Report No: 2013R077

Structures at Taylor's and Davey's Shafts, Consolidated Mines, Gwennap, Cornwall

Historic Environment consultancy during consolidation works

Historic Environment Projects

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The Project Manager was Dr. Andy Jones FSA.

The views and recommendations expressed in this report are those of Historic Environment Projects and are presented in good faith on the basis of professional judgement and on information currently available.

Freedom of Information Act

As Cornwall Council is a public authority it is subject to the terms of the Freedom of Information Act 2000, which came into effect from 1st January 2005.

Historic Environment, Cornwall Council is a Registered Organisation with the Institute for Archaeologists

Cover illustration

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Abbreviations

CRO	Cornwall County Record Office
EH	English Heritage
HER	Cornwall and the Isles of Scilly Historic Environment Record
HE	Historic Environment, Cornwall Council
OD	Ordnance Datum – height above mean sea level at Newlyn
OS	Ordnance Survey

1 Summary

In mid June 2012, Historic Environment Projects, Cornwall Council were requested to provide the costs of providing archaeological consultancy as part of a multi-disciplinary team headed by PDP Green of Truro for a proposed programme of conservation works to mine structures adjacent to Taylor's and Davey's Shafts, part of the Consolidated Mines (Consols) in Gwennap. The structures under consideration comprised the 85" pumping engine house and adjacent chimney, together with the remains of the house for the whim serving Taylor's Shaft and that for the all-indoor beam whim engine house which had worked Davey's Shaft.

Taylor's and Davey's Shafts had been worked as part of Wheal Virgin, the most important of the Consolidated Mines, whose component mines had worked from the mid-18th century and which had been brought together in about 1780. The resultant mine was once one of the largest and most successful copper producers in Cornwall, particularly so when worked by the mining entrepreneur John Taylor between 1815 and 1839, and was the site of pioneering steam technology, including several Newcomen engines and those later erected by Arthur Woolf. John Taylor was unable to renew the lease of Consols and United in 1839 and the mines were amalgamated in 1857 as the Clifford Amalgamated Mines, which eventually closed (after a period of decline) in 1870. With the nearby pumping engine house on Shear's Shaft, Cusvey, the engine houses at Taylor's and Davey's Shafts are some of the earliest to survive anywhere in Cornwall, the pumping engine house dating from 1826.

Consols had never been anything but a copper mine, and its relatively early closure is one of the principal reasons why so few of its structures remain, most of its buildings having been cleared away by the turn of the 20th century. The hillslope above the Wheal Maid Valley had been quarried to form two massive tailings lagoons, material used to create the dams having been quarried from the hillslopes between Taylor's and Davey's Shafts. Subsequent remediation programmes to promote the revegetation of these bare valley sides had destroyed most of what had remained.

The engine houses and chimney had suffered from long-standing neglect, in particularly Davey's whim, and could not be conserved as part of the HLF-funded Mineral Tramways Project. However, the inclusion of this site within a Natural England Higher Level Stewardship scheme allowed the grant funding of this work. The project, undertaken in two stages, was successfully carried out during 2012/13.

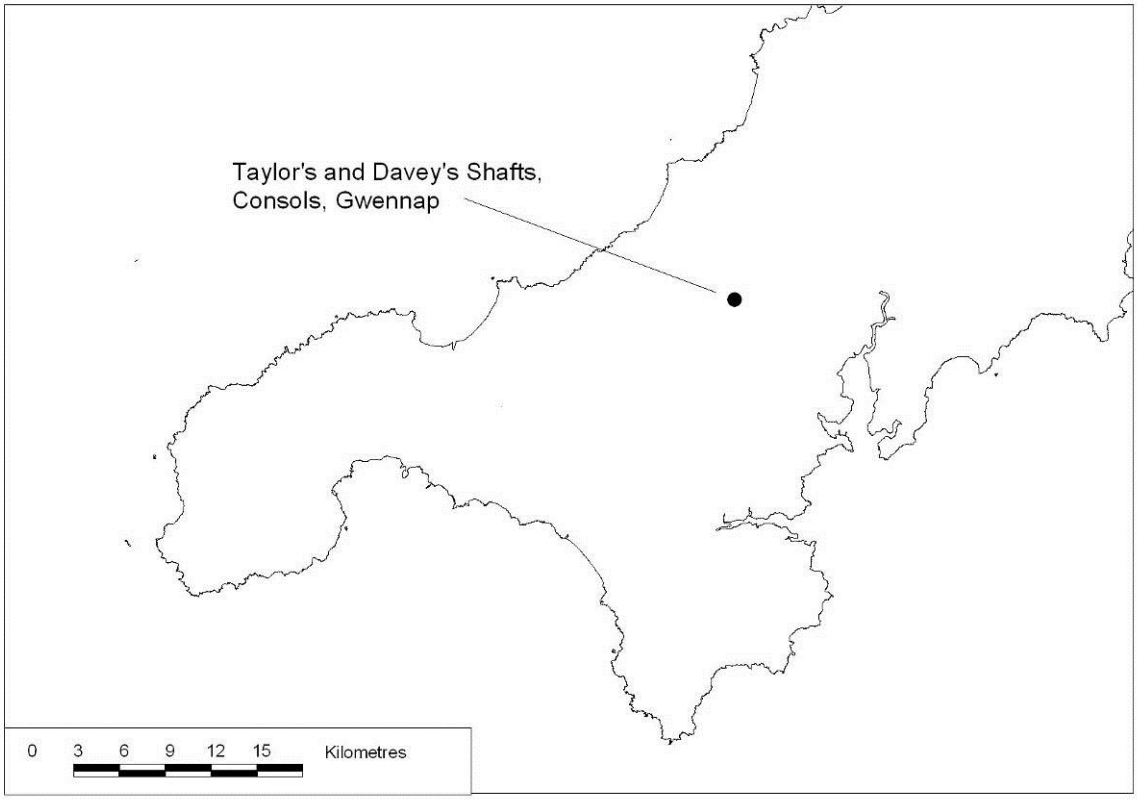

Fig 1. The location of the Taylor's and Davey's Shaft sites, Consolidated Mines, Gwennap.

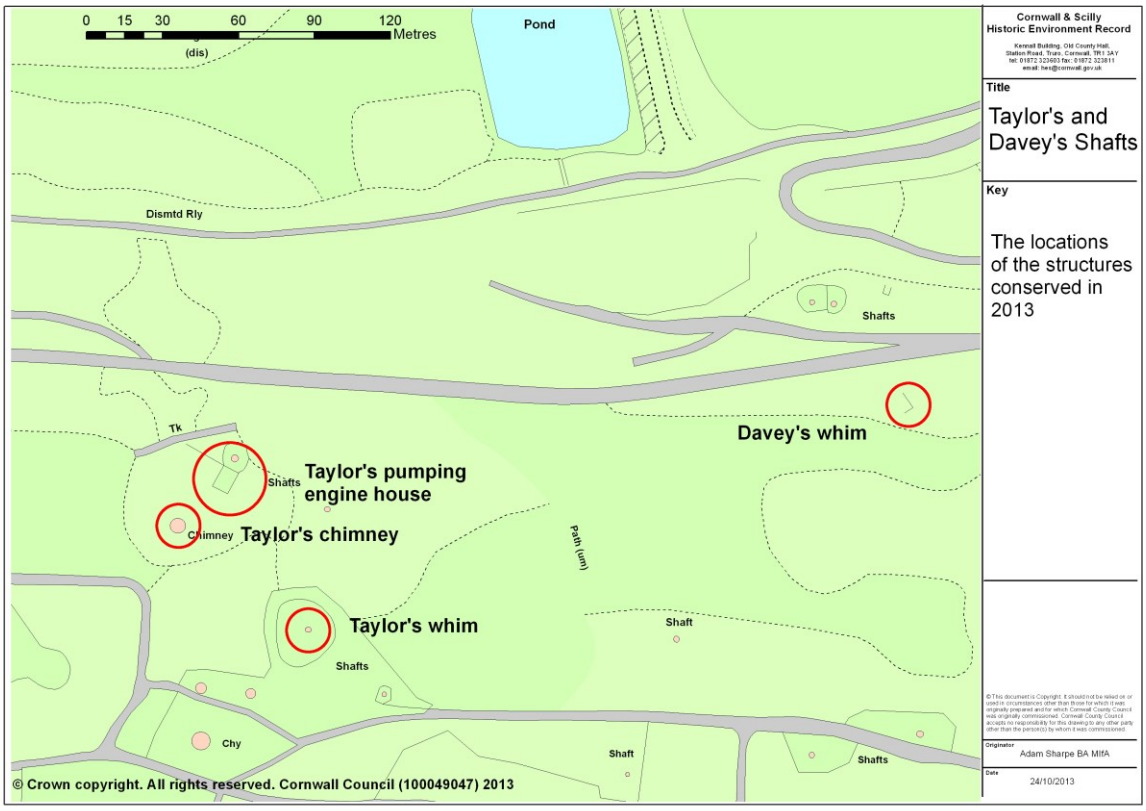

Fig 2. The locations of structures conserved during the 2013 project.

2 Introduction

2.1 Project background

Utilising their Higher Level Stewardship Scheme, Natural England funded conservation works to the above ground structures at Taylor's and Davey's shaft sites, Great Consolidated Mines (also known as Consols), in the Wheal Maid valley. The agreement is held by Gwennap Parish Council, who commissioned pdp Green to project manage these works as part of their HLS Agreement. Both sites are located within the Cornwall and West Devon Mining Landscape World Heritage Site.

A historic buildings consultancy and watching brief were requested in order to inform the proposed conservation and interpretation works and to ensure that an adequate record of the structures was made in advance of and during their conservation. A previous archaeological assessment (Sharpe 2009) forming the first stage of this project involved a desk based assessment, this including a map regression, plus a survey of the extant remains of the site and amendment of survey plans of the buildings undertaken by Nationwide Surveys. This assessment formed the basis for the recommendations for the conservation works undertaken in 2012/13.

The proposed works focussed on the consolidation of the following structures:

- Taylor's Pumping Engine House - Grade II Listed. The bob-wall of the engine house survived intact, but the side walls had been partly lost and the rear wall had mostly collapsed.
- Taylor's pumping engine house chimney - Grade II Listed. Whilst this detached chimney survived to almost its full height, its associated boiler house and flue had been demolished.
- Taylor's Whim Engine House – Grade II Listed. The engine house had been comprehensively demolished, leaving a structurally unstable chimney and parts of the attached rear and nearside walls, together with the lower sections of the whim loadings.
- Davey's Whim Engine House, SW 7482 4213. Parts of the rear wall and half the length of the side walls survived in a very ruinous and unstable condition; the front wall of this all-indoor beam whim engine house had completely collapsed.
- Small scale access improvements to link these structures to the adjacent Coast to Coast Trail (part of the Mineral Tramways Trail network) were also proposed. Wherever possible, access tracks created during the project to facilitate the movement of contractors' vehicles would be upgraded for eventual public use.

A structural survey of the buildings had originally been commissioned from Michael Beardsall Associates engineer by Cornwall Council when these works were proposed as part of the Mineral Tramways Project. This had identified works required to consolidate the buildings and improve access to them:

- wall capping
- sampling and re-pointing of pointing mortars
- brickwork repairs to a chimney
- replacement of timber lintels, wall plates and cills
- masonry re-build and infilling
- control of *Cotoneaster horizontalis*
- access works

Whilst an archaeological assessment was undertaken (Sharpe 2009) and Taylor's pumping engine shaft and Taylor's whim shaft were made safe, it did not prove possible to fund the building conservation works at this time.

At the instigation of the Cornish Mining World Heritage Site team, the project was revived in 2012, funding being made available through Natural England's Higher Level Stewardship scheme. A brief was jointly prepared by Ann Reynolds of the Historic Environment Advice Team and Ainsley Cocks of the World Heritage Site Team in May 2012 (updating a brief prepared by Gary Jago of the WHS Team for the Mineral Tramways Project in 2008). The work was undertaken in two stages. Phase I involved the provision of specialised input during the drawing up of detailed specifications for the works programme; Phase II took the form of an historic environment consultancy during works on site and its subsequent reporting. The works were managed by pdp Green Consulting Ltd. and undertaken by Darrock and Brown, operations being directed by Arthur Britton and Pete Weary.

2.2 Aims

The principal aim of the 2009 assessment phase of the project was to gain a better understanding of the structures on these sites and their surrounding locales prior to works being undertaken to consolidate the structures. A further aim was to update the existing archaeological record of the site prior to its conservation (should this be necessary) and to produce the information which would be required to guide the subsequent conservation project.

The objectives of the historic environment consultancy for the consolidation phase of the works were:

- To advise on proposals and to propose measures to ensure that the special qualities and importance of each of the sites and their components were preserved and enhanced by the proposed works.
- To undertake any necessary further recording of the buildings once scaffolding was in place and vegetation surrounding the buildings had been cleared away to ensure that a record of any undocumented or unrecorded features of the buildings was made.
- To provide advice to the client and contractor to guide the works to ensure that these were sustainable, appropriate to the historic importance and character of the buildings, and in line with current accepted best practice.
- To produce a drawn, photographic and descriptive record of the works undertaken, as required.

The project's specific aims were:

- To re-assess existing sources of historical and archaeological information concerning the sites.
- To work with other members of the project team to develop appropriate and sustainable proposals for the conservation of the site and its structures.
- To inform whether an archaeological evaluation or further archaeological recording of any potential buried remains might be required
- To update the building record through direct measurement once scaffolding is in place and to add any unrecorded or mis-recorded features to the pre-works drawing record.
- To undertake further detailed photography of salient details.
- To provide conservation advice to the site engineer, client and contractor as appropriate and required.
- To attend regular and any other site meetings with other team members.

Following the completion of works on site

- To produce a concise illustrated report summarising the results of the watching brief.
- To create an OASIS/ADS-online record of the works.
- To archive project materials according to HE guidelines.

2.3 Conservation philosophy

The philosophy underpinning the works was that repairs undertaken to the buildings and chimneys should be a close match in terms of detail and materials, pointing should be consistent with original work and repairs should be intended to blend in and be consistent with the overall existing finish of the structures. Appropriate and traditional materials and methods of workmanship were to be used throughout the works. Non original materials were not to be used except in those limited areas where repairs were to be undertaken on structural grounds alone. These were to be small scale and, wherever possible, rendered invisible (for example, the pinning of unstable masonry or the fleeting of wall pockets).

Works required to achieve the provision of materials access routes, storage compounds, pedestrian access routes, safety fencing, securing of elements of the scaffolding and other associated works would, wherever possible, be temporary and reversible, and would take into account the archaeological and ecological sensitivities of the site. Adequate pre-works surveys were undertaken to guide the proposals and to ensure that they did not damage significant features or habitats. These comprised an archaeological assessment and an ecological assessment, this including a bryophyte survey of the site as a whole and a detailed inspection of the structures for bat roosts.

All efforts were taken not to damage any significant site feature or habitat during the works programme. Archaeological and ecological consultants were involved in the finalisation of all decisions relating to groundworks, vegetation clearance or other works which might impinge on habitats, the siting of facilities, etc, whilst allowance was made for appropriate watching briefs for the duration of the works programme.

Reasonable provision was made for continued public access to those parts of the site on which works did not take place, including allowance for viewpoints of the work in progress, whilst information about the project was made available via a variety of means.

This approach is consistent with and supported by the OUV of the World Heritage Site and its policies, which had been adopted by all of Cornwall's local authorities and members of the World Heritage Site Partnership. Specifically, these include:

Management Plan Policy 8a
The conservation and continuing maintenance of the historic fabric of the Site should be undertaken to the highest standards to ensure authenticity and integrity.
Policy 8b
The historic character and distinctiveness of the Cornwall and West Devon mining landscape should be maintained.
Policy 8c
Traditional materials and skills should be encouraged in the maintenance of the authentic historic fabric within the site.
Policy 8e
Resources available for conservation of the Site should be prioritised to meet the Vision and Aims.
Policy 14b
Enjoyment of the Site should be available to all regardless of agility or income.

2.4 Methods

All recording work was undertaken according to the Institute for Archaeology's *Standards and Guidance for Archaeological Investigation and Recording.* Staff will follow the IfA *Code of Conduct* and *Code of Approved Practice for the Regulation of Contractual Arrangements in Archaeology.* The Institute for Archaeology is the professional body for archaeologists working in the UK.

2.4.1 Desk-based assessment

A desk-based assessment was carried out in 2009 to inform the fieldwork stage. This was reviewed to assess its completeness.

Historic environment consultancy and recording in advance of works
The Historic Environment archaeologist attended site and other meetings with PDP Green during the drawing up of the detailing of the works and the associated Listed Building Consent to ensure that the specifications for the work were appropriate to the buildings. This included proposed working methods, mortar mixes (including approval of test panels), repair techniques, locations of works compounds and temporary access roads. A brief Impact Assessment and Mitigation Statement were prepared for each structure and area which would be affected by the proposed works. Avoidance or mitigation measures were set out where appropriate.

Historic environment consultancy and recording during works
Historic Environment Projects undertook a historic environment consultancy during the works programme, providing advice on the extent and nature of repairs and rebuilding (where this occurred), both in general and in relation to specific features of the structures. A photographic record of the works was made during the course of the project. Detailed building surveys drawn up prior to the works by Nationwide Surveys Ltd were amended by HE Projects prior to the works taking place. These surveys were updated by PDP Green during the works and were checked for completeness on their conclusion.

An archaeological watching brief was undertaken during the clearing of cloaking vegetation, the creation of access roadways and paths, and during excavation for the installation of lightning conductor earthing cables.

Report
A summary report (this report) was produced following the completion of the works programme. An entry to the OASIS/ADS-online record has also been produced.

2.4.2 Creation of site archive

A project archive has been created, this including background material, copies of communications, summaries of site meetings, digital photographs, copies of drawings showing the extent of works to the buildings (including all new fabric) and a copy of the project report.

A paper copy and a digital (PDF) copy of the report, illustrations and any other files have been lodged with the Cornwall HER. Copies of the report have been distributed to the client, to local archives and national archaeological record centres.

2.4.3 Archive deposition

An index to the site archive was created and the archive contents prepared for long term storage, in accordance with HE standards.

The archiving comprises the following:

1. All correspondence relating to the project, the WSI, a single paper copy of the report together with an electronic copy on CD, stored in an archive standard (acid-free) documentation box.
2. Copies of annotated record drawings.

3. Digital photographs archived according to HE Projects guidelines.
4. The project archive will be deposited initially at ReStore and in due course (when space permits) at Cornwall Record Office.

3 Location and setting

See Figures 1 and 2.

The sites are located in the parish of Gwennap, Taylor's pumping engine house being located at SW 74552 42091, Taylor's pumping engine house chimney being at SW 74532 42074, Taylor's whim at SW 74584 42033 and Davey's whim engine house at SW 74819 42123. All sites are on the southern slopes of the Wheal Maid Valley, Taylor's engine house being at 87m OD, Davey's whim engine house 265m to the east being at 80m OD. The surrounding landscape is one of the most obviously affected by extractive industry to be found anywhere in Cornwall, consisting of spreads of bare, copper- and arsenic-rich mine waste, quarry spoil and the ochreous slimes forming the Wheal Maid tailings lagoon. The trackbed of the Redruth and Chasewater Railway runs along the foot of the valley side to the south of the tailings lagoon; evidence for other branches of the railway serving the Consolidated Mines were destroyed during post mine closure landscaping works. Beneath the valley floor runs a branch of the County Adit, whilst the sites of the many shafts worked by the Great Consolidated Mines pepper the surrounding landscape. Given the absence of other than patchy scrub vegetation (mostly Buddleia), the engine houses and chimneys (together with the former mine clock tower) are landmark features on the open slopes above this part of the valley.

4 Designations

4.1 International

All the sites conserved during the project fall within the Gwennap Area of the Cornwall and West Devon Mining landscape World Heritage Site.

4.2 National

Taylor's pumping engine house is Listed Grade II (National Monument Number 1136409, SW 74 SW 4/94, first Listed 21st November 1985).

Taylor's pumping engine house chimney is Listed Grade II (National Monument Number 1140934, SW 74 SW 4/95, first Listed 21st November 1985).

Taylor's Whim is Listed Grade II (National Monument Number 1140933, SW 74 SW 4/93, first Listed 21st November 1985).

4.3 Regional/county

The whole of the Wheal Maid/Consolidated Mines site falls within an area designated as an Area of Great Historic Value (AGHV).

5 Site history

Wheal Virgin and its neighbours had a history of rich copper production from relatively shallow levels from the early decades of the 18th century and by 1779, Wheal Virgin, West Wheal Virgin, Wheal Maid and Carharrack Mine were being worked by seven Newcomen engines. In the following year they were amalgamated into the Consolidated Mines. Outputs of ore from both these and the neighbouring United Mines were substantial, but both closed in 1805 during a low period for Cornish mines. The United

Mines were restarted in 1811, the mine extending over a mile and a half of countryside, with the Consolidated Mines being reopened by John Taylor in 1819. From 1824, the two mines were worked as a single concern under his guidance. By 1838, there were 21 steam engines on the mine, which employed a staggering 3,196 persons. From 1819-1840, nearly 300,000 tons of ore were raised and over 63 miles of development levels and shafts cut. Lemon's statistics give some indication of the scale of mining here: in 1836, the Consolidated Mines used 11,817 tons coal, 113,916 lbs candles and 64,000 lbs gunpowder. Over a quarter of the population of Gwennap parish (8,539) worked in this one mine. Huge fortunes were being made by shareholders, promoters and mineral lords like the Williams family of Scorrier or William Lemon, whose agent gained the contemporary nickname 'guinea a minute' Daniell.

John Taylor was, however, refused the right to renew his sett agreement with the mineral lords and although the mine was reworked (as Clifford Amalgamated), employing over 2,000 people, production was falling and outlay exceeding returns. The mine was abandoned in 1870, the machinery dismantled and many of the buildings demolished for their stone. The Consolidated Mines are recorded as having produced 442,000 tons of copper ore, the United Mines over 350,000 tons of copper ore, whilst Clifford Amalgamated raised over 100,000 tons of ore.

The Great Consolidated Mines were very much in the forefront of the use of steam engines for pumping in Cornwall. By 1758 its first steam engine had been erected on Butson's Shaft, West Wheal Virgin, and by 1779 the mine was employing seven Newcomen engines. In 1782, these were replaced by five of the far more efficient Boulton and Watt engines, this later being increased to seven. Most of these replacement engines (two 63" cylinder double-acting engines, a 52" double acting engine and 58", 56" and 36" single-acting engines) were sold off in 1811 when the mine was restarted. Edward Bull was the chief erector for Boulton and Watt from 1782 and was assisted by Richard Trevithick, though subsequently replaced by William Murdock.

In 1819, the new working of Consols started with two 90" cylinder engines, by 1828 this had increased to three 90" engines, a 70" (Taylor's) and a 58"; by 1835 the mine had two 90" engines, an 85" (Taylor's), an 80" and two 65" engines. The renowned Arthur Woolf was associated with the mine as the principal engineer from 1820 until his retirement in 1830, when he was succeeded by Michael Loam and Samuel Hocking. In March 1833, the six largest engines at Consols were recorded as raising 2,707 gallons of water each minute. With the exception of Dolcoath, more Newcomen and early Watt engines were erected on this mine than on any other in Cornwall. Consols was also one of the few mines in Cornwall to site an engine underground, this being a 20" pumping engine erected in 1788 in the Wheal Virgin section.

West Wheal Virgin, which adjoins Wheal Maid and Wheal Fortune was one of the richer sections of the mine, and sited a number of pioneering engines, amongst them a pair of large pumping engines on Taylor's and Davey's Shafts, the former eventually having an 85" cylinder, its house being erected in 1826, the latter an 80" cylinder, the engine being erected in 1833. Both were accompanied by steam whims: an all-indoor 24" at Taylor's and a similarly-sized all-indoor engine at Davey's. Other large pumping engines were sited at Woolf's and Bawden's Shafts in Wheal Fortune and at Shear's Shaft in Cusvey just to the east, the latter building apparently having been built to a more or less identical design to that used at Taylor's Shaft.

The mine closed in 1870, all of the mine materials having been sold off by 1877, these being acquired by Messrs. J.C. Lanyon and Son of Redruth for £12,800. Most of the engines were sold for re-use, though the sites on which they subsequently worked are unknown. An extensive phase of dump re-working occurred between 1880 and 1908.

Twentieth century underground exploration and development took place within the area as part of an unsuccessful attempt to reopen the old Magpie Mine as Mount Wellington

at the eastern end of the Consolidated Mines sett between 1935 and 1941, a small mill being set up to reprocess mine dumps in 1946. In the mid-1960s intensive investigation was commenced by Consolidated Gold Fields and in 1969 it was decided to re-open the sett at an estimated capital cost of £6 million. A tailings dam was opened in the valley at Wheal Maid using stone quarried from the area formerly worked by Wheal Lovelace just to the east of Wheal Virgin (in the area between Taylor's and Davey's Shafts) whilst further material from this area was earmarked for use as cover-down over the tailings.

In the 1970s, it was recognised that the project was uneconomic, and despite the availability of government aid to keep the pumps going, the decision was taken to close Mount Wellington. In 1983, Carnon Consolidated Tin Mines began to re-explore the Wheal Maid workings, a decline shaft and adit driven from near Taylor's Shaft intersecting three mineralised veins; this drive was subsequently extended to connect to the Wheal Jane workings. However, as a result of the 1985 International Tin Crash, both Mount Wellington and Wheal Jane closed and there followed a phase of land reclamation during when many of the bare areas near Taylor's were ploughed and seeded with heather. The valley was acquired from Carnon Consolidated by Gwennap Parish Council in about 2000 (Joseph 2004).

6 The structures

Taylor's 60"/85" pumping engine house SW 74552 42091

See Figures 3-7, 9-34, 82.

This building originally housed a pumping engine acquired in 1826, this being a modified 40"/70" cylinder compound built by Harvey and Co, originally erected at Wheal Alfred by John Taylor, where it employed Arthur Woolf's patent cast iron boilers. At Wheal Alfred this engine had been involved in a trial between compound engines and large single cylinder engines (Barton 1969). On arrival at the Taylor's Shaft site it was converted to a single cylinder 70" engine (*ibid*). In September 1835 the engine was re-cylindered to 85", presumably with a new beam. The engine was still in use in 1861, when it was recorded as being equipped with four 10 ton Cornish boilers, and it was still drawing water from the mine in 1869 when it was working at 9 ½ strokes per minute, raising 912 gallons per minute from 30 fathoms below adit. The engine was stopped shortly after this, and was no longer operational by the summer of 1870 when all pumping at Clifford United was finally stopped and the mine was closed (see Figs 4 and 5).

Probably one of the oldest surviving engine houses in Cornwall, and certainly one of the largest of that group (at 9.6m x 7.05m in plan and 13.5m high), Taylor's pumping engine house with its large detached stack overlooks the bare desolation of the Wheal Maid Valley. Typically for an early engine house, the construction is all of killas masonry, roughly coursed, but with granite long and short work framing the wall corners, as quoins around the window openings, the massive lintel over the boiler house door, the drip ring on the stack, and for the voussoirs and keystone over the four-centred plug door arch (Fig 21).

The stonework forming the bob wall corners consists of 43 alternating long and short granite quoins, this wall being 1.82m thick (Fig 16). A small number of these have holes drilled into them, whilst one on the north-western corner of the building at the level of the top of the plug door opening has been partly cut away, possibly to accommodate a now-lost piece of equipment. There are also a number of sockets cut into the masonry of the bob wall, possibly originally for fixings which tied back the shears which would have stood over the shaft and which were used for the installation and maintenance of the pitwork. Limited excavation during the works to install a ring beam and grille over the shaft during 2008 revealed that the engine house had been constructed in a fairly shallow foundation trench, this being exposed on the eastern side of the building, where it had been backfilled with coarse mine waste.

Unsurprisingly in this early structure, no tie rods were incorporated into the building, though evidence for elongated timbers used as flexible ties within the masonry survived on the inner face of the offside wall (Figs 12 and 13); a rather flimsy tie may have run through the house behind the bob wall at the level of the upper floor. The other walls incorporated hardly any granite and are around 1.0m thick, the side walls lacking erection steps. The rear wall, and the rear and upper parts of the side walls had collapsed over the years or had been deliberately demolished (Figs 9 and 15), and there are no archive photographs of this building, so the original arrangement of wall openings in the house could not be determined. There would, however, have been a large cylinder doorway at ground level and windows on the middle floor and bob loft in the rear elevation. Whilst all evidence for the windows had been lost with the demolition or collapse of the rear wall of the building, the lower parts of the cylinder doorway were found to be buried beneath a mound of rubble over the low remains of this elevation (Figs 18 and 19). On the nearside wall are the boiler house door (Fig 20) and above this, a blocked window, whilst near the base of the wall is a possible steam pipe opening; on the offside wall there is a door opposing the boiler house door, above this a pair of windows (the rearmost being blocked in with masonry). All wall openings have flat heads with elongated timber lintels. The leading edge and part of the cill of the girder opening also survive on this elevation. Fortunately, the lintels over the doorway in this elevation (as on the western wall) were constructed of granite throughout, helping to stabilise the forward part of the engine house.

Internally, two massive pockets above the plug door crown must have carried the longitudinal timbers supporting the first floor (Fig 11), whilst the upper floor position is represented by two further moderately large pockets along the line of the wall step at bob wall height in the side walls. The steam pipe hole seems to have been set below the boiler house door opening. Any remains of the cylinder plat that might have survived were obscured by rubble which also part-filled the cataract pit. The plug door design is typical of these John Taylor engine houses (a similar design can be seen at Shear's pumping engine house at Cusvey, built in the same year) - although its head is a full arch internally, the width has been part-closed on the external wall face to create a narrower flattened arch at its head, the external width of the plug door being 1.08m, the internal width 2.0m and its height 5.4m (Fig 11). Granite was used extensively around the inner opening as quoins, and in the voussoirs. As in other early engine houses, longitudinal stiffening timbers were incorporated into the masonry at a number of levels (Figs 12 and 13). At Taylor's these were just below the level of the top of the bob wall and below the window cills on the two side walls of the house; on the bob wall a similar timber spanned the full width of the construction just above the plug door arch. Most of these timbers had rotted away to a substantial degree, or had now become completely lost.

Traces of the masonry of a substantial surface balance bob plinth had survived on the nearside of the shaft adjacent to the bob wall, though most of this feature was removed during operations associated with constructing foundations for the shaft grille in 2008. No evidence for the surface balance bob arrangements suggested from archive plans of the site as having been to the east of the shaft, and it was concluded that this feature must have been constructed entirely above ground.

Research has shown that Taylor's pumping engine house is an important and early Cornish industrial structure, though one, which, as a result of neglect and age had reached a stage where urgent and substantial conservation measures would be required to save it. In an area where the advent of steam power was so crucial to the development of mining technologies within Cornwall, this was one of the few remaining recognisable structures. One of the principal routes of the Mineral Tramways footpath network runs close to this engine house and, in the absence of structural and conservation works, the decay and eventual loss of this engine house would be significant, both for the area, and for Cornwall as a whole.

The pumping engine house was the second structure to be conserved as part of the Taylor's and Davy's work programme. In late August and early September 2012, as part

of the preliminary phase of the project, some scrub vegetation was strimmed back around Taylor's pumping engine house, whim engine house and chimney. A cherry picker was then brought onto site to enable the hand removal of the dense mat of ivy covering parts of the pumping engine house and a structural inspection of its masonry to be made and the specifications for the work programme to this building to be drawn up (Fig 17). The presence of the cherry picker also allowed a detailed bat roost survey to be undertaken.

Before the scaffolding could be erected, a wheeled excavator had to be brought onto site in early February 2013 to remove the dense mat of Cotoneaster from around the building, to partially remove piles of loose rubble adjacent to the walls, and to provide a reasonably level access route (Fig 18). Prior to this work, almost no trace of the rear wall of the engine house had been visible, but it was decided to carefully excavate away the approximately 1.5m high rubble pile occupying its site and spilling into the interior of the engine house. The removal of this material from both outside and inside the engine house revealed the remaining lower courses of the back wall of the engine house, including the reveals of its 2.95m wide cylinder doorway (Fig 19). Within the engine house, it had been hoped that the excavation of the rubble sloping down into the site of the cataract pit behind the bob wall would expose the cylinder plat and remaining granite bedstones, but these were not found, indicating that the engine had been removed for sale, rather than being scrapped *in situ* (bedstones being treated as engine components, rather than parts of the engine house). Only fragments of the leading face of the cylinder plat were found to have survived, and it was decided to produce a graded and stable rubble slope within the interior of the building, rather that to attempt its full excavation, something which would have been have to be predominantly undertaken by hand, and which would have exposed little diagnostic detail, but a considerable amount of unstable, ruinous masonry, as well as requiring the installation of potentially intrusive features to protect visitors from falls.

The erection of the scaffolding on this structure took place from mid February onwards as lifts were taken down on the adjacent chimney, the scaffolding being complete by late March. A full inspection of the building was undertaken once this was in place. The bob wall was found to be largely sound, being of notably more substantial construction than the remainder of the building, and the removal of the remainder of the vegetation on its wall top had revealed four equally-spaced channels set across its width which had clearly once contained built-in timbers which had originally supported the substantial bob trunnion bearer timber (Fig 29); the outer two of these would have been continued on beyond the face of the wall to support the bob platform which allowed maintenance of the bob nose bearing. On the wall's internal elevation, some loss and distortion of masonry had resulted from the rotting out of longitudinal timbers set into the wall face above and below the pockets for the first floor support timbers and just below the wall head, but no significant instability resulting from this decay was identified.

The upper sections of the eastern wall had distorted somewhat due to the rotting of some of the longitudinal timbers built into the wall faces, particularly within the internal elevation, and the loss of support to masonry above these, but the masonry had not moved to a degree where it was judged that it had become significantly unstable, requiring dismantling and reconstruction. Some limited failure of the masonry over the failed lintel above the northern first floor window had occurred on the outer elevation; the rear window had been historically infilled with masonry which had provided support to the stonework above the lintel, despite its deterioration. The northern reveal of the girder opening remained visible, but to the rear of this feature all walling had collapsed down to about a third of its original height at the southern end of the building. On the internal elevation of the eastern wall, although several longitudinal timbers had rotted away, these had been of no significant depth, and although some limited stone loss had occurred, no major movement of the masonry had occurred.

Less remained of the western wall of the building, where significant collapse had clearly occurred some years ago. Towards the rear (southern end) of the building, only a third of

the elevation had survived. Adjacent to the bob wall, a panel of masonry which had not been tied into the remainder of the structure represented an infilled first floor window; the surviving section of masonry to the south of this was leaning inwards and it was judged that this would require dismantling and reinstatement. The collapse of the upper sections of this wall had occurred at around the level at which the longitudinal timbers had been incorporated, almost certainly as a result of their rotting out, removing support to the masonry above. The granite lintel over the doorway at the northern end of this walling at ground level had snapped, presumably as a result of loads imposed on it during the catastrophic collapse of the upper section of the wall.

The southern wall of the building had been invisible prior to the removal of the rubble pile which had covered it. Whilst the whole of the upper part of the wall had been completely lost, possibly as the result of deliberate demolition, as the area to the south of the building did not contain any significant quantity of collapsed masonry, the rubble mound had preserved and stabilised the surviving lower part of the walling, including the dimensions of the diagnostic cylinder doorway, which was 2.95m wide (116 inches). Its reveals to the west were in good condition, standing to 1.4m high; those to the east were more fragmentary, though their location was clearly visible, and it was decided to reconstruct them to stabilise the somewhat overhanging exposed wall end above them and to assist in the interpretation of the building. 1.5m height of facing was reconstructed on the eastern reveal (Figs 25 and 27). The rear wall was found to be 0.9m thick.

The stone used in the construction of the engine house was found to be of variable quality; that used in the bob wall incorporating better and larger individual stones; this wall, which carried the majority of the dynamic loads exerted on the building from the operation of the engine bob also incorporated a considerable quantity of shaped granite. Elsewhere within the building, generally smaller and in some cases rather inferior pieces of locally-sourced metamorphosed siltstone had been used in its construction. These had been bedded in a burnt lime based gauging mortar which was found to be of variable quality, this being dependant on the degree to which it had been infiltrated and degraded by water making its way in through the exposed wall heads. The original pointing had utilised a similar mix, some of this material on the exposed western side of the building having cured to a considerable level of hardness; on the eastern, lee side of the building, mortar loss through turbulent wind erosion was more noticeable. The only bricks utilised in the construction of the engine house consisted of broken pieces, these generally had been used to infill former putlog holes. A small section of original lime plaster had survived in the arch head of the plug door opening (Fig 21), this indicating two phases of application. Elsewhere within the building, all traces of the internal plastering, and of details of original fixtures and fittings had been lost since the building had been unroofed on the abandonment of the mine in 1870.

With the scaffolding in place, the masonry infill to the rear of the of the middle floor western wall window was carefully taken down and reconstructed, recessed stainless steel helicoil bed jointing being installed to tie the replacement panel into the adjacent masonry. All the surviving original decayed incorporated timberwork on the inner face of the building was removed and replaced in oak, this consisting of lintels and cills to the substantial wall pockets for the middle floor bearer timbers and a further full width timber set into the wall just below its head (Fig 28). On the western wall, an inset timber was replaced at the height of the cill of the middle floor windows (Fig 31); others full length timbers were replaced on the inner face of the eastern wall, these forming lintels and cills for the middle floor windows; another was set into the wall in the original socket below the top of the bob wall. On the external eastern elevation new lintels were provided for both original window openings.

Almost all original pointing (with the exception of some of that on the bob wall) was cut out to a depth of at least 50mm and replaced. Where individual stones had significantly deteriorated or had been lost, these was replaced; additional stonework recovered from rubble piles was used to reconstruct limited areas of broken wall ends where its

replacement was required to confer an adequate level of structural stability. Stainless steel helicoil bedjoint reinforcing wire was incorporated into joints on the bob wall and eastern wall to confer additional structural stability, and the broken lintel over the western ground floor door was drilled and pinned using a stainless steel rod epoxy resined into place (Fig 24). Where wall pockets or openings had become enlarged through stone loss and their original forms could be deduced, these were reformed; where their original forms were unclear they were stabilised through deep pointing. All wall head stonework was lifted and re-bedded to prevent further water ingress and deterioration of wall core mortars.

The majority of the work on this building was undertaken in May and June 2013. On completion of the works, ground levels in and immediately around the building were landscaped to remove rubble and other trip hazards.

Chimney serving Taylor's pumping engine house SW 74532 42074

See Figs 3-7, 35-49, 82.

This large stack is set back from the pumping engine house, which is 20m to its south, was set back from the corner of the former boiler house and is 4.2m in diameter externally at its base and 2.6m in diameter internally. The lowest 2.0m of the interior of the chimney was lined with brick. Above this level the diameter increases slightly for another 2.0m; above this there is another slight increase in diameter. The flue entry is to the north, where fragments of the eastern side of the flue survive to about 1.25m high. Rings of putlog holes can be seen at regular intervals within the build of the chimney (Figs 35 and 36), whilst the drip ring is made up of twelve curving granite segments, their lower faces being flat, their upper faces convex curved. Above this, the mortar in the red brick cap had failed, and the stack was badly distorted (Figs 36, 37 and 39). Fifty five courses of brickwork survived as intact courses, above these between three and six courses survived to give the chimney a ragged top profile, giving a total surviving brickwork height of sixty one courses. It is uncertain what the original height of the chimney would have been, but it is unlikely to have been considerably greater than this. The majority of the brickwork had been built in alternate header and stretcher courses.

The chimney was the first structure to be conserved at Taylor's Shaft, work commencing in early February 2013 and being completed by early May. A full scaffold was constructed off ground level at the chimney base, whilst an access bridge and walkway were built to connect the level ground adjacent to the compound to the west to the main scaffold structure. This access way was secured to prevent unauthorised access. A preliminary inspection of the chimney was then undertaken, revealing that the top five courses of the chimney where the greatest failure had occurred had been constructed in header courses nine inches deep. The mortar bedding on these courses had failed to the point where the joints had opened up loosening the brickwork, with the result that some bricks had fallen to the ground below and others were found within the interior of the chimney. The upper profile of the chimney was ragged. The remainder of the bricks in these courses could be picked off by hand (Fig 39). The chimney at this level was 1.8m in diameter internally. Below this level, the brickwork was one and a half bricks thick over a height of 2.5m, the mortar bedding becoming increasingly sound further down its height.

Following the inspection, it was decided to prioritise the reconstruction of the loose brickwork to lessen the chances of vandalism to these components, given that this part of the chimney had been rendered readily accessible following the construction of the access scaffold. In order to facilitate the installation of the lightning conductor, it was decided to reconstruct the top profile of the chimney with a level profile, utilising both the bricks still remaining *in situ* on the chimney top, and any which could be recovered from the ground below, together with a relatively small number of new bricks where the originals had deteriorated to the degree where they could not be re-used after cleaning. These where used on the interior of the chimney to prevent them being visible (Fig 40). The top thirty two of the sixty one courses were dismantled, cleaned of adhering mortar, temporarily stored on the scaffolding lifts and rebuilt as twenty nine complete courses of

brickwork, recessed stainless steel bedjoint reinforcement being installed at intervals to help to tie the courses together. As soon as the mortar had cured sufficiently, the lightning conductor was fixed to the crown of the top brick course and the upper scaffolding lifts were dismantled.

The stonework and mortar making up the remainder of the chimney was also inspected. Both were found to be of variable quality and condition. In general, the masonry nearer the base of the stack was found to be of higher quality, and incorporated large elongated stones which had been hand trimmed to match the external curve of the chimney (Fig 44). Further up its height, it appears that the stock of higher quality local metamorphosed siltstone had been somewhat depleted, and poorer quality, somewhat smaller-sized material had been used in the build (Fig 43). This particular stone type is characterised by interbedded layers of harder and softer material, the harder layers sometimes being notably quartzy, the intermediate layers being found to have sometimes having degraded to the point where they were soft enough to be eroded by wind and rain. Erosion of the more susceptible stonework was particularly notable on the lee side of the chimney to its east and north. The mortar utilised by the original builders had been based on a burnt lime mix, and, over the course of some 180 years, had cured to a high level of hardness (Fig 42), to the degree that, in places, it stood somewhat proud of the face of the eroded stonework. The condition of the mortar was generally good (though locally poor) and the original mortar beds were often thin and the stonework had ben closely and carefully set in rough courses (Fig 46). Timber putlogs to support scaffolding had been built into the chimney as it had been constructed, these being on average 100mm square in section (Fig 43). On completion of the building work they had been sawn off flush with the outer face of the chimney. Most had subsequently rotted out, leaving 100mm square and 300mm deep rings of sockets in the outer face of the chimney at around 2m intervals vertically up it, though in places, the remnant timbers had survived.

Where the mortar pointing was found to be sound or the bed joints were so narrow that removal of the pointing to replace it would have run the risk of damaging the arrases of the stonework, the mortar was left in place, 60% of the pointing eventually being replaced (Figs 42, 44 to 46). Softer pointing or areas of partially lost pointing were selectively cut out and a hydraulic lime mortar was used to repoint these areas. Following its first cure, the mortar was wire brushed to a final profile, allowed to dry and then tamped up with a churn brush. Following its final cure, the mortar took on an appearance very similar to that of the original pointing.

Limited hand excavation was undertaken around the base of the chimney. It had originally been suggested that material which had apparently banked up against the southern side of the chimney was exerting unwanted ground pressure on its base and should be removed, but it was noticed that this material incorporated the upper courses of a partially buried unmortared wall (this being shown on the *circa* 1877 OS 25" mapping as part of a yard enclosing the boiler house), and this work was not undertaken. Excavation was therefore limited to the removal of a small amount of material to allow access into the flue opening to the chimney in order to provide access for the steeplejacks who would attach the lightning conductor to its interior. Once this had been completed and the earthing mats installed, a galvanised steel gate was constructed and fitted into the flue opening to prevent the theft of the exposed lightning conductor tape within the chimney (Fig 49).

The associated boiler house to the west of the engine house is represented by an area humped, disturbed and cotoneaster-grown ground. The plan of this large building, which contained four large Cornish boilers, can be identified from archive maps and plans (Figs 3-5). This had been completely demolished on the closure of the mine to allow the removal of the boilers. During operations to cap Taylor's Shaft, elements of an earlier boiler house were found at low level next to the north-western corner of the engine house and projecting forward from it, suggesting that a significant re-arrangement of this structure had taken place, probably when the engine was replaced in 1835. Parts of the

flue arrangement between the chimney and the boiler house were exposed during trenching for the lightning conductor earthing (see below).

No works were undertaken on the boiler house site during the 2012/13 works programme.

Taylor's/Consol's Whim SW 74532 42074

See Figures 3-7, 50-68, 82.

Upslope from the remains of Taylor's 85" pumping engine house, an isolated chimney stack stands within an island of vegetation in a sea of bare, heavily landscaped waste dumps. The few scraps of masonry attached to the stack, and the partly-buried debris that was, prior to works, overgrown with cotoneaster represent the last remnants of an early (pre 1836), small (24"), probably all-indoor beam winding engine house, in plan approximately 6.8m long and 4.5m wide, now surviving to 5.5m high. Immediately to the north-east is a somewhat inchoate masonry structure measuring 4.7m x 1.7m and 0.9m high, this representing the remains of the whim loadings. The engine operated until at least 1861, when it was described as having a single four ton boiler.

From what is left on the ground, very little can be said about the original form of this structure. However, on the 1878 OS 1:2500 mapping, the engine was shown as an unroofed structure measuring 10m x 7.86m in plan with a chimney incorporated into its south-western corner. Four metres to the east of its north-eastern corner were the whim loadings measuring 8.17m x 5.12m in plan. Taylor's whim shaft is 35m to the north-west of the loadings, which were shown as being divided in two along an east-west axis. By 1907 (OS map evidence) the chimney might have become truncated, but both the engine house and the loadings had survived. The engine house was shown on a 19th century mine section (Fig 7), though this source shows a gabled-roofed building with its chimney attached to the far end of the boiler house, which does not square with the physical evidence, which suggests that the engine house had a fully hipped roof, the chimney being built into the engine house and not detached from it.

Only fragments of the south-western rear corner of the building survived to any substantial height, and only then, where attached to the stack (Figs 50-53). Within this masonry, the edge of a timber lintelled opening in the remains of the rear wall could be seen (possibly the cylinder doorway), whilst on the nearside (to the west), one edge of a lintelled doorway leading into the small boiler house could be made out. The original appearances of the other walls of the engine house are unknown. They are likely to have been constructed of roughly dressed killas, almost certainly without granite quoining, and would have incorporated a number of relatively small windows.

No evidence for these survives, though they were almost certainly square-headed, with plain timber lintels throughout. Within the house, little evidence for any diagnostic detail survives. The stack is plain, truncated, and built wholly into the nearside rear corner of the house (though utilising slightly different stone), alongside which can be seen the outlines of an elongated structure for a single boiler, the interior of the boiler house appearing to be 3.0m wide. The brick arched flue entry into the chimney from the interior of the boiler house (Fig 54) is in its northern side, whilst an ash raking hole into the base of the stack is to its south (Fig 56). Nothing diagnostic could be made out amongst the overgrown rubble representing the location of the forward end of the house, or on the site of its boiler house. The engine house stands on a mound of material, and it was not evident until the lightning conductor trenching took place the significant proportion of the building which was buried below this material (see below).

Whilst the relatively small proportion of the engine house that survived was in a fairly stable condition, the chimney could be seen to be actively deteriorating (see in particular Figs 59-60). If it had originally had a brick upper section, this had been completely lost, together with parts of the upper section of its stonework, a collapse from this area occurring shortly before the start of the works contract in early 2013. It was evident that

unless this feature was stabilised there was a real risk that it would suffer considerable further collapse.

Thick mats of Cotoneaster surrounding the building and covering the whim loadings had been cut back (with some difficulty) during early 2013 to allow the survey of this building. Little more had been revealed other than some additional detail of the remains of the whim loadings (Fig 55) and parts of the upper sections of the boiler house walling. The latter proved to be rather poorly built, and it was decided not to expose them further, but to consolidate the limited amounts of masonry which protruded from the ground surface (Fig 56). Hand excavation also revealed further detail of the flue opening from the chimney into the boiler house (Fig 54).

The basal 2.0m of the building were consolidated in advance of the erection of the access scaffolding; the opportunity was also taken to stabilise the remains of the whim loadings. Vertical tunnels within the masonry which would originally have contained the hold down bolts for the machinery sited on this mass off masonry were considered to represent significant potential trip hazards; these were partially infilled with salvaged brick so that their locations remained visible but the hazards they posed to visitors were considerably mitigated.

The erection of the scaffolding allowed a detailed inspection of the structure to take place. As had been suspected from ground level inspections, the upper section of the chimney was in a dire condition and on the verge of collapse. Significant delamination had already taken place, and major cracking was evident, this being fringed by large areas of loose, unstable stonework (Figs 59-60). The engine house was found to be of significantly better build quality than the chimney; in addition, the quality of the stone in the surviving section of chimney was noticeably poor, and in places so soft that it had almost completely decayed. Protruding pointing was evident where the stonework had eroded back as a result, whilst almost all internal pointing had been lost.

Except where the original pointing was judged to be of serviceable quality and could be left in place, it was cut out to an average depth of 50mm and replaced. Broken wall ends were also repointed and wall tops lifted and reset in a lime based bedding mortar. Wall pockets were re-formed where required, and a section of new masonry was constructed to support an overhanging section of the eastern wall. Sections of oak were installed at the original locations of the lintels over the eastern doorway and the doorway into the boiler house at the northern end of the western wall (Fig 63). These were installed as stubs to indicate the locations of the original doors and assist with the interpretation of the building. Following limited hand excavation, it was possible to interpret the original form of the flue opening into the chimney from the boiler house. As most of the brickwork had been lost, destabilising the masonry above and leaving it unsupported, it was decided to re-form this brick arch-headed feature using salvaged bricks (Fig 66). The ash clearance opening on the southern side of the chimney was partially buried below ground level (Fig 65). This was more fully exposed during excavation for the installation of the lightning conductor and some limited degree of consolidation of this feature was undertaken.

The most significant component of the works to this building concerned the conservation and partial rebuilding of the remains of the chimney. Much of its pointing had rotted away or fallen out, and some individual stones had decayed to the point where they had lost all coherency. This had resulted in significant areas requiring replacement. The whole of the upper section of the chimney was found to be unstable and would have to be taken down and rebuilt, the rebuild incorporating helicoil bedjoint reinforcement to tie it together.

It was decided that it would be inappropriate to reconstruct the chimney to a level top profile as this might imply that this represented its original (unknown) height and appearance. Temporary profiles were set in place and the chimney was photographically recorded before the dismantling of its upper sections. Much of the remaining top stonework was found to be held in place solely by gravity, given the extent of mortar

loss, and it was evident that solely repointing and adding in some lost stones would be insufficient to confer an adequate level of stability to the structure. Given the very unstable profile of the semi-collapsed upper section of the chimney, it was not possible for this to be exactly replicated during the rebuild; nevertheless a broken top was re-created which preserved its pre-consolidation appearance (Fig 67).

Davey's whim engine house SW 74819 42123

See Figs 3-6, 8, 69-81.

From near the base of the extensive dump of pink shillet produced as a result of Mount Wellington's quarrying operations to create tailings dam bunds and the landscaping of this upper valley side protrude the battered remains of a small and early (*circa* 1835) winding engine house (Fig 69). This measures approximately 6.0m x 5.3m in plan with walls 0.66m thick, the remains standing to a maximum of 5.5m high. The engine was probably started in the early 1830s, but was not listed as being at work in 1861 (Barton 1969), by when had probably become redundant. The 1878 OS mapping showed a structure measuring 10m x 5.36m in plan, with a detached chimney set 4.45m to its south, the location of this feature suggesting that the boiler house (which had already been demolished by that date) had been set on the eastern side of the engine house (Fig 4). The whim loadings would have been on the eastern side of the house, serving a major shaft to the north (one of a closely-set pair with Davy's Engine Shaft). The chimney appears to have been demolished between 1877 and 1907 (OS mapping evidence, Figs 4 and 5), though the engine house still survived at that date.

The engine house seems to have been simply and lightly built, and was apparently constructed of thin pieces of the soft local killas throughout, no granite quoins being used in the building; no tie rods or incorporated stiffening timbers seem to have been employed. No archive photographs of this small engine house have been identified, and as most of the forward part of the building has collapsed, its original appearance is uncertain. The closest surviving parallel for this building is likely to be the Levant whim engine house at Pendeen, suggesting that the building may well have been comparatively windowless. Parts of one 1.25m wide square-headed opening in the rear elevation survives – from its position within the wall and the considerable amounts of material now dumped against the outer face of this wall, this was clearly a window. What remains of the wall head above is level rather than gabled, indicating that the roof would have been hipped; this detail indicates that the building was for an all-indoor beam whim. About half of the lengths of the side walls survive, but there are no traces of windows in the surviving masonry. The front wall had gone completely.

Internally there is little to see in the way of detail beyond one or two joist pockets, the 2.0m wide, 1.3m high cylinder loading across the southern end of the building and what is likely to have been a low level steam pipe entry opening in the north eastern wall. The interior of the house was part-filled with rubble. The loading, chimney stack and boiler house had gone, leaving no physical clues as to their locations or arrangements, though a low-level opening in the eastern wall of the engine house suggests that the boiler house would have been to the east of the building. Ground levels to the north of the engine house had been significantly altered through the construction of a 20th century mine haul road. Prior to works, Cotoneaster covered substantial parts of the building whilst ivy had taken hold on some parts of the walls and *Asplenium* ferns had taken root on the wall heads (Figs 70-74).

The building was clearly inherently fragile, and with the loss of so much of its pointing, and the structural rigidity that the lost sections of walling other walls would have conferred, it was approaching collapse. Both side walls were beginning to lean outwards in their upper sections, and extensive cracks had developed in their masonry. Rubble obscured internal detail, whilst thousands of tons of quarry waste dumped at the rear of the building had probably buried any surviving remains of the boiler house and stack for ever.

It had been suggested that, being in such an advanced state of decrepitude and so unprepossessing, this building should not be repaired and should be allowed to collapse over time. However, the engine house stands next to one of the major routes making up the Mineral Tramways footpath network, and is one of the half dozen oldest surviving engine houses in Cornwall.

Preliminary works on this part of the site consisted of the clearance of scrub and shrub vegetation from around the building, this consisting of self-sown Buddleia to the south east, Gorse and Buddleia to the north east and Cotoneaster to the north west. An access road was cut through mature European gorse and Cotoneaster from the nearby haul road to the north of the building, revealing elements of a largely collapsed masonry wall under the Cotoneaster which would have run more or less parallel to the north western face of the building; it is unclear what this walling represented. A short and largely collapsed section of walling running north eastwards from the north eastern face of the building appears to be the last remnants of the original boiler house structure. Ground levels around the south eastern and north eastern faces of the building were reduced slightly to reduce ground pressure on the walls, revealing an additional small low-level wall opening near to and at a lower level of the steam pipe entry opening, this probably being for the cylinder condensate drain pipe.

The structural problems experienced by this building, as found, were manifold. Landscaped material pushed up against the south eastern end of the building were thought to be exerting loads on the walling, much of the structure had collapsed, what remained was structurally inherently weak and had suffered displacement, the stone of which it had been constructed was soft, eroded and of poor quality, and almost all of its original pointing had been lost to decay and by erosion by the elements. It had also become almost completely engulfed by vegetation and shrub growth. It was evident that, without significant remedial attention, its collapse was inevitable.

Once sufficient of the vegetation surrounding the building had been cleared back and some limited degree of levelling undertaken in and around it, the engine house was fully scaffolded and inspected. The south eastern wall was the most intact, and was repaired by 100% repointing (little hacking out of original pointing being required), the rebuilding of minor areas of the stonework where losses had led to unsupported sections above them, the re-building of the wall top stones and the installation of two oak lintel stubs in their original positions in the south-eastern wall, together with small areas of surrounding stonework. Minor stonework repairs were undertaken to the cill of the window opening, in part to further assist in deterring visitors climbing onto the walling at this point.

As noted, the two side walls (to the south west and north east) were visibly bowing outwards. In order to arrest any further movement, a tie rod and crossed plate patrasses were installed through the south eastern ends of these walls (Figs 77-78). These two side walls were 100% repointed internally and externally, stainless steel helicoil bedjoint reinforcement being installed to add further structural rigidity to the building. Broken wall ends were stabilised through full repointing and limited rebuilding where required on structural grounds. During the installation of the tie rod, the upper sections of the walls were dismantled and rebuilt in fresh bedding mortar (Fig 77). The decision was taken to reduce the height of the northern end of the north eastern wall to some degree during this operation given the poor quality of the stone used in the original construction, the need to utilise salvageable stone in the southern end of the building, and the unstable original profile of the northern end of this wall. The steam pipe entry opening and the cylinder drain opening were partly re-formed and rebuilt to stabilise them (Fig 79).

Within the building, the face of the cylinder plat was cleaned and repointed (Fig 80), an original opening in this structure being retained as found. The upper surface of the cylinder plat was left blanketed in soil and vegetation to protect it from water ingress, as no surviving stone surfacing was found here.

7 Detail of consolidation works

Full details of the specifications for the consolidation programme and allied works carried out in 2013 are contained within pdp Green Consulting's project report file (Newman 2013). The following summarises those elements relevant to the scope of the HE consultancy.

Mortar mixes

Test panels utilising three different mortar mixes were put in place on an interior elevation of Taylor's pumping engine house at the outset of the project. Each was mixed utilising a 2.5:1 mix of NHL 3.5 hydraulic lime and a CLS sand, the mixes using CLS25, CLS26 and a 50:50 mix of CLS 25/26. These were tamped up, protected from the elements and allowed to cure for several days before inspection. The test panels were assessed in terms of their colour and texture for suitability of use on the buildings to be conserved, it being decided that a single mix would be used throughout, given that a similar stone source had been used in the construction of all of the buildings. The chosen mixture was that incorporating the CLS25 sand.

Repairs to Taylor's Shaft grille

Taylor's Shaft had been covered with a bolted multiple section steel grille in 2008. This was found to have been interfered with at the outset of the 2013 project, bolts in the southern panel having been removed to allow access for underground explorers. The panel was temporarily re-fixed at this time. Unfortunately, when the scaffolding was installed on the adjacent pumping engine house, unidentified vandals gained access to this and dislodged a number of large wall topping stones from the bob wall, throwing them onto the grille, badly damaging one of its sections and bending several bars on another.

A temporary cover was placed over the damaged grille to prevent any risk of accidents and a replacement section for the most badly damaged part of the grille was ordered from a local steel fabricator. In the interim, however, other unwelcome site visitors took a number of scaffold boards and pipes from a nearby storage area and threw them down the shaft. Most fell all the way to the bottom and are lost forever in the depths of the shaft, but a number lodged a short way down it. An experienced rope access team from St. Ives Steeplejacks wearing appropriate harnesses and working off fixed ropes recovered the accessible scaffolding materials from the upper part of the shaft before re-fixing the new section of grille.

Installation of lightning conductors

The project specifications called for the installation of lightning protection to Taylor's pumping engine house detached chimney and Taylors' whim. It was not felt necessary to similarly protect the pumping engine house given its close proximity to the much higher chimney, whilst Davy's whim is in a low-lying position and was not thought to be likely to be at risk from lightning strikes.

At Taylor's pumping engine house chimney, a trench averaging 1.0m wide and 1.2m depth was excavated from the flue opening on the northern side of the chimney for a distance of approximately 3.0m following the line of the surviving flue walling to the east; at its end, the trench turned to the east, being excavated for a further 12m. The first section of the trench was cut primarily through a layer of redeposited stony rubble mixed with ash; to the east the remnants of a low brick walls was encountered on the southern side of the trench, this probably represents the southern edge of the flue connecting the chimney to the boiler house. The trench fills consisted of collapsed brick, stony rubble and abundant Cotoneaster roots. Steel plates bolted to the copper earthing tape were buried at 1.0m intervals along the length of the trench, which was backfilled and compacted.

At Taylor's whim, a trench 1.0m wide was excavated southwards from the ash cleaning opening at the base of the chimney for 15m. The first section of the trench was within

the mound on which the remains of the engine house survived. The ground make up here was found to consist of redeposited mine waste and rubble overlying a buried topsoil whose surface (which might have been contemporary with the engine house though certainly predated mining operations) was found at 1.5m from surface near the engine house. At the southern end of the trench (away from the mound siting the engine house) the top of this topsoil layer was found at 500mm from surface. Trenching beneath this land surface was in subsoil and degraded shillet bedrock with poor moisture retaining qualities, and as a result the trench was deepened to a maximum of 3.0m where a rather more clay-rich layer was located which, it was hoped, might achieve the desired results. The earth mats and tape were laid in the base of the trench, which was backfilled and compacted wit the arisings, the damper, clayey material being emplaced adjacent to the earth mats.

Track and path creation works

A broad ramped access track had been excavated in 2008 through the eastern edge of the dump of material deriving from the excavation of the Wheal Maid Decline in order to provide a vehicular access route to Taylor's Shaft during shaft capping operations. The 2013 site compound was located close to the western end of this ramp, which was utilised as the contractors' access to the pumping engine house during the works.

There was no pre-existing access to Taylor's whim or Davy's whim, however. A short section of roadway had been created running eastwards from the levelled area in front of Taylor's pumping engine house to assist in the disposal of arisings from the 2008 shaft excavation. This was re-opened in 2012/13 and a steeply ramped access route was created down the slope from its eastern end to meet the former mine haulage roadway running eastward along the valley side past Davey's whim engine house. A further section of track was excavated from the mine haulage road to a location immediately to the north of Davey's whim engine house to provide contractors' access. A further section of mine haulage road gave access to the levelled area to the south of Davy's whim, whilst an unformalised route across the landscaped area to the south of the building was utilised to gain access to a location immediately to the south of Taylor's whim engine house.

On completion of the conservation works programme to the buildings at Taylors' and Davy's Shafts, additional levelling and surfacing of some sections of these access routes was undertaken to provide footpath routes from the valley base to these sites, a small amount of additional excavation being undertaken to the east of Davy's whim and to the east of Taylor's Shaft to enable a circular route between the buildings to be created. There were no archaeological implications to this work.

Pre-construction and as-built drawing record

A survey of the three engine houses and Taylor's chimney was undertaken by Nationwide Surveys Ltd prior to the works contract. These were amended on site to add in missing or incorrect detail by Historic Environment Projects in 2012 and supplied in *.dwg (AutoCad) format to Ainsley Cocks at the Cornish Mining World Heritage Site office, who passed them on to contractors tendering for the management of the conservation project. The successful project managers, pdp Green, amended these to produce 'as-built' drawings during the project. The finalised drawings were further checked for accuracy by Historic Environment Projects on completion of the works.

8 Discussion

The conservation and access works to the engine houses and chimney at Taylor's and Davey's Shafts were undertaken to a high standard, and should ensure that these historically important and highly visible buildings will stand for many decades without any requirement for further conservation and will be readily accessible to the many visitors who use the nearby Mineral Tramways Coast to Coast Path. Interpretation panels currently being commissioned by Gwennap Parish Council with the assistance of

HE Projects will complement these works, and provide much-needed information about the history of this valley and the achievements of the men and women who worked here.

The conservation of these early industrial buildings at the heart of the Gwennap mining district has taken many years to achieve and in the case of Davey's whim engine house, it was undertaken just in time. Rescuing this humble building from otherwise inevitable collapse represents something of a milestone in the conservation of Cornwall's industrial heritage, in that for many years, unspectacular buildings of this type have been routinely allowed to collapse, or have been demolished as being of no intrinsic worth, leading to a gradual erosion of the range of elements making up the landscape of industrialisation in Cornwall.

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9.3 Websites

http://www.heritagegateway.org.uk/gateway/ English Heritage's online database of Sites and Monuments Records, and Listed Buildings

10 Project archive

The HE project number is **146221**

The project's documentary, photographic and drawn archive is housed at the offices of Historic Environment, Cornwall Council, Fal Building, County Hall, Treyew Road, Truro, TR1 3AY. The contents of this archive are as listed below:

1. A project file containing site records and notes, project correspondence and administration.
2. Electronic drawings stored in the directory ..\CAD ARCHIVE\Sites T\Taylors and Daveys Shafts structures conservation 2013
3. Digital photographs stored in the directory ..\Images\Sites\SITES.Q-T\Taylors and Daveys Shafts structures conservation 2013
4. English Heritage/ADS OASIS online reference: cornwall2-162391

This report text is held in digital form as: ..\HE Projects\Sites\Sites T\Taylors and Daveys WB 2013\Taylor's and Daveys Shaft structures conservation report.doc

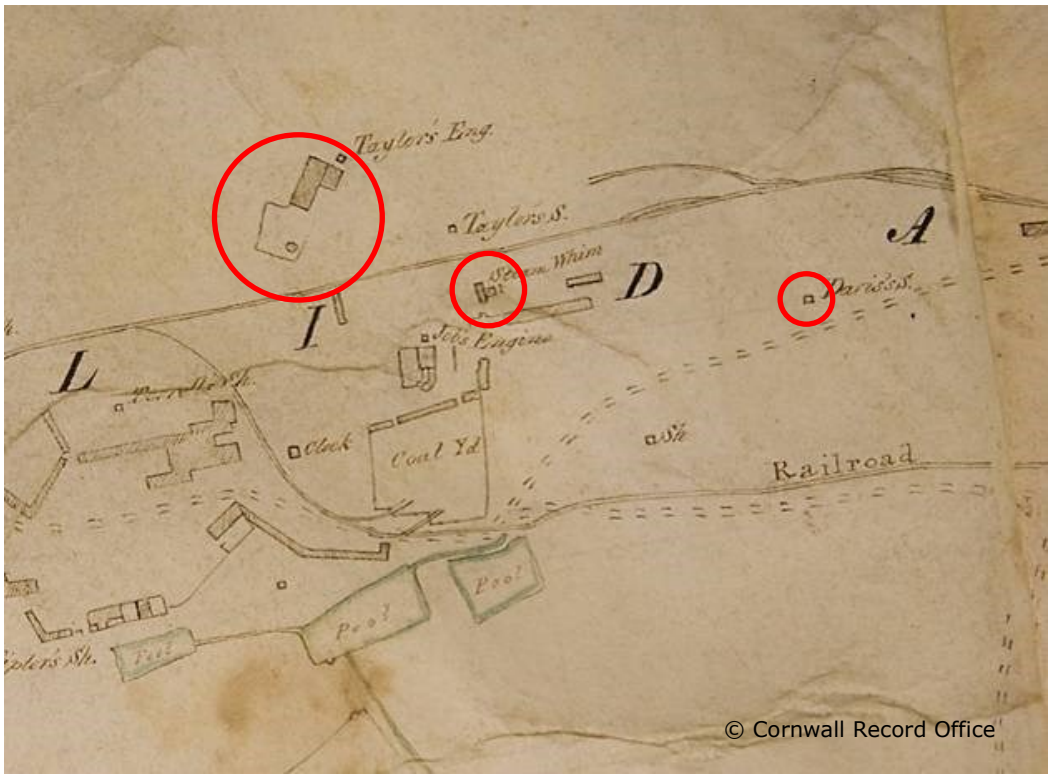

Fig 3. An extract from Symons' 1828 survey of the Manor of Cusgarne, showing the part of Consols including Taylor's Shaft (middle right). Taylor's engine house and boiler house are shown, as well as Taylor's whim engine house. Davey's engine house had not yet been built, and the shaft is labelled 'Davis's Shaft (centre right).

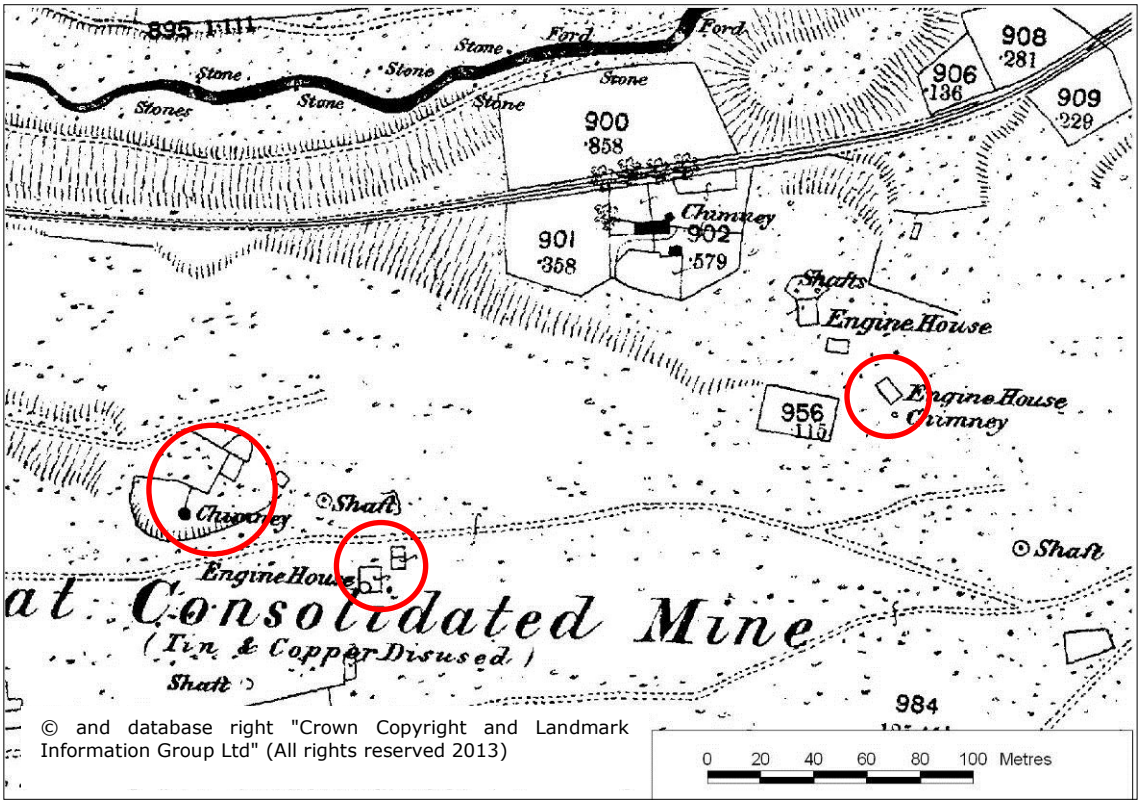

Fig 4. The area of the Great Consolidated Mines between Taylor's and Davey's Shafts as mapped by the Ordnance Survey circa 1877, by which date the boiler houses had been demolished and the engine houses unroofed.

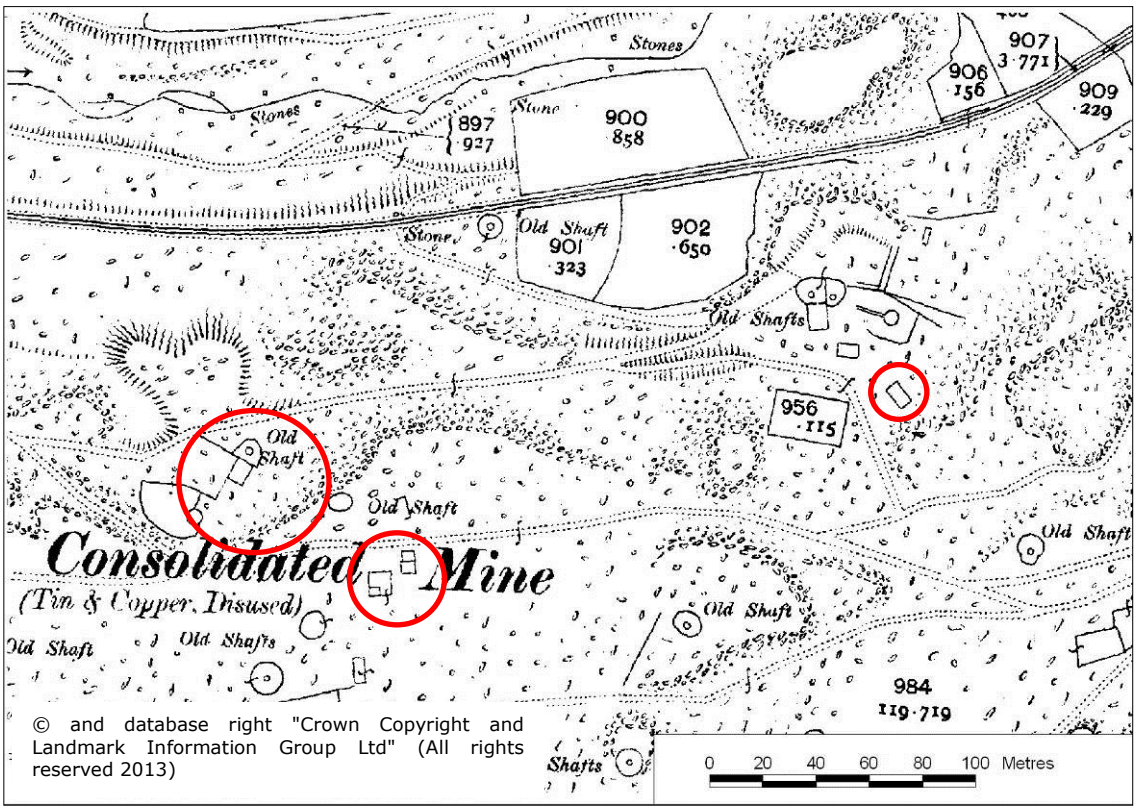

Fig 5. Taylor's and Davey's Shafts as mapped by the Ordnance Survey circa 1907.

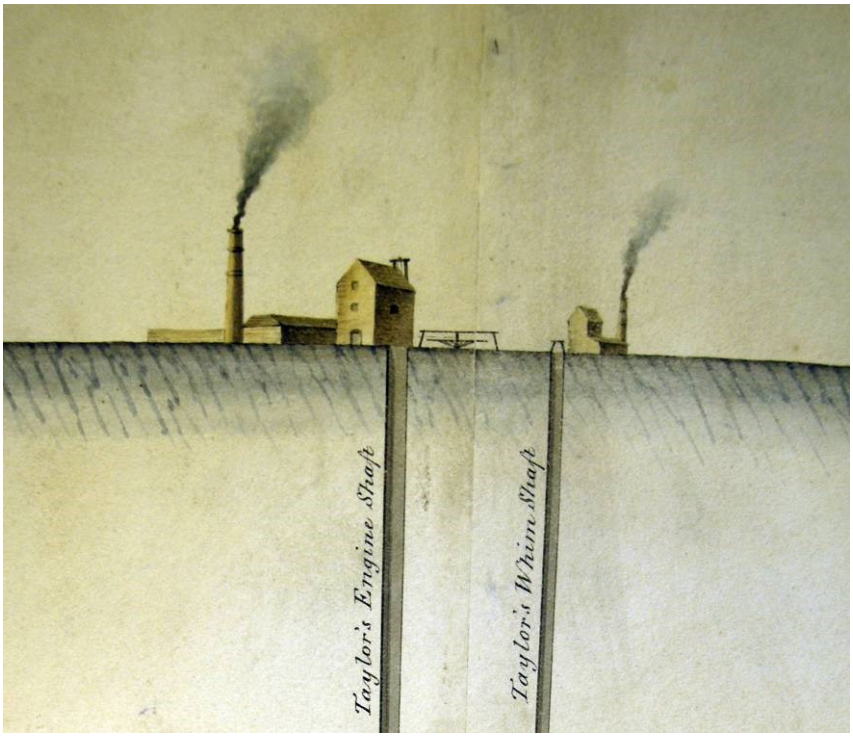

Fig 6. The pumping engine house, capstan and whim engine house at Taylor's Engine Shaft and Taylor's Whim Shaft as shown on an extract from CRO plan MRO103/17. © Cornwall Record Office.

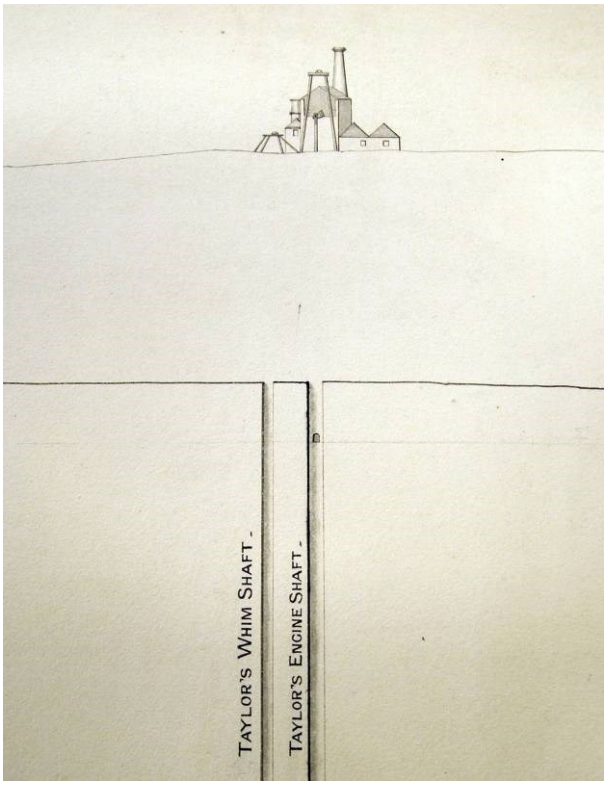

Fig 7. Taylor's pumping engine house and its shafts seen from the north in part of CRO plan MRO 103. The drawing of the buildings may be relatively accurate, showing the double-bayed boiler house, but no evidence for the extension on the eastern side of the engine house was found on site. © Cornwall Record Office.

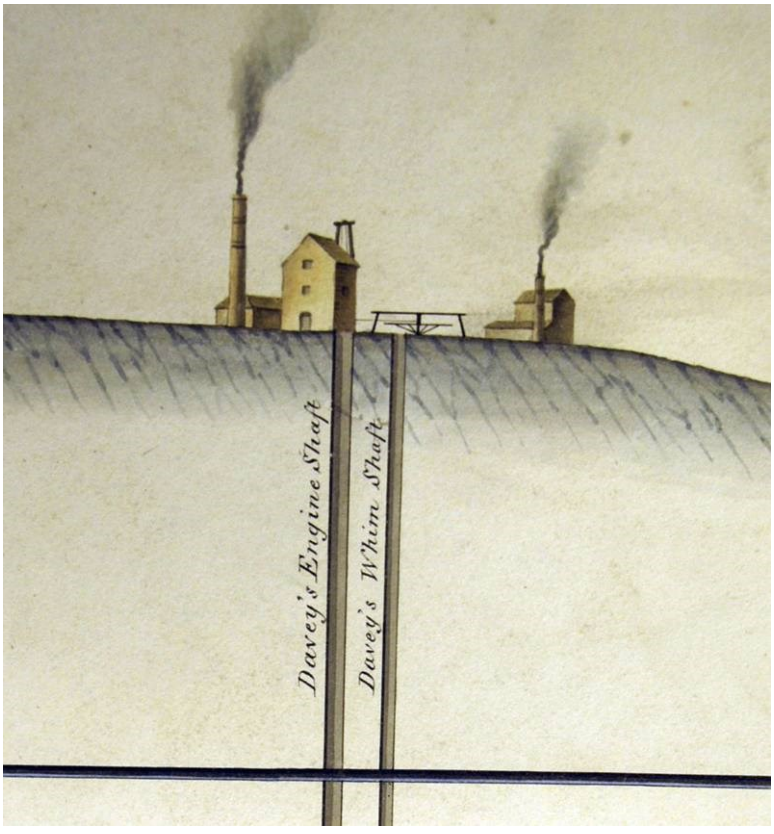

Fig 8. The pumping engine house, capstan and whim engine house on Davey's Shaft, as shown on an extract from CRO plan MRO103/17. © Cornwall Record Office.

Fig 9. Taylor's engine house from the south during 2009. The amount of masonry lost from the rear half of the engine house is apparent, as is the quantity of ivy cloaking the north western corner of the building and the cotoneaster around it.

Fig 10. Taylor's pumping engine house from the west in 2009, showing the boiler house door and the ivy cover which cloaked this elevation.

Fig 12. The eastern wall of Taylor's pumping engine house, showing the doorway and window above and blocked window to its rear, the longitudinal timber and (half-way up the rear edge of the surviving masonry) the remains of the girder opening.

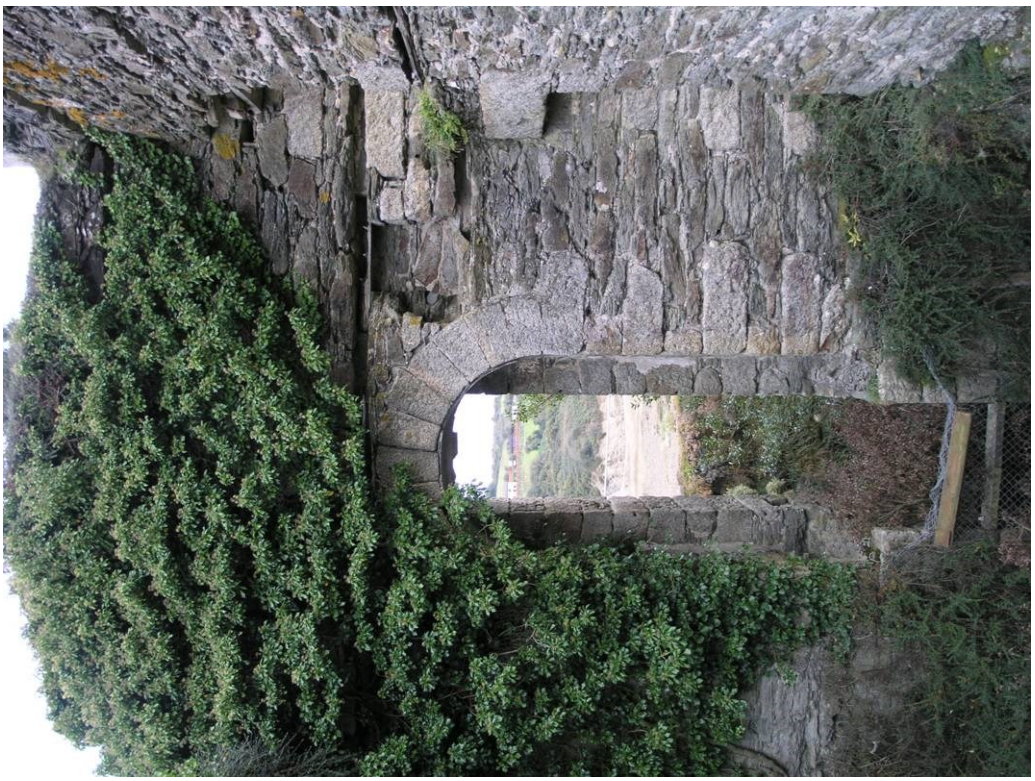

Fig 11. The interior of the bob wall, showing the characteristic part-closed plug door opening; above is the lateral slot which would have held a timber, and, below this to the right of the doorway, one of the pockets for the first floor support timbers.

Fig 14. The internal elevation of the western wall, showing the boiler house door, the cotoneaster which cloaked the wall, and the tree ivy over the north-western corner of the building.

Fig 13. The internal elevation of the eastern wall, showing the two window openings (the rearmost blocked on the outside face) and the two longitudinal timbers whose decay had significantly contributed to the deterioration of the structure.

Fig 16. Taylor's engine house from the north east prior to works.

Fig 15. Taylor's engine house from the south prior to works and once some of the ivy had died back.

Fig 17. Utilising a cherry picker allowed the tree ivy to be removed from Taylor's engine house, a bat survey to be undertaken and a detailed structural assessment made of the building.

Fig 18. A wheeled excavator was used to remove Cotoneaster and rubble from around Taylor's engine house.

Fig 19. Taylor's engine house from the south following the clearance of rubble and scrub, showing the newly-revealed cylinder doorway.

Fig 20.The cracked lintel over the boiler house door on the western elevation of Taylor's engine house.

Fig 21. The dropped voussoirs over the plug door opening in the northern elevation of Taylor's engine house. Note also the remnant plasterwork in the crown of this opening.

Fig 22. Erecting scaffolding on Taylor's engine house prior to works.

Fig 23. Taylor's engine house at the outset of works, as seen from the scaffolding on the nearby chimney.

Fig 24. The lintel over the boiler house door following drilling and pinning to restore its structural integrity.

Fig 25. Taylor's engine house from the south east on completion of the conservation works.

Fig 26. Taylor's engine house from the north east shortly before the completion of the conservation works.

Fig 27. Taylor's engine house from the south on completion of the conservation works and the preliminary levelling of the path network.

Fig 28. The internal eastern elevation of Taylor's engine house, showing the new timbers installed within the face of the wall, and the appearance of the new pointing.

Fig 29. The internal elevation of the bob (northern) wall of Taylor's engine house, showing replacement incorporated oak timbers and the newly-revealed cut outs on the wall head.

Fig 30. The consolidated southern section of the western wall elevation, together with the stabilised western section of the southern wall.

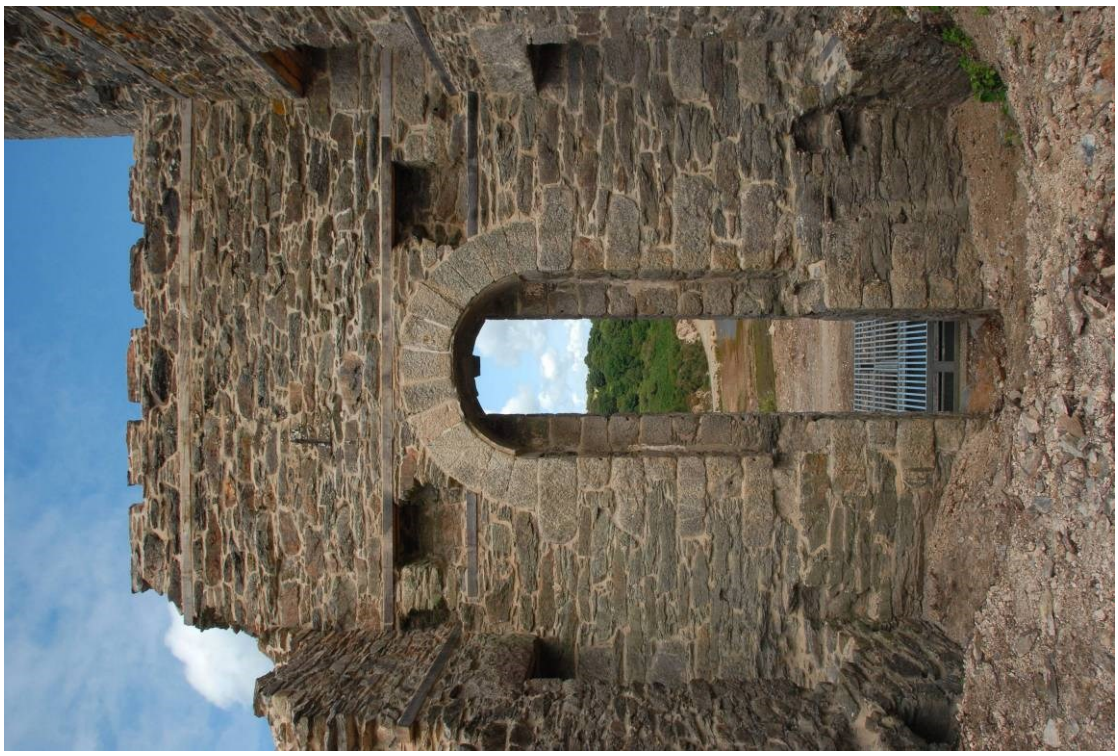

Fig 32. A general view of the conserved internal elevations of Taylor's engine house, showing the high quality of the work undertaken.

Fig 31. The western internal elevation of Taylor's engine house, showing the reconstructed masonry above the replaced lintel.

Fig 34. Taylor's engine house from the north east following its conservation.

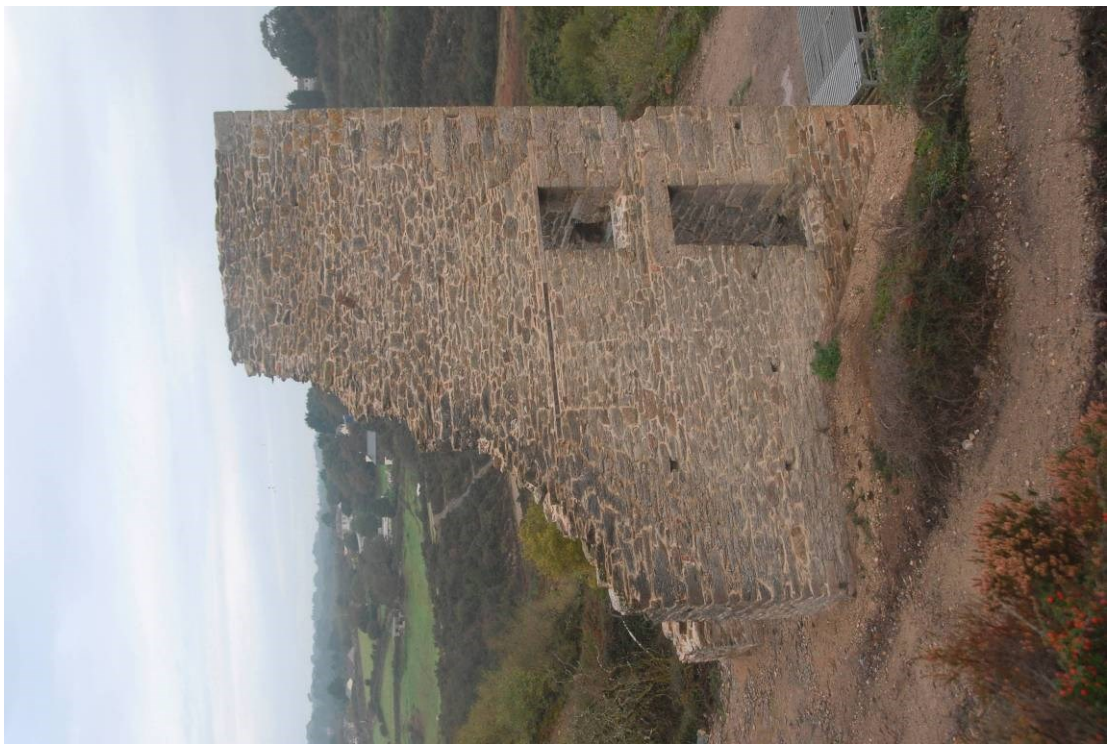

Fig 33. Taylor's engine house from the east following its conservation.

Fig 36. Taylor's chimney from the west prior to works, showing the poor state of the brickwork and the cotoneaster which had begun to grow above the drip ring.

Fig 35. Taylor's chimney from the north-east. The poor state of its brickwork was not particularly evident from this viewpoint.

Fig 38. Scaffolding fully erected on Taylor's chimney and work on its brickwork under way.

Fig 37. Taylor's chimney brickwork from the west, showing its poor condition.

Fig 39. The condition of the upper courses of the chimney brickwork, much of which could be picked off by hand.

Fig 40. Reconstruction of the upper chimney brickwork courses under way, a mixture of old and new bricks being used for its interior.

Fig 41. A general view of the conservation work to the chimney under way. The brick cap had been fully repaired by this point in the work programme.

Fig 42. Original pointing on the western elevation of the chimney had a characteristic weathering appearance. Much of this pointing was sound and could be left in place.

Fig 43. A remnant cut off putlog in the face of the chimney. Note also the differential erosion which has occurred in the stonework of this structure.

Fig 44. Much of the pointing on the lee (northern and eastern) sides of the chimney had been eroded away. Note also the elongated shaped stones used in the structure.

Fig 45. Remnant pointing on the lower part of the chimney. Detached sections of this were removed and patch pointed, but tight joints were left as found.

Fig 46. Roughly coursed masonry on the chimney showing indications (centre stone) of final shaping in situ.

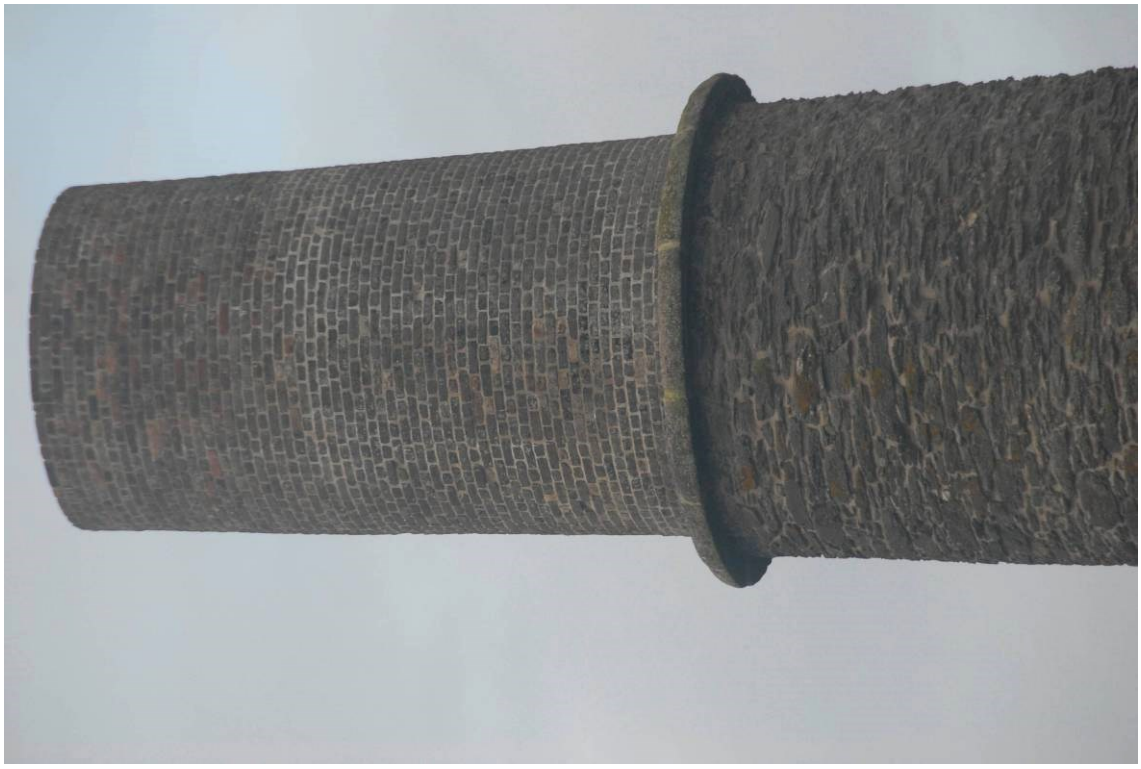

Fig 48. Detail of the upper brick section of the chimney following conservation works.

Fig 47. The conserved chimney from the west.

Fig 49. The bat grille fitted to the flue opening at the base of the chimney.

Fig 50. Taylor's whim from the south east prior to works, showing the poor state of the upper part of the chimney and the small amount of the remainder of the building which survived.

Fig 52. Another view of Taylor's whim, showing the poor state of the broken masonry at the edges of the walls.

Fig 51. Taylor's whim from the south east prior to work.

Fig 54. The condition of the flue from the chimney into the former boiler house prior to works.

Fig 53. Taylor's whim during preliminary vegetation clearance, showing the remains of the loadings (foreground left).

Fig 55. The whim loadings following the clearance of the dense Cotoneaster which formerly completely covered them.

Fig 56. Repointing under way on the lower part of the chimney and the remains of the boiler house walls (left). Note also the collapsed ash clearance hole at the base of the chimney.

Fig 57. A view of Taylor's whim from Taylor's chimney, showing its landscape context.

Fig 58. Scaffold erecting on Taylor's whim. The remains of the loadings had been stabilised by pointing. In retrospect, the visual impact of the pointing is unwelcome, but stabilisation would probably not have been possible in any other way.

Fig 59. The extremely poor state of the upper part of Taylor's whim chimney prior to works.

Fig 60. The topmost section of Taylor's whim chimney, showing the almost complete loss of pointing, and the extremely ragged profile.

Fig 61. The interior of Taylor's whim chimney, showing the almost complete loss of its pointing.

Fig 62. Looking down from Taylor's whim scaffolding on the consolidated remains of the whim loading.

Fig 63. The rebuilt eastern edge of the lower part of the southern wall of Taylor's whim, showing the oak lintel stubs incorporated to indicate the location of the former doorway.

Fig 64. The conserved upper section of the southern wall of Taylor's whim, seen from the north.

Fig 65. The completed work to the lower section of the chimney and boiler house walls at Taylor's whim following the installation of the lightning conductor.

Fig 66. The repaired flue connection between the chimney and boiler house at Taylor's whim (compare with Fig 54).

Fig 67. The reconstructed upper section of Taylor's whim chimney with its unobtrusive lightning conductor.

Fig 68. The completed works to Taylor's whim, viewed from the east.

Fig 69. Davey's whim engine house from the east prior to works, half buried by landscaped shillet.

Fig 70. The south eastern elevation of Davey's whim prior to works, showing the precarious and overgrown state of the building.

Fig 71. The south eastern elevation of Davey's whim following the removal of ivy and other vegetation.

Fig 72. Davey's whim from the east prior to works.

Fig 73. Davey's whim from the north prior to works. Cotoneaster completely covered the cylinder plat. The splayed nature of the upper sections of the walls is clearly visible.

Fig 74. Davey's whim from the north west prior to works, the image giving a clear indication of the challenges posed in the conservation of this building.

Fig 75. Conservation works under way. The unstable stonework forming the wall peaks had been recorded and dismantled by this stage.

Fig 76. A closer view of the condition of Davey's whim masonry, showing the very substantial loss of pointing which had occurred.

Fig 77. The rebuilding of the formerly unstable south eastern wall incorporated a tie bar through the wall cores.

Fig 78. The completed works to Davey's whim as seen from the south. Note the tie rod and pattress and the lintel stubs inserted into their original locations. Compare with Fig 71.

Fig 79. The north eastern wall of Davey's whim, showing the steam pipe entry and cylinder drain openings.

Fig 80. Davey's whim from the north following the conservation works and the creation of the path route around the building. Compare with Fig 73.

Fig 81. The final site meeting at Davey's whim, during the path creation works which now link this building to the structures adjacent to Taylor's Shaft, and with the Mineral Tramways Coast to Coast Trail.

Fig 82. A composite panoramic view of the Taylor's Shaft buildings from the east, showing (from left to right) the previously-conserved clock tower, Taylor's whim, Taylor's chimney and Taylor's pumping engine house.