HERITAGE COUNCIL OF WESTERN AUSTRALIA

REGISTER OF HERITAGE PLACES - ASSESSMENT DOCUMENTATION

11. ASSESSMENT OF CULTURAL HERITAGE SIGNIFICANCE

The criteria adopted by the Heritage Council in November 1996 have been used to determine the cultural heritage significance of the place.

PRINCIPAL AUSTRALIAN HISTORIC THEME(S)

- 3.3.3 Prospecting for precious metals
- 3.4.3 Mining

HERITAGE COUNCIL OF WESTERN AUSTRALIA THEME(S)

- 303 Mining (including mineral processing)

11. 1 AESTHETIC VALUE*

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11. 2. HISTORIC VALUE

As the State's largest lead producer in the early decades of the twentieth century, *Baddera Mines* played an important role in the early development Western Australia. (Criterion 2.2)

The place is closely linked with early attempts to establish a works to smelt Kalgoorlie gold ores, and has associations with important figures in the State's mining history: George Klug, W.G. Sutherland, and E. Protheroe Jones. (Criteria 2.2 & 2.3)

11. 3. SCIENTIFIC VALUE

As the site with the most complete evidence on the mineral field of the application of steam power to mining and processing, the place has the potential to contribute to an improved understanding of the use of this technology. (Criterion 3.1)

North Baddera Mine has unexplored potential to reveal information about the lifestyle of the miners resident on the site. (Criterion 3.2)

The two minesites provide good evidence of a succession of mining and processing techniques spanning more than half a century, and have the potential to improve our knowledge and understanding of these technologies and of their development over time. (Criterion 3.3)

* For consistency, all references to architectural style are taken from Apperly, Richard; Irving, Robert and Reynolds, Peter *A Pictorial Guide to Identifying Australian Architecture: Styles and Terms from 1788 to the Present* , Angus & Robertson, North Ryde, 1989.

11. 4. SOCIAL VALUE

Though dormant now for more than three decades, the mining industry remains very much a part of the living memory of the Northampton community. The tragic events at North Baddera, where two men lost their lives in the worst recorded mining accident in the mineral field, give that site a particular place in the community's history and memory. The place therefore has social value for the community as the site, within living memory, of a tragic mining accident, and as a reminder of the risks involved in mining. (Criteria 4.1 & 4.2)

12. DEGREE OF SIGNIFICANCE

12. 1. RARITY

The surviving Franier pump remnants at Baddera Mine are a rare, and possibly the only example, of the use of this type of pump on an Australian mine site. (Criteria 5.1 & 5.2)

The Cornish boilers and associated settings and flues make Baddera Mine unique in the Northampton Mineral Field, and very rare in the State, in retaining substantial evidence of the application of steam power to mining and processing. (Criterion 5.1)

The Huntington mill at North Baddera is a rare, and possibly unique in Western Australia, in situ example of a type of crusher once common on Western Australian mine sites. (Criterion 5.2)

12. 2 REPRESENTATIVENESS

The two minesites are typical examples from their period of mining operations on the Northampton mineral field. The high quality of their surviving fabric makes them important references sites for the region and the State. (Criterion 6.1)

12. 3 CONDITION

The sites appear to have experienced little disturbance since they were vacated. Viewed in the context of historic mine sites generally, they are in good condition.

12. 4 INTEGRITY

The sites exhibit a high level of integrity in that their original purpose is clearly apparent and there are no conflicting current uses. The identified cultural heritage values are sustainable in the medium to long term with basic protection from human interference, and in the indefinite long term with a modest level of preservation work.

12. 5 AUTHENTICITY

The level of authenticity of the extant fabric is moderate to high in that what survives is, apart from some natural deterioration, in the state in which it was left following the abandonment of the sites and the removal of their equipment to other mines. By the criterion of survival of the whole of the fabric in its original state, the authenticity is low, but this is more often than not the case with historic mine sites.

13. SUPPORTING EVIDENCE

The documentary evidence and physical evidence are based on 'A Heritage Assessment of the Baddera Mines: Northampton Mineral Field', prepared by Gerard MacGill in association with Dr Richard Hartley, for the Heritage Council of Western Australia, June 2000.

13. 1 DOCUMENTARY EVIDENCE

Introduction

Baddera Mines is situated on Location 1472, 8.8km north of Northampton and 1.6km east of the North West Coastal Highway. Two mines have been worked on the site, Baddera and Baddera North. These have also been known as Old Baddera and New Baddera, respectively. The southern extension of the Baddera ore body has been worked as the Baddera South mine.

Baddera Mine was established in 1873 and worked for about ten years to a maximum depth of 30 metres. No production figures are available for this period but lead concentrates averaging 72% lead were produced to the value of £34,000. The mine was reopened and worked from 1910 to 1921, during which time 14,110 tonnes of lead were produced from 131,340 tonnes of ore with an average grade of about 11% lead. This was the largest production of any lead mine in Western Australia. Baddera North was worked from 1948 to 1953 and yielded 730 tonnes of lead from 15,610 tonnes of ore with an average grade of approximately 5% lead.[1]

First Phase of Mining 1873 – c. 1900

The first mine in the Northampton district opened at Wanerenooka in 1856 (for copper and lead).[2] The town of Northampton was proclaimed in 1864.[3]

Galena[4] deposits were discovered at Baddera Mine in 1873 and worked for ten years by Samuel Mitchell and Charles Crowther. The deposits were worked to a maximum depth of 30 metres to produce lead concentrates valued at £34,000.[5] In 1878, 176 tons of lead ore were mined, 68 tons the following year and 374 tons in 1880.[6]

The railway from Geraldton to Northampton, the colony's first Government-owned railway, was commenced in 1874 to reduce the high cost of mineral cartage to the port.[7] Due to the death of the Government's consulting engineer and disagreements among his successors over construction

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1 Mining ceased at North Baddera in January 1953 but its production figures include ore from the Gurkha mine which was treated at the North Baddera processing plant from 1953 to 1956.

2 J.G. Blockley, 'The Lead, Zinc and Silver Deposits of Western Australia', *Mineral Resources Bulletin 9,* GSWA, 1971, p. 15.

3 G. Kelly, 'The History of Mining in the Geraldton District', *Early Days, Journal and Proceedings of the Western Australian Historical Society,* Vol. 8, No. 1, 1962, p. 86.

4 Galena, or lead sulphide (chemical formula PbS), is an opaque, steel grey coloured, crystal mineral. It is the most common mineral containing lead, and may contain impurities such as silver, aresenic, antimony and copper. Galena is sometimes known as Galenite or Lead Glance. Source: www.minerals.net / minerals / sulfideo / galena.

5 Blockley, op. cit, p.41; Kelly, op. cit, p. 82.

6 D.A. Cumming, 'Preliminary Notes on the Northampton Mineral Field', Brentwood, 1993, p.3. The 1880 figure may include ore mined outside Location 1472. All tons are long tons (2240 lb)

7 Kelly, op. cit., p. 87.

standards, the line was not completed until 1879.[8] However, by c. 1883 mining at Baddera ceased as the price of lead in London, which had been £22 per ton in 1875, and £16 in 1878, fell to £12 per ton.[9]

Circa 1885, Baddera North (New Baddera) mine was worked to shallow depths along a length of 90 metres.[10] Baddera Mine was briefly worked again in the 1890s by Mitchell and Crowther.[11]

An average of only 100 to 200 tons of galena ore was mined per year by following the outcrops underground. At least some of the ore was carted to the Wheal Ellen mine (also worked by Mitchell and Crowther) for processing while the remainder was hand picked to make a 70% concentrate for export to the eastern colonies or the United Kingdom (70% being the usual grade produced at Northampton).[12]

Mining for Smelter Flux 1900 - 1906

By the mid-1890s, there was a promotional boom in Western Australian gold mining companies on the London Stock Exchange. In 1897, near the end of the boom, two rival groups were competing to establish a smelting works in Fremantle. The main objective of the works was to process Kalgoorlie ores which, because of their telluride content, were not amenable to treatment by the standard cyanide process.[13] The first of these refractory ores had to be sent to smelters in the eastern colonies, a long and costly journey.

The two groups were led by George Brookman, the leader of the Adelaide syndicate which had pegged many of the valuable mines on the Golden Mile, and Charles Kaufman, an American engineer-financier, who had, in succession, been the agent of two of the most unscrupulous London financiers operating during the boom, Whitaker Wright and Horatio Bottomley. Kaufman, who had gained control of the Golden Harsh Estates, a rich Golden Mile mine, in his own right in 1897, was also interested in using a Fremantle smelter to smelt the copper-gold Ravensthorpe ores.

Brookman's group was the faster to move on the smelter, registering the Western Australian Smelting Co., in London in 1897. The Company acquired three freehold Northampton lead mines, the Baddera and Wheal Ellen mines (both owned by Mitchell and Crowther) and the Narra Tarra mine owned by a Melbourne company, to provide lead flux for the smelter.[14] It also acquired a site for the smelter at Rocky Bay (now in Mosman Park) but later exchanged it for a more suitable site south of Island Road, South Beach, Fremantle. Like many of the companies formed during the boom, WA Smelting Co had a shortage of working capital and was reconstructed in December 1898.[15] In March 1900, Kaufman's company, Fremantle Smelting

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8 J.S.H. Le Page, *Building a State: The Story of the Public Works Department of Western Australia 1829-1985,* Water Authority of Western Australia, Leederville, 1986, pp. 120-25.

9 Kelly, op. cit., p.87, Blockley, op. cit., p. 17.

10 R.C. Wilson, 'The Northampton Mineral Field', Dept of Mines, Perth, 1926.

11 Kelly, op. cit., p. 91. H P Woodward reported mining on a small scale at 'Badara' c. 1895. See H.P. Woodward, *Mining Handbook to the Colony of Western Australia,* Government Printer, Perth, 1896.

12 A. Gibb Maitland, 'The Geological Features and Mineral Resources of Northampton', GSWA Bulletin 9, 1903; Cumming, op. cit., p.3; Blockley, op. cit., p. 15. No physical evidence remains of the first decade of mining by Samuel Mitchell and Charles Crowther.

13 Gold smelting is from R.G. Hartley, 'A History of Technological Change in Kalgoorlie Gold Metallurgy 1895-1915', Murdoch University PhD thesis, 1998, Cpt 3, pp. 98-123.

14 *Mining Manual,*1899, p. 331; Cumming, op. cit., p. 3.

15 *Mining Manual,* 1899, p. 331.

Works Ltd (FSWL), took over all the WA Smelting Co's undertakings.[16] The smelting works were already half finished and in August 1900, operations commenced under the General Management of John Sutherland, manager of Golden Horseshoe Estates and one of the most respected metallurgists in Kalgoorlie.

There is no record of the WA Smelting Co. working its Northampton mines for lead flux. Instead, the company found it more expedient to purchase lead concentrates from Broken Hill. Very rashly, WA Smelting agreed to purchase all lead concentrates produced in 1900 by the Broken Hill Block 10 Company.[17] When FSWL took over the contract it found that it had inherited a debt of £85,600 which proved to be a millstone around its neck. Nevertheless, in the same year FSWL started work on a new access shaft to the Baddera mine.[18] The company went into liquidation in July 1901, largely due to technical problems with the smelter which the company had insufficient resources to rectify, and to the legacy of the Block 10 contract.[19] Work on the Baddera shaft which had been sunk to 49 metres without cutting the lode, had to be abandoned.[20]

In February 1902, the Kaufman group registered another smelting company, Fremantle Smelter Ltd (FSL) to take over the assets of FSWL.[21] FSL General Manager, George Klug, designed new smelters. Formerly Chief Metallurgist of the Golden Horseshoe, Klug was to become one of Australia's best known mining engineers over the next 30 years.

The smelters consisted of a series of parallel units, each consisting of a reverberatory furnace followed by a Bessemer-style converter.[22] The new smelters commenced operation in November 1903. However, in the two years during which there had been no smelters in action, there was a substantial reduction in the number of their potential customers. The majority of Kalgoorlie mines now operated treatment plants for concentrates and sulphide ores and only the Golden Horseshoe mine sent large quantities to the smelter.

The Change from Smelting to Lead Mining 1906-1910

FSL spent four years from 1902 to 1906 dewatering and developing the Narra Tarra mine, but the results were disappointing.[23] In fact, no significant quantities of lead ore were mined at all in Western Australia between 1903 and 1906.[24] From 1906, FSL reorientated its operations. Klug returned to Kalgoorlie and another former Golden Horseshoe metallurgist, W. G. Sutherland, took over as General Manager of FSL. Operation of the Fremantle smelters became only intermittent, dealing mainly with small quantities of specialist material such as Kalgoorlie gold room slag.[25]

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16 *Mining Manual*, 1902, p. 86.

17 *Mining Manual*, 1902, p. 86.

18 Kelly, op. cit., p. 91.

19 *Mining Manual*, 1903, p. 76.

20 Gibb Maitland, op. cit., Appendix A: H.P. Woodward, 'The Northampton Mining District', dated May 1901.

21 *Mining Manual*, 1904, p. 77.

22 Hartley, op. cit., pp. 117-20

23 E.S. Palmer, 'The Lead and Copper Mines at Narra Tarra, near Nabawa', unpublished memoir, 1986.

24 Blockley, op. cit, p. 19.

25 Hartley, op. cit., p.120, note 67.

Sutherland moved to Northampton and FSL concentrated on developing the Baddera Mine.[26] In February1907, C.H. Wray, Bewick Moreing inspecting engineer, reported that 'there is not an accessible mine in the district, although the Baddera and Narra Tarra mines belonging to the Fremantle Smelter Co. (sic) are rapidly approaching that stage'.[27] The following year, Fremantle Smelter Ltd were developing Baddera Mine using a 14 metre high gallows headframe, a Cornish boiler and a double winding steam winch.[28]

Not unexpectedly, FSL went into liquidation in 1909 and its undertakings were taken over by Fremantle Trading Co. Ltd (FTCL), another company promoted by the Kaufman group, now dominated by E. Protheroe Jones, who was Chairman of FTCL and also Managing Director of Golden Horseshoe Estates. W.G. Sutherland, the former FSL General Manager, was appointed General Manager of FTCL.[29]

The First World War and the Lead Mining Boom

In 1914 the Australian Government placed an embargo on the export of lead ore and concentrates from Australia (but not pig lead or refined lead).[30] Small Northampton mines, which before the war had shipped their 70% lead concentrates directly to smelters in the United Kingdom, were now obliged to market their concentrates locally. Alternatively, they could use one of the two smelters in the eastern states (at Port Pirie and Cockle Creek), or the Fremantle smelter, which reopened in 1915.

A crushing and concentrating plant was erected at Baddera Mine in 1914.[31] The mine and mill were worked full time for ten months of the year (14,956 tons ore, 1,797 tons lead). The main shaft was 106 metres deep and No. 2 level was 244 metres long. [32] Stoping at Baddera was being done over a length of 192 metres at No. 1 level, 244 metres at No. 2 level and 122 metres at No. 3 level.[33]

Work recommenced at North Baddera in 1917. An existing 32 metre deep underlay shaft was cleaned out.[34]

The most productive years of *Baddera Mines* were from 1910 to 1920. During this time, 129,265 tons of ore were mined for 13,888 tons of lead.[35] FTCL paid dividends in every year except 1913-14.[36] In August 1918, miners at the three FTCL mines came out on strike in support of a demand for the same rate of pay and hours as miners at a new Ajana lead mine.[37]

Ores from the mines of FTCL and other companies were railed from Northampton or from sidings on the Ajana to Northampton railway (built

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26 Palmer, op. cit.

27 C.H. Wray, 'Bewick Moreing mining prospect inspection report', dated 26 Feb.1907, DOME files.

28 A. Montgomery, 'Report on the Northampton Mineral Field', Department of Mines, 1908.

29 *Mining Manual & Mining Year Book,* 1914, pp. 573-74.

30 Kelly, op. cit., p. 90.

31 *Mining Manual & Mining Year Book,* 1914, p. 244.

32 S. Cullingworth, 'Northampton', Dept of Mines 1914 Annual Report, p. 54.

33 Dept of Mines 1915 Annual Report.

34 Blockley, op. cit., p.47; Wilson, op. cit.

35 Blockley, op. cit., p. 42.

36 *Mining Manual & Mining Year Book,* 1914, 1915, 1919, 1920.

37 'Northampton Lead Mines, WA', *Chemical Engineering and Mining Review,* 5 September 1920, p. 447.

1912) via the WAGR and the Midland Railway to the Fremantle smelters.[38] In 1922, typical costs per ton of a small mine (the Block 7 mine) were as follows: mining and concentrating 65s, bagging 2s 6d, cartage to Ajana 12s 6d, rail to Fremantle 26s 6d, smelting 168s 'per ton plus 10% of concentrate.'[39] It was reported in 1919 that smelting at Fremantle was 'at least' £2 per ton cheaper than sending ore to the smelters in the eastern states.[40]

Although the profitability of the Northampton mines was very small by international standards and had been improved by better transport and local smelting, their continued existence was largely determined by variations in the London lead price. Between 1915 and 1930, the lead price was consistently above the £20 per ton level, peaking at £37 in 1921 and at £35 in 1925.[41] From 1915 to 1920, a period in which mining generally in Western Australia was in the doldrums, FTCL was one of the most consistently profitable mining companies in the State.[42] In 1918, the year after lead prices in London had peaked at £30 per ton, exports of pig lead from the Fremantle smelters also peaked at 5,489 tons. In the same year, lead production in Western Australia reached an all-time high of 6,660 tons.[43]

In March 1919, when the London lead price dropped to £25, W. G. Sutherland announced that the Trading Company was closing down operations.[44] Apart from the lower lead price, Sutherland claimed that other contributing factors included the increased cost of explosives and shipping smelting coke from Newcastle, as well as the higher cost of shipping to Europe and the general high cost of mining stores in the post-war period.[45]

The 1919 fall in the lead price lead also prompted the Mining Association of Western Australia to renew its demands for the raising of the export embargo on lead ore and concentrates.[46] In this the Association was successful, and the embargo was lifted for Western Australia in 1920.[47] Although this move was not to the advantage of FTCL, a rapid rise in the lead price in 1920 caused the company to recommence mining at the Baddera and Narra Tarra mines and to make further preparations for the reopening of the Wheal Ellen mine. There were indications at Baddera, however, that the mines had nearly been worked out as both lodes had begun to pinch out and decrease in value.[48]

At the end of 1920, or in early 1921, the Baddera mines were closed. The main lode had been worked to a depth of 137 metres over a length of 335 metres.[49] When Mines Inspector Crabb visited the Northampton mines in November 1921, only three were producing lead, Narra Tarra, Block 7 and Mary

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38 ibid., p.92

39 *Chemical Engineering and Mining Review* 5 December 1921.

40 *Mining, Pastoral & Industrial Magazine* 4 March 1919.

41 Blockley, op. cit., p. 17.

42 *Mining Manual & Mining Year Book,* 1914, 1915, 1919, 1920.

43 Blockley, op. cit., p. 19.

44 *Mining, Pastoral & Industrial Magazine,* 4 March 1919, p. 33.

45 *Mining, Pastoral & Industrial Magazine,* 4 March 1919, p. 33.

46 *Mining & Pastoral Register,* 4 September 1919, pp. 7-8.

47 *Mining & Pastoral Register,* 1 April 1920.

48 *Mining and Pastoral Register and Builders' Gazette,* 1 December 1921, p. 5.

49 Dept of Mines 1922 Annual Report; Kelly, 1962, p. 93.

Spring.[50] In early 1922, the Baddera milling plant was removed to the Wheal Ellen mine.[51]

In January 1922, after the lead prices had fallen rapidly towards £20 in 1921, Sutherland again announced the impending closure of FTCL's operations.[52] Narra Tarra and Wheal Ellen had been reopened a few months earlier on the understanding that the Surprise mine at Ajana would also be reopened. As the Surprise mine had not reopened, and the output of the two FTCL mines was insufficient to keep the smelters going, Sutherland stated that FTCL 'would be reluctantly compelled' to close down its two mines.[53] In 1923 the two mines and the Fremantle smelting works closed down permanently. In the following year, the Commonwealth Bank foreclosed on assets of FTCL which were held as security against advances made by the directors.[54]

During the years of peak mining activity at Baddera workers and their families lived in a canvas village at the south-western corner of Location 1472 near the existing entry gate.[55]

When the Baddera processing plant was moved to Wheal Ellen all useful machinery was removed from Baddera with the exception of the two Cornish boilers. The boilers were not required as the plant at Wheal Ellen was operated by internal combustion engines rather than steam. The plant at Wheal Ellen was sold when the bank foreclosed on the company's assets.

North Baddera Mine 1947-1953

The North Baddera mine (also known as New Baddera or Baddera Extended) was worked to shallow depths along a length of 90 metres in the mid-1880s.[56] It was probably also explored in the early 1910s, as when it was re-investigated in 1917, an existing 32 metre deep underlay shaft was cleaned out.[57] Another exploratory shaft was sunk in the early 1920s, but mining on a significant scale did not commence until after the Second World War.[58]

In 1947, a miner, H. A. Coles, commenced exploratory work and formed a local company, Northampton Mining and Development Co. Ltd (NMDCL), to develop and work the mine. Co-owners with Coles included K. Sindall, C. Harvey and J. Helsan. Both Coles and Sindall worked at the North Baddera and Helsan had interests in a number of other Northampton mines.[59]

The London lead price rose from £A22 per ton in 1948 to over £A100 a ton in 1953 and NMDCL realised concentrates, lead and silver worth nearly $A130,000 in five years. Underground work at the mine was brought to an

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50 Crabb, J. 'Notes on the Mining Industry of Western Australia', *Mining and Pastoral Register and Builders' Gazette*, 1 December 1921, p.4.

51 Blockley, op. cit., p. 17.

52 *Mining and Pastoral Register and Builders' Gazette*, 1 February 1922, p. 15.

53 'Lead Mines to Close', *Mining and Pastoral Register and Builders' Gazette*, 1 February 1922, p. 15.

54 Kelly, op. cit., p. 93.

55 Interview with Patrick, op. cit. There are no visible remains of these dwellings. The Baddera site contains the ruins of one residence, which is assumed to be the mine manager's house (see Physical Evidence).

56 Wilson, op. cit.

57 ibid..

58 F.R. Feldtmann, 'The Baddera lead mine, Northampton, South West Division', WAGS Annual Report, 1921, pp. 26-30

59 *Daily News* 6 Jan. 1953; interviews with W. Patrick op. cit.; and S. Craygan, ex-miner, 9 Feb. 2000.

abrupt halt in January 1953 by the worst mining disaster experienced on the Northampton Mineral Field.

The January 1953 Mine Disaster

In the morning of 5 January 1953, Bert Coles (part-owner of the mine) and two other miners, George Baston and Clarence Chisholm went to work at the 200 ft level of the mine. Coles instructed Chisholm to work on the 200 ft level while he and Baston went to work in a stope between the 200 and 140 ft levels. When Chisholm returned at the end of the shift he found that a rock fall had occurred in the stope trapping Coles and Baston. For two days an intensive rescue operation took place under Mines Inspector J. Boyland, who had been holidaying at Horrocks Beach at the time.

Miners worked in cramped conditions from the 200 ft level to gradually remove the fallen rock but after another collapse of earth they were forced to cut a new access winze from the 140 ft level. Conditions were made even more difficult by the failure of a ventilation motor. When the men were eventually found it was clear that both had been killed instantly by the fall, which may have been due to the failure of one of the main support timbers in the stope.[60] Conditions were too dangerous for mining to resume, and underground operations at the mine were abandoned.

Two small 'shows' operated for short periods at Baddera (1951-1953). On Mining Lease (ML) 257 (A. Cottack?), 387 tons of ore was mined from an open pit to produce 56 tons of lead.[61] A 37 metre deep inclined shaft was sunk on ML 248 (H. Cotic) but only 17 tons of ore was mined for 9 tons of lead.[62] When NMDCL stopped pumping on closure of the North Baddera mine, water also rose at South Baddera and mining had to cease.[63]

Baddera Mines c. 1953+

After the 1953 accident, the mine's treatment plant continued to operate at North Baddera for another 3 years, processing ore from the Gurkha Mine which was about 7 km from Baddera and was also controlled by Jules Helsan. (Blockley's figures for the Northampton Mining & Development Co. are for the period 1948 to 1956 and include the Gurkha ore treated at North Baddera).

So that the Gurkha ore could be processed with minimal alterations to the North Baddera plant, the decline shaft was boarded over above ground water level. The Gurkha ore was discharged into a hopper in the shaft from which the skips were filled. They were then hoisted up the sloping shaft to a poppet head bin, from which the ore was processed in the same way as the North Baddera ore had been.

From the main bin the ore passed for primary crushing in a jaw crusher and then for secondary crushing in a Huntington mill (in which the ore was crushed by pendulum rollers against a perimeter ring). The crushed ore was elevated to a bin from which it was separated into fines and over-size material by means of a trommel (a cylindrical sieve). The over-size material returned to the Huntington mill, while the fines passed to either of two Wilfley table concentrators on which the metal concentrates were separated

60 *Daily News* 6 Jan 1953; *Geraldton Guardian* 6 Jan 1953; Interview with Craygan, op. cit.

61 Blockley, op. cit., p.42; interview with Craygan, op. cit.

62 K. Berliat, 'Report on the Northampton Mineral Field', WAGS 1952 Annual Report, pp. 27-30.

63 Interview with Patrick, op. cit.

from the tailings by differential settlement and vibration.[64] The tailings were pumped to a dump, while the lead concentrates were usually bagged and trucked to Baddera siding for railing to Geraldton or Fremantle for shipping to smelters.

The North Baddera plant was powered by a large diesel motor and by other smaller motors. Compressed air was used to power underground mining drills. Though a former worker at the mine recalls that no electricity was generated,[65] photographic evidence shows what appear to be insulators and wires extending out from the ore bin. In 1956 the North Baddera processing plant was transferred to the Gurkha mine and the North Baddera site was abandoned. In that year, the average annual London lead price reached £116, fell to £56 in 1962, then rose to £101 in 1964.[66]

Between 1964 and 1966, G.H. Mitchell trucked tailings and hand-picked concentrates from the South Baddera dump for reprocessing at the Northampton State Battery to produce 64 tons of lead.[67]

In 1970, during the base metals pegging boom the Baddera area was pegged for 'speculative purposes'.[68] In 1997/8, Baddera and neighbouring areas were gridded, pegged and sample drilled for mineral exploration by Hillcrest Resources.[69]

13. 2 PHYSICAL EVIDENCE

Baddera Mines are on private property, the entrance road to which runs west off the main highway 1.6 km north of Baddera Road.

Baddera mine is 8km north of the township of Northampton and is reached by travelling 1.4 km east along Baddera Road and entering the wire gate at the south west corner of Location 1472.

North Baddera Mine is some 500m north east of the Baddera, from which its tailings dump can be clearly seen. Vehicle access (4WD) between the mines is possible via a bushtrack and cleared exploration grid lines, but the North Baddera main shaft and treatment area are concealed by thick scrub and not easy to find. There is better vehicle access from a station track heading east from the main highway some 500m north of the Ladyland turnoff, but this is through private property.

Baddera Mine

With some notable exceptions, the evidence is that of the foundations of mining and treatment plant, the equipment having been removed for use at other sites after the mine's closure in the 1920s.

The oldest structures at Baddera probably date from around 1906. The 14 metre high gallows headframe, Cornish boiler and double winding steam winch, which were first referred to in 1908[70], were probably installed when FSL decided to concentrate on the development of Baddera in 1906. Only the stone-work building-in of the Cornish boiler (no longer on site), and the

64 Interview with Craygan, op. cit. Craygan worked in the North Baddera Mill during the period it was used to treat the Gurkha ore.

65 ibid.

66 *Mining & Chemical Engineering Review*, 15 December 1965, pp. 27-30.

67 Blockley, op. cit., p.42, and interview with Patrick, op. cit.

68 Interview with Patrick, op. cit.

69 ibid.

70 A. Montgomery, 'Report on the Northampton Mineral Field', Department of Mines, 1908.

foundations of its stack, remain from this period. Two or possibly three other periods of subsequent work are evident in the main shaft, treatment plant and boiler house areas. One includes the stonework building-in of the two existing Cornish boilers, the ducting of their flues to the older stack, and the stonework plinths of crushers, tanks and Wilfley tables. These probably date from 1910, the beginning of the Baddera mine's most productive period which lasted to 1920.

Several very large concrete engine blocks, with large diameter holding down bolts, at the south-western end of the treatment plant area, were probably built in a third construction phase. The blocks are evidence of an advance on the stonework construction period, although the concrete detailing and finishing is less sophisticated than that of the foundations built in the fourth or last period. Concrete work in the last period mainly consists of plinths for Wilfley tables, treatment tanks and their motors which suggests that the works were primarily intended to provide improved tailings treatment. The detailing and finishing of the concrete have a much more 'modern' appearance and are not unlike those of the North Baddera treatment plant foundations built in the 1950s.

The general layout of the mine is with the steam generation plant at its centre, the main shaft, to the south and the treatment plant to the north. The flow direction of the treatment plant was from west to east, towards the tailings dump. The foundations of a fairly substantial house, possibly that of the mine manager, lie some distance away to the east. A roller crusher east of the main site was evidently not related to the original mine and is discussed separately. The system of mineralised veins on which the mine was based dips towards the north west, hence is at its shallowest in the south east of the site, where the line of old surface workings is shown.

Treatment areas 1 and 2 represent a continuous process and are distinguished only for the purposes of description and presentation.

The treatment plant is sited to take advantage of the natural slope, the tailings dump being at the lowest level. Ground disturbance obscures the head of the process, but substantial concrete foundations further down with 1 1/2 inch (37ml) bolt fixings indicate the likely location of the primary and secondary crushing plant. Below this, the parallel concrete footings are probably the first stage (e.g. Wilfley table) of the mineral concentration process. Concentrate from this stage was probably passed via the piers to the final stage in treatment area 2, with reject material being recycled for re-grinding and concentration. The foundation may have held the driving engine for whatever was on the piers, and for the separation plant in treatment area 2. The piers and strip footings have a simpler and less robust form of construction than the other elements and appear to be remnants of an earlier stage of development.

Two identical, parallel, sets of footings are probably where the final stage of concentration took place, with the flush-to-ground foundations being the sites of intermediate and final storage bins. Tailings would have to have been pumped from here onto the dump. This may have been the function of the Fernier pump. The base of this device was not discovered; it may be obscured by wind-blown tailings.

The setting is all that remains of boiler 1, and it is in a fairly advanced state of collapse. It is smaller than boilers 2 and 3, and its flue has direct access to the flue stack. This is most likely to be the original (1908) boiler, with the other

two being added in 1914.[71] Boiler 2 with its setting is the most intact of the group, part of the asbestos lagging and rubble concrete roof being still in place. Both boilers have had sections of casing salvaged, revealing the furnace tube. Boilers 2 and 3 are connected to the stack base by channels, the roofs of which have collapsed. The stack base is half collapsed, revealing the interior lining of end-in refractory bricks. Two of the four mounting bolts for the metal flue stack remain, but the metal stack itself is no longer on site.

The positions of the main and ventilation shafts as surveyed correspond within a few metres of their positions as shown on the 1926 mine plan. The shaft collar has collapsed, and attempts have been made to cover the opening, obscuring the internal details of construction. The large concrete pad, obscured with drift, probably supported the winder; the smaller pad would have been the base for an auxiliary device such as an air compressor. An isolated concrete foundation with an angular indentation may be a headframe footing. Strip footings would most likely have supported an ore bin and possibly a water tank (evidence from the contemporaneous Wheal Ellen mine shows that mine de-watering was done by bailing tanks[72]. The machine bed's orientation rules it out as a winder base; it may have supported a pump to deliver water to the boilers and treatment plant.

Frenier pump spirals and drive

In the north-west corner of the site are scattered 14 disk-shaped metal casings, some alongside a substantial machine drive. The casings, 4 ft (1.2m) diameter and 10 inches (250ml) deep, are formed of 5 ft (1.5ml) steel plate and contain within them a spiral of 6 turns at 55ml spacing . The remnants match the description of a Frenier pump.[73] This type of pump is suitable for elevating solutions or pulps and could have functioned either to raise waste to the top of the tailings dump or to pump lead slurry to the classifiers.

These are almost certainly the replaceable components of a Frenier spiral pump which was probably used either for pumping lead slurry from a tank at the secondary crusher to a classifier (which removed the heavier, lead-rich, components from the slurry) or for tailings removal. Abrasion of pump parts during the pumping of such slurries is usually quite severe which is why the main part of the pump, the spiral, required frequent replacement. One of the advantages of the Frenier pump was that the spiral could be locally fabricated in a small workshop at low cost. Also located at the dump is the remains of the motor which drove the pump, including the hollow shaft through which the slurry was discharged (though not the box which enclosed the spiral and the fluid to be pumped).

Roller crusher

The crusher has been crudely mounted on a rock foundation, now mainly collapsed. It is distant from the main treatment area and is almost certainly a remnant of a small scale, much later mining operation, possibly from the 1951-53 period. Whether the crusher was salvaged from the earlier mine is uncertain; the bolt fixings do not seem to correspond to any of those on mountings in the treatment area. It is of a type known as 'Cornish rolls' and may have been part of the earlier (1908) development phase of the mine but discarded in the 1914 upgraded operation.

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71 Refer to the Documentary Evidence.

72 G.MacGill, *A Policy and Strategy for the Conservation of Mining Heritage in Western Australia*, Heritage Council of Western Australia, 1997, Ch. 3.

73 Refer to Documentary Evidence.

The 'house'

The base of a stone-walled building survives in the eastern part of the site. Remains of two rooms are visible, one 2.6m x 4.9m wide, the other about 7m x 4.9m. This may have been a manager's residence, or it could have served a mine function such as storage, smithy or explosives magazine.

Ventilation shaft

This is a single compartment shaft, 1.8m x 0.8m, sawn timber lined with a bush timber collar. It has two 200ml timber stumps, 1.5m centres, near its south-western corner.

Southern shaft

Just outside the southern boundary of Location 1472 there is a deep pit that is being used as a rubbish tip. This corresponds to the southernmost shaft on the mine, noted by Feldtmann[74]

Other artefacts

Two sections of flanged cast iron piping lie partially buried in tailings near the roller crusher. Close to these is the spoked shaft of a drum or large wheel, which may or may not prove to be a mining artefact. In the bush about 10m west of the roller crusher lies the remains of a riveted, sheet metal tank or bin some 3m long and 1.2m diameter.

North Baddera Mine

Due to the isolated location of the mine, the remains of the North Baddera treatment plant have been well preserved apart from the ingress of the surrounding bush. In conjunction with the Baddera plant remains, the plant illustrates how the basic treatment technology at small mines such as North Baddera remained largely unchanged over 50 years. At the same time its method of operation (such as the supply of power and methods of transport) and also the style of plant construction (concrete detailing and finishing and the enclosure of the works in a building) altered with the general use of the period.

While the North Baddera mine was operational several houses were built within Location 1472 to the west of the mine, and about 100m from it. The sites are now in very thick bush but traces of at least one can be identified.[75]

The treatment area is concrete floored throughout and was at least in part covered. From the mine shaft the ore was raised to a bin. The rails of the inclined shaft were extended to a head frame at the top of the bin with the winder at its rear.[76] A bracket and a stanchion are evidence of the use of electric power and possibly telephony on the site.

From the documentary evidence it is known that the ore was passed from the bin to a primary crusher, which was probably mounted on the H-shaped foundation near the Huntington mill; it was then fed via a trommel to the mill for fine grinding and thence over the Wilfley tables for mineral concentration. The concentrating process proceeded to the right of Figure 8, the waste being fed to the extensive tailings dump about 10m easterly. The area between the

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74 Feldtmann, op. cit., p. 27

75 Remains of roof sheeting and a house drain vent are visible. Mrs Patrick advised that the sites can identified in season by the garden bulbs planted by their occupiers.

76 **Note:** The nature of the ore bin was not known at the time of survey, and traces of it were not searched for in the heavy local scrub.

treatment plant and the tailings dump was obscured by heavy scrub at the time of survey.

The Huntington mill[77] is a pendulum (or centrifugal) mill in which suspended rollers crush the ore against a ring die. The remnant on site consists of the roller pendulum hanger ('spider' plate), central shaft, part of the ring die housing, timber bed and the drive shaft.

Of the motors that drove the processes, the only remnant (apart from foundations) is the large flywheel.

Other remnants include a shaft to the north of the main shaft, some surface workings and a shaft about 20m north of the northern boundary of Location 1472. Sparse remnants of habitation were noted some 70m east of the main shaft, but there was insufficient time to investigate these in detail.

13. 3 COMPARATIVE INFORMATION

The Baddera mines are two of the hundred or so developed in the course of a century of mining in the Northampton Mineral Field[78]. About a dozen of these mines have significant remnants, and between them they record the history of the development of the mineral field: from the earliest mine at the Geraldine, to the Wheal Fortune, Baddera, Wheal Ellen, Baddera North, Gurkha, Galena (final phase) and Nooka, tracing the history of processing from hand picking and knapping floors through to flotation.

Typically, the last phase of mining and mineral processing overprints and obscures the previous ones, but at Baddera a relatively brief period is represented, with evidence of perhaps three or four phases of mining. Evidence similar to that of the 1920s phase exists at the Wheal Ellen[79], which has similar boiler settings, but no boilers, though does retain the (collapsed) metal flue stack and many mining artefacts such as safety cages and bailing tanks.

Baddera North retains evidence of a single, 1950s, phase of mining. It is comparable to its companion mine the Gurkha[80], from which it treated ore and to which most of its treatment plant was later removed. However, the Baddera North is comparatively undisturbed and retains a very rare remnant of a Huntington mill.

Cornish Boilers

Once one of the commonest elements of early industrial premises and mines in every part of the world where British engineers and miners earned their livings, the Cornish boiler is now a rarity. In Britain, where the Cornish boiler was the work-horse of the Industrial Revolution it has 'almost completely disappeared'.[81] In Western Australia, when gold mining was at its most active in 1901, there were 327 steam boilers in the East Coolgardie Goldfield alone.[82] Most of these would have been Cornish boilers, as they were always far more popular on the goldfields than their chief rival, the

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77 Refer to Documentary Evidence.

78 G.MacGill, op. cit., Ch. 3

79 See Martin Gibbs, 'A preliminary survey of the Wheal Ellen Lead Mine, Northampton, Western Australia, June 1996'. Archaeological Society of Western Australia; MacGill, 1997, Ch.3, and MacGill, 1999, Fig. 4.

80 MacGill, op. cit., Ch. 3.

81 N. Cossons, *The BP Book of Industrial Archaeology*, David & Charles, Newton Abbot, Devon, 3rd ed., 1993, pp. 79-80

82 Hartley, op. cit., pp. 424,427.

Lancashire boiler. The more efficient water-tube boilers were slow to be adopted on the goldfields because they were more difficult to fire using eucalypt firewood. Today there may be only a single Cornish boiler on the Western Australian goldfields remaining in its original location. In eastern Australia, where minesite boilers were often recycled for other uses after their mines had closed, there are still a handful of Cornish boilers at remote minesites in northern Queensland, Burra in South Australia and in high Alpine New South Wales.[83]

The Baddera boilers are the last known minesite Cornish boilers in Western Australia which are still in their working location and still retain their flue ducting and the stonework base of their chimney. As far as their physical condition and potential for interpretation are concerned, the Baddera boilers appear to be as good as, if not superior, to the Cornish boilers noted in Queensland, South Australia and New South Wales (although the list is probably not complete).

Frenier Pump Remains

The discovery of the remains of a Frenier pump at Baddera is, to quote Mr R.W. Birrell, one of the foremost authorities on historic mining equipment in Australia, 'a rare find'.[84] Mr Birrell continued: 'I have never seen or worked with a pump of this type. A colleague of mine, a mechanical engineer of very wide mining experience in Australia, has also never seen or heard of this pump. It seems likely that they were rarely used in Australia'. Why, then, was the pump used at Baddera in the first place and why was it not transferred to the Wheal Ellen mine with the other processing plant equipment?

The pump was probably installed at the time of the last expansion of the treatment plant, either just before or during the First World War. The pump, which was manufactured in the USA, may have been adopted because more commonly used British or Australian pumps were not available in wartime. On the other hand, it may have been chosen for more functional reasons—because of its simple construction and because it required little attendance when working under steady conditions. Its main part could also be replaced cheaply by local labour—an important factor during wartime.

Taggart notes, however, that 'the pump will not operate satisfactorily under changing conditions. If overloaded, it will stop working; neither does it work well when underfed'.[85] These comments probably explain why the pump was rarely used in the Australian mining industry, where a premium has often been placed on the adaptability of equipment. Perhaps they were also the reasons why the pump was not moved to Wheal Ellen. If the Frenier pump had served its purpose during the war, when more adaptable pumps again became available, it was probably replaced with alacrity.

The remains of the Frenier pump at Baddera are significant because the pump is probably the only example of its type in Australia and also because its use at Baddera illustrates how a small British-owned mine was able to adapt its

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83 P. Bell, *Gold, Iron and Steam: The Industrial Archaeology of the Palmer River Goldfield,* JCU, Townsville, op. cit., pp.60, 84 (Comet Mine, Alexandra Mine); *North Queensland's Mining Heritage Trails,* Queensland EPA and Dept of Mines and Energy, 1999, pp. 10, 16 (Duke of Edinburgh Mine, Ravenswood, Great Australia Copper Mine, Cloncurry): B. McGowan, *Lost Mines Revisited,* Canberra, 1996, p.50 (Back Creek Battery, Cowra Creek, NSW)

84 Letter from R.W. Birrell to R.G. Hartley, 3 March 2000.

85 Taggart, *Handbook of Mineral Dressing,* pp. 18-88 & 18-89.

plant acquisitions to cope with wartime conditions. A search should be made at Baddera to see if any of the pump's missing parts are still on site. Mr Birrell recommends that because of its rarity, the pump's remaining parts should be placed under cover to prevent their further deterioration.

The Huntington Mill

The Huntington Mill was introduced into Western Australia in the late 1890s. The mill was initially used on the goldfields as an alternative to the stamp mill as a secondary crusher. It was particularly favoured by mines in their early development phases, by small mines and by mines in remote areas, because it was lighter to transport than a stamp mill and could be set up much more quickly.[86] When it was most commonly used in the early 1900s there were 14 in use in the East Coolgardie Goldfield (which mostly consisted of mines in Kalgoorlie-Boulder).[87] Probably a proportionally larger number would have been employed in the more isolated goldfields outside Kalgoorlie. The mill could successfully crush most oxidised (or near surface) ores but had difficulty in crushing the harder sulphide ores.[88] When the latter became predominant, use of the Huntington Mill for gold processing became less common. During the revival in gold mining in the 1930s and early 1940s some smaller new mines adopted the mill but after 1940 it was a comparatively rare piece of equipment even in the outer goldfields.

The North Baddera mine is believed to have been the only lead mine in Western Australia to have used a Huntington Mill as a secondary crusher. The crusher most commonly used was the roller crusher, which was more economical to install and operate than the Huntington Mill.[89] The North Baddera mill may have been purchased second-hand from one of the smaller gold mines which closed during the early 1950s in one of the north-western goldfields, such as the Murchison Goldfield, where Bert Coles worked before coming to Northampton.[90]

In a Huntington Mill the ore was crushed against a circular ring die by four pendulum rollers which were hung from a horizontal 'spider' plate.[91] The plate was revolved by a central shaft driven by a wheel and pinion below the mill. At North Baddera the four rollers have been removed but the spider plate (with mountings for the roller trunions and the vertical scraper located behind each roller), the circular die, central shaft and driving mechanism are still in place, although the shaft needs resecuring (see physical evidence). One of the drawbacks of the Huntington Mill was that without careful operation the circular die and the roller crushers tended to wear unevenly which caused intense vibration which was difficult to arrest without re-machining the heads of the rollers. This may have been the reason why the mill was not transferred to the Gurkha mine with the rest of the treatment plant equipment in 1956.

The North Baddera Huntington Mill is of great significance because it is almost certainly the only substantially intact Huntington Mill still in its working location in Western Australia. Enquiries into the location of other Huntington Mills at minesites elsewhere in Australia have so far been unsuccessful.

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86 Hartley, op. cit., pp. 70, 446.

87 ibid., pp. 425, 428.

88 S.J. Truscott, *A Text-Book of Ore Dressing*, Macmillan, London, 1923, pp. 84-85.

89 Truscott, op. cit., pp. 170-71.

90 Interview with Patrick, op. cit.

91 Truscott, op. cit., pp. 79-85.

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13. 5 FURTHER RESEARCH

While methods of processing the ores are generally well understood, further research into the specific design of treatment plants at different periods would facilitate a more detailed interpretation of the physical remains.

The Northampton Mineral Field, unlike most of the state's goldfields areas, is relatively undisturbed by modern, large scale mining activity. Now that all sites of significance in the mineral field have been recorded to at least a basic level of detail, a sub-set of perhaps six to ten should be selected for further research and documentation on the basis of the quality of the physical evidence and the period(s) of mining represented. Together, these sites could reveal, in a way not possible elsewhere in Western Australia, the evidence of a complete and important episode in the State's mining history.

Further research should be conducted into the social history of *Baddera Mines*, to provide a context for their operation and the way of life of those who lived near and worked on the mines.