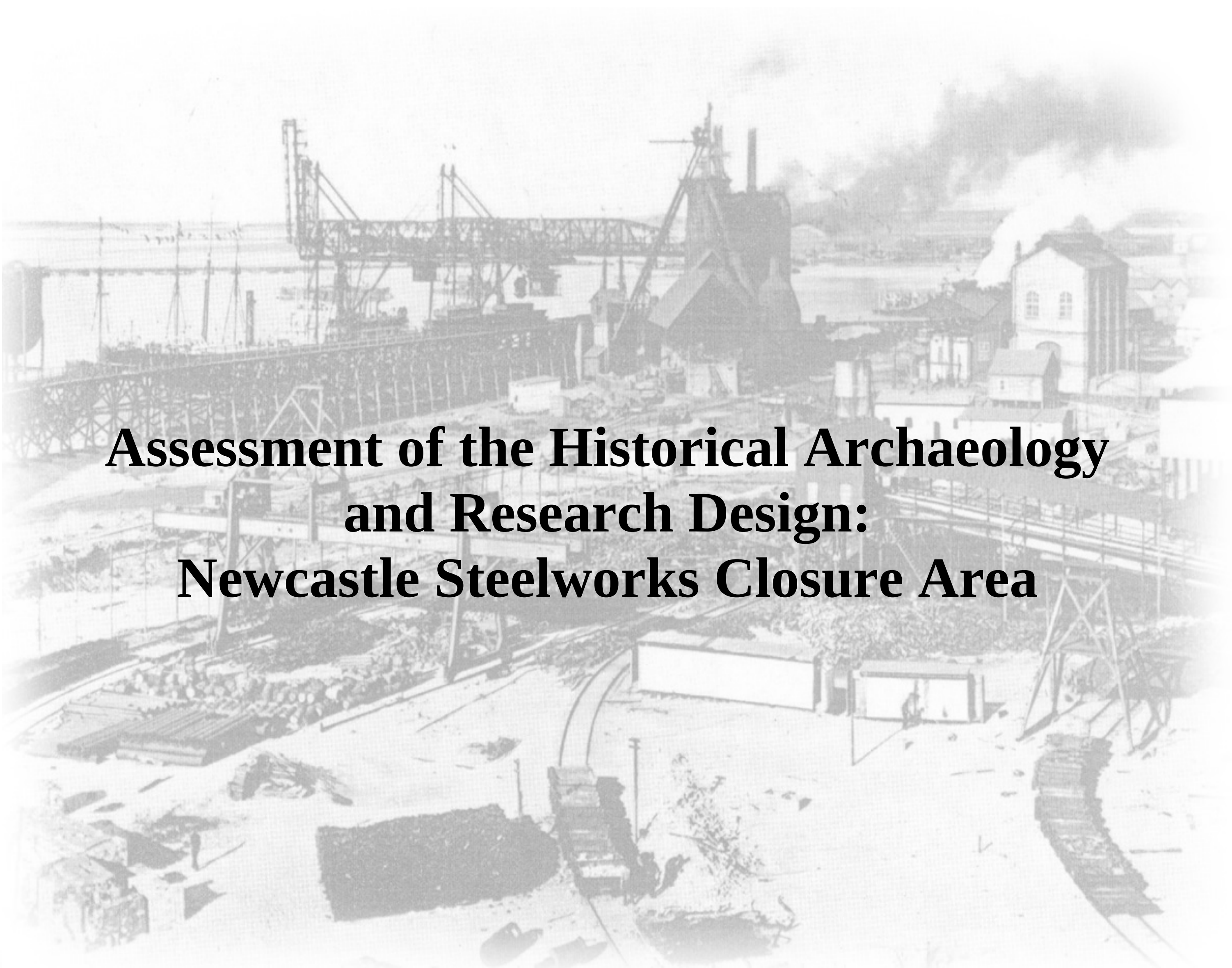
APPENDIX 2

Copy, Extracts from Assessment and Research Design, Closure (Non Heritage Area), Former BHP Steelworks, Newcastle

BHP Billiton Limited



Assessment of the Historical Archaeology and Research Design: Newcastle Steelworks Closure Area

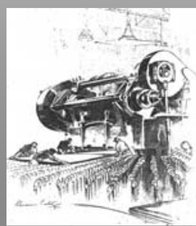
May 2002

Prepared By:

Umwelt (Australia) Pty Limited
Environmental and Catchment Management Consultants








Report No. 1554/R01/V2

Prepared for:

BHP Billiton Limited

ASSESSMENT OF THE HISTORICAL ARCHAEOLOGY AND RESEARCH DESIGN: NEWCASTLE STEELWORKS CLOSURE AREA

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Cover Photographs:
Background – view of the BHP Steelworks in 1917.
Bottom (left to right) – The Ferro-manganese Furnace (“Maggie”) in 1918, Maggie in preparation for felling in 1934, Maggie being felled, Maggie after felling, Skelp Mill Shears, Interior of Skelp Mill.

FIGURES

(located at end of Sections 1, 3 and 5)

PLATES

(located at the end of Section 3)

APPENDICES

1.0 INTRODUCTION

BHP Billiton Limited (the Company) commissioned Umwelt (Australia) Pty Limited to undertake a study and analysis of the historical archaeology of the Closure Area of their Newcastle Steelworks, New South Wales (the study area). It is proposed that the site be redeveloped as a major Container Handling Terminal (the development). BHP Billiton proposes to undertake clearance and levelling of the study area to facilitate its remediation and re-development. The proposal is subject to the perceived needs for the management of historical heritage values of the study area. Historical studies have shown that the site accommodated early industrial development beginning in the 1860s and followed by land reclamation and diversification into the large-scale steel manufacturing industry of BHP that was instrumental in the economic and social growth and development of Newcastle City.

This archaeological assessment concerns potential subsurface archaeological resources. It documents the study and analysis of potential heritage resources identified in the Archaeological Management Action Plan – Non-Heritage Precinct (AMAP) (see **Appendix 1**) and provides a research design. The AMAP has indicated the possible presence of material evidence of former site use and/or occupation and/or functional structures that were either demolished prior to 1952 or incorporated into other uses within the Steelworks. The AMAP should be read in conjunction with this report.

This report specifically addresses eight potential heritage sites, consisting of elements of the former BHP Steelworks, in regard to possible subsurface material remains in the way of footings, foundations and/or artefacts. These elements are:

- The Hunter River Copper Smelting Works (also known as the Wallaroo Mining and Smelting Company);
- Coke Oven Batteries;
- No 2 Blast Furnace;
- Ferro-manganese Furnace;
- 18 Inch Mill Building;
- Small Merchant Mills/Combination Mill;
- Merchant Mill Boilers;
- No 1 Pig Casting Machine.

The study area has been evaluated according to standardised criteria by reference to the determinable individual elements of its past and present structural archaeological and historical heritage and their collective values as components of the historic heritage of the study area and its locality. This report does not address the potential of the study area as a resource for Aboriginal cultural heritage.

1.1 OBJECTIVES OF THE STUDY

Historical material relating to the development of the study area is relatively diverse and in regard to some elements, sparse. Recent publications, although readily available, are largely general in nature and specific historical information relevant to this report has been obtained chiefly from historical BHP publications. This study integrates the results of investigation of the historical and archival records. The principal objective of the study was to identify material cultural evidence that may be located within the study area possibly at risk from direct or peripheral effects of the development.

Within the framework of this general objective, the study was undertaken on the basis that it may identify archaeological resources within, and provide insights into the development of, the study area and its occupational and social fabric that are not available from the historical record. In abstract, archaeological interpretation of the study area individually, and collectively/comparatively with other archaeological and historical studies, may allow the pursuit of such relevant historical themes as:

- the establishment of the first integrated Iron and Steel Works in Australia;
- the development of local, regional and national economies;
- the development of the BHP Company and the diversification of the Company's operations;
- the recycling and/or adaptive re-use of land and buildings during the lifetime of the establishment;
- the influence of the plant on the development of Newcastle together with the attraction of secondary industries to the Newcastle area;
- the involvement of Australia in two World Wars;
- influence on the early completion of the rail system;
- the expansion of port facilities and major changes to the flow of the Hunter River and Throsby Creek; and
- in respect of all of the above, the different emphases and inferences that may attach to the historical phases of use/occupation/development of the study area.

Within this context, this study makes an evaluation of the cultural significance of the archaeological resource of the study area and of the impact on heritage values of the proposed future use. After reviewing issues and options for management, recommendations are made about the management of the archaeological/heritage values of the study area and its environs.

1.2 STUDY RATIONALE

This was undertaken to identify, and if relevant, to define research criteria and objectives in support of an application to the Heritage Office pursuant to s140 of the Heritage Act 1977. Having regard to the implications of the projected development, it is prudent to obtain the issue of an excavation permit from the NSW Heritage Council in respect of the whole of the study area. It is acknowledged that the demolition of existing buildings will not be the subject of an application under s140, Heritage Act, NSW, 1977.

Development consent conditions relating to archaeology and heritage will be satisfied within this report through:

- the assessment of the heritage value of potential subsurface material evidence, based upon the historical archaeology of the study area;

- a research design and s140 application; and
- development of an Archaeological Management Action Plan (included as **Appendix 1**).

1.3 LOCATION AND FEATURES OF THE STUDY AREA

The study area is located on the Hunter River at Port Waratah, New South Wales, approximately 4.2 kilometres north-west of Newcastle CBD.

Other relevant information about the location of the study area is shown in **Table 1.1**.

Table 1.1 - Location Data

Topographic Map Sheet	9232-2-S
Grid reference/range (centre)	$_{3}$8400. $_{63}$5950
Parish	Newcastle
County	Northumberland
Local Government Area	Newcastle City

The regional location of the study area is shown on **Figure 1.1** and the study area is defined in **Figure 1.2**. The study area is located within the former Newcastle Steelworks, now referred to as “The Closure Area”, which includes a Heritage Precinct and a Non-Heritage Precinct. These precincts are defined as follows:

- The **Heritage Precinct** describes that part of the closure area that contains sites of the following buildings and/or relics and their precincts, identified as heritage resources in previous studies, assessments and by EJE & Fenwick *[1991]*:
  - No 1 Blast Furnace;
  - No 1 Blower House;
  - Original Open Hearth Building;
  - No 1 Bloom Mill and Rail Mill Building (incl. Soaking Pits);
  - Steel Foundry/Open Hearths;
  - DC Substation;
  - Original Timber Wharves
  - No 3 Blast Furnace;
  - AC Saltwater Pump House;
  - Power House;
  - Open Hearth Change House;
  - Mould Conditioning Building;
  - BOS Plant;
  - No 4 Blast Furnace.
- The **Non-Heritage Precinct** refers to the closure area to the exclusion of the Heritage Precinct.

Also shown in **Figure 1.2** are the approximate areas of cut during the proposed remediation and the location of the potential heritage sites relevant to this report.

1.4 METHODOLOGY AND REPORTING

This study and analysis has been undertaken broadly within the framework of the *NSW Heritage Manual* of the Heritage Office and the Department of Urban Affairs and Planning (now PlanningNSW). The sequential steps of the study have been as follows:

- the archaeological and historical records of the study area have been researched, with particular attention to the dominant aspects of land use from the initial development of the site. Research results are abstracted in **Sections 2** and **3** respectively;

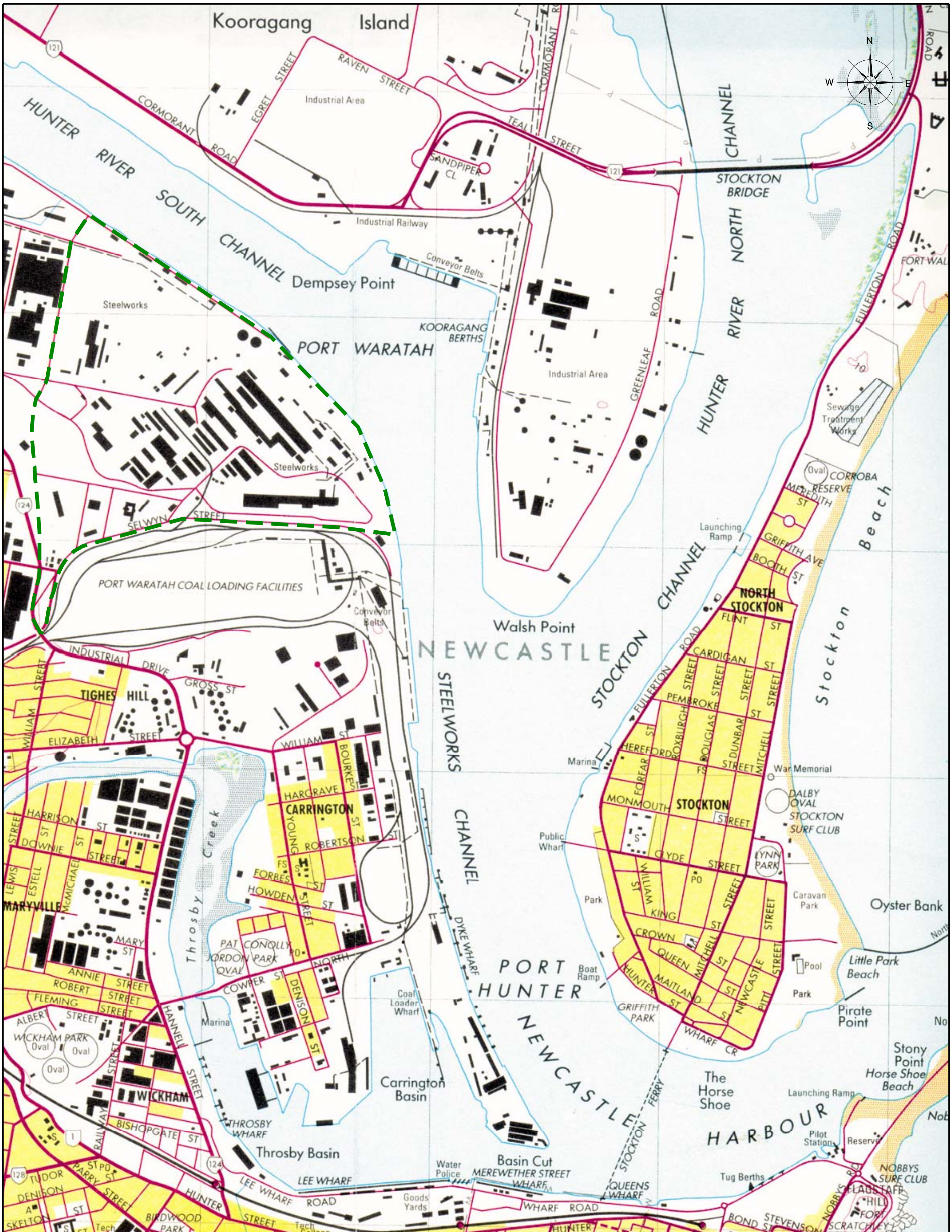
- the cultural significance of the archaeological resource has been assessed and a formal statement of cultural significance is contained in **Section 4**;

- the condition and integrity of the archaeological resource has been reviewed and an evaluation made of the physical impact of proposed use. In consequence of these considerations and of the statement of significance, this report contains a statement of heritage impact. These aspects are dealt with in **Section 5**;

- the report identifies the issues and options for management of the archaeological resource and its values in the environment of its proposed future use, and makes recommendations for their management, in **Section 6**.

1.5 STUDY PERSONNEL

Sue Singleton, Archaeologist, Umwelt (Australia) Pty Limited, conducted the research of the archaeological context and the review and research of the historical context for this assessment. Sue wrote this report in collaboration with Paul Rheinberger, Senior Archaeologist, Umwelt (Australia) Pty Limited.



Legend

Study Area

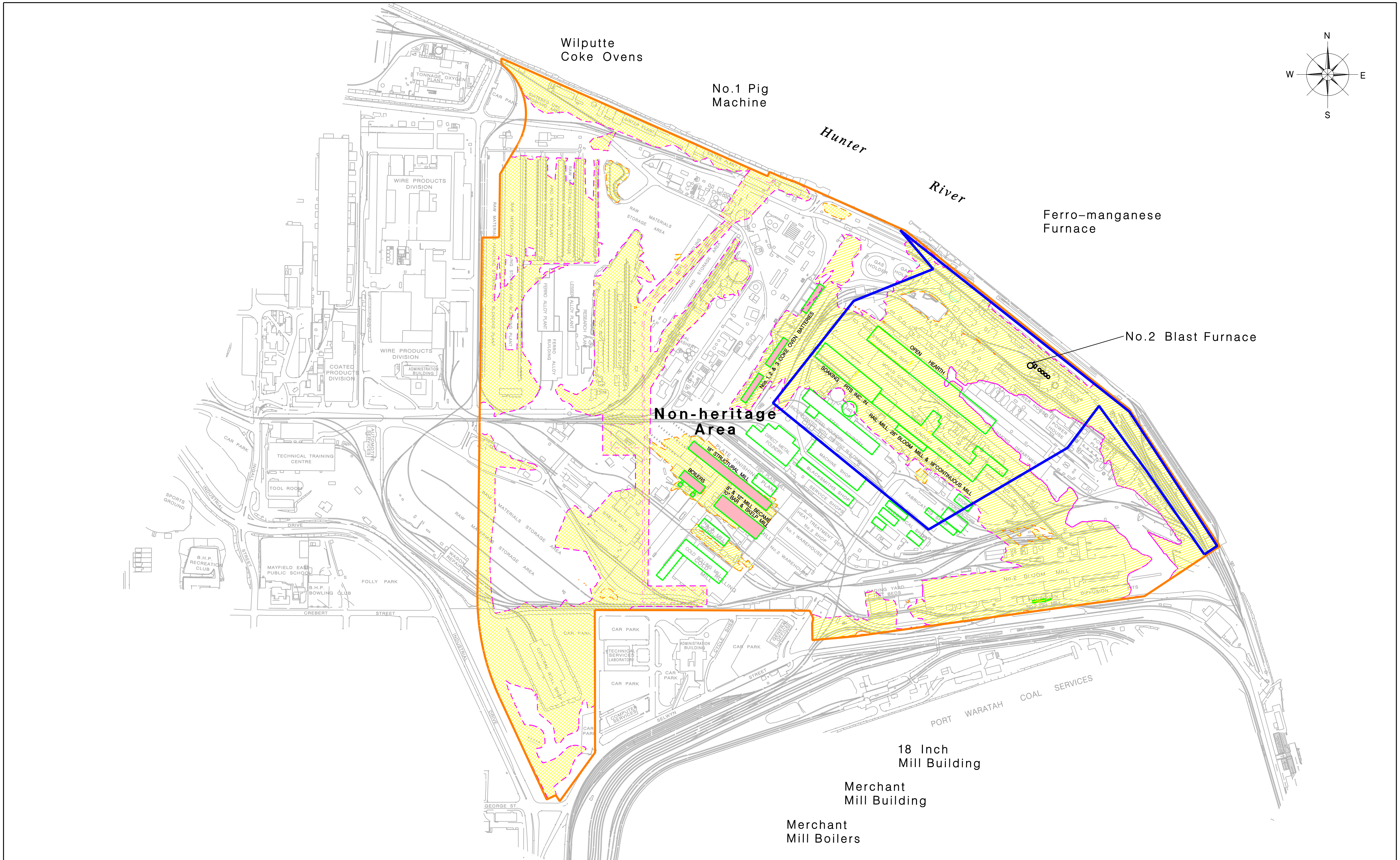
Umwelt (Australia) Pty Limited
Source: Newcastle 1:25 000 Topographic Map

0 0.25 0.5 1km

FIGURE 1.1
Locality Plan

A4 Scale 1:22 000

Ref No.:R01_V1/1554_022.dgn



Legend

Approximate Position of Pre–1951 Buildings in Areas of Cut, which have been Demolished, or Incorporated into other uses, before 1999

Approximate Areas of Cut during Remediation

Heritage Precinct Area

Closure Area Boundary

0 100 200 300 400 500m

Umwelt (Australia) Pty Limited
Source: Hatch Associates P/L Drg.No.ND12356

FIGURE 1.2
Detail of Archaeological Potential – Site Elements

A3 Scale 1:7 500

Ref No.:R01_V1/1554_001.dgn

2.0 ARCHAEOLOGICAL CONTEXT

The iron and steel works site at Port Waratah, Newcastle, is a place of considerable importance in the history of Australian iron and steel manufacture, and in the history of Newcastle's industrial development and subsequent economic and social growth.

A substantial archaeological resource exists, pertaining to most of the elements identified in the study area, in prior archaeological and heritage studies. An extensive historical resource also exists in the form of plans, photographs, BHP publications and prior historical publications for most of the elements identified in the study area. The study area has been reconnoitred in the course of the heritage studies for the Newcastle City Wide Heritage Study 1996/7 and has been the subject of a Conservation Plan in 1991.

Research of the Register of the National Estate maintained by the Australian Heritage Commission, the State Heritage Register and State Heritage Inventory maintained by the NSW Heritage Council, and the Register of the National Trust (NSW) disclosed no heritage resources within the study area.

2.1 COMPARATIVE SITES

Comparative sites were disclosed within Australia for a number of the elements and structures considered in this report.

2.1.1 Copper Smelting Works

Register of the National Estate:
- Mulloon Copper Mines and Smelter (former), Mulloon, NSW (indicative place);
- Frogmore Secondary Copper Mine and Smelter, Boorowa, NSW (indicative place);
- Bolla Bollana Copper Smelter, Arkaroola, SA (registered).

Australian Heritage Places Inventory:
- Chillagoe Smelters, Chillagoe, Queensland;
- The Peake Group, via Oodnadatta, SA.

NSW State Heritage Inventory:
- Gordonbrook Copper Smelter and Site, Copmanhurst, NSW;
- Remains of Newcastle Coal and Copper Smelter, Merewether, NSW;
- Site and remains of Cremorne Copper Smelter, Cremorne, NSW.

2.1.2 Coke Ovens

NSW State Heritage Inventory:
- Coalcliff Colliery Coke Ovens, Wollongong City;
- Coke Ovens, Endeavour Drive, Wollongong;
- Blast Furnace Coke Ovens, Lithgow Blast Furnace, Lithgow;
- Rixs Creek Coke Ovens and Associated Works.

Australian Heritage Places Inventory:
- Coke Ovens at Newnes Shale Oil Plant;
- Ironworks Blast Furnace Site, Lithgow.

2.1.3 Blast Furnaces

Register of the National Estate:
- Lithgow Blast Furnace, Inch Street, Lithgow.

NSW State Heritage Inventory:
- No 3 Blast Furnace Site, Newcastle;
- No 4 Blast Furnace and Stove, Newcastle;
- Remnant No 1 Blast Furnace.

Australian Heritage Places Inventory:
- Chillagoe Smelters, Chillagoe, Queensland;
- Ilfracombe Iron Company Mine, Beaconsfield, Tasmania;
- Ironworks blast Furnace Site, Lithgow, NSW;
- Irvinebank State Treatment Works, Irvinebank, Queensland;
- Lal Lal Blast Furnace, Lal Lal, Victoria;
- Wallace Smelting Works; Bethanga, Victoria;
- Yelta Mine and Smelter Historic Site, Moonta, South Australia.

2.1.4 General

There is no recorded site that compares with the Ferro-manganese furnace and there appears to be no specifically recorded comparatives for the remaining functional elements of the study area although some appear as components of the above listings.

The instance of comparative sites for the particular large plants/undertakings complements rather than diminishes the heritage attributes of the study area. That is, the study of structures and artefacts revealed at the study site may enlarge our understanding of the industrial past.

3.0 HISTORICAL CONTEXT

The historical research of the use, occupation and development of the study area has been limited specifically to those contexts that have a direct relationship to archaeological study and the evaluation of historic heritage of the study area prior to and during the early development of the BHP Steelworks site at Port Waratah.

The compilation of the historical context concerning the development and evolution of the study area acknowledge documentation obtained from BHP Archives and previous reports by:

- The EJE Group – The Conservation Plan for BHP Steelworks Port Waratah Site, 1991.
- Statement of Heritage Impact and Archival Records Series, EJE Architecture, 2000.
- Draft Archaeological Management Plan: BHP Steelworks Site, Umwelt (Australia) Pty Limited, 2001.
- Archaeological Management Action Plan – Non Heritage Precinct, BHP Newcastle, Umwelt (Australia) Pty Limited, 2002.

3.1 HUNTER RIVER COPPER SMELTING WORKS

(AKA the Wallaroo Mining and Smelting Company and the Wallaroo and Moonta Mining and Smelting Company)

The Wallaroo Mining and Smelting Company formed in 1859 to exploit copper discoveries at Wallaroo, 100 miles north west of Adelaide, South Australia. The company was using large quantities of Newcastle small coal, however, the rising cost of transporting the coal from Newcastle to South Australia combined with falling copper prices in the 1860s (as shown in **Figure 3.1**) prompted a review of costs. A further factor contributing to the increasing costs of operation at the Wallaroo Smelter was the decline of high quality ore from the mines. The increasing quantities of ore with less than twelve per cent copper required increasing amounts of coal for smelting. In this light, it was determined that a rationalisation of its works through a more economical use of shipping was required to improve the economics of the company. It was anticipated that a relocation of the smelting works to Newcastle in order to take the ore to the coal would achieve the necessary cost savings.

In 1866, The Wallaroo Mining and Smelting Company secured a twenty-one year lease on a property owned by the Waratah Mining Company and opened a smelting works (NMH, 1931). In August 1866, the Newcastle Chronicle reported the Wallaroo Company had purchased a ten-acre allotment of land from the Waratah Coal Company “adjoining their line of railway, and close to the shoots, for the purpose it was understood of erecting a Smelting Works thereon.” (Newcastle Chronicle, 1866). The smelting works became known as the Hunter River Copper Company Works and was located as shown in **Figure 3.2**. The English and Australian Copper Company also established a smelting works at Broadmeadow about this time. The Newcastle Coal and Copper Company was already an established smelting operation at Burwood although it was smelting imported copper ore. The main attraction for this type of industry to Newcastle was the close proximity of coal mines and the resultant reduced transport costs for coal supplies. The price paid for coal in South Australia in the 1860s was up to 24 shillings per ton, whereas the Newcastle smelters could be fuelled for as little as 3 shillings per ton (EJE, 1991). The Hunter River Company had a distinct advantage over its competitors owing to assured supplies of ore from its Wallaroo mines and its close ties to the Waratah Coal Mine whose best interests were served by negotiating a favourable agreement for the supply of coal.

From a social aspect, the district of Newcastle welcomed the arrival of these operations in anticipation of the employment and commercial opportunities the industry would provide to the area. The coal companies were equally welcoming as the smelters provided a local market for small coal, which was difficult to sell owing to the dangers of spontaneous combustion.

Mr Richard Gower, a former employee, recounted the development of the works in the Newcastle Morning Herald in 1931:

> *A start was made with four furnaces. Two more were added as the work progressed. Two years after, another man came from Wallaroo, and built four more furnaces and two calciners. Two years later four more furnaces and two more calciners were built and later still a copper refiner. Eventually the plant consisted of 16 furnaces, five calciners and the refinery, and formed one of the biggest industries in Australia. Directly and indirectly 200 men were employed.*

Photographic evidence shows the Hunter River works consisted of long, shed like structures, open at the sides as shown in **Plate 3.1**. The buildings were oriented to the north-east and were approximately 150 metres long. They were constructed of zinc coated iron with iron girders for supports (Phillips, 1980). A railway track delivered ore from the private jetty to the assembly floor between the buildings as seen in **Plate 3.2**. The plant consisted of calcining furnaces[1] and furnaces for smelting and refining (Turner, 1980). The furnaces were connected to stacks, up to 120 feet high, necessary for the discharge of sulphurous gases. One stack served a pair of furnaces. The furnaces and stacks were lined with or wholly constructed of English firebricks[2] strengthened with massive metal bands.

The first specimens of refined copper were produced in July 1868. The Newcastle Chronicle (in Turner, 1980) described the tapping of the furnace with full Victorian colour:

> *…..the furnace door is opened, and each of the men … seizes a long iron ladle, which he dips into the liquid fire, and conveys to the first mould on his left hand. Directly the first man has emptied his ladleful of liquid copper in No 1 mould, the second man followed with another ladleful, and no sooner had he deposited his load than the third man was at his heels – the contents of all three ladles being emptied into the same mould …the first pot being full, the men pass on to the second and so on, until the whole of the twenty- six pots surrounding the furnace are filled…*
>
> *The heat from the furnace while this operation is going on is intense – so much so that it is surprising how the men (who are completely surrounded by fire) are able to stand it. Strangers are scarcely able to stand outside the semi-circle of moulds and look into the furnace door, and yet the refiners have to approach quite close to the furnace and consequently encounter the full force of the heat issuing from the 'fiery deluge'.*

Initially, the company anticipated a capacity of 6 000 tons per annum but once production began and the viability of the works became known, the capacity was doubled to 12 000 tons per annum (Turner, 1980). Additional furnaces were announced in 1871 and in September 1872 extensions were made to the jetty. The works yearly consumption of ore was expected to reach 30 000 tons, requiring 35 000 tons of coal for fuel.

[1] **Calcining furnace** - furnace which burnt away clay and other impurities and left the ore in a powdery state.

[2] **Firebrick** - A refractory brick, usually made of fire clay, used for lining furnaces, fireboxes, chimneys, or fireplaces.

In 1885 twenty-two furnaces were in use. Nineteen furnaces were still in use in 1889 with 20 000 tons of ore processed per annum. The works was producing about 60 tons of refined copper per week in 1889 the majority of which was for the London market.

The Port Waratah Smelter was the most successful smelting works in the Newcastle area up until its closure in 1893. A total of 313 000 tonnes of copper ore was smelted between 1868 and 1889 producing more than 39 000 tonnes of refined copper (Phillips, 1980).

In 1889, as a result of falling copper prices the company amalgamated with the Wallaroo mines and became the Wallaroo and Moonta Mining and Smelting Company with Henry Richard Hancock as its general manager (Flinders Ranges Research).

A new smelter was planned for Wallaroo to the value of £4220 and included a new type of roaster with the capacity to significantly reduce the coal to ore ratio which would ultimately reduce production costs. Combined with a reduction in freight costs, the Wallaroo works became the more viable operation. However, the company did not intend to permanently close the Port Waratah works and continued to backload copper ore there for future smelting. Labour disputes, strikes at the Wallaroo Mine and finally considerable damage caused by flooding in 1893 led to the decision to close the Port Waratah site. By mid 1893 production at Port Waratah had ceased. In 1895, plant and equipment were dismantled, salvaged and shipped to South Australia for re-use at Wallaroo.

The Waratah Coal Company subsequently sold the land, after long and tedious negotiations, to BHP on 29 June 1896 (Jay, 1999). The land remained unused for seventeen years until 1913 when construction of the BHP Steelworks began.

In 1913, photographic evidence shows the remains of the smelter buildings, smoke stacks, residential cottages, rail lines and the wharf. The brick stack left from the Copper Smelters was initially used for the Blast Furnace boilers and later for lime burning. **Plate 3.3** shows the disused smelting works before BHP began land reclamation for construction of its Steelworks and **Plate 3.4** shows the demolition of the copper works smokestack in 1923. The location of the Copper Smelting Works in relation to the Steelworks can be derived to some extent from this photograph. The proposed layout of the steelworks, produced for David Baker in 1913, also shows the location of the smoke stack and old buildings/offices (see **Figure 3.3**).

Extensive areas of the site were reclaimed using copper smelter slag and sand residue from the dredging of the shipping channel. **Plate 3.5** shows a cottage on the Copper Smelter Site in the process of being buried with fill. Whilst previous reports have identified no visible evidence of pre-steelworks buildings, it is likely that some buildings may have been left intact during the landfill process and, most likely, only demolished to the final ground level. The historic ground level of the copper smelting works is now covered by at least 7 feet (2.1 metres) of fill with many feet of concrete foundations of BHP plant overlying. The copper works may lie, in some areas, up to 25 feet (7.6 metres) below current ground level and is, therefore, well below the invert of any excavation in the current proposal.

3.2 THE ADVENT OF BHP STEELWORKS

Much has been written of the beginnings of BHP's Newcastle Steelworks, most notably in "A Future More Prosperous" by Christopher Jay. The scope of this report does not warrant a full reiteration of these details. However, the original plant was built on timber poles above tidal mudflats which were filled with dredged sand. This detail is relevant to this report and any subsequent excavation that may take place on the site.

3.2.1 Fixing the Ground Level

David Baker (BHP's manager 1915-1924) reported in his "Reminiscences" in the BHP Review of October 1935 that one of the first decisions to be made was the fixing of the ground level. Reportedly, it took some time to settle this matter with the final agreement for a ground level at the blast furnace ten feet above mean high water level, the open hearth ground 12 feet and the big mills 13 feet. The sand from the channel provided the necessary fill for the furnaces, open hearth and mills but not for the coke ovens. The first battery of coke ovens was built on the island, without piling, the natural ground level being only a few feet above high water level.

Dredging of the channel was undertaken during the construction of the foundations and pouring of concrete. Two suction dredges, supplied by the Government, poured mud, sand and water in enormous quantities onto the site as shown in **Plate 3.6**. Many tools were lost to the dredging as recounted in the BHP Review (in Jay, 1999 pp 128):

> *When the sand pump was working you never knew whether you would find things next day as you left them. The landscape changed continuously and there must be an enormous amount of tools buried under the works. If future ages ever excavate on the site of the works, much missing machinery, which at the time could not be accounted for, will be unearthed, upon which our descendants may speculate.*

3.3 COKE OVEN BATTERIES

3.3.1 The Semet Solvay Ovens

In the BHP Review, October 1935, David Baker states the key to the success of a blast furnace is the quality of the coke used. Therefore the negotiations and decisions regarding the installation of the coke ovens for the new Steelworks were carefully considered long before construction of the works began. Initially, Baker was anxious to install the Koppers By-Product Ovens. The Koppers Company was not amenable to a contract and the next choice was the American Semet Solvay oven – a more modern version of the English Semet Solvay oven. Baker was again disappointed when this was not possible and finally an agreement was negotiated with the London Company for plans, services of an engineer and a supply of bricks to install the English Semet Solvay oven. In the meantime, it was necessary to purchase coke from beehive ovens in the district and from retort ovens on the South Coast (BHP Review, Dec 1935).

In arranging for the purchase of the ovens, the price for the very heavy, long side dumping quenching cars was considered excessive and the decision was made to order a cheaper outfit consisting of steel hoppers. Baker states "this decision had a very important bearing of the quality of the coke subsequently produced, and shows how important it is to place the proper value on details of construction" (BHP Review, 1935).

The construction of the coke ovens began late in 1914 and is shown in **Plate 3.7**. The Semet Solvay ovens were fired for the first time on 20 June 1915. Their location is shown on **Figure 3.4**. A view of a portion of the coke ovens is shown in **Plate 3.8** and a general view in **Plate 3.9**. Tracings of the Semet Solvay ovens are not held in archives.

Not long after firing, production problems became evident. The shape of the deep steel hoppers did not allow the coke to cool sufficiently on quenching and the cumulative effect of further charges pushed on top made quenching still more difficult. The result was that the coke would require further quenching to prevent it from re-lighting. The result was a mass of water-soaked coke mixed with coke breeze[3] from which the fines could not be screened. The furnace was receiving large quantities of coke breeze and Baker anticipated furnace trouble. Baker knew from years of experience that coke must be properly cleaned and reasonably dry to get best results in the furnace (BHP Review, 1935). It was vital to effective furnace operation to secure clean, dry coke.

In an attempt to alleviate the quenching problems, a level coke wharf was made of second quality steel rails. The coke was spread on this wharf in a comparatively thin layer and could be readily quenched with water (see **Plate 3.10**). The coke was then forked into the steel hopper cars. This process eliminated a lot of dirt, however fines were still created in the transfer of the coke from the wharf to the hoppers then from the hoppers to the coke bin at the furnace, followed by the crowding and grinding in the chute to the skips at the furnace. “Dirt” troubles were still occurring with the furnace.

To eliminate this problem, it was decided to by-pass the use of the central coke bin and transfer the coke direct to the furnace skips. A narrow gauge rail system was installed and a narrow gauge locomotive hauled coke in small trucks, direct from the coke wharf to the furnace skip. Baker reports that this system greatly improved furnace function. At first the trucks were filled by hand but later an inclined coke bench was installed where the coke was screened prior to loading.

3.3.2 The Wilputte Ovens

Steel production in the year 1927 had reached nearly 388 000 tons and in the interests of consolidation and modernisation, work began to replace the Semet Solvay coke ovens. After research into various oven designs, a decision was made to install Wilputte type regenerative coke ovens together with a coke handling plant and a by-product plant at a total cost exceeding one million pounds sterling. The Wilputte was an improved Koppers oven that piped and measured the air for combustion under pressure to the ovens as well as gas. It was deemed well adapted to Australian conditions where high winds would have little effect on the combustion taking place in the oven flues (BHP Review, 1936).

BHP undertook the building of the main foundations. Between 10 December 1928 and 15 May 1929, 5831 twenty-five foot wooden piles were driven into the soft ground. Each pile was capable of bearing a load of 25 tons (NMH, 1929). The piles were sawn off at water level and a quarter of a million square feet of formwork was placed with about 200 tons of steel reinforcement to receive 23 000 cubic yards of concrete.

In April, a steel building was erected over the concrete slab to allow the construction of the oven to continue protected from heavy rains. It was planned to construct the No 1 Battery virtually simultaneously. The 106 new ovens required about 10 000 silica bricks and 7000 tons of firebricks, together with about 1 200 tons of silica cement and fireclay[4] for bonding the joints (NMH, 1929).

The two new batteries each consisted of 53 ovens. Each oven chamber was 43’5” long by 13’3” deep and 16” wide and could hold nearly 14 tons of crushed coal. The ovens were equipped with self-sealing doors. The volatile by-products were exhausted by two steam turbines to the by-product plant for the recovery of tar, ammonia and benzol from the gases. These gases were then utilised in other areas of BHP.

[3] **Breeze** - The refuse left when coke or charcoal is made.

[4] **Fireclay** - A type of clay that is able to withstand intense heat, used to make firebricks, crucibles, and other objects that are exposed to high temperatures.

The Wilputte ovens were among the largest in the world at the time. The No 2 battery was bought into commission on 17 November 1930 (BHP, 1935). However, their completion coincided with the Depression when building all over Australia slowed and stopped. **Plate 3.11** and **Figure 3.6** show the completed No 1 and No 2 Batteries Wilputte By-Product Coke Ovens in 1933. Tracings of the layout of the Numbers 1, 2 and 3 Batteries are included in **Appendix 2**. The footings layout of the Number 3 Battery provides an example of the style of construction upon which the ovens were built and indicates the level of potential subsurface residue.

The Semet Solvay coke ovens were demolished in the early 1930s as part of the general clean up campaign on the BHP site.

In 1939 a third battery of 55 Otto-Wilputte ovens were erected at a cost £750 000 and located at the site of the former Semet Solvay ovens (see **Figure 3.7**). These ovens were designed to be fired with either blast furnace gas or coke oven gas and utilised approximately forty per cent of the gas they produced for heating. The remaining sixty per cent of the gas produced during coking was available as fuel for other processes in the works. The three batteries of coke ovens were capable of carbonising 26 000 tons of coal per week at the rate of 2.6 tons per minute and operated continuously. The increased thermal efficiency of the Wilputte ovens reduced fuel consumption by 27% (BHP, 1965).

The Wilputte ovens have been demolished to at least ground level, the first battery in 1954, the third battery in 1971 and the second battery sometime after closure in 1982. BHP site layout plan at closure in 1999 shows no specified structures at this location (see **Figure 3.8**). However, the extent of sub-surface remains is unclear.

3.3.3 Chronology – Coke Ovens

1915 No 1 Battery Semet Solvay Coke Ovens (66 ovens) installed.
Started 20 June 1915.

1918 No 2 Battery Semet Solvay Coke Ovens (first half -33 ovens) installed.

1919 No 2 Battery Semet Solvay Coke Ovens (second half – 33 ovens) installed.
29 ovens added to No 2 Battery Coke Oven Plant.

1921 No 3 Battery Semet Solvay Coke Ovens (66 ovens) installed.

1930 First battery of 53 Wilputte Coke Ovens commenced operations.

1933 The Semet Solvay Coke Ovens demolished about this time.

1934 Second Battery (No 1) of 53 Wilputte Coke Ovens started up.

1939 Third battery (No 3) of Otto-Wilputte Coke Ovens (55 ovens) commenced at a cost of £750 000.

1954 First battery Wilputte ovens demolished.

1971 Third battery demolished to oven floor level – replaced by 5A Battery Coke Ovens.

1982 No 2 battery closed – apparently demolished shortly thereafter.

3.4 NO. 2 BLAST FURNACE

A blast furnace was a substantial steel structure lined with refractory[5] bricks, its role to extract molten iron from iron ore. Iron making is a continuous process where the raw materials – iron ore, coke and limestone – are fed into the top of the furnace. Air, pre-heated in stoves, is blown into the furnace through nozzles called tuyeres[6] spaced around the lower section of the furnace. This causes the coke to ignite producing carbon monoxide, which creates a chemical reaction. In this way the iron oxides are reduced to molten iron by removing the oxygen from the ore. The molten iron runs into ladles[7], which transport it to the steelmaking shop for refining into steel.

During World War I, the demand for steel was high. Towards the end of 1917, steel plates were urgently required for government ship building programs (BHP, 1970). To meet demand, a second blast furnace was approved.

Plate 3.12 shows pile driving and foundations under construction for the No 2 Blast Furnace. Tracings detailing the blast furnace foundations and the arrangement of the furnace, dated 1916, are included in **Appendix 3**. These tracings detail the sub-surface components of construction and represent potential material remains.

The completion of the No 2 Blast Furnace was delayed due to a shortage of steel plates. To resolve this problem, BHP converted the bloom mill to an improvised plate mill and rolled 13 000 tons of plate (BHP, 1970) a great contribution to war time ship building and the only way in which No 2 Blast Furnace could be completed (see **Plate 3.13**). The second Blast Furnace was finally commissioned on 5 December 1918 (BHP, 1999). It was capable of a daily capacity of 450 tons. Its location is shown in the 1924 site layout plan (**Figure 3.4**).

During its life No 2 Blast Furnace was in blast[8] a total of twelve times between December 1918 and March 1985, as shown in **Table 3.1**. In additional to regular relines the furnace underwent demolition and reconstruction in 1946/7. This was described in the BHP Review, 1947, as being "in pursuance of the Company's progressive policy, the opportunity was taken to rebuild the furnace on more modern lines".

Table 3.1 - No 2 Blast Furnace campaigns

Campaign No.	Blown In	Blown Out	Tonnes	Campaign Life (Days)	Reline Time (Days)	Av. Daily Prodn.
1	4/12/18	17/02/21	267,738	806		332
2	7/04/21	18/04/24	260,446	1107	49	235
3	6/10/24	30/03/27	305,640	905	171	338
4	22/07/27	3/12/27	62,769	134	114	468
5	24/06/28	6/03/29	179,404	255	204	704
6	24/09/33	13/07/35	458,104	657	1663	697
7	6/10/35	9/09/46	2,515,041	3991	85	630
8	26/01/47	8/03/57	2,406,439	3694	139	651
9	5/06/57	9/10/62	1,767,502	1952	89	905
10	2/12/62	13/07/70	2,989,600	2780	54	1075
11	30/08/70	26/02/77	3,073,338	2372	48	1296
12	21/02/78	15/03/85	3,218,617	2579	360	1248
Total			**17,504,638**			

Source: Sansom (Ed), 1999.

[5] **Refractory** - Difficult to melt or work; resistant to heat.
[6] **Tuyere** - The pipe, nozzle, or other opening through which air is forced into a blast furnace or forge to facilitate combustion.
[7] **Ladle** – a 'bucket' lined with refractory bricks used to transport molten steel from process to process in a steel plant.
[8] **In blast** – term used to describe period of operation of blast furnace.

For economic reasons the furnace could not be allowed to remain out of commission for any great length of time. The arrangements for the modernisation were carefully planned and scheduled to take the minimum time possible. Many sections were pre-assembled in the Work's fabricating shop. A 60-ton crane, shown in **Plate 3.14**, was specifically designed and built for the rebuild. This crane facilitated the speedy demolition and the re-erection of the new furnace. In total the demolition and rebuild took 82 working days.

The furnace was blown out[9] on 9 September 1946. On 11 September, when the furnace had cooled sufficiently, demolition of the superstructure commenced. The superstructure was taken down in two lifts and set aside for re-use on the new furnace. The bleeders, gas seal, both bells and main hopper were removed and the demolition of the brickwork commenced four days after blowing out. The old shell was cut into pieces of approximately 30 tons each, removed and cut into scrap.

The rebuild was carefully planned as shown in **Plate 3.15**. A new hearth was built and the new shell erected, in five main sections (see **Plate 3.16**). The finished furnace, as shown in **Plate 3.17**, was blown in on 26 January 1947. The new shell had a 17% greater volume and an increased height of 7'9" (2.4 metres) which increased capacity to 700 tons per day. The furnace was blown out for the last time on 15 March, 1985 with a total lifetime production of 17 504 638 tonnes of molten iron.

Previous studies have indicated that all that remains of the pre 1920 blast furnaces is the metallised base or 'button' of the No 1 Blast Furnace. Its deposition resulted from the absence of a base plate that allowed the escape of molten iron into the base (EJE, 1991). Site plan at closure shows no specified structure at the former location of No 2 Blast Furnace (see **Figure 3.8**).

The silhouettes of the blast furnaces along the banks of the Hunter River were synonymous with the Newcastle Steelworks and the town of Newcastle for more than sixty years.

3.5 FERRO MANGANESE BLAST FURNACE (MAGGIE)

The former location of the Ferro-manganese furnace was revealed in the course of the historical research regarding other elements of this report.

When the company decided to build the second blast furnace, it also authorised the construction of four more steel furnaces. There remained very little capacity in the blast furnace department for the production of foundry pig iron. The Federal Government, through the Prime Minister, W M Hughes, urged the Board to build a small furnace to secure at all times an adequate supply of foundry pig iron for the Government's requirements. The Board considered the furnace a necessity for producing the ferro-manganese required for the refining of steel manufacture. Ferro-manganese at this time was expensive, in short supply and not obtainable from overseas.

The furnace was designed with iron pipe stoves for heating the blast and an old air compressor from Broken Hill was modified and equipped with large, low pressure, air cylinders for blowing the furnace. The hearth consisted of a sloping steel shell, held together with kidney rings around lugs. This was surmounted by a cast iron bosh[10] in bolted segments, into which water pipes passed for cooling purposes. On top of this was a heavy steel mantle supported by six mild steel columns. Into the mantle were let rails that continued nearly to the top of the furnace where steel plates formed a shell to carry the top

[9] **Blown out** – term used when a blast furnace ceased operation in preparation for maintenance or rebuild.
[10] **Bosh** - The lower part of a blast furnace, which slopes inward, or the widest space at the top of this part. In forging and smelting, a trough in which tools and ingots are cooled.

structure. The rails were stabilised by circular bands of steel at 2’6” (0.76 metre) centres. The design allowed rapid construction and the ferro-manganese blast furnace was completed in less than a year going into operation on 17 July 1918.

The furnace stood 100 feet (~30 metres) high on the riverside, west of No 1 Blast Furnace as shown in **Figure 3.5** and **Plate 3.18**. A brief description of the furnace, known as “Maggie”, appears in the BHP Review September 1934:

> *The furnace was charged[11] by hand. The ore, coke and limestone was shovelled and forked into “banana carts” which were wheeled into an electrically operated lift and tipped around the bell. The bell was steam operated, the steam taken from No 1 Blast Furnace boilers. When a charge was placed, the steam operation valve opened and the charge dropped into the furnace. The gases leaving the furnace were burned in stoves, the products of combustion passed around cast-iron “U” pipes and to the stack. The blast temperature was about 875 degrees Fahrenheit (470 °C).*

L J Griffiths, blast furnace superintendent in 1918, reported that during the first week of operation the bell rod broke, allowing the bell to fall into the furnace. The bell was successfully retrieved and reinstalled. This was followed by many break outs[12] and production problems, which were gradually overcome. At some point the height of the stack was increased by 17 feet in order to improve operations. However, this furnace remained “a very capricious, fickle maid, fully justifying the feminine name with which she was designated” (BHP Review, 1934a).

During her lifetime, Maggie was in blast five times over various periods from July 1918 to September 1924. She produced a total of 7 345 tons of ferro-manganese and 24 992 tons of pig iron of various grades. (This tonnage of pig iron would subsequently be produced in one month in the No 3 Blast Furnace.) Record tonnage for a week was 651 tons of foundry iron with the coke consumption of about 3000 pounds per ton. The production of iron was an expensive undertaking and was justified only by the urgent need of pig iron[13] in the dark period after the First World War. **Plate 3.19** shows workers lifting pigs of metal at the Ferro-manganese furnace and shows the interior of the cast house.

Maggie was demolished on 29 June 1934. Many of her components were salvaged for re-use. The brick stoves were demolished first with 10 000 firebricks salvaged. The gas mains and foundations were blasted out providing 80 tons of scrap. The cast house building had been dismantled and re-erected for the new 12 inch mill. The lift structure was salvaged for later use at the blast furnaces. The furnace was felled by cutting two of the six support columns and propping with timber. The timbers were charged with gelignite. Bolts securing the furnace to three of the columns were cut and a line attached from the furnace top to a locomotive. The final column was cut while the locomotive took the strain and the gelignite fired. The BHP Review recorded the fall of the furnace in **Plates 3.20** and **3.21** and described the close of Maggie’s life as follows:

> *A shot rang out and for a second the furnace seem to remain vertical, then slowly, for a fraction of a second, but quickly gaining momentum, quietly toppled over into her allotted position on the ground (BHP Review, 1934a).*

The area was graded and paved and Maggie was largely forgotten. The position of the former Ferro-manganese furnace is shown on **Figure 3.8** at closure.

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[11] **Charge** – loading the furnace with raw material.
[12] **Break-out** – the escape or emergence of molten material from a point of weakness in the furnace.
[13] **Pig iron** - the form in which cast iron is made at the blast furnace, being run into moulds, called pigs.

3.6 THE 18 INCH MILL BUILDING

3.6.1 The 18 inch mill

Although not proposed in the original design of the steelworks, this mill went into production in January 1917 along with the small merchant mills.

This mill was housed in a building ~920 feet (280 metres) long, its location shown in **Figure 3.4**. It contained a full-length crane runway. The steel was lifted by crane onto a charging bed situated between two McLaughlin continuous furnaces. Each furnace had a capacity of approximately 28 tons of steel. The billets were delivered to the furnaces by hydraulic ram. The furnaces operated so that as one billet entered the charging end it pushed another billet out the discharge end. The temperatures of the furnaces reached about 1200 degrees centigrade at which temperature steel was fit to roll (BHP, 1927).

When the mill was ready to roll, the steel was pushed out by ram[14] which was manually operated from a cabin located in front of the furnace, the operator having full view of the operations of the mill. The billet was conveyed to the first, or roughing stand, of the mill. This was comprised of four stands of rolls, three of which were three high - namely: first roughing, second roughing and intermediate. The fourth, the finishing stand, was two high. The billet was passed through the various rolls in the mill until it was delivered out of the finishing rolls.

The bar was then carried down to the hot saw by an electrically driven table where it was cut to required length. From there it was taken to the hot bed. When sufficiently cooled it was transferred to the cooling beds and left to cool completely. Ready for shipment, it was then placed in racks in the loading yard.

At first the 18 inch mill did not produce to expectation. According to the BHP Review, 1936, it was difficult to determine if this was the fault of the superintendent or with the heating furnace. It was finally decided to build another heating furnace, which would permit shutting down of one furnace for repairs and alterations. A new superintendent was appointed with little improvement. However, satisfactory results were obtained when Thomas Hale was put in charge. The mill underwent extensions in 1922 including five boilers and chimney. The mill was scrapped in 1932 and replaced by the 18 inch Bar Mill and Plate Mill.

3.6.2 The 18 inch Bar Mill and the Plate Mill

In January 1933 a combined 18 inch tandem mill and 34 inch x 90 inch (86cm x 230 cm) plate mill were completed. The new tandem mill was located in the same building as the preceding 18 inch Mill, as shown on **Figure 3.6**. Two electric overhead travelling cranes served the mill, both equipped with magnets. The re-heating furnace was the continuous type, specially designed for heating either slabs[15] for the plate mill or blooms[16] for the bar mill. The overall length of the furnace was 50 feet (15 metres). The slabs or blooms were pushed through the furnace by two hydraulic rams. The heated slabs or blooms were pushed onto live rollers[17], which conveyed them to the mill in which they were to be rolled. The bar mill was driven by the same engine as the plate mill with only one mill able to operate at a time. The bar mill was designed to produce flats, rounds, square, channels, beams, rails, angles and fishplate[18] rails.

[14] **Ram** - The large output piston of a hydraulic press.
[15] **Slab** - rectangular semi-finished steel shaped up to about 250mm x 2000mm.
[16] **Bloom** - semi-finished steel shape usually 630mm x 400mm x 5-6m in length.
[17] **Live roller** - powered transport roller.
[18] **Fishplate** - a metal or wooden plate bolted to the sides of two abutting rails or beams, used especially in the laying of railroad track.

The plate mill was a 34 inch (86 cm) by 90 inch (230 cm) three high continuous[19] running mill and was designed to roll plates up to 80 inches (200 cm) wide, 30 feet (9 m) long and down to 1/8 inch (3 mm) thick. The mill was driven by a tandem compound Corliss valve condensing steam engine equipped with a heavy flywheel, capable of obtaining a maximum of 3 000 horse-power (2238 kW) at 98 rpm. This mill was capable of rolling 25 tons of ¼ inch (16 mm) plates hourly. **Plate 3.22** shows an interior view of this Plate Mill and 18 inch Bar Mill.

A plate straightener was located at the side of the mill. After straightening, the plates were transferred to the plate finishing building located adjacent to the plate mill. In this building the plates were marked off, sheared[20] to size, inspected and made ready for delivery. The magnitude of this operation is reflected in the sketch of the plate mill shears shown as **Plate 3.23**.

In July 1939 the 18 inch mill was electrified and cited as an example of the tendency towards controlled speed in steel rolling practice (Sangster, 1940). A survey of the existing and future sections to be rolled was undertaken before a decision on horsepower and speeds of the motors required was finalised. The scheme also included an additional re-heating furnace so that the bar mill and the plate mill could be worked as independent units, or so that both heating furnaces could be used to feed one mill when required. **Table 3.2** sets out the specifications of the motors installed.

Table 3.2 - Specifications of electric motors installed in the 18 inch Bar Mill and Plate Mill

Stand	Motors Installed	Speed range	Original speed
No 1 Roughing	2000 hp, 250/500 rpm	70/140 rpm	89 rpm
No 2 Roughing	2000 hp, 250/500 rpm	70/140 rpm	89 rpm
Intermediate	2000 hp, 250/500 rpm	81/162 rpm	98 rpm
Edging	300 hp, 300/600 rpm	118/236 rpm	-
Finishing	2000 hp, 250/500 rpm	81/162 rpm	118 rpm

Source: *BHP Review, February 1940.*

The last bar was rolled in the Bar Mill in 1976 and the mill was shut down. Site layout plans at BHP's closure in 1999 show the mill buildings remained in their original location (see **Figure 3.8**).

3.7 SMALL MERCHANT MILLS

3.7.1 12 Inch Mill

This mill was installed in 1916 and started operation on 18 July 1917. It was housed in a building 360 feet (~110 metres) long and 70 feet (~21 metres) wide and located adjacent to the 18 inch mill as shown on **Figure 3.3**. The operations of this mill were along similar lines to the 18 inch mill (described above) but on a reduced scale. This mill, however, was hand operated with manual labour employed in the actual rolling of the material. The mill was served by a 10 ton electric overhead travelling crane. The re-heating furnace was the continuous recuperative type, with a hearth 40 feet (12 metres) long and 10 feet (3 metres) wide. It was fired by coke oven gas.

[19] **Continuous mill** – mill with a number of stands of rolls arranged in tandem through which steel is rolled in one direction.
[20] **Shear** – cut to size.

The billets[21] were supplied by the 18 inch continuous mill and were stored in the billet yard, until required whereby they were cut into suitable lengths before the electric crane delivered them to the furnace. The billets were fed into the furnace by hydraulic rams and from there onto a live roller system which conveyed them to the mill.

This was a five stand mill, the last of which was the finishing stand. After leaving the finishing stand, the product was conveyed by live rollers to a hand operated hot bed[22], where it was allowed to cool before being conveyed to shears for cutting to length. The mill was driven by vertical cross compound non-condensing Corliss valve type engine driven at the rate of 87 rpm and at between 1000 to 2000 horse-power (~705 to ~1500kW) (BHP Review, 1927). This mill produced rails, fishplate bar, channels, octagons, round and square edge flats, rounds and squares, angles, and tees.

In 1933, with the advent of the combination mill, the 12 inch mill became a standby mill for rolling small tonnages of odd sections. It continued to operate until 15 July 1961.

3.7.2 8 Inch Mill

This mill began operating on 30 November 1917 and was housed with the 12 inch mill. **Plate 3.24** shows a section of the merchant mills. The first layout of this mill was designed to take the crop ends from the 12 inch mill and roll them into small bars of marketable lengths. The furnace was only small and heated with tar[23].

There was an urgent demand for small sizes of merchant bar and it was necessary to increase the capacity of this mill to meet demand. It was decided to increase the number of stands to five and build a larger heating furnace. The rebuild commenced on 11 March 1918 and the mill recommenced operation on 1 May 1918.

The new 8 inch mill consisted of five stands of rolls. It was driven by an “Allen vertical triple expansion condensing engine”, salvaged from the Broken Hill Mine (BHP Review, 1927). This engine was driven at 325 rpm and developed 700 horse-power (~520 kW) (BHP Review, 1927).

This mill was also manually operated and was reportedly quite spectacular to watch. After passing through the finishing rolls, the material was transferred to the cooling bed and transferred along the bed by a man using tongs. The cooling bed was 160 feet (~49 metres) long and was, on occasion, “taken up but 20 feet” (i.e. completely full except for 20 feet or 7 metres) (BHP Review, 1927). A billet 4’6” (1370 mm) by 1 ¾ inch (45 mm) produced 120 feet (~37 metres) of 3/8 inch (9 mm) rounds. The finished product was dragged along the beds and sheared to size before being bundled and stored for shipment.

In 1927, in order to increase production, four continuous stands were added and the mill was electrified (BHP Review, 1940). The sections rolled in this mill included: rounds, squares, all flats for horseshoe makers’ requirements, flats, tees and other small sections as required.

The 8 inch mill operated until 1933 when it was demolished and replaced by the Combination Mill.

3.7.3 Combination mill – merchant, strip and skelp

In 1928, BHP obtained a major shareholding in Stewarts and Lloyds Limited, an establishment employed in the secondary industry of steel pipe making located adjacent to

[21] **Billet** - a 40 foot (12 metre) long semi-finished steel shape.
[22] **Hot bed** - an iron platform in a rolling mill, on which hot bars, rails, etc., are laid to cool.
[23] **Tar** - by product of coke production.

the BHP steelworks. A new pipe plant had been established at Stewarts and Lloyds which necessitated the production of skelp[24] for making pipe. The amount of skelp required was too small to warrant constructing a special mill for this purpose alone. It was decided to scrap the old 8 inch mill and install a new mill capable of rolling skelp and strip up to 8 inches (20cm) wide, as well as products that were rolled on the old 8 inch and 12 inch mill, together with ¼ inch (6 mm) and 5/16 (8 mm) inch rounds and squares.

The new combination mill was built during late 1933 and early 1934. It was housed in the same building as the old 8 inch and 12 inch mills as shown on **Figure 3.7.** The building was 70 feet (~21 metres) wide and 360 feet (110 metres) long and roofed. The new mill required foundations entailing 18 200 cubic yards (13 915 m^3) of excavation, 1 128 piles, 7 700 cubic yards (5890 $m^{3)}$ of concrete and 100 tons of steel rod reinforcing followed by 4 500 cubic yards (3440 $m^{3)}$ of backfill. The new mill was the Morgan type and manufactured in Australia with the exception of the Rendleman Rotary Shears and part of the bevel gearing (BHP Review, 1934a). **Plate 3.25** shows an interior view of the operations of this mill.

The old 12 inch mill, together with its furnace and drive, was retained to produce special sections (hot rolled beam, channel, angle - as distinct from flat or strip steel) and also to roll small billets. The finishing end of this old mill was scrapped and the product delivered to the finishing end of the new mill.

The billets and slabs for this mill were rolled on the 18 inch continuous mill and fed into the heating furnace of the combination mill. The heating furnace was the continuous regenerative type with 13 burners located along the front wall. The furnace was fired with coke oven gas, although it was capable of using producer gas or a mixture of both. The air for combustion was preheated to between 500 and 800 degrees Fahrenheit (260 and 430 degrees Celsius).

The following excerpt from the BHP Recreation Review describes the operation of the combination mill in detail and highlights the versatility and technological innovation employed by BHP:

> *In front of the pinch roll for entering billets to the mill is a pendulum shears for shearing to short lengths when necessary. In front of this shears is the continuous roughing mill, consisting of one set of edging rolls 12 inches diameter, followed by five horizontal stands of rolls, Nos. 0-4, 14 inches diameter and one stand of 12 inch edging rolls. Following this is a drop looping table used for rolling skelp or strip. This drop looping table is a combination table with a drop looper and guides, so that when rolling skelp of strip the drop looper can be used and when rolling merchant bar, the table can be moved sideways and merchant bar rolled through the guides. In front of this is a continuous intermediate mill consisting of four horizontal stands Nos 5 to 8, 12 inches in diameter and one stand of edging rolls, 12 inches in diameter.*
>
> *In front of, and to one side of the intermediate mill, is the finishing mill, consisting of four stands of horizontal rolls, Nos 9, 10,11,and 12 – 12 inches in diameter – in groups of two in staggered formation. The last two stands in this group are so arranged that they can be substituted by 10 inch stands for rolling the smaller sizes.*
>
> *Between the last finishing stand and the cooling bed is located a Rendleman type of rotary disc shears for the purpose of dividing the smaller sections rolled into cooling bed lengths. This shears will cut rounds up to 1 inch diameter, and flats up to 2 in. by ¼ inch.*
>
> *About 280 feet away from the last finishing stand is located the cooling bed. This bed is entirely mechanical of the Morgan single carry-over type, is 240 feet long,*

[24] **Skelp** – narrow, hot rolled strip used for making steel pipes.

and made in two halves, so that either half can be operated, or the two together as a single unit.

From the cooling bed the product is delivered to a bar shears, equipped with a knife 30 inches wide. From the shears the product is delivered on to the back shear table and kicked off into cradles ready for assembly. If the product has to be bundled, it is delivered to a rotary bundling machine, and bundled ready for delivery. Skelp and wide strip are rolled in the roughing and intermediate mills, and delivered through a vibrator to an apron conveyor, whence they are fed into coilers. From the coilers a conveyor takes the coils to the loading crane.

For small rounds and squares, pouring reels are provided adjacent to the finishing mill. These pouring reels are capable of coiling rounds from ¼ in. to $^7/_8$ in. diameter, and sections of equivalent area. The coilers deliver the product to a conveyor, which in turn delivers it into the loading yard.

Narrow strip rolled in the finishing mill is delivered through a vibrator on to an apron conveyor, from which it is fed into the same coilers as used for skelp. These coils are delivered in the same manner as skelp. Skelp and wide strip are finished in the intermediate mill at speeds varying from 292 to 876 feet per minute. All other products are finished in the finishing mill at speeds varying from 480 to 1768 feet per minute.

This mill is electrically operated throughout by 9 motors, varying from 300 to 1200 h.p., totalling 6900 h.p. A motor generator set, consisting of two 1750 k.w.D.C. generators, driven by a 4330 k.v.a.A.C synchronous motor, is provided for driving the main mill motors and to enable voltage control to be used.

This mill is capable of producing rounds from ¼ in. to 1 ¾ in., squares from ¼ in. to 1 ¾ in., angles from ¾ in. x ¾ in. to 3 in. x 3 in. by $^1/_8$ in. to $^5/_8$ in. thick, pack annealed spring flats up to 4 in. wide, merchant flats up to 6 in. wide, skelp and strip 1 in. to 8 in. wide, beams and channels up to 3 in. and 14 and 18 lb. rails. Skelp, and rounds from ¼ in. to $^7/_8$ in., can be delivered in coils or straight lengths; also sections of equivalent area. All other products, with the exception of strip, are delivered in straight lengths.

The No 1 Bar Mill was shown at this location at closure in 1999 (see **Figure 3.8**).

3.7.4 Chronology – 8 inch & 12 inch Mill and Combination Mill

1916 8” and 12” Mill installed;

1917 12” Mill started 18 July;
8” Mill started 30 November;

1921 New engine and drive for 8” and 12” Mill installed;

1927 8” Mill converted to electricity;

1928 Major Shareholding acquired in Stewarts and Lloyds Ltd;

1933 8” Mill demolished;

1934 10” Merchant Bar and Skelp Mill installed;

1955 Decision to build new Skelp Mill;

1961 12” Mill ceased operation.

3.8 MERCHANT MILL BOILER PLANT

The merchant mill boiler plant was installed in conjunction with the 18 inch mill and was operational by October 1916. The boiler plant was housed to the south west of the 18 inch mill building as shown on **Figure 3.4**. The plant comprised 11 boilers with 5 540 square feet (515 m^2)of heating surface and were equipped with superheaters. Six of the boilers burnt coke breeze, two were fitted with pressure type coke oven gas burners and the remaining three with ordinary coal burning chain grates. The steam, which was generated at 160 lbs per square inch (1105 kP) supplied the plate and bar mill, 12 inch mill and rod mill engines, and auxiliaries, and the coke ovens plant, benzol plant and tar distillery (BHP, 1935).

The boilers closed down in May 1968. The location of the former merchant mill boilers is shown in **Figure 3.8** as an unspecified structure.

3.9 PIG CASTING MACHINE

Despite the outbreak of war on 4 August 1914, the construction of the steelworks continued. The pig casting machine was established during the first phase of construction in conjunction with a rail system, locomotives, cranes and pig iron storage yards. The original location of the No 1 Pig Casting Machine is shown on **Figure 3.5** and in **Plate 3.26**.

A modest amount of documentation has been discovered in relation to the pig casting machines and evidence is largely from plans and photographs. However, the Daily Telegraph in 1947 ran an article entitled "Former Mangrove Swamp Now Site of Impressive Steel Industry" and described the production of merchant pig iron:

> *At four-hourly intervals molten pig iron is tapped from the blast furnaces and runs into ladles, each holding up to 35 tons. The bulk of the molten iron then goes to the open hearth furnaces for conversion into high grade steel, but some is used in the foundry for the production of castings, and some at the pig mill where it is cast into merchant pigs.*

Plate 3.27 shows rail trucks at the rear of the mill loaded with pigs and **Plate 3.28** shows the detail of the mill at the Open Hearth end.

In 1921 the No 2 Pig Machine and storage yard were installed and located as shown in **Figure 3.5**. In 1924, the Newcastle Morning Herald reported that the company could sell large tonnages of foundry iron with any of the furnaces capable of switching between production of basic iron (for steel making) and foundry iron. All foundry iron was machine cast in pig mills.

In December 1934 the No 1 Pig Casting machine was dismantled and rebuilt adjacent to the No 2 Pig Casting Machine as shown in **Figure 3.7**. The pig casting machines appear on site plans at least until 1956 (BHP, 1999). The former, original, location of the No 1 Pig Mill is shown in **Figure 3.8** at closure in 1999.

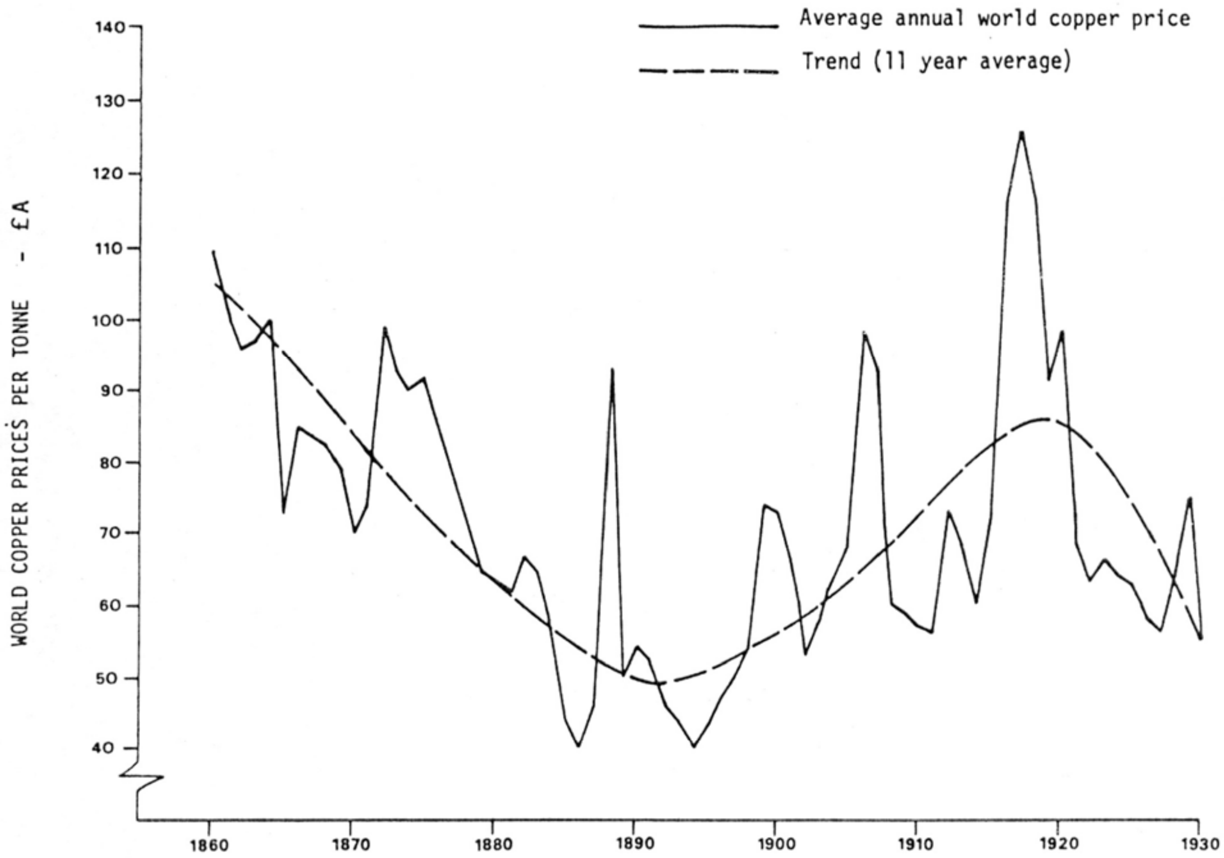


FIGURE 3.1
Fluctuation of World Copper Prices 1860–1930

A4 Not to Scale | Ref No.:R01_V1/1554_015.dgn

Umwelt (Australia) Pty Limited
Source: Phillips, 1980

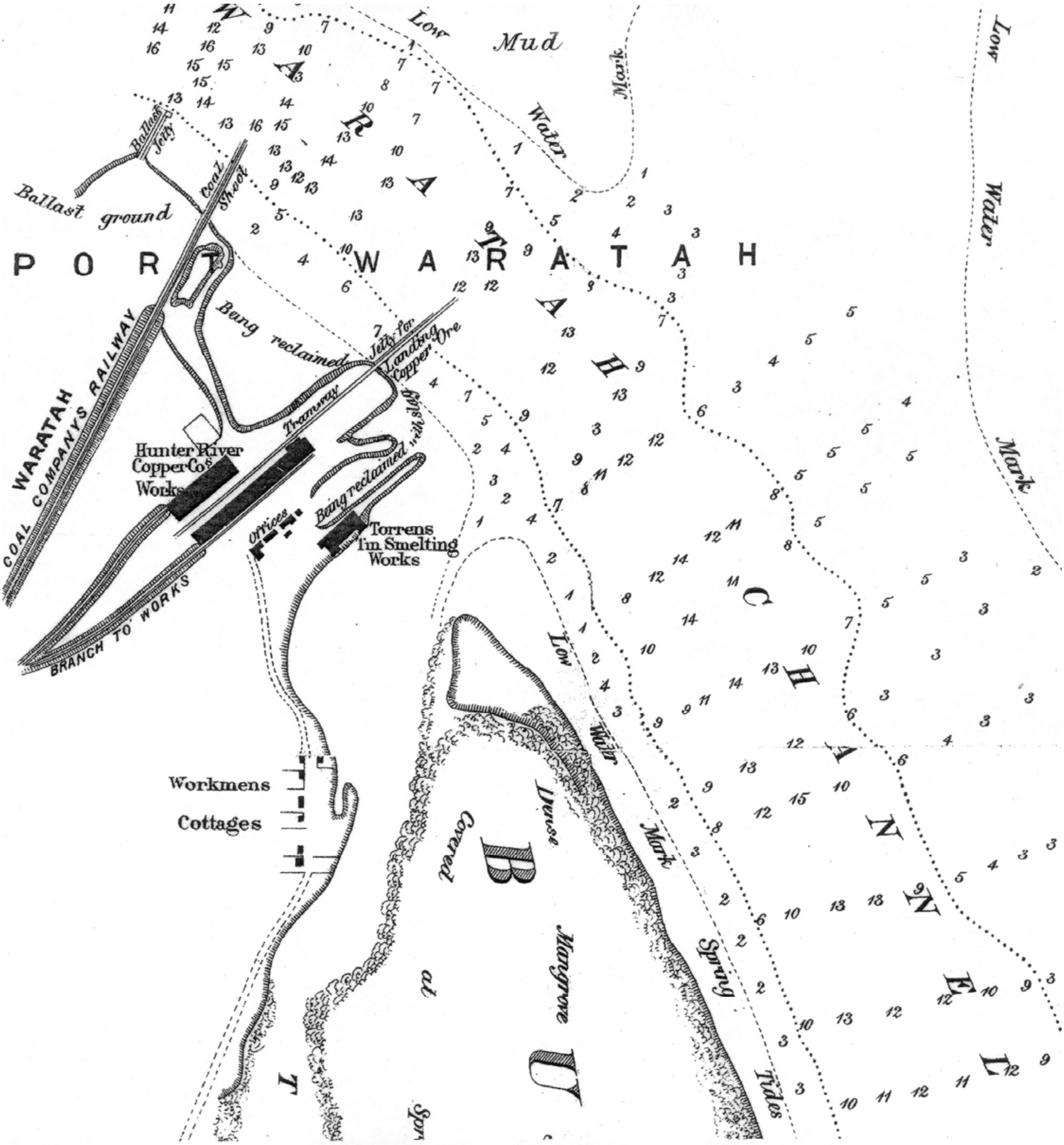


FIGURE 3.2
Location of Hunter River Copper Smelting Works 1880

A4 Not to Scale | Ref No.:R01_V1/1554_014.dgn

Umwelt (Australia) Pty Limited
Source: Knaggs, 1880

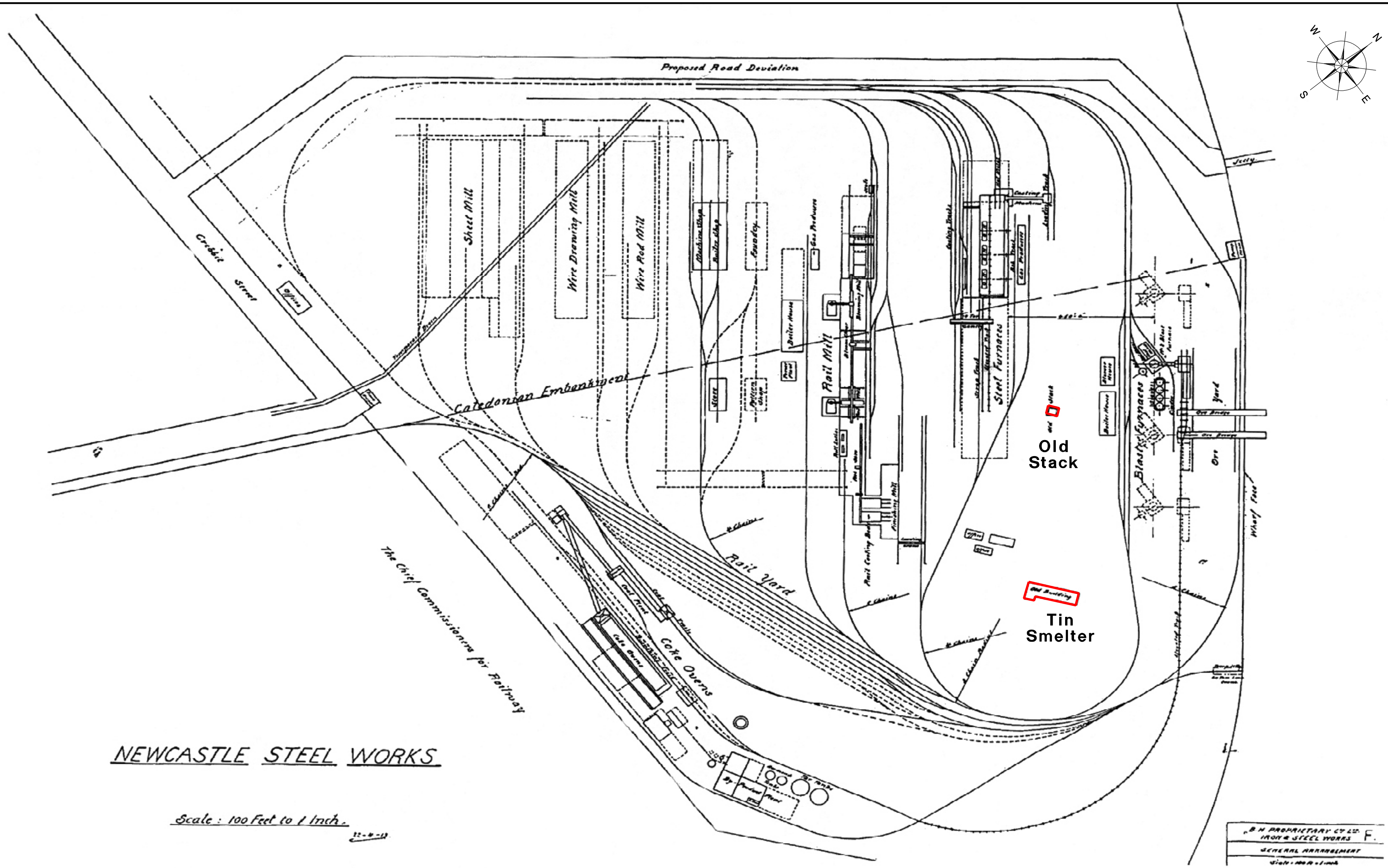
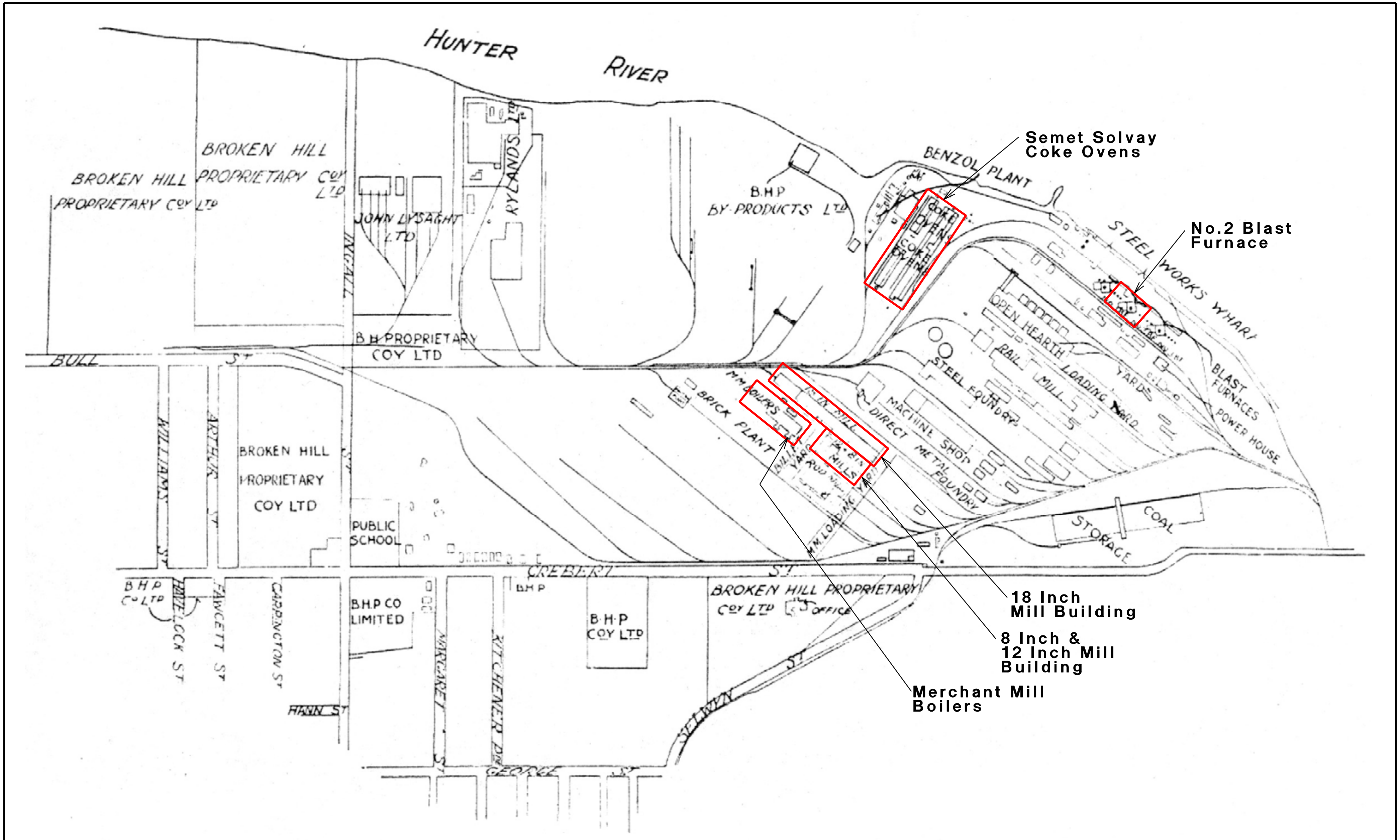


FIGURE 3.3
BHP Proposed Layout 1913

A4 Not to Scale	Ref No.:R01_V1/1554_029.dgn

Umwelt (Australia) Pty Limited
Source: BHP 1999



Umwelt (Australia) Pty Limited
Source: Shapes and Sections Handbook, 1924

FIGURE 3.4
BHP Site Layout Plan 1924

A4 Not to Scale

Ref No.:R01_V1/1554_011.dgn

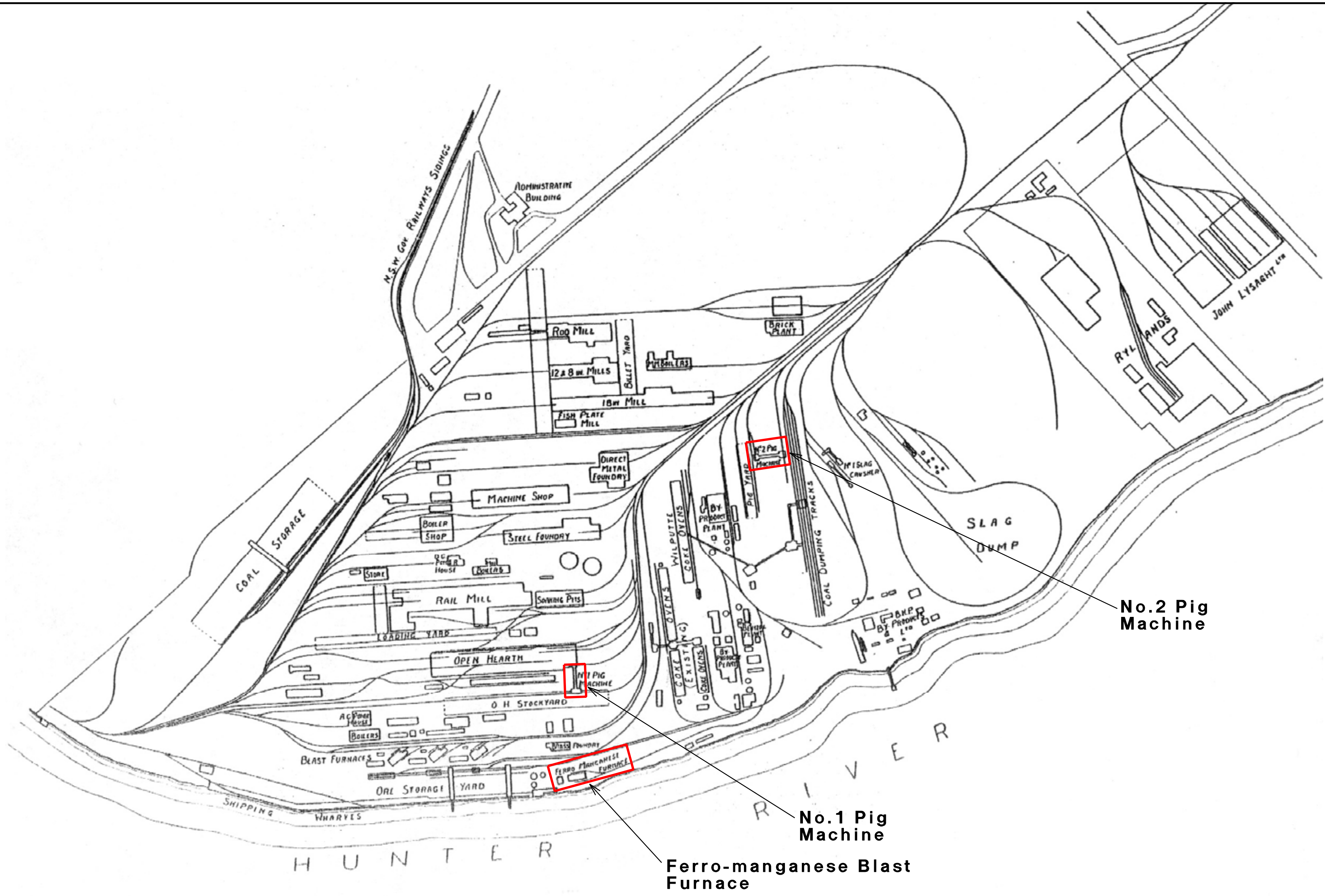


FIGURE 3.5
BHP Site Layout Plan 1929

A4 Not to Scale

Ref No.:R01_V1/1554_010.dgn

Umwelt (Australia) Pty Limited
Source: Iron and Steel Industry in Australia, 1929

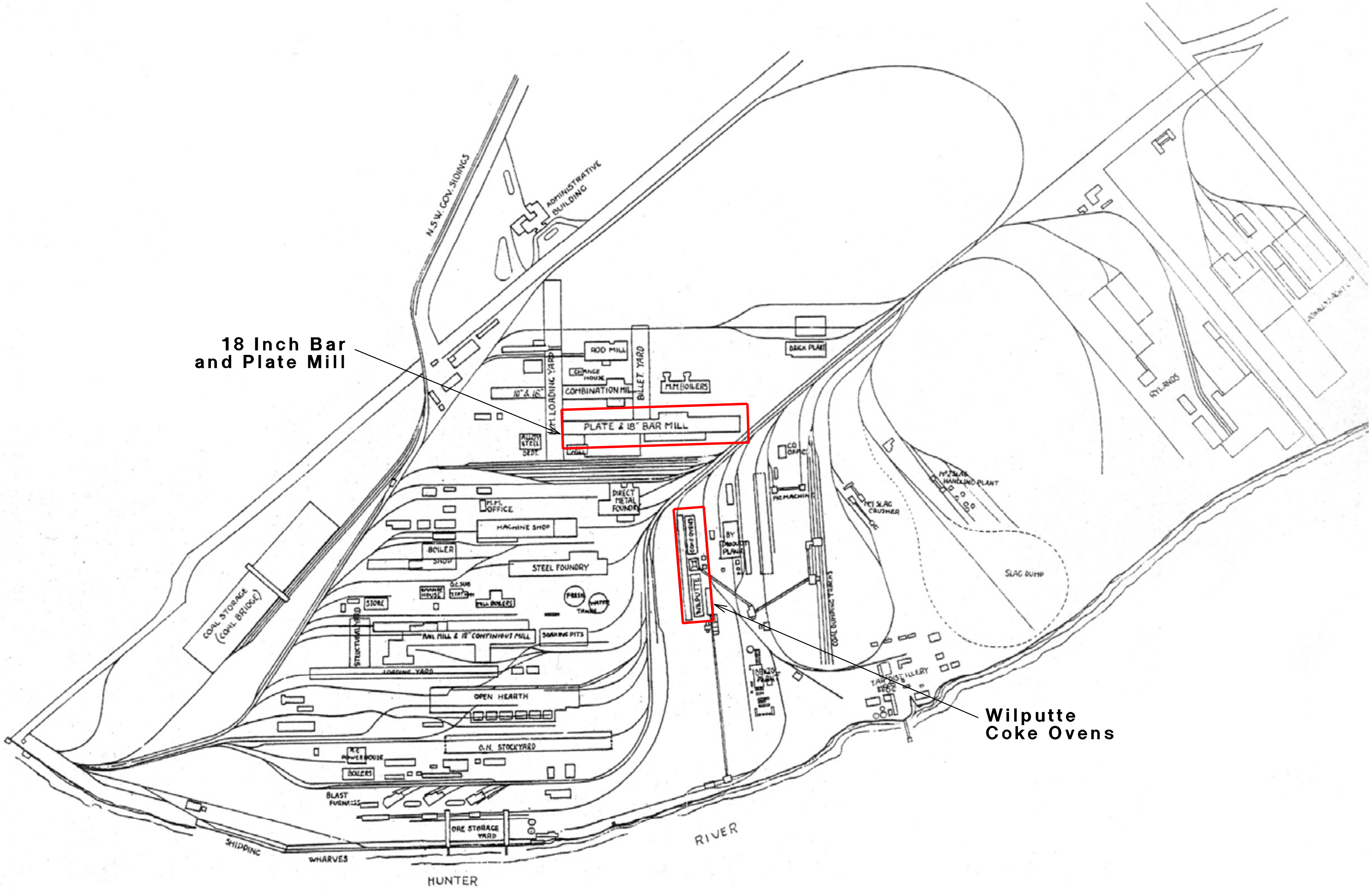


FIGURE 3.6
BHP Site Layout Plan 1933

Umwelt (Australia) Pty Limited
Source: The BHP Review, 1935

Note: Semet Solvay Ovens have been demolished

A4 Not to Scale	Ref No.:R01_V1/1554_009.dgn

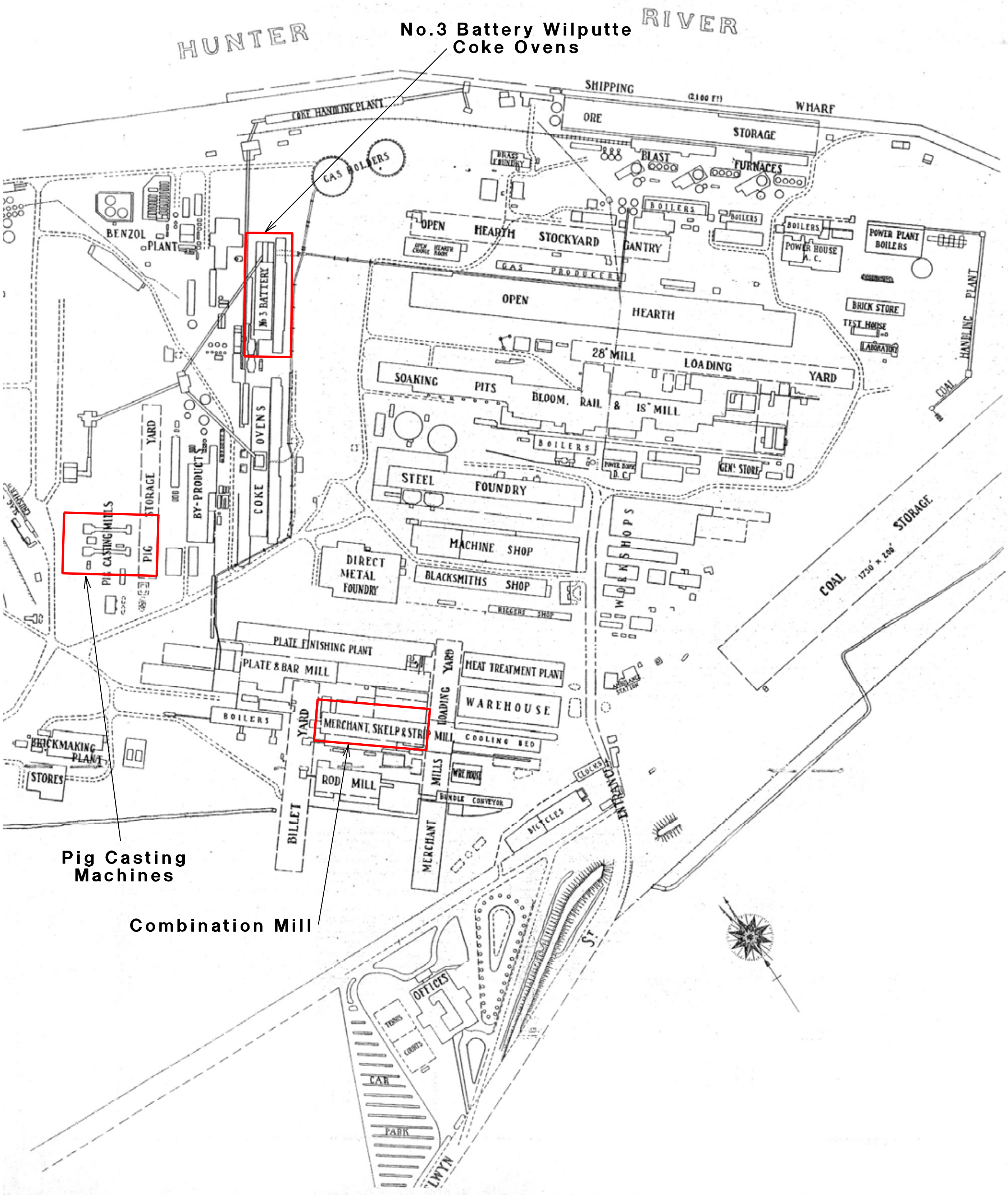


FIGURE 3.7
BHP Site Layout Plan 1939

Umwelt (Australia) Pty Limited
Source: BHP Progress 1939

A4 Not to Scale	Ref No.:R01_V1/1554_008.dgn

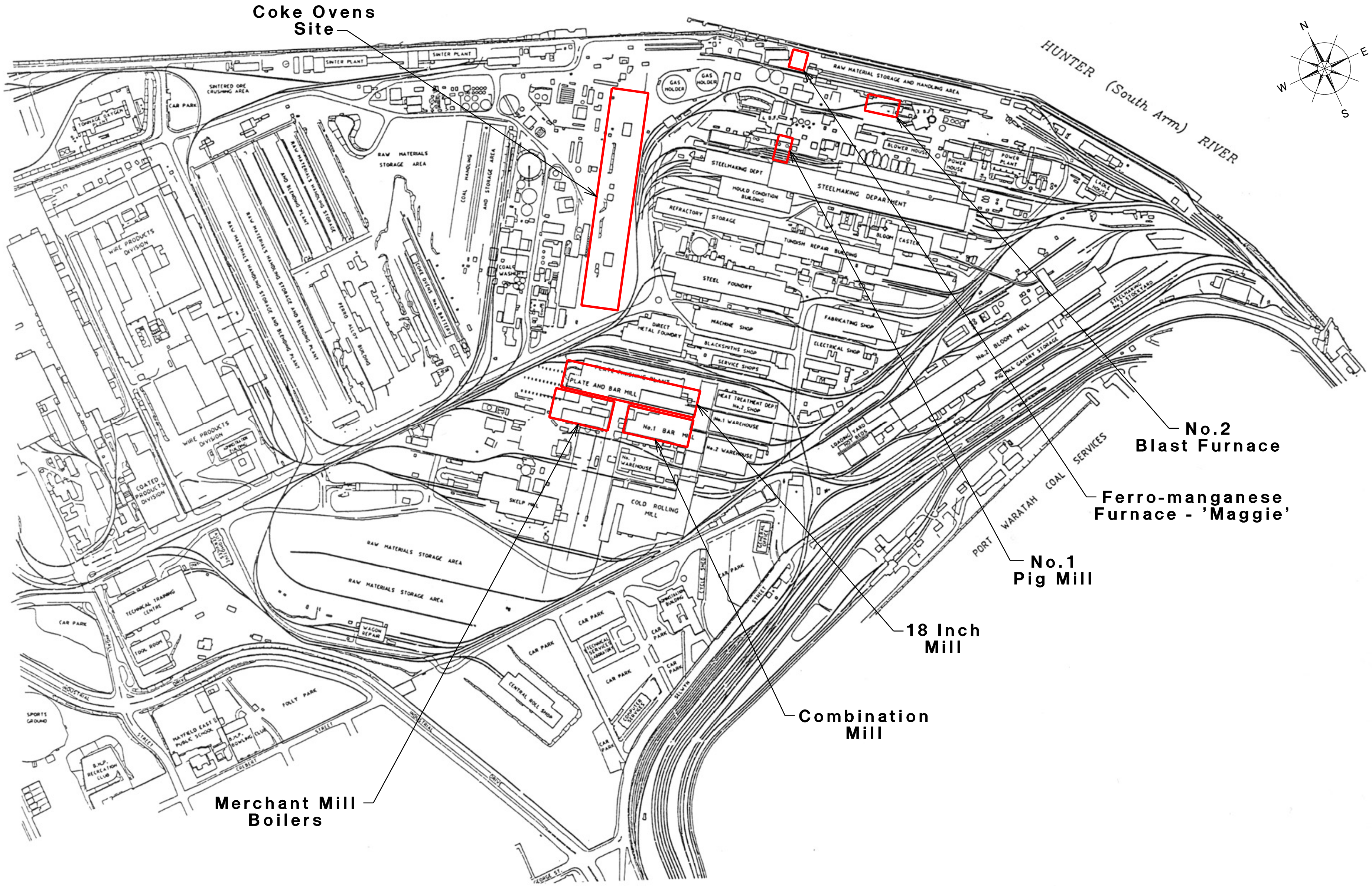


FIGURE 3.8
Newcastle Steelworks Site Layout
at closure of works – 1999
Location of Former Heritage Sites

A4 Not to Scale | Ref No.:R01_V1/1554_028.dgn

Umwelt (Australia) Pty Limited
Source: The BHP Review, 1935