Herefordshire Archaeology
Conservation and Environmental Planning
Planning Services
Environment Directorate
Herefordshire Council

CONDITION ASSESMENT OF NEW WEIR IRON WORKS SYMONDS YAT WEST HEREFORDSHIRE SO 55838 15534

Herefordshire Archaeology Report No. 228

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With contributions by

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Herefordshire Archaeology is Herefordshire Council's county archaeology service. It advises upon the conservation of archaeological and historic landscapes, maintains the county Sites and Monument Record, and carries out conservation and investigative field projects. The County Archaeologist is Dr. Keith Ray.

New Weir Ironworks
Symonds Yat West
Herefordshire
Herefordshire Archaeology Report No. 228

Herefordshire Archaeology, March 2007.

Summary:

This project was undertaken by Herefordshire Archaeology on behalf of the Wye Valley ANOB/Forest Enterprise. The project consists of an archaeological field Survey at RCHME Level 3 of the New Weir Ironworks, Symonds Yat West, in order to interpret the remains and form the basis of their future management. This involved assessing current condition, making basic management recommendations and identifying parts of the site that require input from a conservation architect.

Structures recorded within the wood show a steady progression from a medieval field system, to early Post-medieval woodland, and lastly as a major industrial site in the Victorian period.

During the early post-Medieval period Nupend Wood formed part of the larger Fownhope Park Wood and evidence of woodland management for this period is scarce. The later industrial phase however can been seen in an abundance of features. The most obvious are the large quarries, but charcoal burning platforms and lime production is also noted. The latter is of some importance in that lime was not being produced in a kiln but on platforms similar to those used for charcoal burning. It is also of note that the complete lime production process is evident in the archaeological record, namely quarries providing the raw material, charcoal burning platforms for the heat source and the lime manufacturing site itself.

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Contents

1.Background

An archaeological survey of the New Weir iron works, Symonds Yat West was required to provide an understanding of the significance of the remains and form a basis for future management. This project will assess the current condition, make basic management recommendations and identify parts of the site that require input from a conservation architect.

1.1 Location

The survey area is located at NGR SO 5590 1560 in the parish of Ganarew. It is approximately 5km northeast of Monmouth and is situated in Lords Wood on the banks of the River Wye.

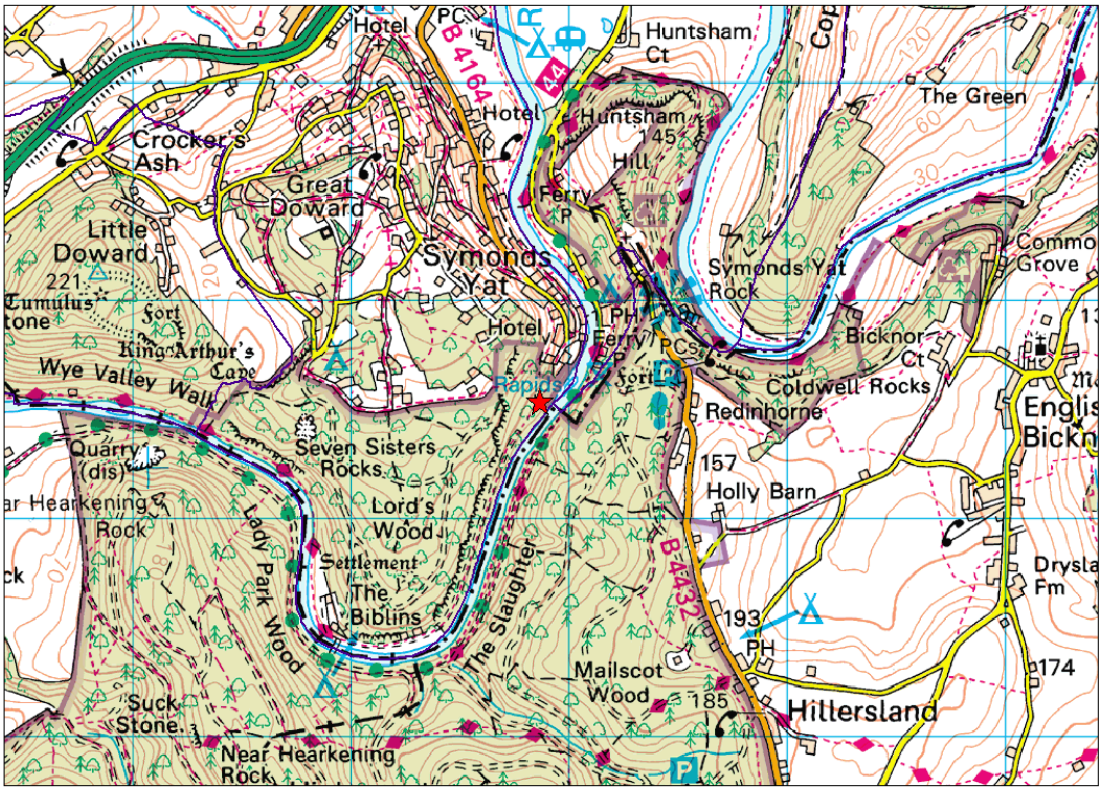

Figure 1: Site location **© OS Crown Copyright (OS Licence 100024168)**

The Historic Landscape Character for Herefordshire describes the survey area as W (B1 & W3); this is defined as extensive woodland overlying a landscape dominated by sinuous enclosure boundaries.

Geologically the survey area lies at the junction of numerous geological layers. The site is characterised by the carboniferous limestone series of the upper old red sandstone. The lower slopes consist of the lower dolomite series and above this is a significant limestone band. The base of the site is marked by the edge of the River Wye so consists of alluvial deposits (British Geological Survey 1989). The soils of this area are the Crwbin series, part of the Rankers group and consists of fine silt over carboniferous limestone.

Plate 1: View from Symonds Yat Rock

Plate 2: View from up stream

1.2 Aims and objectives

To provide an overall site plan at 1:1250 scale and a more detailed plan of the sore of the site at a scale of 1:500, showing the location and extent of archaeological features in the survey area. The plan will be used to provide an interpretation of the site and indicate current condition and management issues,

2.METHODOLOGY

2.1 Documentary search – John Van Laun

NEW WEIR FORGE (SMR 1589 SO 5590 1560)

Geology and landform

After its hairpin sweep around the limestone outcrop at Symonds Yat Rock, the River Wye settles into a straight course for about 3km. About halfway along this it enters the harder limestone, cutting through it to form a gorge. Where it starts its course through the gorge the harder rocks it met formed the rapids at Symonds Yat. This was therefore an ideal spot to harness the forces (or head) of water to power waterwheels needed for the New Weir Forge.

Another advantage to the use of waterpower was the deeper water which accumulated behind the rapids from where they could be led off into a leat. The site chosen for the forge had the advantage that only a moderate length of tailrace was needed to bring the return water to a lower level. Thus, even in times of flood, the problem of a backup of water stopping the wheels from turning was avoided.

Set in the river is an island which does not appear to be geological but the detritus left in the eddy caused by the weir. After the weir was dismantled around 1814, its debris was swept downriver to accumulate around the shallows formed here creating the island. Another casualty was the leat which, once the forge closed and the flow which drove the waterwheels ceased, soon silted up.

Outline history of the Whitchurch Ironworks

There were two ironmaking sites within the parish of Whitchurch and, although the locations of both are known, their histories have become confused. The older lay at 'Old Forge' (Old Weir) where there was a forge by 1513 and a furnace by 1575. [1] The forge and weir which served it was vandalised in 1589 and probably moved as a result to New Weir the following year. The furnace appears to have been salvaged and was rebuilt in 1632 and again in 1657 and maybe have been in existence in 1707 working with the Lower Forge at Tintern and New Weir but was certainly defunct in 1717. There is no documentary evidence known which suggests there was a furnace at New Weir. New Weir was leased to George White by the Earl of Kent in 1684 and continued through to his son until 1753 when it was leased to John Partridge. The works were up for sale in 1811 and 1813 but appear to have faded out of use at the turn of the century partly through the widespread use of puddling, in which malleable iron was produced by using coal rather than charcoal, and partly the demise of the wireworks at Tintern.

[1] Riden 1993, 53

New Weir forge

'New Weir' was so named as the alternative site to Old Weir two miles upstream where the confluence of the Garron Brook and River Wye lay ('Old Forge'). Although we cannot be certain, it appears likely that following the destruction of the weir and forge 'tumultuously' at Old Weir in 1589 it was decided to move to a new site and the Old Weir was not rebuilt. Certainly Dennell states that in 1697 there were few signs of the old weir remaining which surely suggests that there was by now no ironworks for it to serve.[2]

A weir was known at New Weir before 1621.[3] But it seems likely that the forge was built afresh when leased by the Earl of Kent to George White in 1684 for 99 years. The evidence for this is pretty clear from an objection made for the dismantling of weirs when the second Wye Navigation Act[4] was being considered in 1695 - the 'earl of Kent's wear stands on the best iron mills or forges in England which lately being rebuilt on an old foundation, the same dwelling houses, etc cost about 3000*l*.'[5] The same source tells us that the forge had, at that time, two hammers and three chaferies or refineries. In order to keep his weir the Earl therefore conceded a number of proposals which passed into law and, as a result, he was the only landowner along the Wye allowed to keep his weir. It seems he was lucky, as Paul Foley MP for Hereford (which was a major supporter for navigation on the Wye) and Speaker of the House of Commons was gunning for the Earl of Kent. The reason is not hard to find: Foley had just embarked on his 'Ironworks in Partnership' and was out to discredit any rivals in the business.[6]

The 1695 Act then included most of the Earl's proposals: he was debarred from taking fish at the weir and must maintain a lock for navigational purposes and a salmon leap. In more detail he would be obligated to provide a house for the lock keeper and pay him £10 per annum and, to avoid the lock keeper being in the pocket of the Earl, he would be appointed by the Trustees. The salmon leap was to be placed next to the lock and be 10 yards in width and 12in lower than the lowest part of the existing weir. Its base was to be smooth and unobstructed. These works were to be completed by March 1696 but, if not, the Trustees would be at liberty to complete the job themselves. If the Earl wished to, he could dismantle the lock but must leave no impediment to obstruct navigation on the river[7]

Without further evidence we would not know if these obligations were carried out but soon after (1697) Daniel Dennell provides the evidence that it was done reasonably in

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[2] Stockinger 1996, 123 - 124 quoting Daniel Denell 'THE WEIRS, MILLS, BRIDGES, FORDS AND SHALLOWS, VIEWED AND EXAMINED IN REFERENCE TO PORATION AND FISHING UPON THE RIVERS WYE AND LUGG'

[3] Stockinger 1996, 467

[4] The first Act was in 1662 (14 Car Reg II). In this there is mention of 'footrayles'. These were likely to have been wooden railways, probably intended for portage to take cargoe around the weirs.

[5] A newspaper of the time gives a light variation "The Earl of Kent, upon an old Foundation has lately built his Forge, which is one of the best in England, having two hammers and three Chaferies or Fineries which can work in the driest time of summer. There were besides, a dwellign house for a tenant, stables, warehouse and outhouses and several dwelling-houses lately built for above 30 families, costing together about £4,000.

[6] Stockinger 1996, 51

[7] Stockinger 1996 102 - 104

accordance with the Act giving at the same time an account of the weir itself and its placement.[8] In this he states that the forge was 'lately-built' on the west side and that the east side lay in the occupation of [Benedict] Hall with whom the Earl was in dispute over ownership. The weir was built of loose stones with stakes and turfs behind with a hedge on top. Its length was 140 yards and between 6 and 9½ feet in height. The lock was at the east end (opposite the forge) and 13 feet wide but the sills were three feet above the bottom of the river. He felt that the forge took a lot of water but could take less and implies that this had caused the shallow he states as being 100 yards long and 170 yards wide below the weir but then deepened to 10 feet beyond the shallows.

This latter point is particularly interesting from the archaeological point of view and is worth a digression. It is these 'shallows' which were already forming in 1697 which appear to account for the island which now lies on the west bank of the river adjacent to the forge site. In 1763 there were also problems beneath the weir caused by where water from the lock met the salmon wear creating an eddy which made it difficult to haul boats through the flash lock. From this account it is clear that a capstan was used to bring the boats upstream.[9] A point confirming that the island was mostly formed by material carried downstream comes from a 1934 survey made when improvements to the River Wye were being considered. This revealed that the island appeared to be an accumulation of around 13000 cubic yards of quartz conglomerate (foreign to the bed) boulders, and boulder rubble intermingled with large shingle and gravel.[10] Of contemporary cartographic and illustrative material when the forge was working the only one showing an island can be seen in Samuel Ireland's .aquatint. Maps (1754 and 1834, although not of the best quality, do not show the island.

After 1684 the next we hear of New Weir forge is 1707 when it was being operated by George White with the Lower Forge at Tintern. This begs the question where the pig iron was coming from. It could have come from Tintern furnace, Bishopswood furnace or from one mentioned by Rees as lying at New Weir (Old Weir) 'for the running of iron ore and cinders'. However as he is constantly muddling the two sites of Old Weir with New Weir and shows New Weir on a map as lying at Old Weir[11] we cannot be sure. George White junior had leased the Tintern furnace in the Angiddy in 1706 so this seems the best option.[12] Nevertheless it is worth bearing in mind that Partnerships were constantly taking on and shedding furnaces to suit the demand for different types of pig iron for finished products – cast iron, bar iron or Osmund iron (wire making). For instance, for the short period between 1746 and 1751, iron was being sent from Bishopswood to New Weir.[13]

In 1717 the two forges – New Weir and Tintern - were producing 220 tons and 340 tons per annum respectively and in 1737 New Weir had a make of 200 tons. In 1720 George White senior died and his son (also George) took on the works. In 1753 the works were leased to John Partridge for 14 years - towards the end of the century Partridge ran Bishopswood furnace and this suggests that he planned for New Weir to

[8] Stockinger 1996, 41 to 123 quoting from 'A Survey of the Rivers Wye and Lugg'
[9] Stockinger 1996,306
[10] Stockinger 1996, 467
[11] Rees 1968, 649
[12] van Laun 2005, 12
[13] Hart 1971, 94

act as the forge for his pig iron. By then this included a slitting mill and the 27 acres across the water at the Biblins. The Biblins was possibly the area which was in dispute back in the 1690s which had lain in the possession of Benedict Hall. This inclusion of a slitting mill shows an important change from supplying malleable iron for wiremaking to rolling plate which was then cut into strips to supply the nail makers of the Midlands. At the time of the transfer to Partridge the inventory valued the tools, implements, fuel, cast and malleable iron including boats, nets and fishing-tackle at £1125.

Towards the end of the century the forge was in decline and could not compete with the growing South Wales coke ironmaking industry. In 1811 and 1813 it was advertised as [14] 'A Capital IRON FORGE with Two Hammers, three fineries, a Chafery, and excellent Rolling Mill for many years past in the Occupation of William Partridge Esquire'. According to the SMR listing the lease continued in the family until the death of Mrs. Osborne of Monksmill in Gloucestershire in 1798 when the contract ceased and the forge closed down. In 1814 the weir was damaged in severe frosts and soon after the remains of the weir, lock and forge buildings were demolished. By 1820 it was stated 'the extensive iron works…have been abandoned for some time and are now fallen into almost total decay'[15]

2.2 Fieldwork methodology

The fieldwork was not designed to be exhaustive, it is sufficient to inform the basic interpretation of the remains and to permit the site to be broken down into units. These will form the basis of condition assessment and management recommendations. The results for each unit will be presented in a table that includes the following headings:

- Unit name
- Unit number
- Grid reference
- Brief description
- Survival (Good – Poor)
- Condition (Good – Poor) – based on % of unit affected by damaging factors.
- Significance within the monument – importance of unit in providing information to visitors and the potential for further information to be gained from the unit.
- Damage - active management issues on unit)
- Risk to significance (High – Low) – risk from management issues to the significance.
- Priority (High – Low) – based on above factors
- Recommendation – recommended management actions including vegetation removal and the possible inclusion of a conservation architect.
- Figure – sketch of management issues
- Photographic record

[14] Coates and Tucker 1983,
[15] op cit

Preliminary fieldwork consisted of a walk over survey to identify features of note and to assess the accessibility of these features prior to recording. This initial walk over also led to a provisional identification of individual units (see below).

The survey was undertaken using an electronic distancing meter and plain table. The whole area was drawn at a scale of 1:500 as the smaller scale of 1:1250 proved impractical. The core area consists of the main structural elements of the iron works and the surrounding area, which includes visible features within 25m around the core and features that link the site with the river. The drawings were scanned and geo-referenced into Mapinfo 6.5 and these plans were then used for the annotation of units, photographic locations, directions and management issues.

2.3 Terminology

The following terms are used in the *pro formas:*

M Monitoring
RE Repair
RP River protection
R Recreational
TS Trees and scrub

Description
The form of the monument within this Management Unit; the usage, the ground cover, visibility and vegetation; specific features; erosion factors; and other general observations

Survival
The visible components within the Management Unit.
In its basic form the monument comprises three elements: the ditch, bank and counterscarp. Where all three exist the survival is 'good'; only two, the survival is 'medium'; only one, the survival is 'poor'; where there is no defined earthwork the survival is listed as 'below ground only'. Where segments of the monument comprise more than one bank and ditch, this has been highlighted and the survival rating amended accordingly.

Condition
The state of preservation of the surviving elements of the monument within the Management Unit, measured as 'high' (<15% affected), 'medium' (*c* 15-30% affected) or 'low' (>30% affected).

Vulnerability
A description of the specific threats and adverse factors affecting the Management Unit.

Significance
The significance of the Management Unit relative to the rest of the monument. Measured as 'high', 'medium' or 'low', determined by the original form (e.g. single or multiple bank and ditch), the state of preservation, the survival of buried soil profiles and any association with other features (e.g. hill fort, post-medieval field boundary, boundary marker or stone).

Risk
The risk to the significance of the Management Unit. Measured as 'high', 'medium' and
'low' indicating the active nature of the threat from the adverse factors.

Priority
The priority of remediation works, described in Section 6, based on the above factors and
measured as 'high', 'medium' or 'low'.

3. Adverse factors

The adverse factors identified as affecting, or with the potential to affect, the monument are as follows:

- Erosion due to use as a footpath or bridleway (by walkers, bikers and horses)
- Erosion by water action of exposed/bare primarily at times of flood from the River Wye
- Deposition of material caused by water action (River Wye) or landslip
- Weathering, loss of vegetation and soil, due to wind, rain, ice or frost and flooding
- Root disturbance caused by trees, bracken and scrub
- Silting and infilling caused by the build up of vegetation and soil e.g. within the culvert
- Limited animal burrowing

4. Results

Within this section is the completed 1:500 survey plan and this has been reproduced throughout the following section as a location guide and photographic record. As a consequence the reporting of individual Management Units includes a location plan, associated photographs and the completed Monument Condition Assessment Sheet.

The codes in the remediation recommendations refer to the generic management options (see below).

5. Recommendations by Neil Rimmington

The following section of the report outlines the general management issues and aims for New Weir Ironworks and provides a coded list of generic management options that are employed in the management unit tables. The scope for each form of remediation is limited by practical factors, such as topography, and legal factors, such as the alignment of footpaths. Before commencing specific works the advice of Herefordshire Archaeology should be sought to indicate whether consent is required for the proposed works.

5.1 Monitoring

The following sections provide recommendations for dealing with specific management issues that affect the preservation of the site. To achieve effective management of New Weir, a monitoring programme that can identify early signs of deterioration and trigger the appropriate management is essential. The monitoring interval recommendation is based on the attributes of the management units identified in the condition survey. In general terms the monitoring intervals would be as follows:

• *More than one monitoring visit per year* should be implemented where there is an identified management issue that will alter within the year (e.g. the extent of river erosion) and the more regular monitoring period will help understand the impact of the issue and devise suitable remediation.

• *An annual monitoring visit* is recommended where there is a high/medium vulnerability to the monument and that vulnerability may alter within the course of one year (e.g. development of erosion from recreation).

• *A 2-3 year monitoring visit* interval is recommended where there is high/medium vulnerability to the monument and that vulnerability may alter slowly over the course of a number of years (e.g. scrub/bracken extent). It is recommended that the condition of the whole monument should be re-assessed at a five-year interval in the first instance. If the monument does not exhibit a significant change during that period then the whole monument should be re-assessed on a ten-year monitoring cycle.

The time of year of the visit should reflect the management issue to be assessed:
Winter – Erosion by water action
Spring – Burrowing animals (early spring prior to significant vegetation growth)
Summer – Bracken, scrub
Autumn – Recreational erosion
Generic management options
M1 Establish a specific monitoring programme.
M2 Maintain an annual monitoring regime.
M3 Maintain a 2-3 year monitoring regime.

5.2 Management of trees, scrub and bracken
Trees, scrub and bracken have an impact on the site in a number of ways;

• The deposits on site vary in both depth and complexity. As a result the effect upon the archaeology varies. In places trees grow within or on walls causing substantial or potentially substantial damage to the structure. It is also clear that there is a high probability of damage to buried remains. Both methods of destruction ie overground and underground potentially damage our understanding of the site ie construction techniques, repairs, alterations and phasing.

• The presence of trees, scrub and bracken on or in the vicinity of the site influences the recreational routes of people. This can lead to incised routes through the site, which are often further exacerbated by wind and water action.

• Wind action on trees has the potential to uproot them and the archaeology that the roots
have exploited. The resultant hollow also alters the appearance of the site.

• The presence of deciduous vegetation and subsequent leaf drop leads to the silting of the site, which reduces the visibility of the archaeology.

• The presence of trees, scrub and bracken on the site reduces its visibility.

The following guiding principles should be adopted in managing trees, scrub and bracken at New Weir:

• Sapling trees should be removed to prevent further root disturbance to archaeology. It is also possible to highlight certain areas by the removal of saplings and trees ie removal of trees from the base of the various leats would highlight their significance.

• Mature trees are generally considered stable, as they will have established their root system. It has been noted however that in certain places trees are situated on top of walls and as a result have and continue to cause damage.

• Areas of bracken and scrub should not be allowed to increase in extent on or around the site and should be targeted for reduction to improve preservation and visibility of the monument.

• If the material cleared from the site is to be burnt then this should be done off the monument allowing a buffer of around 5m between the monument and the burn site.

• Stumps of trees and scrub should be treated with an herbicide to prevent regrowth.

• The use of machinery (if needed) should be carefully managed to avoid damage to the monument.

• Cleared areas need to be monitored for re-establishment of undergrowth.

• Trees, scrub and bracken form a natural element to the landscape. Therefore, the control of vegetation on the site should aim to maintain the natural feel of the landscape and not to create hard artificial lines that look out of place. In some instances the retention of patches of scrub may be of benefit to the management of the as a control on recreational use. It is therefore recommended that where recreational use is likely (ie footpaths) to lead to erosion of the monument if full removal is implemented, then patches of scrub be retained to divert use away from the monument.

Generic management options

TS1 Complete removal of trees and scrub to ground level and treatment of stumps with herbicide to prevent re-growth

TS2 Retention of mature trees (> girth), removal of trees and scrub below this girth to ground level and treatment of stumps with herbicide to prevent re-growth

5.3 Management of recreational activities

The woodland in which the site is situated is a popular area for recreation, mainly walkers. This has led to erosion of the monument where routes cross or follow the monument. This erosion compromises the long-term preservation of the monument as routes become incised and are exacerbated by wind and especially water erosion.

The general principles for managing recreational impacts on the site are as follows:

• Where incised routes cross the site then management should both aim to prevent further damage to surrounding parts of the site and where the incised route has not exposed bedrock (and therefore the potential for archaeological remains to survive exist) to prevent further incision..

• Where routes traverse the monument and have not exposed the bedrock then management should aim to divert the route from the site or provide a protective layer over the monument where this is unachievable.

Generic management options

R1 Manage to prevent the spread of recreational wear onto surrounding parts of the Monument from main riverside path

R2 Provision of a protective layer to preserve underlying archaeology.

5.4 Repair of erosion

Where erosion has developed on and around the monument and there is a benefit to the preservation of underlying and surrounding archaeology or to its setting then repair is recommended. It is recommended that repair involve the following basic procedures:

• Clearance of trees from standing walls. These have caused damage and continue to do so. Following removal, consolidation and possibly capping will be necessary.

• Clearance of vegetation from standing walls may highlight the need for re-pointing or wall stabilization.

• The river wall revetment, although later in construction to the main site, needs repair to avoid further erosion into the site.

• The main trackway, along the west side of the site, although substantial in itself is suseptable to soil creep. Only a small portion of stone wall remains along the west side and the ground behind is potentially unstable. A form of revetting is therefore recommended.

• If the current riverside footpath is to remain in use then a form of protection is needed to reduce the current rate of erosion. It is felt that grass would not survive the constant flooding and gravel would be washed away. This further substantiates the need to divert the footpath.

Generic management options

RE1 Remove vegetaion cover, re-point and cap with appropriate mortar

RE2 Limited restoration

RE3 Safety grilling (e.g. culvert)

RE4 Bulging – dismantle/repair

5.5 Priority areas

Three specific areas have been highlighted for remediation:

- **Unit 37, east room of main building.**

Management issue

On the west wall of this structure a substantial tree is currently growing. This has de-stabalised the upper section of this wall.

Aims of the work

To stabilize the damaged portion of wall.

Solution

Removal of the tree and as much of the root as possible while keeping damage to the wall to a minimum followed by the consolidation or reconstruction of the damaged section of wall.

- **Unit 9, river revetment wall.**

Management issue

In places the revetment wall has been damaged by the actions of the river and as a consequence there is significant erosion to the river bank that consists primarily of river gravel. This erosion is encroaching onto the site with its subsequent damage to the archaeology.

Aims of the work

The aim of the work is to re-stabilize the existing river edge.

Solution

Rebuild the damaged sections of revetment wall. The existing sections of wall are dry stone constructions using large cut stone blocks. Many of these blocks are still present along the base of the revetment and are clearly visible at low tide, it may be possible, indeed desirable, to re use these.

Constraints

Consent will be rquired to work within a site of Special Scientific interest.

- **Riverside footpath**

Management issue

The existing riverside footpath currently crosses a known building and a possible second building causing damage to these structures. It is also noted that extending from this path are a series of secondary trackways that cross the site and are clearly impacting on the archaeology.

Aims of the work

To reduce traffic across the site and to limit unnecessary erosion.

Solution

Due to its location next to the river, consolidation of the footpath does not appear possible. As a consequence it is suggested that the footpath be closed and that traffic be diverted around the site via the upper existing track way.

Constraints

Consent will be rquired to work within a site of Special Scientific interest.

6. Recommendations for further archaeological investigation

7. **The archive**

The archive consists of:
44 Monument Condition Assessment sheets
163 Digital photographs
1 Computer disk
The project archive is intended to be placed at:
Herefordshire County Sites and Monuments Record
Wye Valley AONB Office
Forestry Commission

8. **Acknowledgements**

The Service would like to thank the following for their kind assistance in the successful conclusion of this project, David Armitage (Acting AONB Officer), Ian Rowat (Director Malvern Hills Conservators), Adam Mindykowski (Worcestershire Historic Environment Countryside Advisor) and Neil Rimmington (Herefordshire Countryside Advisor - Archaeology).

9. Personnel

The fieldwork and report preparation was undertaken by D. N. Williams and N. Preece. The project manager responsible for the quality of the project was N.Rimmington. Illustration was undertaken by the authors. N. Rimmington contributed the recommendations and edited the report. The historical section was undertaken by John Van Laun.

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11. Appendix 1: Illustrations, prints and painting.

Illustration 1: View of the forge by Thomas Hearne (1794) as seen from the north.

Illustration 2: View of the forge site by S.Ireland (1797) as seen from the north.

Illustration 3: An 18th Century painting by Michael Angelo Rooker from north of the weir.

Illustration 4: Dayes painting of the forge site dated 1800.

Illustration 5: James Wathen's painting of 1801 from the north.

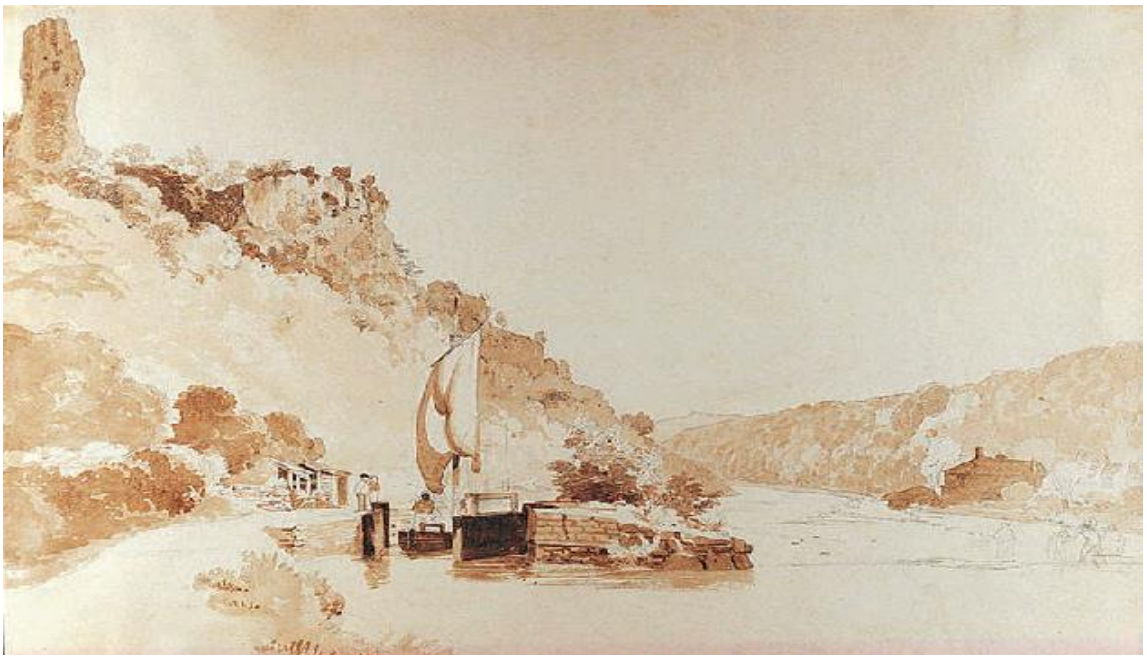

Illustration 6: Picture of the lock with the forge in the distance by Thomas Tudor 1820.

Illustration 7: View of the forge by Fielding 1822.

12. Appendix 2 – Processes by John Van Laun

Processes

The history presented above is only an outline gleaned from secondary sources. Additional research will hopefully yield material which will add considerable to the story (see Appendix 1 for a preliminary list of primary sources). Of particular relevance would be inventories compiled at the time when new leases were made. These generally listed iron castings which lay at the furnace or forge. Furthermore, leases often include a description of the site or plans with a book of reference. To interpret all these it is axiomatic that the processes involved are understood and are presented below.

The charcoal ironmaking process[16]

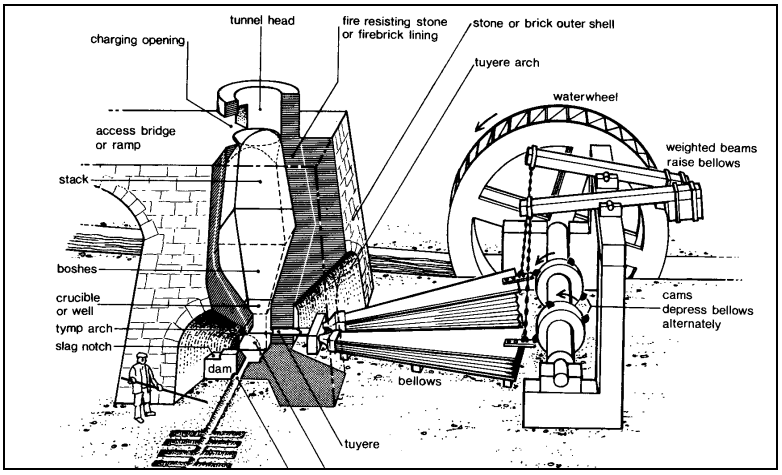

Fig 1. A charcoal blast furnace showing the bellows arrangement on the right (source: Neil Cossons 'The BP Book of Industrial Archaeology' 1975, Fig 19)

Up until the 14th century iron was produced by the direct method in bloomeries: this was small scale with only about 2 kilos being produced in each 'heat' but the advantage was that it produced malleable iron in one process. This 'direct process' was superseded by the indirect or 'Walloon' process. As the name implies there were two stages: the primary process (in the blast furnace which produced around 2 tons of cast or brittle iron), and the secondary process (the forge) in which the brittle iron was changed to malleable iron by burning out carbon.

Charcoal furnaces were almost always built into a bank for ease of charging with the raw materials from the top – charcoal (stored in a large building to keep it dry), iron ore and limestone to act as a flux (Fig 1). Charcoal furnaces were generally square in section tapering from the top to about two-thirds down (at the boshes). From here they narrowed into the crucible where the molten metal gathered. Air was blown into the crucible through twyeres or nozzles – bellows for this 'blast' were driven by waterwheels. Thus we can expect to find three features where furnaces might be located – a platform for the furnace to stand on, a bank for charging and a water supply. Around every 24 hours the iron was drawn at the base and the slag or waste higher up where it floated. Slag is also another prerequisite for identifying the site of a furnace. This generally has flow marks set in it caused by the high temperatures which reduced the slag to a molten state A feature which can survive and is often later

[16] This section is mainly based on van Laun 1979

adapted, is the charcoal house At this period cast iron direct from the furnace could be used for castings such as fire backs, cannon and pots but most would have found its way into the pig beds to be re-worked later at the forge into malleable or wrought iron.

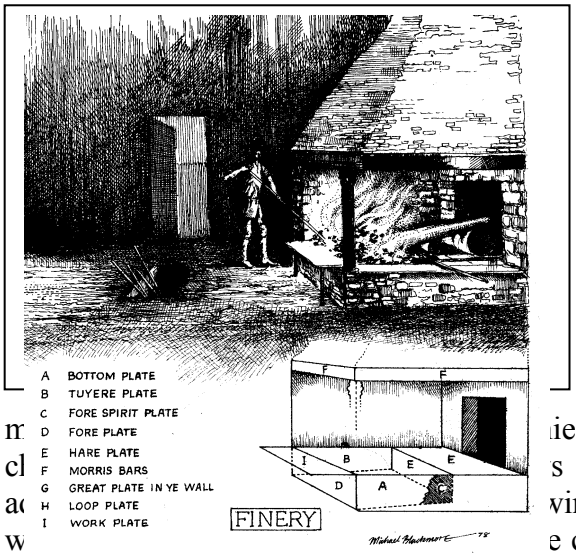

Fig 2. A finery with named cast-iron plates (source: van Laun 1979)

The forge was in three parts. In the first stage of the process (finery) the pig iron was melted and carbon content burnt out in (Fig 2) a water-blown hearth which made it malleable. For the second part the hearth was larger (chafery Fig 3) and here the now m ies'[17] Both hearths would have needed a cl s required counterpoises to lift them up a(ving stroke) was made by tappets on the w e cast-iron plates as shown in Figs 2 and 3. In the early stage of the finery process the pig iron would melt but as it .'came to nature' it become a pasty mass. About 1 ton 7cwt made one ton of malleable iron consequently there was a fair amount of iron in the slag which would have a coagulated appearance.

Finally the iron was hammered under a water-driven helve to weld it into a homogeneous mass (Fig 4). Chafery and helve hammer would be worked in conjunction with each other. The cast-iron hammer head was lifted at the head end by tappets set on the waterwheel axle and once these had passed its weight would bring it down onto the work piece on the anvil. The anvil was subject to enormous vibration and was therefore mounted on timber baulks buried down into the ground to absorb the shock. Much of the hammer slag would accumulate around the base of the anvil and drop through the timber baulks and is like to have survived as layers with a proportion of iron. The solid cast-iron hammer was set at the end of a wooden handle which passed through a cast-iron 'hurst'. The hurst had pinions cast into it which lay between wooden 'arms' which were secured to a beam above. Extra force in the working stroke was applied by a 'rabbit' or wooden spring which was placed above the hammer.

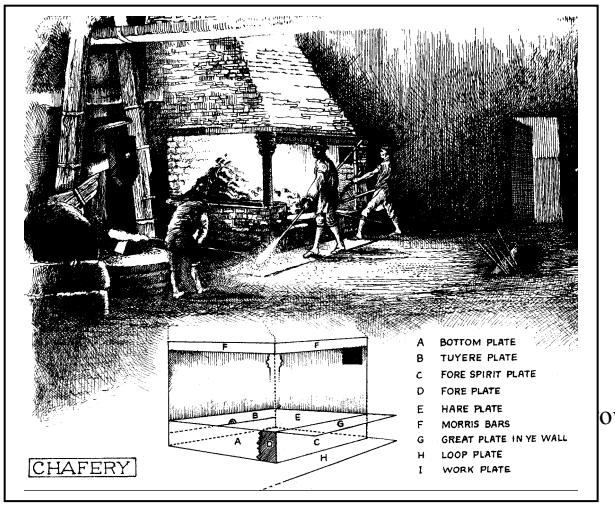

Fig 3. A chafery with named cast-iron plates (source; van Laun 1979)

Two hammers might be worked by a single cam box and waterwheel (Fig 5). Here the 'noses' would be placed opposite each other and worked alternatively. Generally the power generated by the waterwheel was

ow waist and two lumps at the end for ease of

insufficient to work two hammers at a time and one would have been 'gagged' or lifted high enough away from the passing tappets and propped up.

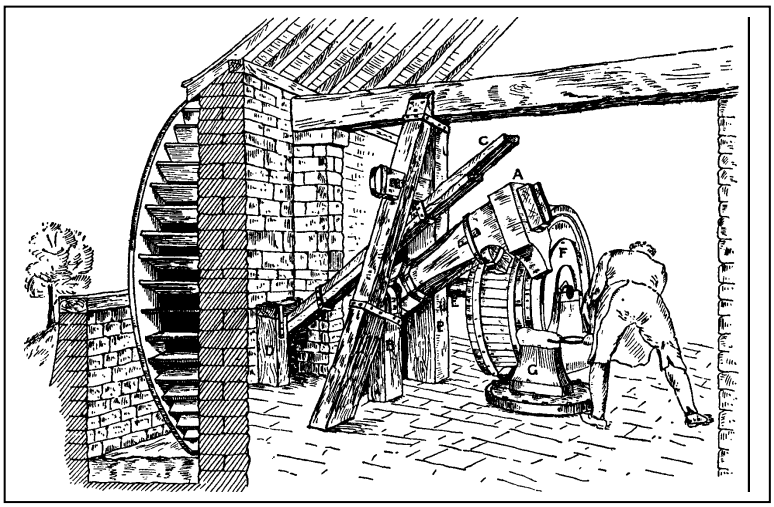

Fig 4. A water-powered helve hammer (source: Straker 1931, 87)

The layout of the forge would have been compact so that iron could be transferred between stages without losing too much heat. As we shall see this was particular evident with rolling. Waterwheels were of different sizes depending on their function. Bellows wheels for fineries and chaferies might be as little as 2m in diameter but the as the chafery hearth was bigger it might require two sets of bellows. The hammer wheel might be 7m in diameter reflecting the weight of hammers which could be as much as 6cwt.

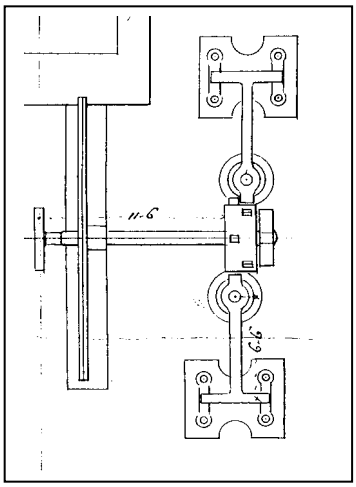

Fig 5. Helve hammers at Wilsontown Lanarkshire 1789. A flywheel lies to the left with the axle running through to the cam box. The noses of the hammers face each other with their tails are secured to a bracket (source: Birmingham Reference Library Boulton & Watt Collection MS3147/5/539) reduced.

The different sized waterwheels might be accommodated by separate leats as at Pontrilas Forge where, in the 17th century, there was a separate 'hammer ditch' and 'finery ditch' which led from a holding pond with a cut-water set in the dam to direct the water each way. Schubert shows a forge where the four wheels (surely a minimum number at New Weir) are arranged like a set of motorcar wheels in tandem.[18] The Tintern Lower Forge, which was working in conjunction with New Weir in 1707, may give an idea of how parts of New Weir may have looked (Fig 6). The larger wheel probably drove a helve hammer and the smaller a set of bellows for one of the two fineries (upper and lower) known to have been refitted in 1693 – 94. At the same time the hammer had a 'rabbit' refitted - a wooden spring which returned the helve to the anvil with additional force.[19] The finery chimneys lay either side of the smaller wheel and were controlled from inside by ramshackle dampers. - the large chimney at the far end would have served the chafery. The bundle of rod-iron resting against the waterwheel may have been awaiting shipment from the nearby tidal dock – the weigh-beam lies to the left.

[18] Schubert 1957
[19] Rees 1998, 651

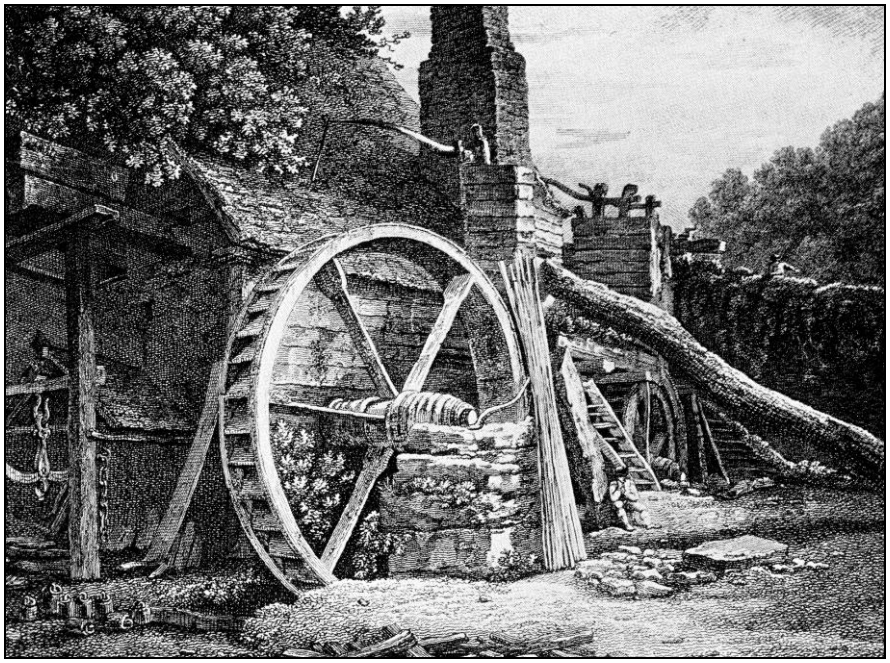

Fig 6. 'Iron Forge at Tintern, Monmouthshire' (Tintern Lower Forge) drawn in 1794 by Thomas Hearne and engraved by B T Pouncey 1798 (source: Rees 1968, 644 – 45).

Charcoal

The most bulky and expensive item was charcoal.[20] Charcoal was made in clamps leaving telltale round patches of around 3m in diameter when abandoned and these can be found around the Doward above the forge. The reason for their close location lies in the fact that during travel it tended to break and, as a result, the 'breeze' would clog up the hearths. The obvious measure to avoid this was to site furnace and forge as close as possible to suitable woodland where 'cordwood' could be produced by coppicing and then coaled nearby. Around 2400 acres of woodland was needed to supply one furnace (120 acres per annum taking 20 years to replenish itself). For all these reasons the forge tended to be separated by some distance from the supplying furnace.

However, not all charcoal was produced locally. For instance, in 1638 the Crown had plenty of cordwood to spare in the Forest of Dean, but instead of building a furnace and forge to consume it they sold it off to nearby established ironworks. In 1692 some of this found its way to New Weir.[21] This was a time when the works were re-establishing themselves and nearby charcoal may have been in short supply.

Other ferrous products at New Weir

New Weir was involved with Tintern Lower Forge in supplying malleable iron for the production of Osmund iron it does not seem likely that New Weir actually produced any. In the production of Osmond iron a more ductile iron was achieved than that in

[20] A late 17th century estimate for production at Pontrilas Forge gives the following costs 3 cords of wood = 1 load (5s 6d), Cutting and cording of same (3s) + carriage from Hollyn Wood (SO 37 31) (2s 6d) or Dore Wood (3s) = 13s 6d or 14s (£0.65 or £0.70) per load. 3 loads made 1 ton of wrought iron ('Perfect') (£2.025 or £2.10). Costs at the furnace were around £7 a ton but after working at the forge to around £13. Although a major charge was the charcoal this should be treated with caution as there was considerable wastage of pig iron during production

[21] Hart 1971, 62

the normal bar-iron forge: such ductility was essential for drawing wire which took place in the Angiddy valley above Tintern. For this reason an Osmond forge was constructed in such a way as to increase heat and thus de-carbonisation, but this increased fuel consumption and a loss of sow iron. These factors increased costs from that for normal bar iron production.

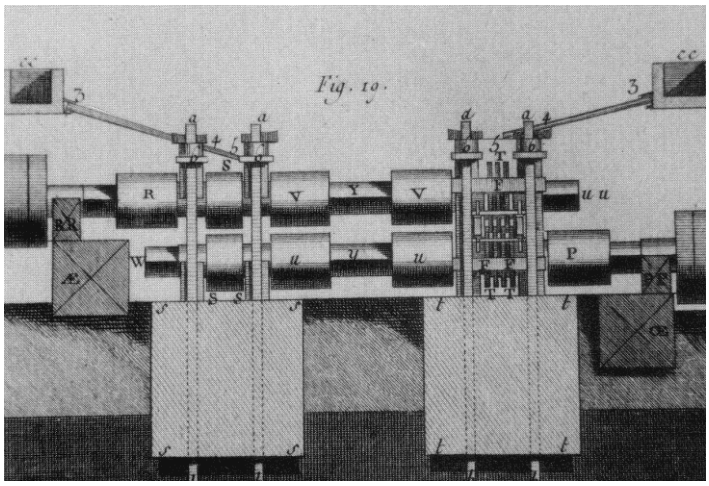

Fig 7. A Rolling and Slitting Mill from Didérot Encyclopédie. The plate rolls lie to the left with the cutters to the right. The narrow bars between join the 'wobblers' which allowed the rolls to part slightly to allow the plate through. To stop the plate melting and slicking to the rolls they were wate-cooled by the tanks to the top left and right.

In the mid-18th century New Weir was operating a slitting and rolling mill. The end product; strips of malleable iron used for a number of smithying products including nail making, was produced in two stages and had been around since the 1590s. Both required power-driven rolls. After heating the malleable iron was passed through a set of flat rolls, rather like an old-fashioned laundry roller, to produce plate. After re-heating it was passed through a set of revolving cutters where the opposing set were larger which cut the plate into strips (Figs 7 and 8). Fig 7 shows that the rolls were held down by bolts passing through baulks of timber or possibly blocks of stone – the pits for these should have survived.

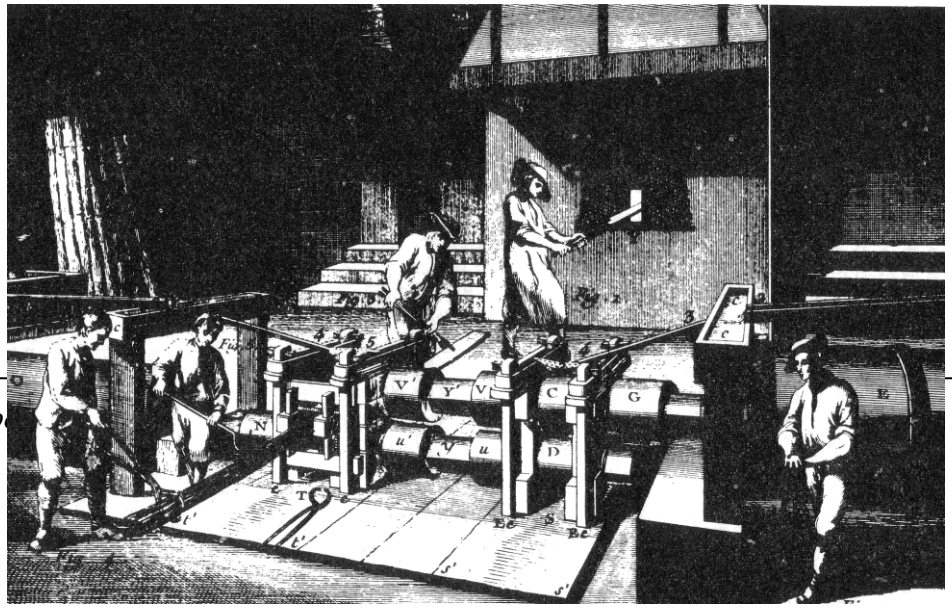

Fig 8. A Rolling and Slitting Mill c1760 from Didérot Encyclo