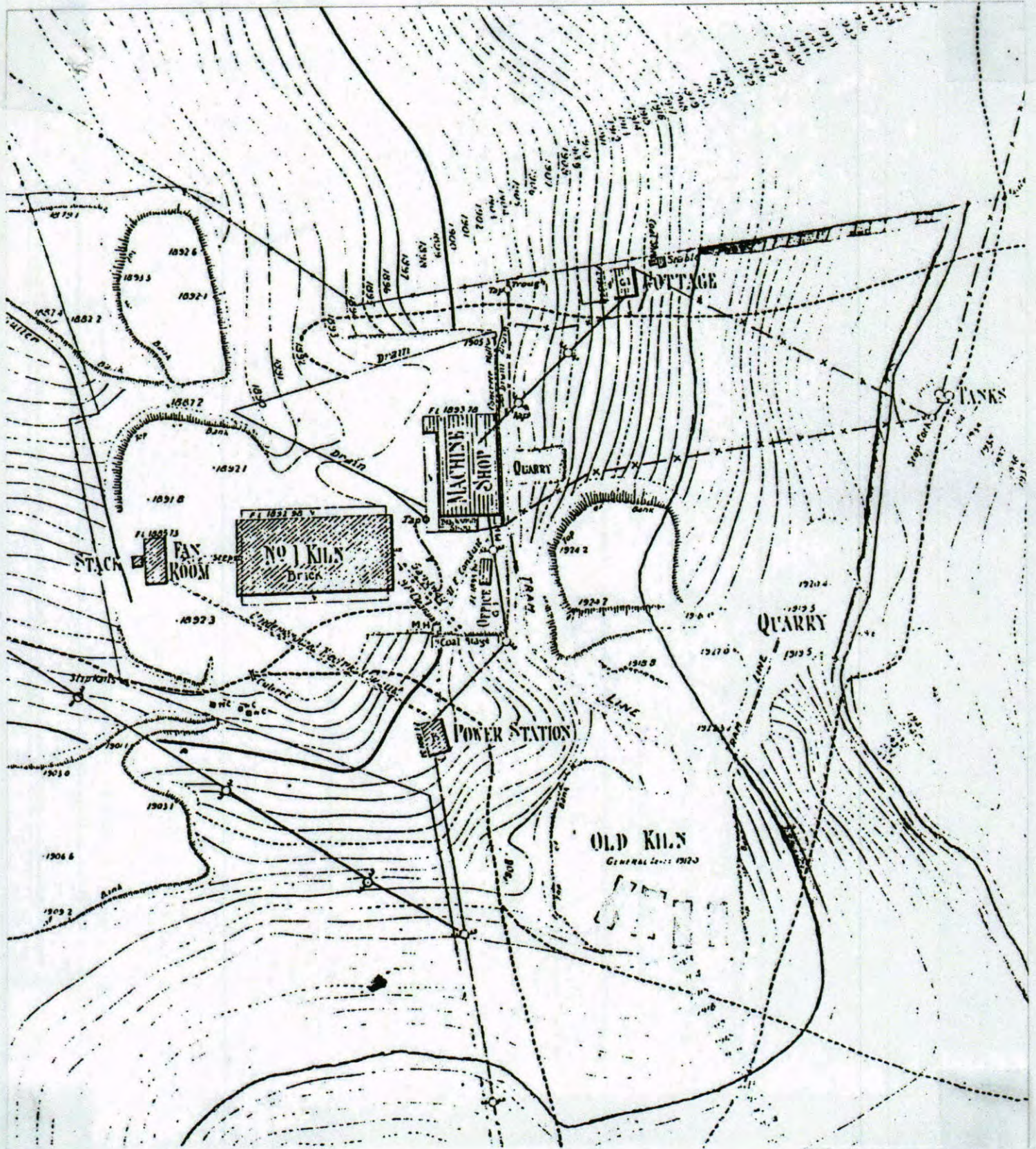
If you have any questions please contact me on (02) 6207 1354 or email [Ronald.chesham@act.gov.au](mailto:Ronald.chesham@act.gov.au).

Yours sincerely

Ron Chesham  
Environment Protection Officer  
Water Regulation  
3 October 2013

## APPENDIX E: HISTORICAL PLANS

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270

# Old Canberra Brickworks

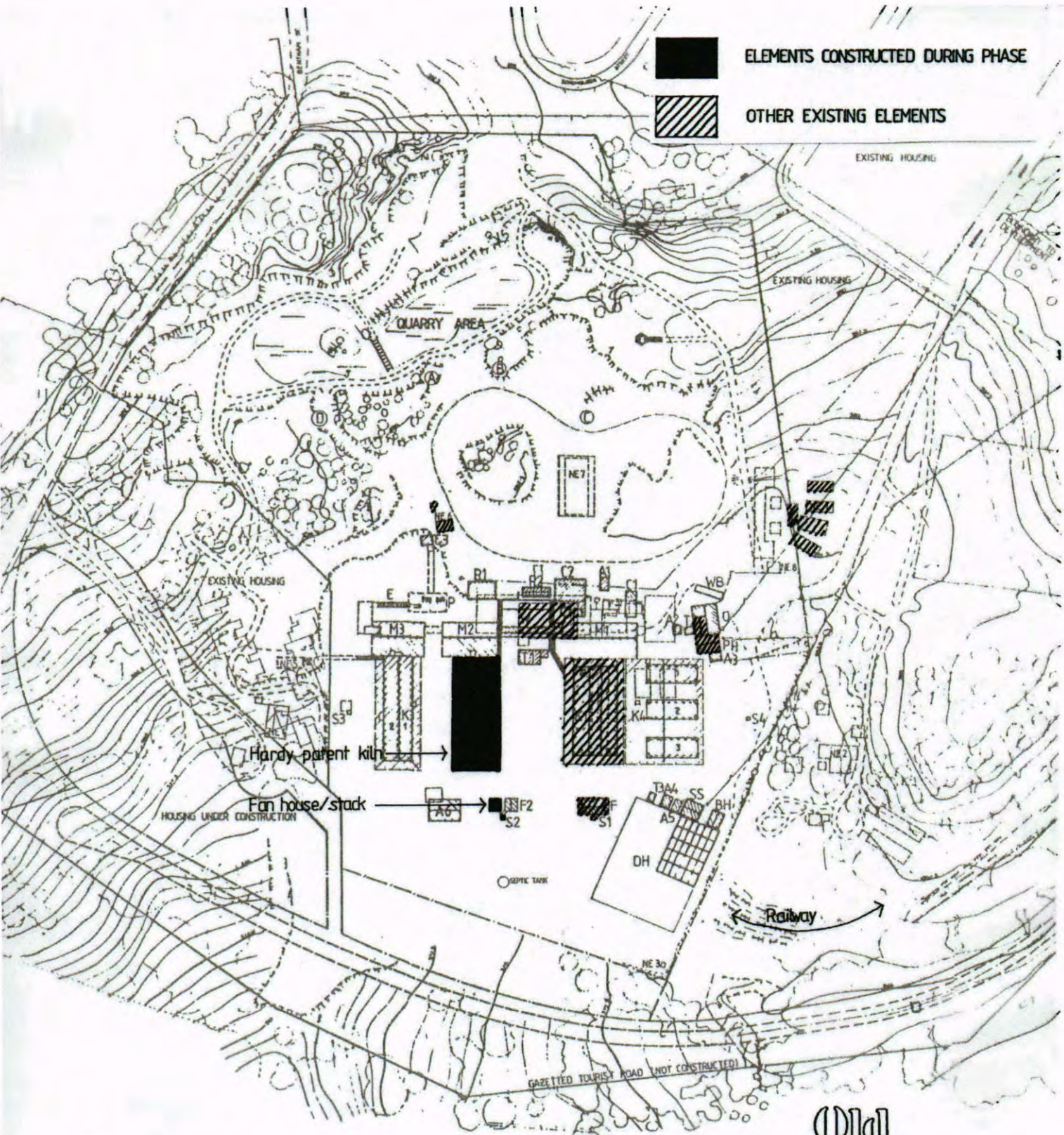
EXTRACT FROM  
DECEMBER 1916 SURVEY



ELEMENTS CONSTRUCTED DURING PHASE



OTHER EXISTING ELEMENTS



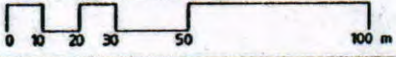
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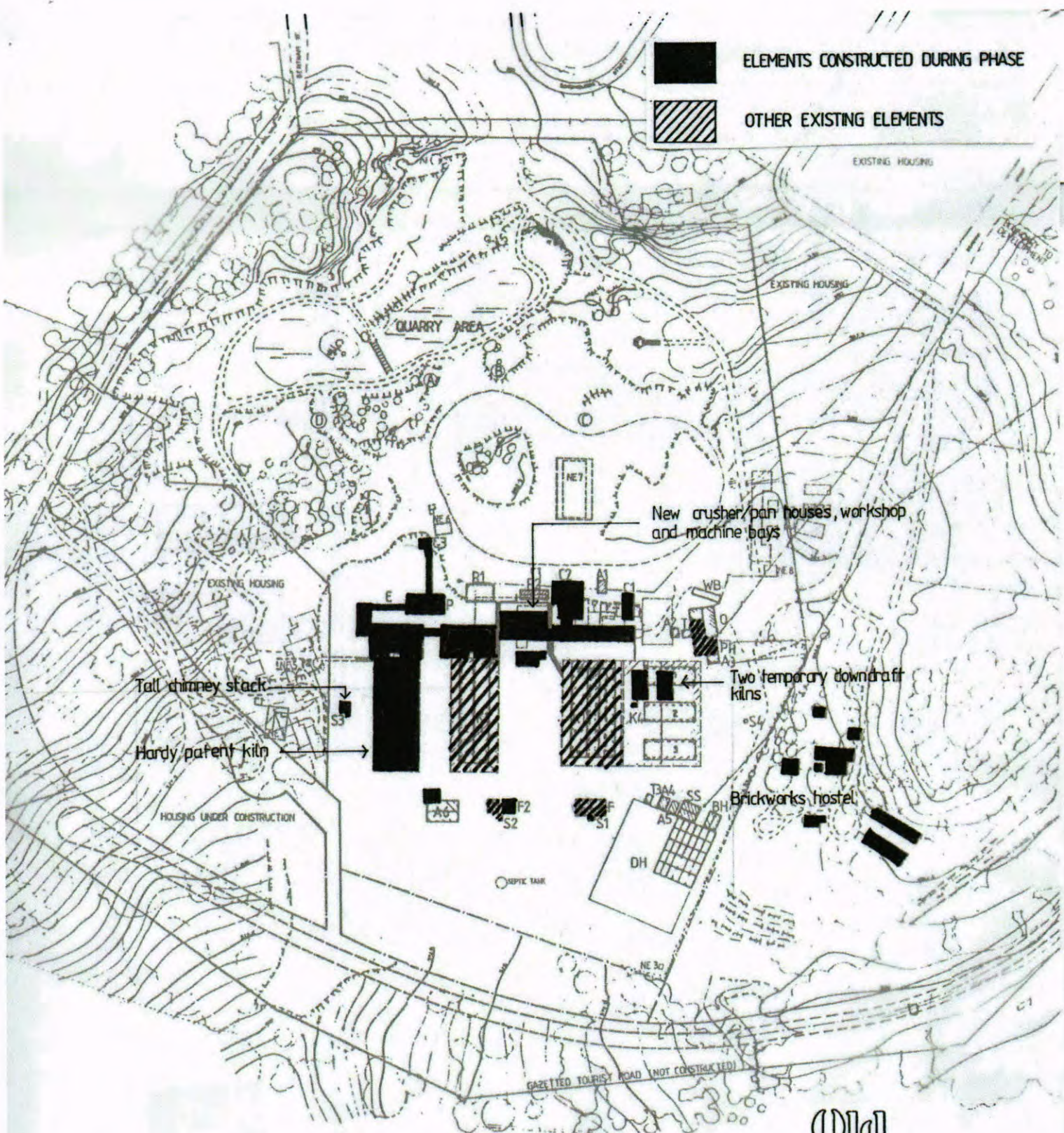
- K1 Kiln . Staffordshire c 1915
- K2 Kiln . Hardy Patent c 1927
- K3 Kiln . Hardy Patent c 1953
- K4 Kiln . Downcraft c 1961
- F1 Fan House for Staffordshire c 1915
- F2 Fan House for Patent c 1927
- S1 Chimney Stack for Staffordshire c 1915
- S2 Chimney Stack for Patent c 1927
- S3 Chimney Stack for Patent c 1953
- S4 Chimney Stack for Downcraft c 1961
- M1 Machine Bay for Staffordshire and Downcraft c 1955 (also Brick Press Building 1)
- M2 Machine Bay Patent c 1955
- M3 Machine Bay Patent c 1955
- N Natchap c 1955
- C1 Small Crusher House (Hazonag)
- C2 Large Crusher House (or Pan Building) c 1955
- C3 Primary Crusher House c 1955
- P Pan Building Site c 1955
- E Elevator Conveyor c 1955
- O Offices c 1916
- M Power House c 1915
- W Weightbridge c 1963's
- T1 Toilet Block (lockers, lunch & first aid) c 1947/50
- T2 Minor toilet block
- T3 Minor toilet block
- BH Roller House c 1971
- SS Sub Station and Control Room c 1971
- DH Drying House and Slab c 1971
- R1 Railway (model) Stockshop c 1979
- R2 Railway (model) Storage Shed c 1979
- Q Quarry Brickpit
- A Geological Monument
- B Geological Monument
- C Geological Monument
- D Geological Monument
- A1 Ancillary Building Storage Shed c 1958
- A2 Ancillary Building Studio/Shed
- A3 Ancillary Building Studio/Shed Former Barner Hut
- A4 Ancillary Building Studio/Shed
- A5 Ancillary Building Studio/Shed
- A6 Forklift Shed c 1965
- NE1 Site of 1913 Temporary Open kilns and workshop
- NE2 Site of Richborts Camp (Accommodation village)
- NE3 Site of Explosives Store
- NE4 Site of Weatherboard Cottage
- NE5 Site of oil tank/coal store
- NE6 Site of Cottage and associated buildings 1916
- NE7 Site of Clay Storage Area (shed)
- NE8 Site of Carpenters Shed

# Old Chamberlain Brickworks

## EXPANSION PHASE mid 1920's

Lester Firsh Associates Pty Ltd





ELEMENTS CONSTRUCTED DURING PHASE  
 OTHER EXISTING ELEMENTS

**KEY**

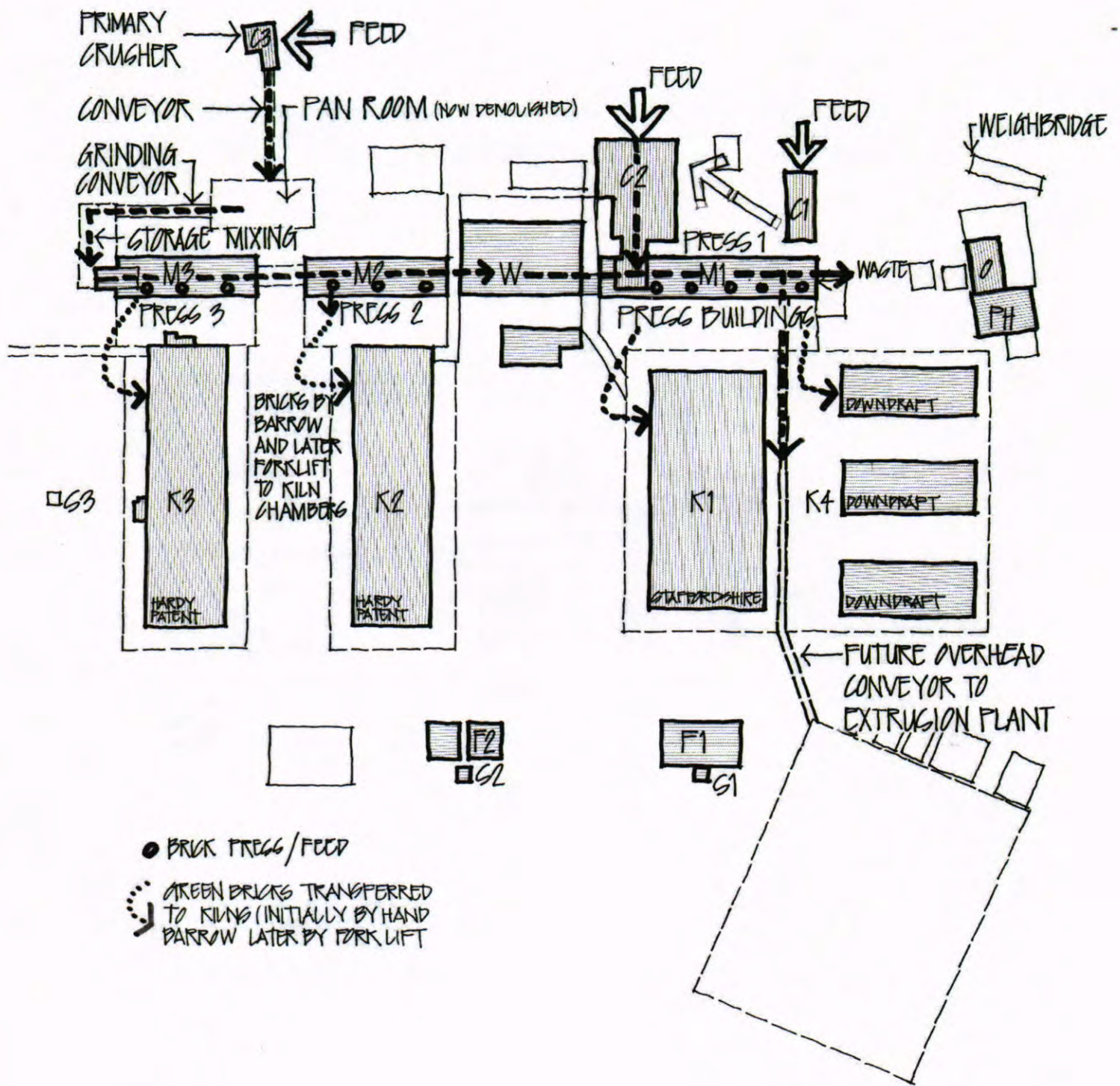
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|--|--|
| <ul style="list-style-type: none"> <li>K1 Kiln - Staffordshire c 1915</li> <li>K2 Kiln - Hardy Patent c 1927</li> <li>K3 Kiln - Hardy Patent c 1951</li> <li>K4 Kiln - Downcraft c 1963</li> <li>F1 Pan House for Staffordshire c 1915</li> <li>F2 Pan House for Patent c 1927</li> <li>S1 Chimney Stack for Staffordshire c 1915</li> <li>S2 Chimney Stack for Patent c 1927</li> <li>S3 Chimney Stack for Patent c 1951</li> <li>S4 Chimney Stack for Downcraft c 1963</li> <li>M1 Machine Ray for Staffordshire and Downcraft c 1955 (also Brick Press Building 1)</li> <li>M2 Machine Ray Patent c 1955</li> <li>M3 Machine Ray Patent c 1955</li> <li>W Workshop c 1955</li> <li>C1 Small Crusher House (Hazones)</li> <li>C2 Large Crusher House (or Pan Building) c 1955</li> <li>C3 Primary Crusher House c 1955</li> <li>P Pan Building Site c 1955</li> <li>E Elevator Conveyer c 1955</li> <li>O Offices c 1916</li> <li>PH Power House c 1915</li> <li>WB Weighbridge c 1950's</li> <li>T1 Toilet block (lockers, lunch &amp; first aid) c 1947/50</li> <li>T2 Minor toilet block</li> </ul> | <ul style="list-style-type: none"> <li>T3 Minor toilet block</li> <li>BH Boiler House c 1971</li> <li>SS Sub Station and Control Room c 1971</li> <li>DH Drying House and Slab c 1971</li> <li>R1 Railway (model) Workshop c 1979</li> <li>R2 Railway (model) Storage Shed c 1979</li> <li>Q Quarry Brickpit</li> <li>A Geological Monument</li> <li>B Geological Monument</li> <li>C Geological Monument</li> <li>D Geological Monument</li> <li>A1 Ancillary Building Storage Shed c 1958</li> <li>A2 Ancillary Building Studio/Shed</li> <li>A3 Ancillary Building Studio/Shed Former Burners Hut</li> <li>A4 Ancillary Building Studio/Shed</li> <li>A5 Ancillary Building Studio/Shed</li> <li>A6 Pocklift Shed c 1965</li> <li>NE1 Site of 1913 Temporary Open kilns and workshop</li> <li>NE2 Site of Brickworks Camp (Accommodation village)</li> <li>NE3 Site of Explosives Store</li> <li>NE4 Site of Weatherboard Cottage</li> <li>NE5 Site of oil tank/coal store</li> <li>NE6 Site of Cottage and associated buildings 1916</li> <li>NE7 Site of Clay Storage Area (shed)</li> <li>NE8 Site of Carpenters Shed</li> </ul> |
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Old  
**Chamberlain  
 Brickworks**

EXPANSION PHASE  
1950's



0249

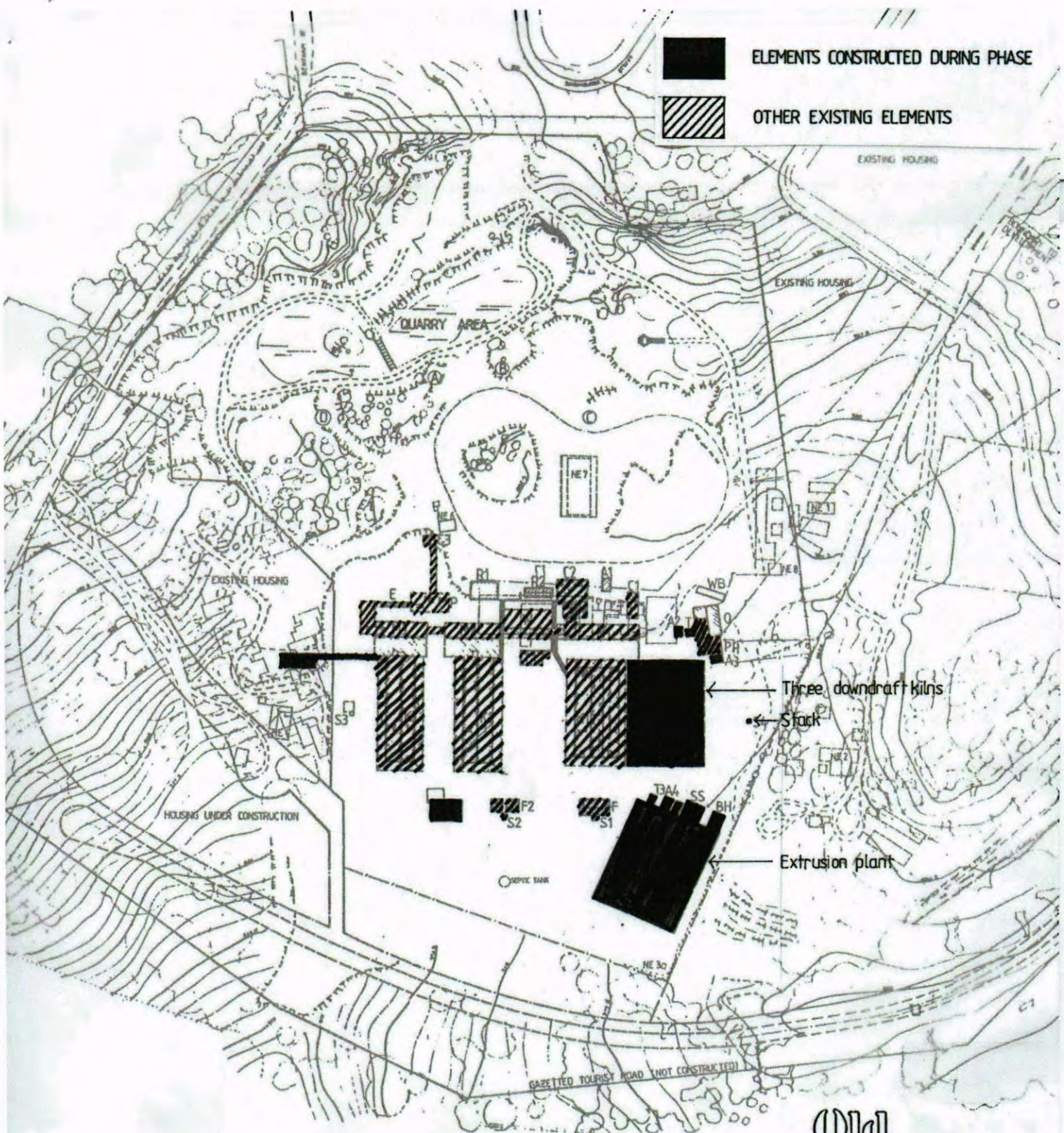
Lester Firth Associates Pty Ltd



# Old Canberra Brickworks

PROCESS c.1960

 ELEMENTS CONSTRUCTED DURING PHASE  
 OTHER EXISTING ELEMENTS



**KEY**

- K1 Kiln - Staffordshire c 1915
- K2 Kiln - Hardy Patent c 1927
- K3 Kiln - Hardy Patent c 1953
- K4 Kiln - Downdraft c 1963
- F1 Fan House for Staffordshire c 1915
- F2 Fan House for Patent c 1927
- S1 Chimney Stack for Staffordshire c 1915
- S2 Chimney Stack for Patent c 1927
- S3 Chimney Stack for Patent c 1953
- S4 Chimney Stack for Downdraft c 1961
- M1 Machine Bay for Staffordshire and Downdraft c 1955 (also Brick Press Building 1)
- M2 Machine Bay Patent c 1955
- M3 Machine Bay Patent c 1955
- M4 Workshop c 1955
- C1 Small Crusher House (Hazones)
- C2 Large Crusher House (or Fan Building) c 1955
- C3 Preliminary Crusher House c 1955
- F Pan Building Site c 1955
- E Elevator Conveyor c 1955
- O Offices c 1916
- PH Power House c 1915
- WB Weighbridge c 1960's
- T1 Toilet Block (lockers, lunch & first aid) c 1947/50
- T2 Minor toilet block
- T3 Minor toilet block
- BH Boiler House c 1971
- SS Sub Station and Control Room c 1971
- DH Drying House and Slab c 1971
- RI Railway (model) Workshop c 1979
- R2 Railway (model) Storage Shed c 1979
- Q Quarry Brickpit
- A Geological Monument
- B Geological Monument
- C Geological Monument
- D Geological Monument
- A1 Ancillary Building Storage Shed c 1958
- A2 Ancillary Building Studio/Shed
- A3 Ancillary Building Studio/Shed
- FB Former Burners Hut
- A4 Ancillary Building Studio/Shed
- A5 Ancillary Building Studio/Shed
- A6 Rocklift Shed c 1965
- NE1 Site of 1913 Temporary Open kilns and workshop
- NE2 Site of Brickworks Camp (Accommodation village)
- NE3 Site of Explosives Store
- NE4 Site of Weatherboard Cottage
- NE5 Site of oil tank/coal store
- NE6 Site of Cottage and associated buildings 1916
- NE7 Site of Clay Storage Area (shed)
- NE8 Site of Carpenters Shed

Old  
**Chamberlain  
 Brickworks**

**EXPANSION PHASE**  
 1960 - mid 1970's

Lester Firth Associates Pty Ltd

