THE YORKSHIRE IMPERIAL METALS SITE, SWANSEA

A SITE APPRAISAL

CAMBRIA ARCHAEOLOGY

in conjunction with
DAVIES SUTTON ARCHITECTURE
VERYARDS
PARRY & DAWKIN

COMMISSIONED BY CITY AND COUNTY OF SWANSEA / WDA

THE YORKSHIRE IMPERIAL METALS SITE

ARCHAEOLOGICAL, CONDITION, AND HEALTH AND SAFETY APPRAISALS BUDGET COSTS

NOVEMBER 2002
REPORT No. 2002/100

Historical and Archaeological Appraisal by Cambria Archaeology

Condition Appraisal of the Listed Buildingsby Davies Sutton Architecture

Health and Safety Appraisals by Veryards Limited

Budget Costs by Parry & Dawkin

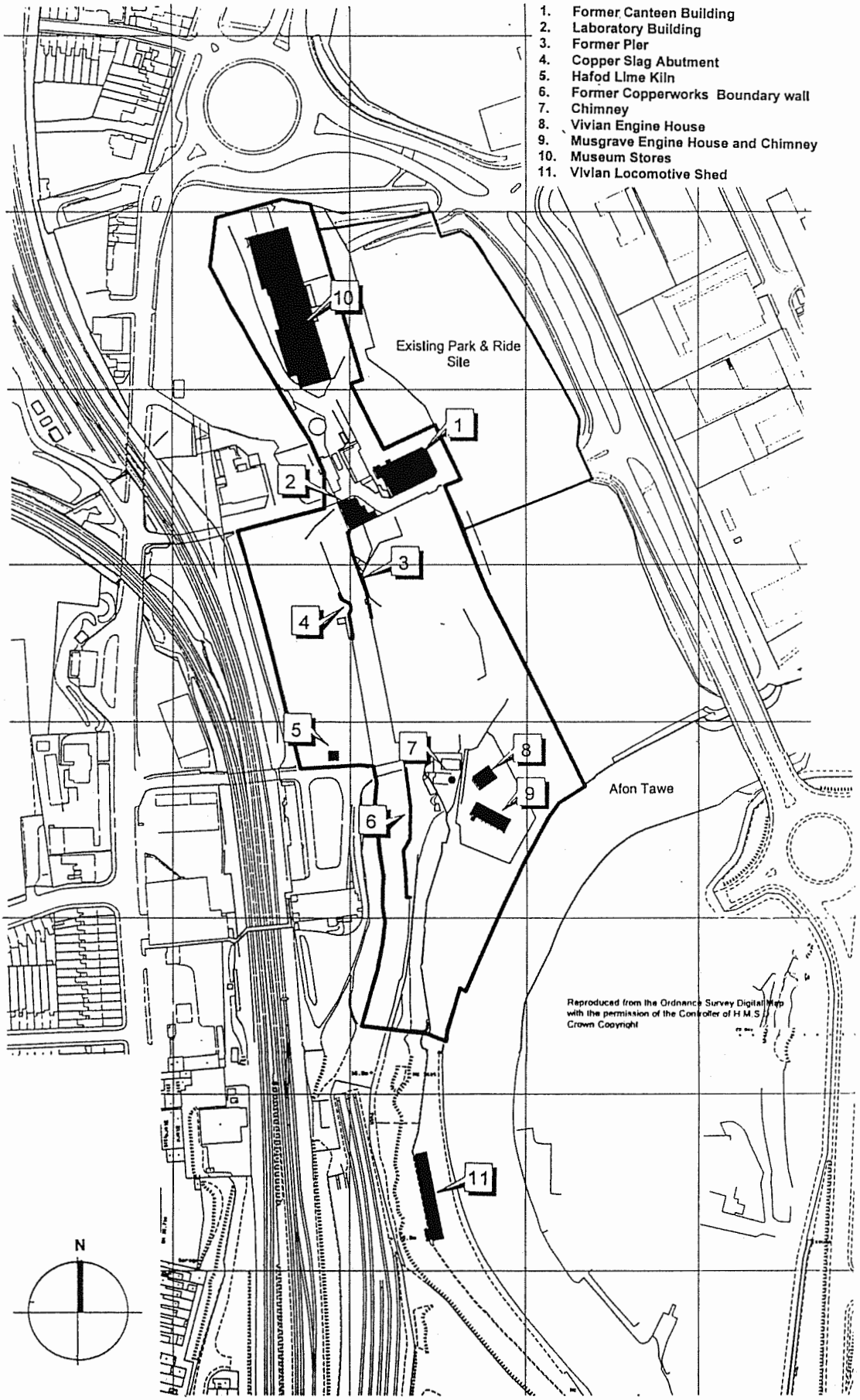
Cambria Archaeology is the marketing name of the Dyfed Archaeological Trust Limited.

ARCHAEOLEG CAMBRIA
Ymddiriedolaeth Archaeoleg Dyfed Cyf
Neuadd y Sir, Stryd Caerfyrddin, Llandeilo, Sir Gaerfyrddin SA10 6AF
Ffon: Ymholiadau Cyffredinol 01558 823121
Adran Rheoli Treftadaeth 01558 823131
Ffacs: 01558 823133
Ebost: cambria@acadat.com Gwefan: www.acadat.com

CAMBRIA ARCHAEOLOGY
Dyfed Archaeological Trust Limited
The Shire Hall, Carmarthen Street, Llandeilo, Carmarthenshire SA19 6AF
Tel: General Enquiries 01558 823121
Heritage Management Section 01558 823131
Fax: 01558 823133
Email: cambria@acadat.com Website: www.acadat.com

The Trust is both a Limited Company (No. 1198990) and a Registered Charity (No. 504616)
CADEIRYDD *CHAIRMAN: B.C.BURNHAM, MA PHD, FSA, MIFA*. CYFARWYDDWR *DIRECTOR: E.G.HUGHES BA MIFA*

GENERAL CONTENTS



SITE LAYOUT PLAN

EXECUTIVE SUMMARY

1.1 The Brief

The study has been commissioned by the City & County of Swansea with funding from the Welsh Development Agency with the objective of undertaking an archaeological condition survey of the buildings and structures of industrial archaeological importance on the former Yorkshire Imperial Metals (YIM) site at Landore, Swansea.

The study identifies and lists remedial works over the short, medium and long term and is supported by survey drawings, condition assessments and cost estimates.

1.2 Buildings & Structures

Contained within the study site are 11 Listed buildings and structures, as noted below, with Building 9.0, the Musgrave Engine House, being also a Scheduled Ancient Monument (SAM). The locations of the buildings are shown on the site plan enclosed.

1.0	Morfa Canteen Building: Former electric powerhouse of the Morfa Copperworks.	Grade II listed, late C19 Condition: derelict
2.0	Morfa Laboratory Building: Formerly part of the Morfa Copperworks.	Grade II listed, mid to late C19 Condition: derelict
3.0	Hafod Pier and adjoining canal wall The pier formed the eastern support of the tram road from the former Hafod Copperworks over the Swansea Canal.	Grade II listed, wall early C19 with pier mid C19 Condition: pier - fair, wall - very poor
4.0	Hafod Copper Slag Abutment: the abutment formed the western support of the tram road from the former Hafod Copperworks over the Swansea Canal. Probably the most impressive surviving example of copper slag block construction in Wales.	Grade II listed, mid C19 Condition: fair
5.0	Hafod Lime Kiln: One surviving lime kiln along the Swansea Canal.	Grade II listed, late C18 to early C19 Condition: poor
6.0	Hafod Canal Wall Boundary: Some 80 metres in length built along the towpath of the Swansea Canal	Grade II listed, early C19 Condition: poor to very poor
7.0	Vivian Chimney: the chimney served the steam boilers of the Vivian Engine House, Building 8.0 of the former Hafod Copperworks.	Grade II listed, 1860-62 Condition: poor to fair
8.0	Vivian Engine House: Housed a steam engine to power copper rolling mills at the former Hafod Copperworks.	Grade II listed, 1860-62 Condition: derelict
9.0	Musgrave Engine House: Houses an extant uniflow type steam engine at the former Hafod Copperworks.	Grade II* listed and SAM, Built 1910 Condition: derelict
10.0	Museum Stores: Formerly Morfa Copperworks rolling mill.	Grade II listed, mid C19 with later additions. Condition: good
11.0	Vivian Locomotive Shed: Built to house the locomotive used to transfer materials around the Hafod Copperworks site.	Grade II listed, early C20 Condition: derelict

IMPORTANCE & HISTORY

1.3 The importance of the site

The YIM site is a strategic riverside site located on the western bank of the River Tawe at Landore, Swansea.

The lower Tawe valley was the most intensely developed copper smelting district of Great Britain and subsequently one of the most significant landscapes of the world's first Industrial Revolution. The site is therefore of both national and international importance.

The YIM site study area, as delineated on the site plan, covers 4.3 hectares of the undeveloped portions of the historic Morfa and Hafod Copperworks together with a section of the former Swansea Canal and contains some of the last remaining groups of surviving 19th century industrial buildings in Swansea.

The Morfa and Hafod Copperworks during the mid 19th century were the largest in the world. Hundreds of workers were employed and housed in purpose built estates in Landore making the site of crucial importance to the later history and development of Swansea

1.4 History

Hafod Copperworks was established in 1810 by John Vivian and remained in the ownership of the Vivian family until 1924 when it amalgamated with the adjacent Morfa Copperworks. The combined works were in 1957 acquired by Yorkshire Imperial Metals. Copperworking ceased in 1980 and the site was subsequently acquired by the then Swansea City Council.

The main body of the Morfa and Hafod Copperworks site was enclosed within a loop of the River Tawe. About half of the site was occupied by spoil tips with the remaining free space densely packed with buildings that have largely been cleared and now underlie the Cross Valley link road and the Landore park-and-ride site.

The study area comprises only about 10% of the former area of the works and therefore increases the importance of preserving the remaining elements.

1.5 Areas between listed buildings

The structural remains within the study area are not limited to the listed buildings. In between are extensive remains of structures, and former surfaces, that together increase the Group Value of the site. The extensive use of local building stone (Pennant sandstone), and copper-slag blocks manufactured on the site itself, are an important contribution to the 'sense of place'.

The geometry of the site is also important, and is still preserved, in particular its terraced nature and relationship to the river and the Swansea Canal. Any future use must therefore be informed by the correct interpretation of the site and must seek to preserve as much as possible of the buildings as well as respecting the site's topography and geometry.

SITE CONDITON

1.6 Listed Buildings

Apart from the Museum Stores, which are still in use, the other buildings on the site are now derelict and have suffered severely from recent vandalism, including fire, active damage and graffiti. They have all lost their roof coverings and most of their roof structure together with windows and doors leaving them as masonry shells vulnerable to further decay. The condition of the Vivian Locomotive Shed is of particular concern.

1.7 Structures & site areas

The listed structures on the site - piers, walls and chimneys - are in poor to fair condition suffering mainly from intrusive vegetation growth. Significant areas of the site are heavily overgrown but contain many previously unrecorded elements of archaeological interest. The study having added 30 new references to the archaeological site record.

1.8 Site security & contamination

The perimeter of the site is presently not secured. A number of footpaths currently cross or skirt the site giving public access. In addition to the safety concerns posed by the derelict buildings there are on the site many unprotected drops and trip hazards.

As part of the study a limited number of surface soil test samples were taken to obtain a view as to the safety of the site in its present condition. Some exceptionally high concentrations of arsenic and copper were recorded. The levels of arsenic in particular could cause harm to children who picked up and put in their mouths any of the most highly contaminated soil.

REMEDIAL WORKS

1.9 Archaeology

To safeguard the surviving archaeology of the site any significant works are to be preceded by a targeted programme of programme of archaeological fieldwork.

1.10 Listed Buildings & Structures

Remedial works for the listed buildings and structures are identified in the study as:

- Short term: initial repairs to make safe and secure the buildings from imminent structural failure and vandalism.
- Medium term: repairs within 5 years, generally to repair and make weather tight the external envelope of the building and prevent further deterioration to the building fabric.
- Long term: repairs within 10 years to complete the works to the building envelop, repair interiors, renew services and make good surrounds such that the buildings can be brought back into use.

1.11 Site Areas, security and contamination

The study appraises the health and safety aspects of the site and sets out the required works in relation to –

- Securing the site
- Risks within the site
- Site contamination

1.12 Site services

Various gas, water, electricity, telecommunications and drainage services cross the site. The locations of the known services are set out in the report. The study does not though give consideration to the provision or cost of a new services infrastructure or road network for the site, these matters being outside the scope of the survey.

1.13 Priorities

The works identified by the study have been prioritised as follows-

1. Securing the site, site risks and short term works to buildings and structures.
2. Medium term works to buildings and structure and further site contamination tests.
3. Long term works to buildings and structures and remediation of site contamination.

COSTS

Budget costs for short, medium and long-term works are summarised below. The full make up of the costs is given in the Budget Costs Specialist Study of the main report.

	Site areas, security & contamination	Short	Medium	Long-term
A.	Site security including fencing, removal of overgrowth, perimeter lighting.	178,000.00		
B.	Site risks including warning signs, barriers to unprotected drops, clearance of debris.	108,000.00		
C.	Site contamination –			
	i) Bore hole sample testing	80,000.00	-	-
	ii) Tests specific to proposed future site use.	-	50,000.00	-
	iii) Remediation measures	-	-	300,000.00
	Sub-total of site works	**366,000.00**	**50,000.00**	**300,000.00**
	Buildings & structures – remedial works			
1.0	Morfa Canteen Building	68,000.00	250,000.00	316,000.00
2.0	Morfa Laboratory Building	45,000.00	203,000.00	300,000.00
3.0	Hafod Pier and adjoining canal wall	1,000.00	55,000.00	-
4.0	Hafod Copper Slag Abutment	6,000.00	13,000.00	-
5.0	Hafod Lime Kiln	21,000.00	20,000.00	-
6.0	Hafod Canal Wall Boundary	6,000.00	60,000.00	-
7.0	Vivian Chimney	500.00	59,000.00	-
8.0	Vivian Engine House	14,000.00	67,000.00	88,000.00
9.0	Musgrave Engine House	30,000.00	93,500.00	112,500.00
10.0	Museum Stores	-	-	1,500,000.00
11.0	Vivian Locomotive Shed	126,000.00	15,000.00	280,000.00
12.0	Conservation of retaining walls about the site	123,000.00	-	-
	Sub-total of buildings & structures	**440,500.00**	**835,500.00**	**2,596,500.00**
	Archaeological recording			
1.0	Morfa Canteen Building	500.00	700.00	1,000.00
2.0	Morfa Laboratory Building	-	2,000.00	1,000.00
3.0	Hafod Pier and adjoining canal wall	-	700.00	-
4.0	Hafod Copper Slag Abutment	-	600.00	-
5.0	Hafod Lime Kiln	1,000.00	1,000.00	-
6.0	Hafod Canal Wall Boundary	1,000.00	700.00	-
7.0	Vivian Chimney	-	700.00	-
8.0	Vivian Engine House	-	700.00	1,000.00
9.0	Musgrave Engine House	-	1,000.00	1,000.00
10.0	Museum Stores	-	3,000.00	5,000.00
11.0	Vivian Locomotive Shed	1,000.00	1,000.00	500.00
12.0	Conservation of retaining walls about the site	1,000.00	-	-
	Sub-total of archaeological recording	**4,500.00**	**12,000.00**	**9,500.00**

Summary of Costs			
Site areas, security & contamination	366,000.00	50,000.00	300,000.00
Buildings & structures – remedial works	440,500.00	835,500.00	2,596,500.00
	806,500.00	885,500.00	2,896,500.00
Contingencies @ 10%	80,650.00	88,550.00	289,650.00
	887,150.00	974,050.00	3,186,150.00
Professional fees & expenses @ 20%	177,430.00	194,810.00	637,230.00
	1,064,580.00	1,168,860.00	3,823,380.00
VAT @ 17.5%	186,302.00	204,550.00	669,092.00
	1,250,882.00	1,373,410.00	4,492,472.00
Archaeological recording (see note below)	4,500.00	12,000.00	9,500.00
Totals for Short/Medium/Long-term works	**1,255,382.00**	**1,385,410.00**	**4,501,972.00**
Total budget cost			**£ 7,142,764.00**

Note: VAT will not be chargeable on the archaeological recording if the work is undertaken by one of the Archaeological Trusts that are also Registered Charities.

REPORT SUMMARY:

REPORT SUMMARY

2.0 Introduction

The following summary of the specialist reports outlines the consultant study team, the study requirements, study contents and recommendations.

2.1 Consultants

The study team comprised of the following consultants.

- **Cambria Archaeology:** Archaeologists and lead consultants for the study responsible for appraisal of historical and archaeological aspects of the brief.

  Archaeological appraisal researched and written by Neil Ludlow, Cambria Archaeology
  Project Manager: Kenneth Murphy, Principal Archaeologist

  Cambria Archaeology,
  The Shire Hall, Carmarthen Street, Llandeilo, Carmarthenshire SA19 6AF. Tel: 01558 823121

- **Davies Sutton Architecture:** Chartered architects advising upon the architectural, conservation and fabric integrity aspects of the brief.

  Director in charge: Kevin Sutton
  Senior Architect: Iwan Davies

  Davies Sutton Architecture, 30 Cowbridge Road, Pontyclun CF72 9EE Tel: 01443 225205

- **Veryards Limited:** Consulting civil and structural engineers responsible for health and safety assessments of site areas and structures, together with appraisal of surface contamination, site security and utility services.

  Director in charge: John Peacock
  Principal Conservation Engineer: Martyn Western

  Veryards Limited, 18d High Street, Llandaff, Cardiff CF5 2DZ Tel: 029 2055 2444

- **Parry and Dawkin:** Chartered surveyors advising on the budget costs for the study proposals.

  Partner in charge: Anthony Dawkin

  Parry and Dawkin, 54 Morfa Road, Swansea SA1 2EN Tel: 01792 460432

3.0 THE STUDIES

3.1 Study requirements

The requirements of the study were as follows:

- Archaeology: historical and archaeological survey and appraisal of site and structures
- Listed Buildings: survey of condition, structural stability and integrity of the fabric; identification of remedial consolidation works with the provision of lists supported by drawings for the short, medium and long-term works required.
- Health & Safety appraisals of: Site security
  Site areas and structures
  Site contamination
- Services: identification of location and extent of incoming services on the site.
- Costs: preparation of estimates for the works covered in the study.

3.2 Study contents

In addressing the requirements of the study the following report sections have been prepared.

- Historical and Archaeological Appraisal: Cambria Archaeology
  The archaeological survey comprised of two elements. The first was a desktop survey study of relevant archives for cartographic and printed sources and selected documentary records. The second element was a field study of the upstanding buildings, walls, structures and other archaeological remains. The site as a whole was considered in the study.
- Condition Appraisal of the Listed Buildings: Davies Sutton Architecture with structural input from Veryards Limited.
  Condition appraisals have been undertaken of the Listed buildings with schedules produced for each building describing construction, condition of fabric and repairs required initially, within 5 years and within 10 years/long-term works. The schedules are accompanied by annotated photographic record sheets and scaled measured plans.
- Health & Safety Appraisals: Veryards Limited
  Site Security: appraisal of consequences of breached site security and recommendations for ensuring site security.
  Site Areas: preamble and schedule of perceived risk and mitigating action for each site area
  Site Structures: preamble and schedule of perceived risk and mitigating action for each building/structure.
  Site Contamination: preamble and schedule of nature of contamination, results of testing and recommendations for controlling pollution together with table of contamination results.
  The Health & Safety Appraisals are accompanied by location plans and photographic record sheets.
- Services: Veryards Limited
  Utility services appraisal: schedule of utility services and comments with accompanying existing utilities location plan.
- Costs: Parry and Dawkin
  Budget costs schedules for the works covered in the report.

4.0 SPECIALIST RECOMMENDATIONS SUMMARY

4.1 Historical and Archaeology Appraisal

The site is of crucial importance to the later history of Swansea and is an important feature in the urban landscape containing one of the very few assemblages of surviving early C19 industrial buildings in Swansea. Any future use must therefore be informed by the correct interpretation of the site and must seek to preserve as much as possible of the buildings as well as respecting the site's topography and geometry.

Archaelogical management recommendations for the site can be summarised as –

- Retention of buildings and structures.
- Relationships of existing site levels to be reflected in any proposed works.
- Any significant works should be preceded by a targeted programme of archaeological fieldwork, in consultation with GGAT Curatorial (and Cadw in the case of the SAM). The detailed recording of any buildings or structure that may be affected by any future proposals and evaluation prior to any disturbance of structures or surfaces.
- Retention of the existing topography and geometry of the site. This is an important consideration for any future interpretation.
- The correct interpretation of the site must be a primary objective of any proposed enhancement/development project.

4.2 Listed buildings and associated structures

The buildings and landscape form a high-visibility site that lies close to the main A4067 route from the M4 into Swansea and can be seen from a number of vantage points in the eastern part of the city. Their conservation and future use are a matter of civic importance. Apart from the Museum Stores, which are in current use, the buildings have suffered severely from recent vandalism including fire, graffiti and active damage and are now in poor to very poor condition without roof coverings, windows or doors.

4.2.1 The archaeological management recommendations and implications for each of the buildings and associated structures are detailed in the archaeological appraisal. In summary the following common recommendations apply –

- Any future use should retain all openings, details and the arrangement of the original internal spaces.
- Any significant works should be preceded by a targeted programme of archaeological fieldwork.

4.2.2 The condition and repairs required to the structure and fabric of the listed buildings are scheduled in the condition appraisal appendix with the recommended objectives as set out below -

- Initial repairs: to secure and make safe and address those immediate concerns.
- Repairs within 5 years: to repair and make weather tight the external envelopes of the buildings to secure against further significant deterioration.
- Repairs within 10 years/long-term: to complete repair works to the external envelop, refurbish interiors, renew services and make good surrounds as part of a programme of future reuse.

4.3 Areas between listed buildings

The structural remains within the study area are not limited to the listed buildings. In between are extensive remains of structures and former surfaces that together increase the Group Value of the site. The geometry of the site is also important and is still preserved in particular its terraced nature and relationship to the Swansea Canal and at its southern end the river.

The areas between the listed buildings, the structures and surfaces they contain, their condition together with management recommendations and implications are detailed in the archaeological appraisal. In general any significant works should be preceded by a targeted programme of archaeological fieldwork.

SPECIALIST RECOMMENDATIONS SUMMARY continued.

4.4 Health and Safety

The Health and Safety considerations of Site Security, Site Areas, Site Structures and Site Contamination are detailed in the respective study appendices. The management recommendations are summarised as follows.

4.4.1 Site Security: introduction of measures for controlling access and monitoring unauthorised activity on the site comprising of –

- Securing site with perimeter fence with controlled points of access (subject to identification of any public rights of way).
- Reduction of vegetation cover
- Improvement of artificial lighting around perimeter of site
- Provision of periodic security patrols

4.4.2 Site Areas: the proposed measures have been based on the consideration that whilst the site on the whole will remain a rough unused area it will be fenced off and no public access will be permitted. Any unprotected drops in excess of one metre have been noted. Lesser drops, being considered to be consistent with the nature of the site, have not been noted. Perceived risks and mitigating action are identified for each site area as follows –

- Unprotected drops – provide secure barriers
- Trip hazards – clear away or fence off
- Stored materials/artifacts – fence off
- Uncovered inspection chambers – fit covers
- Felled trees – clear away
- Opening to water tank – seal off

4.4.3 Site Structures: the proposed measures have been based on the consideration that no public access will be permitted. The minimum structural intervention has been advised consistent with the health and safety requirements. Perceived risks and mitigating action are identified for each of the listed buildings as follows –

- Remove or make secure elements in risk of falling or collapse
- Provide secure barriers to unprotected drops
- Secure perimeter openings to prevent unauthorised entry to buildings

4.4.4 Site Contamination: the scope of the investigation was limited to the taking of surface samples. Some exceptionally high concentrations of arsenic and copper were recorded but not in samples in which contamination was obvious. The levels of arsenic in particular could cause serious harm to children if they ingested any of the most highly contaminated soil. The nature of contamination and the results and detailed recommendations are listed in the site contamination appraisal appendix. The recommendations for controlling pollution are summarised as follows –

- All soil whether or not discoloured should be treated as suspect and both physical contact and exposure to dust etc, should be avoided. Any risk of ingestion should be prevented by the use of suitable protective equipment and careful personnel hygiene.
- Short-term contact with the most contaminated soil may be harmful particularly to small children.
- Avoid disturbance of all existing soil as far as possible. Take steps to control any dust or surface water run-off arising from the site.
- Watch out for discolouration or odour and take samples for testing when carrying out any intrusive work such as excavation for post-holes. Pockets of higher contamination may exist particularly at depth.
- Silt in drains and chambers is likely to contain high levels of contaminants washed from soils and should be handled taking appropriate precautions.
- Put in place a strategy for investigation, control and treatment measures phased in accordance with the planned development of the site.

SPECIALIST STUDY: ARCHAEOLOGICAL APPRAISAL

Appraisal and supporting information prepared by:
Cambria Archaeology, 2002 –2003.
Yorkshire Imperial Metals Site NPRN 300184.

ARCHAEOLOGICAL APPRAISAL CONTENTS

ARCHAEOLOGICAL APPRAISAL CONTENTS continued.

ARCHAEOLOGICAL APPRAISAL CONTENTS continued.

FIGURES

PHOTOGRAPHS

ARCHAEOLOGICAL APPRAISAL CONTENTS continued.

APPENDICES

1.0 SUMMARY

1.1 GENERAL SUMMARY

This report forms part of a study, commissioned by City and County of Swansea Planning Department, on the nature, condition, potential and future management of the buildings and features at the former Yorkshire Imperial Metals Site (YIM) at Landore, Swansea. It should be read in conjunction with the Condition Appraisal of the Listed Buildings produced by Davies Sutton Architecture, the Health and Safety Appraisals produced by Veryards Limited and the Budget Costs produced by Parry & Dawkin.

The site is of crucial importance to the later history and development of Swansea. It represents the Hafod and Morfa Works, two 19th century copperworks which, during the mid 19th century, were the largest in the world. Hundreds of workers were employed, and housed in purpose-built estates in Landore. Copper processing finished in 1980.

The site is also an important feature of the urban landscape. It is one of the very few assemblages of surviving 19th century industrial buildings that survive in Swansea. There are 10 listed buildings on the site, one of them also a Scheduled Ancient Monument, and the incomplete remains of a large number of other structures. The assemblage includes a building from the 1820s, and an engine house with surviving rolling machinery. This study has added 30 new sites to the record.

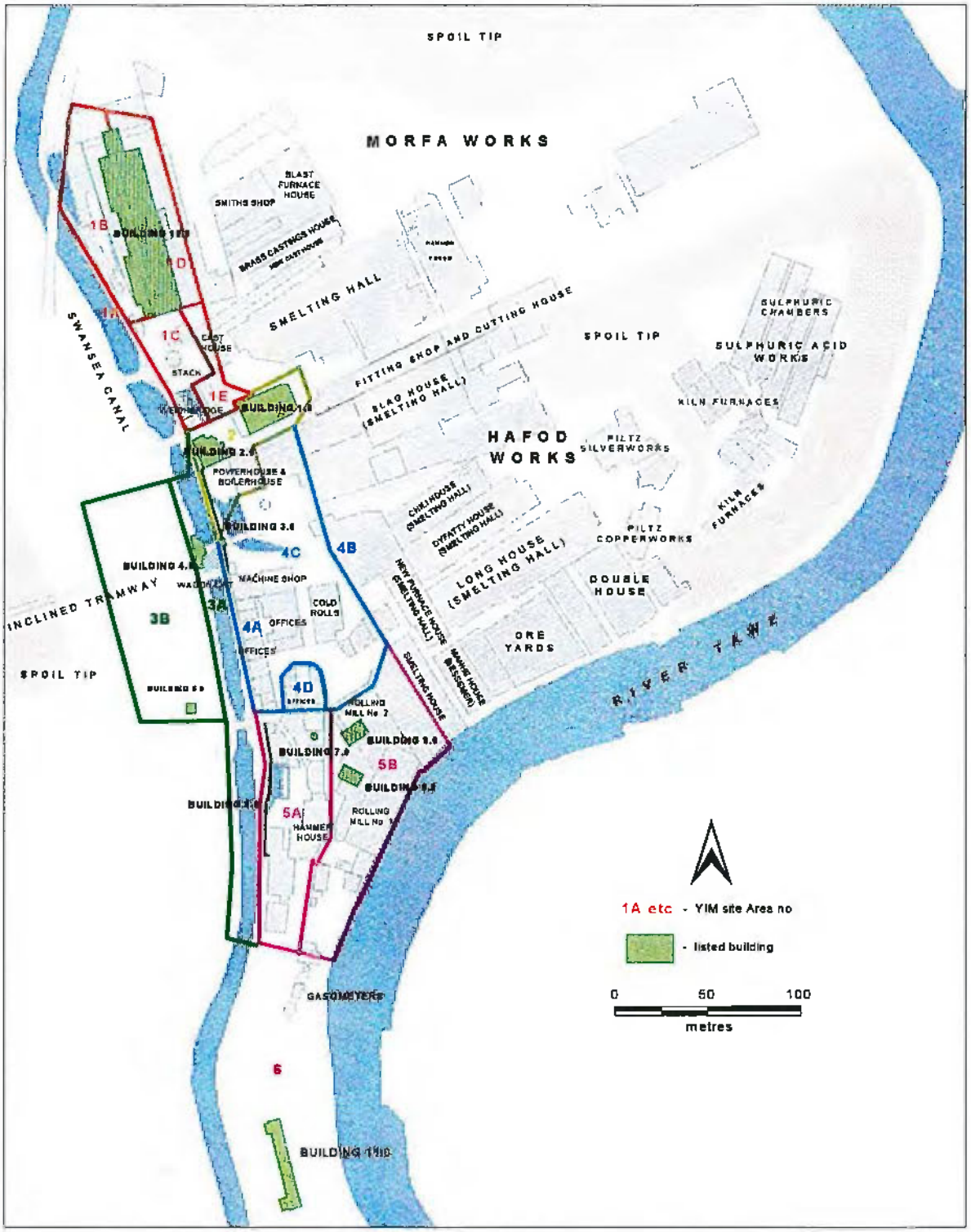
Any future use of the site must preserve as much as possible of the buildings, as well as respecting the topography and geometry of the site. The correct interpretation of the site must also form part of any future development.

1.2 ABBREVIATIONS USED IN THIS REPORT

GGAT -	Glamorgan-Gwent Archaeological Trust
LB -	Listed building
NGR -	National Grid Reference
NLW -	National Library of Wales
NMR -	National Monuments Record (RCAHMW)
NPRN -	National Primary Record Number (RCAHMW)
OS -	Ordnance Survey
PRN -	Primary Record Number (GGAT SMR)
RCAHMW -	Royal Commission on the Ancient and Historical Monuments of Wales
SAM -	Scheduled Ancient Monument
SMR -	Sites and Monuments Record
WGRO -	West Glamorgan Record Office
YIM -	Yorkshire Imperial Metals site

The listed building numbers 1.0 - 10.0 follow those allocated by City and County of Swansea in the project brief (Fig. 1).
The Area designations and Area numbers 1-5 correspond with Veryard's assessment areas (Fig. 1).
NPRNs are numbers allocated in the NMR.
PRNs are numbers allocated in GGAT SMR.
YIM numbers are continued from the YIM numbers allocated by GGAT in 2002 (Locock 2002)

Fig. 1 - The YIM site, showing the study area, listed buildings, site Areas 1- 5 and labelled outlines of former buildings.
(For locations of other structures/archaeological features see Figs. 5.1 - 5.5)



1.3 SUMMARY OF RESOURCE AND MANAGEMENT RECOMMENDATIONS (FIG. 1)

This section is a summary description of the 10 listed buildings and the 5 areas between, their importance and the management issues arising. Issues specific to the historic importance of the buildings and areas, and suggested management strategies, are summarised below.

For general management see the Structural Appraisals produced by Veryards Ltd which form part of this study. Condition and management statements below are general only and reflect archaeological concerns.

Archaeological management recommendations can be summarised as -

- Retention of all buildings and structures
- Retention of existing site levels
- Any significant works should be preceded by a targeted programme of archaeological fieldwork, in consultation with GGAT Curatorial (and Cadw in the case of the SAM). This means detailed recording of any buildings or structures that may be affected by any future proposals, and evaluation prior to any disturbance of structures or surfaces.
- Retention of the existing topography and geometry of the site. This is an important consideration for any future interpretation
- The correct interpretation of the site must be a primary objective target of any proposed enhancement/development project.

1.3.1 Statutory and non-statutory constraints

The study area contains one Scheduled Ancient Monument (Building 9.0, SAM No. Gm 483 – Musgrave Engine House), one Grade II* listed building (also Building 9.0), and 9 Grade II listed buildings (Buildings 1.0 - 8.0; Building 10.0).

The area does not lie within a Registered Historic Landscape. There is no LANDMAP study of the area.

The GGAT Curatorial Section is the archaeological curator for the City and County of Swansea area, and are one of the statutory consultative bodies for the site. Cadw is the curator of the SAM (Building 9.0). Swansea Museum Services currently lease and maintain Building 10.0 (rolling mill) as a museum store.

Consideration should be given to other consultative bodies, in particular regarding any public rights-of-way through the site. The north end of the infilled canal is a public open space, where liability for the maintenance of the boundary wall, which is in poor condition, may become an issue. Consultation over ecological issues may also be considered as the natural colonisation of former industrial sites has been highlighted in recent years.

1.3.2 Value assessment criteria

The value of listed buildings and the areas between have been categorised in accordance with criteria defined in Paragraph 3.4 of Department of Transport/Welsh Office/Scottish Office Design Manual for Roads and Bridges, Vol. 11, Section 3, Part 2 (Cultural Heritage) -

Value category A - sites of national importance
Value category B - sites of regional importance
Value category C - sites of local importance
Value category D - sites of low importance

1.3.3 Listed Buildings and Scheduled Ancient Monument

BUILDING 10.0 - MUSEUM STORE (FORMER MORFA ROLLING MILL)
NPRN 34123; NGR SS 6607 9524
Status - LB II
Value - A
Date - 1828, 1840s and later
Type - Copper rolling mill
General condition - Good
Management recommendations/implications - Retain building. Any future use should retain all openings and detail and the internal space. Nb its current use as a museum store. The cutting revetment wall may require consolidation. Any significant works should be preceded by a targeted programme of archaeological fieldwork.

BUILDING 1.0 - MORFA CANTEEN (FORMER ELECTRIC POWERHOUSE)
NPRN 34125; NGR SS 6613 9516
Status - LB II
Value - A
Date - 1890s; 1920s-30s
Type - Electricity power house
General condition - Poor
Management recommendations/implications - Retain building. Any future use should retain all openings and detail and the arrangement of the original internal spaces (the brick walls can be removed from the eastern space). Nb. built over pond. Any significant works should be preceded by a targeted programme of archaeological fieldwork.

BUILDING 2.0 - MORFA LABORATORY
NPRN 34124; NGR SS 6610 9512
Status - LB II
Value - A
Date - c.1830; 1880s
Type - Offices; assay house
General condition – Very poor
Management recommendations/implications - Retain building if structurally possible. Any future use should retain all openings and detail and the arrangement of the original internal spaces. Nb. partly built over former wet area(s). Any significant works should be preceded by a targeted programme of archaeological fieldwork.

BUILDING 3.0 - HAFOD PIER AND ADJOINING CANAL WALL
NPRN 34892; NGR SS 6610 9508
Status - LB II
Value - A
Date - 1809 (wall); c.1850 (pier
Type - Tramway inclined plane; wall
General condition - Wall very poor; pier poor-fair
Management recommendations/implications - Retain wall if structurally possible. Pier - Retain as existing. Any significant works should be preceded by a targeted programme of archaeological fieldwork.

BUILDING 4.0 - HAFOD COPPER SLAG ABUTMENT
NPRN 34891; NGR SS 6609 9507
Status - LB II
Value - A
Date - c.1850
Type - Tramway inclined plane
General condition - Fair
Management recommendations/implications - Retain as existing.

BUILDING 5.0 - HAFOD LIME KILN
NPRN 85021; NGR SS 6609 9499
Status - LB II
Value - A
Date - mid 19th century
Type - Limekiln
General condition – Poor.
Management recommendations/implications - Retain as existing. Requires consolidation of pot top, and vegetation control and maintenance.

BUILDING 6.0 - HAFOD CANAL BOUNDARY WALL
No NPRN? (YIM 2); NGR SS 6613 9494
Status - LB II
Value - A
Date - 1809 onwards
Type - Wall
General condition – Poor – very poor
Management recommendations/implications - Retain wall if structurally possible. Any significant works should be preceded by a targeted programme of archaeological fieldwork.

BUILDING 7.0 - HAFOD VIVIAN CHIMNEY
NPRN 300187; NGR SS 6615 9496
Status - LB II
Value - A
Date - 1860-62
Type - Chimney stack
General condition – Poor-fair
Management recommendations/implications - Retain as existing.

BUILDING 8.0 - HAFOD VIVIAN ENGINE HOUSE
NPRN: 33743; NGR: SS 6617 9497
Status - LB II
Value - A
Date - 1860-62
Type - Engine House
General condition - Poor
Management recommendations/implications - Retain as existing, with consolidation where necessary. Detailed building recording has already been undertaken so no further recording is necessary prior to any works.

BUILDING 9.0 - HAFOD MUSGRAVE ENGINE HOUSE
NPRN: 33710; NGR: SS 6617 9495
Status - SAM; LB II*
Value - A
Date - 1910
Type - Engine House
General condition - Poor
Management recommendations/implications - Retain as existing. Consolidation where necessary. Detailed building recording has already been undertaken so no further recording is necessary prior to any works.

BUILDING 11.0 - HAFOD VIVIAN LOCOMOTIVE SHED
NPRN: 300 188; NGR: SS 6614 9474
Status - LB II
Value - A
Date – 1920's
Type – Locomotive Shed
General condition – Very poor
Management recommendations/implications – The building will require significant remedial works, which should be preceded by a targeted programme of archaeological recording.

1.3.4 Areas between the Listed Buildings

AREA 1A (MORFA) - AROUND BUILDING 10.0
NGR - SS 6603 9525
Value - B
Summary - The canalside boundary wall to the west of the rolling mill (**YIM 25**)
Archaeological potential (below-ground) - High
General condition – Poor-very poor.
Management recommendations/implications - Site/canalside boundary wall **YIM 25** - consolidation, where it is bowing into a public open space, must be a priority. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 1B (MORFA) - AROUND BUILDING 10.0
NGR - SS 6604 9526
Value - B
Summary - The strip between the canalside wall and Building 10.0 including former canal basin **PRN 1046.35w**, and former structures **YIM 25, 26** and **27**
Archaeological potential (below-ground) - High
General condition - Poor
Management recommendations/implications - Surfaces - general consolidation and maintenance at existing levels. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 1C (MORFA) - AROUND BUILDING 10.0
NGR - SS 6608 9518
Value - B
Summary - A revetted area to the south including chimney stack **YIM 07**, weighbridge office **YIM 30**, former canal basin **YIM 32** and former building **YIM 29**.
Archaeological potential (below-ground) - High
General condition - Poor
Management recommendations/implications - Buildings (**YIMs 7, 30** and **31**) - Retain as existing. Surfaces - general consolidation and maintenance at existing levels. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 1D (MORFA) - AROUND BUILDING 10.0
NGR - SS 6608 9527
Value - B
Summary - The strip east of the rolling mill including engine house **YIM 09**
Archaeological potential (below-ground) - High
General condition - Fair
Management recommendations/implications - Building **YIM 9** - Retain as existing
Surfaces - general consolidation and maintenance at existing levels. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 1E (MORFA) - AROUND BUILDING 10.0
NGR - SS 6610 9511
Value - B
Summary - A section between Buildings 10.0 and **1.0** including a revetment wall **YIM 8** and the remains of former buildings **YIM 10** and **28**, which revet the higher area
Archaeological potential (below-ground) - High
General condition - Poor
Management recommendations/implications - Buildings (**YIMs 10** and **28**) - Retain as existing. Revetment walls (**YIM 8**) - require vegetation control and maintenance. Some of the openings/insertions may require consolidation. Surfaces - general consolidation and maintenance at existing levels. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 2 (MORFA/HAFOD) - AROUND BUILDINGS 1.0 AND 2.0
NGR - SS 661 949
Value - B
Summary - an area immediately south of Buildings 1.0 and 2.0, at the higher site level, on the site of former canal basin **YIM 12**, former building **YIM 14** and former powerhouse/boilerhouse **YIM 36**, and the remains of later 20th century structures **YIM 37**.
Archaeological potential (below-ground) - High
General condition - Poor
Management recommendations/implications - Walls **YIM 37** - Retain as existing. Surfaces - general consolidation and maintenance at existing levels. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 3A (HAFOD) - WEST OF THE SITE
NGR - SS 661 949
Value - B
Summary - Part of Swansea Canal (**NPRN 34504**) including Building 4.0 (copper-slag abutment) and Hafod main entrance bridge **YIM 38**
Archaeological potential (below-ground) - High
General condition - Poor-very poor.
Management recommendations/implications - Canal (**NPRN 34504**) - consolidation of canal revetment wall and Hafod bridge (**YIM 38**) as necessary. Remove vegetation. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 3B (HAFOD) - WEST OF THE SITE
NGR - SS 6603 9525
Value - C
Summary - An area to the west of the canal including Building 5.0 (limekiln)
Archaeological potential (below-ground) - Unknown
General condition - Poor/unknown.
Management recommendations/implications - Cannot be assessed without removal of vegetation

AREA 4A (HAFOD) - BETWEEN BUILDING 1.0 AND BUILDINGS 7.0 - 9.0
NGR - SS 6611 9504
Value - B
Summary - The canalside boundary wall (**YIM 1/15**), including former wagon-lift **YIM 34**, and building range **YIMs 1/15, 39, 40 and 41**
Archaeological potential (below-ground) - High
General condition - Poor-very poor
Management recommendations/implications - Site/canalside boundary wall (**YIM 1/15**) - consolidation, where it collapsing. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 4B (HAFOD) - BETWEEN BUILDING 1.0 AND BUILDINGS 7.0 - 9.0
NGR - SS 6616 9506
Value - B
Summary - The revetment walls (**YIM 42 and 43**) and bank between the higher and lower levels of the site, including cold-rolling mill **YIM 44**
Archaeological potential (below-ground) - High
General condition - Poor-very poor
Management recommendations/implications - Walls - Retain all walls and consolidate where necessary including openings. Clearance of vegetation. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 4C (HAFOD) - BETWEEN BUILDING 1.0 AND BUILDINGS 7.0 - 9.0
NGR - SS 6615 9505
Value - B
Summary - The revetted platform between areas 4A and 4B including the floor surfaces belonging to former machine shop **YIM 16**, former powerhouse/boilerhouse **YIM 36** and former cold-rolling mill **YIM 44**, and the site of canal basin **YIM 12**
Archaeological potential (below-ground) - High
General condition - Poor-very poor
Management recommendations/implications - Surfaces - general consolidation and maintenance at existing levels. Vegetation removal and control. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 4D (HAFOD) - BETWEEN BUILDING 1.0 AND BUILDINGS 7.0 - 9.0
NGR - SS 6615 9500
Value - B
Summary - The southern end of revetted platform, including office building **YIM 5** and revetment wall **YIM 45**
Archaeological potential (below-ground) - High
General condition - Very poor
Management recommendations/implications - Walls - retain as existing. Consolidate as necessary, paricularly openings. Surfaces - general consolidation and maintenance at existing levels. Stabilise eastern section of **YIM 5**. Vegetation removal and control. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 5A (HAFOD) - AROUND BUILDINGS 7.0, 8.0 AND 9.0
NGR - SS 6614 9494
Value - B
Summary - A terraced section around Building 7.0, including terrace/former rail-bed **YIM 46**, the remains of boilerhouse **YIM 47** and office **YIM 48**, wall **49**, and the sites of former canal basin **YIM 20** and hammer house **YIM 50**
Archaeological potential (below-ground) - High
General condition - Very poor
Management recommendations/implications - Walls - Retain all walls and consolidate where necessary including openings. Clearance of vegetation. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 5B (HAFOD) - AROUND BUILDINGS 7.0, 8.0 AND 9.0
NGR - SS 6618 9495
Value - B
Summary - An area around Buildings 8.0 and 9.0, including rolling mill floor surfaces **YIM 51** and **52**
Archaeological potential (below-ground) - High
General condition - Poor-very poor
Management recommendations/implications - Surfaces - general consolidation and maintenance at existing levels. Vegetation removal and control. General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

AREA 6 (HAFOD) – BETWEEN BUILDINGS 7.0-9.0 AND BUILDING 11.0
NGR - SS 6613 9480
Value - B
Summary - An area between Buildings 7.0-9.0 and - Building 11.0, including the remains of gasometers
Archaeological potential (below-ground) - High
General condition – Not assessed
Management recommendations/implications – Not assessed

2.0 INTRODUCTION

2.1 GENERAL DESCRIPTION

The study area is 4.3ha in extent. It comprises the western edge of the former Hafod and Morfa Copperworks (NPRN 300184), which merged in 1924 and were acquired by Yorkshire Imperial Metals in 1957, and are therefore widely known as the YIM site. It lies on the west bank of the River Tawe, bounded to the west by the Swansea Canal which was established in 1794-8 to open up the coal trade at head of Swansea Valley (Hughes and Reynolds 1988, 32).

Copperworking ceased in 1980 and the site was acquired by (then) Swansea City Council. Much of it was cleared. The A4067/A4217 Cross Valley Link Road was carried through the centre of the site in the early 1990s, and light industrial units established in the eastern half. A further 20% of the site was covered over by the car park for the Landore Park-and-ride scheme, which adjoins the study area to the east, in the early 2000s.

2.1.1. The importance of the site

Hafod Copperworks was, at its peak in the mid 19th century, the largest in the world, with the greatest output. Morfa followed closely behind and between them, the 13 copperworks in the Lower Swansea Valley accounted for 90% of the world's copper production (Hughes and Reynolds 1988, 11).

Ten listed buildings (LBs) occupy the site, all within the study area. One of them is also a SAM. It is one of the very few assemblages of surviving 19th century industrial buildings left in Swansea but they are generally in poor or very poor condition. One of the LBs includes masonry from the 1820s, while the SAM has a surviving steam engine from 1910, and rolling-machinery. The former Swansea Canal has largely been filled in but is still definable. The study area also contains the only surviving limekiln (LB) from the complement of 54 that were formerly strung along the canal (Hughes and Reynolds 1988, 9).

The structural remains within the study area are not limited to listed buildings. In between are extensive remains of structures, and former surfaces, which together increase the Group Value of the site. Two further LBs, belonging to the works, lie immediately south of the study area. The extensive use of local building stone (Pennant sandstone), and copper-slag blocks manufactured on the site itself, are an important contribution to the 'sense of place'.

The geometry of the site is also important, and is still preserved, in particular its terraced nature and relationship with the Swansea Canal, and at its southern end, its relationship with the river.

However, the greater proportion of the buildings, including the main smelting halls which contained early components, lie beyond and to the east of the study area, which has been cleared. This increases the importance of preserving the remaining elements of the site, and their geometry.

The buildings and landscape form a high-visibility site that lie close to the main A4067 route from the M4 into Swansea, and can be seen from a number of vantage points in the eastern part of the city. Equally important is its relationship with the Landore Park-and-ride site. Their conservation and future use are a matter of civic importance. The buildings have suffered severely from recent vandalism, including fire, active damage and graffiti. Significant areas of the site are also heavily overgrown.

2.1.2 Location and topography

The study area lies on sloping ground on the west bank of the River Tawe in the Lower Swansea Valley, between the former Swansea Canal, the Landore Park-and-ride scheme and the river. The valley is steep-sided here, but is fairly wide and the works mainly occupy an alluvial floodplain within a loop of the river. The solid geology of the valley sides and surroundings is predominantly Coal Measures, but there are outcrops of Pennant Sandstone from which a significant number of the buildings are constructed. The environs are largely occupied by housing, and road- and railways. However, the eastern valley sides include substantial areas of undeveloped land which have been restored to their natural vegetation (with some conifer planting) within the last 30 years.

Both Hafod and Morfa Works were established on greenfield, if not virgin sites, shown empty on a map of the 1790s (Swansea Museum Service, Factsheet 10, 30) and owned by the Duke of Beaufort from whom the Hafod and Morfa sites were initially leased (tithe map, St John-juxta-Swansea parish, 1844). A long field boundary, shown on both maps, persisted as the boundary wall between the two sites until the 1980s.

The main body of both Hafod and Morfa Works lay on the level ground of the floodplain, enclosed within the loop in the river. The site came to extend over 20ha in all, but about 50% of this area was occupied by spoiltips, the remaining free space being densely packed with buildings. This area of the site is now cleared and largely underlies the Cross Valley link road and Landore Park-and-ride site.

However the study area, which comprises approximately 10% of the former area of the works, along their west side, is terraced into the valley slope. It comprises two main levels

- an upper level, averaging 40m in width, on the level of the canal, and
- a lower level, on the level of the floodplain and the bulk of the works.

The geometry was deliberate. Coal was emptied from canal barges, at the upper level, to supply copper smelting halls situated on the floodplain. The difference in level is only 1m at the north end of the site, but increases to approximately 5m at the south end. The upper level appears to comprise 50% natural ground and 50% made ground.

2.2 CONTEXT AND SETTING

2.2.1 Copperworking at the site

Copper smelting in Swansea had begun in 1717 when Dr John Lane, of Bristol, established a copperworks at Llangyfelach. Thirteen further 18th century works followed (Hughes and Reynolds 1988, 11), and Swansea superseded the Vale of Neath, where copperworks had been established from the late 16th century onwards, as the centre of copper production in Britain (Swansea Museum Service, Factsheet 7, 2).

Hafod was established rather later, in 1808-9, and had supplemented smelting with a rolling mill by 1818 (WGRO D/D NAI M/101/1-15), for rolling copper plates (or 'cakes') produced by the nearby Rose smelting works. The mill was steam-powered from the first. The Morfa Works was established as a steam-powered rolling mill in 1828, but smelting had probably started by 1835 (Hughes and Reynolds 1988, 12). Hafod and Morfa both remained in hands of their founding families until the two works were merged in 1924 (Hughes and Reynolds 1988, 112 *et al.*) but family interests in both sites declined in the 1880s-90s (Swansea Museums Service Factsheet 6, 28, 30).

By the late 18th century the basic processes of copper smelting in Britain had become established - and were always known as 'the Welsh process'. It was described by D. C. Webb (Webb 1812) and Michael Faraday in 1819 (Tomos n.d.). Ore was first heated in 'calcining furnaces' to fuse the ore and drive off impurities, and then tapped off into water to granulate. The grains were then slowly roasted in a succession of 'reverberatory furnaces', for 36-48 hours, during which slag was tapped off. Finally, the copper was either run into pigs, or into water to again granulate.

The copper ore came from Cornwall, carried up the River Tawe, while anthracite came in by canal from the Upper Swansea Valley. The Swansea Canal, running alongside the site, had been opened in 1798. The return trade of copper and coal ensured the success of the Swansea ventures. However, from the 1830s onwards, Cornish ore was gradually supplanted by supplies from Cuba, America and Australia. However Chile became the most important long-term source (Swansea Museum Service, Factsheet 7, 11).

Like most copper smelting works, Hafod and Morfa diversified through the 19th and early 20th centruries with the introduction of subsidiary processes such as rolling, shearing, manufacturing, and the processing of other metals such as silver, lead and zinc (Swansea Museum Service, Factsheet 7, 20).

A useful by-product of the smelting process itself were moulded blocks of copper slag, the use of which was recognised early on - Michael Faraday recorded that at Hafod, in 1819, the smelting furnaces themselves were partly constructed from copper slag blocks (Tomos, n.d.). As a building material, copper-slag was especially popular in Bristol (Hughes 2000, 52-4), but was used extensively on the works site and elsewhere is Swansea. Both unmoulded and moulded slag blocks can be seen in many of the surviving structures, while the curved coping blocks are used both for coping and for decorative facing. The Vivians also patented a copper brick ('Vivian's Patent Brick') which is also used extensively on the site - the Grade II* listed SAM, Building 9.0 (Musgrave Engine House) is constructed almost entirely from this material, which however spalls badly.

The success of the copper industry led to an increase in Swansea's population from 6099 in 1801 to 94537 in 1901 (Morgan 1988, 155). New mines opened up to meet the demand for coal - several of them owned by the Vivian family themselves. And by 1851 the only British copper works outside the region were one on Anglesey and one in Staffordshire (Swansea Museum Service, Factsheet 7, 4).

However, by 1870 the industry was in decline in Swansea, unable to compete because of trade tariffs and smelting at the point of ore production (Hughes and Reynolds 1988, 11). Smelting ceased at Swansea in 1921 and although copper processing continued until 1980, it was only a minor component of the economy. Most of the copperworks sites have now been cleared.

2.2.2 The site in its setting

Hafod and Morfa works lay within a complex of industrial enterprises, which formerly dominated the surrounding landscape either side of the narrow valley of the Tawe, much of which was entirely transformed by the immense slag- and spoil-tips generated by the industries. These are shown on the historic maps in Section 3.3.

Immediately east of Hafod, across the Tawe, were three copperworks, which were to be supplied by Smith's Canal, built in 1783-5 to transport coal from Llansamlet to the Tawe (Hughes and Reynolds 1988, 32). The White Rock Works was the third Swansea copperworks to be established, in 1736 (Hughes and Reynolds 1988, 12). In 1870-71 lead and silver smelting were commenced at the works, which closed in 1924. Immediately to the north lay the Middle Bank Works, another early copperworks established in 1855. Also a lead smelting works, it too closed in 1924. Immediately north again was the Upper Bank Works, commenced in 1757 (Hughes and Reynolds 1988, 12), successively a copper works, Yellow Metal works and spelter works. It closed in 1928.

Sharing the west bank with Hafod and Morfa were a number of other industries. Landore Siemens Steelworks lay some 300m north of the study area. It opened in 1869 and soon expanded to the opposite bank of the river (Hughes and Reynolds 1988, 16). It was acquired as the Mannesmann Tube Works in 1888 (OS 1:2500, 1899 and 1919). Landore Alkali Works, between the steeelworks and the Morfa Works, was established by the Vivians as 'Vivian's Chemical Works' by 1854 (WGRO P/60/CW/204). It continued production until the mid 20th century. Immediately north-west of Morfa Works was the short-lived Mile End Pottery, shown on a map of 1879 (OS 1:2500). South of Hafod, other Vivian industrial concerns ran downstream from the site for nearly a kilometre and included Hafod Phosphate Works, Hafod Foundry, Foundry and Hafod Nickel and Cobalt Works (Hughes 2000, 35; OS 1:2500, 1879).

Most of the works were demolished during the 20th century and little can be seen today, although the remains of White Rock were consolidated and landscaped in the early 1980s, under the then Swansea City Council, and designated as the White Rock Industrial Park. The scant remains of other industrial enterprises survive here and there within the Swansea Valley - the Beaufort Works tin-house, a few colliery engine-houses, and various bits of walling - but they represent a very small fraction of the resource.

However the sites of these works, and more importantly the railway and canal infrastructure, still define the landscape, and certainly influence the settlement and communications pattern. In addition, planned streets of company housing such as 'Vivian's Town', southwest of the site, are still inhabited more-or-less unchanged. Nevertheless, the area is not a Registered Historic Landscape, nor is there a LANDMAP study of the area.

A less welcome by-product of the copper industry was the severe detrimental effect on the environment, caused by the dense clouds of sulphur and arsenic given off by the smelting process and blighted the entire Lower Swansea Valley. As early as 1819 Michael Faraday had commented on the works producing a dense 'plume of (sulphur and arsenic) smoke up the vale' (Tomos, n.d.).

The natural vegetation has however been successful in regenerating itself, although may of the former works sites may still be contaminated. Similarly, many of the former spoil-tips have been landscaped or removed in recent years, meaning that it is now difficult to visualise the industrial landscape. Its correct interpretation must be a primary target of any development/ enhancement project.

2.3 SPECIFICATION AND METHODOLOGIES

2.3.1 Specification

The archaeological survey comprised two elements. The first was a desktop study of relevant archives for cartographic sources, printed sources and selected documentary records. Particular attention was be paid to the collation of maps, plans and other drawings.

The second element was a field survey of the upstanding buildings, walls, structures and other archaeological remains. The desktop study provided information for the structural history of the site and of individual buildings, and data on the location of now demolished and/or buried structures and buildings. The field survey was undertaken in conjunction with, and informed, the architectural and structural surveys. The site as a whole was considered in the study, not just the surviving buildings and structures. There are many areas of archaeological interest on the site in addition to the ten buildings/structures identified in the brief, such as stone and brick retaining walls, cobbled tracks/paths, ancillary structures. For this level of study, detailed elevations and plans will not be required.

Because of the scrub vegetation it was necessary to undertake limited clearance to obtain some of the photographs.

2.3.2 Scope and methodology

This study comprises a review of existing information about the study area. It conforms to the Institute of Field Archaeologists *Standards and Guidance for Archaeological Desk-based Assessments* (1994; amended 1999).

It considers the archaeology of the study area both directly and within its wider local and regional context. All aspects of the resource are considered. Evidence for previous damage to the resource have been noted.

Desktop study methodologies comprised -

- Search of County Sites and Monuments Record and National Monuments Record for information on known sites within, and around, the survey area.
- Searches of cartographic sources held in national and county records offices and other repositories for information regarding the survey area and its environs.
- Searches of primary historic documents held in national and county records offices and other repositories for information relevant to the survey area or its environs.
- Searches of secondary, published sources for information regarding the survey area or its environs.
- Searches of available technical data (i.e. borehole logs; geological survey data) for information relevant to the survey area or its environs.
- Examination of photographic coverage held in local and national repositories.

The field survey comprised –

- Rapidly drawn plans and photographs, compiled by the architects.
- Accompanying archaeological descriptions outlining the structural history of the site as a whole, and of individual buildings and other features of archaeological interest.
- Where it was considered necessary, additional drawings and photographs of features of archaeological interest.
- Annotations of the topographic survey, undertaken by the Structural Engineers.

2.5 ARCHIVE DEPOSITION

The archive, indexed according to the NMR material categories, will be deposited at Swansea Museum. It contains the following:-

A.1. Copy of the final report
A.4. Disk copy of report

B.4. Field notebooks

D.1. Catalogue of site photographs
D.3. CP and Mono prints and negs

G.1. Source documentation

I.4. Final report - manuscript
I.4. Final report - typescript
I.4. Final report - disk
I.4. Proofs

L.1. Project research design/specification
L.4. General admin.

M.1. Non-archaeological correspondence

There is no material for classes **C, E, F, H, J, K** and **N.**

2.6 ACKNOWLEDGEMENTS

This report was researched and written by Neil Ludlow, Cambria Archaeology. Acknowledgements to - Ken Murphy (Project Manager), Gwilym Hughes and other staff of Cambria Archaeology; subconsultants Davies Sutton Architecture, Veryards Ltd. and Parry & Dawkin; Richard Matthews (Cadw); Jeff Saywell (City & County of Swansea) for additional information; Stephen Hughes, David Percival and other staff of RCAHMW; Bernice Cardy and staff of Swansea Museum Service; Neil Maylan, Martin Locock and other staff of GGAT; staff of NLW; staff of WGRO.

3.0 TIMELINES FOR THE WORKS SITE

3.1 HISTORICAL TIMELINE

1809 - Hafod Copperworks established by the Cornishman John Vivian (Hughes 2000, 30). Confined to copper smelting.

1816 - Hafod - John Vivian bought sole rights to 'patent refinery furnace (an adaptation of the standard smelting 'reverberatory' furnace) for £400. Halved smelting time (John and Williams 1980, 70).

1818 - Hafod - steam-powered copper-plate rolling commences (Hughes 2002, 27, 30).

1826 - Hafod - John Vivian succeeded by his son John Henry Vivian (Swansea Museums Service Factsheet 6, 18).

1828 - Morfa Copperworks established by the Cornishman Michael Williams, & J. T. Foster of Norwich, as Williams Foster & Co (Swansea Museums Service Factsheet 6, 29). Until 1835 confined to the steam-powered rolling of copper plate produced by Rose Works (Hughes and Reynolds 1988, 12).

1835 - Morfa expands, and smelting begins, 13 further acres having been added to the site by lease from the Duke of Beaufort in 1831 (Swansea Museums Service Factsheet 6, 18, 29)

1840 - Morfa - fire at works.

1840s - Morfa - workforce rises from c.450 to 700 (John and Williams 1980, 67).

1852 - Hafod - simplified plan of smelting hall reproduced in Tomlinson's *Cyclopoedia* (Hughes 2000, 29-30).

1855 - Hafod - John Henry Vivian succeeded by his son Henry Hussey Vivian, later Lord Swansea (Swansea Museums Service Factsheet 6, 20).

1861 - Morfa - Michael Williams son, John Michael Williams, secures almost complete control of the firm (Swansea Museums Service Factsheet 6, 29).

1863 - Hafod - report on pollution published, arising from experiments with blast-furnaces in 1859 (Locock 2002, 14). As a result, in 1865 the furnaces were replaced by 'Gerstenhofer' furnaces which converted the fumes into sulphuric acid, and a sulphuric acid processing works was established on site (Hughes 200, 25, 30; Swansea Museums Service Factsheet 6, 23), and in 1885 a Bessemer Convertor.

1870 - Beginning of decline in Swansea Copper industry.

1888 - Morfa - H. R. Merton & Co. take a controlling interest in the firm after John Michael Williams death in 1880 (Swansea Museums Service Factsheet 6, 30). Yellow Metal plant established (Yellow Metal, or Muntz Metal, was a zinc/copper alloy).

1889 - Hafod - workforce had declined to 300 (John and Williams 1980, 67).

1894 - Hafod - Henry Hussey Vivian dies. Afterwards family interest in the firm declines (Swansea Museums Service Factsheet 6, 28).

1921 - Hafod and Morfa, the last copper smelting works left in Swansea, cease smelting. From now on the works concentrate on refining ore (Hughes and Reynolds 1988, 11-12). The Raw material was blister copper which was refined and sheet-rolled; India was the biggest customer (National Industrial Development Council of Wales & Monmouthshire 1937, 131).

1924 - Merger of Hafod (under Vivian & Sons) and Morfa (under Williams & Foster), and their acquisition by British Copper Manufacturers Ltd. (Hughes and Reynolds 1988, 12).

1920s - Output from works declined from £2,472,000 in 1924 to £1,468,000 in 1930, and the number of employees from 2078 to 878 (National Industrial Development Council of Wales & Monmouthshire 1937, 131).

1928 - British Copper Manufacturers Ltd. absorbed by ICI Metals Division (Hughes and Reynolds 1988, 12). Hafod and Morfa produced 'copper, brass and alloy sheets, copper plates, rods, rivets, forged copper bottoms, pans, locomotive boilers, yellow metal, spelter, lead piping and sheets, sulphuric acid, zinc chloride and superphosphates' (Swansea Museum Service Factsheet 7, 33).

1930s - Rolling at Morfa, and sulphuric acid production at Hafod, both ceased. Works concentrated on refining, and the processing of Yellow Metal.

1940s - ICI Metals Division employ 2600 at Hafod and Morfa, for the war effort (Swansea Museum Service Factsheet 7, 33).

1957 - Hafod and Morfa taken over by Yorkshire Imperial Metals, a joint firm of ICI Metals Division and Yorkshire Metals (Swansea Museum Service Factsheet 7, 33).

1959 - Only 359 employees at Hafod and Morfa (Swansea Museum Service Factsheet 7, 33).

1967 - Copper refineries at Hafod and Morfa closed. Production mainly limited to locomotive plate forge and zinc chloride (Swansea Museum Service Factsheet 7, 33-4).

1971 - Only 170 employees at Hafod and Morfa, chiefly employed at Hafod rolling mill (Swansea Museum Service Factsheet 7, 34).

1980 - Yorkshire Imperial Metals closes (Hughes and Reynolds 1988, 12). YIM site acquired by (then) Swansea City Council. Much of site cleared.

3.2 DEVELOPMENTAL TIMELINE

See overall Fig. 1, Area Figs. 5.1.1 - 5.1.5 and historic maps and plans in Section 3.3 (Figs. 2-9).

1798 - Swansea Canal (NPRN 34504) fully opened, to open up coal trade at head of Swansea Valley (Hughes and Reynolds 1988, 32).

1809 - Hafod Copperworks established (Hughes 2000, 30). Confined to copper smelting, undertaken in a large smelting hall (the 'Long House'), measuring 110m by 30m and running E-W through the site east of the study area (plan of c.1920, Swansea Museum Stores, YIM). It may have contained 24 reverberatory furnaces, in pairs either side of tramway running to the first (eastern) spoiltip, where the waste was dumped. Calcining furnaces along south side. Simplified drawing in Tomlinson's *Cyclopoedia* (1852) shows the 'Long House' with 11 large open arches on south (river) side for ventilation and fuelling, and a hipped roof.
Three large ore yards established between the Long House and the Tawe to the south, with wharves (plan of c.1920, Swansea Museum Stores, YIM).
Northern canal basin constructed (YIM 12, Area 2) to supply furnaces with coal (Hughes 2000, 30).
Canalside walls built (Buildings 3.0 and 6.0, YIMs 1/15, 25).
Works entrance and bridge (YIM 38, Area 3) established (WGRO P/60/CW/204).

1818 - Hafod - steam-powered rolling commences in Mill No. 1, on site of later Musgrave rolling mill (YIM 51, Area 5). Engine-house occupied site of present Building 9.0 (Musgrave Engine House), with 40" steam engine. Roll-trains, and reheating furnaces, in long SW-NE running building to SE. water conveyed to engine via 10" pipes from canal (WGRO D/D NAI M/101/1-15; M/463/1-39).
Southern canal basin constructed (YIM 20, Area 5) to supply furnaces and engine with coal (Hughes 2000, 30).

1820 - Hafod - Erection of Hammer House, for reheating furnaces and steam-hammer used in manufacture of copper vessel etc., in (YIM 50, Area 5) immediately SW of Building 9.0? (WGRO D/D NAI M/101/18; Hughes 2000, 30, 36, 42).
Establishment of gasworks at southern end of site including gasometers; provision of gas-lighting in works (WGRO D/D NAI G/24/1-23).

1821 - Hafod - construction of horizontal flue from the Long House to a stack 100m from the works, 'on the marsh' (Locock 2000, 15)

1822 - Hafod - addition of a second smelting house, the 'new furnace house', a N-S running building at the NW corner of the Long House, for 8 more reverberatory furnaces (Hughes 2000, 30, 34; plan of c.1920, Swansea Museum Stores, YIM).

1826 - Hafod - addition of a third smelting house, 'Dyfatty House', running E-W against N side of the Long House, for 9 more reverberatory furnaces (Hughes 2000, 30, 34; plan of c.1920, Swansea Museum Stores, YIM).

1828 - Morfa Copperworks established. Confined to the steam-powered rolling of copper brought from the Rose Works (Hughes and Reynolds 1988, 12).
First phase of Building 10.0 (rolling mill).
First phase of Building 2.0 (laboratory).
Canalside walls built (YIM 25, Area 1).
Northern canal basin established (PRN 1046.35w, Area 1) to supply mill reheating furnaces and engine with coal.
Works entrance and bridge (YIM 35, Area 1) established (WGRO P/60/CW/204).

1830 - Hafod - extensive new tramways laid through site, presumably to all smelting halls; ore drawn up to halls, from riverside wharves, by a 2hp steam engine (WGRO D.255).

1831-2 - Hafod - construction of 2 stacks 'at extremes of site' (Locock 2002, 15; WGRO D.255).

1833 - Hafod - completion of a fourth smelting house, 'Chili House', running E-W against N side of Dyfatty House, for 13 more reverberatory furnaces (Hughes 2000, 30, 34; plan of c.1920, Swansea Museum Stores, YIM).
Morfa - establishment of gasworks including gasometer (location unknown); provision of gas-lighting in works (WGRO D/D NAI G/30/1-4).

1830s - Hafod - construction of a fifth smelting house, the 'Slag House', running E-W against the boundary with Morfa Works, for up to 7 more reverberatory furnaces (Hughes 2000, 30, 34; plan of c.1920, Swansea Museum Stores, YIM).
Row of stores/offices/machine shops constructed against canalside boundary wall, north of main entrance (YIM 1/15, Area 4), between 1810 and 1844.

1834 - Hafod - installation of waterwheel to power copper shears. The location of this wheel and leat is unknown (WGRO D/D NAI M/101/19-20).

1835 - Morfa -
Smelting begins, in long E-W smelting hall (later Yellow Metal Mill), measuring 100m by 30m, east of the study area (shown on Railway Deposited Plan of 1835, WGRO P/60/CW/197 - Fig. 3).
Works already occupies nearly all of its maximum extent.
Southern canal basin established (YIM 32, Area 1) to supply furnaces with coal.
Pond (function?) established on site of later Building 1.0 (Canteen).
Morfa Quay constructed to unload copper ore for the works (Hughes and Reynolds 1988, 12).
Spoil tips established in northern half of site.

Hafod -
Works had already grown to its maximum extent and occupies entire site (WGRO P/60/CW/197).
Building of unknown function in Area 2, against later Building 2.0 south wall (YIM 14, Areas 2 and 4), part of a complex extending over west half of remainder of site (later boiler houses and tank rooms - YIM 36), built 1820s-30s (WGRO P/60/CW/197; OS 1:25000, 1879 - Figs. 3 and 5).
The first (eastern) spoiltip was retained by the boundary wall between the two works, apparently over 3m tall, and made of copper slag (Swansea Museums Service Factsheet 6, 24).

1840 - Morfa - Rolling mill burnt down. Rebuilt as longer mill Building 10.0.
Cast house/silver works, and stack (YIMs 7 and 10, Area 1) constructed (Swansea Museums Service Factsheet 6, 29; tithe map, 1944; WGRO P/60/CW/204).

1840s - Hafod - Construction of a sixth smelting house, the 'Smelting House', as two long, parallel buildings running N-S between the ore yards and No. 2 rolling mill (Hughes 2000, 30, 35; plan of c.1920, Swansea Museum Stores, YIM).

1847 - Hafod - steam-powered rolling mill No. 2 established (YIM 52, Area 5). Engine-house occupied site of present Building 8.0, the Vivian Engine House (WGRO D/D NAI M/463/77-99; Hughes 2002, 30).

1850 - South Wales Railway main line, begun 1845, opens through Swansea Valley, running alongside site immediately west of Swansea Canal. Acquired by GWR in 1863 (Hughes and Reynolds 1988, 43).

c.1850 - Hafod - establishment of second (western) spoiltip and construction of inclined tramway, with pier (Building 3.0) and copper slag abutment (Building 4.0). Wagons hauled up tramway by a small steam-engine in an engine-house on the spoiltip.

1859 - Hafod - Silver smelting works established between the Long House and the first (eastern) spoiltip, with 3 Piltz blast furnaces
Copper Piltz furnace house also constructed to south of silverworks (Hughes 2000, 36; Swansea Museum Stores c.1920 plan, YIM)

1862 - Hafod - Building 8.0 (Vivian Engine House) completed (begun 1860). Flue ducted into the contemporary chimney stack (Building 7.0).

1865 - Hafod - Sulphuric Acid Works established on first (eastern) spoiltip, into which waste-gases were diverted (Hughes 2000, 25, 32).

1870s - Hafod - Construction of a wagon-lift (YIM 34, Area 4), between the inclined tramway to the second (eastern) spoiltip, and the South Wales main railway line (OS 1:2500, 1879: Hughes 2000, 98).
Hafod Offices (now Social Club) constructed west of Swansea Canal (NPRN 300190).

c.1840-79 - Extensive development at both sites, shown on the Ordnance Survey 1:2500 First Edition map (Glamorganshire Sheet XXIV.1, Fig. 5), the earliest detailed map of Hafod and Morfa Works, including -

Morfa -
Second bridge built over the canal (YIM 33, Area 1)
Outside study area -
'New' cast house built north of smelting hall, described by A. J. Parkinson in 1978 as having 'original mid 19th century round-headed casement windows' (NMR archive)
Hammer forge building built east of smelting hall
Fitting shop built south of smelting hall, described by A. J. Parkinson in 1978 as a 'mid 19th century, masonry building with cast-iron windows and a timber, queen- and princess-post trussed roof' (NMR archive)
Timber yard established in east half of site, and a large building of unknown function

Hafod -
Buildings established on higher ground to east of site including sites of cold-rolling mill (YIM 44) and machine shop (YIM 16), both Area 4.
Building 5.0 (Limekiln) probably built during this period.
Tramway established at southern end of site (Area 5), on site of later railway.
Outside study area -
Building established on site of later 'Double House'

1880s - Morfa - Building 2.0 (Laboratory and Porter's Lodge) rebuilt in its present form.
Railway constructed across part of Swansea Canal and Morfa Works north canal basin.

1885 - Hafod - Construction of the 'Manhe House', for the Bessemer Convertors (Hughes 2000, 25, 30; Swansea Museum Service, Factsheet 7, 33), over the westernmost riverside ore yard south of the 'Long House' (plan of c.1920, Swansea Museum Stores, YIM).

1890s - Morfa - Building 1.0 constructed as electric power house. Works supplied with electricity.
Yellow Metal plant established within main smelting hall (Yellow Metal, or Muntz Metal, was a zinc/copper alloy).

1879-99 - Some development at both sites, shown on Ordnance Survey 1:2500 Second Edition map (Glamorganshire Sheet XXIV.1, Fig. 6), including -

Morfa -
Building 10.0 (rolling mill) enlarged to north, west and east.
Silver works/cast house (YIM 10, Area 1) enlarged
Railway established across part of Swansea Canal and north canal basin (Area 1A).
Outside study area -
Large block (later containing blast furnaces and nickel silver works) erected on north side of smelting hall
Timber yard to east, and large building of unknown function gone (footprint shown)

Hafod -
Outside study area -
Building established on site of later ore yard, with wharf, between 'Double House' and Tawe
'Manhe House', with Bessemer converter, on site of western ore yard

1900s - Morfa Offices ('Coteglade building') constructed west of Swansea Canal (NPRN 300185).

1902 - Swansea Canal no longer profitable and becomes disused (Hughes and Reynolds 1988, 32).

1910 - Hafod - Building 9.0 (Musgrave Engine House) built in Area 5, on footprint of 1818 engine house, with contemporary Musgrave uniflow engine to drive rolling mill No. 1, YIM 51 (Hughes 2002, 30 et al.)

c.1910 - Hafod - much of works re-roofed with steel stanchions (Hughes 2000, 32)

1899-1919 - Little development at either site shown on Ordnance Survey 1:2500 Second Edition map (Glamorganshire Sheet XXIV.1, Fig. 7), but includes -

Morfa -
Outside study area -
Block (later containing dressing house and warehouse) built east of hammer forge.

Hafod -
Boilerhouse (and powerhouse?), with polygonal stack, built against south wall of Building 2.0 in Area 2 and 4 (YIM 36).
Boilerhouse YIM 47 established immediately north of Building 7.0 (Vivian Stack) in Area 5.
Outside study area -
Gasometers, from 1820, removed (but semicircular retaining wall is shown)
New ore yard, with wharf, established between 'Double House' and Tawe; wharf with new features Transporter House and aerial conveyor to the Sulphuric Acid Works ore crusher.

1921 - Hafod and Morfa cease smelting (Hughes and Reynolds 1988, 11-12). From now on the works concentrate on refining ore and processing of Yellow (or Muntz) Metal.

c.1922 - Tramway at south end of site replaced by standard gauge line for Beyer-Garrett locomotive, and Engine Shed constructed.

c.1928 - Hafod - First labelled overall plan of works (Swansea Museum Stores, YIM; Fig. 8). Identical to the 1919 1:2500 OS map, except labelling. Hafod Works is already supplied with electricity, but no power-plant is shown.

1931 - Swansea Canal finally closed (Hughes and Reynolds 1988, 32).

1930s - Hafod is transformed as shown on a detailed, labelled plan of 1943 (Swansea Museum Stores, YIM, Fig. 9). Smelting ceased in 1924 and the smelting halls have all been variously demolished or converted. Morfa's layout is little altered, although rolling has ceased.

Morfa -
Rolling mill Building 10.0 is given over to nickel and silver processing and reduced to present size. Engine house built (YIM 9, Area 1).
Southern canal basin YIM 32 is infilled and the weighbridge office constructed (YIM 30, Area 1).
Outside study area -
Smelting hall is converted to Yellow Metal Mill.
Refining plant erected in the east half of the site
'New flanging shop' erected to south of refining plant
Site rail network radically changed

Hafod -
The inclined tramway over the canal, and wagon-lift, demolished (Area 2).
Both canal basins (YIMs 12 and 20Areas 2, 4 and 5) filled in, and the coal bunkers removed.
Office buildings YIM 48 (Area 5), south of Building 7.0 (Vivian Stack) removed
Hammer House YIM 50 (Area 5) demolished
New buildings include a new electricity power house and boiler house against the south wall of Building 2.0 (YIM 36, Area 2 and 4)
Site rail network radically changed
Outside study area -
Four of the disused smelting halls - the Long House, Dyfatty House, Chili House and Slag House - and the two Piltz furnace houses, entirely demolished.
The 'New Furnace ' converted into a warehouse.
The 'Smelting House' converted into a pickling and cutting house
The 'Manhe House' converted into a pickling house and warehouse
The ore yards converted into a cold-rolling building and warehouse
Sulphuric Acid Works closed and dismantled (Swansea Museum Service Factsheet **7**, 33)
Buildings against the boundary with Morfa Works removed.
Both rolling mills, and Buildings **7**.0, 8.0 and 9.0, retained, mill No. 1 as 'Plate Mill', mill No. 2 as 'Sheet Mill'.

1967 - Hafod and Morfa cease copper refining. Rolling continues at Hafod, and the production of locomotive plate forge and zinc chloride in unidentified buildings. Alloy casting and machining at Morfa.
Overall area of works reduced to 27 acres; the rest is sold to Swansea City Council for tip clearance, and industrial estate and playing fields (Swansea Museum Service Factsheet 7, 33-4).

1978 - Morfa - Yellow Metal (former smelting hall) now the 'Recovery Area' (NMR archive).
Hafod - Rolling Mill No. 1, with 1910 Musgrave engine in Building 9.0, still operational.

1980 - Hafod and Morfa (now YIM) closed (Hughes and Reynolds 1988, 12). Acquired by (then) Swansea City Council. Much of site cleared.

3.3 HISTORIC MAPS AND PLANS

Fig. 2 - Sketch copy of 1835 Railway Deposited Plan (WGRO/ P/60/CW/197, 'Plan of proposed improvements to Swansea Harbour showing the River Tawe from the piers to Forest Weir', Nov. 1835).

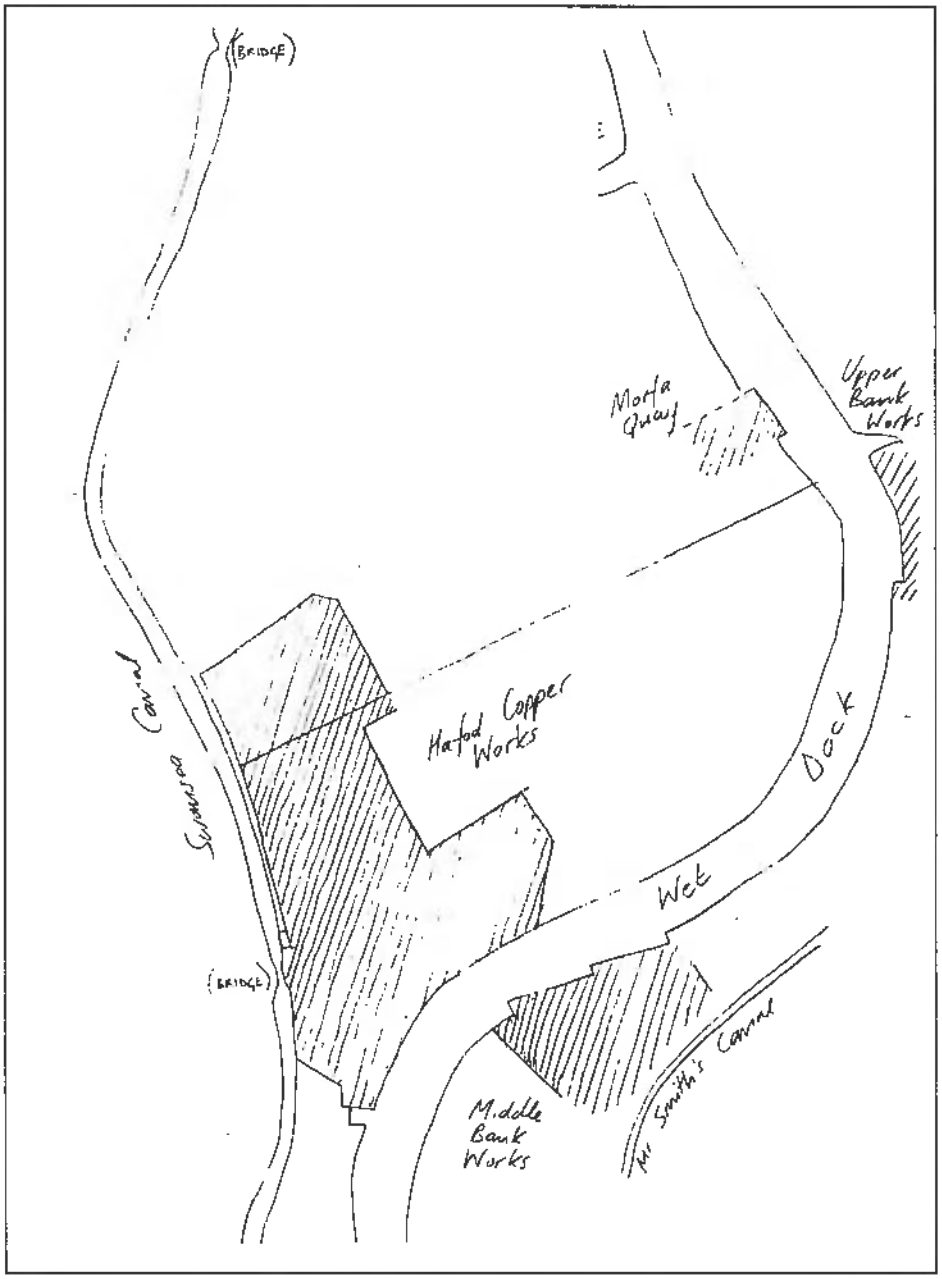


Fig. 3 - Copy of 1844 tithe map
(NLW, Parish of St John-juxta-Swansea, Tithe Map and Apportionment, 1844).

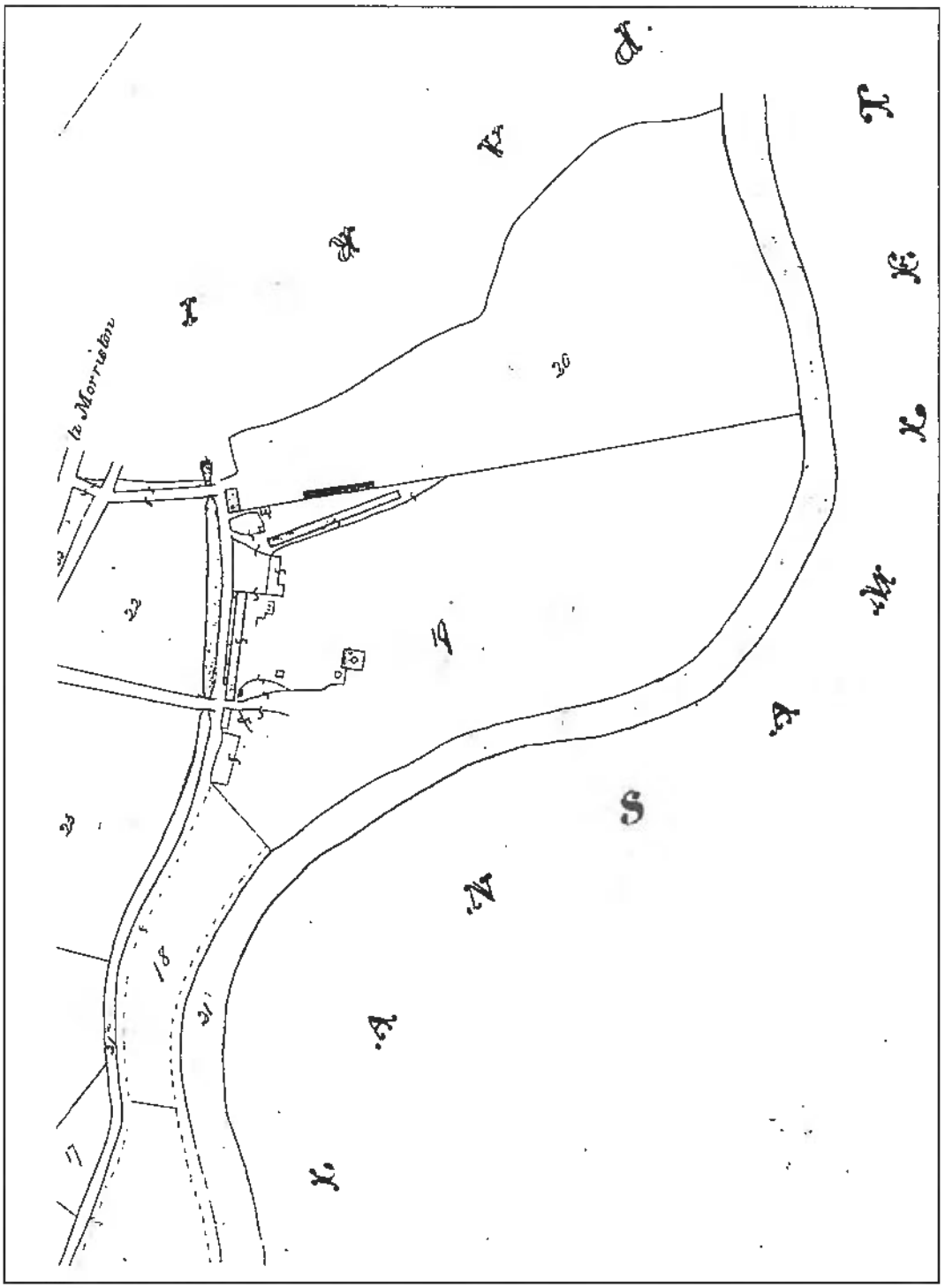


Fig. 4 - Sketch copy of 1854 Railway Deposited Plan (WGRO/P/60/CW/204, 'Plans showing a proposed extension to the Newport, Abergavenny and Hereford Railway, through the parishes of St John-juxta-Swansea and Swansea', 1854).

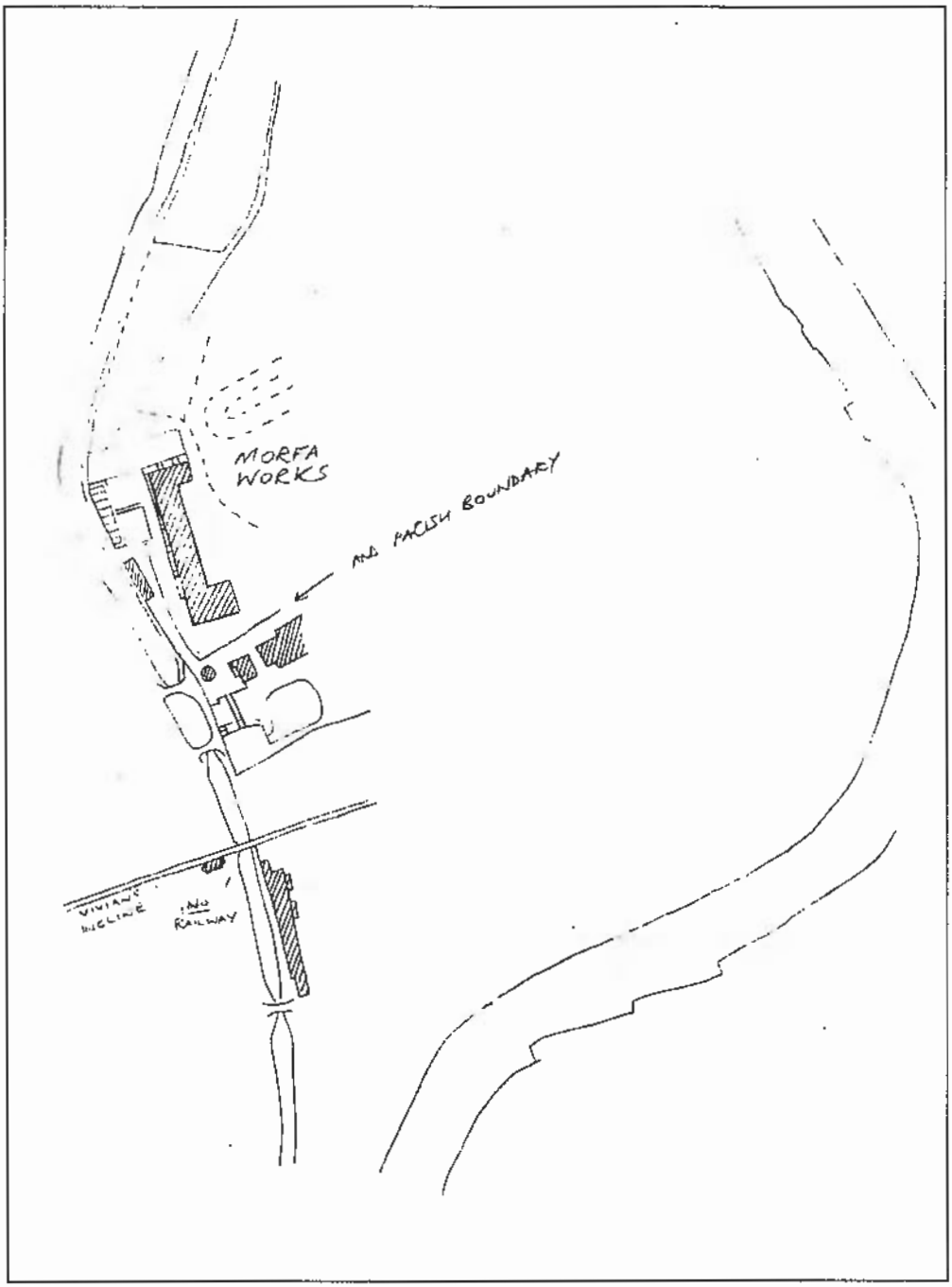


Fig. 5 - Copy of 1879 OS map
(Ordnance Survey 1:2500 First Edition, Glamorganshire Sheet XXIV.1, 1879).

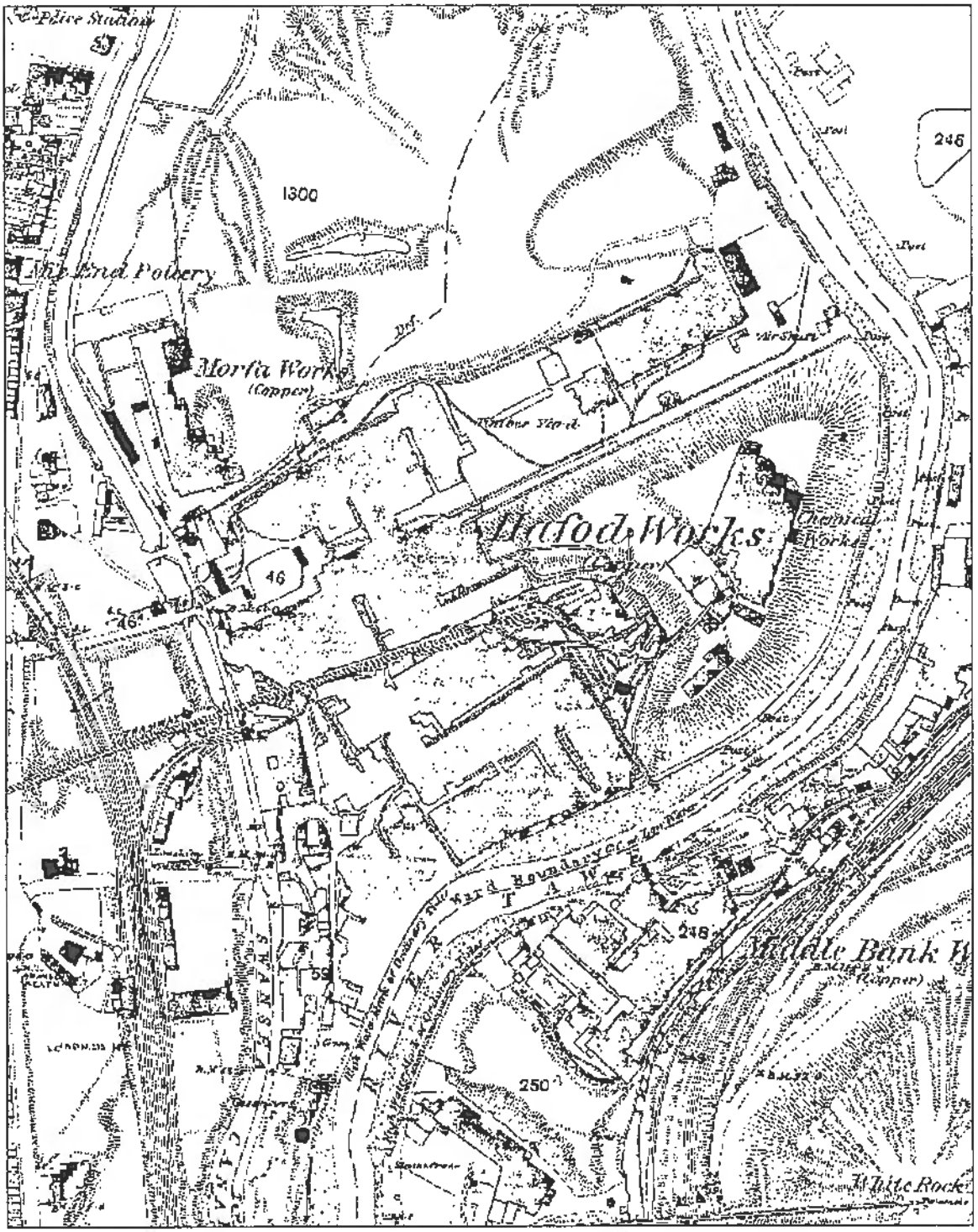


Fig. 6 - Copy of 1899 OS map
(Ordnance Survey 1:2500 Second Edition, Glamorganshire Sheet XXIV.1, 1899).

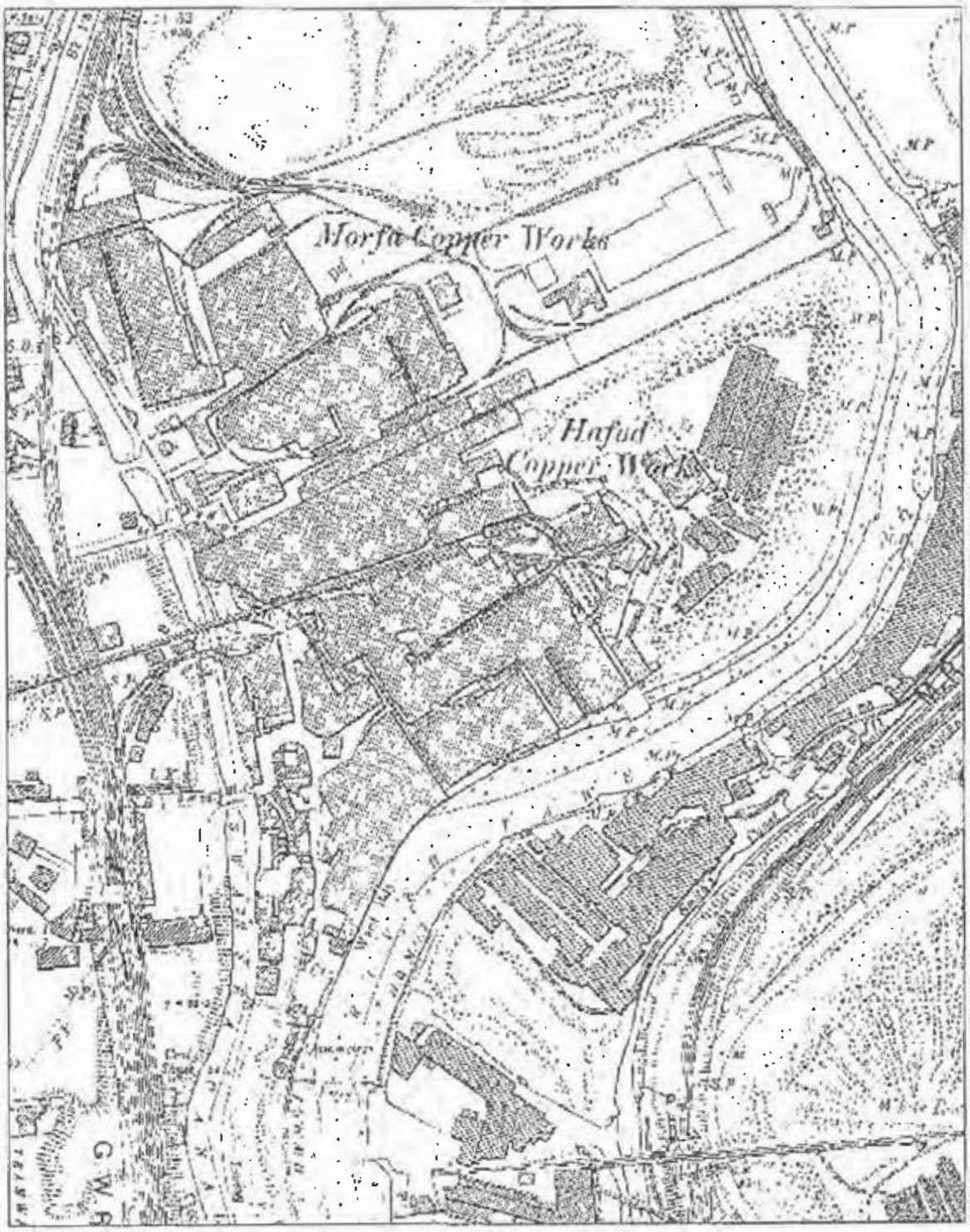


Fig. 7 - Copy of 1919 OS map
(Ordnance Survey 1:2500 Third Edition, Glamorganshire Sheet XXIV.1, 1919).

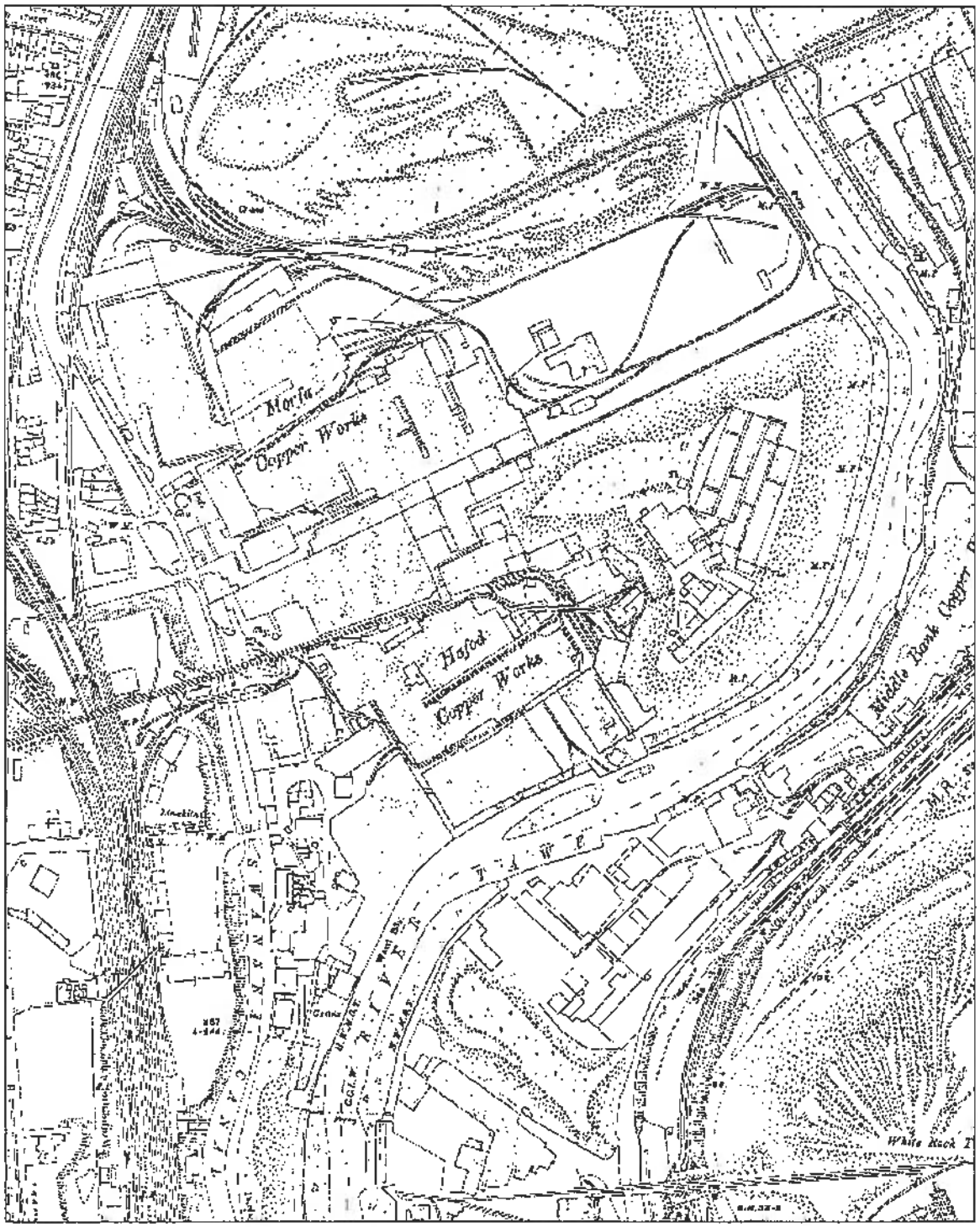


Fig. 8 - Sketch copy of c.1928 plan held at YIM Museum Stores (Swansea Museums Service, 'Plan of Hafod Copperworks prepared by ICI Ltd Metals Division, Landore Works, Swansea', scale 20 in:1 ft, n.d.).

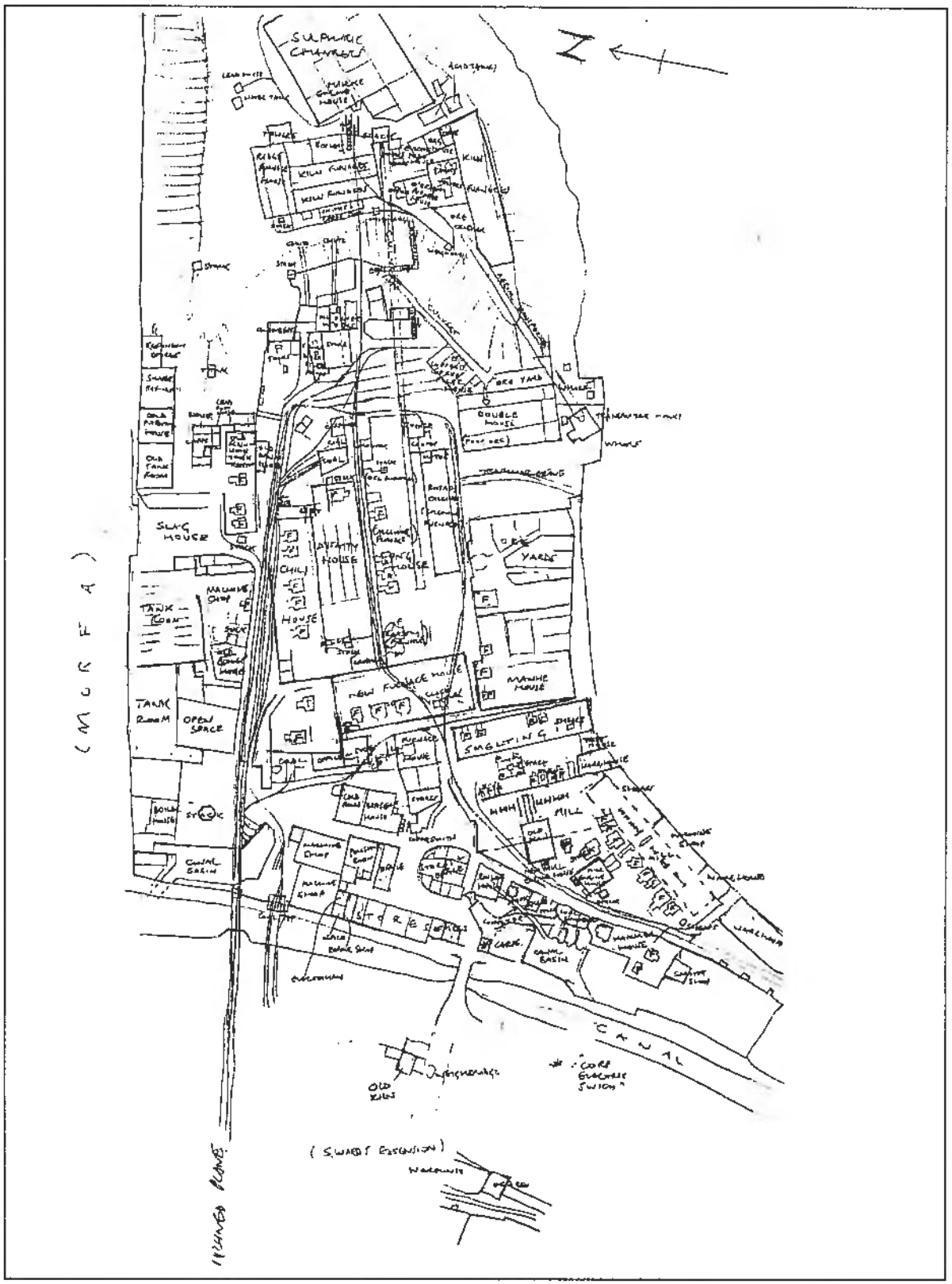
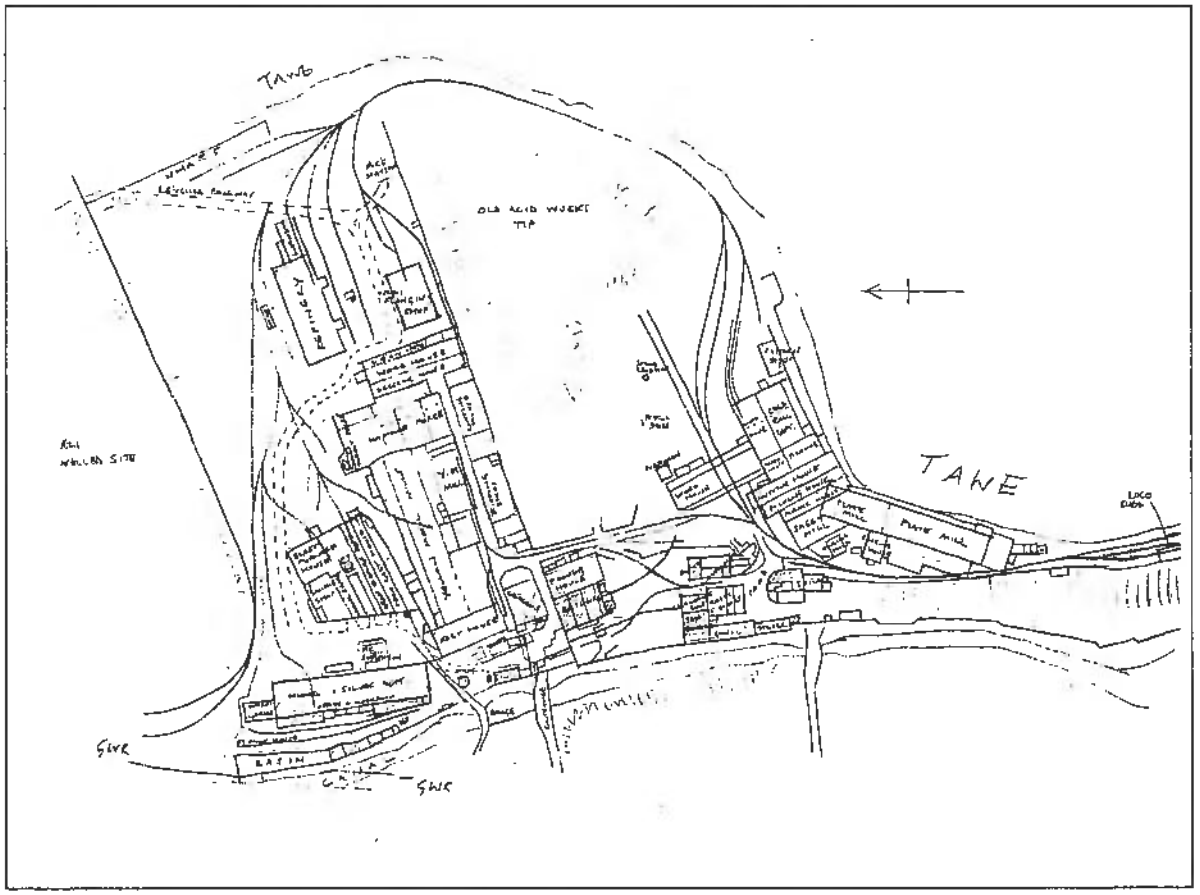


Fig. 9 - Sketch copy of 1943 plan held at YIM Museum Stores (Swansea Museums Service, 'Ground Plan of Swansea Works: ICI Metals Division, Landore, Swansea', scale 1:1250, 1943, retraced 1949).



4.0 THE LISTED BUILDINGS AND SCHEDULED ANCIENT MONUMENT

The listed building numbers 1.0 - 10.0 follow those allocated by City and County of Swansea in the project brief.

NPRNs are numbers allocated in the NMR.

Condition and management statements are general only and reflect archaeological concerns - refer to Veryards Structural Appraisals.

4.1 BUILDING 10.0 - MUSEUM STORE (FORMER MORFA ROLLING MILL)

NPRN 34123
NGR SS 6607 9524

Status
LB II
LB No. 16878; Cadw ref. 47/44/46(3); listed 29/02/96 for its extreme rarity as a surviving copper rolling mill building and for group value with the scheduled Morfa Quay and listed buildings of the Hafod and Morfa copperworks.

Value
A

Date
1828, 1840s and later

Type
Copper rolling mill

General condition
Good. Structurally sound. Still in use and maintained (see Veryards' Structural Appraisal).
The revetment wall of the cutting is now largely unpointed (unmortared?), is bowing in areas and includes areas of deteriorating former structures.

Management recommendations/implications
Retain building as existing.
Any future use should retain all openings and detail and the internal space. Nb its current use as a museum store.
The cutting revetment wall may require consolidation.
Any significant works should be preceded by a targeted programme of archaeological fieldwork.

Description
The former Morfa Works rolling mill is an important building with early elements. It is a large, rectangular, free-standing single-storey building, of masonry and iron-frame/brick-infill construction, aligned north-south and measuring 88m by 23m. It has undergone many alterations and comprises a six main constructional phases. It is still in use and maintained as the Swansea Museum Store.

The earliest phases belong to 1828 when a rolling mill was first established on the site (Hughes 2000, 48). A similar mill had been erected alongside, but some distance from this building before 1840. Both were steam-powered, boiler and condensing water being supplied from the Swansea Canal to the west (NPRN 34504), from which coal was also unloaded. The buildings featured wide, open arches, in order to let the intense heat from the engines and reheating furnaces out of the building. Their remains can be seen at either end of the present building, in roughly-squared Pennant sandstone. More survives from the southern building, which occupies the southern 25m of, and dictated the width of, the main body of the present building. The east wall is pierced by a large, open archway, with a semicircular brick head, while to the north are three similar, but smaller openings. The two southern openings have been reduced in size, and the two northern openings are blocked. The upper part of the wall was rebuilt in red brick later in the 19th century. The wide,

south gable wall features two tiers of large lights, also with semicircular brick heads, in the gable. All but three are now blocked. The west wall is obscured by later alteration. Only the north gable wall survives of the early northern building but like its partner is in squared Pennant sandstone. This wall was pierced by two similar semicircular open arches at ground level, above which are a tier of circular oculi, all with brick surrounds. All are now blocked, and the gable apex was rebuilt in c.1900. (A plan and elevation drawing of 1834 (WGRO D/D NAI M/139/2, reproduced in Hughes 2000, 49), appears to show a *proposed* building rather than one actually built.).

The two mills were damaged by fire in 1840 (Hughes 2000, 49), most of the northern building being lost. They were rebuilt, and linked to form the long rolling mill that we see today - the largest such building in the world at the time. The buildings were connected by the arcade of iron columns that are fossilised within the present east wall and support massive timber wall-plates (the west wall has been heavily altered). The arcade comprises 10 bays, each 6m wide, and the arches were originally open but were blocked with red and yellow brick, probably in the 1930s when rolling ceased.

In its present form, the cutting along the west side, within which the building lies, is clearly contemporary with this linking structure. It is over 1m deep, averaged 10m in width and separated the building from the canal (including a canal basin) which lay at the higher level to the west. The cutting is revetted with a mixture of Pennant sandstone rubble, copper slag and brick, and features the damaged remains of the side walls of a building constructed in the 1870s (**YIM 27**; see Section 5.0)

The link (and cutting) was complete by 1854 when it is shown on a Railway Deposited Plan (WGRO P/60/CW/204). Also shown on this plan are two wings, projecting from the east wall, at either end of the building. These have now gone but the stump of a former south wall can be seen at the south-east corner of the present building. The building continued to be extended throughout the 19th century. The extensions were mainly towards the available ground to the east (OS 1:2500, 1879), but by the end of the century the restricted space to the west was also built over and the OS 1:2500 maps of 1899 and 1919 show the building entirely incorporated within a complex of extensions.

Later alterations are associated with the changing use of the building. Rolling ceased in the 1930s, and the building is labelled 'Nickel and Silver Dept.' on a plan of 1943 (in Swansea Museum Store, YIM). The building shown in this plan has the same plan as at present.

At present, the main body of the building is a single open space, is open to the roof for its full length, with concrete floors and industrial shelving for storage of museum objects. All internal finishes are modern. The steel roof-structure is late 20th century and the gabled roof has a corrugated sheet-metal covering, topped by tall ventilators. However, it was formerly pantiled and the tiles were still present in 1988 (Hughes and Reynolds 1988, 12); the former tie-beams ran through the east wall resting on early 20th century brick corbels both internally and externally. The narrow gabled brick- and sheet-metal structures built against the west wall are from the early-mid 20th century and are shown on the 1943 plan, as is the lean-to between them which was labelled 'Office and Cloakroom' (its present functions). The gabled, steel-frame N-S extension at the north end, re-clad with sheet-metal in the late 20th century, is also shown and marked 'Works Garage'. There is a small, mid 20th century cement-rendered brick lean-to, with a flat concrete roof, against the east wall.

Photo 1a - Building 10.0 (Museum Stores/rolling mill), from the SW showing primary work (c.1830) with contemporary openings

Photo 1b - Building 10.0, Museum Stores/rolling mill, from the NE showing primary arch (c.1830), later blocked

4.2 BUILDING 1.0 - MORFA CANTEEN (FORMER ELECTRIC POWERHOUSE)

NPRN 34125
NGR SS 6613 9516

Status
LB II
LB No. 11691; Cadw ref. 84/A/144(3); listed 03/01/80 for group value with the listed buildings of the former Hafod and Morfa copperworks.

Value
A

Date
1890s; 1920s-30s

Type
Electricity power house

General condition
Poor. Structurally sound. Roof covering gone (see Veryards' Structural Appraisal).

Management recommendations/implications
Retain building. Any future use should retain all openings and detail and the arrangement of the original internal spaces (the brick walls can be removed from the eastern space).
Nb. built over pond.
Any significant works should be preceded by a targeted programme of archaeological fieldwork.

Description
The canteen is a rectangular, free-standing masonry building aligned east-west, measuring 30m by 18m. It was built in the 1890s as an electric power house for Morfa Works, after H. R. Merton & Co. had taken a controlling interest in the firm in 1888 (Swansea Museums Service Factsheet 6, 30); nevertheless, often referred to as 'Foster's power house (NMR, 1978). It is first shown on the OS 1:2500 map of 1899. It was converted into a works canteen during the 1920s-30s. It burnt down in the late 1970s, was restored and burnt down again in the 1980s. It is now derelict and roofless.

It is a handsome building with good-quality detail and features a clock-tower over its east gable. It now comprises two storeys over a below-ground basement. The external walls are of Pennant sandstone rubble, with quoins and freestone dressings. The eastern corners are deeply chamfered externally. Low masonry 'benching', integral with the building, runs along the foot of the south wall exterior, following the present uphill slope to the west, demonstrating that this area was already a sloping ramp in the 1890s. The interior of the building is divided into two unequal spaces by a sandstone internal wall, which is primary (1890s).

The western, larger space was always open to the roof, and it appears that it housed the power house electricity generator. It is largely unaltered from the 1890s and is aisled, in four bays, by contemporary slender, reeded cast-iron columns with capitals. These support composite timber and iron roof trusses, which are basically of queen-post construction, with 'Gothic' arch-braced collars with open, circular cast-iron spandrel mouldings. There are also braces from the end walls, supported on ?concrete corbels. There are tension braces, and ties, of wrought-iron and compression members of cast-iron. The purlins are timber. The internal surfaces are rendered. The north wall is pierced by eight openings, most of them primary lights, from the 1890s, but all have been variously altered and adapted. The westernmost opening is now a doorway; the remainder have largely been blocked or reduced in size, mainly during the 1920s-30s when the building was converted into a canteen. The ventilator fans are also from the 1920s-30s. The smaller openings to the east appear to be related to services associated with the power house machinery. A brick flue, leading from the basement, projects from the west end, and leads to a rubble stack with a moulded cornice; it is primary (1890s). The south wall appears originally to have been blind, but is pierced at its east end by a doorway with a cement-block surround, from the 1920s-30s, now blocked. The west gable wall is pierced by three primary openings at ground level, a central doorway flanked by two windows, all with segmental freestone heads. They are blocked with red-brick (1920-30s?), the

northernmost concealed beneath render from a former attached building. The circular opening in the gable is probably primary, but contains an inserted brick surround, from the 1920s-30s, for the *in situ* ventilator fan. The present concrete floor is from the 1920s-30s when it may have been raised somewhat.

The eastern, smaller space is now divided into two storeys by a concrete floor from the 1920s-30s; this area may also originally have been open to the roof. The east wall, which formed the main facade, features a central doorway flanked by two windows, all now blocked. The doorway is primary with a segmental freestone head, but the present windows are secondary with cement-block surrounds from the 1920s-30s, above which lie ventilators. At first-floor level this wall is pierced by three windows, a central 'Venetian' window with a semicircular head flanked by two square-headed windows; all are primary and feature the remains of iron frames from the 1890s. The corner chamfers also feature primary lights and ground floor level; the northern has been blocked and the southern converted into a doorway in the 1920s-30s. The north and south side walls feature, at both levels, smaller openings related to services associated with the power house machinery, but also adapted. Internally, this southern space is unequally divided, at both levels, by an east-west brick wall which was also inserted during the 1920s-30s. The ground floor is largely rendered internally but features the remains of a plaster, roll-moulded dado which appears to pre-date the brick dividing walls. However, similar plaster detail on the first floor appears to overlie a primary limewash finish. The first floor is now reached by concrete steps in the smaller, southern space. The larger, northern space is primarily occupied by the framing for the clock-tower above. This was rebuilt after the 1970s fire, and is braced from modern brick pads in the walls, but appears to faithfully replicate the original from the 1890s. The iron reinforcing rods visible aginst the internal walls may be primary, as are the low, blocked openings in the chamfers which may have been associated with machinery/services. A flue, leading from the basement, runs upwards through the main N-S dividing wall to a rubble stack with a moulded cornice; it is primary (1890s). The purlins in this space are of steel, and possibly secondary. A vertical, triple-expansion steam engine may originally have occupied the full height of this eastern space, supplying the electric power plant and ventilated by the clock-tower louvers (Stephen Hughes, pers. comm.), but the boiler(s) appear to have been located in the basement.

A wide roof, with gambrel treatment at the east end, covers both areas continuing down over the side aisles; it is supported on wave-moulded kneelers at the gables. Until recently the roof was slated, with long glazed roof-lights and vents along the ridge. The 1890s clock tower over the eastern space, with a trapezoidal base, was formerly louvered, with clock faces, a weathervane etc.; though largely rebuilt after the 1970s fire it is now again in poor condition and the clock gone.

The basement is choked with debris, and partly flooded, and was inaccessible at the time of the survey; however it was observed that it is vaulted with a series of shallow, segmental, N-S running brick barrel-vaults. It is entered, through a primary doorway with a segmental freestone head, from a flight of steps against the north wall with an altered masonry revetment. The two flues leading from the basement suggest that it housed boiler(s) and/or machinery, but the stacks are very small for such a function (Stephen Hughes, pers. comm.).

The building is coterminous with, and was constructed over, a subrectangular pond, of unknown function. The pond is shown as a wet feature on the tithe map of 1844, Railway Deposited Plans of the 1850s-70s (WGRO P/60/CW/200) and the OS 1:2500 map of 1879. The pond is depicted as under separate ownership from the rest of the Morfa site. A small building is depicted at either end of the pond but the present Canteen building does not appear to incorporate any of their fabric.

Photo 2 - Building 1.0 (Canteen/power house), from the SE

4.3 BUILDING 2.0 - MORFA LABORATORY

NPRN 34124
NGR SS 6610 9512

Status
LB II
LB No. 11690; Cadw ref. 84/A/143(3); listed 30/03/87 for group value with the listed buildings of the former Hafod and Morfa copperworks.

Value
A

Date
c.1830; 1880s

Type
Laboratory (offices; assay house)

General condition
Very poor. The north-east corner of the eastern block is actively subsiding into the possible former watercourse; displacement has occurred since 1980. The interior is actively decaying with floors etc. gone; inaccessible and unsafe. The oolite dressings are weathering. Roof covering gone (see Veryards' Structural Appraisal).

Management recommendations/implications
Retain building if structurally possible. Any future use should retain all openings and detail and the arrangement of the original internal spaces.
Nb. partly built over former wet area(s).
Any significant works should be preceded by a targeted programme of archaeological fieldwork.

Description
The laboratory is an irregular, free-standing masonry building, measuring 17m N-S by 18m E-W. It was built in the 1880s, first being shown in its present form on the OS 1:2500 map of 1899, but incorporates substantial elements of at least two earlier buildings. The building possibly housed a laboratory from the 1880s onwards, for assay purposes etc., but may also have been the Morfa Works Office prior to the construction, in the 1900s, of the red-brick office building west of the Swansea Canal (the 'Coteglade building', NPRN 300185).

The laboratory, and the adjoining Porter's Lodge (which is unlisted), flank the main entrance to Morfa Works and as such are handsome buildings with good-quality late Victorian detail. However, the building has been derelict and in decay since the mid 1980s. The interior is inaccessible (2002) and was not seen.

The laboratory building comprises two distinct components. To the west is a rectangular, two-storey N-S block which is shown on the tithe map of 1844 (St John-juxta-Swansea parish), and may be as early as 1828. It may overlie a watercourse leading to the pond that formerly occupied the Canteen site (Building 1.0). This building was substantially altered in the 1880s when an irregular, L-shaped block was added against its east side; this comprises a single storey over a basement.

The earlier, western block is in Pennant Sandstone rubble. Few original openings survive, but some of the simple, square first floor windows in the east wall, which overlook the eastern block's roof, may be pre-1880. Its west wall was rebuilt in the 1880s, with contemporary detail (described below), when the north wall was also entirely rebuilt 2m further north. The south (end) wall is largely unaltered but features inserted doorways at both levels, with brick surrounds. Both may pre-date 1919, after which the building that adjoined to the south was removed, the upper doorway now being reached by an external iron stair from the early-mid 20th century. The back of an inserted, brick chimney-flue can be seen in this wall. The vertical joint running the full height of the building, 2m from the south-east corner, may imply that its constructional history is more complex

yet. This block appears always to have been hip-roofed. The impression of a lean-to building can be seen against the west wall; it must have been very narrow, occupying the tow-path, and is shown on none of the historic maps.

The south wall of the eastern block also pre-existed the 1880s, representing the north wall of an earlier building (**YIM 14**) which appears to have been constructed between 1854 (WGRO P/60/CW/204) and 1879, when it was shown (as part of an extensive complex) on the OS 1:2500 map. The wall, which is offset to the south of the western block's south wall, is also in Pennant Sandstone rubble, and is blind. The double gable is contemporary. The building was demolished shortly after 1919 but the present buttress at the south-east corner lies over the truncated remains of the remainder of its north wall.

The reminder of the eastern block is *de novo* work from the 1880s, and is 'L'-shaped, with hipped roofs at right angles. Like the contemporary rebuilds to the west, it is in snecked Pennant Sandstone rubble, with freestone dressings and rusticated quoins. There is a moulded oolite cornice at eaves level, with ovolo-moulded kneelers, and a similar frieze band between floor levels. The lugged, oolite window architraves have segmental heads, and sill-bands on moulded brackets. The main entry is in the north wall, reached from a short flight of steps. It has a similar oolite surround featuring a ball-finial pediment, containing a cartouche, on panelled pilasters with swagged capitals, around an arched keyblock doorcase. Most of the openings were blocked in the late 20th century. The basement detail is plainer. The slate roof covering over all elements has largely been stripped.

A kerbed area lies between the east wall and the present tarmac path surface. This features an area of pitched copper-slag surfacing, and also two manholes which appear to have led to a large below-ground chamber, which was possibly built over an early watercourse (see above).

The Porters Lodge is a small, single-storey building, measuring 7m N-S by 5m E-W, 5m to the north of the laboratory. It was built new in the 1880s, in a corner of a former canal basin (see Section 5.0), but now adjoins the south wall of a 20th century weighbridge office (**YIM 30**). It is in similar snecked rubble to that in the laboratory and has similar, but plainer detail. It is unlisted.

The entrance between the two buildings, also unlisted, formerly featured rusticated stone disc finials on squared freestone gateposts. It was altered during the 20th century when the iron lintel-beam was introduced and the finials removed; they now lie loose on the ground outside. The entrance was formerly approached by a cast-iron bridge over the Swansea Canal, from c.1830 (**YIM 24**), shown in 19th century photographs (Stephen Hughes, pers. comm.) The bridge has gone, a massive earthen ramp now leading to the entry.

Photo 3a - Building 2.0 (Laboratory) from the east showing main façade (1880s)

Photo 3b - Building 2.0 (Laboratory) from the south showing the earlier work (c.1830s)

4.4 BUILDING 3.0 - HAFOD PIER AND ADJOINING CANAL WALL

NPRN 34892
NGR SS 6610 9508

Status
LB II
LB No. 11693; Cadw ref. 48/46/53; listed 18/10/79 for group value with the listed buildings of the former Hafod and Morfa copperworks.

Value
A

Date
1809 (wall); c.1850 (pier)

Type
Tramway inclined plane; wall

General condition
Wall – Very poor. Areas of the walling are in active decay and the whole is bowing slightly towards the canal (see Veryards' Structural Appraisal).
Pier - Poor, although the top of the pier is missing (see Veryards' Structural Appraisal).

Management recommendations/implications
Wall - Retain wall if structurally possible.
Pier - Retain as existing.
Any significant works should be preceded by a targeted programme of archaeological fieldwork.

Description
Building 3.0 comprises two distinct elements -
The canalside boundary wall, constructed in 1809 at the commencement of Hafod Works
The pier for an inclined tramway, inserted through the wall in c.1850

The wall
Much of the canalside boundary wall (see also **YIM 1**) survives here to its full height of c.4m, and is c.0.40m thick. The section north of the pier (39m long) is all Grade II listed; an arbitrary 7.5m south of the pier is Grade II listed and is contiguous with the unlisted **YIM 1**.

North of the pier, construction is in Pennant Sandstone rubble and copper-slag (both spade-shaped moulded copings and squared blockwork), in alternate bands, with moulded copper-slag copings and some later brick patching. The wall now butts against the west wall of the inserted Building 2.0. There are two blocked openings in the wall, an archway and a doorway. Both formerly led from the canal into a former canal basin in Area 2 (**YIM 12**), established in 1809 to serve the smelting hall. The bargeman entered from the towpath through the doorway, guiding the barge itself through the archway. The archway has a wide, segmental red-brick head and is blocked with red engineering brick - blocked after 1919. The doorway has a timber lintel and ?earlier brick blocking. A short section of the towpath survives on the west side of the wall (**YIM 33**), running northwards for c.8m from the archway before becoming lost. The towpath is 3.5m wide, and revetted by a Pennant Sandstone rubble wall that curves in towards the archway and is visible for 0.75m above the canal fill. The towpath make-up was made ground and has largely weathered away; however a timber sleeper, at the foot of the canalside boundary wall, may be original and mark the original surface; low timber bridges formerly carried the towpath across the basin entrances. South of the archway, much of the upper parts of the canalside wall have gone, but at the south end have been rebuilt in coursed Pennant Sandstone and patent copper brick - probably as a result of the insertion of the pier.

To the south of the pier, the walling is in smaller roughly coursed Pennant rubble. A vertical joint, 6m south of the pier, probably marks the site of the wagon-lift (Area 4, **YIM 34**). This was inserted into the wall in c.1870 to convey wagons, via a bridge over the Swansea Canal, from the works to the main South Wales standard-gauge line (WGRO/P/60/CW/200; contemporary drawing in

Hughes 2000, 98). Above this joint, the upper half of both sides was rebuilt in slag coping and patent copper brick, after the 1920s when the wagon-lift was removed.

The pier

The pier was inserted into the canalside boundary wall to support a tramway inclined plane. The tramway ran E-W between the main smelting halls, to convey slag and waste high over the Swansea Canal to a spoiltip west of the Hafod Works site. It was built in c.1850 (WGRO/P/60/CW/204) to replace a similar tramway that ran to an earlier spoiltip in the east part of the site, but which had become full by 1850. The trams were hauled up the incline by a steam engine located in an engine-house on top of the spoiltip (OS 1:25000, 1879).

The pier is rectangular, measuring 16m N-S by 10m E-W. It is over 5m tall, which probably represents about three-quarters of its original height, and it is slightly tapering, constructed of well-coursed Pennant freestone with square copper slag block quoins. There are inclined putlog holes for the bridge deck braces on both east and west faces, in two tiers on the latter face. However, a contemporary drawing, taken from a photograph (see Plate 1) only shows braces on the *east* face. The braces may have been of timber; the tramway superstructure was iron.

A similar, but slightly lower pier is shown to the east in Plate 1.

Photo 4a - Building 3.0 (Pier) from the SW

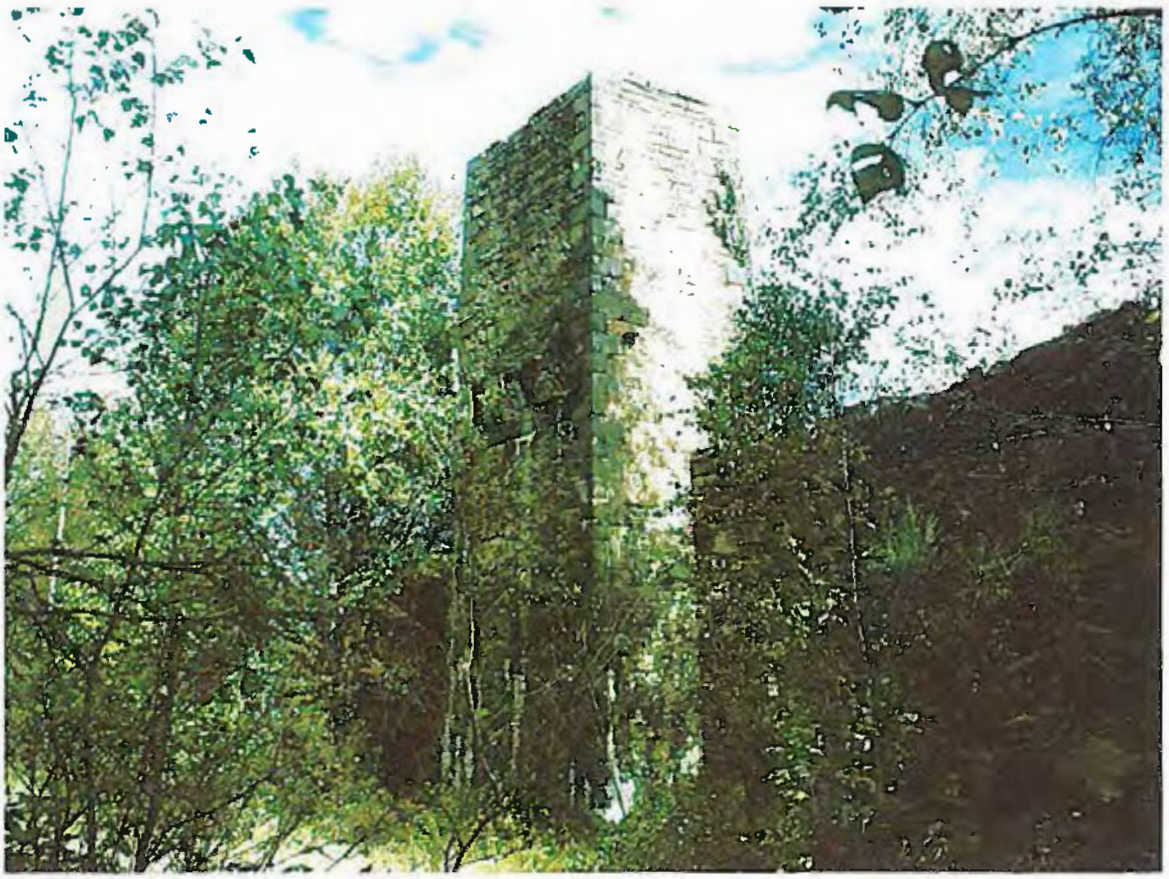
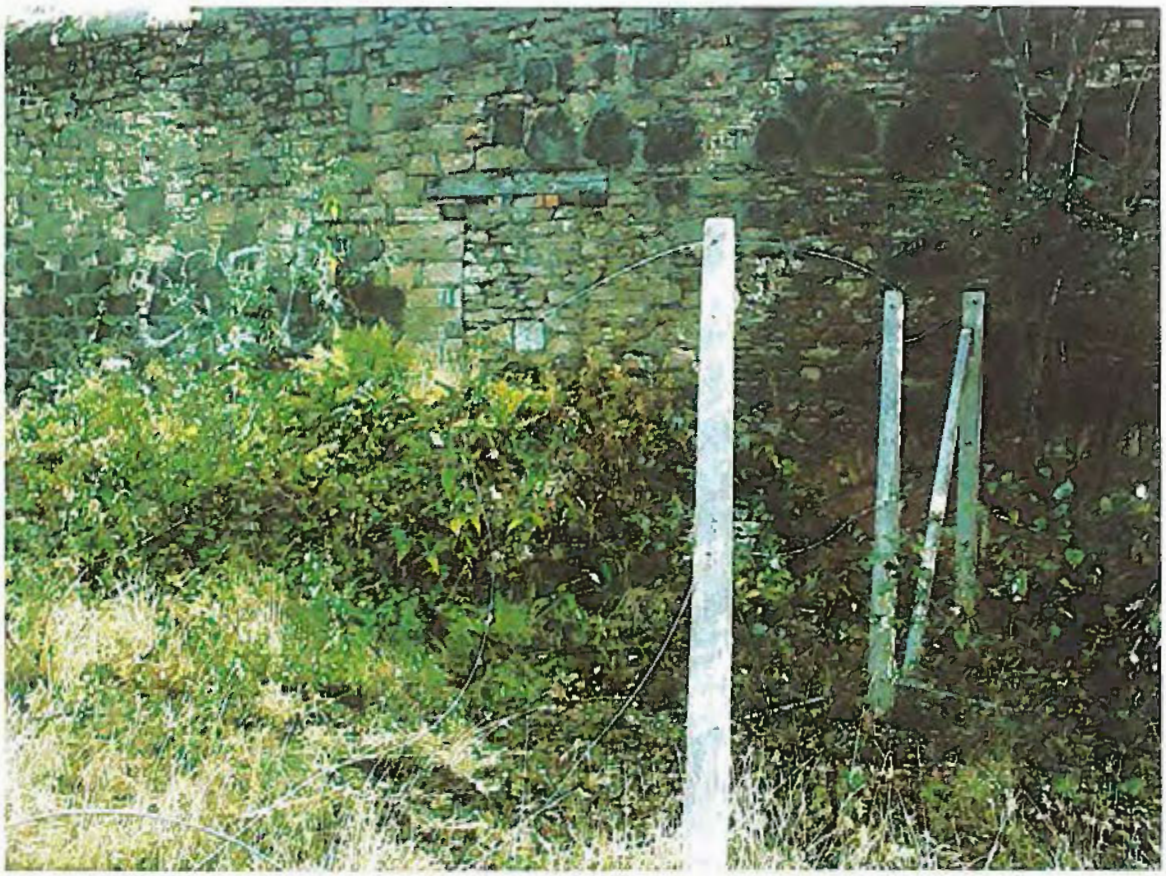


Photo 4b - Building 3.0 (canal wall) from the west showing blocked archway and doorway to canal basin YIM 12, and towpath YIM 33



BUILDING 4.0 - HAFOD COPPER SLAG ABUTMENT

NPRN 34891
NGR SS 6609 9507

Status
LB II
LB No. 11692; Cadw ref. 48/46/54; listed 18/10/79 as probably the most impressive surviving example of copper slag block construction in Wales and for group value with the listed buildings of the former Hafod and Morfa copperworks.

Value
A

Date
c.1850

Type
Tramway inclined plane

General condition
Poor; the top of the pier is missing (see Veryards' Structural Appraisal).

Management recommendations/implications
Retain as existing.

Description
The abutment, like the pier, was inserted into the west canal revetment to support the tramway inclined plane in c.1850 (WGRO/P/60/CW/204). It also served as a massive revetment wall above the canal holding back the slag tip to the west.

Nearly 6m tall, the abutment is more-or-less complete. It projects 4m out from a battered 'glacis' revetment wall, nearly as tall, which extends 7m north and 14m south of the abutment. The whole is built from regularly-coursed, squared copper-slag blocks and was inserted into the earlier canal revetment. The slag blocks are closely bedded and are 0.22m deep, in two lengths, of 0.43m and 0.20cm, and are an exceptionally fine demonstration of the use of a material, produced at the Hafod works, once common in the Swansea and Bristol areas.

The abutment itself is a semi-hexagon in plan, with a steeply battered profile and a ramped projecting bridge abutment, creating a complex geometry. Much of the east face, and the quoins, are in square Pennant freestone. Narrow slots on the east face, which retain their timbers, lie beneath a row of three sloping putlog holes for braces to the bridge deck; however, like the pier, no braces are shown in a contemporary drawing (taken from a photograph - see Plate 1).

Photo 5 - Building 4.0 (Hafod copper slag abutment) from the SE

BUILDING 5.0 - HAFOD LIME KILN

NPRN 85021
NGR SS 6609 9499

Status
LB II
LB No. 11694; Cadw ref. 84/A/147(3); listed 18/10/79 for group value with the listed buildings of the former Hafod and Morfa copperworks.

Value
A

Date
mid 19th century

Type
Limekiln

General condition
Poor. Lies in overgrown area and is itself overgrown (see Veryards' Structural Appraisal).

Management recommendations/implications
Retain as existing.
Requires consolidation of pot top, and vegetation control and maintenance

Description
A square, free-standing masonry limekiln, lying in Area 3 to the west of the Swansea Canal. It measures 5.75m square, and is approximately 4m high and slightly tapering, but the upper courses may be missing. It is first shown on the OS 1:2500 map of 1879 it is labelled 'limekiln' (rather than 'old limekiln') and may date from around the middle of the 19th century (Stephen Hughes, pers. comm.).

It is in Pennant Sandstone rubble with crude quoins. There is a wide discharge-hole, with a segmental brick head, on the east face facing the canal 17m away. This exhibits inserted patent copper brick hearths - for furnaces? A full-height chase in the north face formerly received a lateral retaining wall. There is a further possible opening in the south face, and a chase in the south-east quoin, a third of the way up. The kiln pot was not seen. A charging bank, of copper slag, formerly lay against the west face and part of the north face (Cadw LB database).

This is the last complete survival of the 54 limekilns that once stood alongside the Swansea Canal (Hughes and Reynolds 1988, 9). Limestone was brought in from Mumbles, by rail and canal, and anthracite came in by canal from the upper Swansea Valley. It differs from others on the canal in being built above canal level and not in the actual formation, and also because it was used to supply lime for industrial rather than agricultural use - lime was used as a flux in the initial roasting of copper ore (Hughes 2000, 23-4). Some of the lime may also have been used for building.

Photo 6a - Building 5.0 (Hafod limekiln) from the south

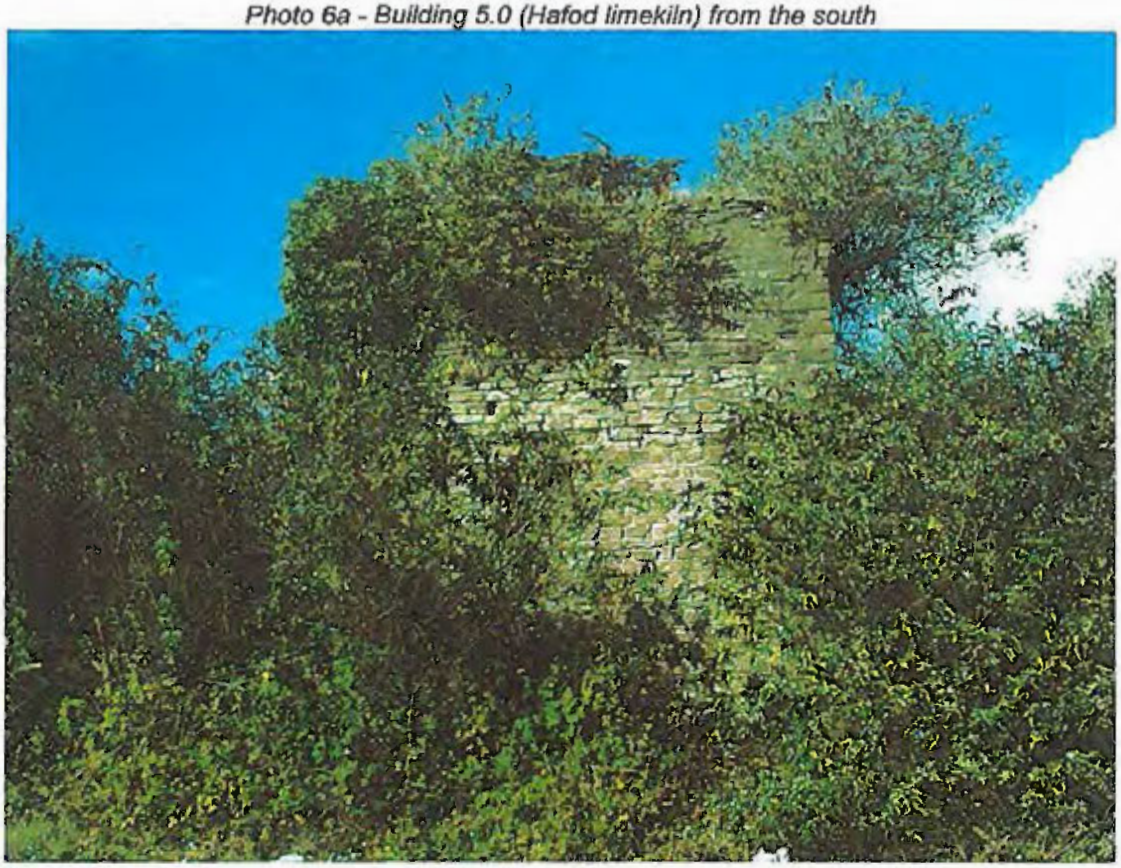
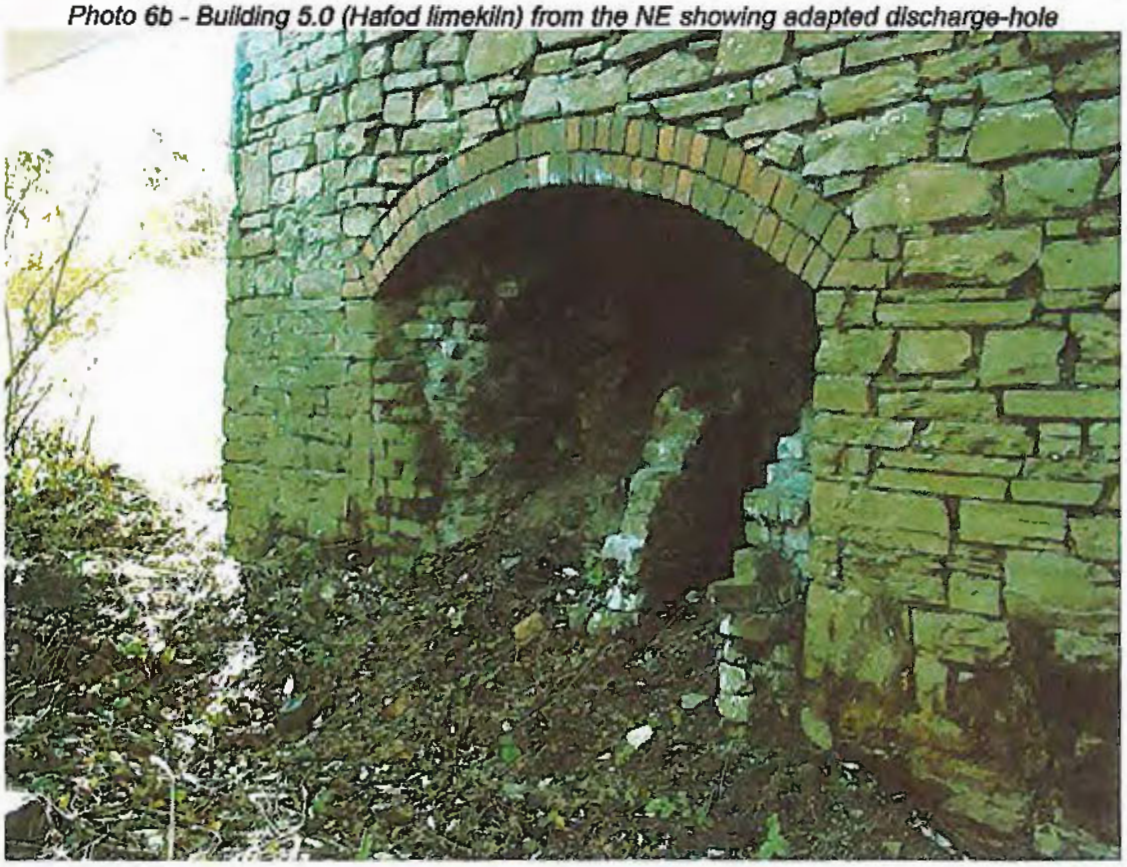


Photo 6b - Building 5.0 (Hafod limekiln) from the NE showing adapted discharge-hole



BUILDING 6.0 - HAFOD CANAL BOUNDARY WALL

No NPRN?; YIM 2
NGR SS 6613 9494

Status
LB II
LB No. 16881; Cadw ref. 47/44/49; listed 29/02/96 as a good example of slag wall, for its relation to former canal docks, and for group value with the listed buildings of the Hafod and Morfa works.

Value
A

Date
1809 onwards

Type
Wall

General condition
Poor-very poor. Areas of the walling are in incipient decay; may be bowing slightly towards the canal.
The wall is almost entirely overgrown with ivy, and saplings have established close to its foot (see Veryards' Structural Appraisal).

Management recommendations/implications
Retain wall if structurally possible.
Any significant works should be preceded by a targeted programme of archaeological fieldwork.

Description
An 80m length of canalside boundary wall immediately south of the former main entrance to the Hafod Works, and running to the south end of the study area. The wall averages 3.5m in height and the is composed of copper slag, sandstone and brick. The lower parts of the wall are almost entirely of copper slag, either in carefully bedded rough nodules or in moulded blocks. A row of square slag copings seem to have been placed on top of this, but the wall was subsequently raised in stone and slag and topped with crenellations of oblong slag blocks interspersed with spade-shaped slag copings laid sideways. The wall was again raised in brick and stone, probably in the late 19th century.

The north end, next to the Hafod main entrance, has been much altered and rebuilt but the large, chamfered Pennant freestone quoins stops in the lower half of the stop, including a short return to the east, appear to be original 1809 work. The remainder of the stop has been rebuilt in patent copper brick. The Pennant wall continues for 6m to the south, again terminating at a finished stop, suggesting that in 1809 only the entrance area was walled, as a free-standing feature. This section has been almost entirely rebuilt in late 19th century red brick, with a second return wall which, along with the entrance return, defined a building 6m square, marked on maps from 1879 onwards and labelled 'Carpenters' in 1943 (Museum Store, YIM).

The remainder of the wall, in slag, may be rather later. There are two wide, low archways in this section. That to the north is 2.5m wide, with a segmental yellow-brick head, and is blocked with ?19th century brick. The archway is too narrow to have led to a canal basin (and no basin is suggested here on any of the historic maps) and its function is unknown, while the area inside the wall is entirely overgrown. The archway to the south, however, is associated with a kink in the wall where it ran around a canal basin (Area 5, **YIM 20**), constructed in 1819 to serve the rolling mill, suggesting that the basin was a pre-existing feature. The archway is 6m wide and again features a segmental yellow-brick head, with copper-slag quoins, and was blocked with (re-used) 19th century brick after 1919 (OS 1:25000, 1919). There is no evidence for an accompanying pedestrian doorway, nor any physical evidence for the towpath here.

A ruined window can be seen in the slag wall, between the northern arch and the Hafod entrance.

No other features are visible in the wall, but it is almost entirely overgrown with ivy, and saplings have established close to its foot.

The wall terminates at its south end as a return to the east, at the top of a steep slope down to the south end of the site. A slender brick wall was built onto it on the mid 20th century, extending its line southwards, but this has been almost entirely destroyed.

Photo 7 - Building 6.0 (Hafod canal boundary wall) from the west, showing blocked archway to canal basin YIM 20

BUILDING 7.0 - HAFOD VIVIAN CHIMNEY

NPRN 300187
NGR SS 6615 9496

Status
LB II
LB No. 11696; Cadw ref. 48/46/52; listed 30/03/87 as an impressive Victorian industrial chimney and for group value with the listed buildings of the former Hafod and Morfa copperworks.

Value
A

Date
1860-62

Type
Chimney stack

General condition
Poor-fair (see Veryards' Structural Appraisal).

Management recommendations/implications
Retain as existing.

Description
A tall, tapering chimney stack, constructed of red brick. The circular shaft has numerous iron bands, and a corbelled ring at its neck. It lies on an octagonal plinth, with a corbelled head, 3.5m in diameter, with a semicircular headed rake-hole in its west face. The chimney served the steam boilers for the Vivian engine house (Building 8.0), which was erected in 1860-2, on the site of an earlier engine-house from 1847 (WGRO D/D NAI M/463/77). However, on stylistic grounds the chimney appears to be a new construction of 1860-62.

Photo 8 - Building 7.0 (Hafod Vivian chimney)

BUILDING 8.0 - HAFOD VIVIAN ENGINE HOUSE

NPRN: 33743
NGR: SS 6617 9497

Status
LB II
LB No. 11695; Cadw ref. 48/46/51; listed 30/03/87 for its rarity as a copper works engine house and for group value with the listed buildings of the former Hafod and Morfa copperworks.

Value
A

Date
1860-62

Type
Engine House

General condition
Poor. Any spalling of the patent brick appears to have stopped. There is no roof covering (see Veryards' Structural Appraisal).

Management recommendations/implications
Retain as existing. Consolidation where necessary. Detailed building recording has already been undertaken so no further recording is necessary prior to any works.

Description
See Appendix 3 for a detailed description of the building, with illustrations, by David Percival, RCAHMW.

The Vivian engine house is a rectangular, free-standing masonry building aligned roughly east-west, measuring 14m by 9m. It was built between 1860 and 1862, as recorded in a plaque over the main entrance doorway, to house a 24" vertical steam engine (WGRO D/D/ NAI M/463/108-111). Both the engine, and the building, replaced an earlier engine house from 1842 (Hughes 2000, 30) or 1847 (WGRO D/D/ NAI M/463/77), which drove the roll-train in mill no. 2 (YIM 52).

It is a tall, two storeyed gabled building, formerly with a slate roof. It is in Pennant Sandstone - partly dressed ashlar and partly snecked rubble. It was built on the footprint of the earlier engine house, from which it is uncertain if anything was retained. The south corner features more dressed stone than the rest of the building, but this may be incidental. It has been suggested that some of hammer-dressed facework in the basement may be 1840s work, and similar facework can be seen on some external walls. the walls were heightened, and the east wall rebuilt, in patent copper-brick, in c.1910. The east wall features corbels for the roof-trusses of the adjoining rolling mill.

It comprises a single, main floor, open to the metal roof trusses, over a service basement. The northwest corner is deeply chamfered to allow passage through what was a cramped site - the retaining terrace is only 3.5m from the corner. The main entrance is in the west wall, now approached from a flight of (later) concrete steps. The entry is a large doorway, over which is an ornate carved stone tablet with scrolls and flowers, reading 'Commenced August 1860; completed February 1862; V & S'. There are four segmental-headed windows, with timber frames, in the north wall. The east gable wall is pierced by a tall opening for the former rope drive from the engine to the rolls, and an oculus high in the gable. The south side has openings irregularly placed on three levels. Internally, there is an offset for a travelling crane below eaves-level, as preserved in Building 9.0. The 1910 heightening features a raised band with red brick oculi and an eaves cornice.

The floor is now concrete. The service basement below has a large engine-pit for servicing the engine, and to access its holding-bolts. Some patent brick can be seen in the pit. It communicates with a basement chamber, entered from the outside through the south wall, which includes a

boilerhouse with a large flue within the south wall. There is also a machine-base with holding bolts — primary? A below-ground archway in (rebuilt) east wall is for a □culvert□ leading to the rolling-mill.

Photo 9 - Building 8.0 (Hafod Vivian engine house) from the south

BUILDING 9.0 - HAFOD MUSGRAVE ENGINE HOUSE AND CHIMNEY

NPRN: 33710
NGR: SS 6617 9495

Status
Scheduled Ancient Monument SAM Gm 483.
LB II *
LB No. 11697; Cadw ref. 48/46/50; listed 03/01/80 for its importance as a rare engine house with in situ steam engine and for group value with the listed buildings of the former Hafod and Morfa copperworks.

Value
A

Date
1910

Type
Engine House

General condition
Poor. Any spalling of the patent brick appears to have stopped. There is no roof covering (see Veryards' Structural Appraisal).

Management recommendations/implications
Retain as existing. Consolidation where necessary. Detailed building recording has already been undertaken so no further recording is necessary prior to any works.

Description
See Appendix 3 for a detailed description of the building, with illustrations, by David Percival, RCAHMW.

The Musgrave engine house is a rectangular, free-standing building aligned roughly northwest-southeast, measuring 12.5m by 8m. It was built in 1900 to house a Uniflow steam engine. Both the engine, and the building, replaced an earlier engine house from 1818 (Hughes 2000, 30; WGRO D/D/ NAI M/101/1), which drove the roll-train in mill no. 1 (YIM 51). It was built on the footprint of this earlier engine house, from which nothing appears to have been retained.

It is a tall, two storeyed, hipped-roof building, formerly with a slate roof, and has a main floor containing the engine, with a service basement below. It is entirely in patent copper-brick, with red-brick dressings including the sill bands, lintels and eaves cornice. The interior is also lined with red brick.

It comprises a single, main floor, open to the timber roof trusses, over a service basement. The main entrance is in the northwest wall end wall and was formerly approached up an iron staircase (NMR), the brick supports for which survive. There are four tall, square-headed windows, with timber frames, in both side walls. The tall, detached brick chimney lies close to the south wall and is square in section, slightly tapering, in brown brick with iron banding towards the top.

The engine, which was operational until 1980, is still *in situ*. It is one of the first uniflow type steam engines made in Britain, manufactured by John Musgrave and Sons of Bolton in 1910. The southeast gable wall features an open passage - also in patent brick - for a rope drive, and a high-level doorway. The rope drive passed out of the building to a set of gears for the roll-train in the mill, which still survives *in situ* in Area 5B (see Section 5.5.2). An iron travelling crane is also still preserved in the building.

The floor is now concrete. The service basement below is reached from a flight of steps against the northwest wall. It has a large engine-pit for servicing the engine, and to access its holding-bolts. It still contains machinery and other fittings.

Photo 10 - Building 9.0 (Hafod Musgrave engine house) from the north

BUILDING 11.0 – VIVIAN LOCOMOTIVE SHED

NPRN 300188
NGR SS 6614 9474

Status
LB II
LB No. 16880; Cadw ref. 47/44/48; listed 29/02/96 as a rare locomotive shed and for group value with the listed buildings of the Hafod and Morfa copperworks.

Value
A

Date
1920s

Type
Locomotive shed

General condition
Very poor. Unsafe. Structural brickwork in an advanced state of decay. Iron roof structure also deteriorating. Roof covering largely gone (see Veryards' Structural Appraisal).

Management recommendations/implications
The building will require significant remedial works, which should be preceded by a targeted programme of archaeological recording.

Description
The Vivian Locomotive Shed is a rectangular, free-standing brick building aligned north-south, measuring 49.60m by 6.50m. It was purpose-built in c.1922 (not on OS 1:2500, 1919; shown on photos of c.1922 and a plan of 1928 in Museum Stores, YIM), when the narrow gauge line south of the site was converted to standard gauge, and housed the first standard gauge Beyer-Garrett locomotive in Britain which was used to transfer materials around the whole Hafod works site. The shed is now derelict and roofless.

The shed was built to a high specification. It is a long, narrow building, of a single storey beneath a saw-tooth (or north-light) roof, comprising nine almost identical bays, one bay in depth. Walling is largely in patent copper brick, which has badly eroded. The bays are defined, both internally and externally, by clasping pilasters of red brick. The pilasters are integral with the rest of the fabric and do not constitute structural piers. Each bay has a dado band of red brick, 11 courses deep externally and 13 courses deep internally. At eaves level, each bay has an external, corbelled string-course, 4 courses deep, and gable cornices that are 2 courses deep and also in red brick. Each gable is pierced by an oculus, with a red brick surround. In addition, all other openings have red brick surrounds. The external pilasters formerly carried hoppers and down-pipes, which have now gone. Internally, the east wall of the two southern bays is entirely faced in red brick. At some period, the interior was whitewashed.

The interior of the building is open for its full length and wide enough for one railway track. A service pit, approx. 1m wide and 1m deep, runs longitudinally down the entire length of the building. It has concrete coping around the sides. Elsewhere, the floor appears to comprise diamond-treaded blue Staffordshire engineering brick throughout, but much of the floor is obscured by debris.

The building faces east to the River Tawe, and the northern 7 bays of this 'show' façade are embellished with white, enameled bricks which pick out letters, more than 1m high and in 'Art Deco' style, which refer to the function of the building – 'V & S Ltd No. 1 SHED'. The lowermost courses of this elevation are also in red brick.

The shed is built into the steep slope down from the Swansea Canal to the River Tawe, and a deep cutting, approx. 1m wide and 1.5m deep, runs the whole length of the west wall. The north and south bays of this wall are pierced by full-width openings up to eaves level, with steel lintel-joists. They are associated with lean-to annexes, with walls only one brick wide, which appear to have been contemporary with the rest of the building but have now largely gone. The southern annexe measured 6m north-south and 3m east-west, but only its end walls now survive above ground to any degree. The interior was floored at a level approx. 1m above shed floor-level, although the flooring material is not now visible. The floor extended into the shed as a 1m wide □platform□, running down the length of the southern bay, with a masonry revetment. The northern annexe measures 4m north-south and 1.3m east-west, and is similarly ruinous. However, it appears to have been open at the north end.

Both north and south end walls have full-width openings up to eaves level, with steel lintel-joists. These formerly had wooden doors, to allow the locomotive access. A shaft and cog associated with the northern opening suggests that the door was raised and lowered, possibly as a roller-door.

The saw-tooth (or north-light) roof, to maximise north light and ventilation of steam/smoke, is supported on I-section steel tie-beams, on concrete pads that are set into the internal pilasters, with steel trusses with tension frames. The roof covering appears always to have been asbestos sheeting. In each bay, the roof-space is divided into three by longitudinal asbestos-sheet panels, as a smoke-funnel. The northern three tie-beams are double, suggesting an additional function but there is no indication on any lifting gear.

Structurally, the entire buildings is in poor condition and unsafe. The structural patent copper brick has spalled badly and in many areas, particularly at ground and eaves level, has significantly decomposed so that only a fraction of the wall-thickness remains. Saplings have become established in parts of the building and in the cutting. The roof-covering has largely gone. The tie-beams, joists and roof framing are corroding badly and, towards the south, many have collapsed into the building.

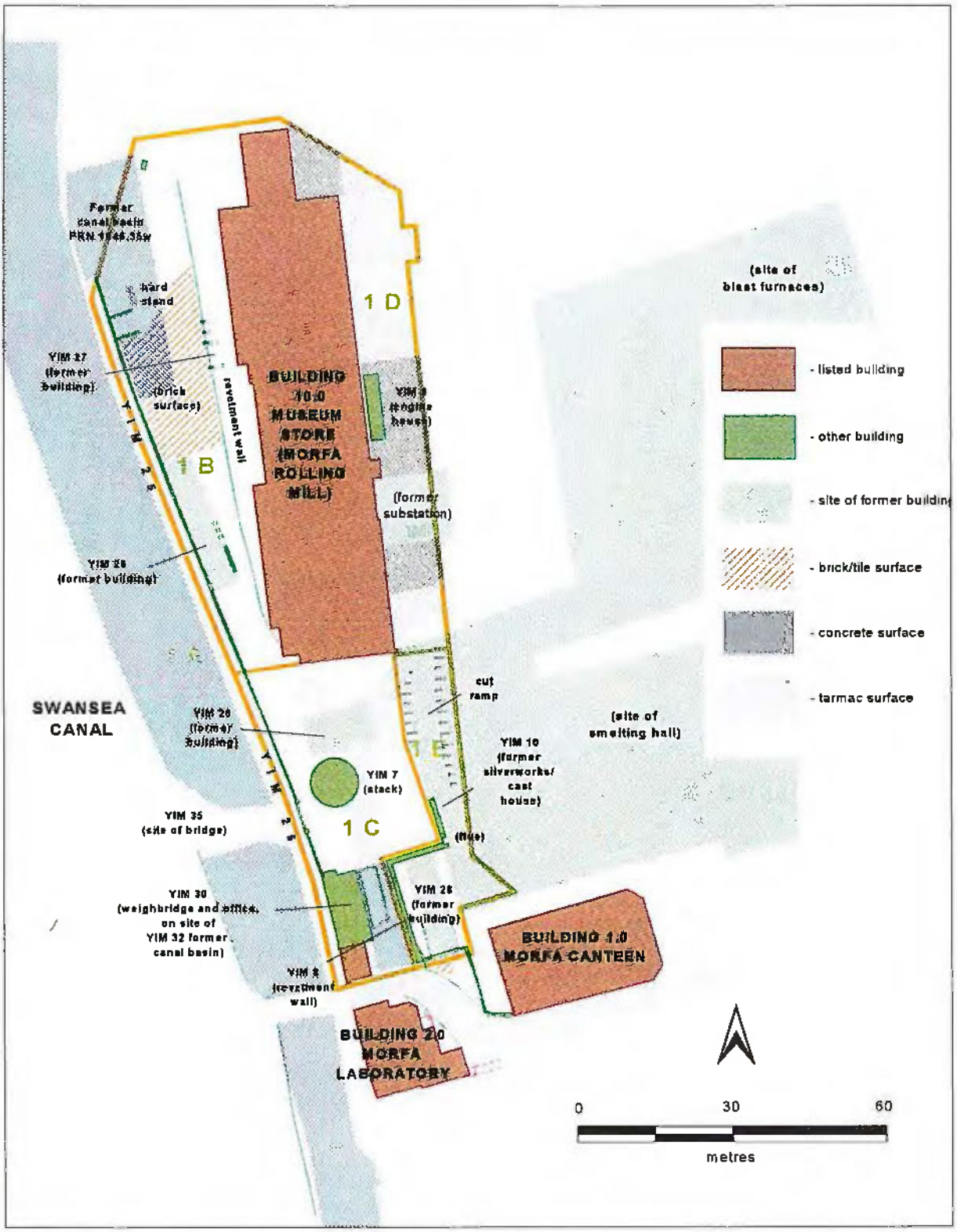
The shed is shown in the 1920s in Plate 10.

Photo 11a - Building 11.0 (Vivian Locomotive Shed) from the southeast

Photo 11b — The south end of Building 11.0 (Vivian Locomotive Shed) from the northwest, showing annexe

Photo 11c — The interior of Building 11.0 (Vivian Locomotive Shed) from the northeast

Fig. 10 - Detailed plan of Area 1, showing all features



5.0 AREAS BETWEEN THE LISTED BUILDINGS

The Area designations and Area numbers 1-5 correspond with Veryards' assessment areas. Condition and management statements are general only and reflect archaeological concerns - refer to Veryards Structural Appraisals.

YIM numbers are continued from the YIM nos. 01 - 22 allocated by GGAT in 2002 (Locock 2002)

5.1 AREA 1 (MORFA) - AROUND BUILDING 10.0 (Fig. 10)

This area, around Building 10.0, occupies two levels, either side of a north-south revetment. Areas 1A, 1B and 1C occupy the higher level.

5.1.1 AREA 1A

NGR - SS 6603 9524
Value - B
Archaeological potential (below-ground) - High

Summary - The canalside boundary wall (**YIM 25**) to the west of the rolling mill

General condition
Poor - very poor. **YIM 25** still forms site boundary. The lean-to roof-joist sockets are actively weathering. Towards the south the wall is bowing out - nb. the area beyond is a public open space.
Management recommendations/implications
Site/canalside boundary wall **YIM 25** - consolidation, where it is bowing into a public open space, must be a priority.
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

YIM 25 – Canalside boundary wall (SS 6603 9524)
The canalside boundary wall to the west of the rolling mill is first clearly shown on a map of 1854 (WGRO P/60/CW/204) but likely to have been built not long after the commencement of Morfa Works in 1828. It is approximately 3m high, and composed of a mixture of materials, chiefly Pennant Sandstone, unmoulded copper slag and brick. These occur in varying proportions, in some areas being laid in alternate courses; this need not always correlate with separate phases, but there is a clear break halfway along, south of which the upper half of the wall is only in brick. The north end of the wall in this area is a finished stop, where the wall terminated at a former GWR extension line, established in the 1870s. In between, the internal face exhibits sawn-off iron joists and sockets of a former lean-to building (YIM 26, see below) and a blocked doorway through the wall is visible; it has a timber lintel and may be primary. An internal brick buttress marks the junction with a red brick section, from the late 19th-early 20th century. The southernmost section of wall, adjoining YIM 30 (the weighbridge office, see below), is largely in Pennant Sandstone which, internally, exhibits the joist sockets of a small lean-to building shown on the OS 1:2500 of 1879. A full-height entry, 5m wide between copper-brick gateposts from c.1900, lay between these two sections, but it was blocked later in the 20th century; it led to a bridge over the canal (YIM 35) which is shown on all historic maps from 1854 to 1943 and is still detectable the ground.

5.1.2 AREA 1B

NGR —SS 6604 9526
Value - B
Archaeological potential (below-ground) - High

Summary - A strip of land averaging 20m in width between the canalside wall and Building 10.0, including former structures **YIM 25, 26** and **27**. It lies west of the rolling mill cutting (see Section 4.0), at a higher level than the mill, and represents the coaling area for the mill. It is partly made ground - as can be seen in the weathering section above the cutting. Nevertheless, the present level/make-up is unlikely to be any later than the date of the cutting ie. 1840s. Much of the northern half of the area is occupied by the yellow-brick floor surface, with a smaller area of hard-standing, belonging to an extension to Building 10.0 added between 1879 and 1899 (OS 1:2500). The low brick retaining walls of a sand store are much later, from the mid-late 20th century.

General condition
Poor. The brick surface is laid on made ground which is weathering into the cutting in the area of deteriorating former structures. The culvert has been damaged.
Management recommendations/implications
Surfaces - general consolidation and maintenance at existing levels.
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

Photo 11a - Area 1B from the south

PRN 1046.35w – Canal basin (SS 6602 9524)
The north half of the area was occupied by a canal basin, constructed c.1828 to serve Building 10.0 (the rolling mill). The basin was infilled between 1879 and 1899 (OS 1:2500), and lies beneath the yellow-brick floor surface a. A damaged brick culvert for the canal basin overflow still survives at the north end of the site. This was still intact in the 1980s and was apparently recorded by RCAHMW (Stephen Hughes, pers. comm.) but the overflow channel has since been altered and obscured.

YIM 27 – Building (SS 6602 9525)
The damaged remains of the side walls of a building that occupied the mill cutting on the OS 1:2500 of 1879. They appear to lie beneath the 1879-1899 yellow-brick surface.

YIM 26 – Building (SS 6602 9523)
The footings of part of the brick east wall of a long, lean-to building associated with the canalside wall roof joists that can be seen in the canalside wall further south; this building is shown on a plan of 1871-2 (WGRO P/60/CW/209), and is shown more-or-less unchanged on all subsequent maps/plans up to 1943 (in Swansea Museum Store, YIM) when a number of internal partitions were shown.

5.1.3 AREA 1C

NGR - SS 6608 9518
Value - B
Archaeological potential (below-ground) - High

Summary - A revetted area to the south of Area 1 including chimney stack **YIM 07**, weighbridge office **YIM 30**, former canal basin **YIM 32** and former building **YIM 29**.

General condition
Poor. Buildings **YIM 7, 30** and **31** are stable, but **YIM 31** is slightly damaged. Nb. part of area formerly wet.
Management recommendations/implications
Buildings (**YIMs 7, 30** and **31**) - Retain as existing
Surfaces - general consolidation and maintenance at existing levels.
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

YIM 7 – Chimney stack (SS 6608 9517)
This higher revetted area is dominated by the base of a large chimney stack, 9.5m in diameter, of roughly-squared Pennant Sandstone (YIM 7). This is said to have been built in 1840 to service the flues from the silver works (YIM 10 - see below), later the cast house (Swansea Museums Service Factsheet 6, 29), and it is shown on the 1854 map (WGRO P/60/CW/204). It was demolished in the 1970s when the Inspector of Ancient Monuments, Douglas Hague, suggested that 2m be left standing (Stephen Hughes, pers. comm.); a number of photographs of the stack are housed in the NMR.

YIM 29 – Site of building (SS 6608 9519)
A small E-W building that is depicted immediately north of the stack on maps from 1879 to 1919; it had gone by 1943 and now lies beneath the later 20th century tarmac surfaces which occupy much of this area .

YIM 32 – Canal basin (SS 6609 9515)
The remainder of this revetted area, to the south, was formerly occupied by a canal basin which was constructed c.1835 to serve the smelting hall rolling mill and shown an all historic maps from 1854 to 1919. It had been infilled by 1943 and is now crossed by a tarmac path from the main works entrance (see Section 4.0),

YIM 30 – Weighbridge Office (SS 6608 9515)
The tarmac is flanked by the present red-brick weighbridge office (YIM 30) which was constructed over the infilled basin between 1919 and 1943 (ICI works plan, Swansea Museum Stores, YIM). It is a simple, rectangular, single storey brick building measuring 14m N-S and 7m E-W, inserted into the gap in the canalside wall for the basin. The weighbridge pit, now infilled, lies immediately east of the building.

YIM 31 – Building (SS 6610 9514)
The tarmac path continues south-east to run down the south wall of Building 1.0 (Canteen), where the higher level is again an original feature. Immediately west of the canteen, between the path and the revetment wall, is a triangular brick structure with a flat concrete surface raised 0.5m above the path (YIM 31). The south wall has been damaged exposing an internal void. The structure lies close to the former canal basin and appears to be a water-tank. It may be contemporary with Building 1.0 (ie. 1890s), supplying the boilers with water via the suspended iron pipe that runs from the structure into the latter's west wall; there is also an overflow downpipe. A truncated, triangular brick superstructure above the tank, measuring 9m E-W by 4m N-S, is suggested by the remains of at least two window reveals, an iron upright ?roof-post and the remains of pitched copper-slag flooring beneath the concrete, but no building is depicted here on any historic map.

Photo 11b - Area 1C from the SE showing weighbridge office YIM 30 and stack YIM 7 behind

5.1.4 AREA 1D

NGR - SS 6608 9527
Value - B
Archaeological potential (below-ground) - High

Summary - A 12m strip between the rolling mill east wall and the site perimeter fence including engine house **YIM 09**. The northern third lies beneath a late 20th century tarmac surface, overlying all earlier features.

General condition
Fair, including building **YIM 9**.
Management recommendations/implications
Building (**YIM 9**) - Retain as existing
Surfaces - general consolidation and maintenance at existing levels.
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

YIM 9 – Engine house (SS 6607 9526)
This is a tall, narrow, single-storey, gabled brick structure, parallel with and 0.5m east of the mill east wall, measuring 13m N-S by 3m E-W. It appears to have been constructed between 1919 (OS 1:2500 Third Edition) and 1943 (ICI works plan, Swansea Museum Stores, YIM). It is occupied by a ventilation plant. There are a number of simple openings, and a corrugated sheet-metal roof. The central third of the area has a concrete surface which may be contemporary. To the south, the surface exhibits a manhole and ventilation pipework associated with a contemporary electricity substation marked in 1943. The southern end of this area lies beneath a late 20th century tarmac surface, overlying all earlier features.

5.1.5 AREA 1E

NGR - SS 6610 9518
Value - B
Archaeological potential (below-ground) - High

Summary
A section between Buildings 10.0 and 1.0 including a revetment wall **YIM 8** and the remains of former buildings **YIM 10** and **28**, which revet the higher area. This area, which occupies the main site level, lies on average 3m below the revetted Area 1C. The revetment wall has largely gone to the north, where the higher level has been cut back, in recent years, by up to 3m and the material used to form a ramp. However, part of the a 10m revetment wall survives (YIMs 8 and 10).

General condition
Poor. Buildings and walls **YIM 8, 10** and **28** still actively retain the area to the west, which was formerly wet. Some of the openings/insertions may be weak spots. Currently overgrown with Buddleia. Ramped area appears to be stable.
Management recommendations/implications
Buildings (**YIMs 10** and **28**) - Retain as existing.
Revetment walls (**YIM 8**) - require vegetation control and maintenance. Some of the openings/insertions may require consolidation.
Surfaces - general consolidation and maintenance at existing levels.
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

Photo 11c - Area 1E, west wall of YIM 10 (silverworks/cast house), showing flues, from the SE

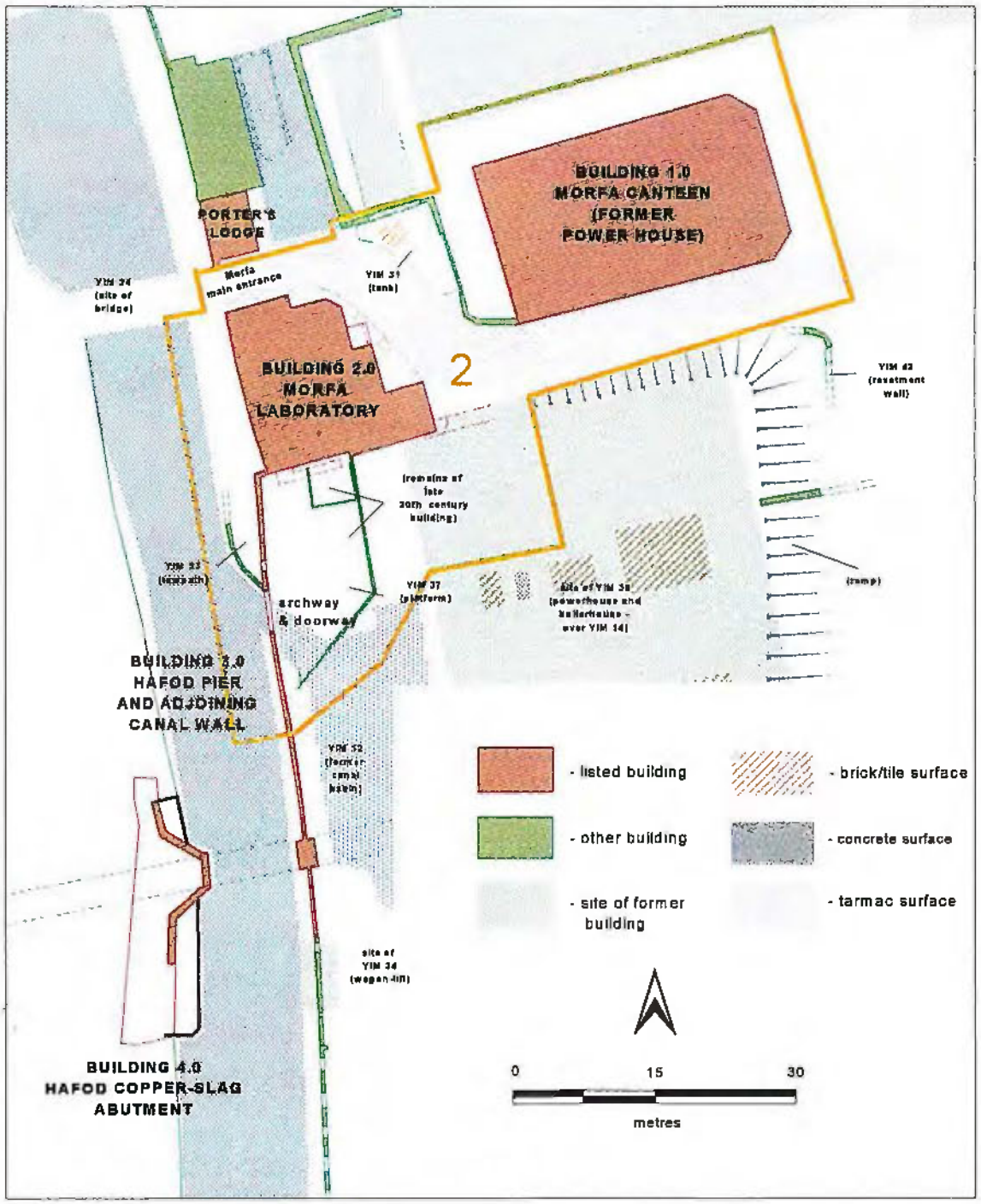
YIM 10 —Cast house/silverworks (SS 6610 9518)
A 10m length of revetment wall, in Pennant Sandstone rubble, which formed the west wall of a rectangular, N-S building, at the lower level. The buildings underwent a number of changes but is first shown on the Railway Deposited Plan of 1854 (WGRO P/60/CW/204); it is suggested that it was established as a silver works in c.1840 (Swansea Museums Service Factsheet 6, 29). It was extended to the south between 1899 and 1919 (OS 1:2500) and the same building is shown in 1943 when it was labelled □Cast House□ (ICI works plan, Swansea Museum Stores, YIM). The surviving wall appears to belong to its earliest phase and the south end is pierced by two furnaces, both brick-lined, one above the other; they may be primary. The roof-joist sockets for the building can be seen further north, and a vertical chase of unknown function. This building was clearly the □Old Cast House□ briefly described by A. J. Parkinson in 1978 when it was still standing (NMR archive). He noted that □modern structures inside show how flues and chimneys could be erected as and where required, sometimes connected to a main permanent stack□.

YIM 8 —Revetment wall (SS 6610 9514)
A dogleg at the southern end of YIM 10 continues around a rectangular enclosure which measures 19m N-S and 11.5m E-W, within Pennant Sandstone and copper slag revetment walls, heightened in red brick, and now open to the east. The west wall of the enclosure formerly retained the canal basin which was open until the early 20th century (see above).

YIM 28 —Building (SS 6610 9515)
The enclosure was unoccupied until 1879 when a N-S building, was depicted within it (OS 1:2500). The building had gone by 1919 but is represented today by its red brick, south gable wall, fossilised within the yard south revetment wall. The wall, which measures 6m E-W, suggests that the building was aisled on both sides, with clerestoreys above, and the depiction of four railway lines entering its long east side suggests that it may have been a wagon-coaling shed, fed by chutes from the dock above, also now gone. The building□s footprint was occupied by □Baths□ in 1943.

Photo 11d - Area 1E, south wall of YIM 28 and revetment wall YIM 8 from the NE

Fig. 11 - Detailed plan of Area 2, showing all features



5.2 AREA 2 (MORFA/HAFOD) - AROUND BUILDINGS 1.0 AND 2.0 (Fig. 11)

NGR - SS 6610 9511
Value - B
Archaeological potential (below-ground) - High

Summary
This area mainly lies immediately south of Buildings 1.0 and 2.0, on the site of former canal basin **YIM 12,** former building **YIM 14** and former powerhouse/boilerhouse **YIM 36**, and the remains of later 20th century structures **YIM 37**. It is a small, level area bounded to the north by the Laboratory and to the west by the canalside boundary wall (Building 3.0). It lies at the upper level of the site, ie. the terrace along the east side of the Swansea canal, which here is 60m wide. The area occupies the west side of the terrace, which is at least partly natural; the east side probably made ground. It also includes the tarmac ramp down the south wall of Building 1.0 (Canteen).

General condition
Poor. Appears to be stable, including the remains of later 20th century structures **YIM 37**.
Management recommendations/implications
Walls **YIM 37** - Retain as existing.
Surfaces - general consolidation and maintenance at existing levels.
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

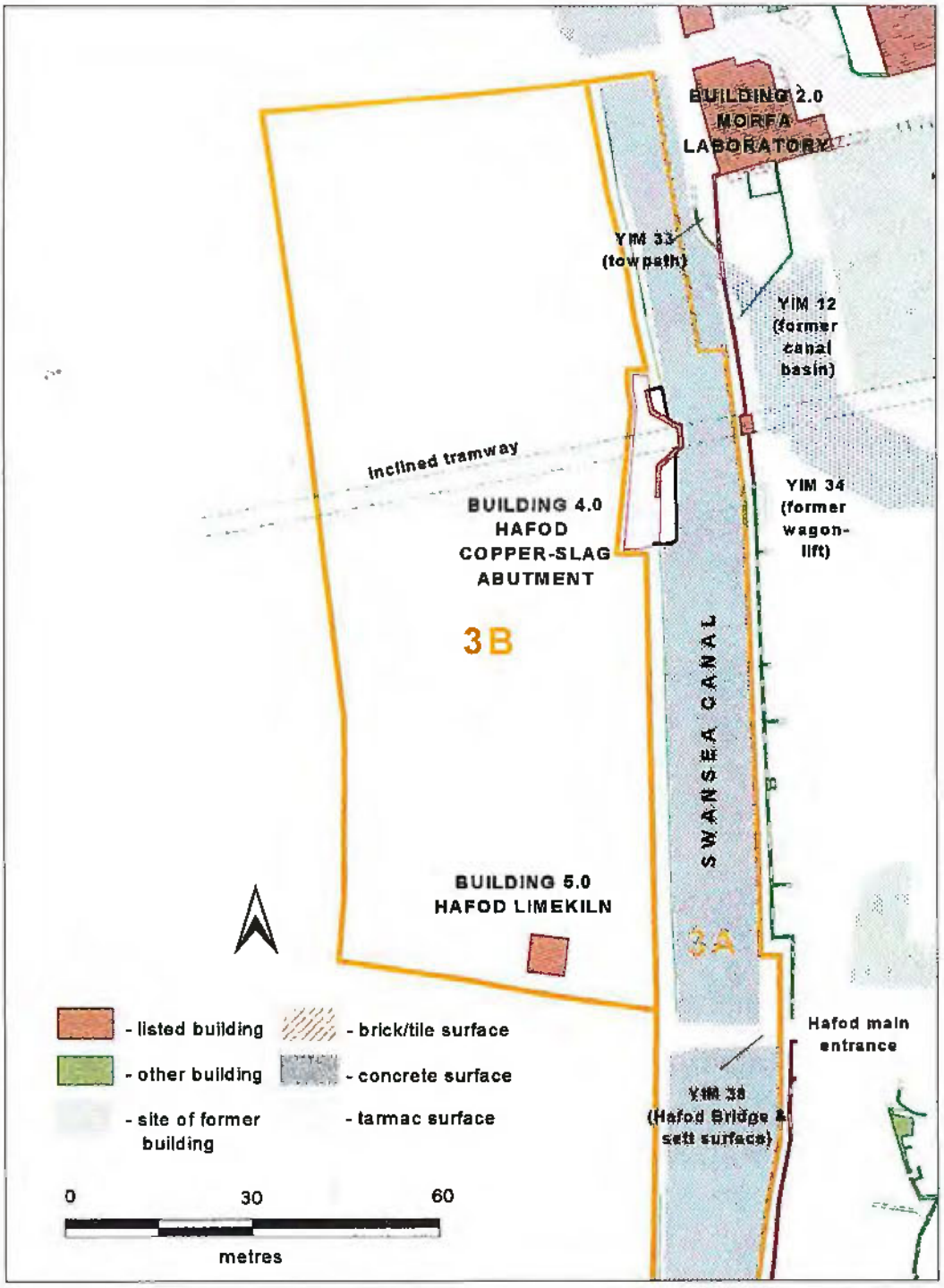
Photo 12 - Area 2, later 20th century tank YIM 37 from the south

YIM 12 – Canal basin (SS 6611 9509)
The northwest corner of the area was occupied by the entry to first of Hafod's canal basins, constructed in 1809 to supply the smelting hall with coal (Hughes 2000, 30). The blocked canal arches can be seen in the canalside boundary wall (Building 3.0). It was filled in the late 1920s (maps of c.1928 and 1943, Museum Stores, YIM).

YIM 14 – Building (SS 6614 9511)
The space between the basin and Building 2.0 was occupied by the northwest corner of a large building, which stretched away eastwards for 200m, over a large part of the works site. The building may have been early, possibly in place by 1835 (WGRO/P/60/CW/197), and is shown on the OS 1:2500 of 1879, but was demolished between 1899 and 1919 (OS 1:2500). Part of the south wall of Building 2.0 appears to belong to this building which, however, has left no physical evidence on the ground (see Building 2.0). By 1919, the building had been replaced by two large buildings, YIM 36, which are described below under Area 4.C.

YIM 37 – Platform (SS 6610 9511)
The only structures now visible are associated with an irregular raised, concrete-revetted platform, 1.2m high, measuring 30m N-S by 10m E-W, in the angle between Buildings 2.0 and 3.0. This is a later 20th century feature and is not shown on the 1943 map (Museum Stores, YIM) - which still shows part of the canal entry walls as an upstanding feature. On top of the platform are the footings of a small, copper-brick building, 5m square, associated with the swan-off iron uprights, in concrete pads, of an open-sided building adjoining to the south, also c.5m x 5m. The functions of these later 20th century buildings are unknown. In the south side of the platform is an large shaft, now filled in but formerly a left-open section of the canal basin. .

Fig. 12 - Detailed plan of Area 3, showing all features



5.3 AREA 3 (HAFOD) - WEST OF THE SITE

This area comprises two distinct parts, **Area 3A** which is part of Swansea Canal (**NPRN 34504**), and **Area 3B** which lies to the west of the canal.

5.3.1 AREA 3A

NGR - SS 661 950
Value - B
Archaeological potential (below-ground) – High

Summary
Area 3A comprises a 300m length of the Swansea Canal between Building 2.0 and the southern edge of the study area, including Building 4.0 (copper-slag abutment) and Hafod main entrance bridge **YIM 38**. The canal averages 15m in width, but has been filled in obscuring the tow-paths (nb. see Building 3.0).

General condition
Poor-very poor. The canal has been filled in. The canal revetment walls appear stable. Overgrown with Buddleia, saplings etc.
Management recommendations/implications
Canal (**NPRN 34504**) - consolidation of canal revetment wall and Hafod bridge (**YIM 38**) as necessary. Remove vegetation
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

NPRN 34504 – Canal (SS 6610 9511)
The Swansea Canal, which was established between 1794 and 1798 to open up the coal trade at head of Swansea Valley (Hughes and Reynolds 1988, 32). Its presence encouraged the establishment of other industries, such as Hafod and Morfa copperworks. No longer profitable by 1902 it became disused and finally closed in 1931 (Hughes and Reynolds 1988, 32). It infilled both naturally and deliberately, a process which in the study area, was complete at by the 1970s. Sections higher up the valley, at Clydach and Pontardawe, were still wet in 1988. Two inspection chambers in the infilled bed reveal that this section is entirely dry. The west revetment wall is in mixed material, chiefly Pennant rubble, and survives for a height of over a metre above the infill. It is largely obscured by vegetation. The filled-in sections over the tow-paths have a very high archaeological potential for structures including bridge abutments and basin entrances, while the infilled canal bed has a high artefactual potential, possibly including barges (as at Burry Port).

YIM 38 – Bridge (SS 6611 9498)
Physical evidence for the main entrance bridge to the Hafod works survives in the form of a limestone sett surface, 1.2m wide, which extends west from the entrance for 6m. The bridge was a single-arched, rubble masonry structure, with copper-slag copings, shown in a photo from the 1920s (Swansea Museums Service, SM 1987.543 1-, C1618 - see Plate 5). The parapet walls have been truncated and the arch itself lies beneath an earthen bank.

Photo 13 - Area 3A, YIM 38, showing the surviving sett surface from the west

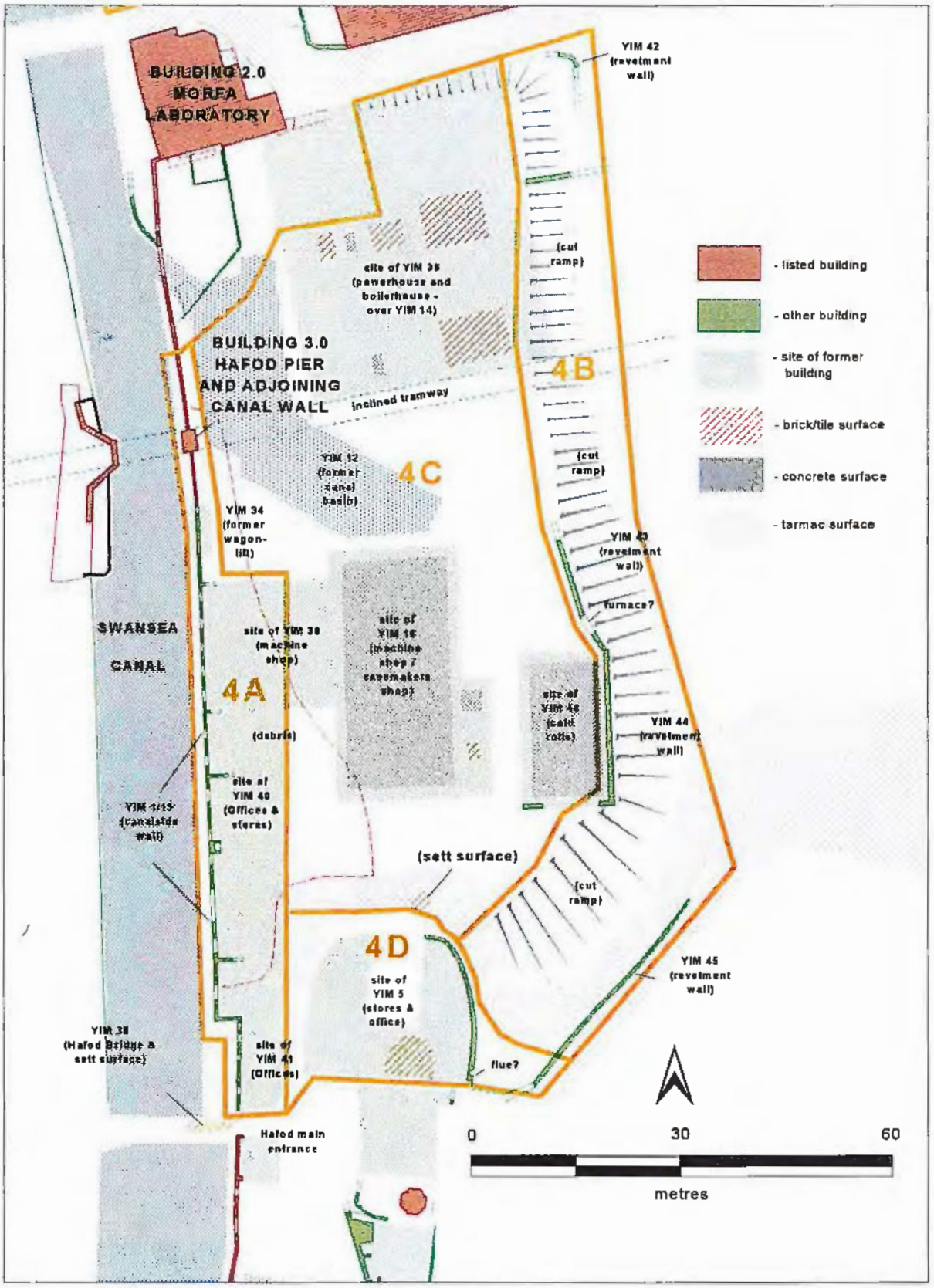
5.3.2 AREA 3B

NGR - SS 661 950
Value - C
Archaeological potential (below-ground) - Unknown

Summary
Area 3B lies west of the canal, including Building 5.0 (Hafod limekiln). It is entirely obscured by vegetation, partly cleared around the limekiln.

General condition
Poor/unknown. Heavily overgrown with Buddleia, saplings etc.
Management recommendations/implications
Cannot be assessed without removal of vegetation

Fig. 13 - Detailed plan of Area 4, showing all features



5.4 AREA 4 (HAFOD) – BETWEEN BUILDING 1.0 AND BUILDINGS 7.0-9.0

This area occupies the higher level of the site alongside the canal.

5.4.1 AREA 4A

NGR - SS 6611 9504
Value - B
Archaeological potential (below-ground) - High

General condition
Poor-very poor. **YIM 1/15** still forms site boundary, but is largely ruinous and in an active state of decay/collapse, particularly around the openings and flues. Most of the interior lies beneath c.1.5m of debris and parts are heavily overgrown with birch saplings.
nb. the adjoining area is accessible to the public.
Management recommendations/implications
Site/canalside boundary wall (**YIM 1/15**) - consolidation, where it collapsing.
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

Summary
The canalside boundary wall (**YIM 1/15**), including former wagon-lift **YIM 34**, and building range **YIMs 1/15, 39, 40** and **41**. The canalside boundary wall (**YIM 1**), between the tramway pier Building 3.0 and Hafod main entrance Building 6.0 was represented by the west walls of a N-S row of small buildings of various functions (**YIM 15**) and the two will herein be grouped together as **YIM 1/15**. The buildings are suggested on the Railway Deposited Map of 1835 (WGRO/P/60/CW/197) and on the 1844 tithe map, and their origins, at least, may lie in the years immediately following the establishment of the works in 1819.The walls run southwards for 90m from their junction with Building 3.0, with which they are contiguous. Overall **YIM 15** breaks down into at least 3 separate internal buildings.

YIM 1/15 – Wall/buildings (SS 6611 9504)
On the map of c.1928 (Museum Stores, YIM) the buildings comprised, from N-S, -

YIM 34 – Building (SS 6611 9506)
The wagon-lift mentioned under Building 3.0, which was removed in c.1930. The site of the wagon-lift is now represented by a 25m length of Pennant rubble wall, nearly 4m high, pierced by a segmental-headed window (blocked with breeze-blocks) and two slit-lights, on above the other. Though the wagon-lift is shown as a projection from the wall on the map, and is shown as a tall, projecting tower in a late 19th century drawing (reproduced in Hughes 2000, 98), the walling and openings appears to be rather earlier in character than the 1930s, and perhaps the lift was partly adapted from earlier walling. The area to the east of this wall lies beneath c.1.5m of debris and is heavily overgrown with birch saplings.

YIM 39 – Building (SS 6611 9505)
The walling certainly predates YIM 39, a rectangular building inserted through the canalside wall in the early 20th century. The building is represented by an 18m length of canalside wall, all in patent copper-brick, pierced by 5 large, square windows with coarse aggregate sills. One of the windows retains part of its frame, but the wall has been lost above lintel level and the building is ruinous. It is not known whether any of the other three walls survive, the area to the east of this wall lying beneath c.1.5m of debris and being heavily overgrown with birch saplings. A rectangular, N-S building is marked in this location on the c.1828 map and is labelled 'Machine Shop' - it may represent this building; labelled 'Saw benches' on the 1943 map (Museum Stores, YIM).

Photo 14a - Area 4A, part of building YIM 40 from the southwest (exterior)

YIM 40 — Building (SS 6612 9502)
YIM 39 can be seen to post-date YIM 40, a 44m length of wall which comprises a large number of different builds - not all of which necessarily represent different phases - defined by joints and copper-slag quoins in the predominantly Pennant rubble fabric. All may represent the *ad hoc* nature of the early 19th century arrangement. Some areas of brick patching and rebuilding are clearly later. This section is in very poor condition, ruinous in areas, while the area to the east lies beneath c.0.5m of debris. It is shown as single long building, divided by internal walls into 6 rooms, on the c.1928 map, labelled □Offices and Stores□, but only two internal cross walls can now be discerned. There are now 7 windows through the wall, all of broadly 19th century character, but few of them retain their heads. In the centre of the section is a battery of four double-flues, in yellow-brick, of mid-late 19th century date - a hearth is visible internally, and an (integral?) iron upright joist. This section is shown in a number of early photographs and drawings, wherein it appears to be a fairly ramshackle row of independently roofed, single-storey structures (see Plates 1 and 5). The wall returns eastwards to connect with -

Photo 14b - Area 4A, part of building YIM 41 from the southwest (exterior)

YIM 41 — Building (SS 6613 9499)
A 13m length of N-S Pennant masonry wall, also ruinous, with a window and three doors. Where the heads survive, they are segmental, in red-brick. Two of the doors are blocked with 20th century red-brick. This section is again basically early-mid 19th century and was labelled □Offices□ in c.1928. It is also shown in Plate 1 as two single-storey, N-S running, hipped-roof buildings, but no internal dividing walls can be seen. The wall has gone entirely at its junction with Hafod main entrance.

5.4.2 AREA 4B

NGR - SS 6616 9506
Value - B
Archaeological potential (below-ground) - High

General condition
Poor-very poor. Revetments **YIMs 42, 42** and **44** still retain the higher area, but much revetment appears to have lost here and the area has been cut back and ramped. Vegetation obscures part of the area.
Management recommendations/implications
Walls - Retain all walls and consolidate where necessary including openings. Clearance of vegetation.
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

Summary
This area comprises a 60m wide terrace at the higher level of the site, running N-S between Buildings 1.0 and 2.00 and the Hafod main entrance, including revetment walls (**YIM 42** and **43**) and bank between the higher and lower levels of the site, including cold-rolling mill **YIM 44**. It is a level platform, which is at least partly natural; the east side is composed of made ground, partly retained by walls YIM 42 and YIM 43, which at its south end is 4.5m higher than the lower, eastern site level.

YIM 42 – Revetment wall (SS 0615 9514)
At the NE corner of the platform, adjoining the tarmac ramp alongside Building 1.0, are the fragmentary remains of a N-S retaining wall, now only 1.5m high. Only 2m survives, in squared Pennant freestone, forming a battered revetment glacis for the deposits to the west. It is clearly a primary feature of the site, retaining canal basin YIM 12 in Area 4C. At its north end it curves around to the west, as a vertical wall alongside the tarmac ramp. To the south, between YIM 42 and YIM 43, any former revetment has gone and the deposits have been ramped back. The revetment is clearly shown on the 1943 plan (Museum Stores, YIM), and to the south was a revetted ramp along which a railway line climbed from the lower part of the site to the terrace. The line is not shown on any earlier maps, when the revetment may have been continuous.

YIM 43 – Revetment wall (SS 0616 9507)
60m south of YIM 42 are the remains of another revetment wall, again possibly primary. It survives for 10m before being lost in undergrowth to the north. It is in Pennant rubble, in poor condition, and survives to a height of nearly 4m, but the lower 2.5m lie beneath a massive talus of debris. A large, semicircular-headed opening in the wall, with a brick head, appears to represent an early furnace site the wall is suggested on none of the historic maps.

YIM 44 – Revetment wall/building (SS 0616 9504)
At its south end, YIM 43 is butted by a 22m section of concrete-block retaining wall, at a slightly different angle, rising over 2m above the debris. The south end is damaged, but appears to return to the west, and a short section of east-west footings, in patent copper-brick, can be seen on the same line 18m to the west, at the higher level. Between the two is an area of concrete floor, much obscured by debris. The walls and floor clearly represent the large, rectangular N-S building, measuring c.22m by c.18m, shown on all historic maps from 1879 to 1943, and the concrete blockwork is a 20th century rebuild. The building was labelled 'Cold Rolls and Warehouse' in c.1928 (Museum Stores, YIM) and might be the cold-rolling mill, of 20th century appearance, whose brick and steel-frame interior is shown in a photo of the 1920s (Swansea Museums Service, SM 1987.543 1- C1628 - Plate 7), when the rolls were driven by an electric power-plant. However, in 1943 the building was labelled 'Electrician and Joiner' while a much larger cold-rolling mill is shown to the east (Museum Stores, YIM) .

Photo 14c - Area 4, the remains of revetment wall YIM 42 from the south

Photo 14d - Area 4, revetment wall YIM 44 from the south

5.4.3 AREA 4C

NGR - SS 6615 9505
Value - B
Archaeological potential (below-ground) - High

Summary
The level revetted platform between areas 4A and 4B including the floor surfaces belonging to former machine shop **YIM 16,** former powerhouse/boilerhouse **YIM 36** and former cold-rolling mill **YIM 44**, and the site of canal basin **YIM 12**. To the north the area is unvegetated, though obscured by superficial debris, but to the south it becomes overgrown, with a dense birch-stand. Nevertheless, a number of surfaces are visible.

General condition
Poor-very poor. Appears to be stable, including the cut-back, ramped area and floor surfaces of **YIMs 12, 36, 44** and **16**. Extensively overgrown with saplings.
Management recommendations/implications
Surfaces - general consolidation and maintenance at existing levels. Vegetation removal and control.
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

YIM 12 – Canal basin (SS 6611 9509)
The body of the 1809 canal basin occupied the northern part of this area but was filled in during the late 1920s and has left no physical evidence on the ground.

YIM 36 – Building (SS 6613 9510)
East of the basin site are two extensive, discrete areas of tile- and concrete surfacing. They clearly represent the floors of YIM 36, the power house and boilerhouse that were established between 1899 and 1919 (over the site of the western part of YIM 14, see Area 2.0). They were two large, parallel, rectangular N-S buildings, each measuring 20m by 10m, which supplied the works with electricity, and were served by a large chimney stack to the south (map of c.1928, Museum Stores, YIM), for which there is now no physical evidence. Electricity was supplied by two 300kw Sulzer engines and two Mather and Platt 600kw generators; a photo from the 1920s shows both buildings, in steel-frame and brick respectively, and the stack (Swansea Museums Service, SM 1987.543 1-, C1589 - see Plate 6). They were enlarged in the 1930s, apparently at the expense of the stack (map of 1943, Museum Stores, YIM), for which no physical evidence is now discernible. In the ramped section to the east can be seen the truncated remains of a brick wall, which appears to represent the end wall of one of the power house lean-tos.

YIM 16 – Building (SS 6614 9504)
Running N-S through the centre of Area 4C, between buildings YIM 15 and YIM 44, is an extensive rectangular area of concrete surfacing, approximately 30m by 12m. It clearly represents the outline of YIM 16, a rectangular block shown on all historic maps from 1879 to 1943. In c.1928, the block was divided into three components labelled 'Machine Shop, Polishing Room and Office'; in 1943, it was the 'Casemakers shop and Case Stores'. At the south-east corner of the surface is an apparent concrete machine base, occupying the latter component. A small concrete surface, and a small part yellow-brick structure or surface, can be seen between the surface and YIM 44, corresponding to the east wall of a wider part of the block shown on the maps.

(The south-west part of this area was occupied by cold rolling mill YIM 44 (see Area 4B), now represented by a short section of its south wall footings, in patent copper-brick, and an area of concrete floor, much obscured by debris.)

Photo 14e - Area 4C, floor surface of YIM 16 from the north

5.4.4 AREA 4D

NGR - SS 6615 9500
Value - B
Archaeological potential (below-ground) - High

Summary
Area 4D - The southern end of revetted platform between Areas 4A and 4B, including office building **YIM 5** and revetment wall **YIM 45**. It is divided from Area C by a sloping tarmac path that cuts through the platform between the main Hafod entry and Buildings 8.0 and 9.0.

General condition
Very poor. Appears to be stable, except the cut-back section of **YIM 5**. Extensively overgrown with saplings.
Management recommendations/implications
Walls - retain as existing. Consolidate as necessary, particularly openings.
Surfaces - general consolidation and maintenance at existing levels. Stabilise eastern section of **YIM 5**. Vegetation removal and control.
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

Photo 14f - Area 4D, exterior of south wall of YIM 5 showing possible weathered flues

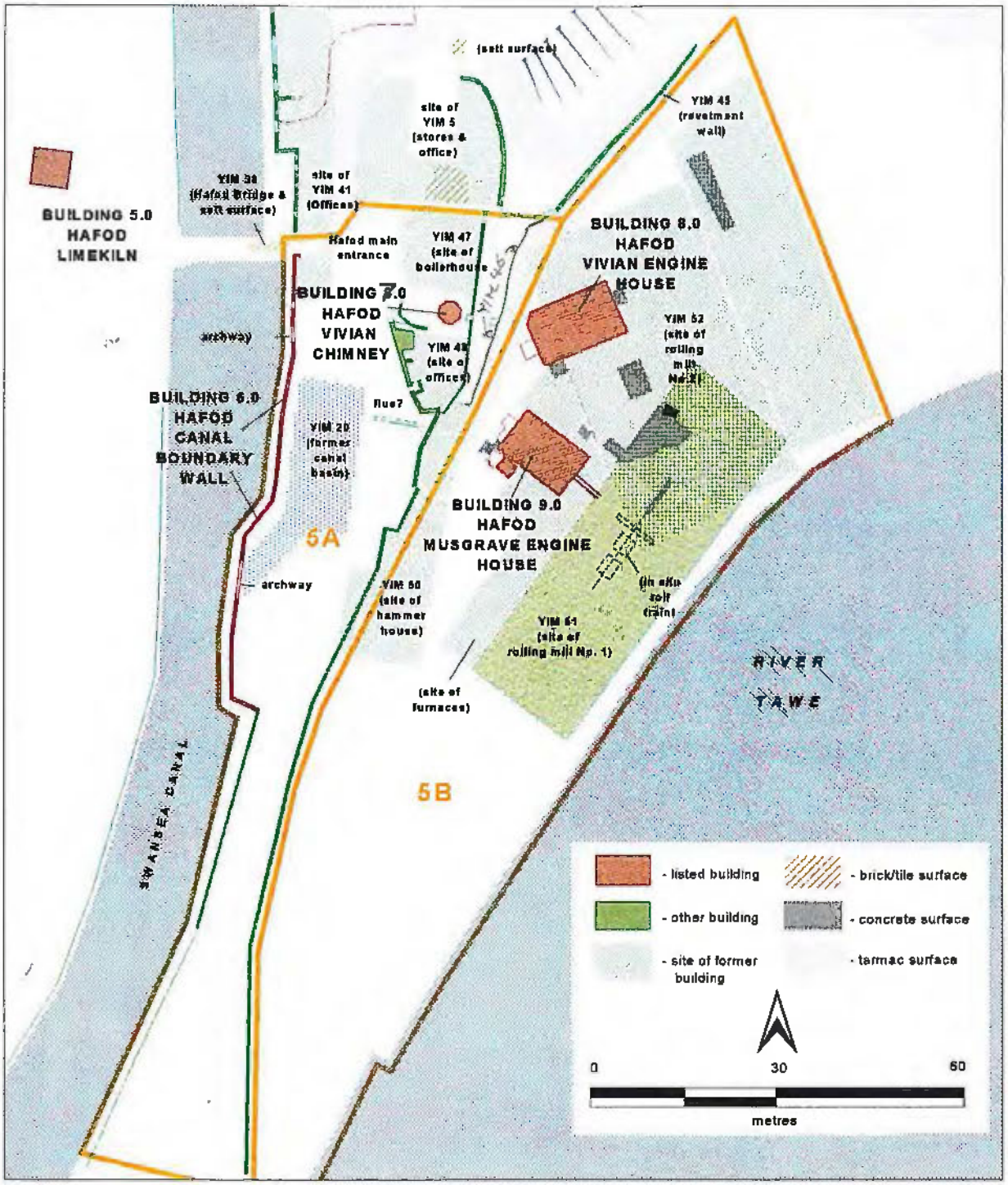
YIM 5 – Buildings (SS 6615 9500)
The line of the tarmac path is shown as a routeway on all historic maps from 1879 onwards. It is carried around the northern half of a block, YIM 5, that is also shown from 1879 onwards and is probably earlier, if not primary. The block is defined by a semicircular wall, now truncated to 1m above floor level, of thinnish Pennant rubble to the north and east. On the east side, the wall forms a 3m high revetment pierced by brick-lined ?flues, now decaying. The north wall ends as a stop for a former entry, but formerly continued around the west side of the block where it has been truncated to ground level and now lies beneath dense overgrowth. The interior space is level, with an area of brick surfacing visible to the south, though much overgrown. The south wall, which formerly revetted the level space against the c.2m drop to the south, has gone, and the section may not be stable, threatening the brick surface. The block thus defined is shown as divided into a number of components, around an open yard, on the c.1928 map (Museum Stores, YIM), 'Stores and Office', but no dividing walls are apparent on the ground.

The remains of a sett surface are exposed beneath the tarmac path immediately opposite the gap in the north wall of YIM 5. The surface is probably more extensive.

YIM 45 – Revetment wall (6617 9499)
The tarmac path doubles back to run downhill to the north-east, where its east side is revetted by a high Pennant Sandstone wall. This rises from ground level at is north end, to 3m to the south, but has been truncated by an unknown amount. The northern part of the wall is in large, squared freestone blocks, the southern part in rubble with poor ribbon pointing. The wall line continues into Area 5 (YIM 46).

In the angle between YIM 5 and YIM 45 is an level, unsurfaced area featuring a large, modern inspection chamber.

Fig. 14 - Detailed plan of Area 5, showing all features



5.5 AREA 5 (HAFOD) - AROUND BUILDINGS 7.0, 8.0 AND 9.0

This area occupies the main lower level of the site, alongside the River Tawe, but is partly terraced into the hillside.

5.5.1 AREA 5A

NGR – SN 6614 9494
Value - B
Archaeological potential (below-ground) - High

Summary - A terraced section around Building 7.0, occupying three levels on the steep slope between 8.0 and 9.0, and Building 6.0. It includes terrace/former rail-bed **YIM 46**, the remains of boilerhouse **YIM 47** and office **YIM 48**, wall **49**, and the sites of former canal basin **YIM 20** and hammer house **YIM 50**

General condition
Very poor. The walls of former **YIMs 47, 48** and revetment wall **YIM 49** still retain the higher area, but the walls are in a rather poor condition. nb. revetted area may still be partly wet. . Vegetation obscures much the area and threatens structures.
Management recommendations/implications
Walls - Retain all walls and consolidate where necessary including openings. Clearance of vegetation.
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

YIM 46 – Wall (SS 6616 9498)
This is a southwards continuation of the line of retaining wall YIM 45, but is here a low wall, only 0.5m high, which revets a flat platform 5m wide at most. It is in concrete, and appears to be a late 20th century feature incorporating part of a pre-existing terrace upon which rail lines were depicted in 1943, but no earlier (Museum Stores map, YIM). The west side of the terrace is formed by a similar low revetment to the higher areas occupied by YIMs 47 and 48.

YIM 47 – Boilerhouse (SS 6615 9498)
A very overgrown area lies between YIM 46 and the higher YIM 5 in Area 4 to the north. Little can now be distinguished on the ground of a rectangular building (YIM 47) , c. 10m N-S and 14m E-W, erected north of Vivian's chimney stack (Building 7.0), between 1899 and 1919, and labelled 'Boiler House' on the plans of c.1928 and 1943 (Museum Stores map, YIM). A 3m high, red-brick wall runs west from the stack, to curve in sections around to the north and towards this building, but becomes lost in the undergrowth. The curving wall itself appears to be a revetment wall, against the steep slope to the west, that is the same shape as, and doubtless contemporary with the stack ie. 1860-62.

YIM 48 – Building(s) (SS 6615 9496)
This is an irregular area defined by YIM 46 and a 3m high retaining wall to the west, in Pennant Sandstone and with a massive raking buttress that is probably early, and part of the original revetment of canal basin YIM 20 from c.1818. A brick-lined doorway through this wall, possibly early, appears to be industrial but now possesses a small brick lobby. Pipework between the lobby and the buttress also appears industrial. A building is shown here on all editions of the OS maps, but in c.1928 it was labelled 'Offices' giving no clue to its former function. It had been demolished by 1943.

Photo 15a - Area 5A, interior of west wall of YIM 48 showing possible flue and pipework

YIM 50 — Hammer House (SS 6616 9492)
Further south was an L-shaped building, again terraced into the slope, shown an all OS editions and labelled □Hammer House□ in c.1928. It had gone by 1943 and there is now no evidence for the building in this very overgrown area, apart possibly from one short length of indefinable walling. It is not know whether this building was the site of the original hammer, for stamping sheet copper, that was purchased by the works in 1820 (WGRO D/D/NAI M/101/18). In the 1920s, contemporary photos show that the hammers were located in an early 19th century building very similar to Morfa rolling mill (Building 10.0), with wide open arches and oculi (Swansea Museums Service, SM 1987.543 1- C1634). Again, it is not know whether this building was the same as YIM 49.

YIM 20 — Canal basin (SS 6614 9495)
At the higher level to the west, and retained by all these structures, lay the canal basin established in 1818 to serve the rolling mills. This has been described in Section 4.0 (Building 6.0); it was filled in between c.1928 and 1943 . The area within which the body of the basin lay is entirely overgrown and inaccessible (Museum Stores maps, YIM). It supplied coal-bunkers located between YIM 48 and YIM 50.

YIM 49 — Revetment wall (SS 6615 9490)
The line of terrace revetment YIM 46 continues 30m south of these buildings as a high Pennant revetment wall, which may be earlier 19th century, but has almost entirely been replaced by concrete. It revets a very steep slope up to the Swansea Canal and Building 6.0.

5.5.2 AREA 5B

NGR — SN 6618 9495
Value - B
Archaeological potential (below-ground) - High

Summary - The lower area around Buildings 8.0 and 9.0, occupying the lower level of the bulk of the works site including rolling mill floor surfaces **YIM 51** and **52**. This area has been occupied by rolling mills, and engine houses, since 1818.

General condition
Poor. Appears to be stable. To the south is an extensive stand of birch saplings.

Management recommendations/implications
Surfaces - general consolidation and maintenance at existing levels. Vegetation removal and control.
General - Any significant works should be preceded by a targeted programme of archaeological fieldwork.

Photo 15b - Area 5B, the rolling machinery associated with Building 9.0 from the north

YIM 51 — Rolling mill (SS 6618 9495)
An area of concrete flooring, of which a 30m length is visible, lies at right angles to the southeast wall of Building 9.0 and represents part the floor of the associated rolling mill no. 1 shown in on all historic maps and in detail in c.1928 and 1943 (Museum Stores, YIM). The mill was established in 1818, contemporary with the first engine house on the site of Building 9.0. but lies beneath this surface. The rolling mill machinery (latest phase arrangement, ie. 1980s) is still *in situ* in a fenced area immediately southeast of, and at right-angles to the engine-house. It includes the southern half of a roll-train, with two pairs of rolls and standards. The northern half has gone but the concrete bearer still survives. The two halves of the train were symmetrical about the flywheel and master-drum - which was driven by the Musgrave Uniflow engine, by wire rope, right up until the 1980s (see Plate 8). The building around the machinery was offered to the Council to purchase in

the 1980s, but the offer was declined (Stephen Hughes, pers. comm.). Apparently reheating furnaces, from 1910, were also still present in this area in 1980, and the impressions of bases are faintly visible in the concrete surface. A smaller rectangular area of concrete immediately north of the engine house, 1.5m by 2.5m, appears to occupy the site of the stack shown in c.1928, and may represent its infill.

YIM 52 – Rolling mill (SS 6618 9497)

An area of concrete flooring south of the Vivian Engine House (Building 8.0) appears to represent the base of a reheating furnace associated with rolling mill no. 1, originally established in 1842/1847. The furnace is shown on the c.1928 and 1943 plans.

5.6 AREA 6 (HAF0D) – BETWEEN BUILDINGS 7.0-9.0 AND BUILDING 11.0 (Fig. 1)

NGR – SN 6613 9480
Value - B
Archaeological potential (below-ground) - High

Summary – This area, south of Buildings 7.0-9.0, and around Building 11.0 (Vivian Locomotive Shed), comprises the level ground on the west bank of the Tawe. It is bounded by the Grade II listed quay. A detailed assessment of this area was not requested in the brief.

The **quay** (Grade II listed, LB No. 16879) forms the eastern edge of this area. The quay appears to have been built in 1810 for the unloading of copper ore and for the export of copper products. It is a tall quay of dressed Pennant sandstone with flat stone copings. The quay is straight for most of its length, from its junction with a recent concrete river wall at the north to a right-angled return near its southern end. The return was designed to allow vessels to draw back from the river current. There is a smaller return before a raised stop at the southern end of the quay (Cadw LB database). The quay wall preserves some original detail such as steps (see Plates 4 and 10).

Also present in this area, between Buildings 7.0-9.0, and around Building 11.0, are the remains of the early gasworks, established in 1820 (WGRO D/D NAI G/24/1-9) and demolished between 1899 and 1919. They are represented by the curving wall, cut into the hillslope above the river, which was built to receive the gasometers.

General condition
Not assessed

Management recommendations/implications
Not assessed

6.0 REFERENCES

6.1 Unpublished maps

National Library of Wales, Parish of St John-juxta-Swansea, Tithe Map and Apportionment, 1844.

Swansea Museums Service, 'Plan of Hafod Copperworks prepared by ICI Ltd Metals Division, Landore Works, Swansea', scale 20 in:1 ft, n.d., c.1928? (held at YIM Museum Stores).

Swansea Museums Service, 'Ground Plan of Swansea Works: ICI Metals Division, Landore, Swansea', scale 1:1250, 1943, retraced 1949 (held at YIM Museum Stores).

West Glamorgan Record Office, Llansamlet Parish Records, WGRO P/60/CW/-, Railways & Canals -

P/60/CW/197, 'Plan of proposed improvements to Swansea Harbour showing the River Tawe from the piers to Forest Weir', Nov. 1835.
P/60/CW/198, 'Plans of Swansea Branch Railway and deviation of Canal in the parish of St John-juxta-Swansea', 1845.
P/60/CW/200, 'Plan of proposed diversion of Canals in Swansea, St John-juxta-Swansea, Llangyfelach and Llansamlet parishes', n.d. (mid 19th century).
P/60/CW/204, 'Plans showing a proposed extension to the Newport, Abergavenny and Hereford Railway, through the parishes of St John-juxta-Swansea and Swansea', 1854.
P/60/CW/209, 'Plan showing GWR and Swansea Canal Co. Railways in the parishes of St John-juxta-Swansea, Swansea and Llangyfelach', 1871-2.

West Glamorgan Record Office, WGRO D/D Xgc 128, Ordnance Survey Original Surveyors' Drawings, 2" to the mile, Sheet 128, 1813.

6.2 Published maps

Ordnance Survey 1:500 First Edition, Glamorganshire (Gower) Sheets XXIV.1.3, XXIV.1.4, XXIV.1.8, XXIV.1.9, XXIV.1.13, XXIV.1.14, 1879.

Ordnance Survey 1:2500 First Edition, Glamorganshire Sheet XXIV.1, 1879.

Ordnance Survey 1:2500 Second Edition, Glamorganshire Sheet XXIV.1, 1899.

Ordnance Survey 1:2500 Third Edition, Glamorganshire Sheet XXIV.1, 1919.

Ordnance Survey 1:10560 Old Series, Sheet 37, 1830 (railways added 1882).

6.3 Unpublished drawings

National Monuments Record, NPRN 300184 (Hafod and Morfa), scale drawings of 'Vivian' and 'Musgrave' Engine Houses NPRNs 33710 and 33743, and surviving machinery, 2000.

Swansea Museums Service, Smaller Print Collection, 477 (engraving of Forest Copperworks, by Thomas Rothwell, c.1790).

West Glamorgan Record Office, WGRO D/D Xgb 17 (print of Middle Bank Copperworks (possibly Hafod?), by Henri Gastineau, c. 1830).

West Glamorgan Record Office, Neath Abbey Ironworks Collection, WGRO D/D NAI G/- (gas installations) -

G/24/1-9, Hafod - drawings of work for retorts, retort ovens, gasometer and gasometer well, etc., 1820.
G/24/10, Hafod - drawing of pipes for gas light, Dec. 1820.
G/24/11-23, Hafod - drawings of sundry work on gas lights, gasometer, condensing main etc., 1820-30.
G/30/1-3, Morfa - drawings of work for gasometer, hydraulic main and sundry pipes, 1833.
G/30/4, Morfa - plan and elevation of gas works, 1833.
G/30/5, Morfa - drawings of sundry work, 1841.

West Glamorgan Record Office, Neath Abbey Ironworks Collection, WGRO D/D NAI L/- (drawings of locomotives) -

L/45, 'Tubal-cain', 12" cylinder 20" stroke locomotive built for Vivian & Sons, 1859.
L/46, 10" locomotive built for Vivian & Sons, 1857.
L/47, 12" locomotive built for Morfa Works, 1855.

West Glamorgan Record Office, Neath Abbey Ironworks Collection, WGRO D/D NAI M/- (plans of machinery) -

M/101/1, Hafod - plan of Rolling Mill, Dec. 1818.
M/101/2-12, 15, Hafod - drawings of rolling machinery, shears etc.,1818-1820.
M/101/13-14, Hafod - drawings of wrought ironwork and piping for lime-agitation machine, Aug. 1820.
M/101/16-17, Hafod - drawings of work and sundries for copper smoke consumer, 1821-22.
M/101/18, Hafod - drawing of hammer for stamping sheet copper, 1820.
M/101/19-20, Hafod - drawings of water-wheel and fly-shears, Feb.-March 1834.
M/101/21, Hafod - drawings of rolls, n.d..
M/139/1, Morfa - drawing of purifier, Sept. 1833.
M/139/2, Morfa - drawings of Mill and Engine House, April 1834.
M/196, Vivian & Sons - drawing of punching machine, Nov. 1827.
M/463/1-24, Hafod - drawings of cranks, gearing etc. for 40" steam engine for Rolling Mill, 1818-20, 1825-57.
M/463/25, Hafod - ground plan of engine house, April 1818.
M/463/26, Hafod - drawing of engine house, Aug. 1818.
M/463/27-33, Hafod - drawings of engine, boiler and details, 1818.
M/463/34, Hafod - plan and elevation of engine house, December 1818.
M/463/35-8, Hafod - drawings of Rolling Mill engine, rolls, shears etc., 1818-21.
M/463/39, Hafod - plan, elevation and end-view of 10" pipes for conveying water from engine to canal, April 1819.
M/463/40-76, Hafod - drawings of Rolling Mill engine, boiler, rolls, shears, 'small crane for fixing', punching machine etc., 1819-32.
M/463/77, Hafod - drawing of Mill, June 1847.
M/463/78-99, Hafod - drawings of details of Rolling Mill machinery, 1847 onwards.
M/463/100, Hafod - general section of engine house, n.d..
M/463/101, Hafod - drawing of 2hp engine, 1829.
M/463/102-3, Hafod - drawings of 'slag engine', 1839 & n.d..
M/463/104-7, Hafod - drawings of 'Mill engine', 1854-63.
M/463/108-111, Hafod - drawings of 24" vertical engine, and masonry for engine, 1863.
M/571/1-5, Morfa - drawings of flywheel, gearing etc. for 22" stamping engine, 1824-34.
M/571/6-16, Morfa - drawings of gearing, pipes, nozzles and governor etc. for 45" engine, 1828-45.
M/571/17-28, Morfa - drawings of various work including rotative shears, boiler, hammer mill sundries, standards and carriages, copper-shears, crane etc., 1829-56.
M/571/29-41, Morfa - drawings of gearing, steam-valves, rods, cocks and flyshaft for 40" engine, 1836-7 and n.d.
M/571/42, Morfa - drawing of hammer-shaft for 43" engine, 1837.

6.4 Unpublished photographs

National Monuments Record, NPRN 300184 (Hafod and Morfa), photographs of Hafod Works in 1900, 1952 and 1978.

National Monuments Record, NPRN 300184 (Hafod and Morfa), photograph of Hafod spoil-tip, n.d. (early 20th century?).

National Monuments Record, NPRN 300184 (Hafod and Morfa), photographs of 'Vivian' and 'Musgrave' Engine Houses NPRNs 33710 and 33743, and Musgrave Engine, 1978.

Swansea Museums Service, SM 1987.543 1- (Vivian Collection, 2 x photograph albums of Hafod and Morfa Works, plant and process, by Colquhoun Photographers, n.d., c.1920s).

Swansea Museums Service, Smaller Print Collection, 403a & 403b (2 x photographs of Hafod Works c.1924).

6.5 Unpublished works

Cadw, listed building information (MS Access database)

Locock, M., 2002 'Landore Park and Ride to Neath Road, Swansea: archaeological desktop study' (client report for the City and County of Swansea, July 2002; copy held with Glamorgan-Gwent Archaeological Trust Sites and Monuments Record, report no. 2002/046).

National Monuments Record, 'notes made on Yorkshire Imperial Metals Works by A. J. Parkinson', 8 December 1978.

Swansea Museums Service, Lower Swansea Valley Factsheet 5, 'Early Copper Works' (G. Gabb, n.d.).

Swansea Museums Service, Lower Swansea Valley Factsheet 6, 'Later Copper Works' (G. Gabb, n.d.).

Swansea Museums Service, Lower Swansea Valley Factsheet 7, 'The Rise and Fall of the Copper Industry' (G. Gabb, n.d.).

Toft, L. A., 1990 'A4607/A4217 Cross Valley Link at Pentrechwyth: an archaeological assessment' (client report, April 1990; copy held with Glamorgan-Gwent Archaeological Trust Sites and Monuments Record, report no. GGAT 35).

West Glamorgan Record Office, WGRO D.255 'Notebook of an unknown engineer.... containing notes on Millbank Works, Hafod Works, Landore Pits etc., 1830-31'.

6.6 Printed works

Alexander, W. O., 1955 'A Brief Review of the Development of the Copper, Zinc and Brass Industries in Great Britain', *Murex Review* Vol. 1, No. 15.

Grant-Francis, G., 1881 *The Smelting of Copper in the Swansea District.*

Hughes, S. and Reynolds, P., 1988 *Industrial Archaeology in the Swansea Region.*

Hughes, S., 2000 *Copperopolis.*

Hurst, J. T. (ed.), 1904 *Treadgold on Carpentry.*

John, A. H., and Williams, G. (eds.), 1980 *Glamorgan County History Vol. V, Industrial Glamorgan from 1700 to 1970.*

Lewis, S., 1833 *A Topographical Dictionary of Wales.*

Morgan, P. (ed.), 1988 *Glamorgan County History Vol. VI, Glamorgan Society 1780-1980.*

National Industrial Development Council of Wales & Monmouthshire, 1937 *The Second Industrial Survey of South Wales*, Vols. 1 and 2.

Tomos, D., n.d., *Michael Faraday in Wales.*

Webb, D. C., 1812 *Observations made during Four Excursions made to Various Parts of Great Britain in the Years 1810 and 1811, Part IV, London to Swansea.*

Press cuttings

Western Mail, 10 March 1982 (Musgrave Engine threatened with scrapping).

Western Mail, 10 December 1985 (Vandalism to Morfa Canteen).

APPENDIX 1 - REVIEW OF THE SOURCES

Publications

The key text to understanding the YIM site is *Copperopolis*, by Stephen Hughes of RCAHMW (Hughes 2000), a detailed, wide-ranging and full-referenced study of the copper industry in Swansea. It gathers together and synthesises much of the available information on the Hafod and Morfa works, and the surveys undertaken by RCAHMW. Stephen Hughes is also the co-author, with Paul Reynolds, of the valuable summary *Guide to the Industrial Archaeology of the Swansea Region* (Hughes and Reynolds 1988).

Swansea Museums Service produce a series of Factsheets dealing with the copper industry in the Lower Swansea Valley, written in an authoritative style by the industrial archaeologist Gerald Gabb. These contain some additional information, but are not fully referenced.

The post-medieval volumes of the Glamorgan County History provide much background detail on productivity, the workforce, conditions etc.

Documents

The NLW, Swansea Museums Service and WGRO were consulted for primary source documentation, but there appears to be little specifically concerning the works. However, the Neath Abbey Ironworks Collection at WGRO mainly comprises drawings (see below), but these provide valuable evidence as to the form, and date, of the structures that were built to contain it.

WGRO also possesses a notebook compiled by an unknown engineer working for the Vivians in 1830-31 (WGRO D.255), which contains eye-witness testimony to various aspects of the contemporary Hafod Works.

Historic maps

The most useful resource of all, historic maps however normally lack labelling and only the outline plan of buildings is shown. Nonetheless, all additions of the OS 1:2500 maps were consulted, and the OS 1:500 town plans.

Manuscript maps proved variable in quality. Two key maps to understanding the site are stored at YIM Museum Stores itself. The first is a plan of Hafod drawn in c.1928, soon after its acquisition by ICI, and is a detailed plan of the works at its greatest extent. It is fully labelled, enabling the identification of all buildings, many of which had their origins in the early 19th century and retained the same functions. Some of these may already have been demolished and it is possible that the plan shows the situation at a slightly earlier date than 1928. The other Museum Stores map shows both works in 1943, after the smelting halls had been demolished at Hafod. Again fully labelled, it identifies the functions of the buildings at Morfa including the former smelting hall.

Other manuscript maps are less useful. In particular, the Tithe map of St John-juxta-Swansea parish, drawn in 1844, is a very difficult map to interpret. Few structures are shown - the site appears to be 90% empty - and what is shown can be misleading. It is clear from a slightly earlier map at WGRO, a Railway Deposited Plan from 1835 (WGRO/P/60/CW/197), that both Hafod and Morfa had already grown to their maximum extent.

Two slightly later Railway Deposited Plans, from 1854 (WGRO/P/60/CW/204) and 1871-2 (WGRO/P/60/CW/209), are limited to the west side of the site but show much of the study area. They demonstrate that little development or change took place here between the two dates.

A detailed OS surveyor's plan of Hafod Works, from 1821, is said to be in the British Library (Stephen Hughes, pers. comm.). Unfortunately it was not possible to examine this map, nor the Canal Records at the Public Record Office, Kew.

There are no Insurance Plans of this part of Swansea. These late 19th- and early 20th century plans, deposited with WGRO and Swansea Reference Library, are very detailed and give information on function, and even the materials, of buildings, but are confined to Swansea City

Centre. Nor does the Board of Health plan, from 1852 (MP/LBH/Swansea/1852), extend this far out from the city centre.

Historic pictures

There are a number of 19th century drawings and prints of Hafod and Morfa Works. Many of them are reproduced in Hughes (2000). They are not always clear, but the best of them shows Hafod main entrance, canal docks and inclined tramway as completed, is reproduced in this report (Appendix 2).

The Neath Abbey Ironworks Collection at WGRO is a collection of drawings of machinery etc. manufactured at Neath for a variety of customers. Much of the Hafod and Morfa machinery was made at Neath during the 19th century, and there are many drawings in the collection. However, few of them show the machinery *in situ*, or the structures around them. Nevertheless, there are detailed drawings of the 1828 mill at Morfa (WGRO NAI M/139/2) and the 1818 and 1847 engine houses at Hafod (WGRO NAI M/463/25; M/463/100).

Historic photographs

There are an even larger number of 19th and early 20th century photos of Hafod and Morfa Works, many of them also reproduced in Hughes (2000). A number of these photos are from Swansea Museums Service, SM 1987.543 1-, comprising two albums of photographs professionally taken in the 1920s. They are not fully labelled, but it is usually possible to identify the buildings and processes, and there are a number of good overall views. See Appendix 2.

The NMR (RCAHMW) contains a number of photos of the Musgrave engine and engine house just before it stopped operating 1980. There are also earlier photos of the site. See Appendix 2.

Aerial photographs are normally from the 1940s and 50s and will only record the decline of the site. They area of limited use in such a densely built-up area. Also not seen were the collection in the National Museums and Galleries of Wales, Department of Industry, many of which are reproduced in Hughes (2000).

Oral sources

Consultation of local oral sources lay beyond the scope of the study. However, Stephen Hughes and David Percival of RCAHMW were consulted, the former accompanying the author on a site visit, as well as staff at GGAT who have been the archaeological curators for Swansea since 1975 and who have carried out a number of archaeological projects within the site, and staff of Swansea Museum who have considerable knowledge of the history of, and the sources for, the study area.

Previous archaeological work

There has been little systematic archaeological work on the site, and no below-ground intrusive work. However, Stephen Hughes' documentary searches and fieldwork produced much of the information in 'Copperopolis', while David Percival (RCAHMW) has produced detailed surveys of the Vivian and Musgrave engine houses, and the surviving machinery, at NMR (RCAHMW). The NMR also contains the field notes of A. J. Parkinson, who visited the site when it was still operational in 1978.

GGAT have undertaken two archaeological assessment projects in the area, the results of which have been drawn on in the report (Locock 2002 and Toft 1990).

Geotechnical work

Neither the GGAT SMR nor the client are aware of there having been any previous geotechnical work in the study area and no physical evidence for such work is visible on the site.

APPENDIX 2 - HISTORIC PICTURES AND PHOTOGRAPHS

Plate 1 - Hafod Works looking northeast from the canal towards the main entry, showing canalside wall and bridge, inclined tramway etc, c.1850 (reproduced from Grant-Francis 1881)

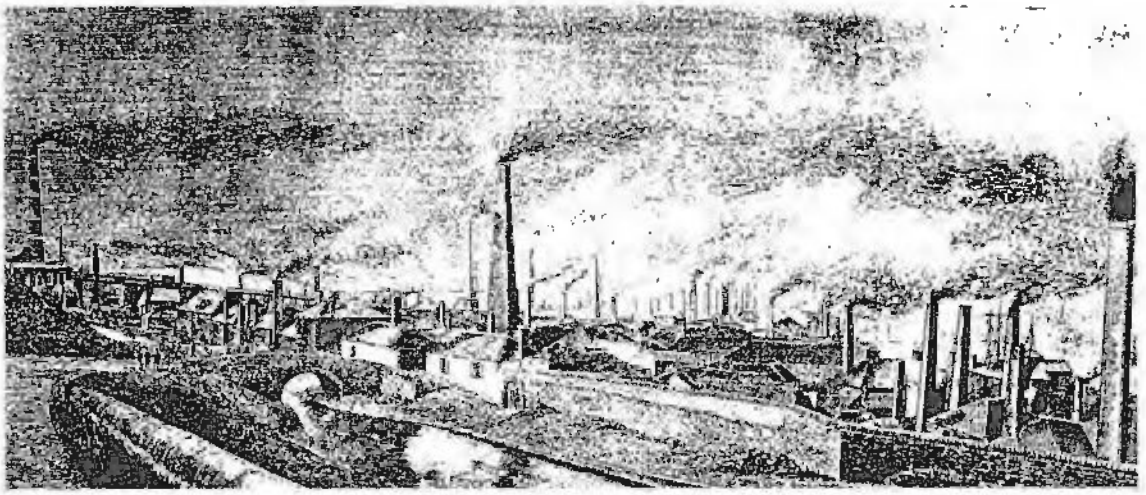


Plate 2 - The River Tawe in c.1865, looking north showing Hafod Works to the left, and Middle and Upper bank works to the right (reproduced from Hughes and Reynolds 1988)

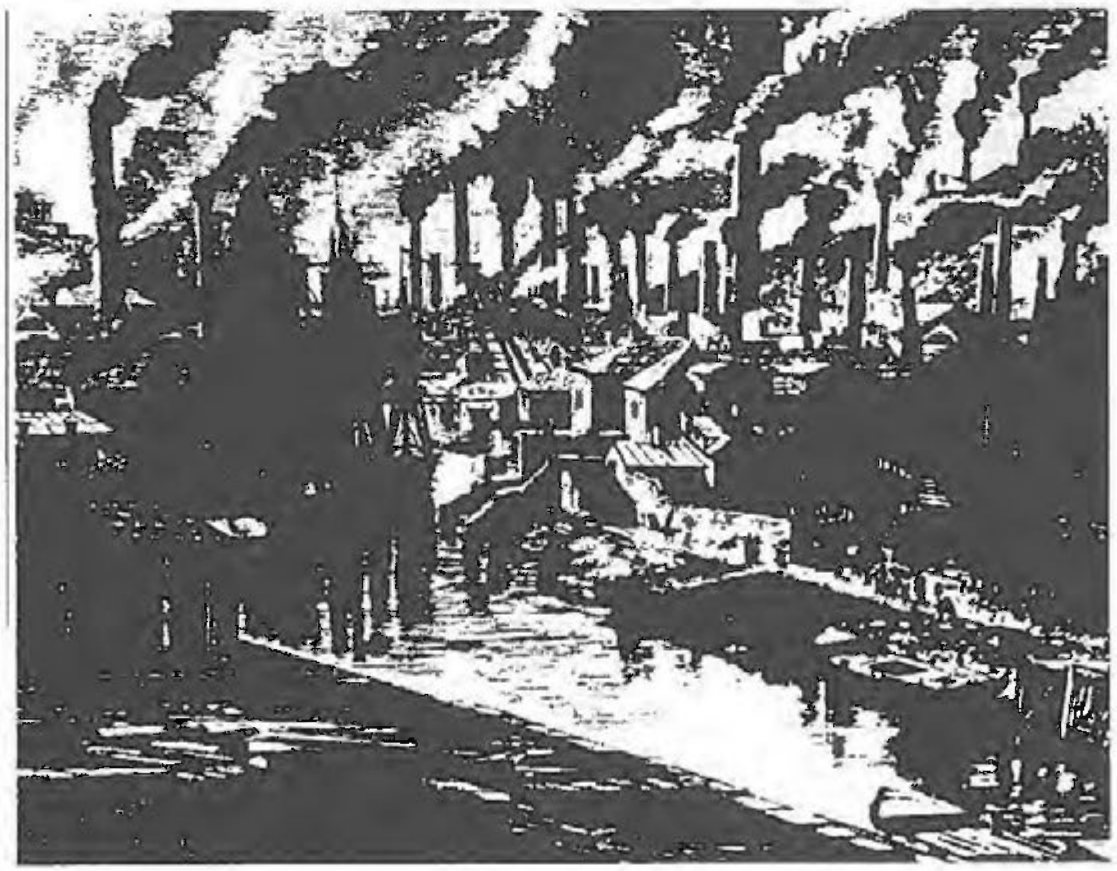


Plate 3 - Hafod and Morfa Works in 1900 looking east, from above the canal, showing the Laboratory (Building 2.0) to left
(reproduced from Alexander 1955)

Plate 4 - The south end of Hafod Works in the 1920s, showing rolling mill No. 1 (YIM 51) and the sulphuric acid works on the eastern spoiltip behind
(Swansea Museums Service, SM 1987.543 1-, C.1619)

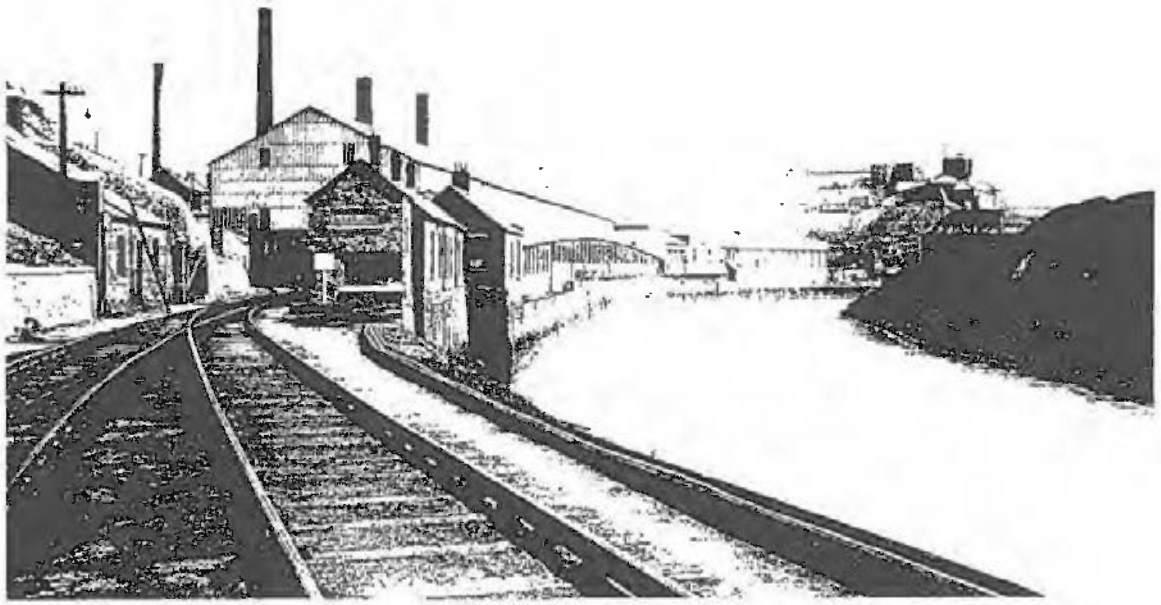


Plate 5 - The entrance to Hafod Works, looking north at the bridge (YIM 38) and buildings beyond (YIM 41), in the 1920s (Swansea Museums Service, SM 1987.543 1-, C.1618)

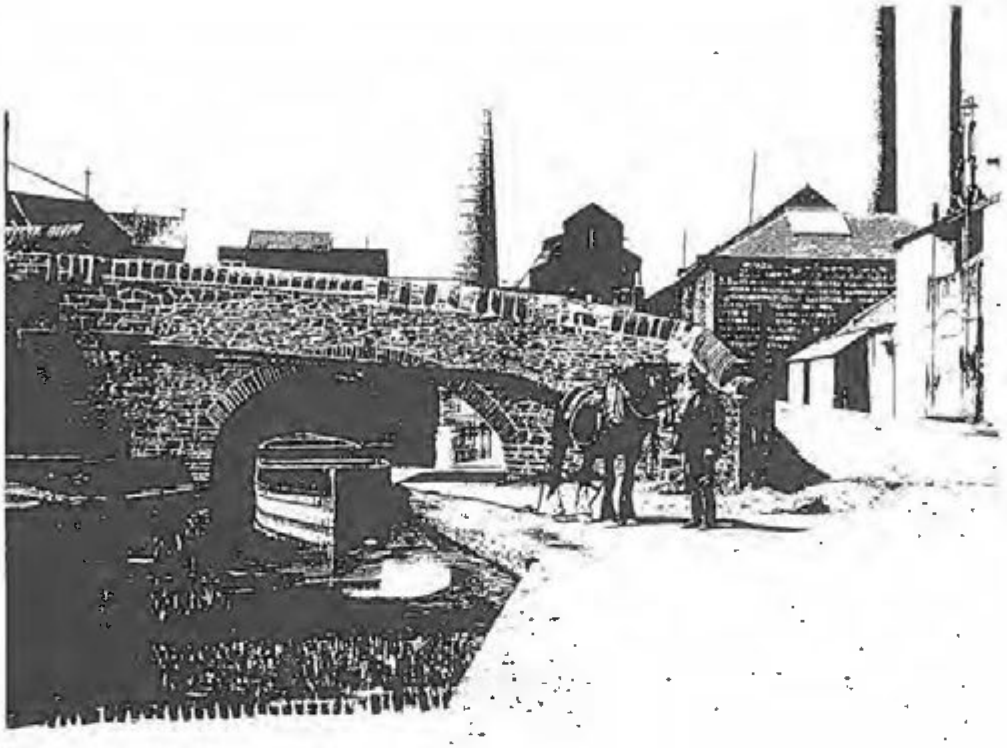


Plate 6 - The powerhouse and boilerhouse at Hafod (YIM 36), from the southwest showing stack, in the 1920s (Swansea Museums Service, SM 1987.543 1-, C.1589)

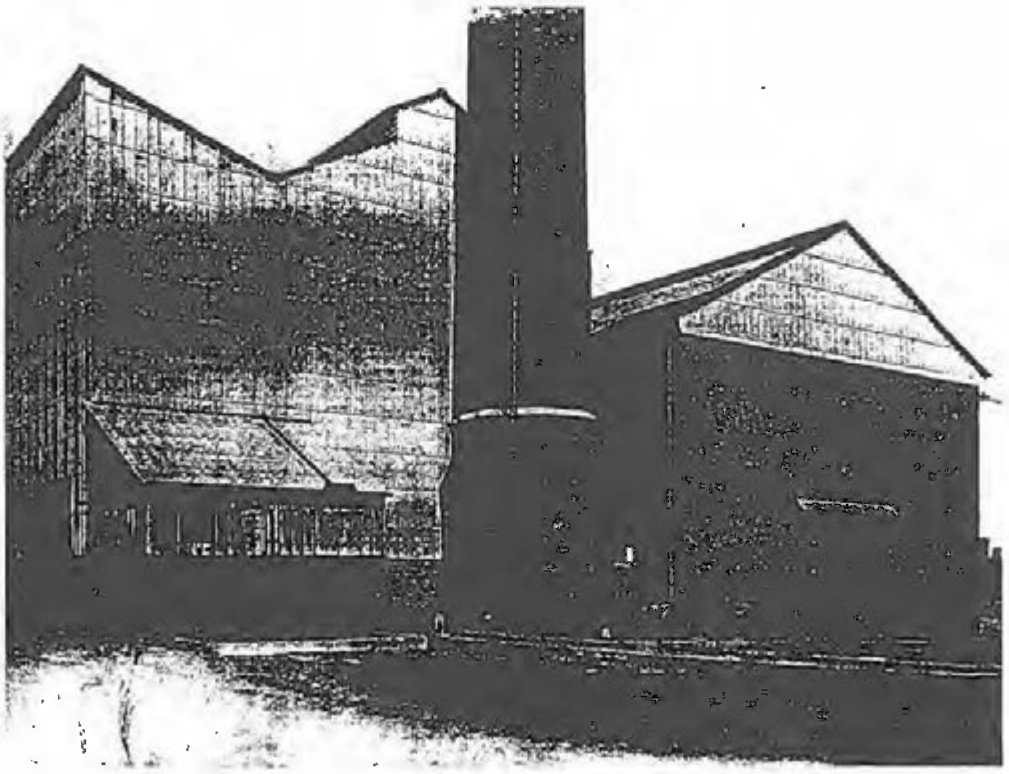


Plate 7 - The cold-rolling mill at Hafod Works (doubtfully YIM 44) in the 1920s (Swansea Museums Service, SM 1987.543 1-, C.1628)

Plate 8 - Rolling mill No. 1 at Hafod Works (YIM 51) in the 1920s, showing Building 9.0, Musgrave Engine House, at far right (Swansea Museums Service, SM 1987.543 1-, C.1612)

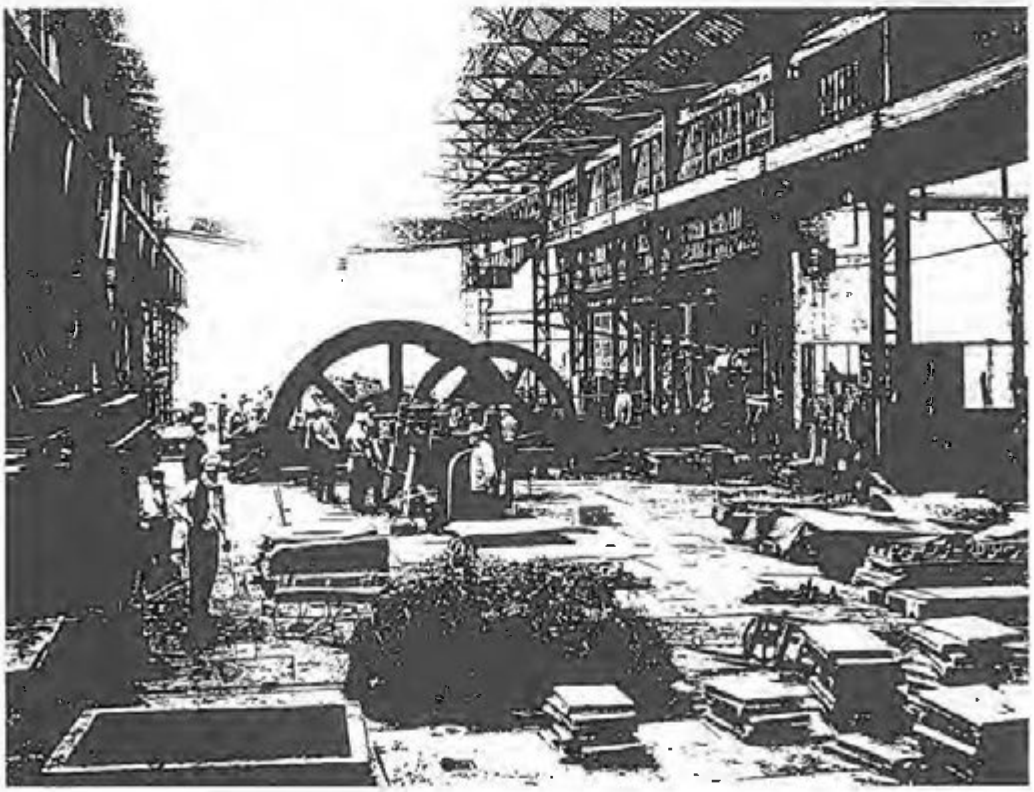


Plate 9 - The hammer house at Hafod Works (possibly YIM 50?) in the 1920s (Swansea Museums Service, SM 1987.543 1-, C.1634)

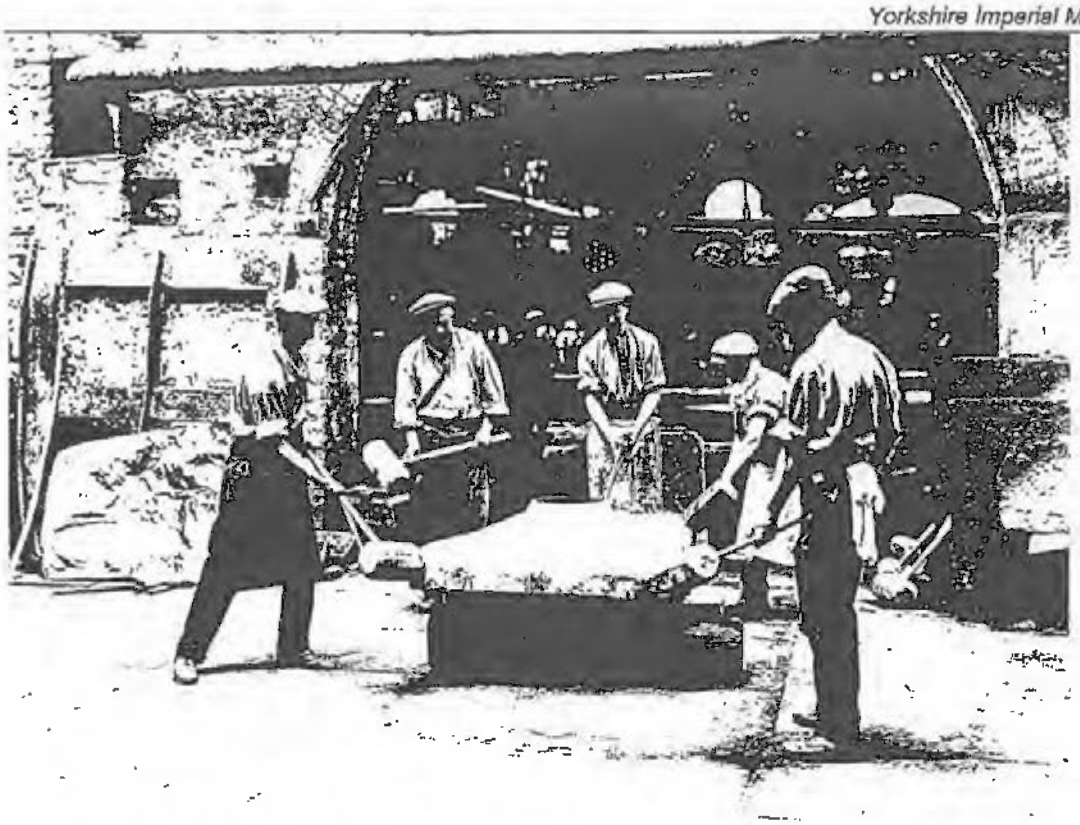


Plate 10 - The south end of Hafod Works, looking N to show Beyer-Garrett locomotive and shed, and rolling mill YIM 51 in the 1920s (Swansea Museums Service, SM 1987.543 1-, C.1612A)

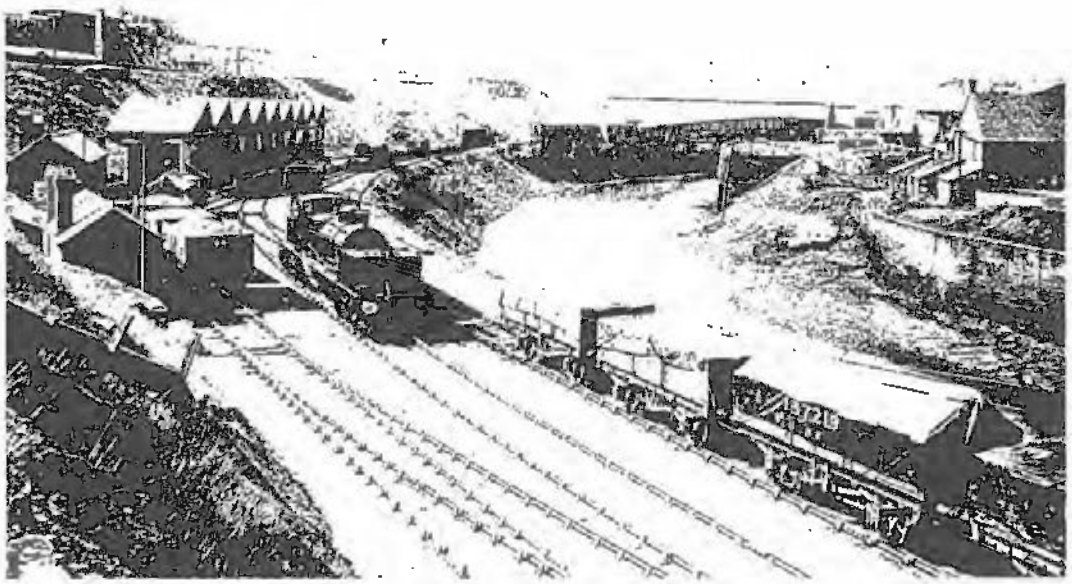
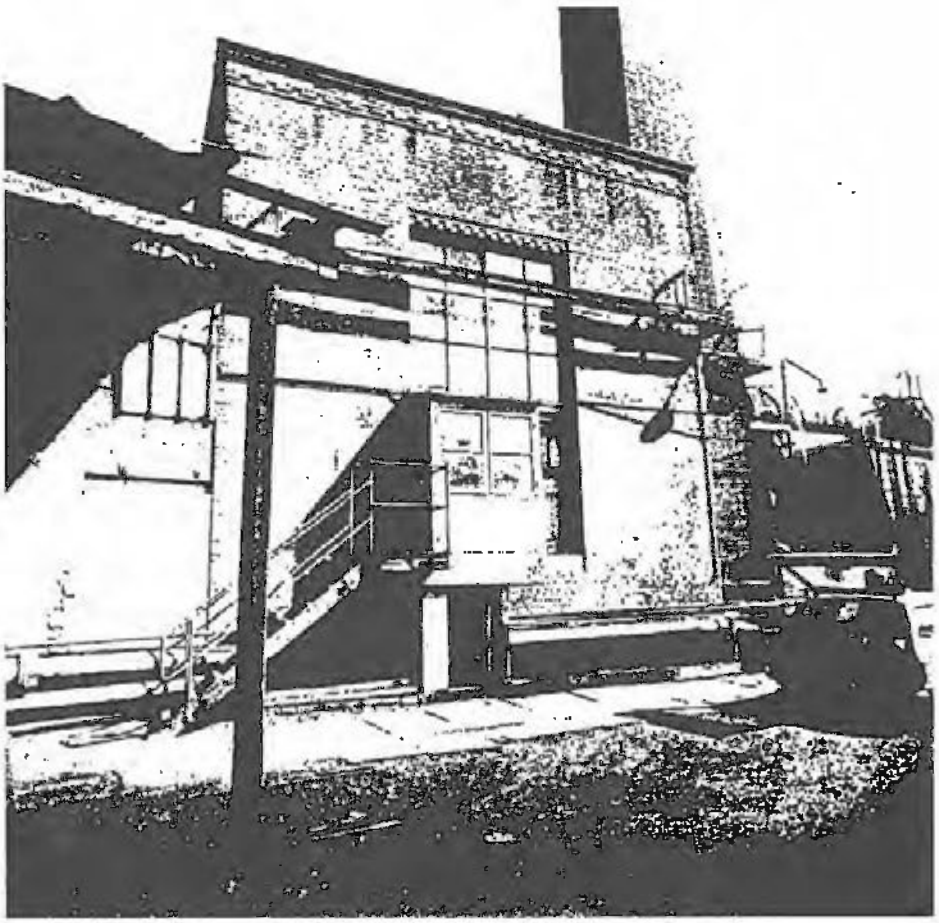


Plate 11 - Hafod Works looking northeast from the canal towards the main entry, showing canalside wall and bridge, buildings YIM 40 and 41, Vivian Chimney (Building 7.0), and the spoiltip behind, in the 1930s (reproduced from Alexander 1955)

Plate 12 - The Musgrave Engine House (Building 9.0), from the south, in c.1978 (MMR, RCAHMW)



APPENDIX 3 - HAFOD COPPERWORKS ENGINE HOUSES
(copy of report produced by David Percival, RCAHMW, August 2002)

Hafod Copperworks

The Hafod Copperworks was built by John Vivian in 1808-9 on southern part of level land enclosed by a loop of the tidal River Tawe. The area occupied by the works was bounded on the west by the Swansea Canal and later, to the north, by the Morfa Copperworks.

In 1819 a steam-powered rolling-mill was erected on the narrow neck of land between the River Tawe and the Swansea Canal. The mill was orientated northeast-southwest and the engine house positioned halfway along the northwest side. In 1910 a new mill and engine house was erected on approximately the same site. The engine house and one of the sets of rollers still survive *(Musgrave Engine House, or No.1 Rolling Mill Engine House).*

In 1842 a second mill containing four pairs of rollers powered by a 60hp steam engine was erected to north of the first. The mill was orientated northwest-southeast and the engine house was situated halfway along the southwest side. The engine house was rebuilt in 1860-2 and survives *(Vivian Engine House, or No.2 Rolling Mill Engine House).*

Musgrave Engine House, or No.1 Rolling Mill Engine House (BUILDING 9.0 - NPRN 33710)

This engine house was built in 1910 to house a single-cylinder Musgrave Uniflow engine that is still in-situ. It comprises a rectangular building with a full height machine hall and a basement beneath, a freestanding chimney on the southwest side at the west corner, and an extension to the southeast shielding the cable drive. The main machine floor is about 2.0m above the exterior ground level. Brick walls and a slate roof hipped at each end. To the south east of the building, a flywheel and a set of rollers are also in situ.

Exterior

Externally the walls of the main part are of grey-black brick, probably Vivian & Sons own patent slag bricks, with two intermediate horizontal bands of terra cotta bricks and a third just below the eaves; each band is of four courses. The north and west corners below the lowest band are rounded and have imitation quoins in red terra cotta bricks. On the highest band, the upper course projects forward, the middle course alternates between stretchers on the plane of the upper and headers on the plane of the lower, and the lower course is on the main wall plane.
Northwest elevation: The elevation is dominated by a large, centrally placed, square-headed opening with its sill at machine floor level. The steel lintel is faced with terra cotta brickwork as part of one of the intermediate horizontal bands; over the opening, lower two courses of the band are recessed and form a dentil pattern. A level timber transom spans the opening, about halfway up. Access is by way of external wooden steps leading to a concrete-slab landing projecting forward and supported on red brick piers; the steps have been removed. Below the landing, a square-headed doorway, slightly offset to the right from centre, gives access to the basement. It has a steel doorframe and is reached by external steps descending from the right hand corner of the building.
Northeast Elevation: Of four bays with square-headed windows lighting the machine hall. The lintels are similar to that on the northwest elevation. The sills are of four courses of chamfered terra cotta bricks continuing the lower of the intermediate horizontal, terra cotta bands. The two left-hand window openings had steel girders inserted across them at sill level; that on the first from the left has been removed. The third window opening from the left has a girder across it at midway height. Between each window opening a large, flat, iron bar-end is inserted into the top two courses of the horizontal band at lintel level. These and the steel girders may relate to a structure that formerly abutted the engine house on this side. The east corner of the building is undercut to machine floor level, the latter supported by concrete lintels and a red terra cotta brick corner pillar. The steam inlet pipe enters the basement through a hole in the lower right-hand corner.

Southeast Elevation: The extension to shield the drive cables occupies most of the elevation. The cables pass through a tall opening that extends from about one third of the way up the machine hall down to the basement floor, which is well below the surrounding ground level. The northeast wall of the extension is plain and constructed of grey-black brick; the southwest wall is also plain but is a mixture of red and grey-black brick. The southeast side is open. To the right of the extension, in the wall of the main building, is a square-headed doorway. It has a flat, iron lintel and the sill is at machine floor level; there is no apparent means of external access.

Southwest Elevation: The elevation is similar to that on the northeast, of four bays, the third window opening from the left has a girder across it at midway height. The chimney mostly obscures the first window opening from the left.

Chimney: The chimney stands a little away from the engine house but is obviously connected to it below present ground level. Square in plan it stands to a height of 27 metres and tapers from the base to the top. The main body is constructed of orange-grey brindled brickwork but the top two metres are in red brick and may be a later extension. Seven horizontal iron-bar tie frames set at approximately 1.5 metre vertical intervals clasp the upper part of the chimney. At ground level, in the northwest face, is a small, camber-headed open archway set in a larger, round-headed blocking. Immediately to the northwest is an open, concrete-walled sump.

Interior

The machine hall is full height, open to the roof. The northeast half of the hall is occupied by the engine which is installed on a solid concrete base that continues through the basement. Over the basement voids, the floor is a concrete slab reinforced with steel girders, and is surfaced with terra cotta quarry tiles in walkway areas. In several places the basement is open; these areas would have been covered with removable wooden or sheet metal flooring. The interior walls are of red terra cotta brick and have been painted. Along the long sides, between each window opening, pilasters support rails for a overhead lifting gantry which is in situ; a plate on the hoist cradle *John Musgrave & Sons Ltd., Bolton. 1910.* The walls above the rail level are thinner. The window openings have wooden frames with six large panes, the top pair in some forming opening lights. In the east corner is the doorway noted on the exterior. Timber king-post trusses support the roof. The basement comprises two large voids either side the central solid engine block.

Engine: The Uniflow engine was the last major development in reciprocating steam engine design. It was an attempt to overcome the heat loss experienced through condensation of steam in the cylinders during the exhaust period by allowing the steam to move in one direction only. The principle had been recognised as early as 1827 but the theory was not put into practice until 1908 when Professor Johann Stumpf of Charlottenburg University, Berlin patented a suitable valve gear and developed commercially applicable designs. A license was obtained by John Musgrave & Sons, Globe Ironworks, Bolton in 1909 and manufacture of Uniflow engines by them commenced in 1910. This engine is therefore one the earliest Uniflow engines to be constructed, the type continuing to be made by Musgraves well into the 1920s.

The engine occupies the northeast half of the hall, the single cylinder at the northwest end, the crank and axle at the southeast. Steam was supplied via the inlet pipe, which enters the building at basement level through the northeast wall near the north corner. It then passed through the steam drier or separator chamber, the vertical cylindrical tank contained in the northeast basement void, to the inlet control valve (controlled by a valve wheel on the machine floor). Beyond this the supply pipe divides to supply steam to both ends of the cylinder from underneath. Steam was exhausted through the chamber in the centre of the cylinder and passed to the condenser, which is situated alongside in the southwest basement void. Between the cylinder and the condenser, a manifold allowed exhaust steam, via a control valve, again situated on the machine floor, to be expelled through the chimney. The condenser, a large horizontal cylindrical tank with a pair of vertical ventilation pipes, also contains an air pump, which is operated by a pulley drive taken off the main crankshaft.

The main crankshaft lies across the southeast end of the machine hall. To the northeast of the main crank, the flywheel of the centrifugal governor is covered with a sheet metal casing. A connecting rod emerges from this to drive a rocking arm connected to the valve shaft. The inlet valves are situated on the top of each end of the cylinder but the rod connecting them has been cut away. From the main crank southwest along the crankshaft there is firstly a pulley connected by cable to the air pump pulley in the basement, then a larger pulley that has sixteen cable grooves in it; this is the main drive to the flywheel pulley that lies outside the building, to the southeast. Next along the crankshaft is a large flywheel 8.6 metres in diameter. This has a gear ring cut into the centre of its rim. This connected with a small spur gear that was part of the final drive of the crank-positioning gear, which was situated immediately to the northwest of the main crankshaft. Many of the parts of this gear have been removed. It would have been used to turn the crank round for

inspection and maintenance, and to move the engine over top-dead-centre if it had stopped in this position. Finally, a large bearing housing supported the end of the main crank.

The Rolling Mill

The sixteen-cable pulley drove a larger flywheel pulley 14.5m in diameter, in-line to the southeast. This has twelve spokes and the axle centre is slightly above ground level so that almost half of the wheel is in a pit, a continuation of the pit in the engine house. The wheel is not a single casting, the spokes being keyed into the central hub at the inner end, and at the outer end, bolted to a cast housing attached to the rim. On the southwest edge of the rim is a gear ring. The pulley/flywheel drives a combined clutch and reversing gear that enables the direction of the final drive to be reversed almost instantaneously. The final drive is connected to a gearbox, which divides the drive and is linked via flexible couplings to each of a pair of 24 inch (600mm) diameter rollers. The flywheel is by Musgraves, the gearbox by Taylor & Farley of West Bromwich, the rollers by the Glanmor Foundry, Llanelly. The surviving machinery is situated to the southwest of the flywheel. There was most probably similar equipment to the northeast, driven directly from the flywheel, and more driven by a secondary drive.

Vivian Engine House, or No.2 Rolling Mill Engine House (BUILDING 8.0 - NPRN 33743)

The engine house appears to be on the site of the 60hp engine of 1842 but there is no evidence that anything from this date remains. The present building is dated 1860-2 but has clearly been enlarged since then. It consists of a rectangular building with a chamfered west corner and contains a full height machine hall and a basement beneath; the machine floor is approximately 2.0m above ground level. All machinery has been removed. The tall red-brick chimney situated on the bank to the west of the building is said to be connected to this engine house. This was probably the site of the boiler complex that generated steam for both engine houses and other appliances.

Exterior

The building is constructed in Pennant sandstone and grey-black brick: snecked sandstone on three elevations, brick on the northeast elevation. The masonry walls are extended in height with grey-black brick. This and the brickwork on the northeast elevation are probably in Vivian & Sons own patent slag bricks. The masonry on the southwest elevation has blocks of relatively consistent size; that on the northwest and the eastern half of the southeast sides is a mixture of large, peck-dressed blocks and smaller roughly dressed blocks. The larger blocks may well be reused from the 1860 building or earlier. The south, north and east corners have dressed stone quoins; those at the north and east are larger and are pick-dressed. There are also quoins on the southwest wall where it meets the facet at the west corner. The northwest and southeast walls are extended above the masonry in grey-black brick. This is topped with a pediment of three courses of red header bricks, which also continues across the southwest elevation. The bottom course of the pediment is dentilled, the upper two projecting forward. Much of the northeast and southeast sides show traces of whitewash where the walls were inside adjoining buildings.

Southwest elevation: The left-hand (west) corner of the building is facetted; the facet wall is rendered, the reminder is masonry as described above. It is clear that the masonry wall indicates the original width of the building, as all openings below eaves level in this elevation are central to it. A central doorway giving access to the machine floor is accessed via external concrete steps. The opening has a camber-headed arch with stone voissoirs. There is a small rectangular opening containing a pipe, to the lower right of the doorway. Above the doorway, a stone plaque reads *Commenced August 1860, completed February 1862, V&S.* Above again is a central camber-headed window opening with a dressed-stone sill and stone voissoirs, the keystone projecting forward. The opening is blocked with red brick. A steel I-girder is set immediately above the sill. Above window opening, a frame made of I-girders projects forward from the elevation. To the right of window is a braced, cast-iron bracket and a similar one close to the west corner. The masonry wall is topped by a pediment in red brick. Above this the gable is in grey-black brick and spans the full width of the building. In its centre is a circular light bounded by a double row of header bricks. Remains of the wooden window frame are still in place. Truncated purlins show that the roof projected over the facetted corner and was rectangular in plan.

Northwest elevation: Of four-bays with tall, camber-headed windows lighting the machine hall. The openings have stone voissoirs with projecting keystones, and stone sills. The dressings appear to have a finer finish than those on the southwest elevation. Wooden window frames are in-situ. The windows had four large, rectangular panes, and above, an opening light of four small panes shaped to the camber. Above the masonry, the wall is extended in grey-black brick and above each window bay is a circular light with a surround of a double row of header bricks. Each light has a wooden window frame except the left-hand end one, which is blocked with brick.

On the stonework to the right of and above the second bay from the left, the pitch flashing of the sloping roof of a formerly adjoining building is visible. This does not continue on to brick portion.

Northeast elevation: This elevation is built entirely in grey-black brick apart from the corner quoins. There is a variation in the colour of the bricks at the highest level, probably due to differential weathering because of structures abutting the elevation below gable level. At the lower left-hand side is a square-headed doorway giving access to the basement. The opening has a steel rail lintel and a timber frame and door. Above the opening are the sawn-off stumps of a pair of U-channel girders set on edge in square holes blocked with brick. Towards the right-hand side there is a large opening giving access to the machine pit but extending high into the machine hall. The sill was probably originally at machine floor level, but the wall below has been knocked out to facilitate removal of machinery. Truncated timbers emerge from the wall either side of the opening. To the right is a narrow rectangular opening, a concrete lintel spanning both this and the larger opening. A similar rectangular opening with concrete lintel is close to the left-hand corner. Above, a lagged iron pipe emerges from the wall. The upper part of the elevation appears to have had a

frame attached to it. Three cast-iron inverted T brackets are set on chamfered stone corbels and above each, a mark on the wall show that a vertical member continued upwards as far as a square hole. In the gable is a circular opening similar to that on the southwest. The wooden window frame is more complete and contains an opening light, horizontally pivoted. A concrete slab to northeast of building is a former machine base.

Southeast elevation: The left-hand part of this elevation is considerable different to the right-hand; the difference in masonry style has already been noted. The right hand side has two camber-headed windows similar to those of northwest elevation; the right-hand one has its lower part blocked in red brick. Midway along the elevation, a square-headed doorway with a concrete lintel, gives access to basement. The stone sill is at ground level. In the left-hand part of the elevation are two windows, one above the other. Both are camber-headed with dressed stone sills and voissoirs with protruding keystones. The lower window opening is blocked in grey-black brick, the truncated ends of a pair of U-channel girders are set on edge in the blocking, and the sill has been hacked off. To the right of the window are the remains of a substantial steel bracket. Below the windows, concrete machine bases adjoin the wall and to the right of them, a hole in the wall was probably for a pipe. The quoins in the lower left-hand corner are chamfered and have a horizontal groove cut into them. Above, a cast-iron bracket is set in the wall and above that, a truncated I girder is set at an angle. High on this corner, are the traces of the concrete flashing of a pent roof against the wall and, to the right a cast-iron bracket similar to those on southwest elevation. Above the masonry, the wall is extended in brick in similar fashion to the northwest elevation. Of the four circular lights, the right-hand one is blocked.

Interior

The machine hall is full height and open to the roof. The northwest part of the machine floor is taken up by a large pit, wider at its southwest end, where it was spanned by four I girders, now cut away. Three arched conduits lead southeast from the pit bottom. The pit is lined in brick except for the northwest side of the narrower section, where the lower part is constructed of masonry. An arched tunnel leads northeast from bottom of the narrow pit. A sloping bottomed recess extends southwest from the main pit, and alongside it to the northwest, are four holding down bolts for machinery. Northwest of the wider part of the pit is a square access shaft with iron bars set in it for footholds. At the bottom, it connects to the main pit through a low, arched opening. To the southeast of the pit is a concrete machine base and against the southeast wall, a metal-framed manhole. Alongside the narrow part of the pit, to the southeast, a wooden stair gives access to the basement. Walkway areas of machine floor have terra cotta quarry tiles. Interior walls are cement rendered with a high dado moulding around all four sides. The southwest part of the southeast wall is considerably wider than the rest and this and the southwest wall as far as the facetted west corner, are the remains of the 1860-62 build. The entrance in the southwest wall has a cast-iron sill and a cast-iron lintel behind the external stone voissoirs. The top of masonry walls on the northwest and southeast sides are corbelled out in red brick to provide ledges for the rails of a hoist, except on the 1860 part of the southeast wall, where this is not necessary. A galvanized water tank is set on a concrete slab in the blocked opening high in southwest wall. The remains of a vertical steel ladder lead to an iron landing at hoist rail level in south corner. A cast-iron pipe runs from south corner along southeast wall to east corner then down to machine floor. The roof is supported intermediately by three standard steel trusses and is timber-lined beneath the slates, although most of the roof covering is now missing.

COMMENT

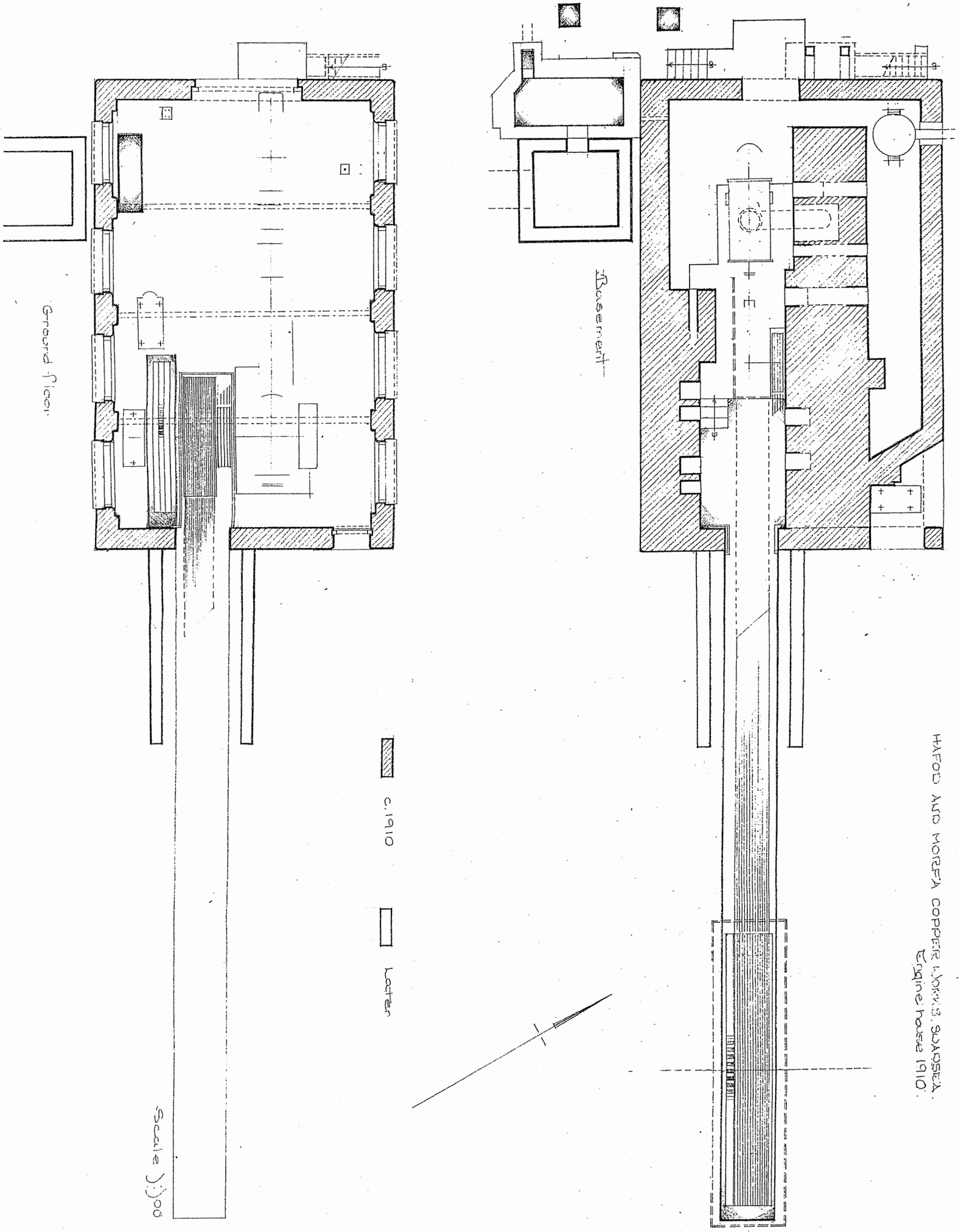
The former No.1 Rolling Mill Engine House is a good example of early 20th century upgrading of industrial plant, where the building and the machinery contained therein are designed as a single entity. This structure is particularly unusual because of the survival, not only of its engine, but also of a substantial part of the machinery for which it provided power. The engine is one the first Uniflow engines to be built and it is a particularly rare and important survival. I can find reference to only two other uniflow engines surviving in UK, neither of them by Musgrave & Sons.

In contrast, the former No.2 Rolling Mill Engine House shows how infrastructure was modified and expanded over time to cater for developing technology. There is no evidence of the 1842 building but the southwest wall and part of the southeast clearly belong to the 1860-1862 replacement. Later this engine house was rebuilt and extended to the northwest and probably to the northeast, presumably to accommodate a larger engine. It has been suggested that later still, the building was raised. This may be the case and the upper parts being built in brick would support this. If

this was the case then presumably the whole of the northeast wall was rebuilt at the same time. However, it is common in engine houses provided with railed hoists, for the walls above the rails to be considerably thinner than the lower part (e.g. the 1910 engine house). The brick sections of the northwest and southeast walls end at the same level as the masonry of the southwest (1860) wall, all three topped by the red-brick pediment. The southwest wall shows no indication of upper part being a different build to the lower. In addition, the dressed quoins on the north and east corners continue above the masonry. This would seem to be an unnecessary detail if the brickwork was later. It may be therefore that the brickwork is in fact contemporary with the initial enlargement of the 1860 engine house.

Drawings
1910 Engine House: Machine Hall and Basement Plans
1910 Engine House: NW and SW Elevations
1910 Engine House: Long and Cross Sections
1910 Engine House: Flywheel – elevation
1862 Engine House: Machine Hall and Basement Plans
1862 Engine House: NW, WS, SE, NE Elevations; Long and Cross Sections

& MORFA COPPER WORKS, SWANSEA NPRN: 300184
COPPER WORKS: 1910 ENGINE HOUSE (NPRN: 33710)
SS66179495

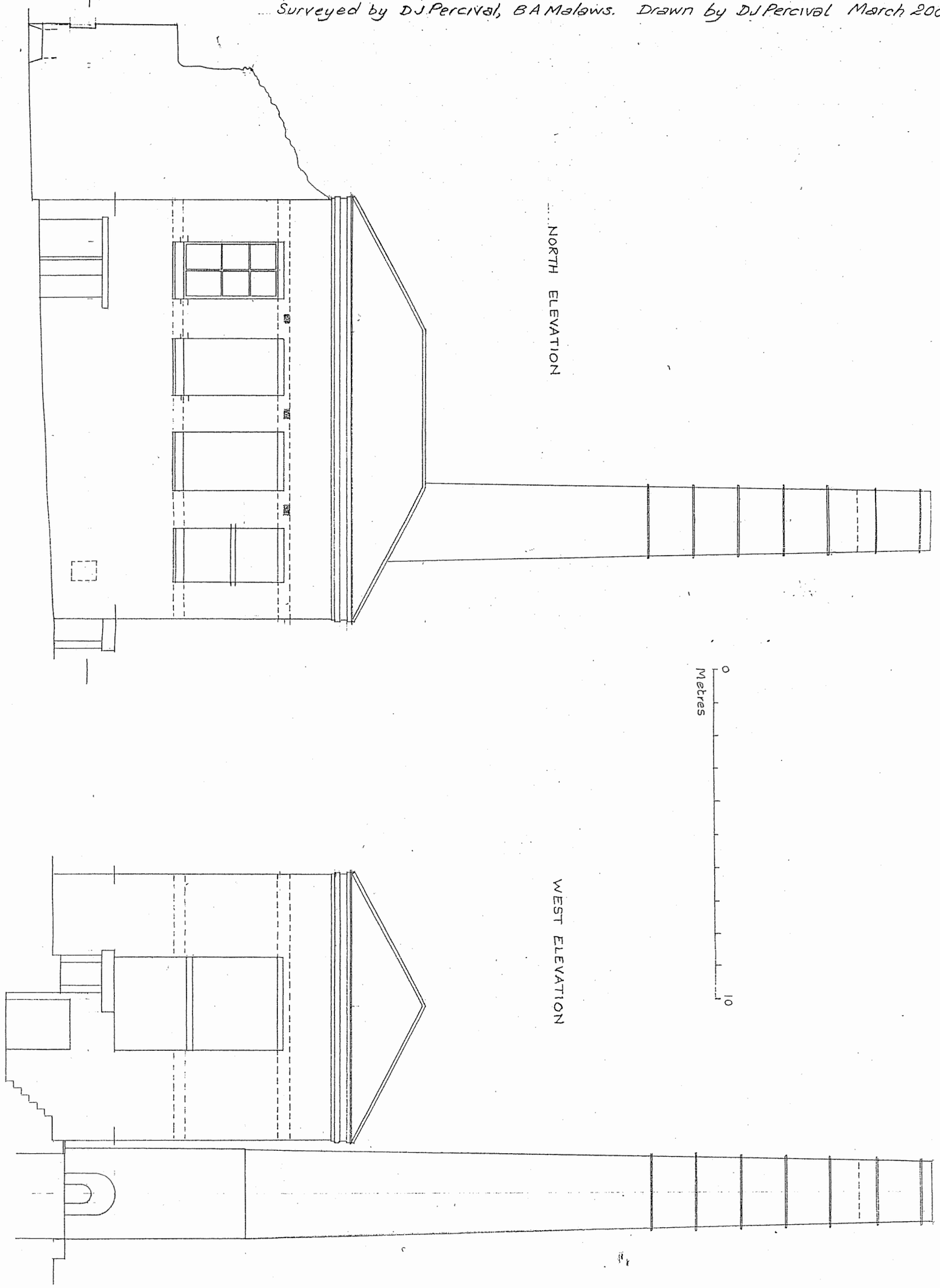


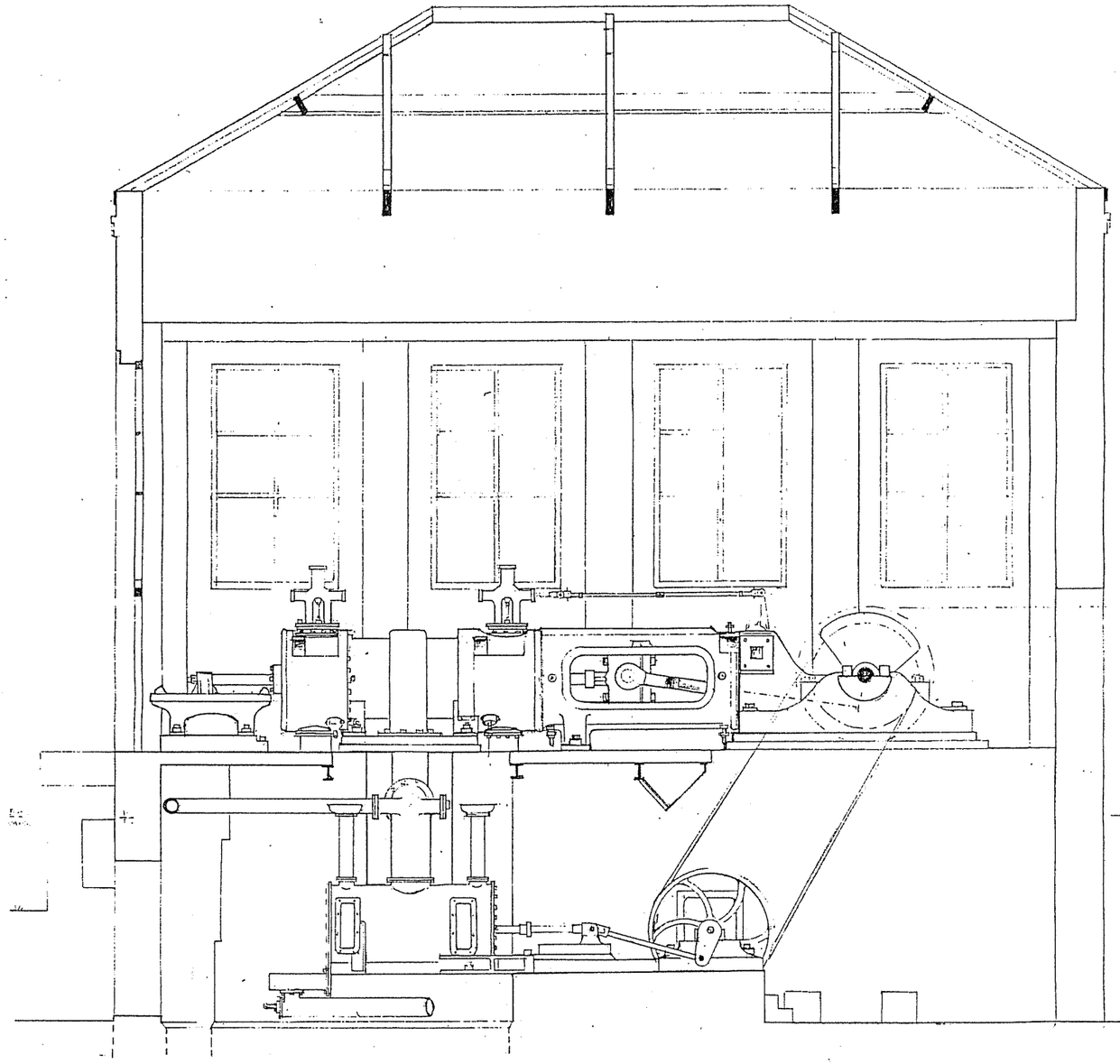
HAFOD & MURTA COPPER WORKS, SWANSEA NPRN: 33710

HAFOD COPPER WORKS: 1910 ENGINE HOUSE (NPRN: 33710)

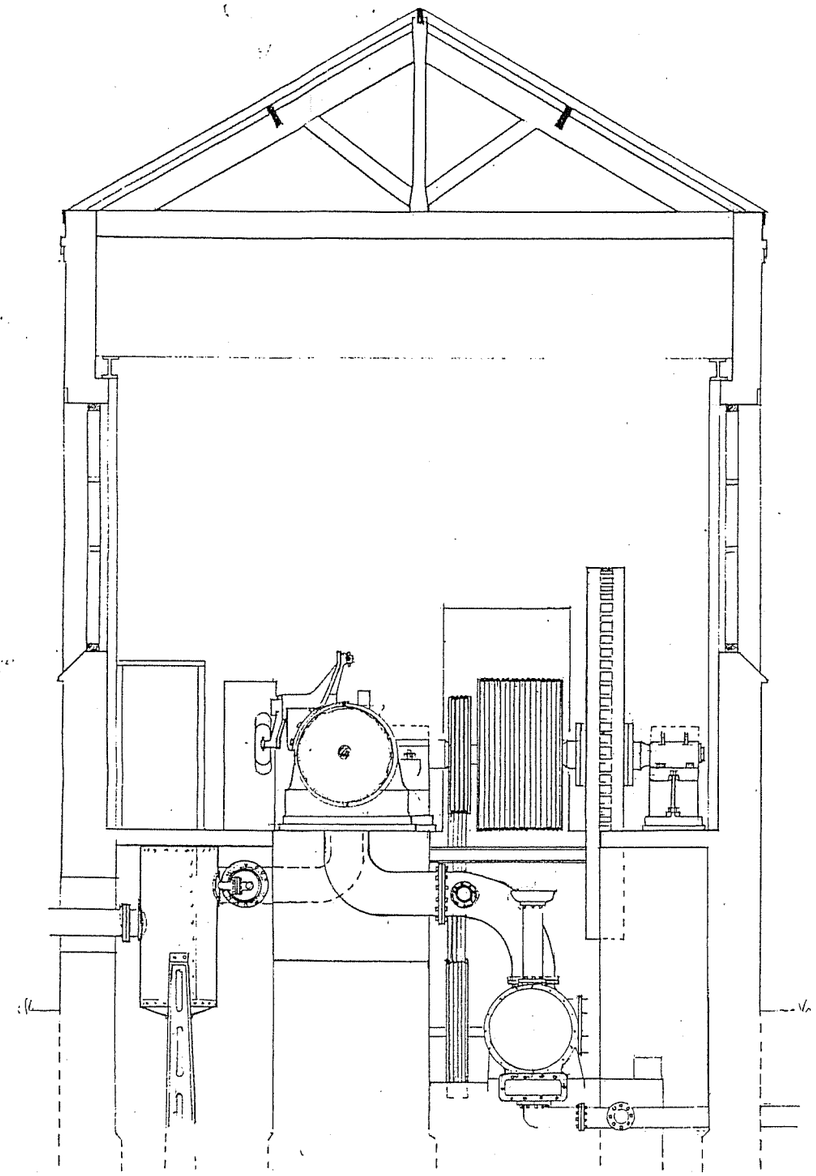
NGR: SS66179495

Surveyed by DJ Percival, BA Malaws. Drawn by DJ Percival March 200





LONG. SECTION AA



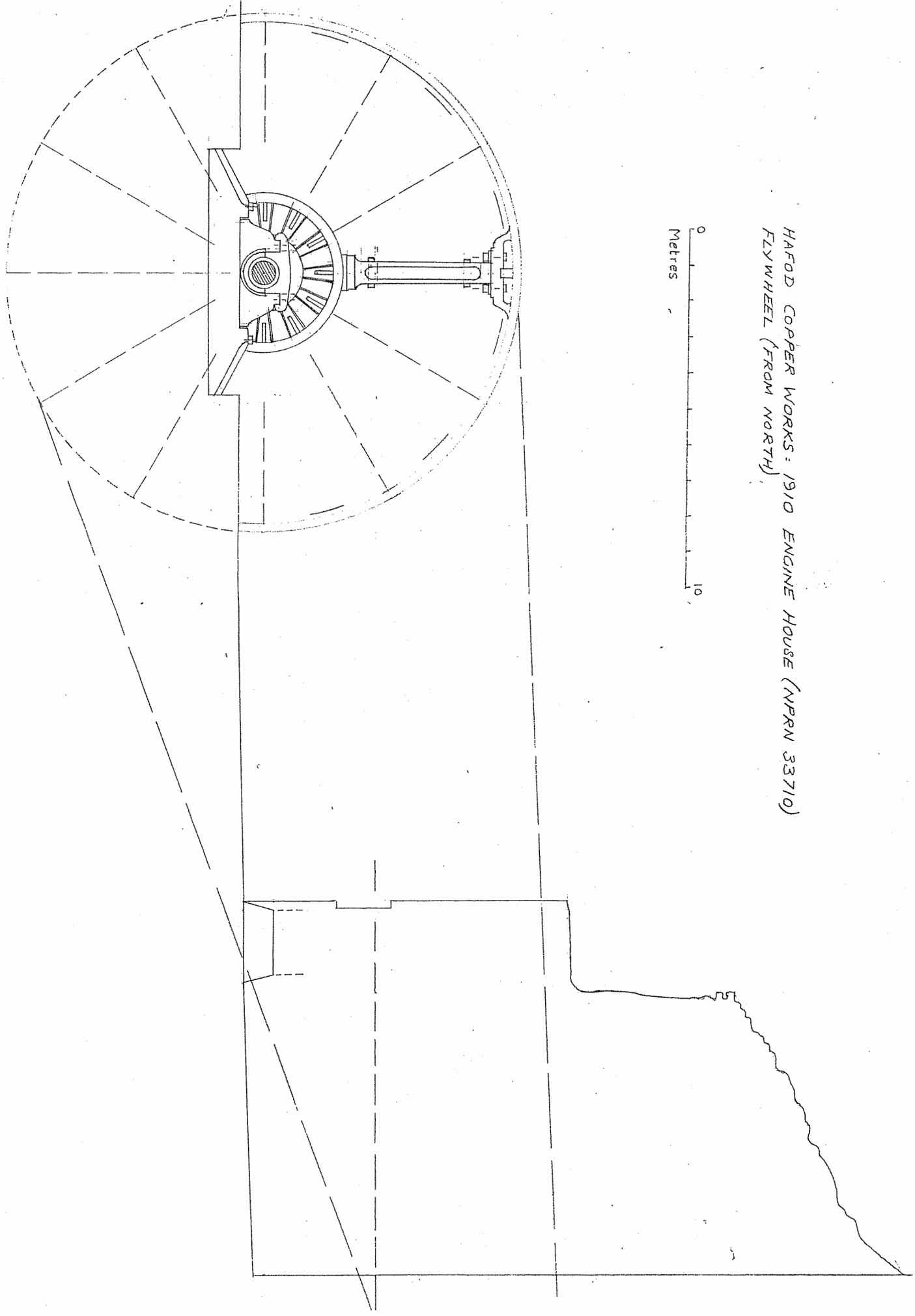
CROSS SECTION BB

HAFOD + MORFA COPPERWORKS, SWANSEA

0 METRES 5.

HAFOD & MORFA COPPER WORKS, SWANSEA NPRN 300184
HAFOD COPPER WORKS: 1910 ENGINE HOUSE (NPRN: 33710)
NGR: SS66179495

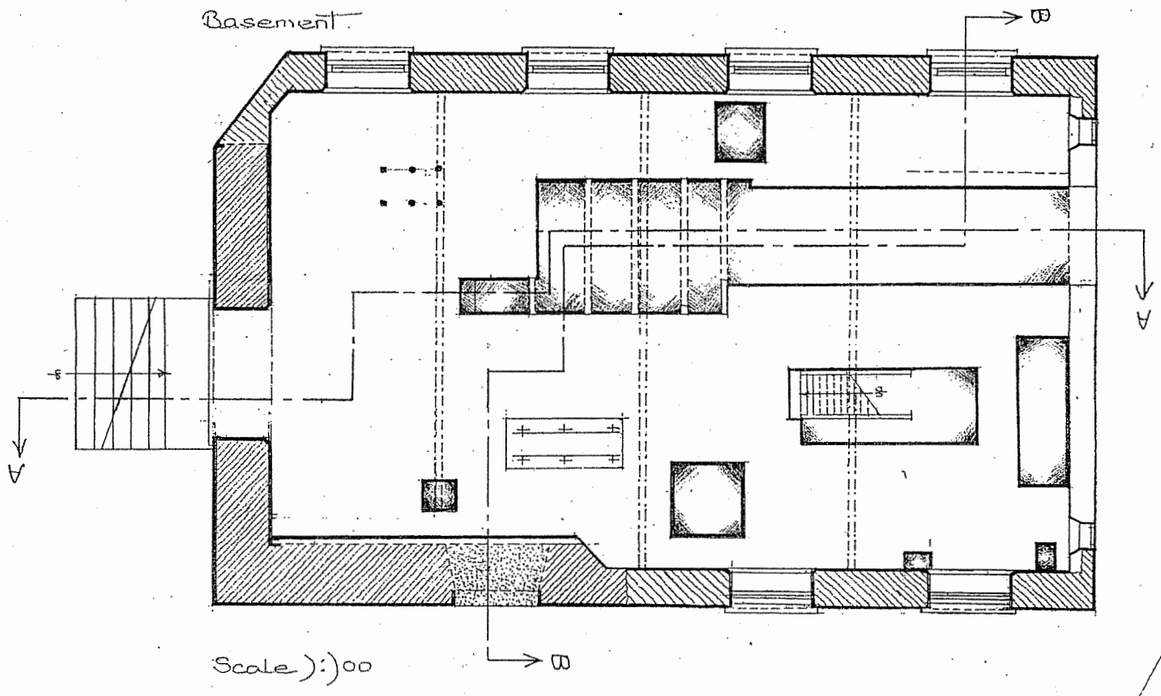
HAFOD & MORFA COPPER WORKS, SWANSEA NPRN 300184
HAFOD COPPER WORKS: 1910 ENGINE HOUSE (NPRN: 33710)
NGR: SS66179495
Surveyed and drawn by DJ Percival March 2000



HAFOD COPPER WORKS: 1910 ENGINE HOUSE (NPRN 33710)
FLYWHEEL (FROM NORTH)

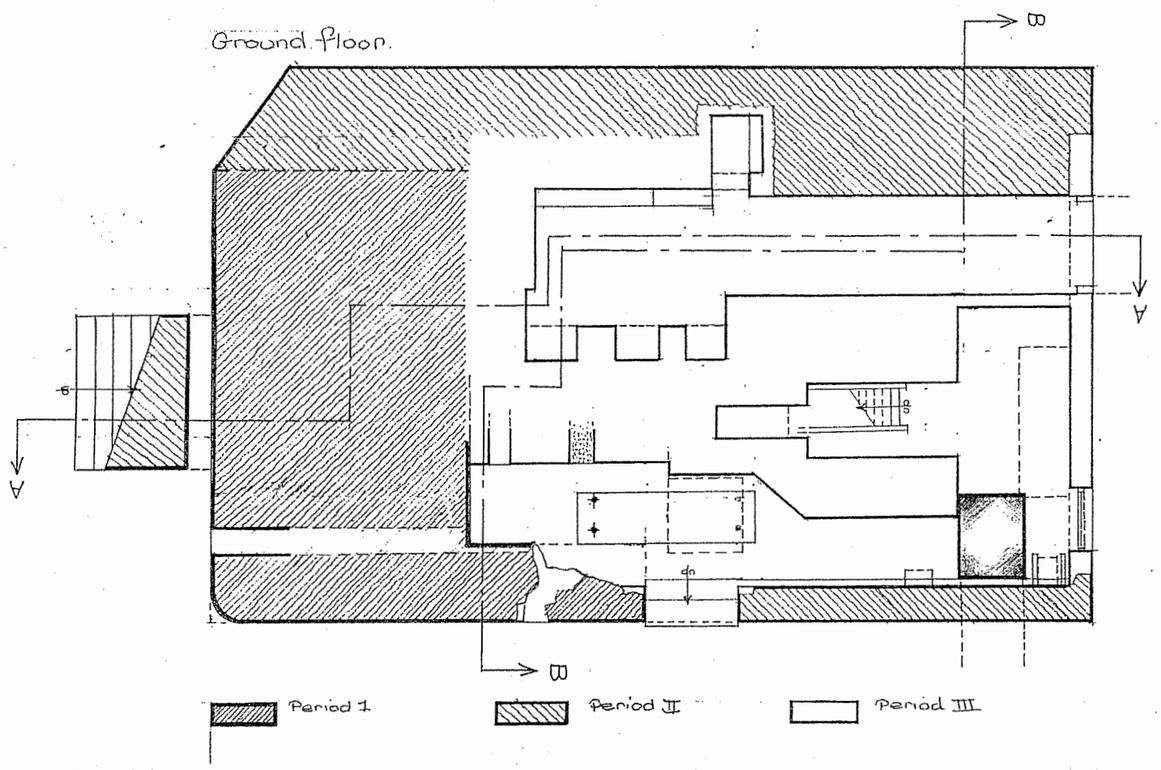
HAFOD AND MORFA COPPER WORKS, SWANSEA.
HAFOD COPPER WORKS 1860 ENGINE HOUSE

Basement



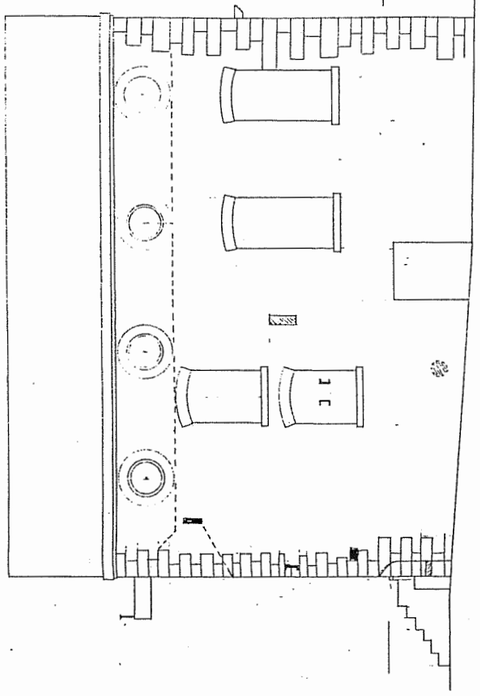
Scale 1:100

Ground floor.

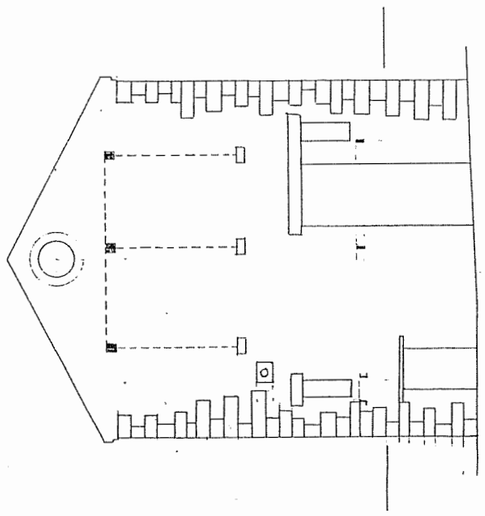


HAFOD & MORFA COPPER WORKS, SWANSEA NPRN 300184
HAFOD COPPER WORKS: 1860 ENGINE HOUSE (NPRN 33743)
NGR: SS66179497

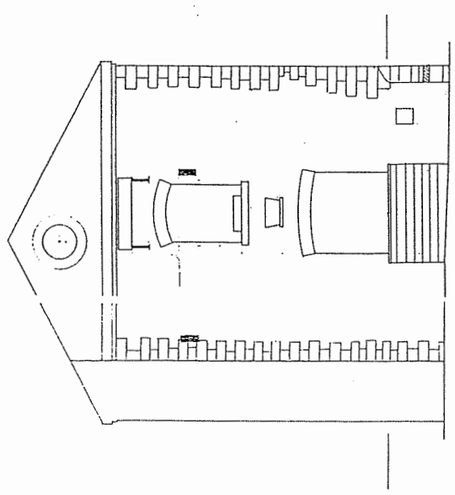
D.J.T. Roberts - March 2000



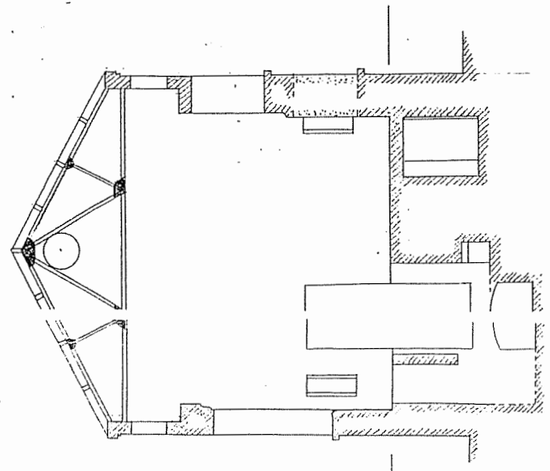
SOUTH-EAST ELEVATION



NORTH-EAST ELEVATION

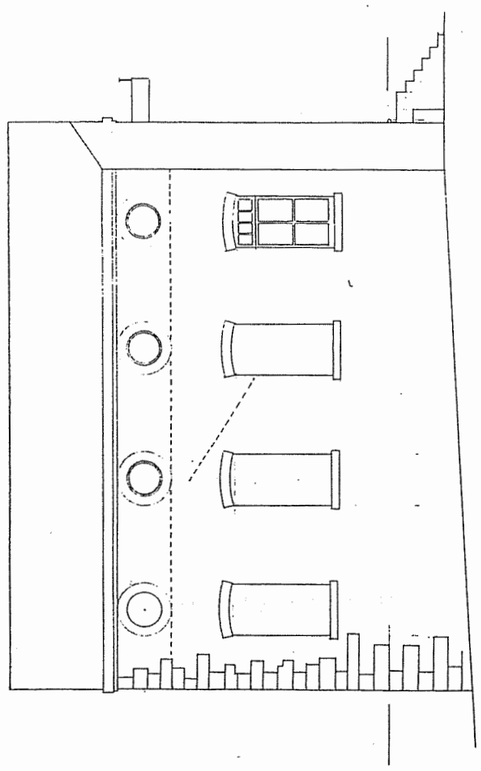


SOUTH-WEST ELEVATION

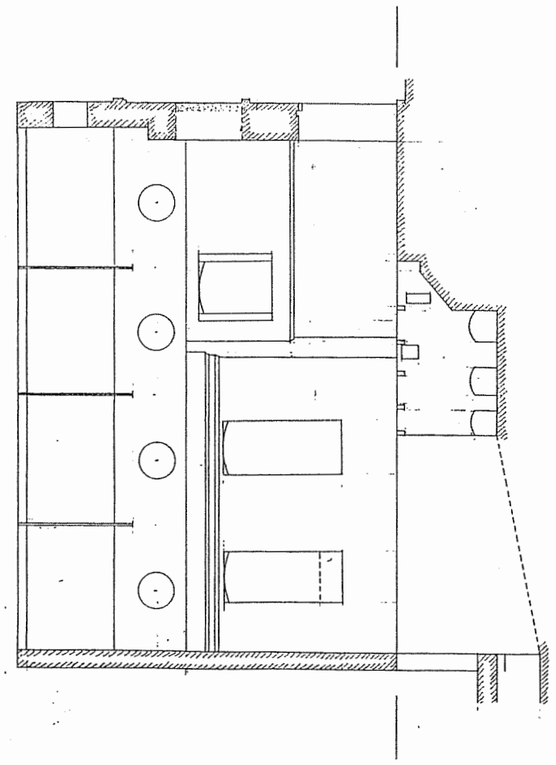


COMPOSITE SECTION B-B

0 Metres 10



NORTH-WEST ELEVATION



COMPOSITE SECTION A-A

HAFOD & MORFA COPPER WORKS, SWANSEA - NPRN 300184
HAFOD COPPER WORKS: 1860 ENGINE HOUSE (NPRN: 33743) NGR: SS66179497
Surveyed: DJ Percival, BA Malaws. March 2000. Drawn: DJ Percival

SPECIALIST STUDY: LISTED BUILDINGS

Appraisals and supporting information prepared by: Davies Sutton Architecture (with structural input from Veryards Limited) *Job reference 2220.*

CONDITION APPRAISAL SHEETS **1 to 15**

PHOTOGRAPHIC RECORD SHEETS

DRAWINGS: Existing Floor Plans and Location Plans

Canteen Building	1: 200 scale
Laboratory Building	1: 200 scale
Pier & Copper Slag Abutment	1: 250 scale
Lime Kiln & Canal wall	1: 200 scale
Chimney & Engine Houses – lower floor	1: 200 scale
Engine Houses – upper floor plans	1: 200 scale
Museum Store	1: 500 scale
Vivian Locomotive Shed	1: 200 scale

1.0 MORFA CANTEEN BUILDING - Appraisal

1.1 Description

Listed Grade II
Late C19
Presently derelict.
Former powerhouse of the Morfa Copperworks.
Approximately 30 metres long by 18 metres wide on plan.
2 storeys at east end, double storey height space to west, basement under.
Approximately 600 square metres internal floor area excluding basement.

Construction

Roof: formerly slate covered on composite timber trusses and iron arch braces carried internally on cast iron columns.

Clock tower structure of timber/metal frame at eastern end of building.

Stone chimney stacks in squared rubble.

Walls: solid masonry random rubble in lime mortar with squared sandstone quoins and window surrounds.

First floor at eastern end of building concrete slab with later steel support for clock tower incorporated.

Ground floor concrete slab over vaulted basement.

General interior formerly lime plastered.

Condition

Roof: covering completely lost and supporting timbers badly fire damaged.

Clock tower framework with timber louvres remaining in part.

Chimney stacks in fair condition.

Some corrosion of iron arch roof braces and internal columns.

Walls: generally sound but masonry loosening due to weathering on exposed heads, localised damage and dislodgement of masonry mainly to upper portions of walls due to shrub growth in mortar joints.

Widow openings mainly infilled with brickwork & rendered blockwork; remnants of timber windows/glazing bars in upper openings on east face.

Floor slabs debris covered.

Interior plaster greatly deteriorated, part of ground floor has been cement rendered/tiled as for use as a graffiti gallery.

Basement flooded.

1.2 MORFA CANTEEN BUILDING - Repairs

Initial repairs

Roof: record remaining timber elements, remove battens, rafters and fascias complete. Remove failed sections of purlins and install temporary scaffold tube ties to provide restraint to remaining elements.

Clock tower: record remaining elements. Remove loose timber louvres and frames.

Iron arch braces and columns apply temporary primer to protect against continuing corrosion.

Walls: cut back vegetation, treat roots with herbicide, temporarily infill and make safe loose or dislodged areas of masonry, mortar cap exposed tops of walls.

Secure ground floor openings to prevent intrusion.

Fit protection from falling to stairs and east windows.

Floors: remove debris

Exterior surrounds: clear debris and treat plant growth around the base of the building with herbicide.

Repairs within 5 years

Repair and make weather tight external envelope of building:

- Reinstate roof structure and re-slate
- Re-clad clock tower
- Reinstate rainwater goods and connect to temporary soakaways
- Repair and re-point external walls
- Temporary enclosure of window and other external openings
- Repair and apply protective coating to iron roof arch braces and columns

Repairs within 10 years / long-term works

Complete works to envelope, refurbish interior, renew services and make good surrounds:

- Reinstate external doors & windows
- Repair floor slabs and stairs
- Renew wall and ceiling finishes
- Reinstate internal doors
- Redecorate
- Provide new connections to main electrical, gas and telephone services.
- Reconnect to main foul and surface water drainage.
- Construct wall and floor lining to basement incorporating cavity drainage system and drain to sump collection point.
- Install flood protection pump in basement
- Repair external steps to basement
- Re-grade exterior ground levels and lay new paved surrounds to building

2.0 MORFA LABORATORY BUILDING - Appraisal

2.1 Description

Listed Grade II
Mid to late C19
Presently derelict.
Formerly part of the Morfa Copper Works.
Western part 2 storeys with basement, eastern part single storey with stepped frontage.
Approximately 18 metres wide by maximum of 18 metres deep on plan being about 420 square metres internal floor area overall.

Construction

Roof: formerly slate covered on timber trussed purlin roof.

External walls: solid masonry in coursed rubble sandstone in lime mortar, south elevation has some brick patches; squared stone quoins; dressed stone cornice, string courses and moulded window surrounds; main north entrance has carved stone pediment above arched opening supported on twin pilasters.

First floor: formerly boarded on timber joists.

Ground floor: formerly part boarded on timber joists, part solid.

Internally walls plaster finished.

Steel fire escape stairs from first floor on south elevation.

Condition

Roof covering has been lost with roof timbers remaining in part.

Fire damage has caused the collapse of chimney stacks together with sections of the internal walls and the greater part of the timber floors, making the interior of the building unsafe to enter. Remnants of internal doors, finishes and fittings remain.

External walls: the centre portion of the east elevation has subsided towards its north corner causing distortion and cracking in the stonework, this is believed to be due to the building being built over a former canal or water course through the site; the west face has bowed about 200 mm outwards along its length as the result of long term progressive movement; on the north elevation the arched head of the large ground floor window has dropped causing cracking and deflection of the masonry above; on the south elevation there is extensive vegetation growth. Dressed stone elements have suffered general damage, part of the pediment stonework to the north entrance has been dislodged. Window openings are mainly infilled with blockwork.
The steel escape stairs are heavily corroded and represent a hazard.

2.2 MORFA LABORATORY BUILDING - Repairs

Initial repairs

Roof: record and remove loose slates and fascia timbers.

External walls: generally cut back vegetation, treat roots with herbicide.

Exterior surrounds: treat plant growth around the base of the building with herbicide.

Erect temporary raking shores to north corner of east face to prevent further dislodgement of stonework.

Erect temporary raking shores to retain the west elevation and prevent further movement.

Secure perimeter of building to prevent intrusion due to hazards.

Repairs within 5 years

Stabilise, repair and make weather tight external envelope of building and make safe interior:

- Reinstate roof structure and re-slate
- Reinstate rainwater goods and connect to temporary soakaways
- Stabilise and generally repair and re-point external walls including installation of masonry anchors and restraint ties
- Locally rebuild west face where masonry has bowed
- Provide minipile support to east face to arrest subsidence movement
- Locally rebuild east face damaged by subsidence
- Remove debris from interior and reconstruct internal structural walls and chimney stacks
- Temporary enclosure of window and other external openings

Repairs within 10 years / long-term works

Complete works to envelope, refurbish interior, renew services and make good surrounds:

- Repair dressed and carved stonework
- Reinstate external doors & windows
- Renew interior floors and partitions
- Reinstate internal doors and stairs
- Renew wall and ceiling finishes
- Redecorate
- Provide new connections to main electrical, gas and telephone services.
- Reconnect to main foul and surface water drainage.
- Construct wall and floor lining to basement incorporating cavity drainage system and drain to sump collection point.
- Install flood protection pump in basement
- Replace external fire escape stairs
- Re-grade exterior ground levels and lay new paved surrounds to building

3.0 HAFOD PIER and adjoining canal wall

3.1 Description

Listed Grade II
Early C19.
The pier formed the eastern support of a tramroad that passed high over the Swansea Canal.

Construction

The pier is tall and tapering and constructed of coursed rubble sandstone with copper slag block quoins. Putlog holes for the former tramroad supports are present in the front and back faces. The canal wall, some 60 metres long in all and up to 4 metres high, extends away from the pier in both directions. To the north it extends as far as the Laboratory Building. This northern section of the wall is built mainly of rubble stonework and in part copper slag blocks. The portion immediately adjacent to the Laboratory Building has retained its pointed copper slag coping blocks. A wide brick arch near the base of the wall formerly acted as an entrance to one of the canal dock basins.

Condition

Pier: the masonry is generally in fair condition, with some loose or dislodged stonework on its top and to a lesser extent on its faces.

Canal wall: There has been some erosion of the black ash mortar pointing and spalling of the faces of brickwork and copper blocks due to frost damage together with isolated loss or dislodgement of masonry. Generally there are no major cracks in the wall, however there is a visible lean of approximately 75 mm towards the original canal. A timber lintel over a blocked up door opening remains in the wall.

Vegetation: along the base of the wall there is extensive undergrowth together with tree saplings that have become established in the former canal bed.

3.2 Initial Repairs

Vegetation: cut back undergrowth and tree saplings along base of the wall and pier. Treat with herbicide.

Repairs within 5 years

Pier: consolidate and cap masonry top; repair, rake out and re-point faces of pier.

Canal wall: repair locally and generally rake out and re-point; construct masonry piers on new bases to retain wall where out of plumb

Repairs within 10 years / long-term works

Institute planned programme of inspection and upkeep.

4.0 HAFOD COPPER SLAG ABUTMENT

4.1 Description

Listed Grade II
Mid C19
The abutment formed the western support of the tramroad that passed over the Swansea Canal.

Construction

The tall, substantial projecting abutment, trapezoidal in plan, is flanked either side by battered walls. Constructed in large copper slag blocks with dressed stone quoins. A timber wall plate is built into the face of the abutment at mid-height.

Condition

The abutment appears to be of robust construction and in fair condition with some loose or dislodged masonry on its top and to a lesser extent on its faces due to vegetation growing in the mortar joints.

4.2 Initial repairs

Vegetation: remove from face of masonry. Treat with herbicide.

Repairs within 5 years

Consolidate and cap masonry top; repair, rake out and re-point faces of abutment.

Repairs within 10 years / long-term works

Institute planned programme of inspection and upkeep.

5.0 HAFOD LIME KILN

5.1 Description

Listed Grade II
Late C18 to early C19
Presently derelict
About 6 metres by 6 metres on plan

Construction

Random rubble masonry with squared quoins; brick arched opening to kiln oven on the east face; north elevation has a central vertical full height chase in the face of the wall. Remnants of iron plate device on top of north wall.

Condition

Mortar joints in the upper portion of the kiln are heavily eroded.
Loose masonry to tops of walls
Extensive ivy growth on the west face and on the tops of the walls generally.

5.2 Initial repairs

Clear debris and treat plant growth around the base of the building with herbicide.
Consolidate and mortar cap tops of walls; rake out re-point wall faces; clear debris from and consolidated remains of kiln oven.

Repairs within 5 years

Complete the archaeological investigation and restoration of the kiln and its surrounds and improve access.

Repairs within 10 years / long-term works

Institute planned programme of inspection and upkeep.

6.0 HAFOD CANAL BOUNDARY WALL of the canal docks.

6.1 Description

Listed Grade II
Early C19
The wall runs along the east side of the Swansea Canal southwards from the former canal bridge for approximately 80 metres.

Construction

Built in part of copper slag, sandstone and clay brickwork.

Lower portions originally built in rubble, rectangular blocks and pointed copings all of copper slag.

Upper sections subsequently raised in red brickwork. Within the wall are two wide blocked up brick archways being former canal dock entrances.

Condition

Mortar joints heavily eroded particularly in upper brick portions.
Removal of abutting buildings has left isolated panels of brickwork.

Vegetation: along the base of the wall there is extensive undergrowth together with tree saplings.

6.2 Initial repairs

Record and take down unstable sections of masonry.

Vegetation: cut back undergrowth and tree saplings along base of the wall. Treat with herbicide.

Repairs within 5 years

Reconstruct unstable sections of wall, repair locally and rake out and re-point generally.

Repairs within 10 years / long-term works

Institute planned programme of inspection and upkeep.

7.0 VIVIAN CHIMNEY west of the Vivian Engine House of the former Hafod Copperworks.

7.1 Description

Listed Grade II
Late C19
About 4 metres by 4 metres on plan at base

Construction

Built in red clay brickwork a tall circular tapering stack, bound up to mid height with 5 no. iron bands. The octagonal stack base has a brick arched opening on its west side.

Condition

The corbelled ring top of the chimney appears to have been rebuilt in the recent past. Generally the stack is in fair condition, some erosion of the mortar joints has occurred together with some local damage to the brick arched opening at its base.
A limited amount of vegetation growth is present on the face of the chimney.

7.2 Initial repairs

Exterior surrounds: clear debris and treat plant growth around the base of the chimney with herbicide.

Repairs within 5 years

Undertake an archaeological investigation of the chimney surrounds and improve access.

Remove vegetation from face of stack.

Repair, rake out and re-point brickwork generally.

Inspect, repair / replace / redecorate iron bands

Repair and secure opening to base of chimney

Install lightning protection strap to chimney

Repairs within 10 years / long-term work

Institute planned programme of inspection and upkeep.

8.0 VIVIAN ENGINE HOUSE - Appraisal

8.1 Description

Listed Grade II
Mid C19
Presently derelict.
2 storey structure with basement; built to house a steam engine for the Hafod Copperworks.
The engine house is approximately 14 metres long by 9 metres wide on plan.

Construction

Roof: steel angle trusses supporting timber purlins. Formerly slate covered on timber boarding.

External walls: solid masonry construction; west gable together with north and south side elevations built mainly in squared sandstone rubble with upper portions of walls in grey copper slag brickwork, with red brick eaves courses; east gable built in grey brickwork with stone quoins; render to splay of north-west corner.
Squared stone surrounds to the main door and window openings; north and south side elevations have circular window openings In the brick upper sections.
Main entrance door on west gable reached by short flight of stone steps.
Commemorative tablet set in wall above doorway.

Upper ground floor: concrete slab with inset steel beams and various pits and openings to lower ground level.

Walls rendered on interior faces.

Condition

Roof: original roof covering completely lost, limited remnants of roof boarding remain. Steel trusses corroding.

External walls: generally in sound condition.
Extensive spalling of copper slag brickwork in upper sections, particularly on north elevation.
Various iron and steel brackets and projecting beams built into walls; stone corbels built into east gable at mid height.
Limited vegetation growth to exposed tops of walls.

Window openings: bricked up in part, remnants of timber window frames & glazing bars remain.

Main west door opening, arch segment missing near crown.

Exposed flanges of inset steel beams to ground floor corroding.

Section of machinery pipework remains in the south-east corner of building.

8.2 VIVIAN ENGINE HOUSE – Repairs

Initial Repairs

Roof: remove and record loose remnants of roof boards and other timbers; apply temporary primer to steel roof trusses to protect against continuing corrosion.

Secure openings to prevent intrusion.

Main west door: temporarily brick up to support arch.

Remove remnants of possible asbestos based lagging from remaining section of machinery pipework.

Exterior surrounds: clear debris and treat plant growth around the base of the building with herbicide.

Repairs Within 5 years

Repair and make weather tight external envelope of building:

- Reinstate roof structure and re-slate
- Repair and apply protective coating to steel trusses and beams
- Reinstate rainwater goods and connect to temporary soakaways
- Repair and re-point external walls
- Temporary enclosure of window and other external openings

Repairs within 10 years / long-term

Complete works to envelope, refurbish interior, renew services and make good surrounds:

- Reinstate external doors & windows
- Repair floor slabs and steps
- Renew wall and ceiling finishes
- Redecorate
- Provide new connections to main services.
- Reconnect to foul and surface water drainage.
- Repair external steps
- Re-grade exterior ground levels and lay new paved surrounds to building

9.0 MUSGRAVE ENGINE HOUSE - Appraisal

9.1 Description

Listed Grade II*
Built 1910
2 storey structure with basement with adjoining stack and machinery cage; built to house a steam engine for the Hafod Copperworks.
The engine house is approximately 13 metres long by 8 metres wide on plan with the brick stack being just under 3 metres by 3 metres on plan at its base.

Construction

Roof: low hipped timber trussed purlin roof, slate covered with clay hip and ridge tiles.

External walls: solid construction; exterior of grey copper slag bricks with red clay brick decorative bands at window head, sill and eaves level.
Interior faces of walls built in red clay bricks with bull nose bricks to piers.
Large rectangular window openings to north and south side elevations; double height opening on west end; east end of building has opening with brick flank walls connecting to steel mesh machinery cage.

Upper ground floor: concrete slab with openings to lower ground level.

Brick chimney : square section tapering stack in brown brickwork with basement opening on west side.
6 no. steel tie rod bands at high level and 1 no. band low level.

Condition

Roof: greater part of roof structure remaining with some remnants of slate covering and guttering.

External walls: generally in sound condition with some localised damage and cracking associated with insertion of steel beams and attachments to former structures. Some spalling of the copper slag brickwork mainly on upper sections of wall; brickwork overall has a very weathered appearance. Limited vegetation growth to exposed tops of walls.
Window openings: some closed up with corrugated metal sheets; remnants of timber window frames & glazing bars remain.

Upper ground floor: corrosion to exposed flanges of inset beams to underside of slab.
Steam engine and associated machinery remain in place.

Brick chimney: generally in fair condition, some erosion of the mortar joints has occurred; previously treated fracture in brickwork at low level on west face. Upper section only remains of lightning conductor strap on west face.
Vegetation growth mostly on south face of stack.

9.2 MUSGRAVE ENGINE HOUSE – Repairs

Initial repairs

Roof: remove and record remnants of slates, tiles and battens; replace defective rafters; counter batten and fix temporary roof covering of profiled metal sheets to protect building interior and steam engine machinery from further deterioration.

Remove vegetation from tops and faces of walls and treat with herbicide.

Close up window openings with profiled metal sheets and secure door openings to prevent intrusion.

Exterior surrounds: clear debris and treat plant growth around the base of the building with herbicide.

Repairs within 5 years

Repair and make weather tight external envelope of building:

- Re-slate roof
- Reinstate rainwater goods and connect to temporary soakaways
- Repair and re-point external walls
- Temporary enclosure of window and other external openings
- Repair and protect exposed flanges of steel beams beneath ground floor slab

Chimney stack:

- Remove vegetation from face of stack.
- Repair, rake out and re-point brickwork generally.
- Inspect, repair / replace / redecorate iron bands
- Repair and secure opening to base of chimney
- Replace lightning protection strap to chimney

Repairs within 10 years / long-term works

Complete works to envelope, refurbish interior, renew services; provide facilities for upkeep and display of steam engine; make good surrounds to building:

- Reinstate external doors & windows
- Repair floor slabs and steps
- Renew wall and ceiling finishes
- Redecorate
- Provide new connections to main services
- Install electrical power and lighting
- Install water services and sanitary facilities
- Reconnect to foul and surface water drainage
- Re-grade exterior ground levels and lay new paved surrounds to building, repair external steps
- Undertake preservation work to steam engine machinery and institute planned programme of upkeep

10.0 MUSEUM STORES

10.1 Description

Formerly the Morfa Copperworks rolling mill.
Listed Grade II
Mid C19 with later additions.
Long single storey building with lower single pitch lean-to extension on its west side and smaller double pitched extension on north end.

Construction

Roof: steel angle trusses and sheeting rails with corrugated roof covering lined internally with insulation board in metal grid. Tall cylindrical metal air vents along ridge.

External walls: generally of random sandstone rubble and red brick; upper section of south gable contains 8 no. semi-circular arched window openings 5 no. of which have been bricked up, lower section of gable rendered; east elevation is formed mainly of brickwork infill panels set between round cast iron columns supporting massive timber beam carrying eaves brickwork; upper section of north gable is of brickwork panels and piers and contains 2 no. window openings, lower section built of random rubble with wide infilled brick arched opening; north and west extensions modern steel frame with corrugated metal roof and wall cladding on brick dwarf walls; large industrial metal doors set in new openings in east elevation.

Condition

Generally in fair condition, being used for the storage of industrial and maritime museum artefacts.

Main building: roof presently being over-clad and industrial door openings enlarged as part of a refurbishment programme.

Interior of main building has been racked out for storage; brick piers have been built at intervals against the external walls to carry an overhead travelling beam crane.

Ground floor slab: large areas of cracking and surface spalling

Extensions: lean-to extensions on contain offices, workrooms and toilet facilities; bottom edge of the metal cladding on east face of north extension is rusting through.

10.2 Initial repairs

Not applicable

Repairs within 5 years
Prepare programme for restoration of original structure and removal / replacement of later extensions and additions.

Repairs within 10 years / long-term works
Undertake restoration of building to original form.
Replace cracked and deformed floor slab if necessary for further use.
Replace later extensions with new separate structures.

11.0 VIVIAN LOCOMOTIVE SHED - Appraisal

11.1 Description

Listed Grade II
Early C20.
The shed was built to house the locomotive used to transfer materials around the whole of the Hafod Copperworks site.
A single storey building, in plan approximately 6 metres wide by 50 metres long in 9 equal bays. Wide square engine shed door openings in the north and south ends of the building with adjacent lower openings in the west faces of the end bays.
The shed is set on a narrow level strip of land between the River Tawe and the foot of the main line railway embankment.

Construction

Roof: north-light pattern roof covered with profiled asbestos cement roof sheets on steel angle roof trusses, 2 no. intermediate trusses per bay supported on I-section steel beams spanning between brick piers. Ends of beams carried on padstones set into piers. The 3 northern most beams approximately 180 x 450 mm deep with the remainder being about 100 x 180 mm deep.
Sides of steel trusses also clad with asbestos cement sheets to form smoke funnel.

External walls: generally one and a half bricks thick built of grey copper slag bricks subdivided into two wall and one gable panel per bay by red clay brick piers, intermediate string courses and gable cornices. Circular vent opening in red clay brickwork to centre of each gable panel. Red clay brick base along east face. White glazed bricks spell out 'V & S Ltd No1 SH ED' in letters about a metre high in the upper wall panels of the 7 northern most bays of the east face.

Floor: Paved with blue Staffordshire paving bricks with diamond tread pattern faces. A brick lined service pit runs centrally up the full length of the building.

Surrounds: along the west side of the building a brick retaining about 1 metre high and 1 metre from the face of the building holds back the foot of the railway embankment.

Condition

Roof: Greater part of the asbestos cement roof covering has been lost, now lying as debris around the building.

The remaining steelwork trusses and beams are severely corroded. The roof trusses to the 5 southern most bays have collapsed and those remaining to the 4 northern most are in imminent danger of collapse.

External walls:
The grey copper slag brickwork is generally in poor condition with more severe deterioration having occurred in those locations where the brickwork has been persistently saturated. The worst affected areas being the exposed gable panels, wall areas either side of the piers subject to water overflowing from north-light roof gutters and areas where the copper slag brickwork is in contact with the ground.
Brickwork deterioration and roof structure collapse has caused several of the gable panels to lean outward resulting in the loss of brickwork from the gable cornices.

Door openings: steel lintels corroding.

Floors: sound but debris covered.

Surrounds: heavily overgrown with mature trees leaning against the upper part of the building on the west face.

11.2 VIVIAN LOCOMOTIVE SHED - Repairs

Initial repairs

Roof: record remaining elements, remove all asbestos sheeting and those steel members in imminent danger of collapse.

Walls: record and take down gable brickwork in imminent danger of collapse. Cut back plant growth on walls and treat roots with herbicide.

Floors: remove debris.

Surrounds: clear debris, cut back and treat plant growth around the building.

Support & protection: erect scaffold frame to shore up the remaining structure and support a temporary over-roof of profiled metal sheets over the whole structure to protect from further deterioration.

Secure openings to prevent intrusion.

Repairs within 5 years

Prepare programme for restoration of the structure.

Undertake investigation of copper slag brickwork failure and methods of repair and arresting future deterioration.

Prepare proposals for inserting permanent structural frame to support the brickwork wall panels.

Repairs within 10years / long term works

Undertake restoration of building to original form.

- Reinstate roof structure, cladding and rainwater goods.
- Repair external walls and install new structural support frame.
- Reinstate louvres to circular openings.
- Reinstate engine shed doors and infill the low level openings on west face.
- Decorate steelwork, rainwater goods and joinery.
- Provide new connections to mains services including foul drainage.
- Lay new paved surrounds to the building.

Left top : east gable elevation and clock tower frame of the former Canteen Building.

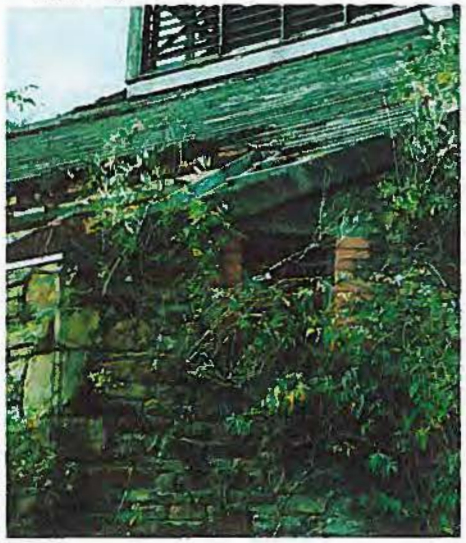
Left centre: view of the former Canteen Building from the north east.

Left bottom: view of the former Canteen Building from the north west.

Right upper: a modern steel frame has been inserted at first floor level to support the clock tower structure.

Below centre: vegetation growth on the north east corner of the building; intrusive root growth has resulted in the dislodging of masonry.

Below right: due to the extensive fire damage to the roof timbers over the western portion of the building, temporary ties are required to give restraint to the iron arch braces and supporting columns.

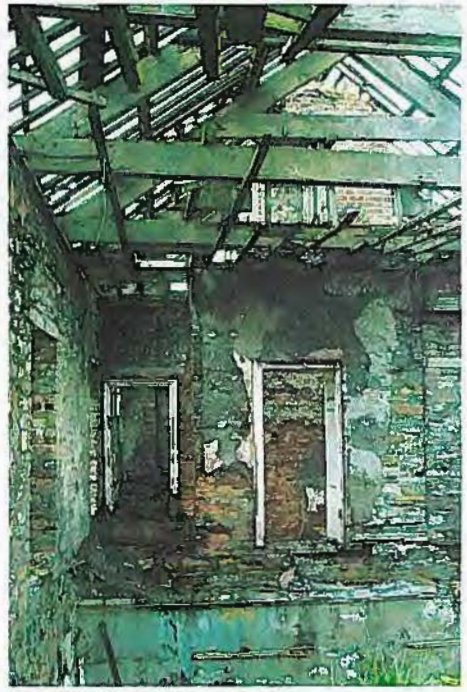


Left upper:
west elevation backing on to the Swansea canal.

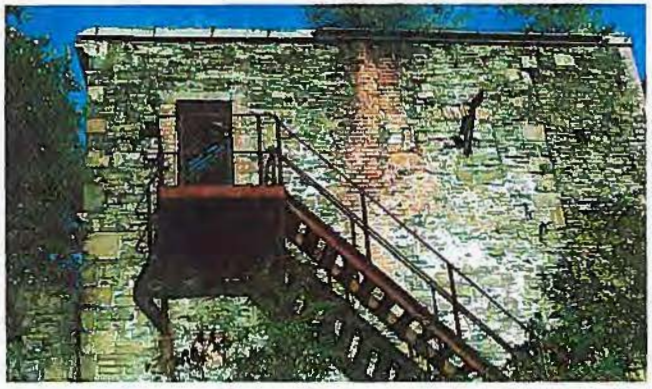
Right upper:
east elevation, the centre portion has subsided towards its north corner causing cracking and distortion of stonework, most pronounced in the sills and lintols of window openings.

Left centre:
north elevation.

Near right:
part of the pediment stonework of the main north entrance has been dislodged.



Far right:
view of interior showing the extent of damage.

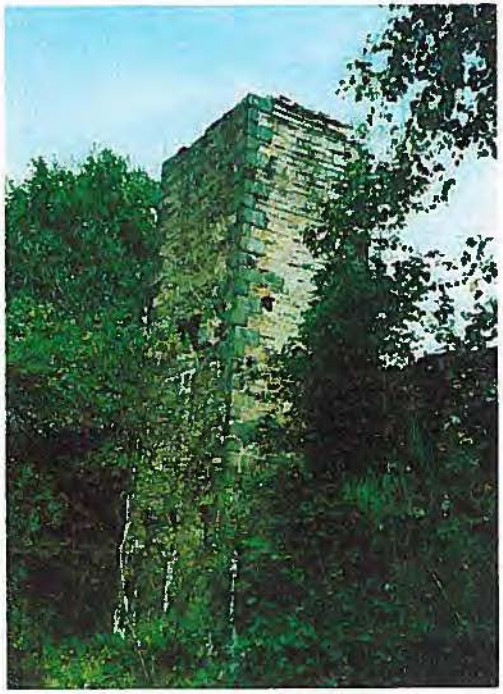


Left lower:
south elevation with steel fire escape stair from first floor.

4.0 Copper Slag Abutment to former waste tip tramroad

Above: view from south looking up the bed of the former Swansea Canal.
The tall, substantial projecting abutment, trapezoidal in plan, is flanked either side by battered walls. Constructed in large copper slag blocks with dressed stone quoins.
The abutment formed the western support of the tramroad over the canal.

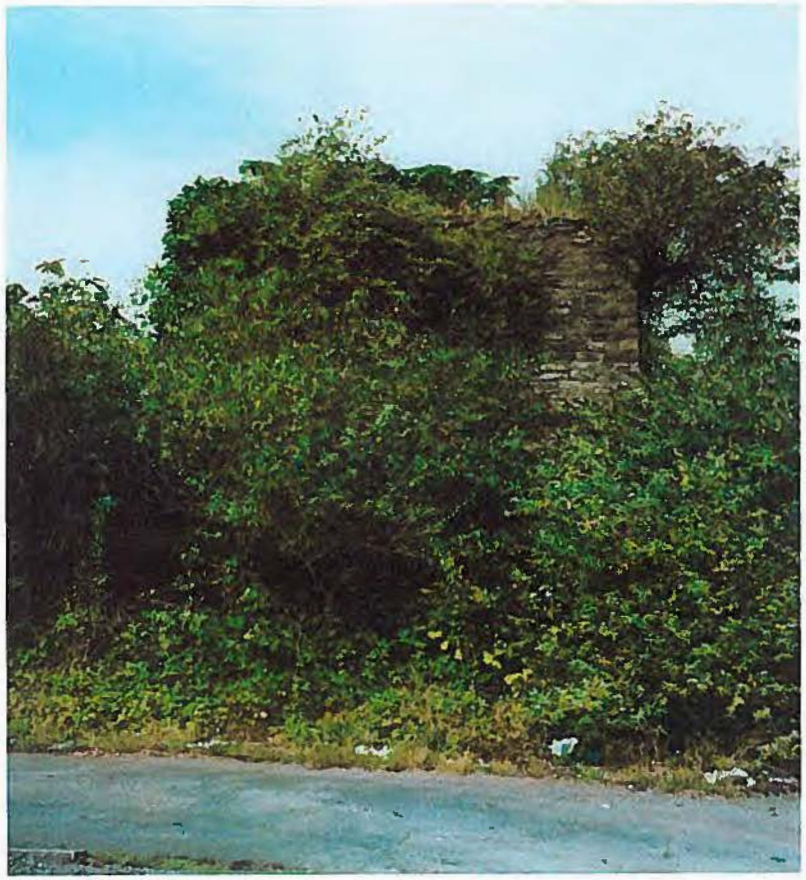
3:0 Pier to former waste tip tramroad



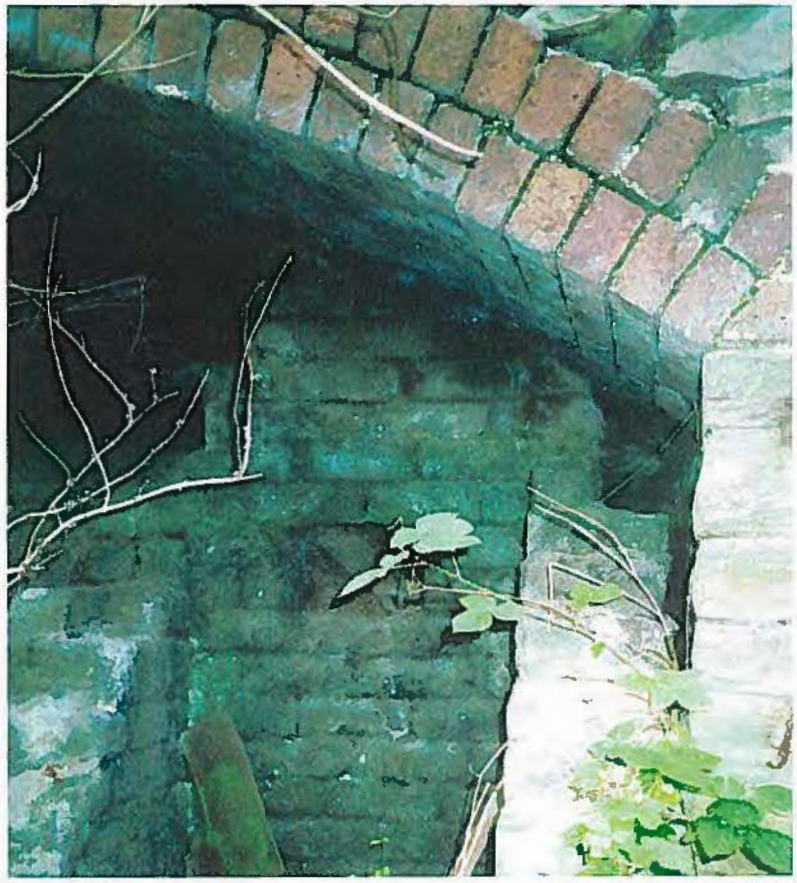
Above: view from south looking up the bed of the former Swansea Canal.
The tall and tapering pier is constructed of coursed rubble sandstone with copper slag block quoins. Putlog holes for the former tramroad supports are present in the front and back faces of the pier.
The pier formed the eastern support for the tramroad over the canal.

3.0 Boundary wall of former Morfa Copperworks

Above: east face of the boundary wall at its northern end near the Laboratory building; the wall is constructed of copper slag and rubble stone capped with pointed copper slag copping blocks.
Below: west / canal face of the boundary wall; a wide brick arch near the base of the wall formerly acted as an entrance to one of the canal dock basins.

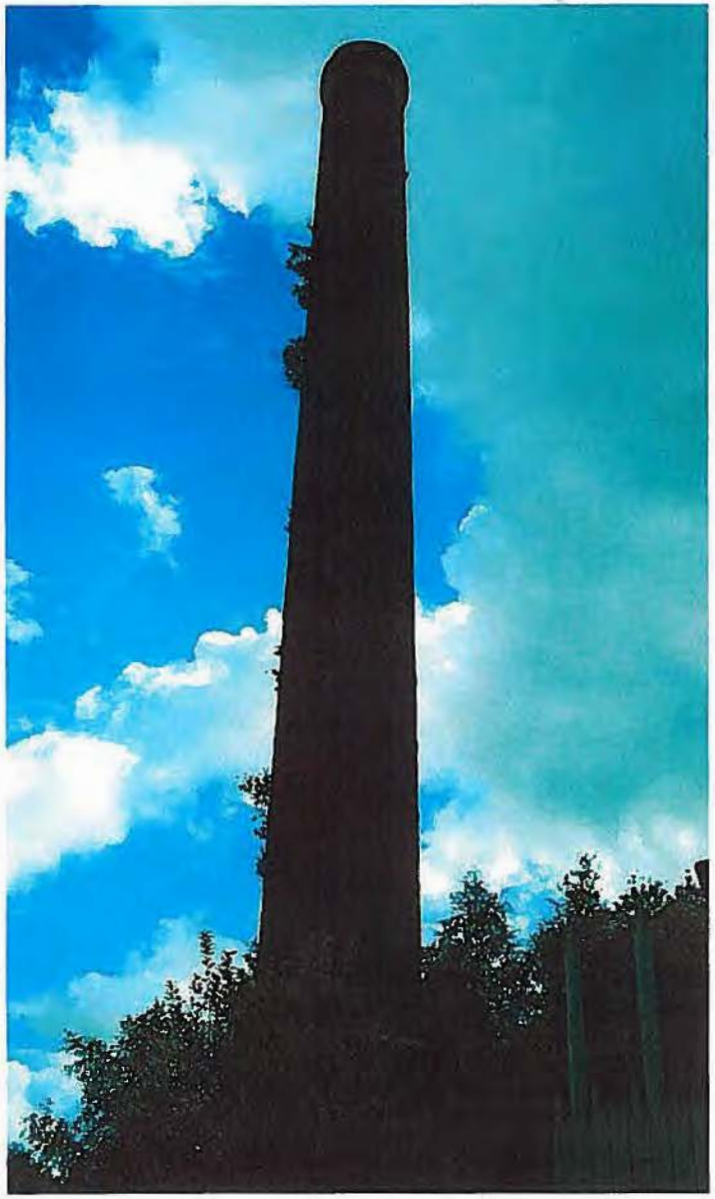


Above:
South face of the lime kiln viewed from the adjoining car park.
The kiln is constructed of random rubble masonry and is heavily overgrown, in particular on the north face.



Above:
Detail view of the brick arched opening to the oven at the base of the east face of the kiln.

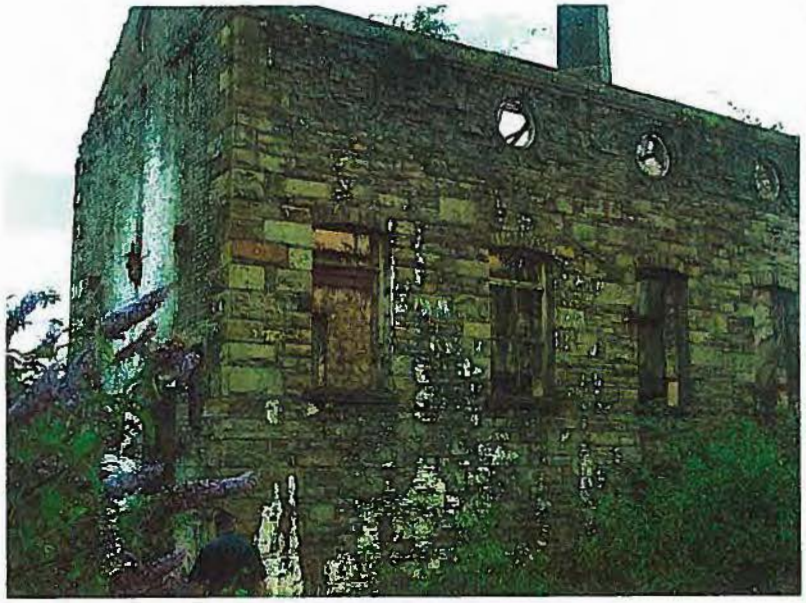
Boundary wall of the former Hafod Copperworks canal docks.
Above left: view of the west / canal face of the boundary wall at its northern end; sections of the wall formerly incorporated into adjoining buildings have been rebuilt in brickwork on the original random rubble base and dressed stone quoins.
Right upper: view of the west / canal face of the boundary wall; a base section of the wall built in rough copper slag nodules can be seen in the lower left hand portion of the photograph with to the right the infilled brick arched opening to the former canal dock.
Right lower: the high wall of copper slag, sandstone and brick runs along the canal boundary of the former Hafod Copperworks for some 80 metres in length. The lower parts of the wall were originally built in copper slag blocks and rough nodules and capped with rectangular and pointed copper slag copping blocks. The wall was subsequently built up again in red clay brickwork.



Chimney west of the Vivian Engine House of the former Hafod Copperworks.
Built in red clay brickwork, the tall tapering circular chimney stack sits on an octagonal base.

Above:
Brick arched opening on the west face of the stack base.

Right:
View of chimney from the north east, the chimney shaft is bound up to mid height with five iron bands.



Left upper:
north elevation of the Vivian engine house, the upper portion is built in copper slag bricks.

Below centre:
west elevation, a short flight of stone steps lead up to the main entrance.

Left lower:
south elevation of the engine house.

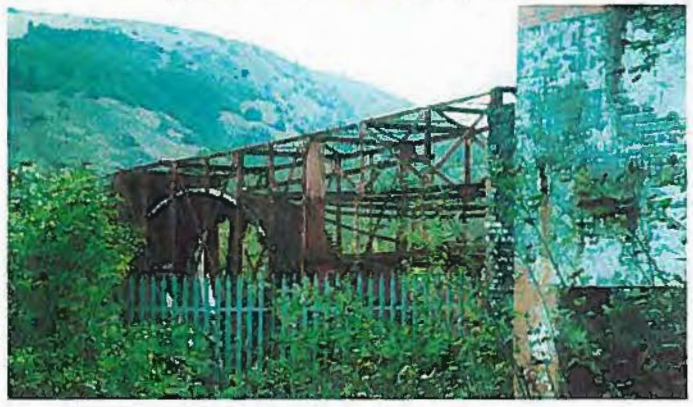
Below left:
Interior view of the west gable and roof structure. Remnants only of the timber roof boards remain, these carried the slate roof covering, the boards span between timber purlins in turn supported by steel angle trusses.

Left upper:
north elevation, the large rectangular windows to the upper ground floor of the engine house have been boarded over.

Right upper:
detail of red brick courses to head and eaves.

Right centre:
interior view of the engine house showing part of the steam engine and the overhead travelling crane.

Right lower:
machinery cage at the eastern end of the engine house.



Left lower:
west elevation showing the hipped roof and adjoining brick stack.

Left upper:
south gable of the stores,
five of the original eight windows have been bricked in.

Left centre:
view of east elevation with over-cladding of the roof in progress.

Below centre:
on east elevation brickwork infill panels are set between round cast iron columns carrying a massive timber eaves beam.

Left lower:
internal view of stores, steel angle roof trusses bear onto an eaves beam; brick piers have been built at intervals along the external walls to carry an overhead travelling crane.

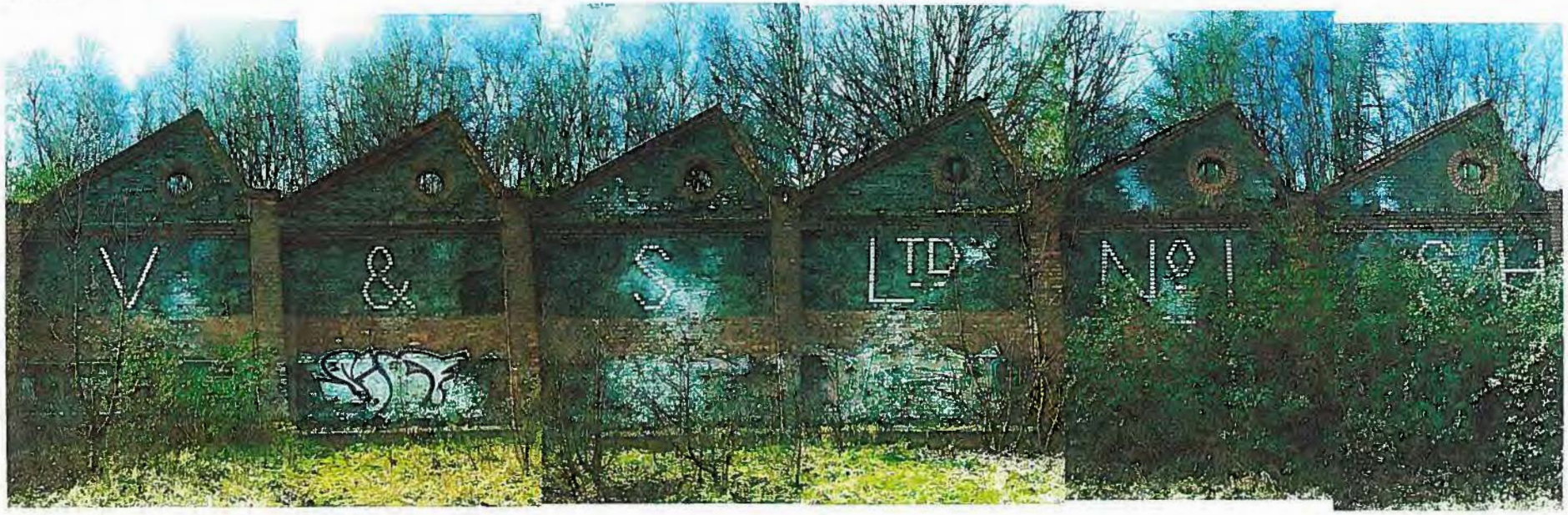
Right upper:
north gable with wide infilled brick arched opening.

Right centre:
modern steel frame lean-to extensions have been built along the west elevation.

Right lower:
modern steel framed profiled metal clad extension at the north end of the museum stores.

Above left: brickwork deterioration and roof structure failure has caused several of the gables to lean outward resulting in the loss of brickwork from the cornices.
Above centre: severe deterioration of the grey copper slag brickwork either side of the red clay brick piers probably due to water overflowing from north-light roof gutters.
Above right: a remaining section of north-light roof structure showing the steel angle trusses and asbestos cement roof cladding.

Below: White glazed bricks spell out V & S Ltd No1 SH ED in letters about a metre high in the upper wall panels of the central bays of the east elevation



NORTH

First floor plan

Iron columns

Blocked opening (primary)

Clock tower over

Secondary stairs 1920's - 30's

Primary opening in gable apex

Blocked opening (primary)

Ground floor plan

Inserted doorway

Inserted windows and surrounds

Inserted windows and surrounds

Block primary doorway

Secondary stairs 1920's - 1930's

Inserted doorway

Water tank (YIM 31)

Benching to base of wall

CANTEEN BUILDING

Yorkshire Imperial Metals Site, Swansea

DAVIES SUTTON ARCHITECTURE

scale 1: 200

EXISTING FLOOR PLANS

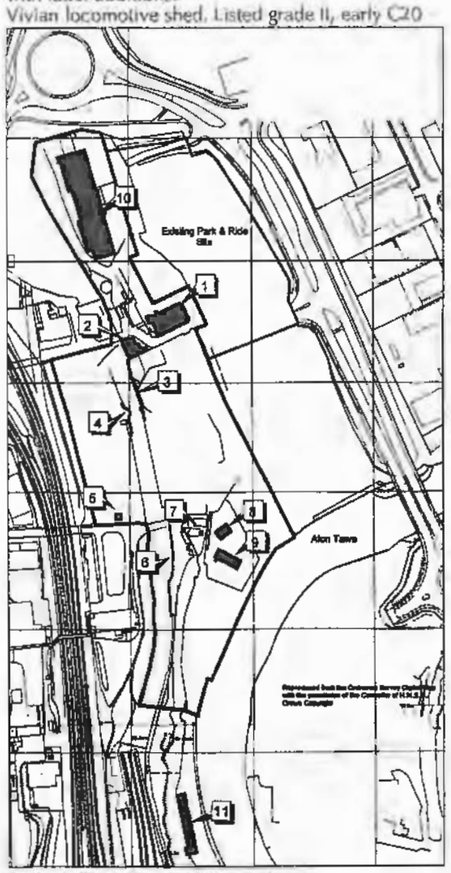
- Primary (1890's)
- Secondary (Mainly 1920's -30's)

Location Plan

scale 1:5000

Buildings & Structures -

1.0 Canteen building. Listed grade II , late C19. Former powerhouse of the Morfa Copperworks.
2.0 Laboratory Building. Listed grade II, mid to late C19 Formerly part of the Morfa Copperworks.
3.0 Pier and adjoining canal wall. Listed grade II, canal wall 1807pier c. 1850.
4.0 Copper slag abutment. Listed grade II, mid C19. The pier and abutment supported the waste tip tramroad over the Swansea canal.
5.0 Hafod lime kilm. Listed grade II, mid C19
6.0 Boundary wall of the canal docks of the former Hafod copperworks. Listed grade II, early C19
7.0 Vivian chimney. Listed grade II, 1860 - 62
8.0 Vivian engine house. Listed grade II, 1860 - 62
9.0 Musgrave engine house. Listed grade II*, built 1910
10.0 Musuem store. listed grade II, mid C19 with latter additions.
11.0 Vivian locomotive shed. Listed grade II, early C20



Used under licence. Crown copyright reserved

LABORATORY

Yorkshire Imperial Metals
Site, Swansea

DAVIES SUTTON ARCHITECTURE

scale 1: 200

EXISTING FLOOR PLANS

- c 1828 -1846
- 1880's
- 1854 - 1879
- Latter

NORTH

Weighbridge office
(YIM 301)

Site of bridge
(YIM 24)

Tank
(YIM 31)

Inspection chamber
Stairwell
Inspection chamber
Joint
Pitched copper slag surface

Joint
Joint
Joint
Iron staircase

First floor over
Lower ground floor under
Line of first floor over
Joint
Buttress/
Trunkcated wall

First floor plan

Ground floor plan

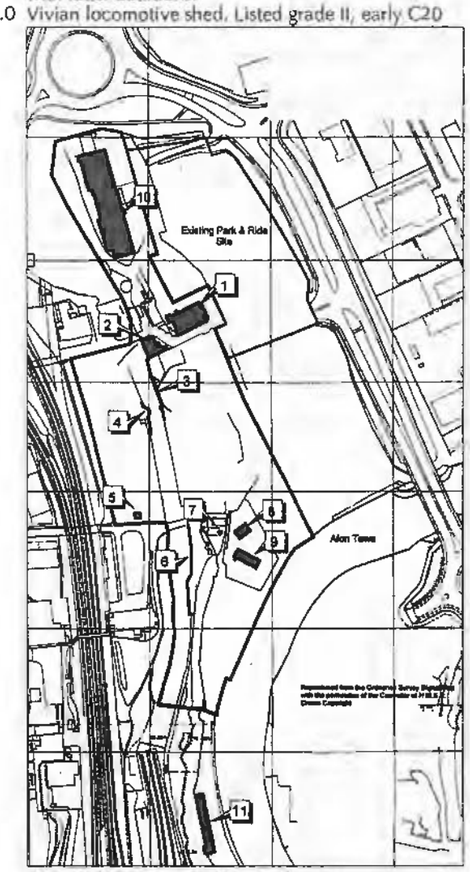
Lower ground floor plan

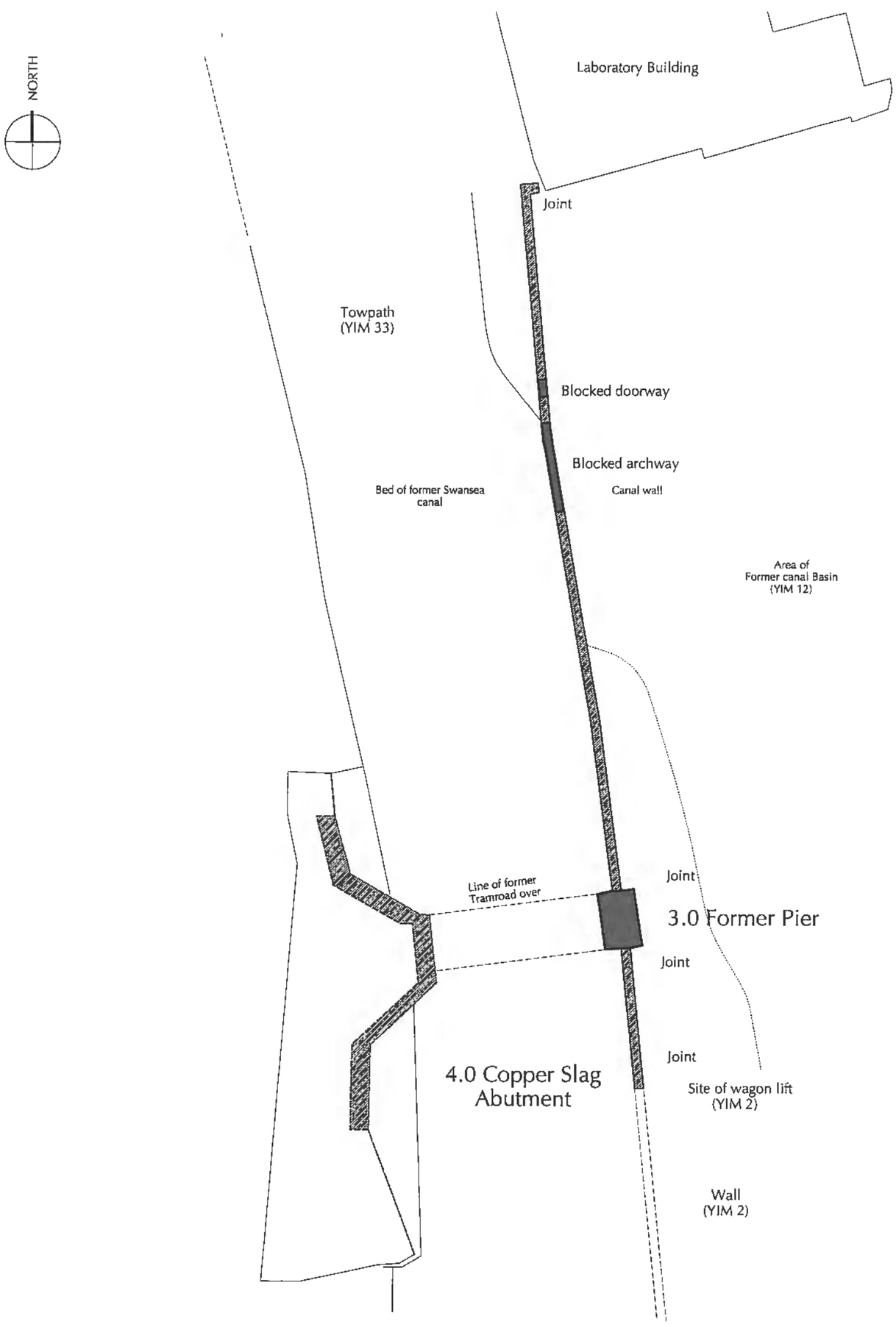
Location Plan

scale 1:5000

Buildings & Structures -

1.0 Canteen building. Listed grade II , late C19. Former powerhouse of the Morfa Copperworks.
2.0 Laboratory Building. Listed grade II, mid to late C19 Formerly part of the Morfa Copperworks.
3.0 Pier and adjoining canal wall. Listed grade II, canal wall 1807pier c. 1850.
4.0 Copper slag abutment. Listed grade II, mid C19. The pier and abutment suppported the waste tip tramroad over the Swansea canal.
5.0 Hafod lime kiln. Listed grade II, mid C19
6.0 Boundary wall of the canal docks of the former Hafod copperworks. Listed grade II, early C19
7.0 Vivian chimney. Listed grade II, 1860 - 62
8.0 Vivian engine house. Listed grade II, 1860 - 62
9.0 Musgrave engine house. Listed grade II*, built 1910
10.0 Musuem store. listed grade II, mid C19 with latter additions.
11.0 Vivian locomotive shed. Listed grade II, early C20





PIER & COPPER SLAG ABUTMENT

Yorkshire Imperial Metals
Site, Swansea

scale 1: 250

DAVIES SUTTON ARCHITECTURE

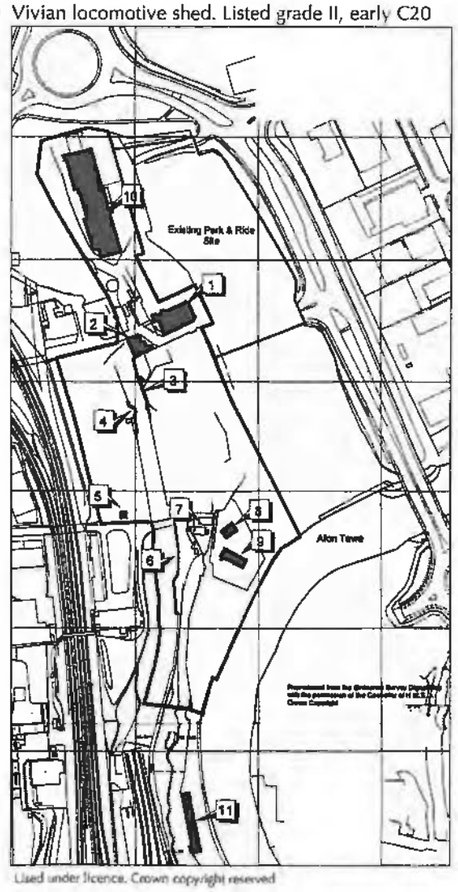
EXISTING

Location Plan

scale 1:5000

Buildings & Structures -

1.0 Canteen building. Listed grade II , late C19.
Former powerhouse of the Morfa Copperworks.
2.0 Laboratory Building. Listed grade II, mid to late C19
Formerly part of the Morfa Copperworks.
● 3.0 Pier and adjoining canal wall. Listed grade II,
canal wall 1807pier c. 1850.
● 4.0 Copper slag abutment. Listed grade II, mid C19.
The pier and abutment suppported the waste
tip tramroad over the Swansea canal.
5.0 Hafod lime kiln. Listed grade II, mid C19
6.0 Boundary wall of the canal docks of the former
Hafod copperworks. Listed grade II, early C19
7.0 Vivian chimney. Listed grade II, 1860 - 62
8.0 Vivian engine house. Listed grade II, 1860 - 62
9.0 Musgrave engine house. Listed grade II*, built 1910
10.0 Musuem store. listed grade II, mid C19
with latter additions.
11.0 Vivian locomotive shed. Listed grade II, early C20



Used under licence. Crown copyright reserved

CHIMNEY & ENGINE HOUSES

Yorkshire Imperial Metals Site, Swansea

scale 1: 200

EXISTING LOWER FLOOR

NORTH

(YIM 47)

Terrace (YIM 46)

Concrete surface over culvert

Infilled culvert

7.0 Vivian Chimney

Buttress

Pipework

(YIM 48)

Faces of retaining walls

Upper site level

Furnace

Concrete steps

8.0 Vivian Engine house

Timber pad

Lower site level

Concrete surface

Fence line

Well

Machine bases

Concrete surface inc. shaft

Concrete surface (YIM 51)

Well

Flue

Stack

Concrete bearer

9.0 Musgrave Engine house and Chimney

Machinery cage

(YIM 49)

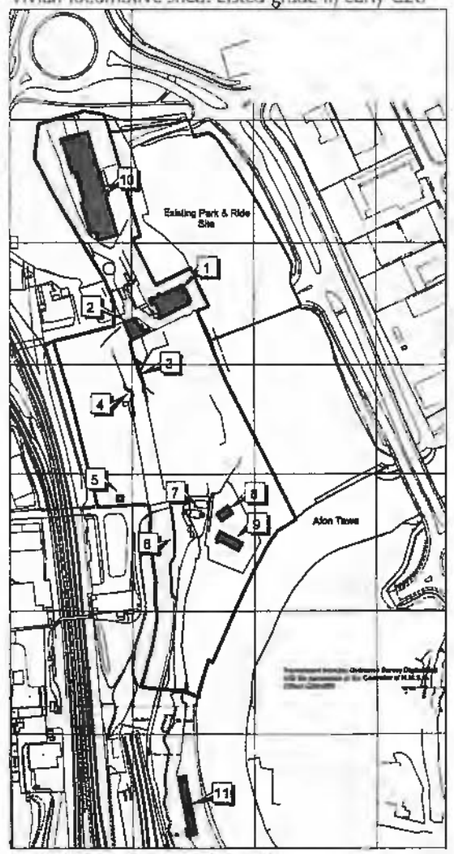
Standards, flywheel & drive wheel of rool train (approximate)

Location Plan

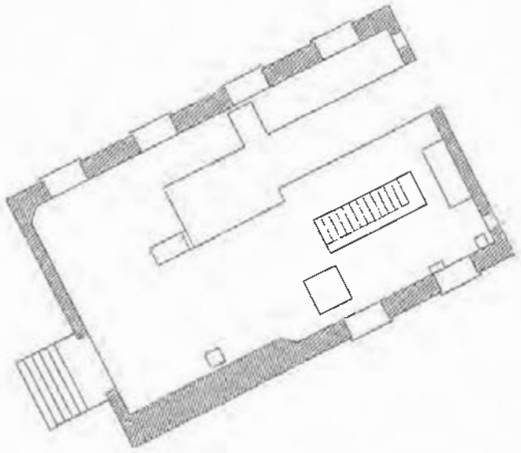
scale 1:5000

Buildings & Structures -

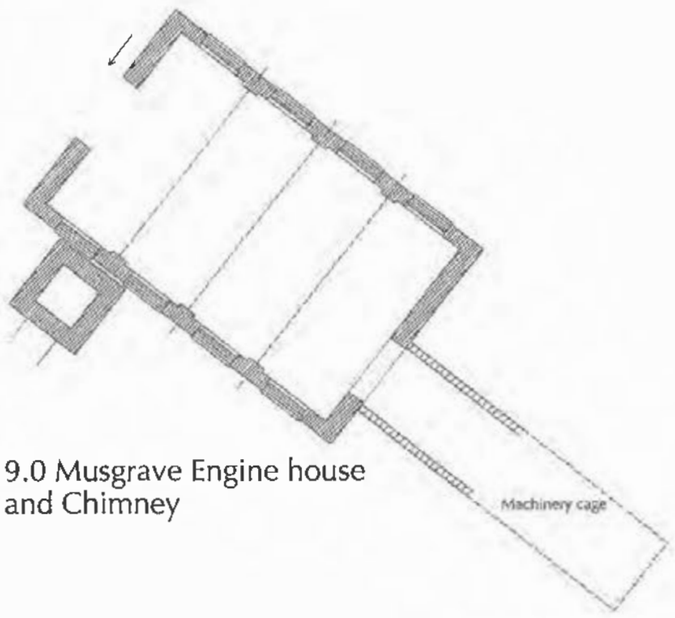
1.0 Canteen building. Listed grade II , late C19. Former powerhouse of the Morfa Copperworks.
2.0 Laboratory Building. Listed grade II, mid to late C19 Formerly part of the Morfa Copperworks.
3.0 Pier and adjoining canal wall. Listed grade II, canal wall 1807pier c. 1850.
4.0 Copper slag abutment. Listed grade II, mid C19. The pier and abutment suppported the waste tip tramroad over the Swansea canal.
5.0 Hafod lime kilm. Listed grade II, mid C19
6.0 Boundary wall of the canal docks of the former Hafod copperworks. Listed grade II, early C19
● 7.0 Vivian chimney. Listed grade II, 1860 - 62
● 8.0 Vivian engine house. Listed grade II, 1860 - 62
● 9.0 Musgrave engine house. Listed grade II*, built 1910
10.0 Musuem store. listed grade II, mid C19 with latter additions.
11.0 Vivian locomotive shed. Listed grade II, early C20



NORTH



8.0 Vivian Engine house



9.0 Musgrave Engine house
and Chimney

ENGINE HOUSES

Yorkshire Imperial Metals
Site, Swansea

scale 1: 200

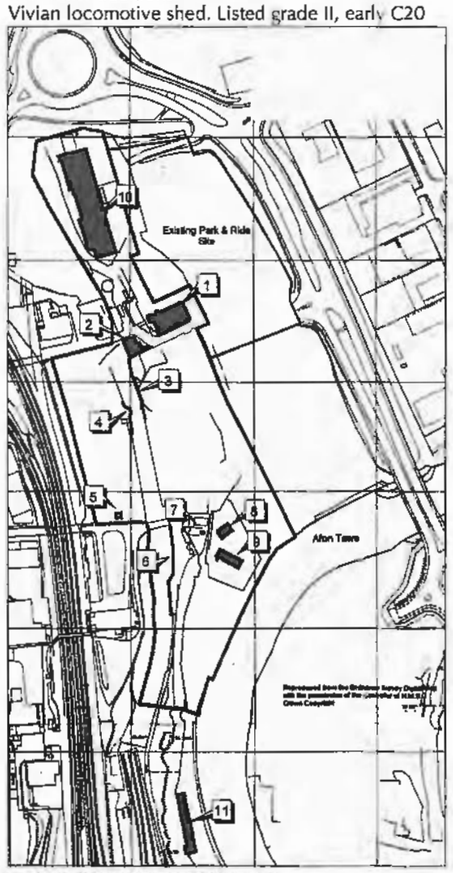
DAVIES SUTTON ARCHITECTURE

EXISTING UPPER FLOOR

Location Plan
scale 1:5000

Buildings & Structures -

1.0 Canteen building. Listed grade II , late C19.
Former powerhouse of the Morfa Copperworks.
2.0 Laboratory Building. Listed grade II, mid to late C19
Formerly part of the Morfa Copperworks.
3.0 Pier and adjoining canal wall. Listed grade II,
canal wall 1807pier c. 1850.
4.0 Copper slag abutment. Listed grade II, mid C19.
The pier and abutment suppported the waste
tip tramroad over the Swansea canal.
5.0 Hafod lime kilm. Listed grade II, mid C19
6.0 Boundary wall of the canal docks of the former
Hafod copperworks. Listed grade II, early C19
7.0 Vivian chimney. Listed grade II, 1860 - 62
● 8.0 Vivian engine house. Listed grade II, 1860 - 62
● 9.0 Musgrave engine house. Listed grade II*, built 1910
10.0 Musuem store. listed grade II, mid C19
with latter additions.
11.0 Vivian locomotive shed. Listed grade II, early C20



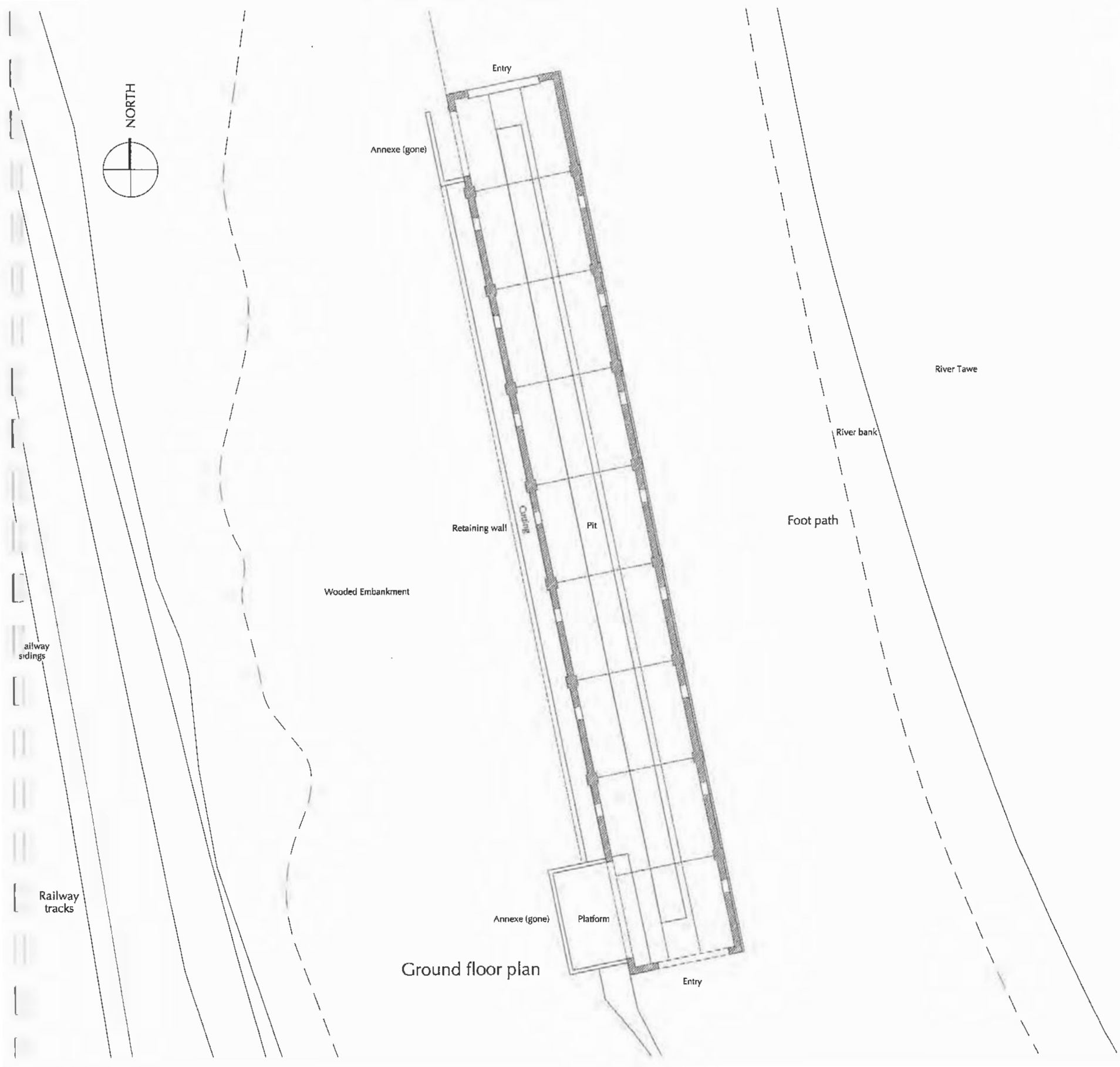
VIVIAN LOCOMOTIVE SHED

Yorkshire Imperial Metals
Site, Swansea

DAVIES SUTTON ARCHITECTURE
CHARTERED ARCHITECTS
CONSERVATION CONSULTANTS
BUILDING SURVEYORS

scale 1: 200

EXISTING FLOOR PLAN



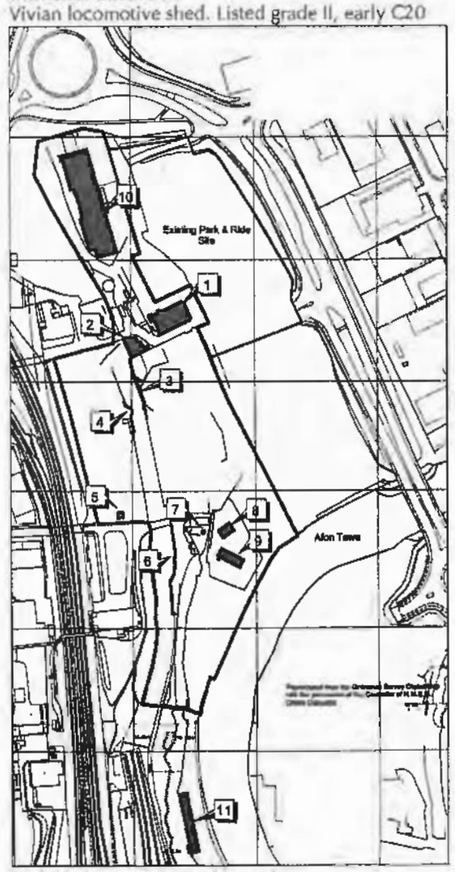
Ground floor plan

Location Plan

scale 1:5000

Buildings & Structures -

1.0 Canteen building. Listed grade II , late C19.
Former powerhouse of the Morfa Copperworks.
2.0 Laboratory Building. Listed grade II, mid to late C19
Formerly part of the Morfa Copperworks.
3.0 Pier and adjoining canal wall. Listed grade II,
canal wall 1807pier c. 1850.
4.0 Copper slag abutment. Listed grade II, mid C19.
The pier and abutment suppported the waste
tip tramroad over the Swansea canal.
5.0 Hafod lime kiln. Listed grade II, mid C19
6.0 Boundary wall of the canal docks of the former
Hafod copperworks. Listed grade II, early C19
7.0 Vivian chimney. Listed grade II, 1860 - 62
8.0 Vivian engine house. Listed grade II, 1860 - 62
9.0 Musgrave engine house. Listed grade II*, built 1910
10.0 Musuem store. listed grade II, mid C19
with latter additions.
●11.0 Vivian locomotive shed. Listed grade II, early C20



SPECIALIST STUDY: HEALTH & SAFETY

Appraisals and supporting information prepared by: Veryards Limited, Consulting Civil & Structural Engineers. Job reference CS6956.

SITE SECURITY APPRAISAL

Consequence of breached site security:-

- Injury to trespassers.
  Consideration of the duty of care of owner and liability in respect of third party claims.
- Further damage to the listed structures (vandalism, arson)
- Fly tipping
- Illicit use of the site.

Recommendations for ensuring site security.

1. Identify the most suitable site access points and routes for pedestrians and vehicles.

2. Identify any public rights of way through the site.

3. Secure the site perimeter with a continuous fence taking into consideration the requirements of 1 and 2 above.
   A 2.4 m high steel palisade fence is recommended.
   All other fencing should be removed to clear the site area.

4. Reduce vegetation to ground level, and maintain a clearance programme to provide clear visibility across the site. This will:
   a. Discourage trespass.
   b. Discourage illicit use of the site.
   c. Enable inspections by security personnel or others.

5. Consideration should be given to the improvement of artificial lighting around the perimeter of the site.

6. Consideration should be given to the provision of periodic patrols by security personnel to prevent or monitor trespass.

7. Vivian Locomotive Shed: as this structure is located outside the original site boundary , its perimeter including a masonry fall zone should be enclosed by a 2.4 metre high steel palisade fence.

SITE AREAS APPRAISAL

Preamble

The following parameters have been applied in considering the Health and Safety requirements of the open areas of the site.

1. The site will be fenced off and no public access will be permitted.

2. It is not considered appropriate to carry out extensive work to raise the standard of the site to conform with standards appropriate to public areas. The site will remain a rough unused area on the whole.

3. Significant risks have been addressed.
   Any unprotected drops in excess of approximately 1 m have been noted as such, lesser drops are considered to be consistent with the nature of the site, and have not been noted. Consideration should be given to signage at site entrances drawing attention to such risks.

4. The perimeter of the Vivian Locomotive Shed, including a masonry fall zone, will be fenced to prevent public access.

SITE AREAS APPRAISAL Refer to drawing No. HS 1, HS2 and HS3 for site areas, and photographs as referenced under 'P' numbers.	**Perceived Risk**	**Mitigating Action**
Area 1	Unprotected drops from retaining walls P1.	Provide secure barriers.
	Trip Hazards: P2, P3, P4. • Uneven ground • Exposed column bases • Debris • Tree stumps • Raised kerb at building entrance.	Provide secure fence around perimeter of site. Clear site of debris.
	Leaning fence to north boundary P5.	Provide secure fence. Remove redundant fencing
	Stored material. (Industrial artefacts) P6.	Fence off stored material.
	Adit' marked on topographical survey (North-west corner).	Investigate and seal off if necessary.
Area 2	Unprotected drops: P7, P8, P9 • Retaining walls to west of canteen building • Retaining wall to south of laboratory building • Open pit to south of laboratory building	Provide secure barriers.
	Trip Hazards: • Uneven ground • Exposed column bases • Tree stumps	Provide secure fence around perimeter of site.

SITE AREAS APPRAISAL Refer to drawing No. HS 1, HS2 and HS3 for site areas, and photographs as referenced under 'P' numbers.	**Perceived Risk**	**Mitigating Action**
Area 3	Unprotected drop P19 (from top of abutment)	Provide secure barrier
	Trip Hazards: P10 • Uneven ground • Tree stumps	Provide secure fence around perimeter of site.
	Uncovered inspection chamber to pipe culvert P11	Provide permanent cover.
	Felled trees P12	Clear site.
Area 4	Trip Hazards: • Uneven ground • Demolition rubble • Trees/undergrowth.	Provide secure fence around perimeter of site. Clear site of rubble.
Area 5	Unprotected drops from retaining walls. P13, P14	Provide secure barriers.
	Unprotected drops to River Tawe. P15	Provide secure fence around perimeter of site.
	Access to air raid shelter built into retaining wall P16	Seal off entrance.
	Trip Hazards: P17, P18 • Uneven ground • Trees/undergrowth	Provide secure fence around perimeter of site.

SITE AREAS APPRAISAL Refer to drawing No. HS 1, HS2 and HS3 for site areas, and photographs as referenced under 'P' numbers.	**Perceived Risk**	**Mitigating Action**
Area 6	Risk of falling masonry to building footprint and immediate area. Trip Hazards: • Uneven ground • Trees/undergrowth Unprotected drops. P.30, P.32 Steeply sloping ground. P.42 Unprotected drop to River Tawe. P.31	Erect enclosing perimeter fence to prevent unauthorised public access.

SITE STRUCTURES APPRAISAL

Preamble

In considering the health and safety aspects of the structures as they exist, the following factors have been taken into consideration.

1. The site will be fenced off, and no public access will be permitted

2. The minimum structural intervention has been advised consistent with health and safety requirements. In many cases the health and safety requirement is consistent with the advice given on the stabilising and consolidating the structures e.g. the risk from partial collapse of a structure will be mitigated by the requirement to stabilise the structure for conservation reasons.

3. Where partial demolition has been advised (wall to south of the former pier, former external wall of building) it is considered that the rebuilding and stabilisation of the wall would substantially change the structure. The wall would need additional support to ensure stability after substantial rebuilding.

4. The perimeter of the Vivian Locomotive Shed, including a masonry fall zone, will be fenced off to prevent public access.

SITE STRUCTURES APPRAISAL	Perceived risk	Mitigating Action
1.0 Former Canteen Building	Risk of falling structure internally. P27	Remove loose/insecure structural elements. (Roof timbers and high level masonry) Provide restraint to remaining frame elements (as condition appraisal)
	Unprotected drops • Staircase and landings • Window openings at first floor level • Changes in level at ground floor	Provide secure barriers. Secure building to prevent entry.
2.0 Laboratory Building	Building open to intrusion. P22 Risk of falling structure internally. Risk of dropping through insecure structure internally.	Secure building to prevent entry.
	Corroded steel external access stair to 1st floor. Risk of injury through partial collapse of stairs.	Either:- (i) Remove staircase (ii) Repair staircase
Flat roofed brick building adjacent to laboratory building.	Unauthorised entry. P23 Building debris – trip hazard.	Secure building to prevent entry.
3.0 Former Pier	Risk of falling masonry. P24	Cap and consolidate tops of walls (As condition appraisal)
Wall to south of former pier (Former external wall of building)	Unstable masonry Risk of collapse. P20 & P21	Reduce wall to 2m height.

SITE STRUCTURES APPRAISAL	Perceived risk	Mitigating Action
4.0 Copper slag abutment and adjacent walls.	Unprotected drop from top of wall. P25	Provide secure barriers and signage.
	Risk of falling masonry.	Cap and consolidate tops of walls. (As condition appraisal)
5.0 Lime Kiln	Risk of falling masonry. P26	Cap and consolidate tops of walls (As condition appraisal)
6.0 Former Copperworks boundary wall.	Risk of falling masonry.	Reconstruct unstable sections of wall, repair locally and rake out and repoint generally. (As condition appraisal)
7.0 Chimney west of Vivian Engine House	Assessed to be in fair condition.	No action advised in relation to safety issues.
8.0 Vivian Engine House	Unprotected drops, pits etc. inside engine house. P28	Secure building to prevent entry.
	Risk of falling structure internally (roof boarding)	Remove loose boarding. Secure building to prevent entry.
	Main west door entry. Insecure arch stones. Risk of falling masonry.	Brick up entry to support arch. (As condition appraisal)
9.0 Musgrave Engine House	Unprotected drops to interior. P29	Secure building to prevent entry.

SITE STRUCTURES APPRAISAL	Perceived risk	Mitigating Action
10.0 Museum Stores	Assessed to be in fair condition.	No action advised in relation to safety issues.
11.0 Vivian Locomotive Shed	Unauthorised entry Risk of falling structure internally. P33, P34, P35. Risk of falling masonry internally and externally. P36, P37, P38. Unprotected drops – pits. P30, P32. Building debris – trip hazards. Hazardous materials – asbestos sheeting. P39, P40.	Erect enclosing perimeter fence to prevent unauthorised entry to building.

HEALTH & SAFETY WORKS

Recommendations for mitigating actions: materials and workmanship.

SITE AREAS

Unprotected drops:

- Secure barriers to be wooden post and wire fences in accordance with BS1722 Part 2.

SITE STRUCTURES

Securing of buildings to prevent entry:

- All openings in the external walls of building structures to be bricked up with a single leaf of brickwork, except for one ground floor door opening for access.
- The brickwork is to be tied to the surrounding reveals using stainless steel ties at 450mm vertical centres, twice plugged and screwed in place.
- Steel access doors to be formed of 3mm thick mild steel plate in a 50 x 50 x 4mm thick angle frame, fixed to a doorframe out of 50 x 50 x 4mm thick steel angle.
- Doorframe to be fixed in place using 8mm diameter resin bolts at 600mm centres.
- Doors to be fitted with hasp and staple and padlock.

SITE CONTAMINATION APPRAISAL

Preamble

1. The scope of the investigation for this report was limited to taking surface soil test samples to obtain a view as to the safety of the site in its present condition. Only twelve test samples were taken, largely at random, from a very large site and whilst one had a bright colour indicating some unusual composition most had no particular distinguishing features apart from a significant amount of ash and clinker type particles.

2. The samples taken from the site were tested by Geolabs Limited following the suite of tests recommended in Table 3, Groups A &B and Table 4 of the Interdepartmental Committee for the Redevelopment of Contaminated land (ICRCL) Report 59/83 'The assessment and redevelopment of contaminated land'.

3. Some exceptionally high concentrations of arsenic and copper were recorded but not in samples in which the contamination was obvious.

4. The levels of arsenic in particular could cause serious harm to children who picked up and put in their mouths any of the most highly contaminated soil. It is important therefore that the public be excluded from the site until more detailed investigation has been carried out and permanent control measures undertaken.

5. Further investigations would involve a grid of samples taken across the site at various depths, this would though prove to be costly if the whole site was covered. As any remedial measures found necessary will depend on the future use of the site, it is recommended that a strategy is devised by the City & County of Swansea in consultation with the Environment Agency for investigation, control and treatment measures phased in accordance with the planned development of the site.

SITE CONTAMINATION APPRAISAL

Nature of Contamination	Results of Testing and Recommendations for Controlling Pollution
• Poisonous heavy metals, particularly arsenic, lead and cadmium together with other contaminants such as cyanides and sulphates associated with copper smelting and slag residues.	1. Although there were few signs of obvious surface contamination but the test results showed most of the samples to be highly contaminated even when they had no special distinguishing features. Arsenic levels in particular we found to be exceptionally high at concentrations of nearly 8000mg/kg in one case (S8). 2. All soil on site, whether or not discoloured, should be treated as suspect and both physical contact and exposure to dust, etc. should be avoided. 3. Pockets of higher contamination may exist, particularly at depth. 4. Short term contact with the most contaminated soil may be harmful, particularly to small children, and any risk of ingestion should be prevented by suitable protective equipment and careful personal hygiene. 5. Avoid disturbance of all existing soil as far as possible. 6. Watch out for any discolouration or odour and take samples for testing when carrying out any intrusive work such as excavation for post holes. 7. Take steps to control any dust or surface run-off arising form the site.
• Acidity mainly associated with sulphates and similar compounds	1. Acidity does not appear to be a problem as all but one of the samples (S10) were either neutral or slightly alkaline. 2. Weather will have tended leached acids, sulphates and other soluble chemicals from surface material. 3. Any more acid material found may be dealt with by following the control measures employed for heavy metals.

SITE CONTAMINATION APPRAISAL

Nature of Contamination	Results of Testing and Recommendations for Controlling Pollution
• Phytotoxic metals compounds including copper, zinc and nickel associated with copper smelting and slag residues.	1. High levels of contamination were found with up to 20% copper in one sample (S5). 2. Lack of vegetation in the former ore stockyard (Area 3) is symptomatic of high concentrations of these metals but the highest values of contaminants were recorded elsewhere on site. 3. Vigorous plant growth over many areas of site other than Area 3 suggests the establishment of tolerant plant species. 4. Although not harmful to humans these contaminants cannot be separated from the poisonous compounds and therefore the same control measures need to be employed in all cases.
• Petrochemical and organic compounds	1. No obvious signs seen on surface around the site. 2. Specific testing other than polyaromatic hydrocarbons (PAH) and phenols has not been included on samples taken. 3. Only one sample had PAH exceeding the trigger concentration for domestic gardens.
• Contamination of groundwater by leachates from soil	1. There is little working drainage on the site and the vast majority of surface water will soak away into the ground. Mobile contaminants will tend to move down until they meet less permeable soil and travel laterally carried by groundwater. No groundwater water was seen in pits and even the lower part of the site is well above the river and there was no obvious discharge but the situation may change in wet weather.

SITE CONTAMINATION APPRAISAL

Nature of Contamination	Results of Testing and Recommendations for Controlling Pollution
• Silt and debris lying in drains	1. Virtually all of the old drains around the site are filled with silt or debris and often have collapsed 2. Silt in drains and manholes is likely to contain high concentrations of contaminants washed from the soils and should be handled taking appropriate precautions.
• Industrial and domestic waste from fly tipping	1. Not seen as a serious problem at present, due to difficulty of accessing site in vehicles, but may worsen as site is opened up. 2. Secure the site perimeter and follow other recommendations in the Site Security Appraisal. 3. Maintain a clearance programme to reduce the appearance of dereliction. This will discourage further tipping.
• Risk of hypodermic needles, etc contained in refuse or buried around the site.	1. Discourage all illicit use of site by security measures. 2. Make disposal boxes and collection facilities available to security patrols.

Contaminants			Sample Reference												ICRCL Trigger Concentration		CLEA - Soil Guidance Values (SGV)	
			1	2	3	4	5	6	7	8	9	10	11	12				
ICRCL 59/83 Group A Contaminants															Gardens	Open space	Residential	Comm/Ind
Total Arsenic	(As)	mg/kg	189	590	539	850	114	1260	2524	7684	531	700	195	182	10	40	20	500
Total Cadmium	(Cd)	mg/kg	4.0	21	17	22	17	16	27	76	12	18	5.3	8.0	3	15	1-30*	1400
Total Chromium	(Cr)	mg/kg	27	21	36	11	8	26	28	19	14	13	15	31	600	1000	130/200*	5000
Hexavalent Chromium	(Cr^{VI})	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	25	100		
Total Lead	(Pb)	mg/kg	221	2648	4012	1026	576	791	586	2194	861	809	487	897	500	2000	450	750
Total Mercury	(Hg)	mg/kg	<0.1	2.40	0.63	1.30	0.36	0.10	0.16	7.70	0.47	0.67	0.42	0.26	1	20	8/15*	480
Total Selenium	(Se)	mg/kg	<3	3	4	<3	<3	<3	<3	17	<3	<3	<3	<3	3	6	35/260*	8000
ICRCL 59/83 Group B Contaminants																	* without plant uptake	
Water Soluble Boron	(B)	mg/kg	0.2	0.2	0.2	0.1	0.3	0.1	0.1	0.3	0.3	0.2	0.4	0.2	3			
Total Copper	(Cu)	mg/kg	2853	14321	18515	3410	197001	2516	5329	5850	5751	8597	1954	12564	130			
Total Nickel	(Ni)	mg/kg	76	121	159	72	164	196	93	92	81	84	61	74	70		**ICRCL Action Threshold**	
Total Zinc	(Zn)	mg/kg	1052	4119	4251	4158	608	849	321	766	2861	3411	1714	1790	300			
ICRCL 59/83 Table 4 Contaminants																	Gardens	Open space
PAH Screening by Fluorimetry		mg/kg	<10	40	32	<10	<10	<10	<10	<10	13	76	47	11	50	1000	500	10000
Monohydric Phenols		mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	5	5	200	1000
Total Cyanide		mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1				
Free Cyanide		mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	25	100	500	500
Thiocyanide		mg/kg	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	50	-	-	-
Sulphide	(SD)	mg/kg	2.9	0.7	1.1	1.7	0.5	1.4	<0.5	1.4	<0.5	0.7	<0.5	1.1	250	250	1000	1000
Total Sulphur		mg/kg	0.43	0.35	0.32	0.33	0.25	1.88	0.46	1.91	0.62	0.36	0.31	0.18	5000	5000	20000	20000
Total Sulphate	(SO_4)	%	0.16	0.20	0.19	0.21	0.24	3.88	0.91	3.1	0.12	0.14	0.07	0.10	0.20	0.20	1.0	5.0
pH		Units	7.0	7.5	8.0	8.3	8.2	7.7	7.0	7.9	7.2	5.3	10.5	8.5	5.0	-	3.0	-

Above CLEA-SGV for Commercial/Industrial use / Copper concentration greater than 10,000 mg/kg.

Above ICRCL Trigger Level for Open Space or Action Level for Gardens.

Above ICRCL Trigger Levels for Gardens.

TABLE 1 – CONTAMINATION TEST RESULTS

HEALTH & SAFETY: PHOTOGRAPHS

P1 to P29: For locations refer to drawing CS6956 / HS2

P1:	Unprotected drop at structure 10.
P2:	Protruding column at structure 10.
P3:	Uneven ground adjacent structure 10.
P4:	Raised kerb at structure 10.
P5:	Fence adjacent to structure 10 (north end).
P6:	Stored material adjacent structure 10.
P7:	Unprotected drop to west of structure 1.
P8:	Unprotected drop to south of structure 2.
P9:	Unprotected drop (pit) to south of structure 2.
P10:	Area 3, view south.
P11:	Uncovered culvert chamber.
P12:	Felled trees, Area 4.
P13:	Unprotected drop west of structure 8.
P14:	Unprotected drop west of structure 9.
P15:	Unprotected drop to River Tawe.
P16:	Entrance to air raid shelter.
P17:	Area 5, view south.
P18:	Fence to south of structure 9.
P19:	Rear of structure 4 (access to unprotected drop).
P20:	Wall to south of former pier, unstable masonry
P21:	Former Copperworks boundary wall. Risk of falling masonry.
P22:	Laboratory Building.Risk of falling structure. Risk of dropping through insecure structure.
P23:	Flat roofed building adjacent to Laboratory building. Unauthorised entry and building debris – trip hazard.
P24:	Former pier. Risk of falling masonry.
P25:	Copper slag abutment and adjacent walls. Unprotected drop from the wall, risk of falling masonry.
P26:	Lime Kiln. Risk of falling masonry.
P27:	Former Canteen Building. Risk of falling structure.
P28:	Vivian Engine House. Unprotected drops, risk of falling structure.
P29:	Musgrave Engine House. Unprotected drops.

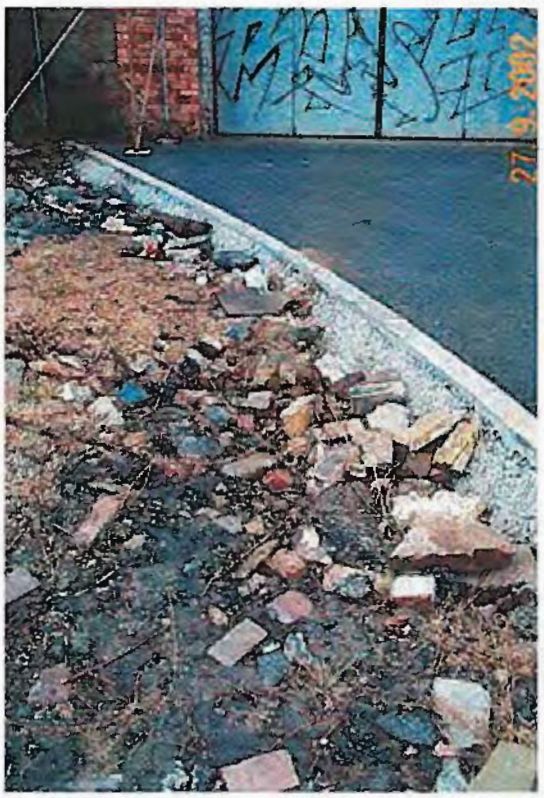
P30 to P42: For locations refer to drawing CS6956 / HS3

P30:	Unprotected drop to rear of Locomotive Shed.
P31:	Unprotected edge to River Tawe.
P32:	Unprotected drop to pit in Locomotive Shed.
P33:	Dilapidated condition of roof structure to Locomotive Shed.
P34:	Dilapidated condition of roof structure to Locomotive Shed.
P35:	Dilapidated condition of roof structure to Locomotive Shed.
P36:	Poor condition of brickwork to Locomotive Shed.
P37:	Poor condition of brickwork to Locomotive Shed.
P38:	Poor condition of brickwork to Locomotive Shed.
P39:	Broken asbestos sheets lying Locomotive Shed.
P40:	Broken asbestos sheets lying Locomotive Shed.
P41:	Close proximity of footpath to Locomotive Shed.
P42:	Steeply sloping bank and unprotected drop to rear of Locomotive Shed.

P1: Unprotected drop at structure 10.

P2: Protruding column at structure 10.

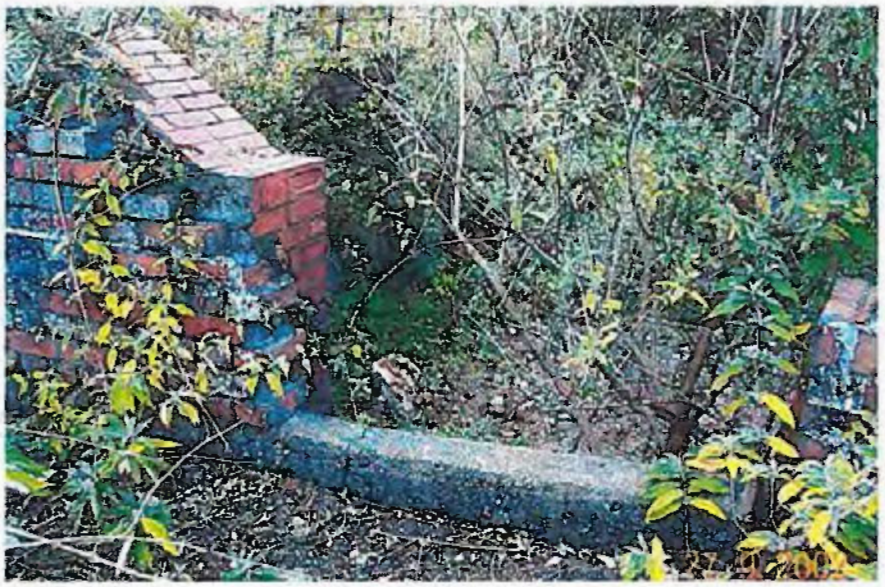
P3: Uneven ground adjacent structure 10.



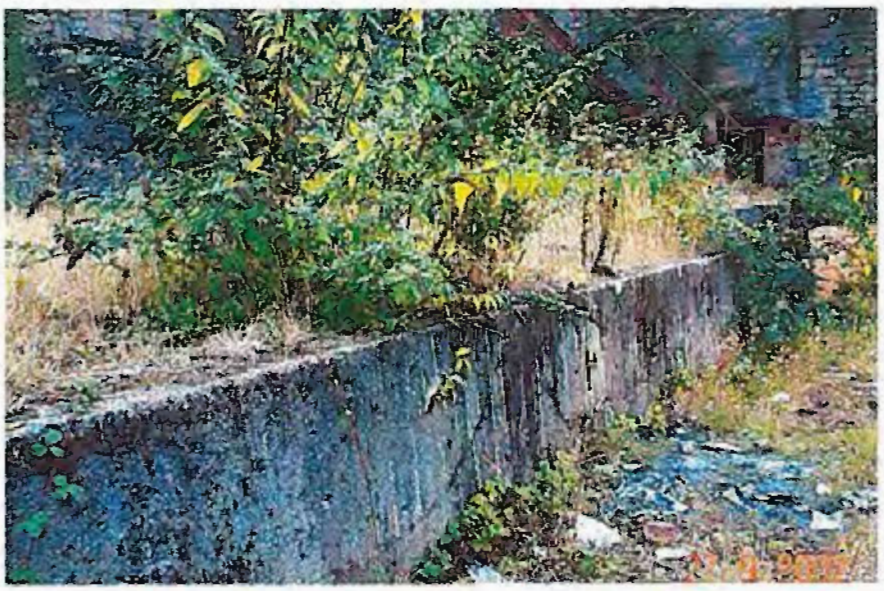
P4: Raised kerb at structure 10.

P5: Fence adjacent to structure 10 (north end).

P6: Stored material adjacent structure 10.



P7: Unprotected drop to west of structure 1.



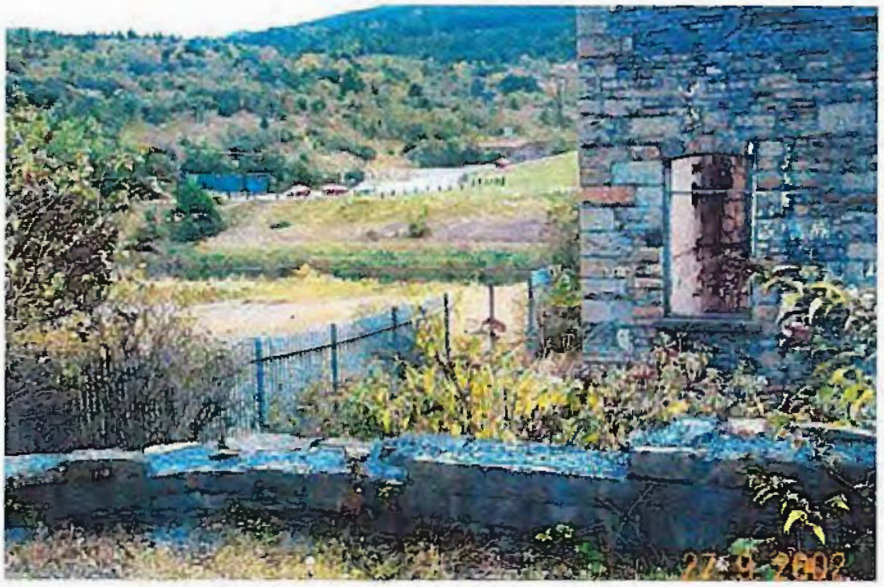
P8: Unprotected drop to south of structure 2.

P9: Unprotected drop (pit) to south of structure 2.

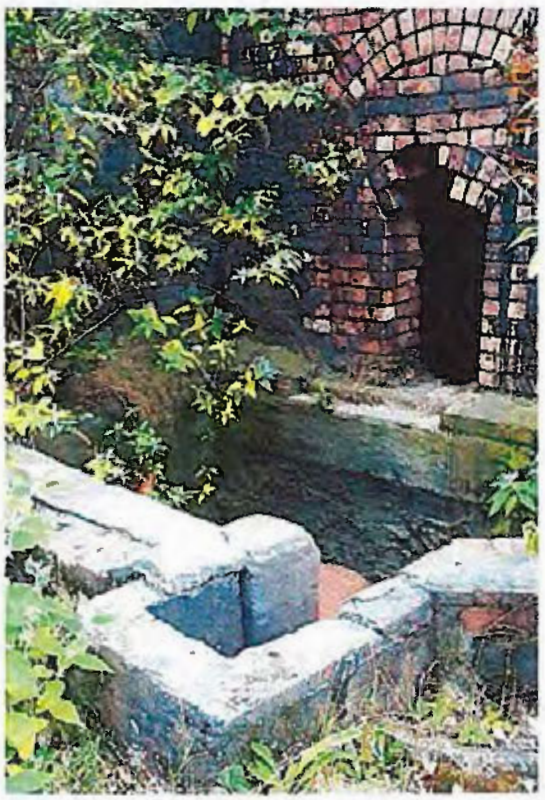
P10: Area 3, view south.

P11: Uncovered culvert chamber.

P12: Felled trees, Area 4.

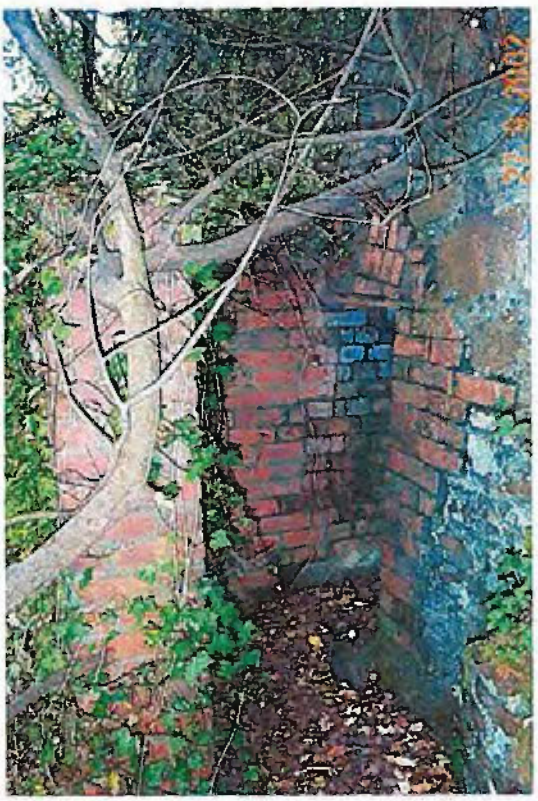


P13: Unprotected drop west of structure 8.



P14: Unprotected drop west of structure 9.

P15: Unprotected drop to River Tawe.

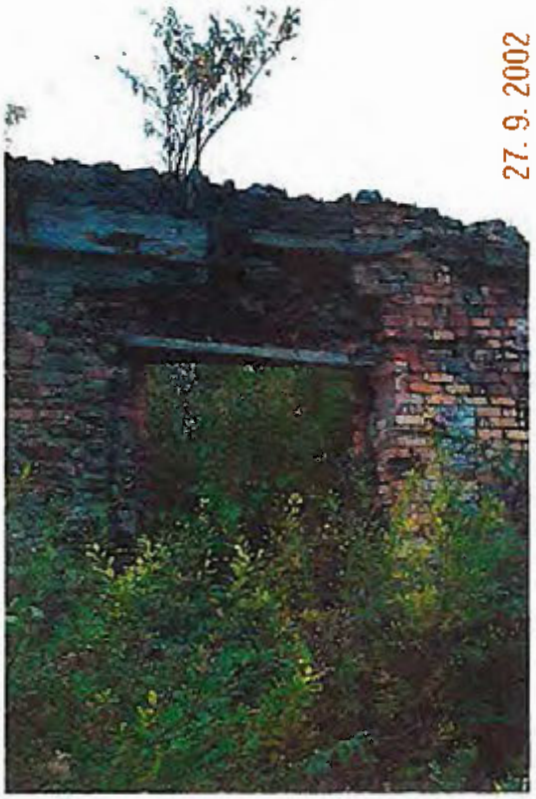


P16: Entrance to Air Raid Shelter.

P17: Area 5, view south.

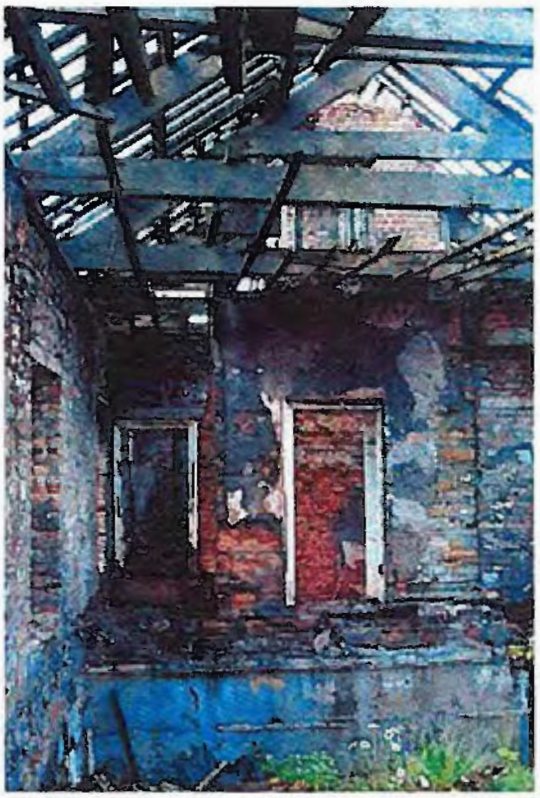
P18: Fence south of structure 9.

P19: Rear of structure 4 (access to unprotected drop).



P20: Wall to south of former pier, unstable masonry.

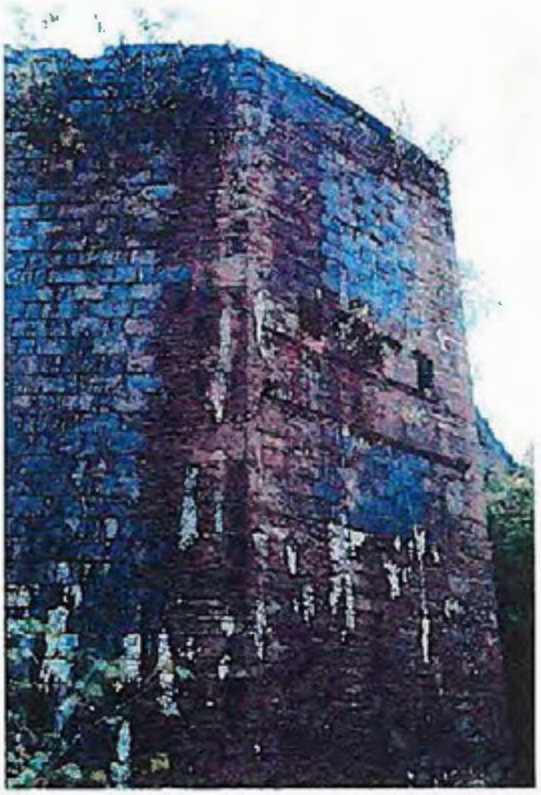
P21: Former Copperworks boundary wall. Risk of falling masonry.



P22: Laboratory Building. Risk of falling structure. Risk of dropping through insecure structure.

P23: Flat roofed building adjacent to Laboratory building. Unauthorised entry and building debris – trip hazard.

P24: Former pier. Risk of falling masonry.



P25: Copper slag abutment and adjacent walls. Unprotected drop from the wall, risk of falling masonry.

P26: Lime Kiln. Risk of falling masonry.

P27: Former Canteen Building. Risk of falling structure.

P28: Vivian Engine House. Unprotected drops, risk of falling structure.

P29: Musgrave Engine House. Unprotected drops.

P30: Unprotected drop to rear of Locomotive Shed

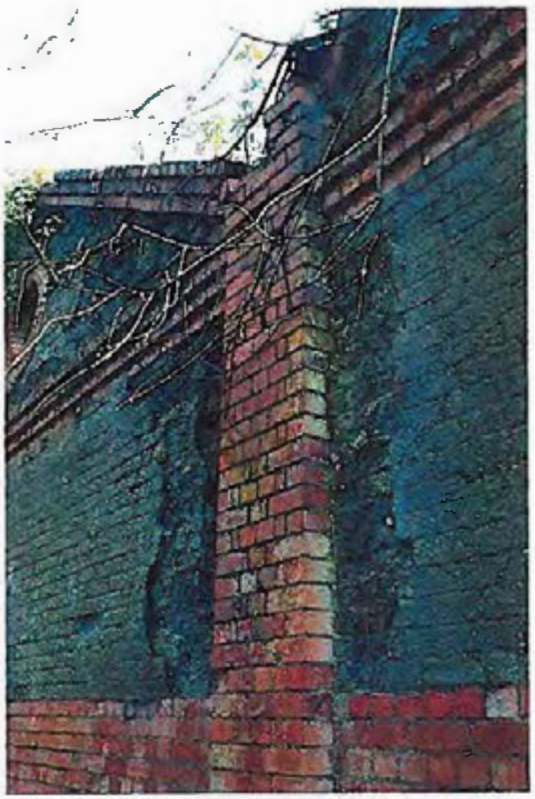
P31: Unprotected edge to River Tawe

P32: Unprotected drop to pit in Locomotive Shed

P33: Dilapidated condition of roof structure to Locomotive Shed

P34: Dilapidated condition of roof structure to Locomotive Shed

P35: Dilapidated condition of roof structure to Locomotive Shed



P36: Poor condition of brickwork to Locomotive Shed

P37: Poor condition of brickwork to Locomotive Shed

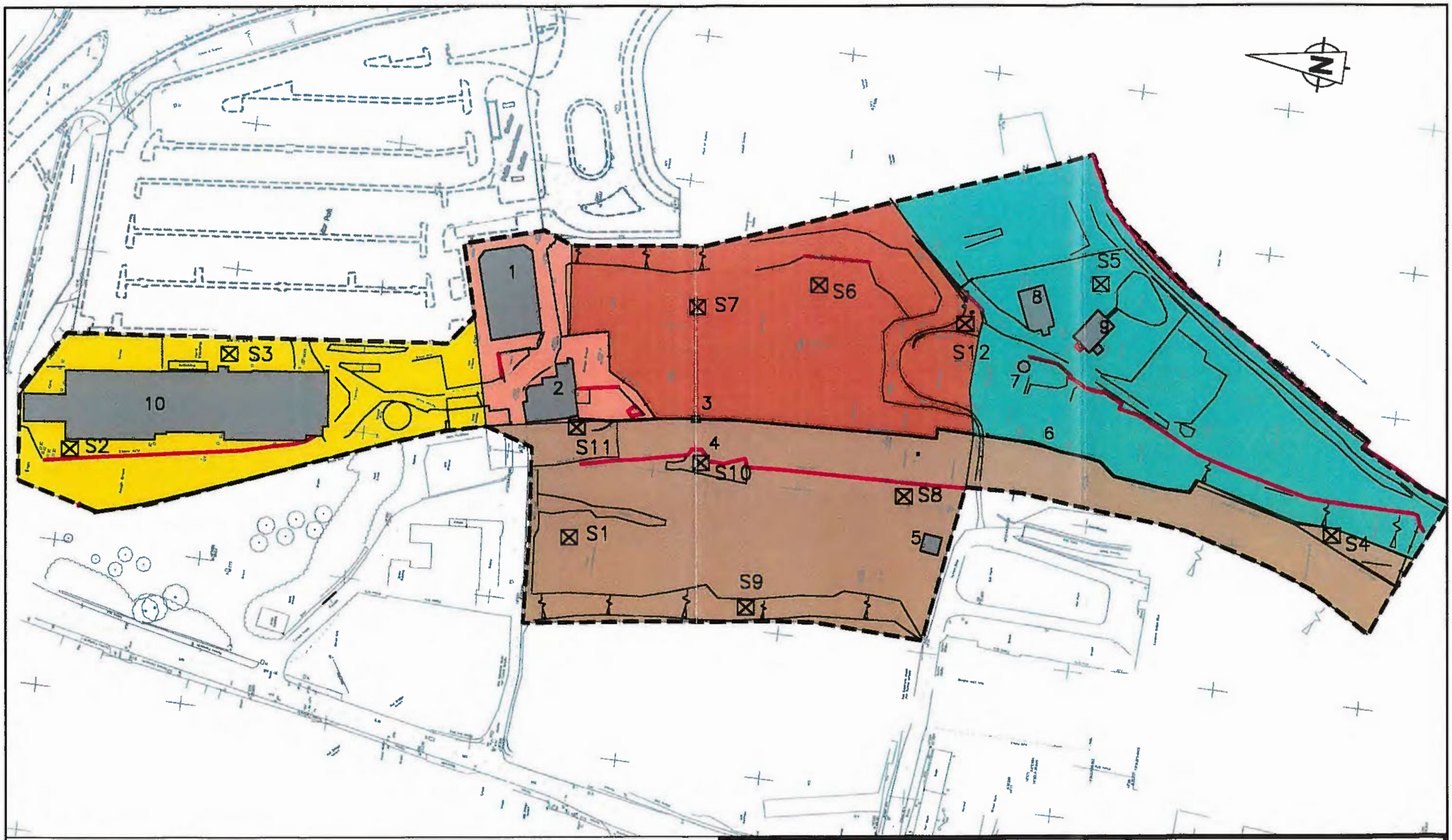
P38: Poor condition of brickwork to Locomotive Shed

P39: Broken asbestos sheets lying in Locomotive Shed

P40: Broken asbestos sheets lying in Locomotive Shed

P41: Close proximity of footpath to Locomotive Shed

P42: Steeply sloping bank and unprotected drop to rear of Locomotive Shed



KEY:

AREA 1
AREA 2
AREA 3
AREA 4
AREA 5

1. FORMER CANTEEN BUILDING
2. LABORATORY BUILDING
3. FORMER PIER
4. COPPER SLAG ABUTMENT
5. HAFOD LIME KILN
6. FORMER COPPER WORKS BOUNDARY WALL
7. CHIMNEY
8. VIVIAN ENGINE WORKS
9. MUSGRAVE ENGINE HOUSE AND CHIMNEY
10. MUSEUM STORES

UNPROTECTED DROP
SITE BOUNDARY
S1 SAMPLING POINT FOR CONTAMINATION TESTING

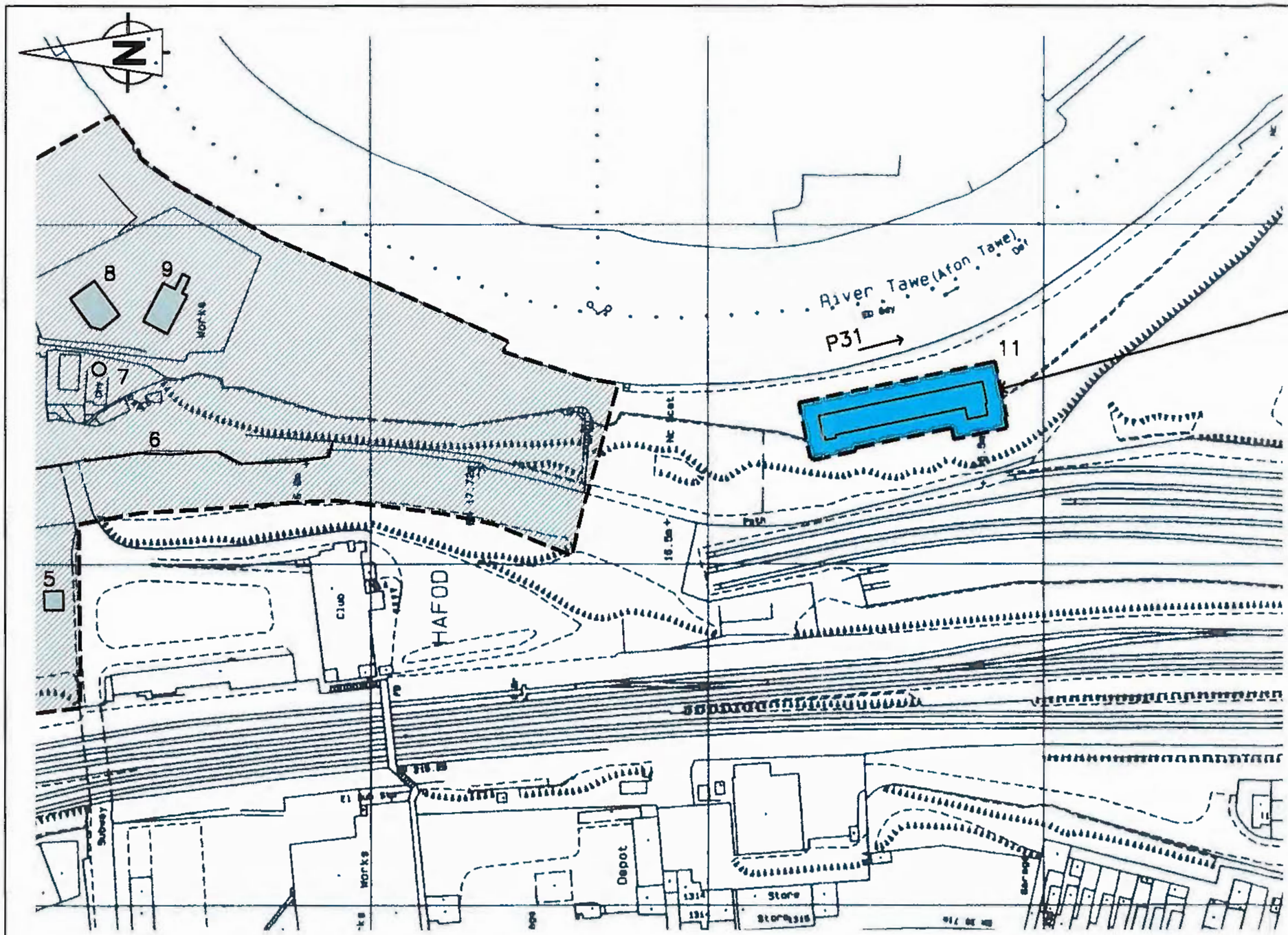
Project
SWANSEA: FORMER YORKSHIRE IMPERIAL METALS SITE

Title
HEALTH AND SAFETY APPRAISAL
SITE AREAS

Scale	Date	Drawn	Checked
1:1250 @ A3	Oct 02	GWF	DAD

VERYARDS Ltd
CONSULTING ENGINEERS
TEL. 029 2055 2444 FAX. 029 2055 4447

No CS6956 / HS1 Rev.



NOTE:

THIS DRAWING TO BE READ IN CONJUNCTION WITH DRAWINGS CS6956/HS1 AND HS2

KEY:

AREA 6

P10 → PHOTOGRAPH LOCATIONS

ACCESSED AREA FOR HEALTH AND SAFETY APPRAISAL i.e. LOCO SHED AND IMMEDIATE ENVIRONS

5. HAFOD LIME KILN
6. FORMER COPPER WORKS BOUNDARY WALL
7. CHIMNEY
8. VIVIAN ENGINE WORKS
9. MUSGRAVE ENGINE HOUSE AND CHIMNEY
11. VIVIAN LOCOMOTIVE SHED

Project: SWANSEA: FORMER YORKSHIRE IMPERIAL METALS SITE

Title: HEALTH AND SAFETY APPRAISAL SITE AREAS AND PHOTOGRAPH LOCATIONS

Scale	Date	Drawn	Checked
1:1250 @ A3	Apr '03	AS	MW

VERYARDS Ltd
CONSULTING ENGINEERS
TEL. 029 2055 2444 FAX. 029 2055 4447

No: CS6956 / HS3 Rev.

PHOTOGRAPHS Nos. P30, P32–42 INCLUSIVE

NOTE:

THIS DRAWING TO BE READ IN CONJUNCTION WITH DRAWINGS CS6956/HS1 AND HS2

KEY:

AREA 6

P10 → PHOTOGRAPH LOCATIONS

ACCESSED AREA FOR HEALTH AND SAFETY APPRAISAL i.e. LOCO SHED AND IMMEDIATE ENVIRONS

5. HAFOD LIME KILN
6. FORMER COPPER WORKS BOUNDARY WALL
7. CHIMNEY
8. VIVIAN ENGINE WORKS
9. MUSGRAVE ENGINE HOUSE AND CHIMNEY
11. VIVIAN LOCOMOTIVE SHED

Project: SWANSEA: FORMER YORKSHIRE IMPERIAL METALS SITE

Title: HEALTH AND SAFETY APPRAISAL SITE AREAS AND PHOTOGRAPH LOCATIONS

Scale	Date	Drawn	Checked
1:1250 @ A3	Apr '03	AS	MW

VERYARDS Ltd
CONSULTING ENGINEERS
TEL. 029 2055 2444 FAX. 029 2055 4447

No	Rev.
CS6956 / HS3	

SPECIALIST STUDY: UTILITY SERVICES

Appraisals and supporting information prepared by: Veryards Limited, Consulting Civil & Structural Engineers. Job reference CS6956.

UTILITY SERVICES APPRAISAL

UTILITY SERVICES APPRAISAL

Electricity

		COMMENTS
1	LIVE LV supply to Museum Stores Building (10)	From Neath Road Landore Substation (52/1813) northwards via Neath Road then by Normandy Road roundabout turning south through Park & Ride Car Park. Entering at middle of east side of building. Only live cable actually within site.
2	Twin HV cables crossing site south of Museum Stores Building (10) – Not Connected	From Neath Road Landore Substation (52/1813) eastwards via lane north of Cotelidge building. Only one cable present in duct crossing canal. Turns north through Park & Ride Car Park after leaving site to terminate in Normandy Road. Previously looping into Museum compound.
3	LV cable passing through site between Laboratory (2) and Canteen (1) buildings – Not Connected	Previously fed from Neath Road Landore Substation (52/1813). From disconnected end by Cotelidge building turning south after entering site and then turning eastward just outside fenceline.
4	LIVE Twin HV cables on south side of Normandy Road north of Museum Stores Building (Outside site)	From Neath Road Landore Substation (52/1813) northwards via Neath Road then by roundabout to Normandy Road industrial area. Nearest HV supply, route diverted from item 2.

UTILITY SERVICES APPRAISAL

Gas

		COMMENTS
1	LIVE 90mm PE supply to Museum Stores Building (10)	From 250 mm in Normandy Road south of roundabout. Branches off one of two mains in Neath Road. Enters building at north-west corner.
2	LIVE 32mm PE supply to west of Laboratory building (2)	From Neath Road opposite entrance to Landore Diesel Depot eastwards via bridge under railway. Terminating a short distance into site south-east of Cotelidge building. Inserted in old 3 inch CI main Likely to have been connected to old services inside the site.
3	LIVE 63mm PE to Hafod Canal Bridge	From Neath Road opposite John Weaver Construction eastwards via bridge under railway, terminating at west abutment of former Hafod canal bridge. Likely to have been connected to old services around Engine Houses. 63 mm branch southwards serving Landore Social Club.
4	250 mm PE main on south side of Normandy Road north of Museum Stores Building (Outside site)	From Neath Road roundabout to Normandy Road industrial area. Feeds 90 mm branch to Museum Stores Building (item 1).

UTILITY SERVICES APPRAISAL

		COMMENTS
Water		
1	Unknown supply to Museum Stores Building (10) (awaiting details)	Route to be determined
2	150 mm PE main on south side of Normandy Road north of Museum Stores Building (Outside site- awaiting details)	From Neath Road roundabout to Normandy Road industrial area. Feeds service to Museum Stores Building (item 1).
3	Unknown supply to Landore Social Club (Outside site - awaiting details)	Route to be determined
Telecommunications		
1	BT underground route passing through site west of Museum Stores (10) and Laboratory (2) buildings	Running south from ducts on south side of Normandy Road roundabout. Connection to Museum Stores Building at middle of west side.
2	BT underground route from Laboratory Building (2) to Park & Ride Offices	Continuation of item 1, turning east and running just outside fenceline south of Canteen Building (1) to Park & Ride offices.
3	BT underground route from south of Laboratory Building to Landore Social Club	Running southwards close to eastern boundary of site then turning west to pass through site of Hafod Canal Bridge
4	BT underground route from Neath Road to south of Museum Stores Building (10)	From Neath Road opposite Morfa Terrace eastwards via lane north of Cotelidge building to join item 1.
5	BT underground spur south-west of Museum Stores Building (10)	Short spur north of item 4. Runs west crossing canal from junction with items 1 and 4.

UTILITY SERVICES APPRAISAL

COMMENTS

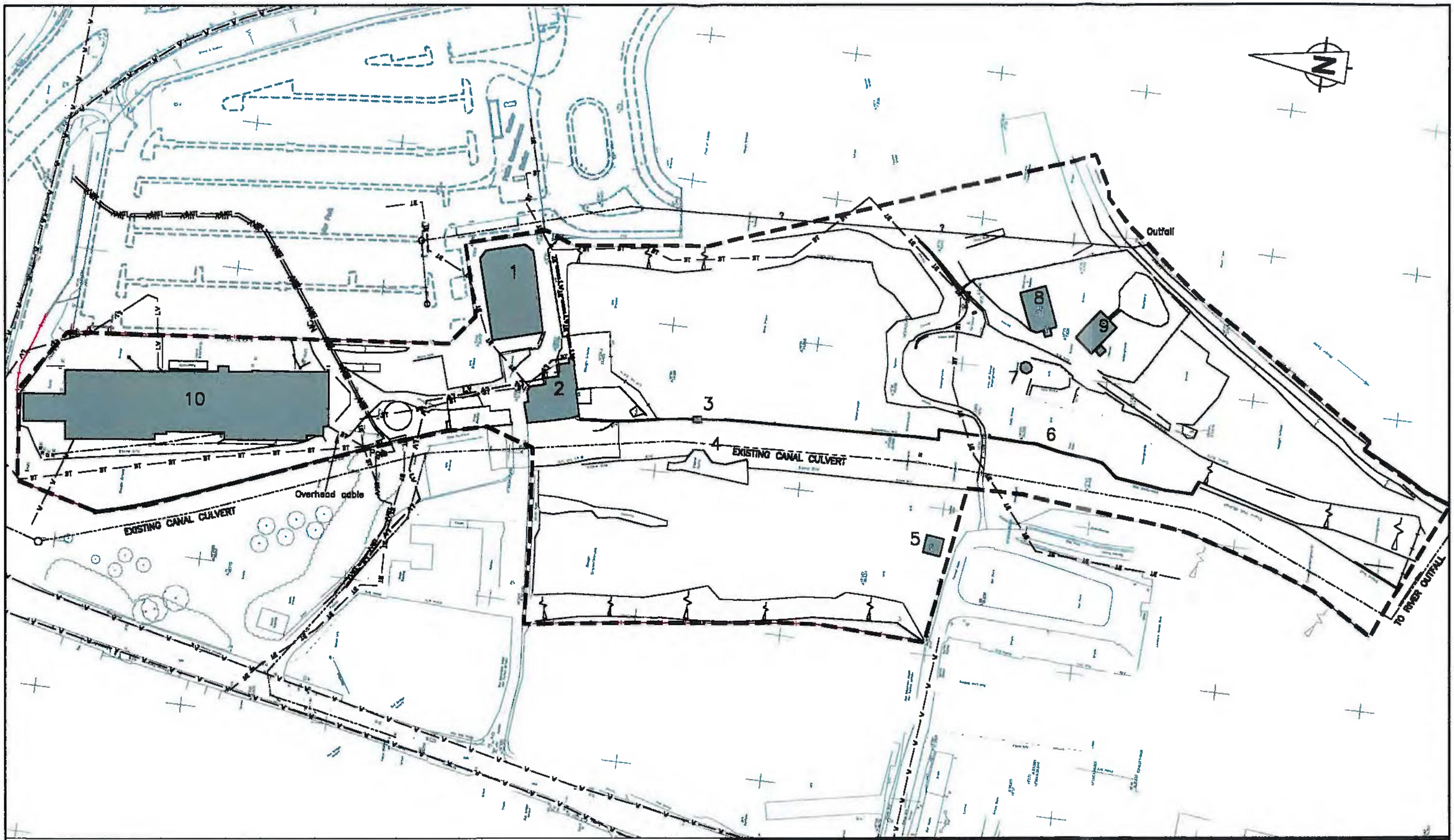
Foul, Combined or Process Drainage

1	Network of drains serving rear of Museum Stores Building (10)	On west side of building running north from south-west corner to septic tank and triple soakaways at near north-west corner. Two 100mm pipes connecting half way along into 150 mm dia. also taking surface water. Pumping station has been proposed via rising main to existing branch off sewer in Neath Road on south-west side of Normandy Road roundabout.
2	Drain from manhole(s) on east side of Museum Stores Building (10)	Catchpit with two 225 mm dia. pipes Outfall route and location unknown.
3	Network of old drains around Laboratory Building (2)	Manholes filled with rubble. Not able to investigate without out major clearing and possible decontamination exercise.
4	Network of old drains above retaining wall north of Engine Houses.	Manholes filled with rubble. Not able to investigate without out major clearing and possible decontamination exercise.

UTILITY SERVICES APPRAISAL

Surface Water Drainage and Culverts

		COMMENTS
1	Swansea Canal Culvert	Approx. 750 mm dia. following line of former canal. Not classed as public sewer but presumed to provide for riparian rights. Receives discharge from surface water sewer(s) which formerly had outfall(s) into canal.
2	Surface Water Sewer from Pentre Mawr Road and Neath Road to Swansea Canal	Run northwards up Neath Road before turning eastwards via lane north of Cotelidge building. Originally had open outfall into Swansea Canal. Connection to Swansea Canal Culvert assumed but not located .
3	Surface Water Drains at south-east corner of Museum Stores Building (10)	Catchpit with two 225 mm dia. pipes Disused as pipes collapsed. Outfall route and location unknown.
4	Surface Water Drain towards north end on east side of Museum Stores Building (10)	Running north-east from building to soakaway. Outfall route and location unknown.
5	Surface Water Drain in Park & Ride Car Park	Commences north of Canteen Building (1). Outfall route and location unknown (probably same as item 3). Extension has been proposed to collect surface water drainage from east side of Museum Stores Building (10) to replace items 3 and 4.
6	Culvert shown on plan in Museum Stores Building (10) passing to the north	Details awaited from Archaeologists.



KEY:

- SITE BOUNDARY
- WATER SUPPLY
- BT UNDERGROUND
- GAS (LOW PRESSURE)
- ELECTRICITY (11kV) UNDERGROUND
- ELECTRICITY (LV) UNDERGROUND
- EXISTING FOUL WATER DRAIN
- EXISTING SURFACE WATER DRAIN

1. FORMER CANTEEN BUILDING
2. LABORATORY BUILDING
3. FORMER PIER
4. COPPER SLAG ABUTMENT
5. HAFOD LIME KILN
6. FORMER COPPER WORKS BOUNDARY WALL
7. CHIMNEY
8. VIVIAN ENGINE WORKS
9. MUSGRAVE ENGINE HOUSE AND CHIMNEY
10. MUSEUM STORES

Project
SWANSEA: FORMER YORKSHIRE IMPERIAL METALS SITE

Title
EXISTING UTILITIES

Scale	Date	Drawn	Checked
1:1250 @ A3	Oct 02	GWF	DAD

VERYARDS Ltd
CONSULTING ENGINEERS
TEL. 029 2055 2444 FAX. 029 2055 4447

No CS6956 / U1 Rev.

SPECIALIST STUDY: BUDGET COSTS

Budget costs and supporting information prepared by: Parry and Dawkin, Chartered Surveyors, Swansea.

NOTES

Attention is drawn to the following qualifications in respect of the preparation of the budget costs.

- Inflation: no allowance has been made for inflation in respect of works to be carried out in either five years or in ten years time.
- Cost calculations are relevant to the year 2003
- Site security: the initial site investigation has shown a high level of contamination. Securing the site and addressing health & safety matters have therefore been scheduled respectively as the first and second elements of work.
- Site contamination: budget costs for whole site testing and remediation measures have been included to follow the initial repairs to the listed buildings. Remediation costs will be dependent upon the extent of contamination discovered.
- Contingencies: cost calculations include a contingency allowance of 10%.
- Professional fees: an allowance has been made for fees at 20%.
- VAT: has been calculated at 17.5%.
- Archaeology: provisional costs have been included for archaeological recording – if the recording is undertaken by one of the Archaeological Trusts that are also Registered Charities then VAT will not be chargeable on this element of the works.

BUDGET COSTS: MAIN SUMMARY

Site security	sheet 2	178,000.00
Health and safety matters	sheet 4	108,000.00
Initial repairs	sheet 5	317,500.00
Site contamination	sheet 9	430,000.00
Repairs within five years	sheet 10	835,500.00
Repairs within 10 years/long-term works	sheet 14	2,596,500.00
Works additional to brief: conservation of retaining walls about the site	sheet 18	123,000.00
Contingency allowance (10%)		458,850.00
		5,047,350.00
Professional fees and expenses		1,009,470.00
		6,056,820.00
Value Added Tax @ 17.5%		1,059,944.00
Archaeology – Provisional	sheet 21	26,000.00
Total budget cost		**£ 7,142,764.00**

BUDGET COSTS: SITE SECURITY

SITE AREAS

Remove all redundant site security fencing	Item	8,000.00
New 2.40 m high galvanised steel palisade fencing to the boundary of the site	Item	59,000.00
Reduce vegetation to ground level over the whole of the site; treat with herbicide	Item	90,000.00
Improvement of artificial lighting around the perimeter of the site	Item	20,000.00

FLAT ROOFED BUILDING ADJACENT TO LABORATORY BUILDING

Secure building to prevent entry	Item	500.00

AIR RAID SHELTER BUILDING

Secure building to prevent entry	Item	500.00

Total to Main Summary **£ 178,000.00**

BUDGET COSTS : HEALTH & SAFETY MATTERS

SITE AREAS

Provide signage at site entrances advising the public of the dangers of encroaching/trespassing on the site	Item	5,000.00
Remove leaning/redundant fencing, north boundary	Item	500.00
New 2.40 m high galvanised steel palisade fencing to replace leaning/redundant fencing, north boundary.	Item	3,000.00
New 2.40 m high galvanised steel palisade fencing to perimeter of Vivian Locomotive Shed	Item	9,500.00
Provide secure barriers to unprotected drops:		
At rear of museum stores	Item	1,500.00
At retaining wall west of Canteen	Item	500.00
At retaining wall south of Laboratory	Item	500.00
At open pit south of Laboratory	Item	500.00
At rear of copper slag abutment	Item	2,500.00
At tops of retaining walls	Item	3,000.00
West of Vivian engine house	Item	500.00
West of Musgrave engine house	Item	1,000.00
Vivian Locomotive Shed	Item	1,000.00
Provide secure fences:		
To stored material adjacent to building 10	Item	2,500.00
Contaminated ground:		
Allow for dealing with isolated instances of contaminated ground encountered during site security work	Item	10,000.00
Clear site of debris		
Area 1	Item	12,000.00
Area 3	Item	26,000.00
Area 4	Item	18,000.00
Carried forward	**£**	**97,500.00**

BUDGET COSTS: HEALTH & SAFETY MATTERS

	Brought forward	97,500.00
PIER AND ADJOINING CANAL WALL		
Demolition of wall to window cill level	Item	5,000.00
OPEN INSPECTION/MANHOLE PIT		
Provide permanent cover	Item	500.00
ADIT LOCATED IN AREA ONE		
Investigate and seal off adit	Item	5,000.00

Total to Main Summary **£ 108,000.00**

BUDGET COSTS: INITIAL REPAIRS

SUMMARY

1.0 Canteen Building	68,000.00
2.0 Laboratory Building	45,000.00
3.0 Pier and Adjoining Canal Wall	1,000.00
4.0 Copper Slab Abutments	6,000.00
5.0 Hafod Lime Kiln	21,000.00
6.0 Boundary Wall of the Canal Docks	6,000.00
7.0 Chimney West of the Vivian Engine House	500.00
8.0 Vivian Engine House	14,000.00
9.0 Musgrave Engine House	30,000.00
11.0 Vivian Locomotive Shed	126,000.00
Total to Main Summary	**£ 317,500.00**

BUDGET COSTS: INITIAL REPAIRS

1.0 CANTEEN BUILDING

Roof: record remaining timber elements, remove battens, rafters and fascias complete. Remove failed sections of purlins and install temporary scaffold tube ties to provide restraint to remaining elements	Item	15,000.00
Clock tower: record remaining elements. Remove loose timber louvres and frames	Item	3,000.00
Iron arch braces and columns: apply temporary primer to protect against continuing corrosion	Item	7,000.00
Walls: cut back vegetation, treat roots with herbicide, temporarily infill and make safe loose or dislodged areas of masonry, mortar cap exposed tops of walls	Item	29,000.00
Block up ground floor openings to prevent intrusion	Item	4,000.00
Fit protection from falling to stairs and east windows	Item	2,000.00
Floors: remove debris	Item	6,000.00
Exterior surrounds, clear debris, treat plant growth	Item	2,000.00

2.0 LABORATORY BUILDING

Roof: record and remove loose slates and fascia timbers	Item	12,000.00
External walls; generally cut back vegetation, treat roots with herbicide	Item	11,000.00
Erect temporary raking shores to north corner of east face to prevent further dislodgement of stonework	Item	4,000.00
Block up ground floor openings to prevent intrusion	Item	3,000.00
Exterior surrounds: treat plant growth around the base of the building with herbicide	Item	4,000.00
Erect temporary raking shores to retain the west elevation and prevent further movement	Item	8,000.00
Remove metal external access staircase	Item	3,000.00

Carried forward	**£**	**113,000.00**

BUDGET COSTS: INITIAL REPAIRS

	Brought forward	113,000.00
3.0 PIER AND ADJOINING CANAL WALL		
Vegetation: cut back undergrowth and tree saplings along base of the wall and pier. Treat with herbicide	Item	1,000.00
4.0 COPPER SLAG ABUTMENT		
Vegetation: remove from face of masonry. Treat with herbicide	Item	6,000.00
5.0 HAFOD LIME KILN		
Clear debris and treat plant growth around the base of the building with herbicide	Item	1,000.00
Consolidate and mortar cap tops of walls; rake out, repoint wall faces; clear debris from and consolidate remains of kiln oven	Item	20,000.00
6.0 BOUNDARY WALL OF THE CANAL DOCKS		
Record and take down unstable sections of masonry	Item	5,000.00
Vegetation: cut back undergrowth and tree saplings along base of the wall. Treat with herbicide	Item	1,000.00
7.0 CHIMNEY WEST OF THE VIVIAN ENGINE HOUSE		
Exterior surrounds: clear debris and treat plant growth around the base of the chimney with herbicide	Item	500.00
8.0 VIVIAN ENGINE HOUSE		
Roof: remove and record loose remnants of roof boards and other timbers; apply temporary primer to steel roof trusses to protect against continuing corrosion	Item	8,000.00
Block up ground floor openings to prevent intrusion	Item	4,000.00
Main west door: temporarily brick up to support arch	Item	500.00
Carried forward	**£**	**160,000.00**

BUDGET COSTS: INITIAL REPAIRS

	Brought forward	160,000.00
8.0 VIVIAN ENGINE HOUSE (continued)		
Remove remnants of possible asbestos based lagging from remaining section of machinery pipework	Item	1,000.00
Exterior surrounds: clear debris and treat plant growth around the base of the building with herbicide	Item	500.00
9.0 MUSGRAVE ENGINE HOUSE		
Roof: remove and record remnants of slates, tiles and battens; replace defective rafters; counter batten and fix temporary roof covering of profiled metal sheets to protect building interior and steam engine machinery from further deterioration	Item	15,000.00
Remove vegetation from tops and faces of walls and treat with herbicide	Item	8,500.00
Secure upper window openings with profiled metal sheets. Block up ground floor window openings and secure door openings to prevent intrusion	Item	6,000.00
Exterior surrounds: clear debris and treat plant growth around the base of the building with herbicide	Item	500.00
11.0 VIVIAN LOCOMOTIVE SHED		
Roof: record remaining elements, remove all asbestos sheeting and those steel members in imminent danger of collapse.	Item	25,000.00
Walls: record and take down gable brickwork in imminent danger of collapse. Cut back plant growth on walls and treat roots with herbicide.	Item	27,000.00
Floors: remove debris	Item	15,000.00
Surrounds: clear debris, cut back and treat plant growth around building.	Item	6,000.00
Support and protection: erect scaffold frame to shore up the remaining structure and support a temporary over-roof of profiled metal sheets over the whole structure to protect from further deterioration	Item	45,000.00
Secure openings to prevent intrusion	Item	8,000.00
Total: Initial Repairs	**£**	**317,500.00**

BUDGET COSTS: SITE CONTAMINATION

Bore holes at 3 metre depth including sample testing – 50 Nr	80,000.00
Further tests, specific to the proposed use of the site	50,000.00
Remediation measures	300,000.00

Total to Main Summary	**£**	**430,000.00**

BUDGET COSTS: REPAIRS WITHIN 5 YEARS

SUMMARY

1.0 Canteen Building	250,000.00
2.0 Laboratory Building	203,000.00
3.0 Pier and Adjoining Canal Wall	55,000.00
4.0 Copper Slag Abutment	13,000.00
5.0 Hafod Lime Kiln	20,000.00
6.0 Boundary Wall of the Canal Docks	60,000.00
7.0 Chimney West of the Vivian Engine House	59,000.00
8.0 Vivian Engine House	67,000.00
9.0 Musgrave Engine House	93,500.00
11.0 Vivian Locomotive Shed	15,000.00
Total to Main Summary	**£ 835,500.00**

BUDGET COSTS: REPAIRS WITHIN 5 YEARS

1.0 CANTEEN BUILDING

Repair and make weather tight external envelope of building:

Reinstate roof structure and re-slate	Item	120,000.00
Reclad clock tower	Item	30,000.00
Reinstate rainwater goods and connect to temporary soakaways	Item	15,000.00
Repair and repoint external walls	Item	62,000.00
Temporary enclosure of upper window and other external openings	Item	3,000.00
Repair and apply protective coating to iron roof arch braces and columns	Item	20,000.00

2.0 LABORATORY BUILDING

Stabilise, repair and make weather tight external envelope of building and make safe interior:

Reinstate roof structure and re-slate	Item	50,000.00
Reinstate rainwater goods and connect to temporary soakaways	Item	8,000.00
Stabilise and generally repair and repoint external walls including installation of masonry anchors and restraint ties	Item	65,000.00
Locally rebuild west face where masonry has bowed	Item	40,000.00
Provide minipile support to east face to arrest subsidence movement	Item	15,000.00
Locally rebuild east face damaged by subsidence	Item	12,000.00
Remove debris from interior and reconstruct internal structural walls and chimney stacks	Item	10,000.00
Temporary enclosure of upper window and other external openings	Item	3,000.00

Carried forward	**£**	**453,000.00**

BUDGET COSTS: REPAIRS WITHIN 5 YEARS

	Brought forward	453,000.00
3.0 PIER AND ADJOINING CANAL WALL		
Pier: consolidate and cap masonry top; repair, rake out and repoint faces of pier	Item	5,000.00
Canal wall: repair locally and generally rake out and repoint; construct masonry piers on new bases to retain wall where out of plumb	Item	50,000.00
4.0 COPPER SLAG ABUTMENT		
Consolidate and cap masonry top; repair, rake out and repoint faces of abutment	Item	13,000.00
5.0 HAFOD LIME KILN		
Complete archaeological investigation and restoration of the kiln and its surrounds and improve access	Item	20,000.00
6.0 BOUNDARY WALL OF THE CANAL DOCKS		
Reconstruct unstable sections of wall, repair locally and rake out and repoint generally	Item	60,000.00
7.0 CHIMNEY WEST OF THE VIVIAN ENGINE HOUSE		
Undertake an archaeological investigation of the chimney surrounds and improve access	Item	3,000.00
Remove vegetation from face of stack	Item	5,000.00
Repair, rake out and repoint brickwork generally	Item	40,000.00
Inspect, repair/replace/redecorate iron bands	Item	5,000.00
Repair and secure opening to base of chimney	Item	2,000.00
Install lightning protection strap to chimney	Item	4,000.00
Carried forward	**£**	**660,000.00**

BUDGET COSTS: REPAIRS WITHIN 5 YEARS

	Brought forward	660,000.00
8.0 VIVIAN ENGINE HOUSE		
Repair and make weather tight external envelope of building:		
Reinstate roof structure and re-slate	Item	20,000.00
Repair and apply protective coating to steel trusses and beams	Item	2,000.00
Reinstate rainwater goods and connect to temporary soakaways	Item	6,000.00
Repair and repoint external walls	Item	30,000.00
Temporary enclosure of window and other external openings	Item	9,000.00
9.0 MUSGRAVE ENGINE HOUSE		
Repair and make weather tight external envelope of building:		
Re-slate roof	Item	9,000.00
Reinstate rainwater goods and connect to temporary soakaways	Item	6,000.00
Repair and repoint external walls	Item	21,000.00
Temporary enclosure of window and other external openings	Item	7,500.00
Repair and protect exposed flanges of steel beams beneath ground floor slab	Item	8,000.00
Chimney stack:		
Remove vegetation from face of stack	Item	4,000.00
Repair, rake out and repoint brickwork generally	Item	26,000.00
Inspect, repair/replace/redecorate iron bands	Item	6,000.00
Repair and secure opening to base of chimney	Item	2,000.00
Replace lightning protection strap to chimney	Item	4,000.00
11.00 VIVIAN LOCOMOTIVE SHED		
Prepare programme for restoration of structure:		
Undertake investigation of copper slag brickwork failure and methods of repair and arresting future deterioration	Item	5,000.00
Prepare proposals for inserting permanent structural frame to support the brickwork wall panels	Item	10,000.00
Total: Repairs within 5 years.	**£**	**835,500.00**

BUDGET COSTS: REPAIRS WITHIN 10 YEARS/LONG-TERM WORKS

SUMMARY

1.0 Canteen Building	316,000.00
2.0 Laboratory Building	300,000.00
8.0 Vivian Engine House	88,000.00
9.0 Musgrave Engine House	112,500.00
10.0 Museum Stores	1,500,000.00
11.0 Vivian Locomotive Shed	280,000.00

Total to Main summary	**£**	**2,596,500.00**

BUDGET COSTS: REPAIRS WITHIN 10 YEARS/LONG-TERM WORKS

1.0 CANTEEN BUILDING

Complete works to envelope, refurbish interior, renew services and make good surrounds:		
Reinstate external doors and windows	Item	25,000.00
Repair floor slabs and stairs	Item	35,000.00
Renew wall and ceiling finishes	Item	112,000.00
Reinstate internal doors	Item	4,000.00
Redecorate	Item	22,000.00
Provide new connections to main electrical, gas and telephone services	Item	15,000.00
Reconnect to main foul and surface water drainage	Item	5,000.00
Construct wall and floor lining to basement incorporating cavity drainage system and drain to sump collection point	Item	60,000.00
Install flood protection pump in basement	Item	10,000.00
Repair external steps to basement	Item	3,000.00
Regrade exterior ground levels and lay new paved surrounds to building	Item	25,000.00

2.0 LABORATORY BUILDING

Complete works to envelope, refurbish interior, renew services and make good surrounds:		
Repair dressed and carved stonework	Item	25,000.00
Renew external doors and windows	Item	25,000.00
Renew internal floors and partitions	Item	85,000.00
Renew internal doors and stairs	Item	15,000.00
Renew wall and ceiling finishes	Item	50,000.00
Redecorate	Item	15,000.00
Provide new connections to main electrical, gas and telephone services	Item	15,000.00

Carried forward	**£**	**546,000.00**

BUDGET COSTS: REPAIRS WITHIN 10 YEARS/LONG-TERM WORKS

	Brought forward	546,000.00
2.0 LABORATORY BUILDING (continued)		
Reconnect to main foul and surface water drainage	Item	5,000.00
Construct wall and floor lining to basement incorporating cavity drainage system and drain to sump collection point	Item	30,000.00
Install flood protection pump in basement	Item	10,000.00
Replace external fire escape stairs	Item	10,000.00
Regrade exterior ground levels and lay new paved surrounds to building	Item	15,000.00
8.0 VIVIAN ENGINE HOUSE		
Complete works to envelope, refurbish interior, renew services and make good surrounds:		
Reinstate external doors and windows	Item	12,000.00
Repair floor slabs and steps	Item	10,000.00
Renew wall and ceiling finishes	Item	29,000.00
Redecorate	Item	6,000.00
Provide new connections to main services	Item	15,000.00
Reconnect to foul and surface water drainage	Item	5,000.00
Repair external steps	Item	1,000.00
Regrade exterior ground levels and lay new paved surrounds to building	Item	10,000.00
9.0 MUSGRAVE ENGINE HOUSE		
Complete works to envelope, refurbish interior, renew services; provide facilities for upkeep and display of steam engine; make good surrounds to building:		
Reinstate external doors and windows	Item	10,000.00
Repair floor slabs and steps	Item	9,000.00
Renew wall and ceiling finishes	Item	27,500.00
Carried forward	**£**	**750,500.00**

BUDGETCOSTS: REPAIRS WITHIN 10 YEARS/LONG-TERM WORKS

	Brought forward	750,500.00
9.0 MUSGRAVE ENGINE HOUSE (continued)		
Redecorate	Item	6,000.00
Provide new connections to main services	Item	15,000.00
Install electrical power and lighting	Item	10,000.00
Install water services and sanitary facilities	Item	20,000.00
Reconnect to foul and surface water drainage	Item	5,000.00
Regrade exterior ground levels and lay new paved surrounds to building, repair external steps	Item	10,000.00
10.0 MUSEUM STORES		
Undertake restoration of building to original form. Replace cracked and deformed floor slab if necessary for further use. Replace later extensions with new separate structures	Item	1,500,000.00
11.0 VIVIAN LOCOMOTIVE SHED		
Undertake restoration of building to original form:		
Reinstate roof structure, cladding and rainwater goods	Item	100,000.00
Repair external walls and install new structural support frame	Item	105,000.00
Reinstate louvres to circular openings	Item	9,000.00
Reinstate engine shed doors and infill the low level openings on the west face	Item	18,000.00
Decorate steelwork, rainwater goods and joinery	Item	8,000.00
Provide new connections to mains services including foul drainage	Item	15,000.00
Lay new paved surrounds to the building	Item	25,000.00
Total: Repairs within 10 years/long-term works		**£ 2,596,500.00**

BUDGET COSTS: Work additional to the brief; conservation of retaining walls about the site

CANAL SIDE WALL BETWEEN HAFOD WORKS BRIDGE AND PIER ABUTMENT

Consolidate and mortar cap tops of walls, rake out, repoint wall faces, consolidate walls and rebuild return walls	Item	52,000.00

RETAINING WALLS AROUND THE HAFOD CHIMNEY STACKS

Consolidate and mortar cap tops of walls, rake out, repoint wall faces and consolidate walls	Item	46,000.00

RETAINING WALLS WEST AND SOUTH OF THE CANTEEN BUILDING

Consolidate and mortar cap tops of walls, rake out, repoint wall faces and consolidate walls	Item	25,000.00

Total to Main Summary	**£**	**123,000.00**

BUDGET COSTS: CAMBRIA ARCHAEOLOGY

HEALTH & SAFETY MATTERS:
Demolition of wall to sill level- recording of sections of walls that may be removed -

Archaeological recording - 1,000.00

INITIAL REPAIRS:

1.0 Canteen Building
Recording remaining elements of the clock tower -

Archaeological recording - 500.00

2.0 Laboratory Building

N/A

3.0 Pier and Canal Wall

N/A

4.0 Copper Slag Abutment

N/A

5.0 Hafod Lime Kiln
Clear debris, consolidate tops of walls, rake and repoint, clear debris from consolidated remains-

Archaeological recording - 1,000.00

6.0 Canal Boundary Wall
Record and take down unstable sections of masonry -

Archaeological recording - 1,000.00

7.0 Vivian Chimney

N/A

8.0 Vivan Engine house

N/A

9.0 Musgrave Engine House

N/A

10.0 Museum Stores

N/A

11.0 Vivian Locomotive Shed
Record and take down unstable sections of masonry -

Archaeological recording - 1,000.00

Sub-total

carried to sheet 21 - **£4,500.00**

BUDGET COSTS: CAMBRIA ARCHAEOLOGY

REPAIRS WITHIN 10 YEARS		
1.0 Canteen Building		
Regrade external ground levels	Archaeological recording -	1,000.00
2.0 Laboratory Building		
Regrade external ground levels	Archaeological recording -	1,000.00
3.0 Pier and Canal Wall		N/A
4.0 Copper Slag Abutment		N/A
5.0 Hafod Lime Kiln		N/A
6.0 Canal Boundary Wall		N/A
7.0 Vivian Chimney		N/A
8.0 Vivan Engine house		
Regrade external ground levels	Archaeological recording -	1,000.00
9.0 Musgrave Engine House		
Repair and repoint external walls	Archaeological recording -	1,000.00
10.0 Museum Stores		
Implement programme of restoration	Archaeological input -	5,000.00
11.0 Vivian Locomotive Shed		
Implement programme of restoration	Archaeological input -	500.00
Sub-total : Repairs within 10 years		**9,500.00**
Sub-total: Repiairs within 5 years	brought forward from sheet 20 -	**12,000.00**
Sub-total: Initial Repairs/Health & Safety	brought forward from sheet 19 -	**4,500.00**
Total to Main Summary	**£**	**26,000.00**

Notes in respect of archaeological costs:

- The four Welsh Archaeological Trusts are all Registered Charities and if they are employed to undertake the archaeological works VAT will not be chargeable. Other archaeological contractors may charge for VAT.
- No costs for future site interpretation were requested in the study brief and accordingly have not been submitted.
- The possible drilling of circa 50 bore holes will not require an accompanying programme of archaeological work.
- No provision has been made for archaeological costs arising from further intrusive work associated with any future site decontamination. At present the scope of any such work cannot be properly anticipated.
- Similarly no provision has been made for 5- and 10-year requirements for any other archaeological work within the areas between the the listed buildings. Such figures would have to be produced from any specification by a future structural engineer.