Report No: 2013R046

Tavistock Canal, Devon

Archaeological impact and recording report

Historic Environment Projects

Report No	Report Name	Report Author
2013R046	Tavistock Canal – Impact assessment and archaeological recording during a program of repair works	Colin Buck

Event Type

Site consultancy	Archaeological impact assessment	Archaeological watching brief	

Client Organisation	Client Contact
TVMHP (West Devon Borough Council)	Chris Hariades (TVMHP)

Monuments (MonUID)

DHER 3879 (Tavistock canal)	18721	4069	3882	5449	3956

Fieldwork dates (From)	(To)	(Created By)	(Create Date)
05/05/09 05/05/12	29/05/09 05/09/12	Colin Buck	13/05/13

Location (postal address; or general location and parish)

Tavistock Canal (northern section from Tavistock to Lumburn), Tavistock, West Devon

(Town – for urban sites)	(Postcode)
Tavistock	

(Easting) X co-ord	(Northing) Y co-ord		
From: SX 47367 To: SX 46183	73572 72589		

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

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Abbreviations

AONB	Area of Outstanding Natural Beauty
CC	Cornwall Council
DCC	Devon County Council
DHER	Devon Historic Environment Record
DRO	Devon Record Office
HES	Historic Environment Service
OS	Ordnance Survey
SWW	South West Water
TVMHP	Tamar Valley Mines Heritage Project
WHS	World Heritage Site

Acknowledgements

Thanks are due to Robert Waterhouse for providing some primary survey data and information files from his research relating to a forthcoming book about the Tavistock Canal. Chris Hariades (Tamar Valley Project Manager), and Bill Horner were involved in the project throughout its entirety. Andrew White of Knevitts Cons. Engs. was involved in preparing the specifications of the aqueduct bridge.

Front cover image: a copy of the Tavistock Canal Company Seal.

1. Project background

The Tamar Valley Mining Heritage Project (TVMHP – 2005 to 2013), a £7 million Heritage Lottery Fund project focusing on the World Heritage Site landscapes of West Devon in the Tamar Valley, is co-ordinated by the Tamar Valley Area of Outstanding Natural Beauty (AONB). The TVMHP was approved for Stage 2 consent by HLF in 2003. It involves the conservation of former mine sites and trail creation along the Devon side of the Tamar Valley (from Devon Great Consols to Morwellham). These sites include Devon Great Consols, the largest mine in Europe during the 19th century. The project also included conservation and repair works to the Bere Alston to Tavistock railway line (Buck 2011), the Tavistock Canal, and parts of Morwellham Quay itself (other contractors). This project covers works undertaken along the Tavistock Canal (Fig 1).

The Historic Environment Service (HES), Cornwall Council was commissioned in July 2007 by the Tamar Valley Mining Heritage Project (Chris Hariades as TVMHP Project Manager), to undertake an archaeological impact assessment, archaeological recording and site consultancy, photographic building recording of affected sites impacted by the works. An impact assessment project brief had not been produced, but it follows a similar project design by Historic Environment Service, Cornwall Council; *'Project design for production of archaeological recording, as part of the Tamar Valley Mining Heritage Project (2006-2009)',* dated 23/06/06. A Project Design for this site and other building conservation schemes in the TVMHP was produced on 21/07/2006, and was subsequently approved by Bill Horner (Devon County Archaeologist).

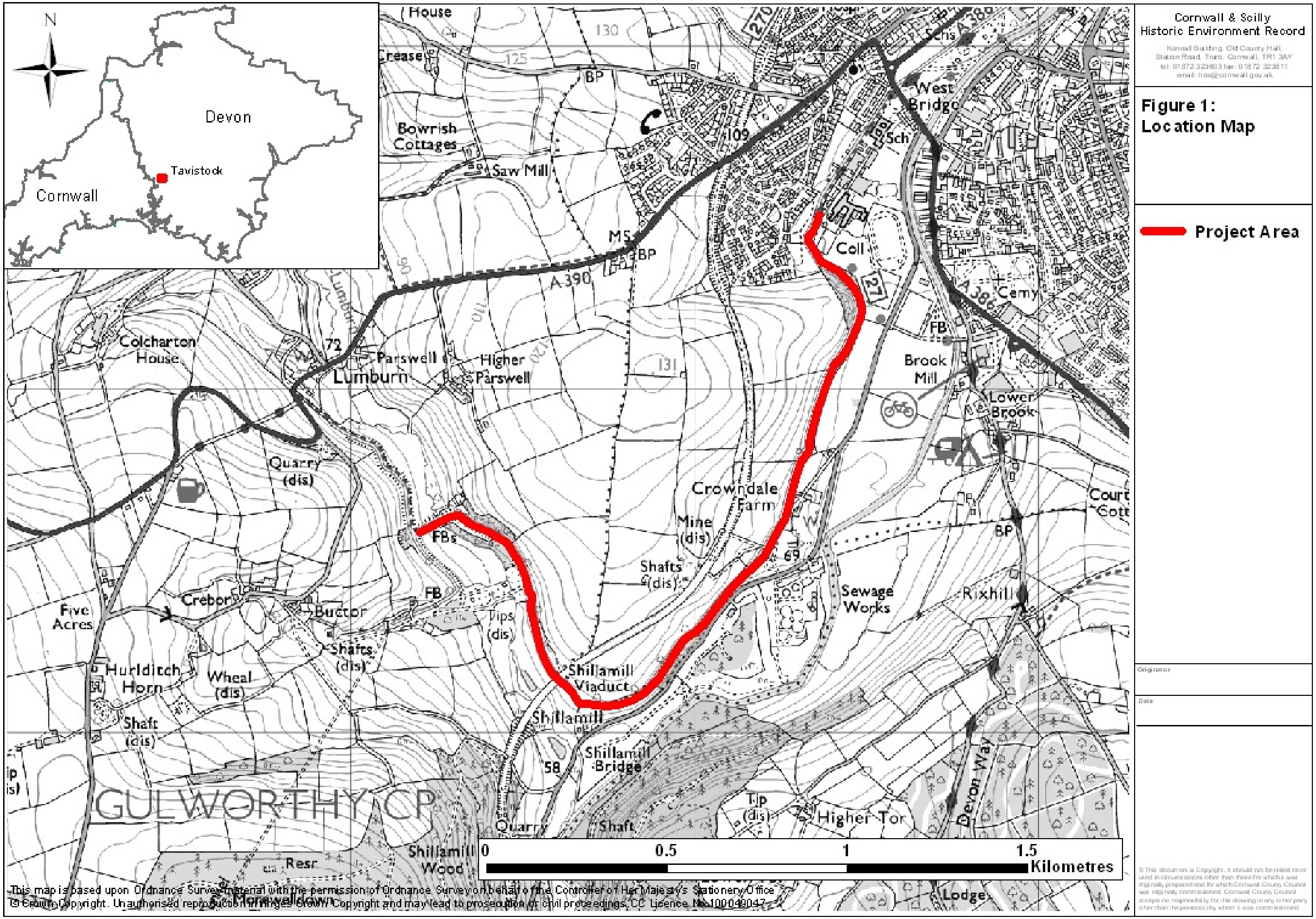
The conservation and management of features relating to the TVMHP's mining heritage and enablement of safe public access forms the basis for the Tamar Valley site conservation scheme. This report will assess the impact of the proposed conservation works on the Tavistock Canal's significant assets (canal within the WHS), describe the mitigation undertaken and also a description of the archaeological record for the (intermittent) works from May 2009 to May 2012. Following the first phase of works in the summer of 2009 (to describe and record the repair works and the minimal impacts to the canal sides), an interim report was produced for Bill Horner (Devon archaeology – Buck 2009).

In a joint project with SWW, the TVMHP agreed to fund cattle fencing along all of the west side of the canal, in order to stop further damage being caused to both sides by cattle drinking the water and wandering (on one occasion into Tavistock!), and to create four cattle drinking sites. SWW agreed to fund the repair of the sides of the canal bed. Furthermore the TVMHP agreed to re-bed and re-seed where necessary the canal towpath later in the autumn of 2009, and at a later stage (2011), to repair the damaged lock gates. In addition, the TVMHP agreed to undertake small-scale structural repairs to the small aqueduct bridge in 2012, and a small amount of repointing.

2. Aims and objectives

The aims of the project were as follows:

- To ensure that site works are undertaken in such a way as to maintain the integrity and authenticity of the historic resource, minimising adverse impact upon the resource.
- To ensure that the Devon County Historic Environment Service (DCHES – Bill Horner) are appraised of all site works.
- To ensure that the highest possible standards of the historic environment conservation works are maintained, which must be carried out to recognised current best standards in this discipline.
- To ensure that works are undertaken in such a way as to allow adequate recording of remains affected by the works.
- To record sites, features, deposits and artefacts affected by or uncovered by the works.


Cornwall & Scilly
Historic Environment Record
Figure 1:
Location Map
Project Area
Devon
Cornwall
Tavistock
N
0
0.5
1
1.5
Kilometres
Crowndale Farm
Shillamill Viaduct
Shillamill
Shillamill Bridge
Lumburn
Colcharton House
Parswell
Higher Parswell
Bowrish Cottages
Saw Mill
West Bridge
Coll
Brook Mill
Lower Brook
Sewage Works
Rixhill
Crebor
Buctor
Five Acres
Hurlditch Horn
Wheal (dis)
Quarry (dis)
Mine (dis)
Shafts (dis)
Tips (dis)
Higher Tor
Devon Way
Shillamill Wood
GULWORTHY CP
A 390
A 386
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- To record the character and extent of works to the sites.
- To inform the Devon County Archaeologist of the nature, condition and significance of the canal and towpath, and describe the proposed impacts and a mitigation strategy (agreeable with the Devon County Archaeologist).
- To disseminate the results of the project appropriately and arrange for the deposition of the project archive (within IfA Guidelines).

It was proposed that the building conservation and repair programme will address the following:

- The protection and consolidation of significant archaeological remains in their settings.
- Health and safety aspects of the site relating to public access.
- Provision of low-key public amenity use where appropriate, incorporating access.
- Interpretation of the site to the public, including on-site and written materials.
- Linking the site into the local economic, social, tourism and recreational contexts.

In terms of the management of archaeological features, engineering works were kept to a minimum, but in view of the fact that the entire site is part of the Tamar Valley component (Area 10) of the Cornwall and West Devon World Heritage Site mining landscape, particular attention was paid to suggestions for the best mitigation of any such works.

3. Historical background

This subject matter has already been written in far more detail than is necessary for this report, notably by Hadfield (1967), Booker (1971, who reproduces the tonnages in Appendix 2), Hedges (1975), Woodcock (1995, Vol 6; 2005), and more recently a publication by Robert Waterhouse (2012), and a forthcoming detailed book. The text below is a summary history and construction account of the Tavistock Canal extracted from all of the above sources.

The medieval borough of Tavistock has always been closely linked to its port, Morwellham. That link was dramatically improved by the construction of the Tavistock Canal from 1803 to 1817. The main structural features of this major construction throughout its full length can still be seen today, over two hundred years later; the wharves at Tavistock and Morwellham, the aqueduct over the River Lumburn, the 1.5 mile long tunnel under Morwell Down, and the remnants of the incline plane down to Morwellham.

The historical chronology for the canal can be summarised as follows:

1796 The opening of Wheal Friendship Copper Mine, Mary Tavy, unintentionally led to the construction of this canal. The export of ore and import of coal and other materials needed to be cost effective – its transport costs by horse and cart must have been prohibitive. The young mine's engineer (in his twenties), John Taylor, had the idea of linking the Tavy and Tamar valleys, whilst using Morwellham to export the ore (via sea going ships); the nearest active port to Tavistock.

1800 By the turn of the 19th century, the country had been at war with France for a few years. Demand for metallic ore, and therefore the need for a canal were high.

1802 Survey of the proposed canal route (presumably with the blessing of the Duke of Bedford) by John Taylor, the mining engineer of Wheal Friendship copper mine.

1803 (March) A canal company, funded by shares from the London Stock Exchange (see front cover seal image), was formed. Work began on the route in 1803, following the passing of an Act of Parliament. The canal was to be 16ft wide and 3ft deep, with a branch to the slate quarries at Millhill. It is likely that the first section of the canal route followed an earlier leat from the River Tavy to Crowndale Mine. Raising funds on the stock exchange gained stock interest from adventurers to exploit known lodes whilst tunnelling through the granite of Morwell Down, and for additional shares to be

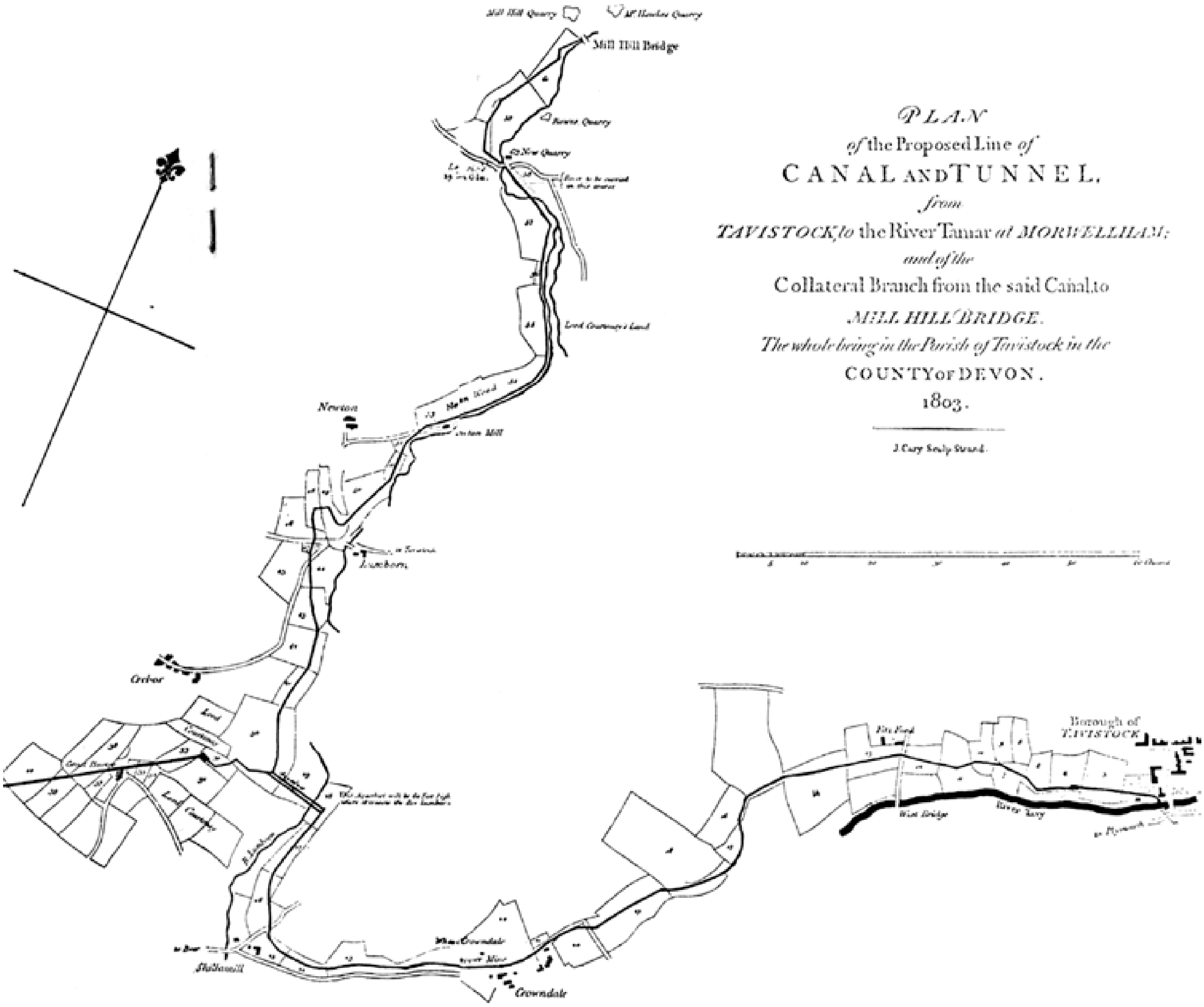

Figure 2 Excerpt of the 1803 survey plan (within the study area) of the proposed Canal route from Tavistock to Morwell Tunnel (Hedges 1975)

purchased by other mines and Tavistock businesses along its course, all recipients of the canal's cheaper transport costs. However, Hedges (1975) hints that Taylor's real motivation for the project was not primarily to build the canal, rather the opportunity to exploit known lodes under Morwelldown, a mining speculation.

Figure 2 shows the original planned 1803 route. The provision of water via leats from the western end of the canal (top of the Morwellham incline) for other mines in the Tamar Valley as far north as Gunnislake to power water wheels was also planned. The original cost estimate for the canal was £40,000 (including testing for ore lodes), at £100 per share. The Duke of Bedford, who owned all the land along the canal's course, also purchased 1/8 of the shares and took dues for use of Morwellham Quay. He also agreed to a request to make a grant of a Mining Set: (for working all Lodes discovered in the Course of the Canal, Embankment, Tunnel and collateral branch for copper, tin and lead to the extent of 500 fathoms East and West of the canal for every Lode discovered), for the sum of 1/10 dues and a term of 42 years.

The principal engineering features being the aqueduct over the River Lumburn, the 2,540 yard tunnel through Morwelldown, and the inclined plane west of the western end of the tunnel down to Morwellham – a fall of 237 ft, the greatest in southern England at that time.

Figure 3 Excerpt of the 1867 Bedford Estates survey plan (DRO T1258M) showing the canal within the study area.

1803 (23rd August) Work began on the tunnel. Almost immediately copper was struck at the Tavistock end of the tunnel, and the lode developed to realise what later became Wheal Crebor (see Fig 3). Men were employed to work both concerns – the accounts separated. The Canal Committee managed both concerns until 1812 when a separate Committee was appointed after further copper ore discoveries in the tunnel under Morwelldown (Hadfield (1967, 128).

1808 The waste rock and ground from the tunnel excavation was boated eastwards back to the tunnel entrance and used to infill and form the Lumburn Aqueduct over the valley, with a central spanning arch.

1809 Work progressed slowly in the tunnel (by this date it was half finished), as the canal section from Tavistock to the tunnel was finished (ie, this project's study area). This was built more permanently with stone sides (on edge) rather than puddle clay. The tunnel rock was granite, its depth 160 yards below the top of the hill. Pumping/ventilation/winding and access shafts (at least four – the main one being Bray Shaft), had to be sunk from the top of Morwelldown to the underground canal. John Taylor designed the power source for the shaft workings by utilising flat rods (for lengths up to 1.5 miles) powered from a large 40′ water wheel. He also designed a ventilation fan for improving the air quality, for which the company was awarded the medal of the Society of Arts in 1809 (Hedges 1975).

1810 The tunnel advanced at a rate of about 150 fathoms (six feet per fathom) per year until this year when three granitic dykes were cut, slowing the work rate to nearly a third that amount for two years. 30 to 40 workmen were continually employed, with some authors suggesting French prisoners of War used as 'navvies' (Barton 1964, 93 and Booker 1971, 108).

1815 From this year there were shipments of manganese from mines around Brentor and Milton Abbot carried by the canal. These were the principal sources of manganese in the country at a time when it was used in the manufacture of glass. For example, 13,335 tons were shipped to Plymouth in 1819. The ore was ground in a mill powered by the Morwellham water wheel (Booker 1976, 19), and exported in casks.

1816 (August) Tunnels were cut from both ends (simultaneously), to form a working area and to align both ends. They connected on the 21st August. Then the tunnel was enlarged (downwards and wider) throughout its length.

The demand for metallic ores to feed the Napoleonic war years (1793 – 1815) slumped as the soldiers returned, as markets waned. The canal committee, sensing further financial difficulties in September stated *'That the Tonnage will fall very short of the original estimate cannot be doubted; at the time when this was made the Mines in the neighbourhood were in their most flourishing condition, or rapidly advancing to it. Agriculture encouraged by high prices was improving everywhere, and the use of lime, so essential … was very great and increasing. Slate quarries, then making large returns, were in full activity, and new ones opening. In all these sources of oecumenical mode of carriage, the greatest reverses have taken place, and at present a stagnation of enterprise and consequent inactivity prevails'* (Hadfield 1967, 130). However, the population of Tavistock had increased from 1801 to 1821 by over 62%, reflecting the growth in the area, primarily a result of mining operations and related tertiary expansion.

1817 The tunnel was finally completed early in the year, with the official opening ceremony held on 24th June. Thousands attended the event, with over 300 going in boats (with a band) through the tunnel – to be met (with obvious relief) by thousands more at the Morwellham side. All were then given a demonstration of the workings of the incline railway mechanism and tramway down to Morwellham (see Buck 2005 – Sites 58 to 64), powered by a large water wheel and the canal water – which was also recently completed. The boats (specially designed and built by the Tavistock foundries from 1811 to replace an earlier wooden design), were *c*30 feet long, 5 feet wide and towed along the slow moving open canal by horses. They were worked through the long tunnel by two men using iron bars against the rock face.

The canal had taken 13 years to build. Its final cost was £62,000, the excess over the authorised capital of £40,000 having been raised by calling £155 on each £100 share.

1819 Although the economic outlook for the area was not good, the company decided to press ahead with the Millhill canal branch to the slate quarry. It was 2 miles long and cost £8000. It rose by 19.5ft to Millhill, with an inclined plane for the final section due to the scarcity of water (double tracked with two cradles counterbalanced with loaded boats going down pulling the empty ones up with the help of three horses).

1820s The expected tolls were halved from their pre-construction estimates – due to the gloomy economic climate. Over the next three decades the canal carried between 15,000 to 20,000 tons per year, earning an annual profit of approximately £600.

1831-2 A Cholera epidemic in the locality severely affected the workforce, the local economy and (temporarily), the canal's fortunes.

1841 Great Western Railway completed.

1844 Discovery of the main copper lode (40′ wide) at Wheal Maria later Devon Great Consols – reversing the fortunes of Tavistock over the next 30 years, but reducing those of the canal. The Mill Hill Tramway was constructed this year (replacing the earlier section of the canal which had been closed after 1831), at a cost of £1,381 (Hadfield 1967, 132).

1847 20,132 tons were carried on the canal (Woodcock 1995, 23).

1848–9 Another Cholera epidemic.

1850 The goods carried on the canal were (tons): Sundries (7548), Limestone (3130), Copper ore (2.499), Slate (676), Granite (83) and Mundic (pyrites) (94). Tonnage carried fluctuated from year to year, reflecting the area's economic woes (or successes). In a bid to maintain revenue, at various times throughout this period, the company reduced tolls, or raised them again when economic conditions improved. But dividends, throughout the life of the canal were always modest, and profits turned out to be at a level 1/3 predicted at the outset.

1851 In the 1851 census, there were 27 barge men working for their various employers regularly using the canal.

1857 Shares that had changed hands at £100 in 1803 were now changing hands at £5.

1859 Construction of the Devon Great Consols railway from the mine to Morwellham with a separate incline section down to the port finished this year. Also the South Devon & Tavistock Railway from Plymouth to Tavistock opened (later extended to Launceston) – in direct competition to the canal. Due to this competition, the company further reduced its tolls after the opening of the railway. However, in the same year it expended more capital on renewing the inclined plane mechanism, and investing funds on a steam mechanism to pull loaded barges through the tunnel against the water flow (it often took a couple of hours or more to undertake this manually!). This was not successful.

There is no doubt that the waning fortunes of the Tavistock and Tavy copper mines, working for the past half century, were no competition for the resurgence of the Tamar Valley copper mines from the mid 19th century. Whilst the former utilised the Tavistock Canal as a transport medium during this period, the latter formed its own railway equivalent; but both used Morwellham as the export destination. Given the rapidly changing transport infrastructure due to the construction of mainline railways to the south west from the mid 19th century (consequently resulting in dramatic changes to market influences), across Devon and Cornwall at this formative period, so the fortunes of this old transport route was found wanting and uneconomic.

1860 In the previous year, the canal tonnage was 17,455. In this year it fell to 13,500. From 1863 onwards there was a steady decline in the tonnage until, in the early 1870s it dwindled to nothing (Hedges 1975, 28).

1862 A shareholder from Birmingham wrote to Mr Gill, representative of the Canal Company and said: *'I am afraid there is little hope of the canal rising in its fortunes with the railway for a rival. Here we have in several cases united the canal with the railway with advantage to both – you know best whether such an arrangement with the Tavistock canal would be advisable'* (Hedges 1975, 28).

1866 In September, the canal committee recorded; *'That a very considerable reduction having taken place in the traffic and dues of the Tavistock Canal Company since the opening of the Tavistock and Launceston branch of the South Devon Railway it was resolved that His Grace the Duke of Bedford be applied to kindly assist the Tavistock Canal Company to compete with the Railway Company by reducing the Canal Dock dues at Morwellham'.* The Duke was evasive (Hadfield 1967, 134).

1870 Only 783 tons were carried on the canal (Woodcock 1995, 24).

1872 Presumably the economic situation became even direr. At a meeting on 2nd September the Duke offered to buy all the shares at £8 each, and to pay half the cost of an Act to transfer the canal to him. Within the month, the committee accepted his terms. Since the summer there had been no traffic on the canal. However, this was not a localised occurrence; the impact of the railways had dealt a death blow to innumerable canals all over the country.

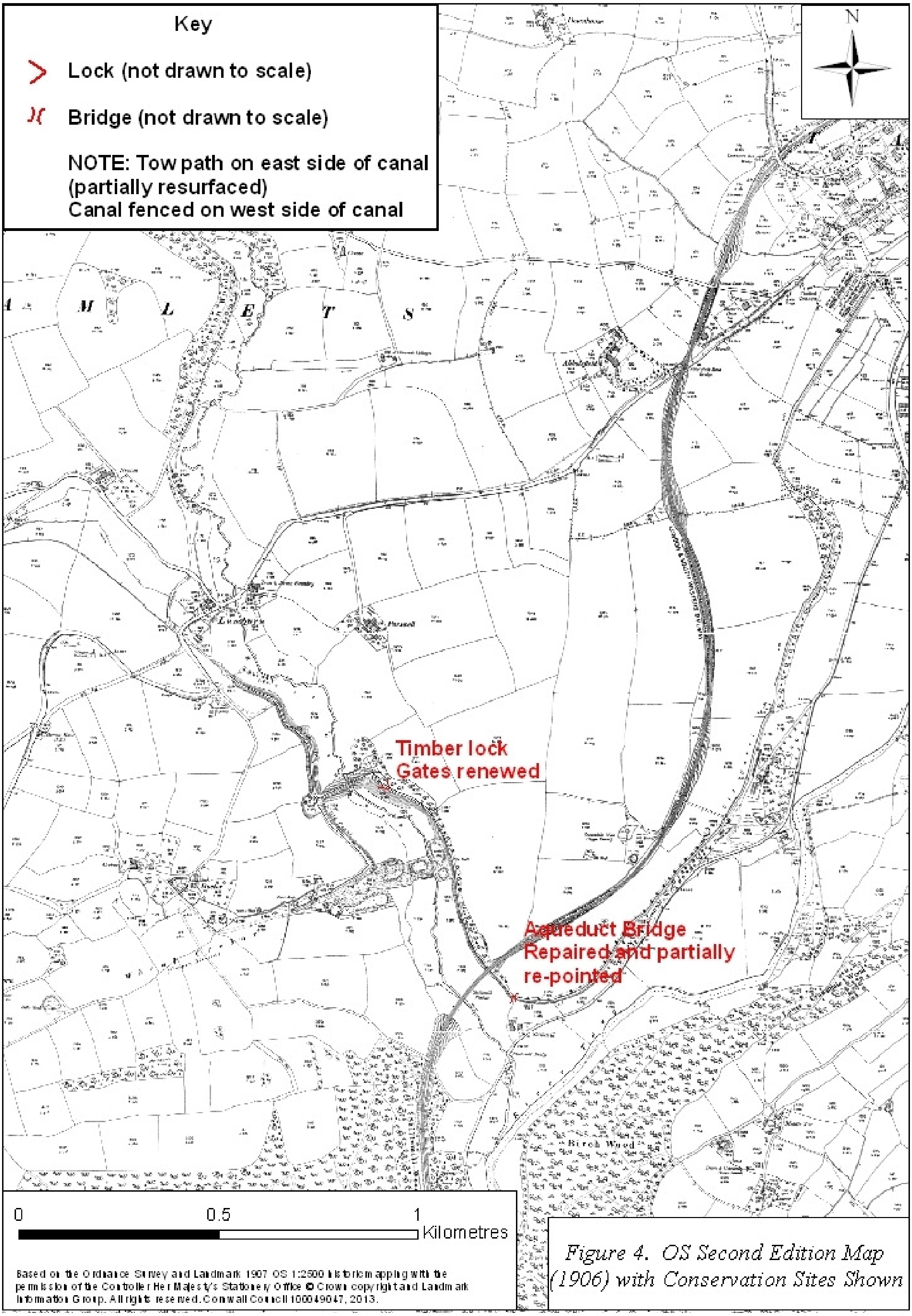

Figure 4. OS Second Edition Map (1906) with Conservation Sites Shown

1873 In May the Act was passed and the Tavistock Canal and land returned to the Duke of Bedford for £3,200, there being no obligation on the Duke to maintain the canal. It is uncertain what use the canal had for the next twenty five years.

1896 This perhaps was made clear in May of this year when the Tavistock Gazette reported that on Whit Monday the basin of the Tavistock Canal was to be cleaned out (it appears a regular activity on this day). *'The cleaning is wanted more now than when it was a hive of industry … a resident noted ... A great deal of sewage was emptied into it, and the water does not run at a greater rate than half a mile an hour. I have seen dead dogs, cats and rats in the canal'* (Woodcock 2005, 26).

1898 The Tavistock Canal was not included the Canal Returns.

1933 After cleaning the canal bed (which must have been quite onerous!), the West Devon Electric Supply Company built a sluice gate near the west end of the tunnel portal, to convey water to a header pond (Forebay) to go down to hydro electric turbines via large tubes at Morwellham Power Station, next to the River Tamar.

In 1923 and 1933, mining geologists Cloke and Barclay carefully assessed the lodes intersected by the tunnel during a tunnel assessment and clearance scheme (CRO AD58-26). They confirmed that the tunnel intersected eight or nine lodes and three cross-courses, but only two of these (East Russell and Georgenia Lodes), had any stoping accessed by the canal. The only repairs necessary were to the Morwellham portal end retaining wall.

Footnote:

The canal has been maintained and managed by the owners of Morwellham Power Station since 1933. For some time this work has been undertaken by South West Water and British Waterways, the former now monitors and maintains the canal, carefully regulating the flow to utilise the instant generating capacity of the hydro-electric power station at times of peak demand (to provide a cost effective monetary return). It is poignant perhaps that the canal still exists today due to its economic usefulness.

4. Impact assessment

This summary impact assessment is intended to inform and guide Devon County Council Historic Environment Service of the impact of the canal repair works, the aqueduct bridge repair and lock gates replacement. This section of the report summarises the archaeological resource, and describes the impact and mitigation of the canal works as part of a mitigation strategy. However, it should be noted that the mitigation procedure was undertaken during the project (due to the lack of advanced project specifications), by efficient communication between the report author (as site archaeologist), Bill Horner (DCC archaeologist), Chris Hariades (TVMHP Project manager), and South West Water. A structural engineer, Andrew White of Knevitts Ltd produced specifications for the aqueduct bridge structural repair (see Fig 12).

The sites impacted by the repair works are shown in Figures 5, 6 and 12 and reproduced on plan in Figure 4. The main sites include repair works to the sides of the canal itself, structural repairs to the aqueduct bridge, and repairs to the lock gates. The impact of the repair and conservation works on each site is then described, and a final section details the impact remediation measures.

The potential impacts during works are described below. Impacts are described in the text section for each site on a feature-by-feature basis. The following site impact terms are used within each site identification description:

Major positive	Site continues in, or is restored to, its original design and use
Moderate positive	Site restored as far as possible respecting its original function, but its use is altered
Minor positive	Site partially restored; interpretation introduced
Negligible positive	Stabilisation/maintenance of site
Negligible negative	Benign neglect – losses of fabric over a long period of time

Minor negative	Site suffers areas of alteration or damage, which contribute to loss of meaning
Moderate negative	Significant loss of fabric or alteration, leading to erosion of original character
Major negative	Complete demolition/removal

Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the end of the Lumburn Aqueduct **SX 46237 72628,** see Fig 1).

Description

The canal section impacted by the repair works was built between 1803 and finished by 1809 (as described in the historical background section). This section of the canal may well follow the course of a mine leat from the River Tavy to Crowndale Mine, which pre-dates construction of the canal. For much of its length the canal's west side (see Fig 4), cuts into the valley side – revealing vertical bed-rock and also frequently forming the bed of the canal. Excess stone material from the rock cut was used to form the rounded profile edge of the east side of the canal – using slate/killas stones set on edge. The tow path was formed along this eastern side. The canal is approximately 4.0m wide, 0.3m to 0.5m deep, with the east side approximately 0.6m to 0.8m deep from tow path surface to water level.

Repair works to the canal's east side (and towpath) has been undertaken in the past, sometimes inappropriately using cement and concrete formwork. The 2009 repair work to both sides of the canal and re-surfacing parts of the towpath continued with this theme of patching the damaged sections (Fig 11).

Site works impact (2009)

The repair works relate to identifying areas of the canal sides that needed to be patched with new (similar specification) stone within the section of canal identified above. This should immediately stop progressive damage to the canal sides and help to support the well used canal towpath. There is no site plan showing each small repair section, rather a canal bank repair work schedule (Appendix 1).

Other works to the canal itself that were proposed include patching and re-surfacing the tow path. South West Water (SWW) undertook its own Risk Assessment for each tree close to the tow path. Mitigation works resulting from that survey (i.e. branch or tree removal) was undertaken by SWW.

The overall impact of the works on the canal can be defined as '*Negligible positive'.* The works reduced collapse of parts of the canal's east side to maintain structural stability, provided more tow path stability and a higher degree of Health and Safety for increased public access for at least another generation. However, it is hoped that the track is adequately annually maintained.

Residual impact (2009)

There have not been significant residual impacts in the medium term – apart from the visual aspect of the replacement stone looking newer than the original stone surrounds.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of replacement stone (to match existing), reduced the visual impact of patching the sides of the canal. Other reduction impact measures included the tendering for appropriately qualified and experienced contractors to reduce the visual effect of repair sections to the canal, and for the quality of the work, which was of a good standard (reflecting the original construction style). This project should reduce the need for this work to be undertaken for at least another generation.

Aqueduct Bridge SX 46630 72090

Description

The aqueduct bridge carries the canal over an access lane to fields north of Shillamill Farm – whose access was cut by construction of the canal. The iron plated trough structure seen today was built in 1839 by Gill & Co of Mount Foundry, Tavistock (Buck 2007), replacing an earlier structure. The bolted sections of the trough extend to either side of the granite quoined masonry, and are supported by four wrought iron lintels (widening into the masonry sides) set into the granite masonry. Three other similarly styled lintels (see Fig 13) provide the support for large slates under the tow path on the south side of the canal. The middle lintel however has rusted to the extent of being ineffectual. A structural survey by Knevitts Ltd has recommended its replacement, as the aqueduct is not only used by tow path walkers, but is proposed to be accessed via the adjacent fields, in order to link up the railway (Buck 2009) with the canal – by a new DCC footpath route under the aqueduct – formerly used for access to the upper field.

Patch repointing to the sides of the bridge under the aqueduct in recent years has occurred, however more often than not this has been using cement, using a variety of styles. At the northern end of the side walls the stonework has been leaking for some time where water is leaking from the junction of the wrought iron plates with the canal bed. This has caused the masonry to be soft, and the stonework made weak – causing a noticeable dip on either side.

On the south west side of the aqueduct a high vertical retaining wall supports the tow path and masonry for retaining remnants of steps, to allow pedestrians walking the towpath to access the lower field. Some of this vertical retaining wall has areas of lime mortar pointing that is loose.

Site works impact (2012)

After dialogue with the TVMHP manager, the structural engineer, the landowner of Shillamill Farm, the Devon County Archaeologist and consulting project archaeologist; the TVMHP agreed to fund replacement of the centrally located rusty wrought iron lintel, and to undertake limited lime mortar repointing where structural stability of the adjacent walling could be compromised.

Site impact of the replacement lintel was minimised by matching most of the original profile of the replacement item as far as could be possible from an 'off the shelf' steel equivalent (in order for the project to be cost-effective), with the original wrought iron lintel.

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works have reduced the potential for collapse of the tow path as it runs next to the canal aqueduct. This project will provide a higher degree of Health and Safety for increased public access for at least another generation.

Residual impact (2009)

There are unlikely to be significant residual impacts in the medium term – apart from the aspect of the replacement iron lintel and repointed masonry looking newer than the adjacent (cement) based repairs.

Reduction of impact (2009)

Site consultancy with the project manager and structural engineer will minimise any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors should mitigate the visual effect of a new structural item, and for the quality of the work to be of a good standard, reducing the need for this work to be undertaken for at least another generation.

Lock Gates and timber lifting bridge SX 46327 72628

Description

The construction of the adjacent Canal cottage for operation of the lock gates, the lifting bridge and the visible remnants of the semi-circular trans-shipment basin (or turning/waiting area) is indicative that this part of the canal was quite busy! The latter

(sited close to the lock gates) is now infilled, but the tops of some of its vertical timbers still visible. The necessity of keeping the water at the correct level was important for the tunnel – this lock gate possibly forming this function also for the Lumburn Aqueduct (SX 46311 72632 to SX 46184 72581), with its single arch to the south. According to Waterhouse (forthcoming) the timber lifting bridge is of a Dutch design common on canals in the Welsh borders, and may not be contemporary with the canal's construction.

The lock gate and lift bridge was previously restored by October 1998, funded by South West Water and British Waterways. However, as Figure 15 shows, one of the timber arms of the lift bridge had snapped and parts of the timber walkway rotted. In addition the lower parts of the swing lock gate has rotted where it is in contact with the canal water.

Site works impact (2012)

The TVMHP agreed to fund replacement of the timber components that were rotted or had broken or snapped off. This includes the large timbers to open the bridge and the Lock gate. The TVMHP tendered for experienced Carpenters to assess both features and to price for the production of making and erecting replacements.

Site impact for the replacement timbers was minimised by specifying exact replacements with the existing timbers (previously replaced in 1998).

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works reduced the potential for further timber rotting and collapse, an important Health & Safety measure so close to the well-used canal towpath. This project has provided a higher degree of Health and Safety for bridge use and public access for at least another generation.

Residual impact (2009)

There are unlikely no significant residual impacts in the short term.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors mitigated any possible mistakes, the quality of the work was of a good standard, and reduced the need for this work to be undertaken for at least another generation (Fig 16).

5. Impact mitigation strategy

The impact mitigation strategy is divided into three stages: The pre-works consultancy, the Historic Buildings Consultancy during works and the archaeological recording record (during and after works). This mechanism demonstrates the steps that have been taken to avoid or minimise adverse impacts, and confirms that the proposed works have been designed in close liaison with the historic environment consultant. Consultation is based on a clear understanding of the significance of the site using appropriate methods and techniques for site monitoring and recording.

HES Projects (Project number 20070793) was commissioned to undertake the three components described as the impact mitigation strategy. The project was based on a project design produced by Colin Buck (21/07/06), and recording specifications defined by Bill Horner (DCC archaeologist).

6. Working method

The following text summarises the general WSI for all archaeological consultancy and archaeological recording for projects relating to the TVMHP (Tamar Valley Mines Heritage Project: Written Scheme of Investigation: Historic Building and Archaeological Recording Consultancy 21/07/06).

- A brief historical survey was compiled from existing Devon County sources (DCHER, DRO, and local libraries and historians (including Robert Waterhouse's recent published work on the canal).
- A walk-over survey was undertaken of the entire length of the canal for sites impacted by the TVMHP.
- An impact assessment described and mitigated the proposed work as part of a Mitigation Strategy to minimise the works affecting the site's character.
- General working methods for archaeological recording, treatment of finds, photographic surveying and report production are described in detail in the Tamar trails WB WSI produced in 21/07/06.

All archaeological recording work was undertaken according to the Institute for Archaeologists (IfA) *Standards and Guidance for Archaeological Investigation and Recording. Staff follow the IfA Code of Conduct* and *Code of Approved Practice for the Regulation of Contractual Arrangements in Archaeology.*

The principal factor in effective project delivery was the employment of key project staff who are expert in the management and recording of the industrial heritage. Cornwall Historic Environment Service project staff can draw upon a substantial track record in undertaking similar work throughout Cornwall, as well as a detailed knowledge of the project area and its sites.

Historic buildings consultancy

- HES (Senior Archaeologist) liaised with the Devon County Historic Environment Service - DCHES (Bill Horner), and the TVMHP Project Manager (Chris Hariades).
- The HES Senior Archaeologist attended regular site meetings when appropriate during the duration of the project.
- HES ensured that site conservation works are carried out to standards recommended by English Heritage best practice.
- **Fieldwork: archaeological recording**
- There were no newly exposed archaeological features revealed through excavation.
- Where appropriate, measured survey was carried out by hand measurements (using offset techniques at a scale of 1:50.
- The resulting survey output was a revised measured survey drawing showing all conservation works that had been undertaken. This was reproduced at a scale of either 1:50 or 1:100 (appropriate to the size of area recorded) and will form part of this archive watching brief report.
- Analysis of the building fabric was recorded in the form of field notes and written up in this archive report production stage.
- DCHES (Bill Horner) advised that archaeological recording should be undertaken during any excavation that revealed archaeological features. Recording was undertaken using a mix of direct measurement, sketch plotting and photography, as appropriate (constrained by safety factors).
- Where significant remains were encountered the site archaeologist was given the opportunity to make an appropriate form of record before work proceeds.
- The chosen site archaeologist adhered to Health and Safety Policies (see below), under the direction of the designated Site Safety Officer.

Site recording (general)

- Site drawings (plans, sections, locations of finds) were made by pencil (4H) on drafting film; all plans were linked to the Ordnance Survey landline map; all drawings included standard information: site details, personnel, date, scale, north-point.

- The site archaeologist undertook the recording in line with recommendations given by IfA. Sections and plans were drawn on site at appropriate scales which adequately recorded structures or features at appropriate levels of detail, and appropriate sections reproduced in the archive report at either 1:50 or 1:100 to adequately demonstrate revealed archaeological features.
- All features and finds were accurately located by means of a National Grid reference and all archaeological contexts will be described using a standard format and linked to a continuous numbering sequence.
- The archaeological watching brief report detailed all forms of archaeological recording that had been undertaken at each of the mine sites. Each major mine site had a single archaeological watching brief report that details all project related work to that site (i.e. trails works, building conservation works, interpretation works, etc).

For Treatment of finds, Photographic recording specifications, report production and archiving specifications refer to the TVMHP WSI (2006).

7. Results

Unfortunately, there was insufficient time (following receipt of a detailed plan and description of the canal repair works from the TVMHP), prior to the start of works on site to produce an impact and mitigation report for DCC (Bill Horner). A decision was therefore taken to minimise impacts and mitigate directly with the TVMHP and site contractors on site as works were progressing as part of a weekly site recording and consultancy. SWW funded the stone and path repairs to the canal bed whilst the TVMHP funded fencing of the north and west sides of the canal, to stop encroaching animals from the adjacent fields from directly accessing the canal (and walking up the towpath!). An interim archaeological recording report of these works was produced by the author on 17/06/2009. This report supersedes that report.

Repair works to the bed and towpath of the Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the start of the Lumburn Aqueduct **SX 46237 72628**)

In early 2009, the TVMHP tendered for stone masons (on behalf of SWW) experienced in rebuilding stone walls, etc, to undertake these works within a narrow time-scale of three weeks, when SWW were willing to reduce the water flow through the canal (which would stop the electricity generating turbine). The turbine normally operates all year round, often at short notice when generation rates for electricity peak (the turbine can instantly generate electricity). Clemens Stonemasons of North Cornwall were successful in winning the contract. Prior to this, the TVMHP Manager, the archaeological consultant and SWW projects officer, produced a repair work specification schedule (measured from the small swing bridge at Tavistock: SX 47348 73503), which focussed on identifying the repair of collapsed sections of canal bank on the south or east sides. Appendix 1 is a reproduction of this original document.

Site work started on 05/05/09 at the northern end of the canal and progressively worked southwards towards the lock gates at the Lumburn Valley. With the reduced water level in the canal (and its slow movement when full), many stones that had fallen out of place were found in the canal bed not far from their original bank location. When the canal was constructed the stones were originally set on edge, a minimum of two/three stones height (approximately 0.6m to 0.8m above water level). During the repair project, where there was insufficient stone to replace the collapsed sections, a similar stone was imported from Trebarwith Quarry, North Cornwall (purchased from the local quarry at Millhill). These stones were reset on edge, following the original profile of the canal bank, and tightly tamped down in position (tops and sides). Earth was backfilled into the top sides of the stone to re-form the edge of the towpath. This was then at a later date, re-seeded. Figures 7 and 8 show examples of before and after photographs of the repaired canal bank. The work has been sensitively undertaken and reflected the style and character of the original construction a century ago.

Weekly site meetings were arranged to view the previous week's repairs and to discuss any foreseeable problems within the following weeks programmed work. A granite towpath stone under the Crowndale bridge at SX 47194 72541 had become dislodged (into the canal), and some quoin stones from the bridge parapet wall had fallen into the canal. The former was repaired by contractors; the latter will be removed from the river by SWW to be replaced on the bridge parapet wall at a later date. A small section of old 2" timber (2m long) set in the lower part of the bank was replaced back into its original position following repair of the wall at this location (SX 47270 72707).

The canal bank repair works (see Appendix 1), were finished on 28/05/09, including an additional element of work totalling 87 metres, which the contractors identified whilst on site. A total of 337 linear metres of canal bank was repaired (only on the south/west side), using a total of 86 tons of additional Trebarwith stone. The canal repair works were funded by South West Water.

Figure 5 is a site plan and specification document for the installation of timber post and wire stock fencing along the west/north side of the canal and construction of three cattle drinking areas to minimise any future erosion of the opposite (north/west) side of the canal bed. The cattle drinking sites are located at SX 47384 73064, SX 47257 72705, and SX 47078 72415. A concrete pad (min 0.3m thick), varying from 3m to 4m wide and approximately 5m long, has been created to at each of these sites to form the post and rail fenced cattle drinking areas that should minimise further damage to the banks (on either side). An additional cattle drinking area was constructed on bedrock immediately on the west side of the Shillamill Viaduct (see Fig 6). Figures 9 and 10 show before and after views of a cattle drinking site (SX 47384 73064).

Approximately four months later, the surface of the canal towpath was patched with crushed stone (803 specification) where the path was potholed or muddy, then sections covered with finely ground stone (6mm to dust) from Meldon Quarry.

During construction of the cattle drinking sites and during the canal repair works there has been minimal archaeological impact, nor any finds recorded.

Aqueduct Bridge SX 46630 72090

Knevitts Ltd was commissioned by the TVMHP in 2011, to undertake a structural survey of the aqueduct bridge at this location. Their report and structural drawing (see Fig 12), recommended that a rusty wrought iron support (middle one of three similar supports – see Fig 13) sited under wide slates below the towpath next to the canal, be replaced with a modern equivalent. In addition, it was recommended that the tall retaining wall on the south west side of the aqueduct bridge be repointed and structural ties inserted (using 7mm diameter stainless steel helibars) into the masonry bedding joints to strengthen a structural crack in the masonry.

This work was not started until May 2012, following an extensive dialogue with SWW and the site owner. Figure 13 shows the failed rusty element needed to be replaced. The original lintel was 50mm x 50mm for most of its length but widened to 100mm at both ends (and set in the side walls). Unfortunately the original wrought iron section specification was impossible to replace, and an 'off the shelf' item had to be found due to budgetary constraints. Figure 14 shows the new steel replacement *in situ*. Scaffolding had to be erected to remove the original rusty support and to replace it with the new 50mm wide x 115mm deep iron profile steel section. A slightly wider opening had to be made into each granite quoined side of the bridge for insertion of this new structural element. The localised setting was then repointed with lime. The steel was painted with a red primer and then painted black.

Other works to this site included removal of a tree growing out of the west side of the north end of the aqueduct bridge and treatment of the stump, as its unchecked growth had caused structural issues to the masonry at this point. On the opposite side of the bridge opening, the top flanking stones over the east side revetment walling had become dislodged. These were moved back to their original position. TVMHP funded the project.

At the north end of the structure under the aqueduct section, it appears that water has been leaking from the canal at the intersection of the metal 'trough' profile bolted plates and the canal bed – on both sides, through the stone masonry. This has caused the masonry and water at this point lower down under the aqueduct to be constantly wet.

Consequently, the foundations masonry and pointing in this area have softened to the extent that the masonry is collapsing and arching downwards. SWW attempted to add some clay to the leaking intersection point in the bed of the canal, but this has not worked. Structural deterioration will continue unless this issue is resolved. This is a significant feature of the canal which is in places, is now a Scheduled Monument. It is a recommendation of this report that the aqueduct bridge be considered for Listing.

Finally, the vertical retaining walling on the south west side of the aqueduct was repointed and the structural crack that had been identified by the structural engineer, repaired with the use of helibar reinforcing. This work finished in mid June 2012. The repointed wall acted to retain not only the towpath running along the south side of the canal, but also steps that allowed access from the towpath down into the adjacent field. These steps have badly deteriorated, leaving a steep slippery slope. It is recommended that they need to be rebuilt before use of them can be made by a new DCC footpath from the nearby railway linking up with the canal footpath.

Lock Gates and timber lifting bridge SX 46327 72628

The timber lock gate and timber lift bridge was 'restored' in 1998 by SWW and British Waterways. It is not know what the restoration replaced, but parts of the timber lift bridge (mainly the western timber arm), had rotted resulting in collapse (see Fig 15). Other parts of the bridge were showing that many timber items were rotting. In addition, the section of timber lock gate that was in constant contact with canal water had also rotted during the last 14 years. SWW and the TVMHP decided to replace the rotted and unsafe timber items as being a Health and Safety issue, given the frequent public use of the towpath. SWW funded the project.

The project of dismantling the bridge and lock gate, replacement of the main and structural timbers, and re-assembling and fixing on site was tendered. The contract was won by Will Sterling and Son, a traditional timber boat builder and carpenter who worked at Morwellham Quay (repairing and building boats, etc). The work was started in July 2012 and finally finished in September 2012.

Figure 16 is an 'after' view of the works on these features, and should be compared to its preceding figure. It is hoped that this repair will last longer than its predecessor!

Note:

In 2013, the TVMHP constructed a new footpath from near Morwell Rocks (SX 44128 70435) to above George & Charlotte Mine (SX 45101 69962). This new route links the main route of the railway line from Devon Great Consols to Morwellham and the forestry tracks north of Morwellham. Scheduled Monument Consent was obtained in 2012 for construction of a new timber footbridge over the Tavistock Canal (the section from the west end of the Morwell Down tunnel to the incline railway cottage was Scheduled in 2011, SM No. 30973). As part of this project, an impact assessment report was produced (Buck 2012). The results of the new footpath creation and footbridge construction will be produced within the main body of the TVMHP archaeological recording report (Buck forthcoming).

8. References

8.1 Primary sources

CRO AD 58-26 Tunnel Lodes (1923-33) Report by F Cloke and CF Barclay.

DRO T1258M-14B Bedford Estate Map

8.2 Secondary sources

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Booker, F., 1970, *Morwellham – a history*, DART Publication No. 2

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Hedges, C., 1975, The Tavistock Canal, DART Publication No. 16

Waterhouse, R., 2012, *Tavistock Canal, Surveying a forgotten marvel of the industrial age*, Current Archaeology, Issue 273 December

Waterhouse, R., Forthcoming publication on 'Tavistock Canal'.

Woodcock, G., 1995, 2005, Booklets on the 'History of Tavistock'.

9. Project archive

The HE project number is **20070793**

The project's documentary, photographic and drawn archive is housed at the offices of Historic Environment, Cornwall Council, Fal Building, New County Hall, 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 (20070793).
2. Black and white photographs archived under the following index numbers:

   GBP 2091/12-21; 2207/12-22; 2250/1-17; 2253/19-22.
3. Digital photographs stored in the directory R:\HE images\Sites\Devon\Tavistock\Tavistock Canal
4. This report text is held in digital form as: G:\HE Documents\HE Projects\Sites\Devon\Tavistock Canal IA WB report 20070793
5. English Heritage/ADS OASIS online reference: cornwall2-154344

No artefacts or environmental material was retrieved during the project.

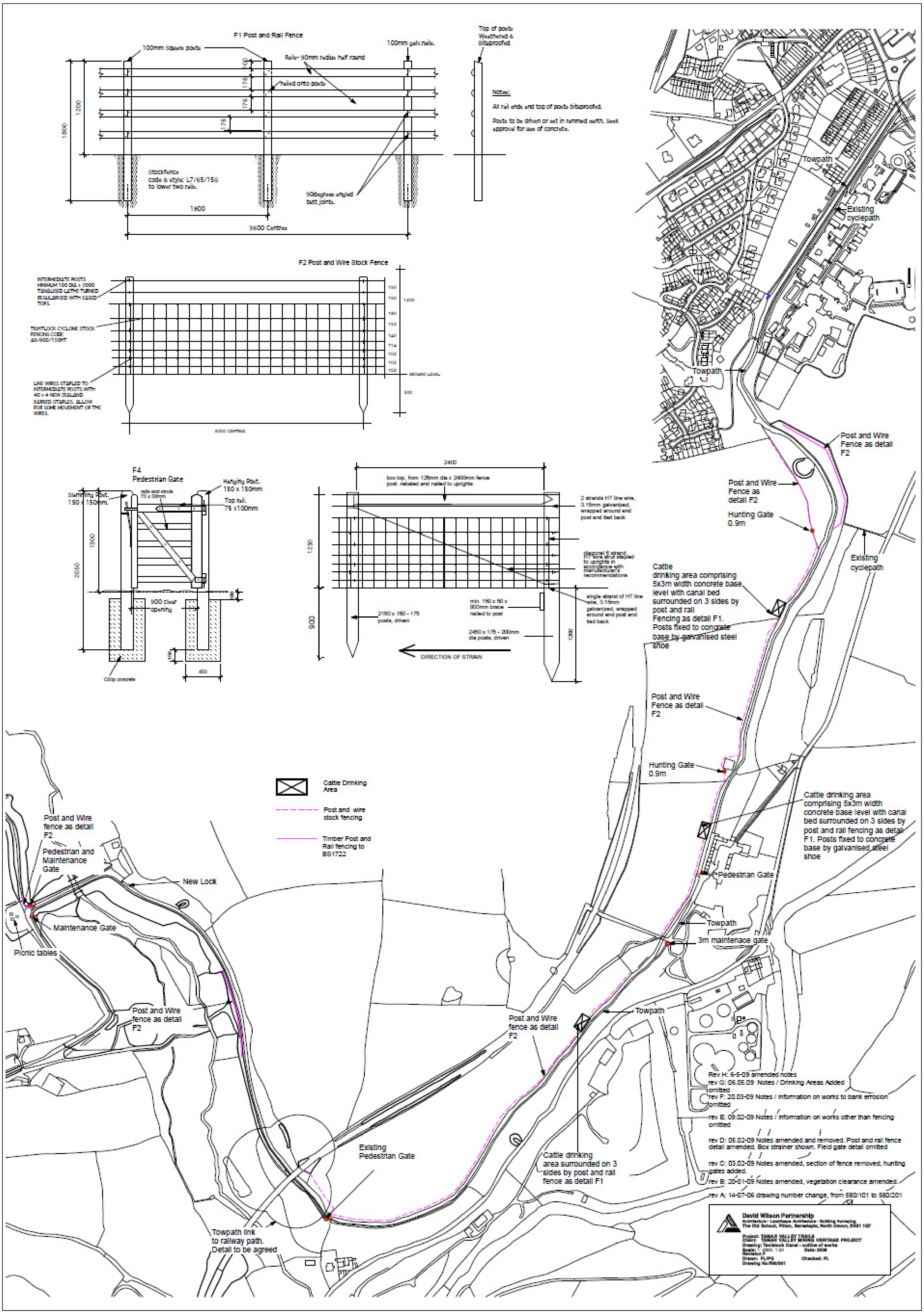


Figure 5 Specifications and plan showing fencing and three cattle drinking areas at the Tavistock Canal(East section)

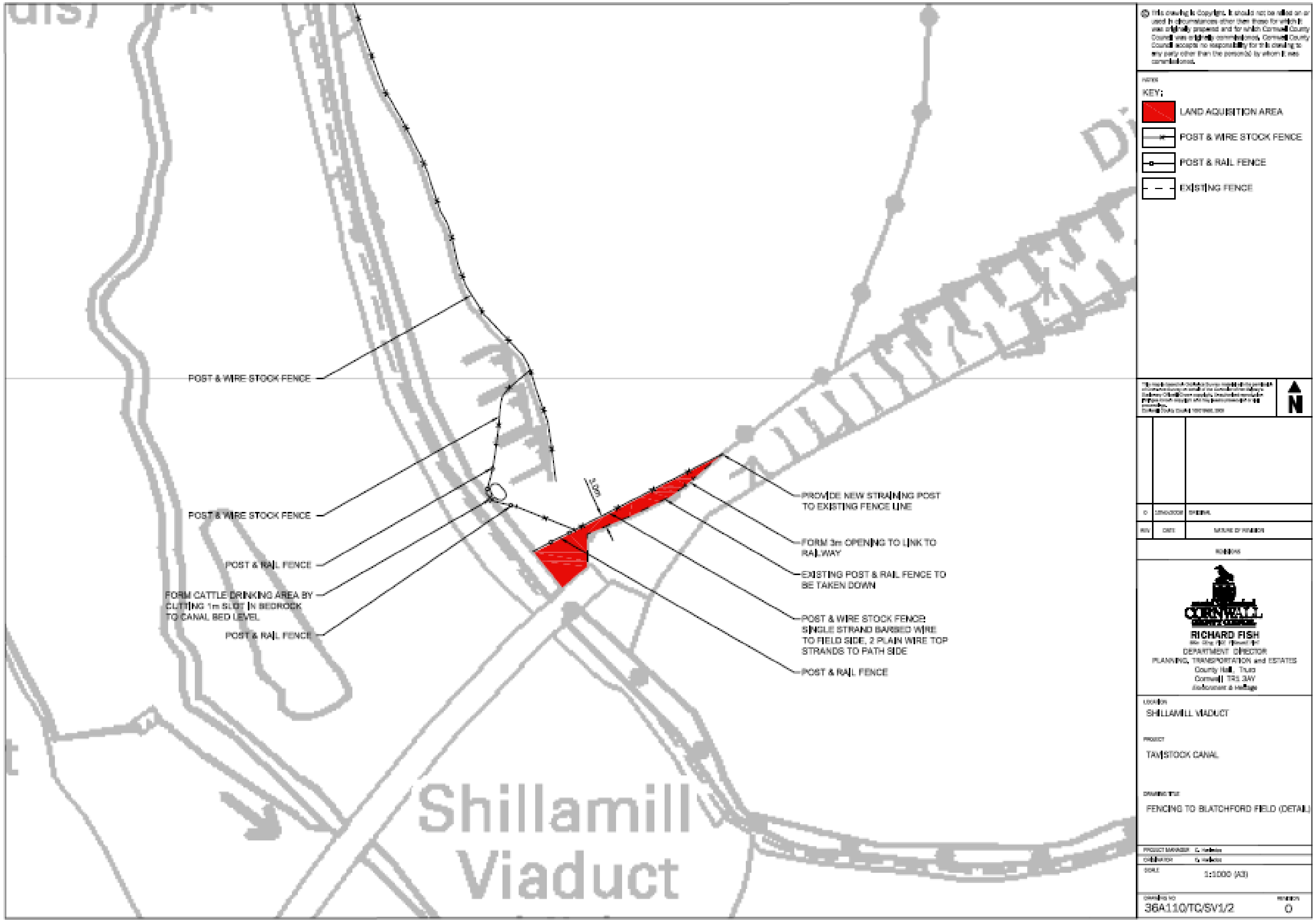


Figure 6 Detail plan showing the cattle drinking area west of the Shillamill Viaduct

Figure 7 A view of the Tavistock Canal east bank before works © CC HE Projects

Figure 8 A view of the Tavistock Canal east bank after works © CC HE Projects

Figure 9 A view of a Cattle Drinking site before works (SX 47257 72705) © CC HE Projects

Figure 10 A view of the same Cattle Drinking site after works © CC HE Projects

Figure 11 A view of the canal towpath after re-surfacing works © CC HE Projects

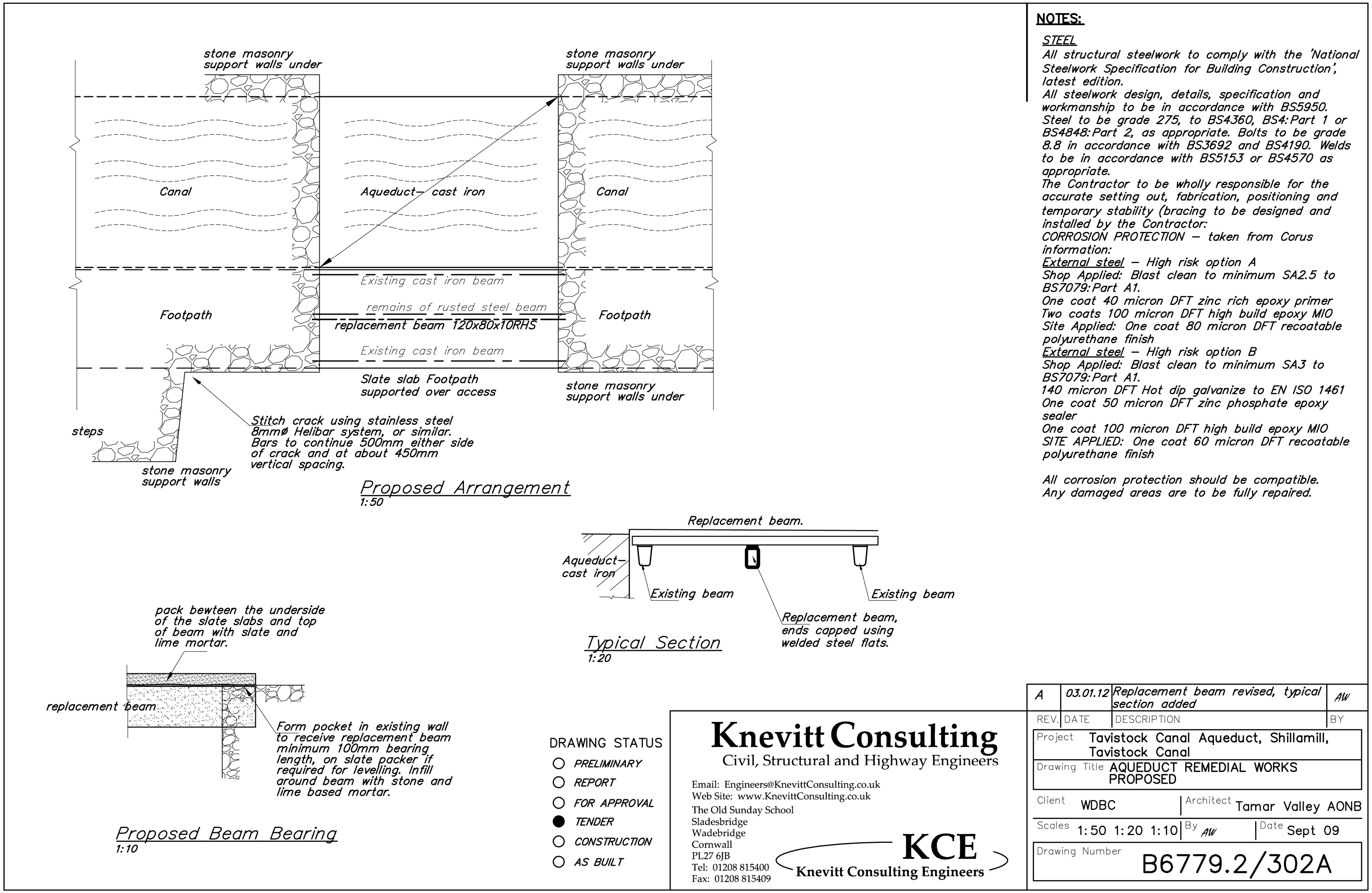


Figure 12 Specifications plan for repair of the aqueduct bridge

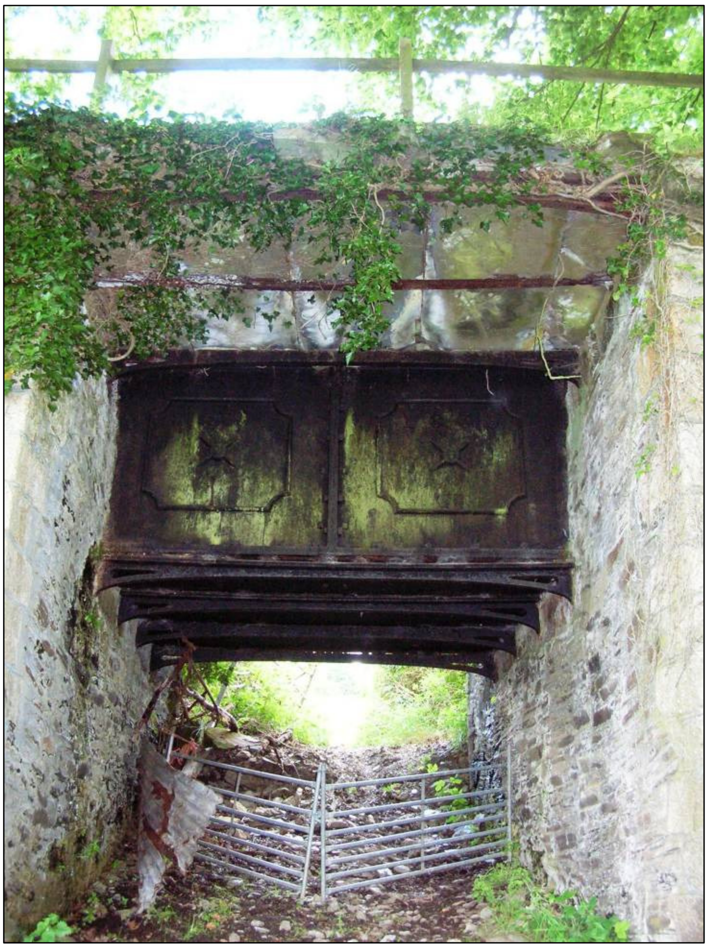


Figure 13 A view of the canal aqueduct bridge before works © CC HE Projects

Figure 14 A view of the canal aqueduct bridge after works © CC HE Projects

Figure 15 A view of the canal lock gate and bridge before works © CC HE Projects

Figure 16 A view of the canal lock gate and bridge after works © CC HE Projects

Appendix 1: TAVISTOCK CANAL BANK REPAIR WORK SCHEDULE

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
20		Side out path and hedge (140m length)
76		1.5m infill behind c $2m^3$
118		1.5m infill behind c $1m^3$
140-150	10	Minor wall top repair
159-160	1	End of hedge
162-163	1	1m infill behind $0.25m^3$
166-179	13	
225-247	22	
253-308	55	Break out conc block
314-323	9	
328-330	2	
394-418	24	
433-461	29	Take off conc
P A T H		
467-469	2	Break out conc
472-473	1	Good example, flat stone
485-488	3	Remove conc, Repair bank
494-513	19	Remove section of conc
530-541	11	
557-558	1	
563-573	10	
577-578	1	
581-584	3	
591-592	1	
600-650	50	
664-673	29	
691-694	3	
703-704	1	
714-718]	4	Soft path, build up levels (ch 14-27)
722-727]	5	
730-735	5	
744-745	1	
751-754	3	
755-760	5	
771-773	2	
779-780	1	
782-798	16	800 ⇒path surface 80ft
800-804	4	
804-806	2	Build up path surface to fall to canal

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
		(ch 800-902)
808-809	1	
813-814	1	
819-820	1	Lay hedge, remove barbed wire (ch 800-902)
823-826	3	
839-842	3	
875-876	1	
892-894	2	
902-903	1	Remove gate, overhanging branch
902-907	5	
970-971	1	Gate and post and rail across path
975-976	1	Surface ok
985-990	5	In deep
1009-1010	1	
1019-1020	1	Take out tree growing out from opposite bank
1068-1069	1	Path surface repair
1093-1094	1	Under bridge
1099-1100	1	Bridge coping repairs 4m copings in canal
1130-1131	1	Boulders ⇑ make up path ⇓ scrape leaf mould
1158-1159	1	
1165-1166	1	
1169-1170	1	
1187-1192	5	
1197-1199	2	
1202-1207	5	
1208-1209	1	
1225-1232	7	
1260-1268	8	
1271-1272	1	
1279-1280	1	
1282-1283	1	
1295-1298	3	
1308-1309	1	
1317-1319	2	
1334-1342	8	
1353-1356	3	
1409-1414	5	
1421-1422	1	
1424-1425	1	

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
1441-1442	1	
1454-1456	2	
1514-1515	1	
1546-1548	2	
1573-1574	1	
1581-1582	1	
1603-1604	1	
1600		Path falls away from canal. (1.5m width)
1691-1692	1	
1718-1719	1	
1721-1722	1	
1726-1729	3	
1820-1821	1	
1856		AQUADUCT (Clear vegetation, Take out gate)
1958-1968	10	Under viaduct
1970-1972	2	
2020-2023	3	
2151-2152	1	
2220-2221	1	
2316-2318	2	WHEEL SLUICE Interpretation Barrier (Take down concrete posts and blocks)
2463-2464	1	
2534-2535	1	
2541-2543	2	Replace Bascule bridge
		Lumburn Valley Turning area at lock (excavate)
2586-2600	214	Opposite bank
TOTAL		

Note:

An additional 87 linear metres of repairs were undertaken by the site contractors as they deemed them necessary. These additional repairs are not reflected in the above schedule chainage list, which was originally compiled by Chris Hariades (in consultation with Colin Buck and SWW (Laura Wotton) in April 2009 to inform tender information and site specifications prior to the start of works. The location of the small swing bridge in Tavistock (from which the chainages are measured) is at SX 47348 73503.

Tavistock Canal - Canal Bank Repair Works Schedule

Item	Description	Qty	Unit	Rate (£)	Cost (£)
1	Provide site welfare facilities to comprise as a minimum porta-loo with handwashing facilities, maintain and take down on completion	Item			
2	Provide all necessary fencing, barriers, signage, maintain for duration of contract and take down on completion	Item			
3	Break out concrete capping (provisional)	50	lm		
4	Clear rubbish from canal bed and dispose to licensed tip (Provisional)	10	m3		
5	Repair identified sections of failed or colapsing drystone facings to canal bank to match adjoining sections using stone salvaged from canal bed	250	m2		
6	Tie and marry in each repair to adjacent sound sections.	100	no.		
7	Extra to bed bottom course of stone on 50mm depth drymix sand/lime/cement bed in ratio 6:2:1 where laying directly onto bed rock.(Provisional)	50	l.m		
8	Extra to import suitable matching stone to make up shortfall in site salvaged material (Provisional)	50	tonnes		
8	Backfill voids behind stone facing to level with top of bank with imported scalpings compacted in layers not exceeding 200mm depth (provisional)	10	tonnes		

Report No: 2013R046

Tavistock Canal, Devon

Archaeological impact and recording report

Historic Environment Projects

Report No	Report Name	Report Author
2013R046	Tavistock Canal – Impact assessment and archaeological recording during a program of repair works	Colin Buck

Event Type

Site consultancy	Archaeological impact assessment	Archaeological watching brief	

Client Organisation	Client Contact
TVMHP (West Devon Borough Council)	Chris Hariades (TVMHP)

Monuments (MonUID)

DHER 3879 (Tavistock canal)	18721	4069	3882	5449	3956

Fieldwork dates (From)	(To)	(Created By)	(Create Date)
05/05/09 05/05/12	29/05/09 05/09/12	Colin Buck	13/05/13

Location (postal address; or general location and parish)

Tavistock Canal (northern section from Tavistock to Lumburn), Tavistock, West Devon

(Town – for urban sites)	(Postcode)
Tavistock	

(Easting) X co-ord	(Northing) Y co-ord		
From: SX 47367 To: SX 46183	73572 72589		

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

List of Figures

Abbreviations

AONB	Area of Outstanding Natural Beauty
CC	Cornwall Council
DCC	Devon County Council
DHER	Devon Historic Environment Record
DRO	Devon Record Office
HES	Historic Environment Service
OS	Ordnance Survey
SWW	South West Water
TVMHP	Tamar Valley Mines Heritage Project
WHS	World Heritage Site

Acknowledgements

Thanks are due to Robert Waterhouse for providing some primary survey data and information files from his research relating to a forthcoming book about the Tavistock Canal. Chris Hariades (Tamar Valley Project Manager), and Bill Horner were involved in the project throughout its entirety. Andrew White of Knevitts Cons. Engs. was involved in preparing the specifications of the aqueduct bridge.

Front cover image: a copy of the Tavistock Canal Company Seal.

1. Project background

The Tamar Valley Mining Heritage Project (TVMHP – 2005 to 2013), a £7 million Heritage Lottery Fund project focusing on the World Heritage Site landscapes of West Devon in the Tamar Valley, is co-ordinated by the Tamar Valley Area of Outstanding Natural Beauty (AONB). The TVMHP was approved for Stage 2 consent by HLF in 2003. It involves the conservation of former mine sites and trail creation along the Devon side of the Tamar Valley (from Devon Great Consols to Morwellham). These sites include Devon Great Consols, the largest mine in Europe during the 19th century. The project also included conservation and repair works to the Bere Alston to Tavistock railway line (Buck 2011), the Tavistock Canal, and parts of Morwellham Quay itself (other contractors). This project covers works undertaken along the Tavistock Canal (Fig 1).

The Historic Environment Service (HES), Cornwall Council was commissioned in July 2007 by the Tamar Valley Mining Heritage Project (Chris Hariades as TVMHP Project Manager), to undertake an archaeological impact assessment, archaeological recording and site consultancy, photographic building recording of affected sites impacted by the works. An impact assessment project brief had not been produced, but it follows a similar project design by Historic Environment Service, Cornwall Council; *'Project design for production of archaeological recording, as part of the Tamar Valley Mining Heritage Project (2006-2009)',* dated 23/06/06. A Project Design for this site and other building conservation schemes in the TVMHP was produced on 21/07/2006, and was subsequently approved by Bill Horner (Devon County Archaeologist).

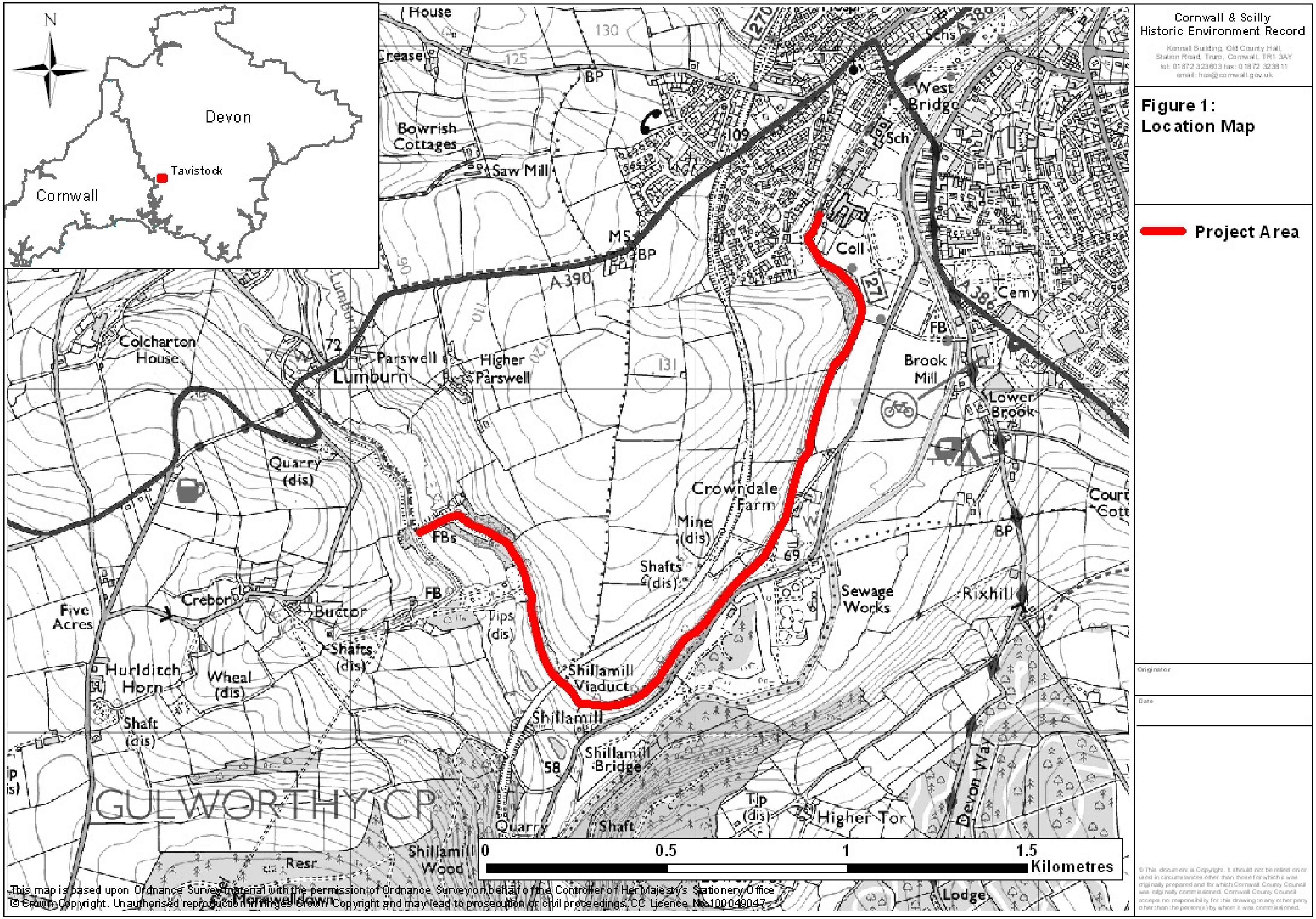
The conservation and management of features relating to the TVMHP's mining heritage and enablement of safe public access forms the basis for the Tamar Valley site conservation scheme. This report will assess the impact of the proposed conservation works on the Tavistock Canal's significant assets (canal within the WHS), describe the mitigation undertaken and also a description of the archaeological record for the (intermittent) works from May 2009 to May 2012. Following the first phase of works in the summer of 2009 (to describe and record the repair works and the minimal impacts to the canal sides), an interim report was produced for Bill Horner (Devon archaeology – Buck 2009).

In a joint project with SWW, the TVMHP agreed to fund cattle fencing along all of the west side of the canal, in order to stop further damage being caused to both sides by cattle drinking the water and wandering (on one occasion into Tavistock!), and to create four cattle drinking sites. SWW agreed to fund the repair of the sides of the canal bed. Furthermore the TVMHP agreed to re-bed and re-seed where necessary the canal towpath later in the autumn of 2009, and at a later stage (2011), to repair the damaged lock gates. In addition, the TVMHP agreed to undertake small-scale structural repairs to the small aqueduct bridge in 2012, and a small amount of repointing.

2. Aims and objectives

The aims of the project were as follows:

- To ensure that site works are undertaken in such a way as to maintain the integrity and authenticity of the historic resource, minimising adverse impact upon the resource.
- To ensure that the Devon County Historic Environment Service (DCHES – Bill Horner) are appraised of all site works.
- To ensure that the highest possible standards of the historic environment conservation works are maintained, which must be carried out to recognised current best standards in this discipline.
- To ensure that works are undertaken in such a way as to allow adequate recording of remains affected by the works.
- To record sites, features, deposits and artefacts affected by or uncovered by the works.



Cornwall & Scilly
Historic Environment Record
Figure 1:
Location Map
Project Area
N
Devon
Cornwall
Tavistock
0
0.5
1
1.5
Kilometres
House
Crease
Bowrish
Cottages
Saw Mill
BP
MS
A 390
West
Bridge
Sch
Coll
Cemy
A 386
FB
Brook
Mill
Lower
Brook
Colcharton
House
Lumburn
Parswell
Higher
Parswell
Quarry
(dis)
Crowndale
Farm
Mine
(dis)
Shafts
(dis)
Sewage
Works
Court
Cott
Rixhill
FBs
FB
Crebor
Buctor
Five
Acres
Tips
(dis)
Shafts
(dis)
Hurlditch
Horn
Wheal
(dis)
Shaft
(dis)
Shillamill
Viaduct
Shillamill
Shillamill
Bridge
58
GULWORTHY CP
Quarry
Shaft
Tip
(dis)
Higher Tor
Devon Way
Shillamill
Wood
Resr
Lodge
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- To record the character and extent of works to the sites.
- To inform the Devon County Archaeologist of the nature, condition and significance of the canal and towpath, and describe the proposed impacts and a mitigation strategy (agreeable with the Devon County Archaeologist).
- To disseminate the results of the project appropriately and arrange for the deposition of the project archive (within IfA Guidelines).

It was proposed that the building conservation and repair programme will address the following:

- The protection and consolidation of significant archaeological remains in their settings.
- Health and safety aspects of the site relating to public access.
- Provision of low-key public amenity use where appropriate, incorporating access.
- Interpretation of the site to the public, including on-site and written materials.
- Linking the site into the local economic, social, tourism and recreational contexts.

In terms of the management of archaeological features, engineering works were kept to a minimum, but in view of the fact that the entire site is part of the Tamar Valley component (Area 10) of the Cornwall and West Devon World Heritage Site mining landscape, particular attention was paid to suggestions for the best mitigation of any such works.

3. Historical background

This subject matter has already been written in far more detail than is necessary for this report, notably by Hadfield (1967), Booker (1971, who reproduces the tonnages in Appendix 2), Hedges (1975), Woodcock (1995, Vol 6; 2005), and more recently a publication by Robert Waterhouse (2012), and a forthcoming detailed book. The text below is a summary history and construction account of the Tavistock Canal extracted from all of the above sources.

The medieval borough of Tavistock has always been closely linked to its port, Morwellham. That link was dramatically improved by the construction of the Tavistock Canal from 1803 to 1817. The main structural features of this major construction throughout its full length can still be seen today, over two hundred years later; the wharves at Tavistock and Morwellham, the aqueduct over the River Lumburn, the 1.5 mile long tunnel under Morwell Down, and the remnants of the incline plane down to Morwellham.

The historical chronology for the canal can be summarised as follows:

1796 The opening of Wheal Friendship Copper Mine, Mary Tavy, unintentionally led to the construction of this canal. The export of ore and import of coal and other materials needed to be cost effective – its transport costs by horse and cart must have been prohibitive. The young mine's engineer (in his twenties), John Taylor, had the idea of linking the Tavy and Tamar valleys, whilst using Morwellham to export the ore (via sea going ships); the nearest active port to Tavistock.

1800 By the turn of the 19th century, the country had been at war with France for a few years. Demand for metallic ore, and therefore the need for a canal were high.

1802 Survey of the proposed canal route (presumably with the blessing of the Duke of Bedford) by John Taylor, the mining engineer of Wheal Friendship copper mine.

1803 (March) A canal company, funded by shares from the London Stock Exchange (see front cover seal image), was formed. Work began on the route in 1803, following the passing of an Act of Parliament. The canal was to be 16ft wide and 3ft deep, with a branch to the slate quarries at Millhill. It is likely that the first section of the canal route followed an earlier leat from the River Tavy to Crowndale Mine. Raising funds on the stock exchange gained stock interest from adventurers to exploit known lodes whilst tunnelling through the granite of Morwell Down, and for additional shares to be

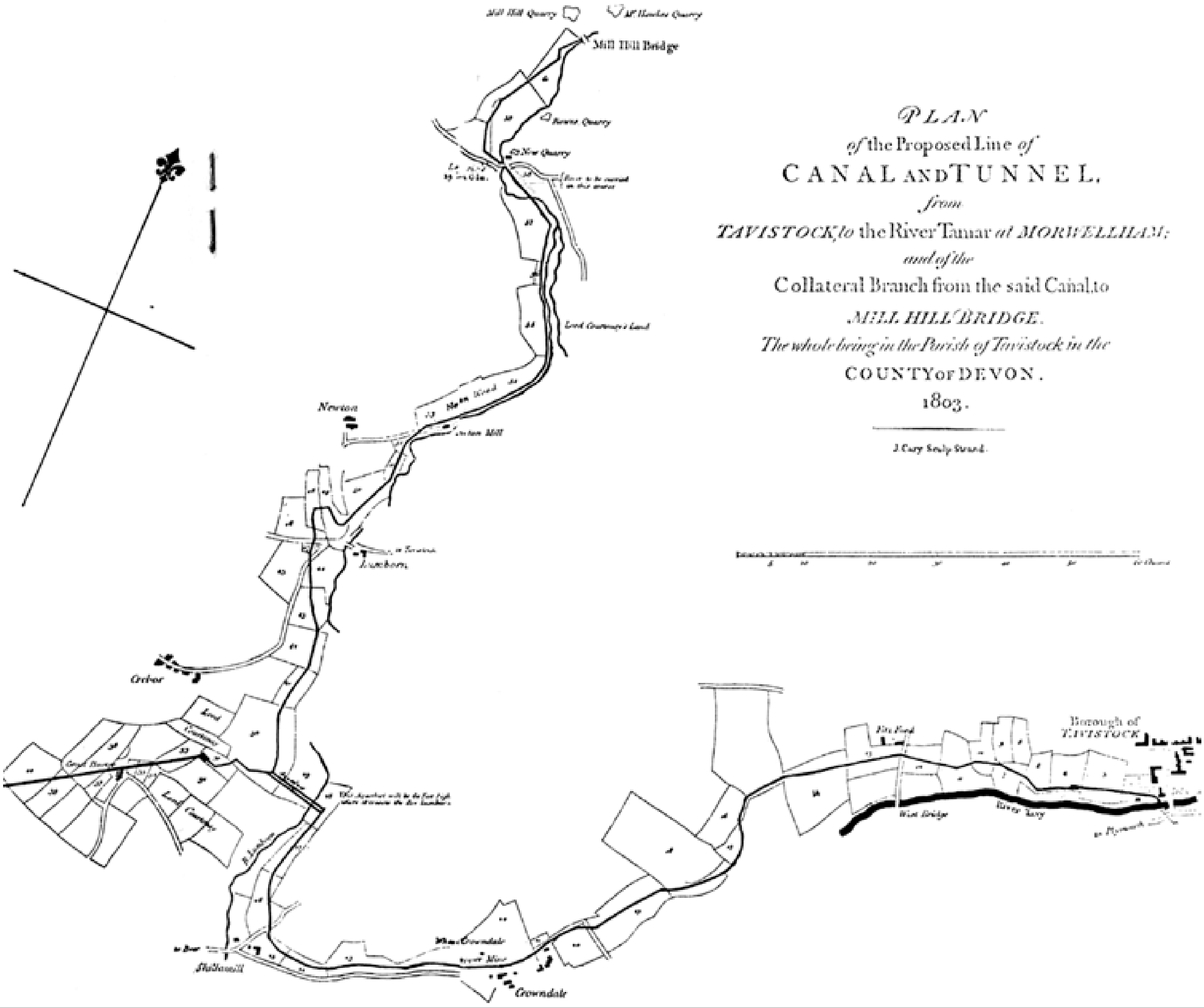

Figure 2 Excerpt of the 1803 survey plan (within the study area) of the proposed Canal route from Tavistock to Morwell Tunnel (Hedges 1975)

purchased by other mines and Tavistock businesses along its course, all recipients of the canal’s cheaper transport costs. However, Hedges (1975) hints that Taylor’s real motivation for the project was not primarily to build the canal, rather the opportunity to exploit known lodes under Morwelldown, a mining speculation.

Figure 2 shows the original planned 1803 route. The provision of water via leats from the western end of the canal (top of the Morwellham incline) for other mines in the Tamar Valley as far north as Gunnislake to power water wheels was also planned. The original cost estimate for the canal was £40,000 (including testing for ore lodes), at £100 per share. The Duke of Bedford, who owned all the land along the canal’s course, also purchased 1/8 of the shares and took dues for use of Morwellham Quay. He also agreed to a request to make a grant of a Mining Set: (for working all Lodes discovered in the Course of the Canal, Embankment, Tunnel and collateral branch for copper, tin and lead to the extent of 500 fathoms East and West of the canal for every Lode discovered), for the sum of 1/10 dues and a term of 42 years.

The principal engineering features being the aqueduct over the River Lumburn, the 2,540 yard tunnel through Morwelldown, and the inclined plane west of the western end of the tunnel down to Morwellham – a fall of 237 ft, the greatest in southern England at that time.

Figure 3 Excerpt of the 1867 Bedford Estates survey plan (DRO T1258M) showing the canal within the study area.

1803 (23rd August) Work began on the tunnel. Almost immediately copper was struck at the Tavistock end of the tunnel, and the lode developed to realise what later became Wheal Crebor (see Fig 3). Men were employed to work both concerns – the accounts separated. The Canal Committee managed both concerns until 1812 when a separate Committee was appointed after further copper ore discoveries in the tunnel under Morwelldown (Hadfield (1967, 128).

1808 The waste rock and ground from the tunnel excavation was boated eastwards back to the tunnel entrance and used to infill and form the Lumburn Aqueduct over the valley, with a central spanning arch.

1809 Work progressed slowly in the tunnel (by this date it was half finished), as the canal section from Tavistock to the tunnel was finished (ie, this project's study area). This was built more permanently with stone sides (on edge) rather than puddle clay. The tunnel rock was granite, its depth 160 yards below the top of the hill. Pumping/ventilation/winding and access shafts (at least four – the main one being Bray Shaft), had to be sunk from the top of Morwelldown to the underground canal. John Taylor designed the power source for the shaft workings by utilising flat rods (for lengths up to 1.5 miles) powered from a large 40' water wheel. He also designed a ventilation fan for improving the air quality, for which the company was awarded the medal of the Society of Arts in 1809 (Hedges 1975).

1810 The tunnel advanced at a rate of about 150 fathoms (six feet per fathom) per year until this year when three granitic dykes were cut, slowing the work rate to nearly a third that amount for two years. 30 to 40 workmen were continually employed, with some authors suggesting French prisoners of War used as 'navvies' (Barton 1964, 93 and Booker 1971, 108).

1815 From this year there were shipments of manganese from mines around Brentor and Milton Abbot carried by the canal. These were the principal sources of manganese in the country at a time when it was used in the manufacture of glass. For example, 13,335 tons were shipped to Plymouth in 1819. The ore was ground in a mill powered by the Morwellham water wheel (Booker 1976, 19), and exported in casks.

1816 (August) Tunnels were cut from both ends (simultaneously), to form a working area and to align both ends. They connected on the 21st August. Then the tunnel was enlarged (downwards and wider) throughout its length.

The demand for metallic ores to feed the Napoleonic war years (1793 – 1815) slumped as the soldiers returned, as markets waned. The canal committee, sensing further financial difficulties in September stated *'That the Tonnage will fall very short of the original estimate cannot be doubted; at the time when this was made the Mines in the neighbourhood were in their most flourishing condition, or rapidly advancing to it. Agriculture encouraged by high prices was improving everywhere, and the use of lime, so essential … was very great and increasing. Slate quarries, then making large returns, were in full activity, and new ones opening. In all these sources of oecumenical mode of carriage, the greatest reverses have taken place, and at present a stagnation of enterprise and consequent inactivity prevails'* (Hadfield 1967, 130). However, the population of Tavistock had increased from 1801 to 1821 by over 62%, reflecting the growth in the area, primarily a result of mining operations and related tertiary expansion.

1817 The tunnel was finally completed early in the year, with the official opening ceremony held on 24th June. Thousands attended the event, with over 300 going in boats (with a band) through the tunnel – to be met (with obvious relief) by thousands more at the Morwellham side. All were then given a demonstration of the workings of the incline railway mechanism and tramway down to Morwellham (see Buck 2005 – Sites 58 to 64), powered by a large water wheel and the canal water – which was also recently completed. The boats (specially designed and built by the Tavistock foundries from 1811 to replace an earlier wooden design), were *c*30 feet long, 5 feet wide and towed along the slow moving open canal by horses. They were worked through the long tunnel by two men using iron bars against the rock face.

The canal had taken 13 years to build. Its final cost was £62,000, the excess over the authorised capital of £40,000 having been raised by calling £155 on each £100 share.

1819 Although the economic outlook for the area was not good, the company decided to press ahead with the Millhill canal branch to the slate quarry. It was 2 miles long and cost £8000. It rose by 19.5ft to Millhill, with an inclined plane for the final section due to the scarcity of water (double tracked with two cradles counterbalanced with loaded boats going down pulling the empty ones up with the help of three horses).

1820s The expected tolls were halved from their pre-construction estimates – due to the gloomy economic climate. Over the next three decades the canal carried between 15,000 to 20,000 tons per year, earning an annual profit of approximately £600.

1831-2 A Cholera epidemic in the locality severely affected the workforce, the local economy and (temporarily), the canal's fortunes.

1841 Great Western Railway completed.

1844 Discovery of the main copper lode (40' wide) at Wheal Maria later Devon Great Consols – reversing the fortunes of Tavistock over the next 30 years, but reducing those of the canal. The Mill Hill Tramway was constructed this year (replacing the earlier section of the canal which had been closed after 1831), at a cost of £1,381 (Hadfield 1967, 132).

1847 20,132 tons were carried on the canal (Woodcock 1995, 23).

1848–9 Another Cholera epidemic.

1850 The goods carried on the canal were (tons): Sundries (7548), Limestone (3130), Copper ore (2.499), Slate (676), Granite (83) and Mundic (pyrites) (94). Tonnage carried fluctuated from year to year, reflecting the area's economic woes (or successes). In a bid to maintain revenue, at various times throughout this period, the company reduced tolls, or raised them again when economic conditions improved. But dividends, throughout the life of the canal were always modest, and profits turned out to be at a level 1/3 predicted at the outset.

1851 In the 1851 census, there were 27 barge men working for their various employers regularly using the canal.

1857 Shares that had changed hands at £100 in 1803 were now changing hands at £5.

1859 Construction of the Devon Great Consols railway from the mine to Morwellham with a separate incline section down to the port finished this year. Also the South Devon & Tavistock Railway from Plymouth to Tavistock opened (later extended to Launceston) – in direct competition to the canal. Due to this competition, the company further reduced its tolls after the opening of the railway. However, in the same year it expended more capital on renewing the inclined plane mechanism, and investing funds on a steam mechanism to pull loaded barges through the tunnel against the water flow (it often took a couple of hours or more to undertake this manually!). This was not successful.

There is no doubt that the waning fortunes of the Tavistock and Tavy copper mines, working for the past half century, were no competition for the resurgence of the Tamar Valley copper mines from the mid 19th century. Whilst the former utilised the Tavistock Canal as a transport medium during this period, the latter formed its own railway equivalent; but both used Morwellham as the export destination. Given the rapidly changing transport infrastructure due to the construction of mainline railways to the south west from the mid 19th century (consequently resulting in dramatic changes to market influences), across Devon and Cornwall at this formative period, so the fortunes of this old transport route was found wanting and uneconomic.

1860 In the previous year, the canal tonnage was 17,455. In this year it fell to 13,500. From 1863 onwards there was a steady decline in the tonnage until, in the early 1870s it dwindled to nothing (Hedges 1975, 28).

1862 A shareholder from Birmingham wrote to Mr Gill, representative of the Canal Company and said: '*I am afraid there is little hope of the canal rising in its fortunes with the railway for a rival. Here we have in several cases united the canal with the railway with advantage to both – you know best whether such an arrangement with the Tavistock canal would be advisable*' (Hedges 1975, 28).

1866 In September, the canal committee recorded; '*That a very considerable reduction having taken place in the traffic and dues of the Tavistock Canal Company since the opening of the Tavistock and Launceston branch of the South Devon Railway it was resolved that His Grace the Duke of Bedford be applied to kindly assist the Tavistock Canal Company to compete with the Railway Company by reducing the Canal Dock dues at Morwellham'.* The Duke was evasive (Hadfield 1967, 134).

1870 Only 783 tons were carried on the canal (Woodcock 1995, 24).

1872 Presumably the economic situation became even direr. At a meeting on 2nd September the Duke offered to buy all the shares at £8 each, and to pay half the cost of an Act to transfer the canal to him. Within the month, the committee accepted his terms. Since the summer there had been no traffic on the canal. However, this was not a localised occurrence; the impact of the railways had dealt a death blow to innumerable canals all over the country.

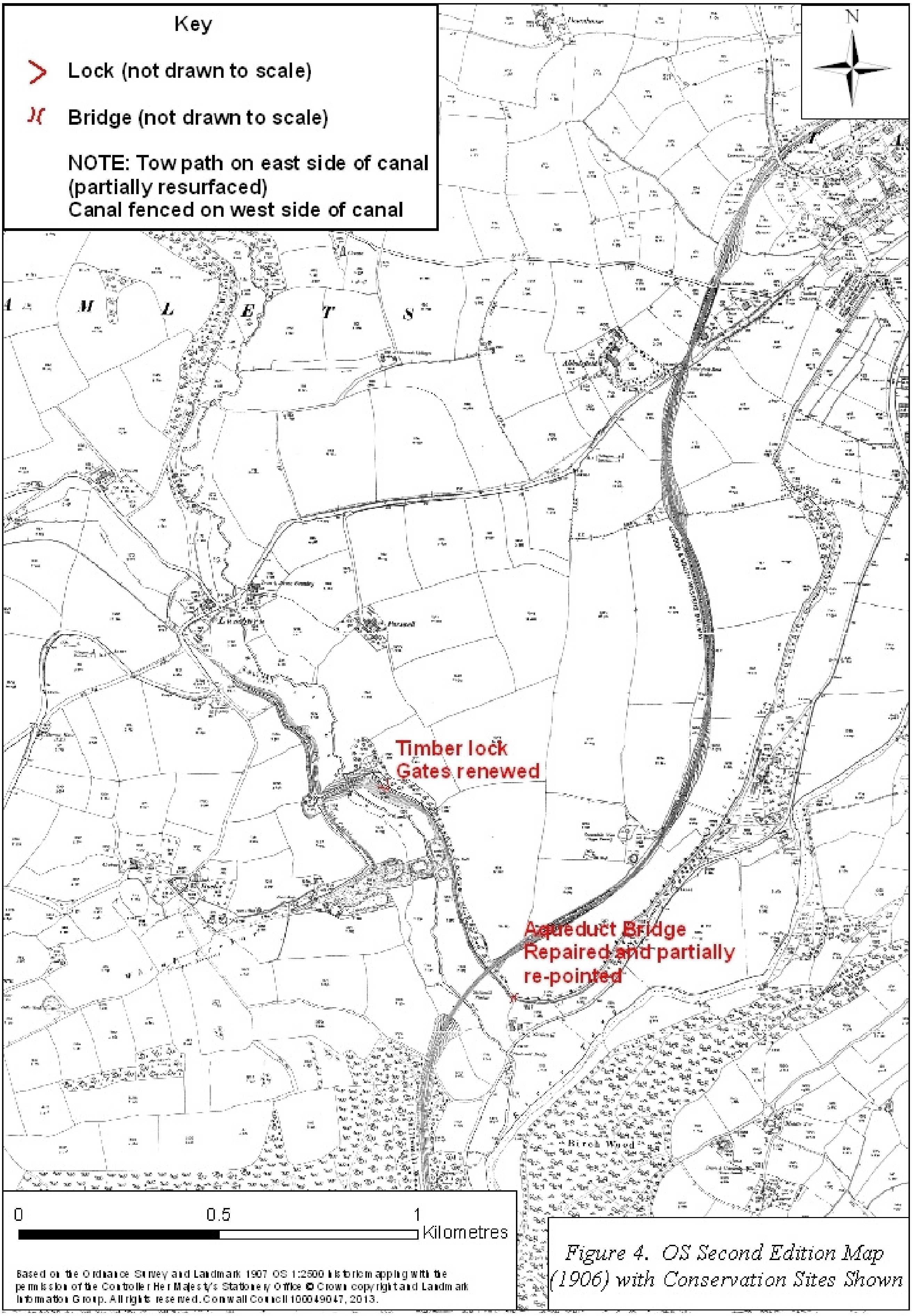

Figure 4. OS Second Edition Map (1906) with Conservation Sites Shown

1873 In May the Act was passed and the Tavistock Canal and land returned to the Duke of Bedford for £3,200, there being no obligation on the Duke to maintain the canal. It is uncertain what use the canal had for the next twenty five years.

1896 This perhaps was made clear in May of this year when the Tavistock Gazette reported that on Whit Monday the basin of the Tavistock Canal was to be cleaned out (it appears a regular activity on this day). *'The cleaning is wanted more now than when it was a hive of industry … a resident noted ... A great deal of sewage was emptied into it, and the water does not run at a greater rate than half a mile an hour. I have seen dead dogs, cats and rats in the canal'* (Woodcock 2005, 26).

1898 The Tavistock Canal was not included the Canal Returns.

1933 After cleaning the canal bed (which must have been quite onerous!), the West Devon Electric Supply Company built a sluice gate near the west end of the tunnel portal, to convey water to a header pond (Forebay) to go down to hydro electric turbines via large tubes at Morwellham Power Station, next to the River Tamar.

In 1923 and 1933, mining geologists Cloke and Barclay carefully assessed the lodes intersected by the tunnel during a tunnel assessment and clearance scheme (CRO AD58-26). They confirmed that the tunnel intersected eight or nine lodes and three cross-courses, but only two of these (East Russell and Georgenia Lodes), had any stoping accessed by the canal. The only repairs necessary were to the Morwellham portal end retaining wall.

Footnote:

The canal has been maintained and managed by the owners of Morwellham Power Station since 1933. For some time this work has been undertaken by South West Water and British Waterways, the former now monitors and maintains the canal, carefully regulating the flow to utilise the instant generating capacity of the hydro-electric power station at times of peak demand (to provide a cost effective monetary return). It is poignant perhaps that the canal still exists today due to its economic usefulness.

4. Impact assessment

This summary impact assessment is intended to inform and guide Devon County Council Historic Environment Service of the impact of the canal repair works, the aqueduct bridge repair and lock gates replacement. This section of the report summarises the archaeological resource, and describes the impact and mitigation of the canal works as part of a mitigation strategy. However, it should be noted that the mitigation procedure was undertaken during the project (due to the lack of advanced project specifications), by efficient communication between the report author (as site archaeologist), Bill Horner (DCC archaeologist), Chris Hariades (TVMHP Project manager), and South West Water. A structural engineer, Andrew White of Knevitts Ltd produced specifications for the aqueduct bridge structural repair (see Fig 12).

The sites impacted by the repair works are shown in Figures 5, 6 and 12 and reproduced on plan in Figure 4. The main sites include repair works to the sides of the canal itself, structural repairs to the aqueduct bridge, and repairs to the lock gates. The impact of the repair and conservation works on each site is then described, and a final section details the impact remediation measures.

The potential impacts during works are described below. Impacts are described in the text section for each site on a feature-by-feature basis. The following site impact terms are used within each site identification description:

Major positive	Site continues in, or is restored to, its original design and use
Moderate positive	Site restored as far as possible respecting its original function, but its use is altered
Minor positive	Site partially restored; interpretation introduced
Negligible positive	Stabilisation/maintenance of site
Negligible negative	Benign neglect – losses of fabric over a long period of time

Minor negative	Site suffers areas of alteration or damage, which contribute to loss of meaning
Moderate negative	Significant loss of fabric or alteration, leading to erosion of original character
Major negative	Complete demolition/removal

Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the end of the Lumburn Aqueduct **SX 46237 72628,** see Fig 1).

Description

The canal section impacted by the repair works was built between 1803 and finished by 1809 (as described in the historical background section). This section of the canal may well follow the course of a mine leat from the River Tavy to Crowndale Mine, which pre-dates construction of the canal. For much of its length the canal's west side (see Fig 4), cuts into the valley side – revealing vertical bed-rock and also frequently forming the bed of the canal. Excess stone material from the rock cut was used to form the rounded profile edge of the east side of the canal – using slate/killas stones set on edge. The tow path was formed along this eastern side. The canal is approximately 4.0m wide, 0.3m to 0.5m deep, with the east side approximately 0.6m to 0.8m deep from tow path surface to water level.

Repair works to the canal's east side (and towpath) has been undertaken in the past, sometimes inappropriately using cement and concrete formwork. The 2009 repair work to both sides of the canal and re-surfacing parts of the towpath continued with this theme of patching the damaged sections (Fig 11).

Site works impact (2009)

The repair works relate to identifying areas of the canal sides that needed to be patched with new (similar specification) stone within the section of canal identified above. This should immediately stop progressive damage to the canal sides and help to support the well used canal towpath. There is no site plan showing each small repair section, rather a canal bank repair work schedule (Appendix 1).

Other works to the canal itself that were proposed include patching and re-surfacing the tow path. South West Water (SWW) undertook its own Risk Assessment for each tree close to the tow path. Mitigation works resulting from that survey (i.e. branch or tree removal) was undertaken by SWW.

The overall impact of the works on the canal can be defined as '*Negligible positive'.* The works reduced collapse of parts of the canal's east side to maintain structural stability, provided more tow path stability and a higher degree of Health and Safety for increased public access for at least another generation. However, it is hoped that the track is adequately annually maintained.

Residual impact (2009)

There have not been significant residual impacts in the medium term – apart from the visual aspect of the replacement stone looking newer than the original stone surrounds.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of replacement stone (to match existing), reduced the visual impact of patching the sides of the canal. Other reduction impact measures included the tendering for appropriately qualified and experienced contractors to reduce the visual effect of repair sections to the canal, and for the quality of the work, which was of a good standard (reflecting the original construction style). This project should reduce the need for this work to be undertaken for at least another generation.

Aqueduct Bridge SX 46630 72090

Description

The aqueduct bridge carries the canal over an access lane to fields north of Shillamill Farm – whose access was cut by construction of the canal. The iron plated trough structure seen today was built in 1839 by Gill & Co of Mount Foundry, Tavistock (Buck 2007), replacing an earlier structure. The bolted sections of the trough extend to either side of the granite quoined masonry, and are supported by four wrought iron lintels (widening into the masonry sides) set into the granite masonry. Three other similarly styled lintels (see Fig 13) provide the support for large slates under the tow path on the south side of the canal. The middle lintel however has rusted to the extent of being ineffectual. A structural survey by Knevitts Ltd has recommended its replacement, as the aqueduct is not only used by tow path walkers, but is proposed to be accessed via the adjacent fields, in order to link up the railway (Buck 2009) with the canal – by a new DCC footpath route under the aqueduct – formerly used for access to the upper field.

Patch repointing to the sides of the bridge under the aqueduct in recent years has occurred, however more often than not this has been using cement, using a variety of styles. At the northern end of the side walls the stonework has been leaking for some time where water is leaking from the junction of the wrought iron plates with the canal bed. This has caused the masonry to be soft, and the stonework made weak – causing a noticeable dip on either side.

On the south west side of the aqueduct a high vertical retaining wall supports the tow path and masonry for retaining remnants of steps, to allow pedestrians walking the towpath to access the lower field. Some of this vertical retaining wall has areas of lime mortar pointing that is loose.

Site works impact (2012)

After dialogue with the TVMHP manager, the structural engineer, the landowner of Shillamill Farm, the Devon County Archaeologist and consulting project archaeologist; the TVMHP agreed to fund replacement of the centrally located rusty wrought iron lintel, and to undertake limited lime mortar repointing where structural stability of the adjacent walling could be compromised.

Site impact of the replacement lintel was minimised by matching most of the original profile of the replacement item as far as could be possible from an 'off the shelf' steel equivalent (in order for the project to be cost-effective), with the original wrought iron lintel.

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works have reduced the potential for collapse of the tow path as it runs next to the canal aqueduct. This project will provide a higher degree of Health and Safety for increased public access for at least another generation.

Residual impact (2009)

There are unlikely to be significant residual impacts in the medium term – apart from the aspect of the replacement iron lintel and repointed masonry looking newer than the adjacent (cement) based repairs.

Reduction of impact (2009)

Site consultancy with the project manager and structural engineer will minimise any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors should mitigate the visual effect of a new structural item, and for the quality of the work to be of a good standard, reducing the need for this work to be undertaken for at least another generation.

Lock Gates and timber lifting bridge SX 46327 72628

Description

The construction of the adjacent Canal cottage for operation of the lock gates, the lifting bridge and the visible remnants of the semi-circular trans-shipment basin (or turning/waiting area) is indicative that this part of the canal was quite busy! The latter

(sited close to the lock gates) is now infilled, but the tops of some of its vertical timbers still visible. The necessity of keeping the water at the correct level was important for the tunnel – this lock gate possibly forming this function also for the Lumburn Aqueduct (SX 46311 72632 to SX 46184 72581), with its single arch to the south. According to Waterhouse (forthcoming) the timber lifting bridge is of a Dutch design common on canals in the Welsh borders, and may not be contemporary with the canal's construction.

The lock gate and lift bridge was previously restored by October 1998, funded by South West Water and British Waterways. However, as Figure 15 shows, one of the timber arms of the lift bridge had snapped and parts of the timber walkway rotted. In addition the lower parts of the swing lock gate has rotted where it is in contact with the canal water.

Site works impact (2012)

The TVMHP agreed to fund replacement of the timber components that were rotted or had broken or snapped off. This includes the large timbers to open the bridge and the Lock gate. The TVMHP tendered for experienced Carpenters to assess both features and to price for the production of making and erecting replacements.

Site impact for the replacement timbers was minimised by specifying exact replacements with the existing timbers (previously replaced in 1998).

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works reduced the potential for further timber rotting and collapse, an important Health & Safety measure so close to the well-used canal towpath. This project has provided a higher degree of Health and Safety for bridge use and public access for at least another generation.

Residual impact (2009)

There are unlikely no significant residual impacts in the short term.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors mitigated any possible mistakes, the quality of the work was of a good standard, and reduced the need for this work to be undertaken for at least another generation (Fig 16).

5. Impact mitigation strategy

The impact mitigation strategy is divided into three stages: The pre-works consultancy, the Historic Buildings Consultancy during works and the archaeological recording record (during and after works). This mechanism demonstrates the steps that have been taken to avoid or minimise adverse impacts, and confirms that the proposed works have been designed in close liaison with the historic environment consultant. Consultation is based on a clear understanding of the significance of the site using appropriate methods and techniques for site monitoring and recording.

HES Projects (Project number 20070793) was commissioned to undertake the three components described as the impact mitigation strategy. The project was based on a project design produced by Colin Buck (21/07/06), and recording specifications defined by Bill Horner (DCC archaeologist).

6. Working method

The following text summarises the general WSI for all archaeological consultancy and archaeological recording for projects relating to the TVMHP (Tamar Valley Mines Heritage Project: Written Scheme of Investigation: Historic Building and Archaeological Recording Consultancy 21/07/06).

- A brief historical survey was compiled from existing Devon County sources (DCHER, DRO, and local libraries and historians (including Robert Waterhouse's recent published work on the canal).
- A walk-over survey was undertaken of the entire length of the canal for sites impacted by the TVMHP.
- An impact assessment described and mitigated the proposed work as part of a Mitigation Strategy to minimise the works affecting the site's character.
- General working methods for archaeological recording, treatment of finds, photographic surveying and report production are described in detail in the Tamar trails WB WSI produced in 21/07/06.

All archaeological recording work was undertaken according to the Institute for Archaeologists (IfA) *Standards and Guidance for Archaeological Investigation and Recording. Staff follow the IfA Code of Conduct* and *Code of Approved Practice for the Regulation of Contractual Arrangements in Archaeology.*

The principal factor in effective project delivery was the employment of key project staff who are expert in the management and recording of the industrial heritage. Cornwall Historic Environment Service project staff can draw upon a substantial track record in undertaking similar work throughout Cornwall, as well as a detailed knowledge of the project area and its sites.

Historic buildings consultancy

- HES (Senior Archaeologist) liaised with the Devon County Historic Environment Service - DCHES (Bill Horner), and the TVMHP Project Manager (Chris Hariades).
- The HES Senior Archaeologist attended regular site meetings when appropriate during the duration of the project.
- HES ensured that site conservation works are carried out to standards recommended by English Heritage best practice.
- **Fieldwork: archaeological recording**
- There were no newly exposed archaeological features revealed through excavation.
- Where appropriate, measured survey was carried out by hand measurements (using offset techniques at a scale of 1:50.
- The resulting survey output was a revised measured survey drawing showing all conservation works that had been undertaken. This was reproduced at a scale of either 1:50 or 1:100 (appropriate to the size of area recorded) and will form part of this archive watching brief report.
- Analysis of the building fabric was recorded in the form of field notes and written up in this archive report production stage.
- DCHES (Bill Horner) advised that archaeological recording should be undertaken during any excavation that revealed archaeological features. Recording was undertaken using a mix of direct measurement, sketch plotting and photography, as appropriate (constrained by safety factors).
- Where significant remains were encountered the site archaeologist was given the opportunity to make an appropriate form of record before work proceeds.
- The chosen site archaeologist adhered to Health and Safety Policies (see below), under the direction of the designated Site Safety Officer.

Site recording (general)

- Site drawings (plans, sections, locations of finds) were made by pencil (4H) on drafting film; all plans were linked to the Ordnance Survey landline map; all drawings included standard information: site details, personnel, date, scale, north-point.

- The site archaeologist undertook the recording in line with recommendations given by IfA. Sections and plans were drawn on site at appropriate scales which adequately recorded structures or features at appropriate levels of detail, and appropriate sections reproduced in the archive report at either 1:50 or 1:100 to adequately demonstrate revealed archaeological features.
- All features and finds were accurately located by means of a National Grid reference and all archaeological contexts will be described using a standard format and linked to a continuous numbering sequence.
- The archaeological watching brief report detailed all forms of archaeological recording that had been undertaken at each of the mine sites. Each major mine site had a single archaeological watching brief report that details all project related work to that site (i.e. trails works, building conservation works, interpretation works, etc).

For Treatment of finds, Photographic recording specifications, report production and archiving specifications refer to the TVMHP WSI (2006).

7. Results

Unfortunately, there was insufficient time (following receipt of a detailed plan and description of the canal repair works from the TVMHP), prior to the start of works on site to produce an impact and mitigation report for DCC (Bill Horner). A decision was therefore taken to minimise impacts and mitigate directly with the TVMHP and site contractors on site as works were progressing as part of a weekly site recording and consultancy. SWW funded the stone and path repairs to the canal bed whilst the TVMHP funded fencing of the north and west sides of the canal, to stop encroaching animals from the adjacent fields from directly accessing the canal (and walking up the towpath!). An interim archaeological recording report of these works was produced by the author on 17/06/2009. This report supersedes that report.

Repair works to the bed and towpath of the Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the start of the Lumburn Aqueduct **SX 46237 72628**)

In early 2009, the TVMHP tendered for stone masons (on behalf of SWW) experienced in rebuilding stone walls, etc, to undertake these works within a narrow time-scale of three weeks, when SWW were willing to reduce the water flow through the canal (which would stop the electricity generating turbine). The turbine normally operates all year round, often at short notice when generation rates for electricity peak (the turbine can instantly generate electricity). Clemens Stonemasons of North Cornwall were successful in winning the contract. Prior to this, the TVMHP Manager, the archaeological consultant and SWW projects officer, produced a repair work specification schedule (measured from the small swing bridge at Tavistock: SX 47348 73503), which focussed on identifying the repair of collapsed sections of canal bank on the south or east sides. Appendix 1 is a reproduction of this original document.

Site work started on 05/05/09 at the northern end of the canal and progressively worked southwards towards the lock gates at the Lumburn Valley. With the reduced water level in the canal (and its slow movement when full), many stones that had fallen out of place were found in the canal bed not far from their original bank location. When the canal was constructed the stones were originally set on edge, a minimum of two/three stones height (approximately 0.6m to 0.8m above water level). During the repair project, where there was insufficient stone to replace the collapsed sections, a similar stone was imported from Trebarwith Quarry, North Cornwall (purchased from the local quarry at Millhill). These stones were reset on edge, following the original profile of the canal bank, and tightly tamped down in position (tops and sides). Earth was backfilled into the top sides of the stone to re-form the edge of the towpath. This was then at a later date, re-seeded. Figures 7 and 8 show examples of before and after photographs of the repaired canal bank. The work has been sensitively undertaken and reflected the style and character of the original construction a century ago.

Weekly site meetings were arranged to view the previous week's repairs and to discuss any foreseeable problems within the following weeks programmed work. A granite towpath stone under the Crowndale bridge at SX 47194 72541 had become dislodged (into the canal), and some quoin stones from the bridge parapet wall had fallen into the canal. The former was repaired by contractors; the latter will be removed from the river by SWW to be replaced on the bridge parapet wall at a later date. A small section of old 2" timber (2m long) set in the lower part of the bank was replaced back into its original position following repair of the wall at this location (SX 47270 72707).

The canal bank repair works (see Appendix 1), were finished on 28/05/09, including an additional element of work totalling 87 metres, which the contractors identified whilst on site. A total of 337 linear metres of canal bank was repaired (only on the south/west side), using a total of 86 tons of additional Trebarwith stone. The canal repair works were funded by South West Water.

Figure 5 is a site plan and specification document for the installation of timber post and wire stock fencing along the west/north side of the canal and construction of three cattle drinking areas to minimise any future erosion of the opposite (north/west) side of the canal bed. The cattle drinking sites are located at SX 47384 73064, SX 47257 72705, and SX 47078 72415. A concrete pad (min 0.3m thick), varying from 3m to 4m wide and approximately 5m long, has been created to at each of these sites to form the post and rail fenced cattle drinking areas that should minimise further damage to the banks (on either side). An additional cattle drinking area was constructed on bedrock immediately on the west side of the Shillamill Viaduct (see Fig 6). Figures 9 and 10 show before and after views of a cattle drinking site (SX 47384 73064).

Approximately four months later, the surface of the canal towpath was patched with crushed stone (803 specification) where the path was potholed or muddy, then sections covered with finely ground stone (6mm to dust) from Meldon Quarry.

During construction of the cattle drinking sites and during the canal repair works there has been minimal archaeological impact, nor any finds recorded.

Aqueduct Bridge SX 46630 72090

Knevitts Ltd was commissioned by the TVMHP in 2011, to undertake a structural survey of the aqueduct bridge at this location. Their report and structural drawing (see Fig 12), recommended that a rusty wrought iron support (middle one of three similar supports – see Fig 13) sited under wide slates below the towpath next to the canal, be replaced with a modern equivalent. In addition, it was recommended that the tall retaining wall on the south west side of the aqueduct bridge be repointed and structural ties inserted (using 7mm diameter stainless steel helibars) into the masonry bedding joints to strengthen a structural crack in the masonry.

This work was not started until May 2012, following an extensive dialogue with SWW and the site owner. Figure 13 shows the failed rusty element needed to be replaced. The original lintel was 50mm x 50mm for most of its length but widened to 100mm at both ends (and set in the side walls). Unfortunately the original wrought iron section specification was impossible to replace, and an 'off the shelf' item had to be found due to budgetary constraints. Figure 14 shows the new steel replacement *in situ*. Scaffolding had to be erected to remove the original rusty support and to replace it with the new 50mm wide x 115mm deep iron profile steel section. A slightly wider opening had to be made into each granite quoined side of the bridge for insertion of this new structural element. The localised setting was then repointed with lime. The steel was painted with a red primer and then painted black.

Other works to this site included removal of a tree growing out of the west side of the north end of the aqueduct bridge and treatment of the stump, as its unchecked growth had caused structural issues to the masonry at this point. On the opposite side of the bridge opening, the top flanking stones over the east side revetment walling had become dislodged. These were moved back to their original position. TVMHP funded the project.

At the north end of the structure under the aqueduct section, it appears that water has been leaking from the canal at the intersection of the metal 'trough' profile bolted plates and the canal bed – on both sides, through the stone masonry. This has caused the masonry and water at this point lower down under the aqueduct to be constantly wet.

Consequently, the foundations masonry and pointing in this area have softened to the extent that the masonry is collapsing and arching downwards. SWW attempted to add some clay to the leaking intersection point in the bed of the canal, but this has not worked. Structural deterioration will continue unless this issue is resolved. This is a significant feature of the canal which is in places, is now a Scheduled Monument. It is a recommendation of this report that the aqueduct bridge be considered for Listing.

Finally, the vertical retaining walling on the south west side of the aqueduct was repointed and the structural crack that had been identified by the structural engineer, repaired with the use of helibar reinforcing. This work finished in mid June 2012. The repointed wall acted to retain not only the towpath running along the south side of the canal, but also steps that allowed access from the towpath down into the adjacent field. These steps have badly deteriorated, leaving a steep slippery slope. It is recommended that they need to be rebuilt before use of them can be made by a new DCC footpath from the nearby railway linking up with the canal footpath.

Lock Gates and timber lifting bridge SX 46327 72628

The timber lock gate and timber lift bridge was 'restored' in 1998 by SWW and British Waterways. It is not know what the restoration replaced, but parts of the timber lift bridge (mainly the western timber arm), had rotted resulting in collapse (see Fig 15). Other parts of the bridge were showing that many timber items were rotting. In addition, the section of timber lock gate that was in constant contact with canal water had also rotted during the last 14 years. SWW and the TVMHP decided to replace the rotted and unsafe timber items as being a Health and Safety issue, given the frequent public use of the towpath. SWW funded the project.

The project of dismantling the bridge and lock gate, replacement of the main and structural timbers, and re-assembling and fixing on site was tendered. The contract was won by Will Sterling and Son, a traditional timber boat builder and carpenter who worked at Morwellham Quay (repairing and building boats, etc). The work was started in July 2012 and finally finished in September 2012.

Figure 16 is an 'after' view of the works on these features, and should be compared to its preceding figure. It is hoped that this repair will last longer than its predecessor!

Note:

In 2013, the TVMHP constructed a new footpath from near Morwell Rocks (SX 44128 70435) to above George & Charlotte Mine (SX 45101 69962). This new route links the main route of the railway line from Devon Great Consols to Morwellham and the forestry tracks north of Morwellham. Scheduled Monument Consent was obtained in 2012 for construction of a new timber footbridge over the Tavistock Canal (the section from the west end of the Morwell Down tunnel to the incline railway cottage was Scheduled in 2011, SM No. 30973). As part of this project, an impact assessment report was produced (Buck 2012). The results of the new footpath creation and footbridge construction will be produced within the main body of the TVMHP archaeological recording report (Buck forthcoming).

8. References

8.1 Primary sources

CRO AD 58-26 Tunnel Lodes (1923-33) Report by F Cloke and CF Barclay.

DRO T1258M-14B Bedford Estate Map

8.2 Secondary sources

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Hadfield, C., 1967, *The Canals of South West England*, David & Charles, Newton Abbott

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Waterhouse, R., 2012, *Tavistock Canal, Surveying a forgotten marvel of the industrial age*, Current Archaeology, Issue 273 December

Waterhouse, R., Forthcoming publication on 'Tavistock Canal'.

Woodcock, G., 1995, 2005, Booklets on the 'History of Tavistock'.

9. Project archive

The HE project number is **20070793**

The project's documentary, photographic and drawn archive is housed at the offices of Historic Environment, Cornwall Council, Fal Building, New County Hall, 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 (20070793).
2. Black and white photographs archived under the following index numbers:

   GBP 2091/12-21; 2207/12-22; 2250/1-17; 2253/19-22.
3. Digital photographs stored in the directory R:\HE images\Sites\Devon\Tavistock\Tavistock Canal
4. This report text is held in digital form as: G:\HE Documents\HE Projects\Sites\Devon\Tavistock Canal IA WB report 20070793
5. English Heritage/ADS OASIS online reference: cornwall2-154344

No artefacts or environmental material was retrieved during the project.

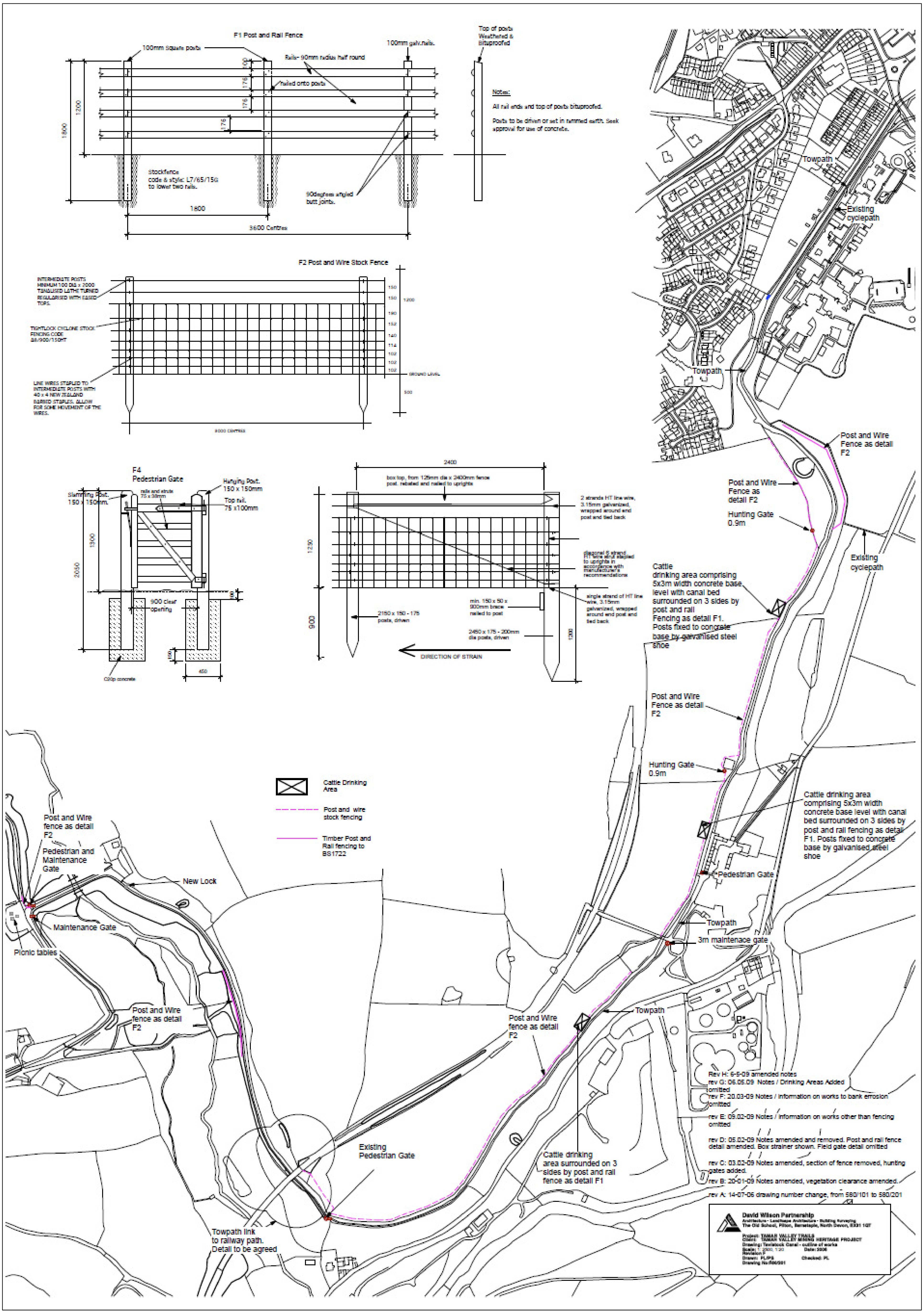

Figure 5 Specifications and plan showing fencing and three cattle drinking areas at the Tavistock Canal(East section)

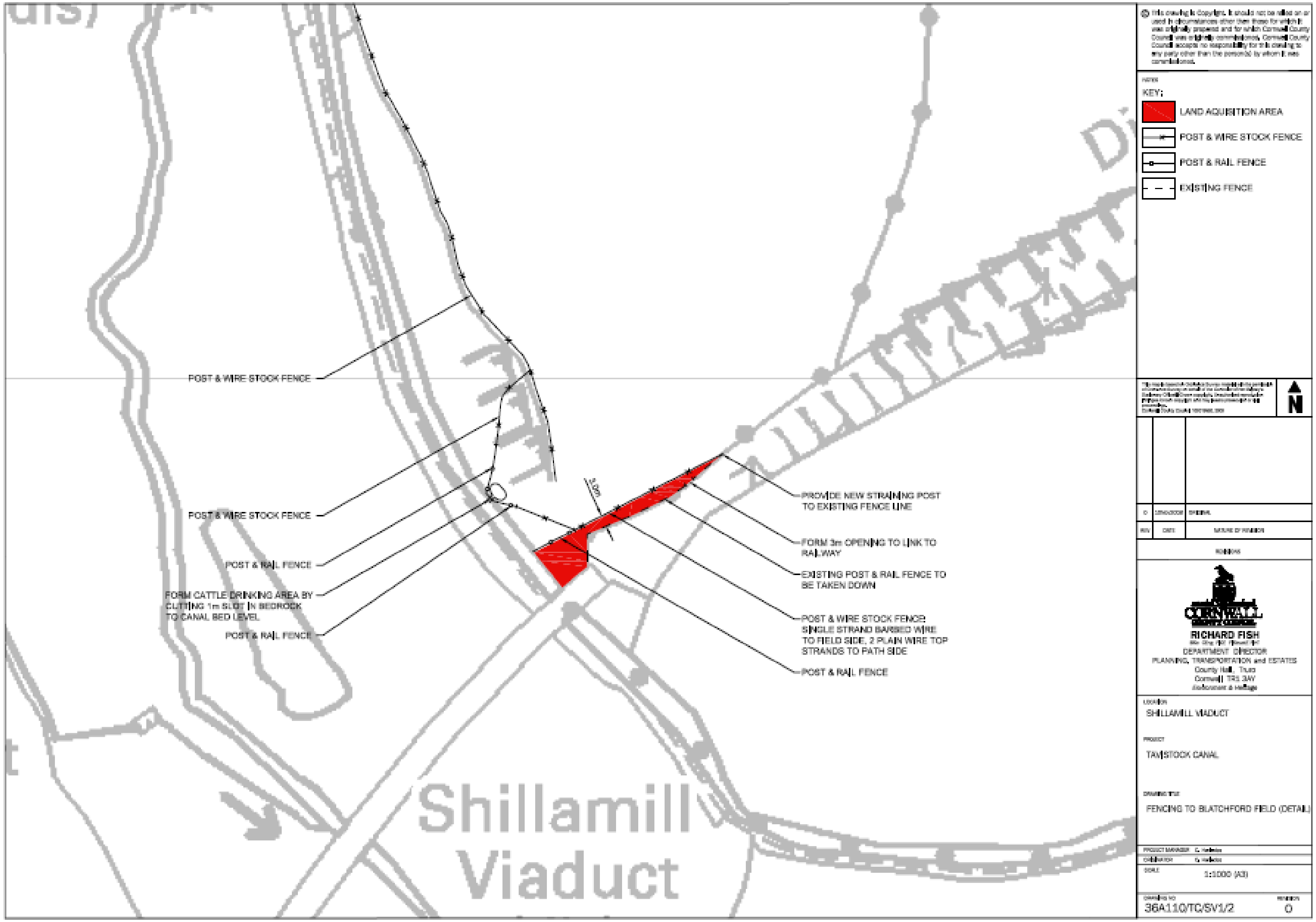

Figure 6 Detail plan showing the cattle drinking area west of the Shillamill Viaduct

Figure 7 A view of the Tavistock Canal east bank before works © CC HE Projects

Figure 8 A view of the Tavistock Canal east bank after works © CC HE Projects

Figure 9 A view of a Cattle Drinking site before works (SX 47257 72705) © CC HE Projects

Figure 10 A view of the same Cattle Drinking site after works © CC HE Projects

Figure 11 A view of the canal towpath after re-surfacing works © CC HE Projects

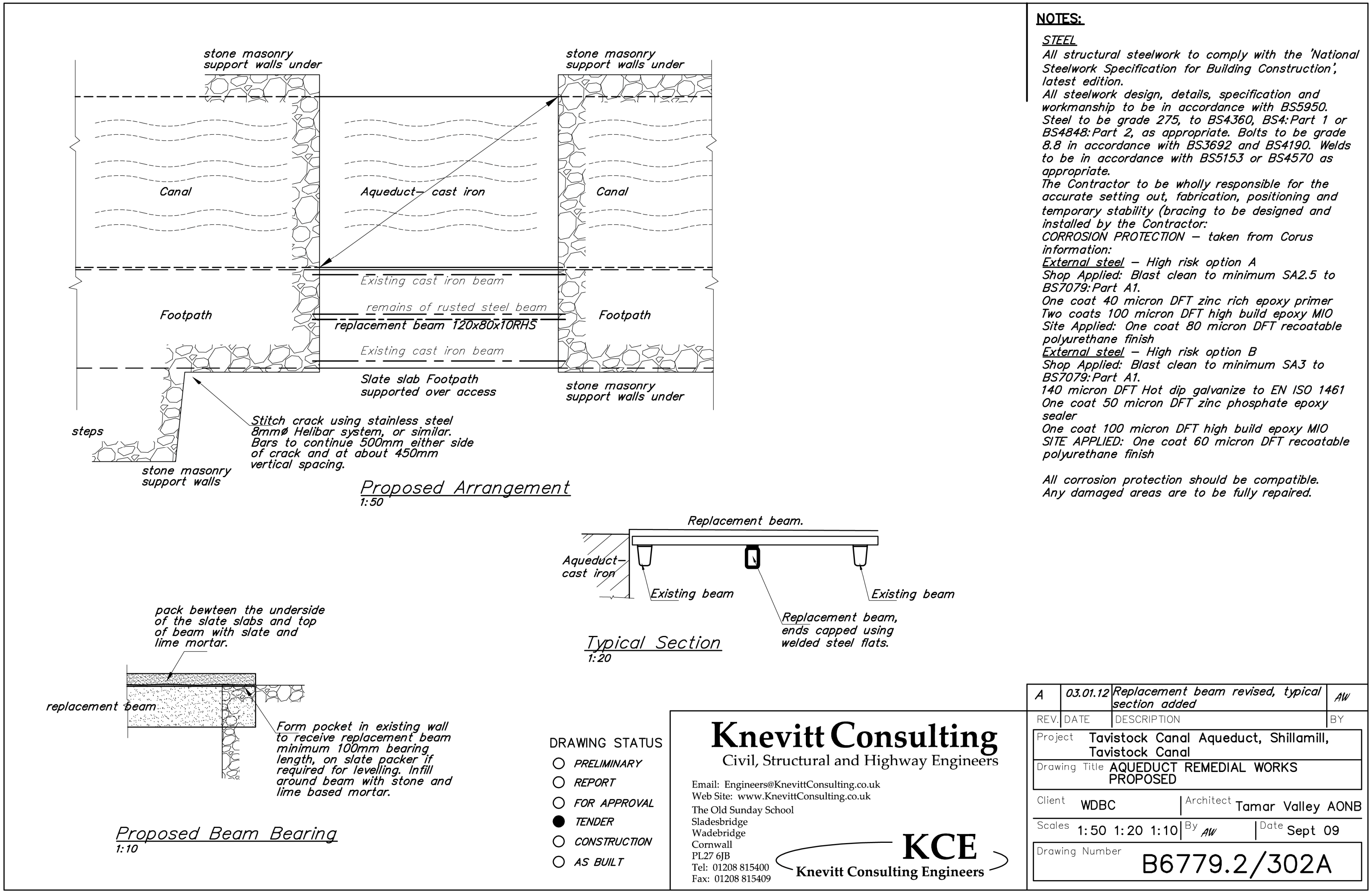

Figure 12 Specifications plan for repair of the aqueduct bridge

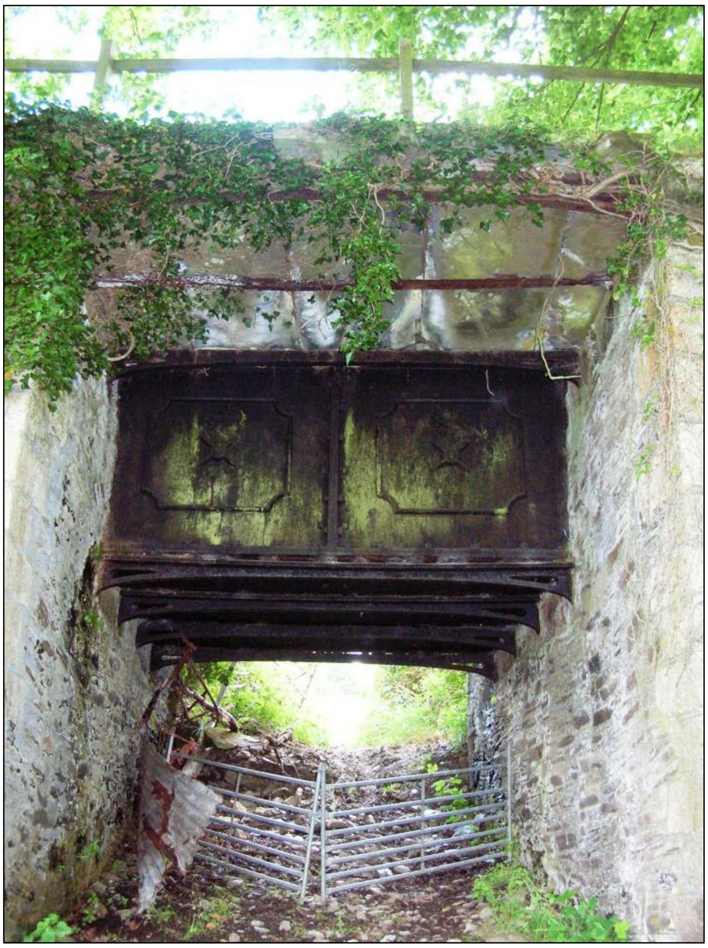

Figure 13 A view of the canal aqueduct bridge before works © CC HE Projects

Figure 14 A view of the canal aqueduct bridge after works © CC HE Projects

Figure 15 A view of the canal lock gate and bridge before works © CC HE Projects

Figure 16 A view of the canal lock gate and bridge after works © CC HE Projects

Appendix 1: TAVISTOCK CANAL BANK REPAIR WORK SCHEDULE

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
20		Side out path and hedge (140m length)
76		1.5m infill behind c $2m^3$
118		1.5m infill behind c $1m^3$
140-150	10	Minor wall top repair
159-160	1	End of hedge
162-163	1	1m infill behind $0.25m^3$
166-179	13	
225-247	22	
253-308	55	Break out conc block
314-323	9	
328-330	2	
394-418	24	
433-461	29	Take off conc
P A T H		
467-469	2	Break out conc
472-473	1	Good example, flat stone
485-488	3	Remove conc, Repair bank
494-513	19	Remove section of conc
530-541	11	
557-558	1	
563-573	10	
577-578	1	
581-584	3	
591-592	1	
600-650	50	
664-673	29	
691-694	3	
703-704	1	
714-718]	4	Soft path, build up levels (ch 14-27)
722-727]	5	
730-735	5	
744-745	1	
751-754	3	
755-760	5	
771-773	2	
779-780	1	
782-798	16	800 ⇒path surface 80ft
800-804	4	
804-806	2	Build up path surface to fall to canal

Chainages – measured from swing bridge at Tavistock	**Lengths of Wall Repair (M)**	**Notes**
		(ch 800-902)
808-809	1	
813-814	1	
819-820	1	Lay hedge, remove barbed wire (ch 800-902)
823-826	3	
839-842	3	
875-876	1	
892-894	2	
902-903	1	Remove gate, overhanging branch
902-907	5	
970-971	1	Gate and post and rail across path
975-976	1	Surface ok
985-990	5	In deep
1009-1010	1	
1019-1020	1	Take out tree growing out from opposite bank
1068-1069	1	Path surface repair
1093-1094	1	Under bridge
1099-1100	1	Bridge coping repairs 4m copings in canal
1130-1131	1	Boulders ⇑ make up path ⇓ scrape leaf mould
1158-1159	1	
1165-1166	1	
1169-1170	1	
1187-1192	5	
1197-1199	2	
1202-1207	5	
1208-1209	1	
1225-1232	7	
1260-1268	8	
1271-1272	1	
1279-1280	1	
1282-1283	1	
1295-1298	3	
1308-1309	1	
1317-1319	2	
1334-1342	8	
1353-1356	3	
1409-1414	5	
1421-1422	1	
1424-1425	1	

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
1441-1442	1	
1454-1456	2	
1514-1515	1	
1546-1548	2	
1573-1574	1	
1581-1582	1	
1603-1604	1	
1600		Path falls away from canal. (1.5m width)
1691-1692	1	
1718-1719	1	
1721-1722	1	
1726-1729	3	
1820-1821	1	
1856		AQUADUCT (Clear vegetation, Take out gate)
1958-1968	10	Under viaduct
1970-1972	2	
2020-2023	3	
2151-2152	1	
2220-2221	1	
2316-2318	2	WHEEL SLUICE Interpretation Barrier (Take down concrete posts and blocks)
2463-2464	1	
2534-2535	1	
2541-2543	2	Replace Bascule bridge
		Lumburn Valley Turning area at lock (excavate)
2586-2600	214	Opposite bank
TOTAL		

Note:

An additional 87 linear metres of repairs were undertaken by the site contractors as they deemed them necessary. These additional repairs are not reflected in the above schedule chainage list, which was originally compiled by Chris Hariades (in consultation with Colin Buck and SWW (Laura Wotton) in April 2009 to inform tender information and site specifications prior to the start of works. The location of the small swing bridge in Tavistock (from which the chainages are measured) is at SX 47348 73503.

Tavistock Canal - Canal Bank Repair Works Schedule

Item	Description	Qty	Unit	Rate (£)	Cost (£)
1	Provide site welfare facilities to comprise as a minimum porta-loo with handwashing facilities, maintain and take down on completion	Item			
2	Provide all necessary fencing, barriers, signage, maintain for duration of contract and take down on completion	Item			
3	Break out concrete capping (provisional)	50	lm		
4	Clear rubbish from canal bed and dispose to licensed tip (Provisional)	10	m3		
5	Repair identified sections of failed or colapsing drystone facings to canal bank to match adjoining sections using stone salvaged from canal bed	250	m2		
6	Tie and marry in each repair to adjacent sound sections.	100	no.		
7	Extra to bed bottom course of stone on 50mm depth drymix sand/lime/cement bed in ratio 6:2:1 where laying directly onto bed rock.(Provisional)	50	l.m		
8	Extra to import suitable matching stone to make up shortfall in site salvaged material (Provisional)	50	tonnes		
8	Backfill voids behind stone facing to level with top of bank with imported scalpings compacted in layers not exceeding 200mm depth (provisional)	10	tonnes		

Report No: 2013R046

Tavistock Canal, Devon

Archaeological impact and recording report

Historic Environment Projects

Report No	Report Name	Report Author
2013R046	Tavistock Canal – Impact assessment and archaeological recording during a program of repair works	Colin Buck

Event Type

Site consultancy	Archaeological impact assessment	Archaeological watching brief	

Client Organisation	Client Contact
TVMHP (West Devon Borough Council)	Chris Hariades (TVMHP)

Monuments (MonUID)

DHER 3879 (Tavistock canal)	18721	4069	3882	5449	3956

Fieldwork dates (From)	(To)	(Created By)	(Create Date)
05/05/09 05/05/12	29/05/09 05/09/12	Colin Buck	13/05/13

Location (postal address; or general location and parish)

Tavistock Canal (northern section from Tavistock to Lumburn), Tavistock, West Devon

(Town – for urban sites)	(Postcode)
Tavistock	

(Easting) X co-ord	(Northing) Y co-ord		
From: SX 47367 To: SX 46183	73572 72589		

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

List of Figures

Abbreviations

AONB	Area of Outstanding Natural Beauty
CC	Cornwall Council
DCC	Devon County Council
DHER	Devon Historic Environment Record
DRO	Devon Record Office
HES	Historic Environment Service
OS	Ordnance Survey
SWW	South West Water
TVMHP	Tamar Valley Mines Heritage Project
WHS	World Heritage Site

Acknowledgements

Thanks are due to Robert Waterhouse for providing some primary survey data and information files from his research relating to a forthcoming book about the Tavistock Canal. Chris Hariades (Tamar Valley Project Manager), and Bill Horner were involved in the project throughout its entirety. Andrew White of Knevitts Cons. Engs. was involved in preparing the specifications of the aqueduct bridge.

Front cover image: a copy of the Tavistock Canal Company Seal.

1. Project background

The Tamar Valley Mining Heritage Project (TVMHP – 2005 to 2013), a £7 million Heritage Lottery Fund project focusing on the World Heritage Site landscapes of West Devon in the Tamar Valley, is co-ordinated by the Tamar Valley Area of Outstanding Natural Beauty (AONB). The TVMHP was approved for Stage 2 consent by HLF in 2003. It involves the conservation of former mine sites and trail creation along the Devon side of the Tamar Valley (from Devon Great Consols to Morwellham). These sites include Devon Great Consols, the largest mine in Europe during the 19th century. The project also included conservation and repair works to the Bere Alston to Tavistock railway line (Buck 2011), the Tavistock Canal, and parts of Morwellham Quay itself (other contractors). This project covers works undertaken along the Tavistock Canal (Fig 1).

The Historic Environment Service (HES), Cornwall Council was commissioned in July 2007 by the Tamar Valley Mining Heritage Project (Chris Hariades as TVMHP Project Manager), to undertake an archaeological impact assessment, archaeological recording and site consultancy, photographic building recording of affected sites impacted by the works. An impact assessment project brief had not been produced, but it follows a similar project design by Historic Environment Service, Cornwall Council; *'Project design for production of archaeological recording, as part of the Tamar Valley Mining Heritage Project (2006-2009)',* dated 23/06/06. A Project Design for this site and other building conservation schemes in the TVMHP was produced on 21/07/2006, and was subsequently approved by Bill Horner (Devon County Archaeologist).

The conservation and management of features relating to the TVMHP's mining heritage and enablement of safe public access forms the basis for the Tamar Valley site conservation scheme. This report will assess the impact of the proposed conservation works on the Tavistock Canal's significant assets (canal within the WHS), describe the mitigation undertaken and also a description of the archaeological record for the (intermittent) works from May 2009 to May 2012. Following the first phase of works in the summer of 2009 (to describe and record the repair works and the minimal impacts to the canal sides), an interim report was produced for Bill Horner (Devon archaeology – Buck 2009).

In a joint project with SWW, the TVMHP agreed to fund cattle fencing along all of the west side of the canal, in order to stop further damage being caused to both sides by cattle drinking the water and wandering (on one occasion into Tavistock!), and to create four cattle drinking sites. SWW agreed to fund the repair of the sides of the canal bed. Furthermore the TVMHP agreed to re-bed and re-seed where necessary the canal towpath later in the autumn of 2009, and at a later stage (2011), to repair the damaged lock gates. In addition, the TVMHP agreed to undertake small-scale structural repairs to the small aqueduct bridge in 2012, and a small amount of repointing.

2. Aims and objectives

The aims of the project were as follows:

- To ensure that site works are undertaken in such a way as to maintain the integrity and authenticity of the historic resource, minimising adverse impact upon the resource.
- To ensure that the Devon County Historic Environment Service (DCHES – Bill Horner) are appraised of all site works.
- To ensure that the highest possible standards of the historic environment conservation works are maintained, which must be carried out to recognised current best standards in this discipline.
- To ensure that works are undertaken in such a way as to allow adequate recording of remains affected by the works.
- To record sites, features, deposits and artefacts affected by or uncovered by the works.

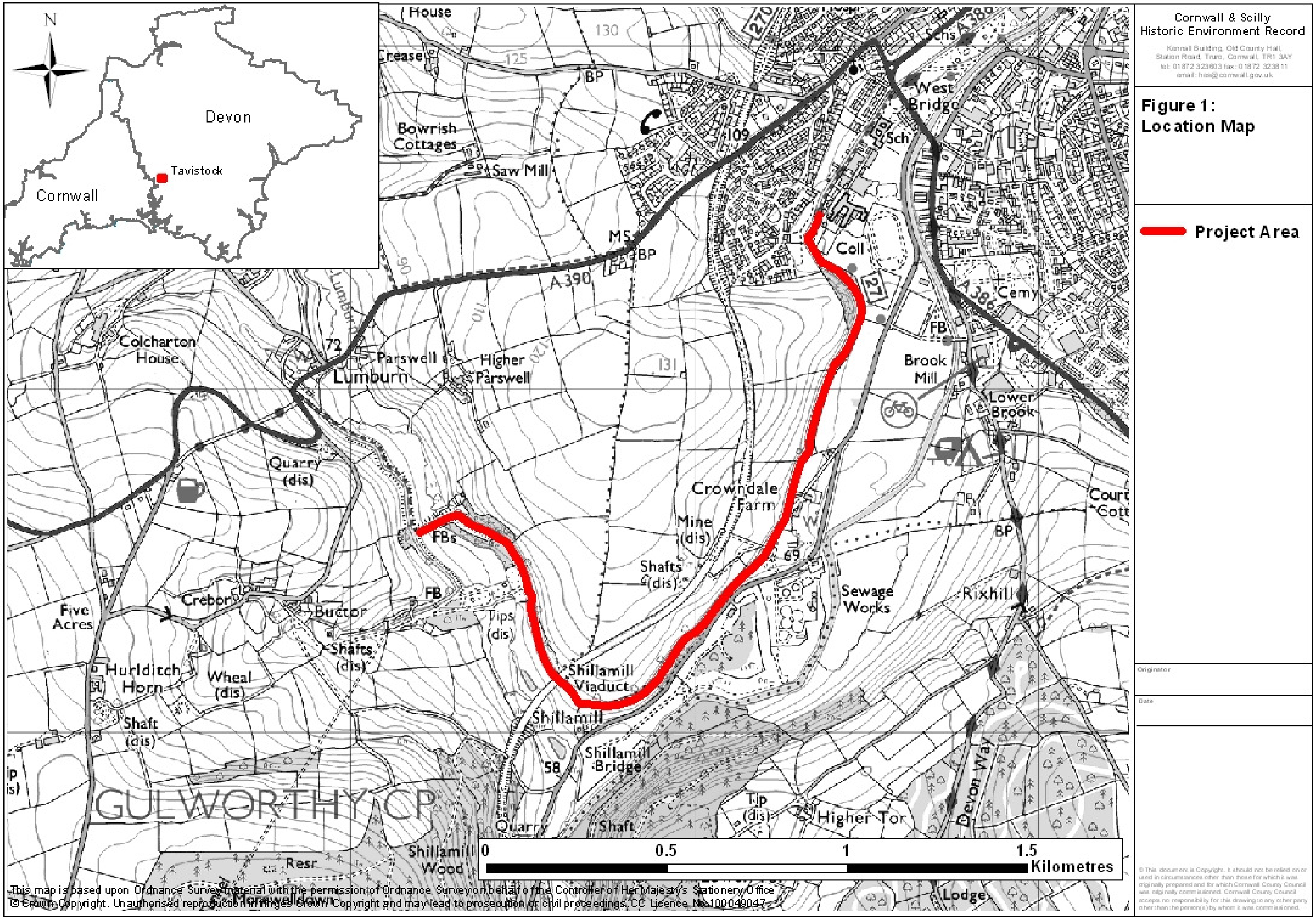

Figure 1: Location Map

- To record the character and extent of works to the sites.
- To inform the Devon County Archaeologist of the nature, condition and significance of the canal and towpath, and describe the proposed impacts and a mitigation strategy (agreeable with the Devon County Archaeologist).
- To disseminate the results of the project appropriately and arrange for the deposition of the project archive (within IfA Guidelines).

It was proposed that the building conservation and repair programme will address the following:

- The protection and consolidation of significant archaeological remains in their settings.
- Health and safety aspects of the site relating to public access.
- Provision of low-key public amenity use where appropriate, incorporating access.
- Interpretation of the site to the public, including on-site and written materials.
- Linking the site into the local economic, social, tourism and recreational contexts.

In terms of the management of archaeological features, engineering works were kept to a minimum, but in view of the fact that the entire site is part of the Tamar Valley component (Area 10) of the Cornwall and West Devon World Heritage Site mining landscape, particular attention was paid to suggestions for the best mitigation of any such works.

3. Historical background

This subject matter has already been written in far more detail than is necessary for this report, notably by Hadfield (1967), Booker (1971, who reproduces the tonnages in Appendix 2), Hedges (1975), Woodcock (1995, Vol 6; 2005), and more recently a publication by Robert Waterhouse (2012), and a forthcoming detailed book. The text below is a summary history and construction account of the Tavistock Canal extracted from all of the above sources.

The medieval borough of Tavistock has always been closely linked to its port, Morwellham. That link was dramatically improved by the construction of the Tavistock Canal from 1803 to 1817. The main structural features of this major construction throughout its full length can still be seen today, over two hundred years later; the wharves at Tavistock and Morwellham, the aqueduct over the River Lumburn, the 1.5 mile long tunnel under Morwell Down, and the remnants of the incline plane down to Morwellham.

The historical chronology for the canal can be summarised as follows:

1796 The opening of Wheal Friendship Copper Mine, Mary Tavy, unintentionally led to the construction of this canal. The export of ore and import of coal and other materials needed to be cost effective – its transport costs by horse and cart must have been prohibitive. The young mine's engineer (in his twenties), John Taylor, had the idea of linking the Tavy and Tamar valleys, whilst using Morwellham to export the ore (via sea going ships); the nearest active port to Tavistock.

1800 By the turn of the 19th century, the country had been at war with France for a few years. Demand for metallic ore, and therefore the need for a canal were high.

1802 Survey of the proposed canal route (presumably with the blessing of the Duke of Bedford) by John Taylor, the mining engineer of Wheal Friendship copper mine.

1803 (March) A canal company, funded by shares from the London Stock Exchange (see front cover seal image), was formed. Work began on the route in 1803, following the passing of an Act of Parliament. The canal was to be 16ft wide and 3ft deep, with a branch to the slate quarries at Millhill. It is likely that the first section of the canal route followed an earlier leat from the River Tavy to Crowndale Mine. Raising funds on the stock exchange gained stock interest from adventurers to exploit known lodes whilst tunnelling through the granite of Morwell Down, and for additional shares to be

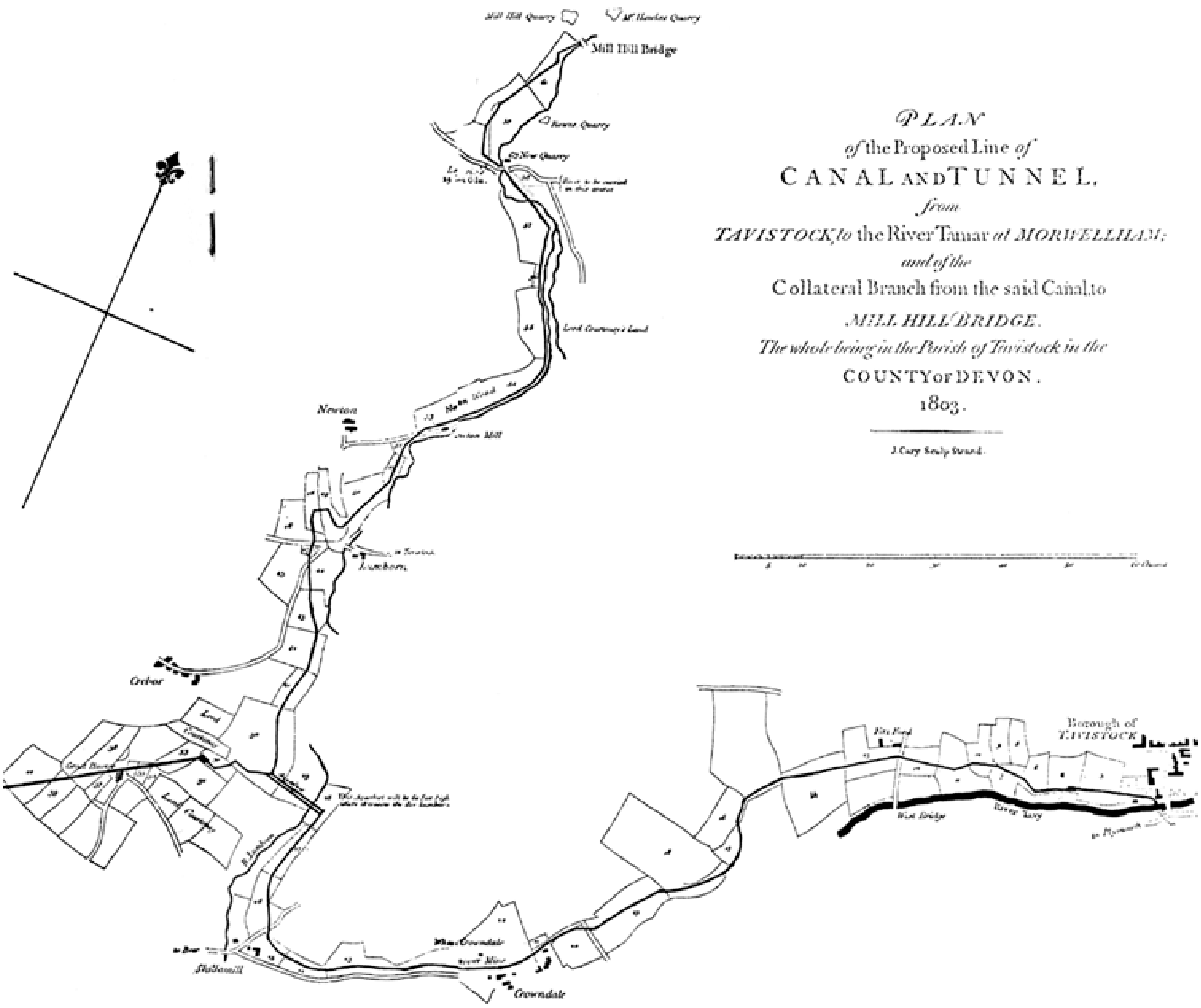

Figure 2 Excerpt of the 1803 survey plan (within the study area) of the proposed Canal route from Tavistock to Morwell Tunnel (Hedges 1975)

purchased by other mines and Tavistock businesses along its course, all recipients of the canal's cheaper transport costs. However, Hedges (1975) hints that Taylor's real motivation for the project was not primarily to build the canal, rather the opportunity to exploit known lodes under Morwelldown, a mining speculation.

Figure 2 shows the original planned 1803 route. The provision of water via leats from the western end of the canal (top of the Morwellham incline) for other mines in the Tamar Valley as far north as Gunnislake to power water wheels was also planned. The original cost estimate for the canal was £40,000 (including testing for ore lodes), at £100 per share. The Duke of Bedford, who owned all the land along the canal's course, also purchased 1/8 of the shares and took dues for use of Morwellham Quay. He also agreed to a request to make a grant of a Mining Set: (for working all Lodes discovered in the Course of the Canal, Embankment, Tunnel and collateral branch for copper, tin and lead to the extent of 500 fathoms East and West of the canal for every Lode discovered), for the sum of 1/10 dues and a term of 42 years.

The principal engineering features being the aqueduct over the River Lumburn, the 2,540 yard tunnel through Morwelldown, and the inclined plane west of the western end of the tunnel down to Morwellham – a fall of 237 ft, the greatest in southern England at that time.

Figure 3 Excerpt of the 1867 Bedford Estates survey plan (DRO T1258M) showing the canal within the study area.

1803 (23rd August) Work began on the tunnel. Almost immediately copper was struck at the Tavistock end of the tunnel, and the lode developed to realise what later became Wheal Crebor (see Fig 3). Men were employed to work both concerns – the accounts separated. The Canal Committee managed both concerns until 1812 when a separate Committee was appointed after further copper ore discoveries in the tunnel under Morwelldown (Hadfield (1967, 128).

1808 The waste rock and ground from the tunnel excavation was boated eastwards back to the tunnel entrance and used to infill and form the Lumburn Aqueduct over the valley, with a central spanning arch.

1809 Work progressed slowly in the tunnel (by this date it was half finished), as the canal section from Tavistock to the tunnel was finished (ie, this project's study area). This was built more permanently with stone sides (on edge) rather than puddle clay. The tunnel rock was granite, its depth 160 yards below the top of the hill. Pumping/ventilation/winding and access shafts (at least four – the main one being Bray Shaft), had to be sunk from the top of Morwelldown to the underground canal. John Taylor designed the power source for the shaft workings by utilising flat rods (for lengths up to 1.5 miles) powered from a large 40′ water wheel. He also designed a ventilation fan for improving the air quality, for which the company was awarded the medal of the Society of Arts in 1809 (Hedges 1975).

1810 The tunnel advanced at a rate of about 150 fathoms (six feet per fathom) per year until this year when three granitic dykes were cut, slowing the work rate to nearly a third that amount for two years. 30 to 40 workmen were continually employed, with some authors suggesting French prisoners of War used as 'navvies' (Barton 1964, 93 and Booker 1971, 108).

1815 From this year there were shipments of manganese from mines around Brentor and Milton Abbot carried by the canal. These were the principal sources of manganese in the country at a time when it was used in the manufacture of glass. For example, 13,335 tons were shipped to Plymouth in 1819. The ore was ground in a mill powered by the Morwellham water wheel (Booker 1976, 19), and exported in casks.

1816 (August) Tunnels were cut from both ends (simultaneously), to form a working area and to align both ends. They connected on the 21st August. Then the tunnel was enlarged (downwards and wider) throughout its length.

The demand for metallic ores to feed the Napoleonic war years (1793 – 1815) slumped as the soldiers returned, as markets waned. The canal committee, sensing further financial difficulties in September stated *'That the Tonnage will fall very short of the original estimate cannot be doubted; at the time when this was made the Mines in the neighbourhood were in their most flourishing condition, or rapidly advancing to it. Agriculture encouraged by high prices was improving everywhere, and the use of lime, so essential … was very great and increasing. Slate quarries, then making large returns, were in full activity, and new ones opening. In all these sources of oecumenical mode of carriage, the greatest reverses have taken place, and at present a stagnation of enterprise and consequent inactivity prevails'* (Hadfield 1967, 130). However, the population of Tavistock had increased from 1801 to 1821 by over 62%, reflecting the growth in the area, primarily a result of mining operations and related tertiary expansion.

1817 The tunnel was finally completed early in the year, with the official opening ceremony held on 24th June. Thousands attended the event, with over 300 going in boats (with a band) through the tunnel – to be met (with obvious relief) by thousands more at the Morwellham side. All were then given a demonstration of the workings of the incline railway mechanism and tramway down to Morwellham (see Buck 2005 – Sites 58 to 64), powered by a large water wheel and the canal water – which was also recently completed. The boats (specially designed and built by the Tavistock foundries from 1811 to replace an earlier wooden design), were *c*30 feet long, 5 feet wide and towed along the slow moving open canal by horses. They were worked through the long tunnel by two men using iron bars against the rock face.

The canal had taken 13 years to build. Its final cost was £62,000, the excess over the authorised capital of £40,000 having been raised by calling £155 on each £100 share.

1819 Although the economic outlook for the area was not good, the company decided to press ahead with the Millhill canal branch to the slate quarry. It was 2 miles long and cost £8000. It rose by 19.5ft to Millhill, with an inclined plane for the final section due to the scarcity of water (double tracked with two cradles counterbalanced with loaded boats going down pulling the empty ones up with the help of three horses).

1820s The expected tolls were halved from their pre-construction estimates – due to the gloomy economic climate. Over the next three decades the canal carried between 15,000 to 20,000 tons per year, earning an annual profit of approximately £600.

1831-2 A Cholera epidemic in the locality severely affected the workforce, the local economy and (temporarily), the canal's fortunes.

1841 Great Western Railway completed.

1844 Discovery of the main copper lode (40' wide) at Wheal Maria later Devon Great Consols – reversing the fortunes of Tavistock over the next 30 years, but reducing those of the canal. The Mill Hill Tramway was constructed this year (replacing the earlier section of the canal which had been closed after 1831), at a cost of £1,381 (Hadfield 1967, 132).

1847 20,132 tons were carried on the canal (Woodcock 1995, 23).

1848–9 Another Cholera epidemic.

1850 The goods carried on the canal were (tons): Sundries (7548), Limestone (3130), Copper ore (2.499), Slate (676), Granite (83) and Mundic (pyrites) (94). Tonnage carried fluctuated from year to year, reflecting the area's economic woes (or successes). In a bid to maintain revenue, at various times throughout this period, the company reduced tolls, or raised them again when economic conditions improved. But dividends, throughout the life of the canal were always modest, and profits turned out to be at a level 1/3 predicted at the outset.

1851 In the 1851 census, there were 27 barge men working for their various employers regularly using the canal.

1857 Shares that had changed hands at £100 in 1803 were now changing hands at £5.

1859 Construction of the Devon Great Consols railway from the mine to Morwellham with a separate incline section down to the port finished this year. Also the South Devon & Tavistock Railway from Plymouth to Tavistock opened (later extended to Launceston) – in direct competition to the canal. Due to this competition, the company further reduced its tolls after the opening of the railway. However, in the same year it expended more capital on renewing the inclined plane mechanism, and investing funds on a steam mechanism to pull loaded barges through the tunnel against the water flow (it often took a couple of hours or more to undertake this manually!). This was not successful.

There is no doubt that the waning fortunes of the Tavistock and Tavy copper mines, working for the past half century, were no competition for the resurgence of the Tamar Valley copper mines from the mid 19th century. Whilst the former utilised the Tavistock Canal as a transport medium during this period, the latter formed its own railway equivalent; but both used Morwellham as the export destination. Given the rapidly changing transport infrastructure due to the construction of mainline railways to the south west from the mid 19th century (consequently resulting in dramatic changes to market influences), across Devon and Cornwall at this formative period, so the fortunes of this old transport route was found wanting and uneconomic.

1860 In the previous year, the canal tonnage was 17,455. In this year it fell to 13,500. From 1863 onwards there was a steady decline in the tonnage until, in the early 1870s it dwindled to nothing (Hedges 1975, 28).

1862 A shareholder from Birmingham wrote to Mr Gill, representative of the Canal Company and said: *'I am afraid there is little hope of the canal rising in its fortunes with the railway for a rival. Here we have in several cases united the canal with the railway with advantage to both – you know best whether such an arrangement with the Tavistock canal would be advisable'* (Hedges 1975, 28).

1866 In September, the canal committee recorded; *'That a very considerable reduction having taken place in the traffic and dues of the Tavistock Canal Company since the opening of the Tavistock and Launceston branch of the South Devon Railway it was resolved that His Grace the Duke of Bedford be applied to kindly assist the Tavistock Canal Company to compete with the Railway Company by reducing the Canal Dock dues at Morwellham'.* The Duke was evasive (Hadfield 1967, 134).

1870 Only 783 tons were carried on the canal (Woodcock 1995, 24).

1872 Presumably the economic situation became even direr. At a meeting on 2nd September the Duke offered to buy all the shares at £8 each, and to pay half the cost of an Act to transfer the canal to him. Within the month, the committee accepted his terms. Since the summer there had been no traffic on the canal. However, this was not a localised occurrence; the impact of the railways had dealt a death blow to innumerable canals all over the country.

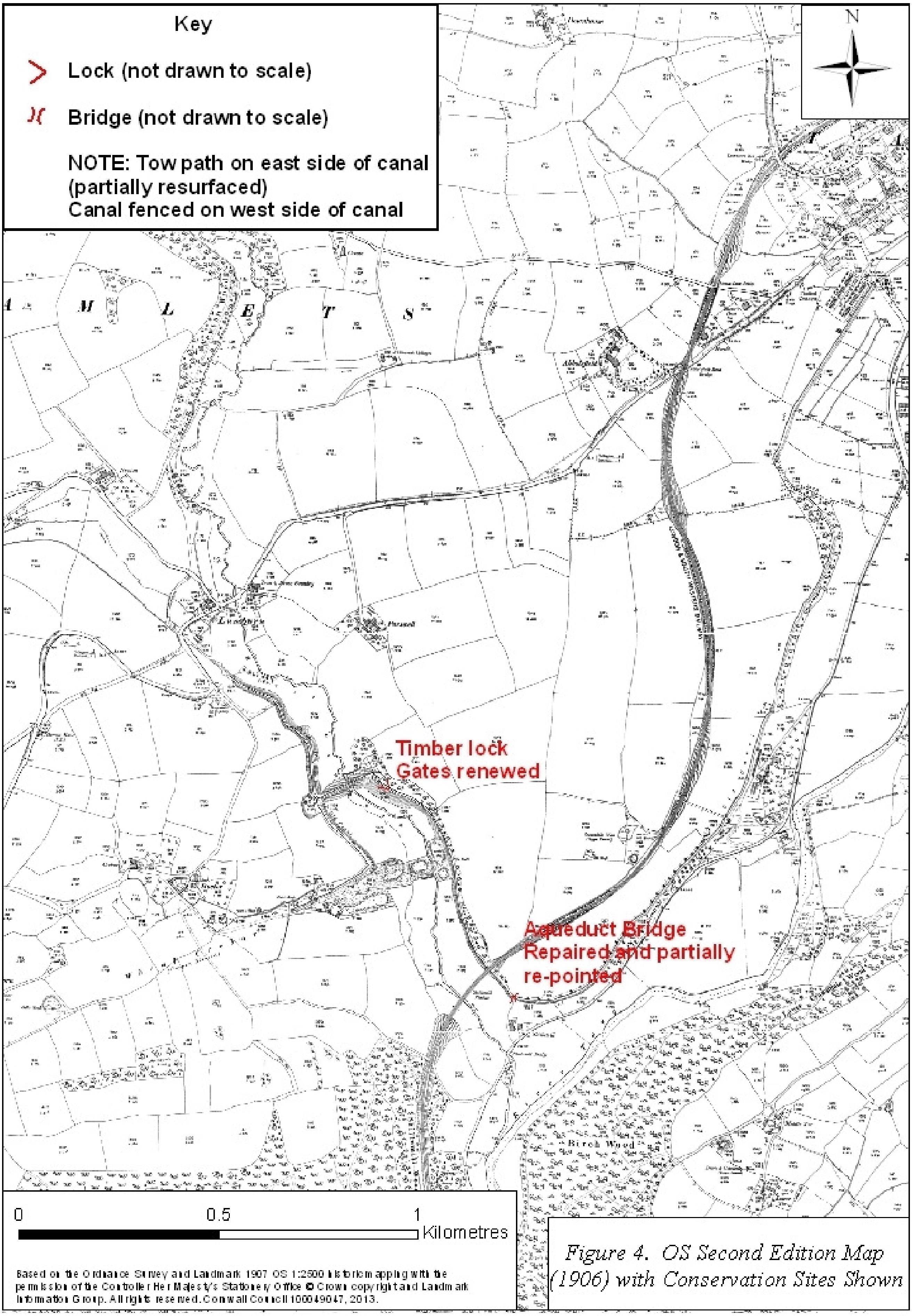

Figure 4. OS Second Edition Map (1906) with Conservation Sites Shown

1873 In May the Act was passed and the Tavistock Canal and land returned to the Duke of Bedford for £3,200, there being no obligation on the Duke to maintain the canal. It is uncertain what use the canal had for the next twenty five years.

1896 This perhaps was made clear in May of this year when the Tavistock Gazette reported that on Whit Monday the basin of the Tavistock Canal was to be cleaned out (it appears a regular activity on this day). *'The cleaning is wanted more now than when it was a hive of industry … a resident noted ... A great deal of sewage was emptied into it, and the water does not run at a greater rate than half a mile an hour. I have seen dead dogs, cats and rats in the canal'* (Woodcock 2005, 26).

1898 The Tavistock Canal was not included the Canal Returns.

1933 After cleaning the canal bed (which must have been quite onerous!), the West Devon Electric Supply Company built a sluice gate near the west end of the tunnel portal, to convey water to a header pond (Forebay) to go down to hydro electric turbines via large tubes at Morwellham Power Station, next to the River Tamar.

In 1923 and 1933, mining geologists Cloke and Barclay carefully assessed the lodes intersected by the tunnel during a tunnel assessment and clearance scheme (CRO AD58-26). They confirmed that the tunnel intersected eight or nine lodes and three cross-courses, but only two of these (East Russell and Georgenia Lodes), had any stoping accessed by the canal. The only repairs necessary were to the Morwellham portal end retaining wall.

Footnote:

The canal has been maintained and managed by the owners of Morwellham Power Station since 1933. For some time this work has been undertaken by South West Water and British Waterways, the former now monitors and maintains the canal, carefully regulating the flow to utilise the instant generating capacity of the hydro-electric power station at times of peak demand (to provide a cost effective monetary return). It is poignant perhaps that the canal still exists today due to its economic usefulness.

4. Impact assessment

This summary impact assessment is intended to inform and guide Devon County Council Historic Environment Service of the impact of the canal repair works, the aqueduct bridge repair and lock gates replacement. This section of the report summarises the archaeological resource, and describes the impact and mitigation of the canal works as part of a mitigation strategy. However, it should be noted that the mitigation procedure was undertaken during the project (due to the lack of advanced project specifications), by efficient communication between the report author (as site archaeologist), Bill Horner (DCC archaeologist), Chris Hariades (TVMHP Project manager), and South West Water. A structural engineer, Andrew White of Knevitts Ltd produced specifications for the aqueduct bridge structural repair (see Fig 12).

The sites impacted by the repair works are shown in Figures 5, 6 and 12 and reproduced on plan in Figure 4. The main sites include repair works to the sides of the canal itself, structural repairs to the aqueduct bridge, and repairs to the lock gates. The impact of the repair and conservation works on each site is then described, and a final section details the impact remediation measures.

The potential impacts during works are described below. Impacts are described in the text section for each site on a feature-by-feature basis. The following site impact terms are used within each site identification description:

Major positive	Site continues in, or is restored to, its original design and use
Moderate positive	Site restored as far as possible respecting its original function, but its use is altered
Minor positive	Site partially restored; interpretation introduced
Negligible positive	Stabilisation/maintenance of site
Negligible negative	Benign neglect – losses of fabric over a long period of time

Minor negative	Site suffers areas of alteration or damage, which contribute to loss of meaning
Moderate negative	Significant loss of fabric or alteration, leading to erosion of original character
Major negative	Complete demolition/removal

Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the end of the Lumburn Aqueduct **SX 46237 72628,** see Fig 1).

Description

The canal section impacted by the repair works was built between 1803 and finished by 1809 (as described in the historical background section). This section of the canal may well follow the course of a mine leat from the River Tavy to Crowndale Mine, which pre-dates construction of the canal. For much of its length the canal's west side (see Fig 4), cuts into the valley side – revealing vertical bed-rock and also frequently forming the bed of the canal. Excess stone material from the rock cut was used to form the rounded profile edge of the east side of the canal – using slate/killas stones set on edge. The tow path was formed along this eastern side. The canal is approximately 4.0m wide, 0.3m to 0.5m deep, with the east side approximately 0.6m to 0.8m deep from tow path surface to water level.

Repair works to the canal's east side (and towpath) has been undertaken in the past, sometimes inappropriately using cement and concrete formwork. The 2009 repair work to both sides of the canal and re-surfacing parts of the towpath continued with this theme of patching the damaged sections (Fig 11).

Site works impact (2009)

The repair works relate to identifying areas of the canal sides that needed to be patched with new (similar specification) stone within the section of canal identified above. This should immediately stop progressive damage to the canal sides and help to support the well used canal towpath. There is no site plan showing each small repair section, rather a canal bank repair work schedule (Appendix 1).

Other works to the canal itself that were proposed include patching and re-surfacing the tow path. South West Water (SWW) undertook its own Risk Assessment for each tree close to the tow path. Mitigation works resulting from that survey (i.e. branch or tree removal) was undertaken by SWW.

The overall impact of the works on the canal can be defined as '*Negligible positive'.* The works reduced collapse of parts of the canal's east side to maintain structural stability, provided more tow path stability and a higher degree of Health and Safety for increased public access for at least another generation. However, it is hoped that the track is adequately annually maintained.

Residual impact (2009)

There have not been significant residual impacts in the medium term – apart from the visual aspect of the replacement stone looking newer than the original stone surrounds.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of replacement stone (to match existing), reduced the visual impact of patching the sides of the canal. Other reduction impact measures included the tendering for appropriately qualified and experienced contractors to reduce the visual effect of repair sections to the canal, and for the quality of the work, which was of a good standard (reflecting the original construction style). This project should reduce the need for this work to be undertaken for at least another generation.

Aqueduct Bridge SX 46630 72090

Description

The aqueduct bridge carries the canal over an access lane to fields north of Shillamill Farm – whose access was cut by construction of the canal. The iron plated trough structure seen today was built in 1839 by Gill & Co of Mount Foundry, Tavistock (Buck 2007), replacing an earlier structure. The bolted sections of the trough extend to either side of the granite quoined masonry, and are supported by four wrought iron lintels (widening into the masonry sides) set into the granite masonry. Three other similarly styled lintels (see Fig 13) provide the support for large slates under the tow path on the south side of the canal. The middle lintel however has rusted to the extent of being ineffectual. A structural survey by Knevitts Ltd has recommended its replacement, as the aqueduct is not only used by tow path walkers, but is proposed to be accessed via the adjacent fields, in order to link up the railway (Buck 2009) with the canal – by a new DCC footpath route under the aqueduct – formerly used for access to the upper field.

Patch repointing to the sides of the bridge under the aqueduct in recent years has occurred, however more often than not this has been using cement, using a variety of styles. At the northern end of the side walls the stonework has been leaking for some time where water is leaking from the junction of the wrought iron plates with the canal bed. This has caused the masonry to be soft, and the stonework made weak – causing a noticeable dip on either side.

On the south west side of the aqueduct a high vertical retaining wall supports the tow path and masonry for retaining remnants of steps, to allow pedestrians walking the towpath to access the lower field. Some of this vertical retaining wall has areas of lime mortar pointing that is loose.

Site works impact (2012)

After dialogue with the TVMHP manager, the structural engineer, the landowner of Shillamill Farm, the Devon County Archaeologist and consulting project archaeologist; the TVMHP agreed to fund replacement of the centrally located rusty wrought iron lintel, and to undertake limited lime mortar repointing where structural stability of the adjacent walling could be compromised.

Site impact of the replacement lintel was minimised by matching most of the original profile of the replacement item as far as could be possible from an 'off the shelf' steel equivalent (in order for the project to be cost-effective), with the original wrought iron lintel.

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works have reduced the potential for collapse of the tow path as it runs next to the canal aqueduct. This project will provide a higher degree of Health and Safety for increased public access for at least another generation.

Residual impact (2009)

There are unlikely to be significant residual impacts in the medium term – apart from the aspect of the replacement iron lintel and repointed masonry looking newer than the adjacent (cement) based repairs.

Reduction of impact (2009)

Site consultancy with the project manager and structural engineer will minimise any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors should mitigate the visual effect of a new structural item, and for the quality of the work to be of a good standard, reducing the need for this work to be undertaken for at least another generation.

Lock Gates and timber lifting bridge SX 46327 72628

Description

The construction of the adjacent Canal cottage for operation of the lock gates, the lifting bridge and the visible remnants of the semi-circular trans-shipment basin (or turning/waiting area) is indicative that this part of the canal was quite busy! The latter

(sited close to the lock gates) is now infilled, but the tops of some of its vertical timbers still visible. The necessity of keeping the water at the correct level was important for the tunnel – this lock gate possibly forming this function also for the Lumburn Aqueduct (SX 46311 72632 to SX 46184 72581), with its single arch to the south. According to Waterhouse (forthcoming) the timber lifting bridge is of a Dutch design common on canals in the Welsh borders, and may not be contemporary with the canal's construction.

The lock gate and lift bridge was previously restored by October 1998, funded by South West Water and British Waterways. However, as Figure 15 shows, one of the timber arms of the lift bridge had snapped and parts of the timber walkway rotted. In addition the lower parts of the swing lock gate has rotted where it is in contact with the canal water.

Site works impact (2012)

The TVMHP agreed to fund replacement of the timber components that were rotted or had broken or snapped off. This includes the large timbers to open the bridge and the Lock gate. The TVMHP tendered for experienced Carpenters to assess both features and to price for the production of making and erecting replacements.

Site impact for the replacement timbers was minimised by specifying exact replacements with the existing timbers (previously replaced in 1998).

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works reduced the potential for further timber rotting and collapse, an important Health & Safety measure so close to the well-used canal towpath. This project has provided a higher degree of Health and Safety for bridge use and public access for at least another generation.

Residual impact (2009)

There are unlikely no significant residual impacts in the short term.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors mitigated any possible mistakes, the quality of the work was of a good standard, and reduced the need for this work to be undertaken for at least another generation (Fig 16).

5. Impact mitigation strategy

The impact mitigation strategy is divided into three stages: The pre-works consultancy, the Historic Buildings Consultancy during works and the archaeological recording record (during and after works). This mechanism demonstrates the steps that have been taken to avoid or minimise adverse impacts, and confirms that the proposed works have been designed in close liaison with the historic environment consultant. Consultation is based on a clear understanding of the significance of the site using appropriate methods and techniques for site monitoring and recording.

HES Projects (Project number 20070793) was commissioned to undertake the three components described as the impact mitigation strategy. The project was based on a project design produced by Colin Buck (21/07/06), and recording specifications defined by Bill Horner (DCC archaeologist).

6. Working method

The following text summarises the general WSI for all archaeological consultancy and archaeological recording for projects relating to the TVMHP (Tamar Valley Mines Heritage Project: Written Scheme of Investigation: Historic Building and Archaeological Recording Consultancy 21/07/06).

- A brief historical survey was compiled from existing Devon County sources (DCHER, DRO, and local libraries and historians (including Robert Waterhouse's recent published work on the canal).
- A walk-over survey was undertaken of the entire length of the canal for sites impacted by the TVMHP.
- An impact assessment described and mitigated the proposed work as part of a Mitigation Strategy to minimise the works affecting the site's character.
- General working methods for archaeological recording, treatment of finds, photographic surveying and report production are described in detail in the Tamar trails WB WSI produced in 21/07/06.

All archaeological recording work was undertaken according to the Institute for Archaeologists (IfA) *Standards and Guidance for Archaeological Investigation and Recording. Staff follow the IfA Code of Conduct* and *Code of Approved Practice for the Regulation of Contractual Arrangements in Archaeology.*

The principal factor in effective project delivery was the employment of key project staff who are expert in the management and recording of the industrial heritage. Cornwall Historic Environment Service project staff can draw upon a substantial track record in undertaking similar work throughout Cornwall, as well as a detailed knowledge of the project area and its sites.

Historic buildings consultancy

- HES (Senior Archaeologist) liaised with the Devon County Historic Environment Service - DCHES (Bill Horner), and the TVMHP Project Manager (Chris Hariades).
- The HES Senior Archaeologist attended regular site meetings when appropriate during the duration of the project.
- HES ensured that site conservation works are carried out to standards recommended by English Heritage best practice.
- **Fieldwork: archaeological recording**
- There were no newly exposed archaeological features revealed through excavation.
- Where appropriate, measured survey was carried out by hand measurements (using offset techniques at a scale of 1:50.
- The resulting survey output was a revised measured survey drawing showing all conservation works that had been undertaken. This was reproduced at a scale of either 1:50 or 1:100 (appropriate to the size of area recorded) and will form part of this archive watching brief report.
- Analysis of the building fabric was recorded in the form of field notes and written up in this archive report production stage.
- DCHES (Bill Horner) advised that archaeological recording should be undertaken during any excavation that revealed archaeological features. Recording was undertaken using a mix of direct measurement, sketch plotting and photography, as appropriate (constrained by safety factors).
- Where significant remains were encountered the site archaeologist was given the opportunity to make an appropriate form of record before work proceeds.
- The chosen site archaeologist adhered to Health and Safety Policies (see below), under the direction of the designated Site Safety Officer.

Site recording (general)

- Site drawings (plans, sections, locations of finds) were made by pencil (4H) on drafting film; all plans were linked to the Ordnance Survey landline map; all drawings included standard information: site details, personnel, date, scale, north-point.

- The site archaeologist undertook the recording in line with recommendations given by IfA. Sections and plans were drawn on site at appropriate scales which adequately recorded structures or features at appropriate levels of detail, and appropriate sections reproduced in the archive report at either 1:50 or 1:100 to adequately demonstrate revealed archaeological features.
- All features and finds were accurately located by means of a National Grid reference and all archaeological contexts will be described using a standard format and linked to a continuous numbering sequence.
- The archaeological watching brief report detailed all forms of archaeological recording that had been undertaken at each of the mine sites. Each major mine site had a single archaeological watching brief report that details all project related work to that site (i.e. trails works, building conservation works, interpretation works, etc).

For Treatment of finds, Photographic recording specifications, report production and archiving specifications refer to the TVMHP WSI (2006).

7. Results

Unfortunately, there was insufficient time (following receipt of a detailed plan and description of the canal repair works from the TVMHP), prior to the start of works on site to produce an impact and mitigation report for DCC (Bill Horner). A decision was therefore taken to minimise impacts and mitigate directly with the TVMHP and site contractors on site as works were progressing as part of a weekly site recording and consultancy. SWW funded the stone and path repairs to the canal bed whilst the TVMHP funded fencing of the north and west sides of the canal, to stop encroaching animals from the adjacent fields from directly accessing the canal (and walking up the towpath!). An interim archaeological recording report of these works was produced by the author on 17/06/2009. This report supersedes that report.

Repair works to the bed and towpath of the Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the start of the Lumburn Aqueduct **SX 46237 72628**)

In early 2009, the TVMHP tendered for stone masons (on behalf of SWW) experienced in rebuilding stone walls, etc, to undertake these works within a narrow time-scale of three weeks, when SWW were willing to reduce the water flow through the canal (which would stop the electricity generating turbine). The turbine normally operates all year round, often at short notice when generation rates for electricity peak (the turbine can instantly generate electricity). Clemens Stonemasons of North Cornwall were successful in winning the contract. Prior to this, the TVMHP Manager, the archaeological consultant and SWW projects officer, produced a repair work specification schedule (measured from the small swing bridge at Tavistock: SX 47348 73503), which focussed on identifying the repair of collapsed sections of canal bank on the south or east sides. Appendix 1 is a reproduction of this original document.

Site work started on 05/05/09 at the northern end of the canal and progressively worked southwards towards the lock gates at the Lumburn Valley. With the reduced water level in the canal (and its slow movement when full), many stones that had fallen out of place were found in the canal bed not far from their original bank location. When the canal was constructed the stones were originally set on edge, a minimum of two/three stones height (approximately 0.6m to 0.8m above water level). During the repair project, where there was insufficient stone to replace the collapsed sections, a similar stone was imported from Trebarwith Quarry, North Cornwall (purchased from the local quarry at Millhill). These stones were reset on edge, following the original profile of the canal bank, and tightly tamped down in position (tops and sides). Earth was backfilled into the top sides of the stone to re-form the edge of the towpath. This was then at a later date, re-seeded. Figures 7 and 8 show examples of before and after photographs of the repaired canal bank. The work has been sensitively undertaken and reflected the style and character of the original construction a century ago.

Weekly site meetings were arranged to view the previous week's repairs and to discuss any foreseeable problems within the following weeks programmed work. A granite towpath stone under the Crowndale bridge at SX 47194 72541 had become dislodged (into the canal), and some quoin stones from the bridge parapet wall had fallen into the canal. The former was repaired by contractors; the latter will be removed from the river by SWW to be replaced on the bridge parapet wall at a later date. A small section of old 2" timber (2m long) set in the lower part of the bank was replaced back into its original position following repair of the wall at this location (SX 47270 72707).

The canal bank repair works (see Appendix 1), were finished on 28/05/09, including an additional element of work totalling 87 metres, which the contractors identified whilst on site. A total of 337 linear metres of canal bank was repaired (only on the south/west side), using a total of 86 tons of additional Trebarwith stone. The canal repair works were funded by South West Water.

Figure 5 is a site plan and specification document for the installation of timber post and wire stock fencing along the west/north side of the canal and construction of three cattle drinking areas to minimise any future erosion of the opposite (north/west) side of the canal bed. The cattle drinking sites are located at SX 47384 73064, SX 47257 72705, and SX 47078 72415. A concrete pad (min 0.3m thick), varying from 3m to 4m wide and approximately 5m long, has been created to at each of these sites to form the post and rail fenced cattle drinking areas that should minimise further damage to the banks (on either side). An additional cattle drinking area was constructed on bedrock immediately on the west side of the Shillamill Viaduct (see Fig 6). Figures 9 and 10 show before and after views of a cattle drinking site (SX 47384 73064).

Approximately four months later, the surface of the canal towpath was patched with crushed stone (803 specification) where the path was potholed or muddy, then sections covered with finely ground stone (6mm to dust) from Meldon Quarry.

During construction of the cattle drinking sites and during the canal repair works there has been minimal archaeological impact, nor any finds recorded.

Aqueduct Bridge SX 46630 72090

Knevitts Ltd was commissioned by the TVMHP in 2011, to undertake a structural survey of the aqueduct bridge at this location. Their report and structural drawing (see Fig 12), recommended that a rusty wrought iron support (middle one of three similar supports – see Fig 13) sited under wide slates below the towpath next to the canal, be replaced with a modern equivalent. In addition, it was recommended that the tall retaining wall on the south west side of the aqueduct bridge be repointed and structural ties inserted (using 7mm diameter stainless steel helibars) into the masonry bedding joints to strengthen a structural crack in the masonry.

This work was not started until May 2012, following an extensive dialogue with SWW and the site owner. Figure 13 shows the failed rusty element needed to be replaced. The original lintel was 50mm x 50mm for most of its length but widened to 100mm at both ends (and set in the side walls). Unfortunately the original wrought iron section specification was impossible to replace, and an 'off the shelf' item had to be found due to budgetary constraints. Figure 14 shows the new steel replacement *in situ*. Scaffolding had to be erected to remove the original rusty support and to replace it with the new 50mm wide x 115mm deep iron profile steel section. A slightly wider opening had to be made into each granite quoined side of the bridge for insertion of this new structural element. The localised setting was then repointed with lime. The steel was painted with a red primer and then painted black.

Other works to this site included removal of a tree growing out of the west side of the north end of the aqueduct bridge and treatment of the stump, as its unchecked growth had caused structural issues to the masonry at this point. On the opposite side of the bridge opening, the top flanking stones over the east side revetment walling had become dislodged. These were moved back to their original position. TVMHP funded the project.

At the north end of the structure under the aqueduct section, it appears that water has been leaking from the canal at the intersection of the metal 'trough' profile bolted plates and the canal bed – on both sides, through the stone masonry. This has caused the masonry and water at this point lower down under the aqueduct to be constantly wet.

Consequently, the foundations masonry and pointing in this area have softened to the extent that the masonry is collapsing and arching downwards. SWW attempted to add some clay to the leaking intersection point in the bed of the canal, but this has not worked. Structural deterioration will continue unless this issue is resolved. This is a significant feature of the canal which is in places, is now a Scheduled Monument. It is a recommendation of this report that the aqueduct bridge be considered for Listing.

Finally, the vertical retaining walling on the south west side of the aqueduct was repointed and the structural crack that had been identified by the structural engineer, repaired with the use of helibar reinforcing. This work finished in mid June 2012. The repointed wall acted to retain not only the towpath running along the south side of the canal, but also steps that allowed access from the towpath down into the adjacent field. These steps have badly deteriorated, leaving a steep slippery slope. It is recommended that they need to be rebuilt before use of them can be made by a new DCC footpath from the nearby railway linking up with the canal footpath.

Lock Gates and timber lifting bridge SX 46327 72628

The timber lock gate and timber lift bridge was 'restored' in 1998 by SWW and British Waterways. It is not know what the restoration replaced, but parts of the timber lift bridge (mainly the western timber arm), had rotted resulting in collapse (see Fig 15). Other parts of the bridge were showing that many timber items were rotting. In addition, the section of timber lock gate that was in constant contact with canal water had also rotted during the last 14 years. SWW and the TVMHP decided to replace the rotted and unsafe timber items as being a Health and Safety issue, given the frequent public use of the towpath. SWW funded the project.

The project of dismantling the bridge and lock gate, replacement of the main and structural timbers, and re-assembling and fixing on site was tendered. The contract was won by Will Sterling and Son, a traditional timber boat builder and carpenter who worked at Morwellham Quay (repairing and building boats, etc). The work was started in July 2012 and finally finished in September 2012.

Figure 16 is an 'after' view of the works on these features, and should be compared to its preceding figure. It is hoped that this repair will last longer than its predecessor!

Note:

In 2013, the TVMHP constructed a new footpath from near Morwell Rocks (SX 44128 70435) to above George & Charlotte Mine (SX 45101 69962). This new route links the main route of the railway line from Devon Great Consols to Morwellham and the forestry tracks north of Morwellham. Scheduled Monument Consent was obtained in 2012 for construction of a new timber footbridge over the Tavistock Canal (the section from the west end of the Morwell Down tunnel to the incline railway cottage was Scheduled in 2011, SM No. 30973). As part of this project, an impact assessment report was produced (Buck 2012). The results of the new footpath creation and footbridge construction will be produced within the main body of the TVMHP archaeological recording report (Buck forthcoming).

8. References

8.1 Primary sources

CRO AD 58-26 Tunnel Lodes (1923-33) Report by F Cloke and CF Barclay.

DRO T1258M-14B Bedford Estate Map

8.2 Secondary sources

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Hadfield, C., 1967, *The Canals of South West England*, David & Charles, Newton Abbott

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Waterhouse, R., 2012, *Tavistock Canal, Surveying a forgotten marvel of the industrial age*, Current Archaeology, Issue 273 December

Waterhouse, R., Forthcoming publication on 'Tavistock Canal'.

Woodcock, G., 1995, 2005, Booklets on the 'History of Tavistock'.

9. Project archive

The HE project number is **20070793**

The project's documentary, photographic and drawn archive is housed at the offices of Historic Environment, Cornwall Council, Fal Building, New County Hall, 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 (20070793).
2. Black and white photographs archived under the following index numbers:

   GBP 2091/12-21; 2207/12-22; 2250/1-17; 2253/19-22.
3. Digital photographs stored in the directory R:\HE images\Sites\Devon\Tavistock\Tavistock Canal
4. This report text is held in digital form as: G:\HE Documents\HE Projects\Sites\Devon\Tavistock Canal IA WB report 20070793
5. English Heritage/ADS OASIS online reference: cornwall2-154344

No artefacts or environmental material was retrieved during the project.

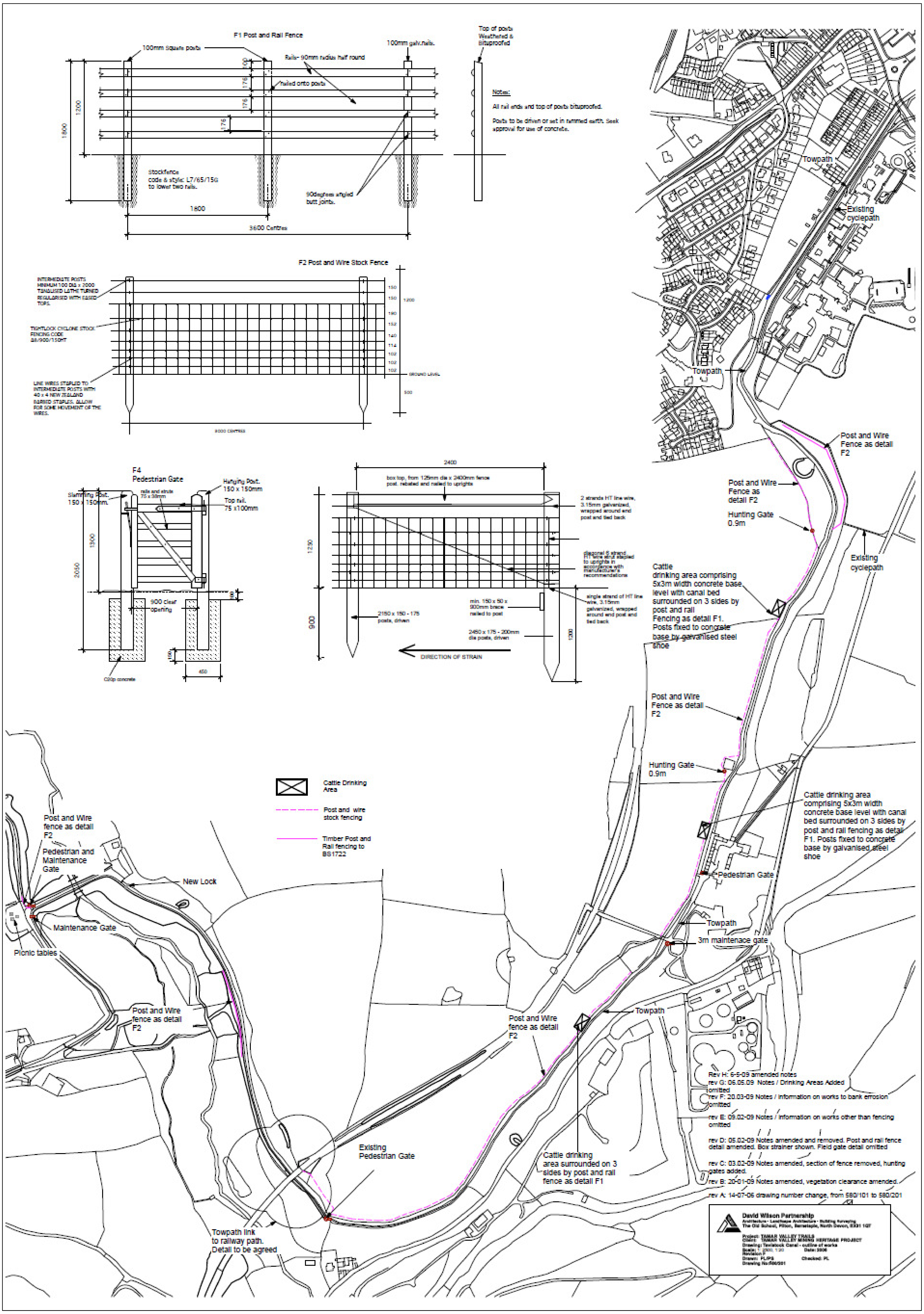

Figure 5 Specifications and plan showing fencing and three cattle drinking areas at the Tavistock Canal(East section)

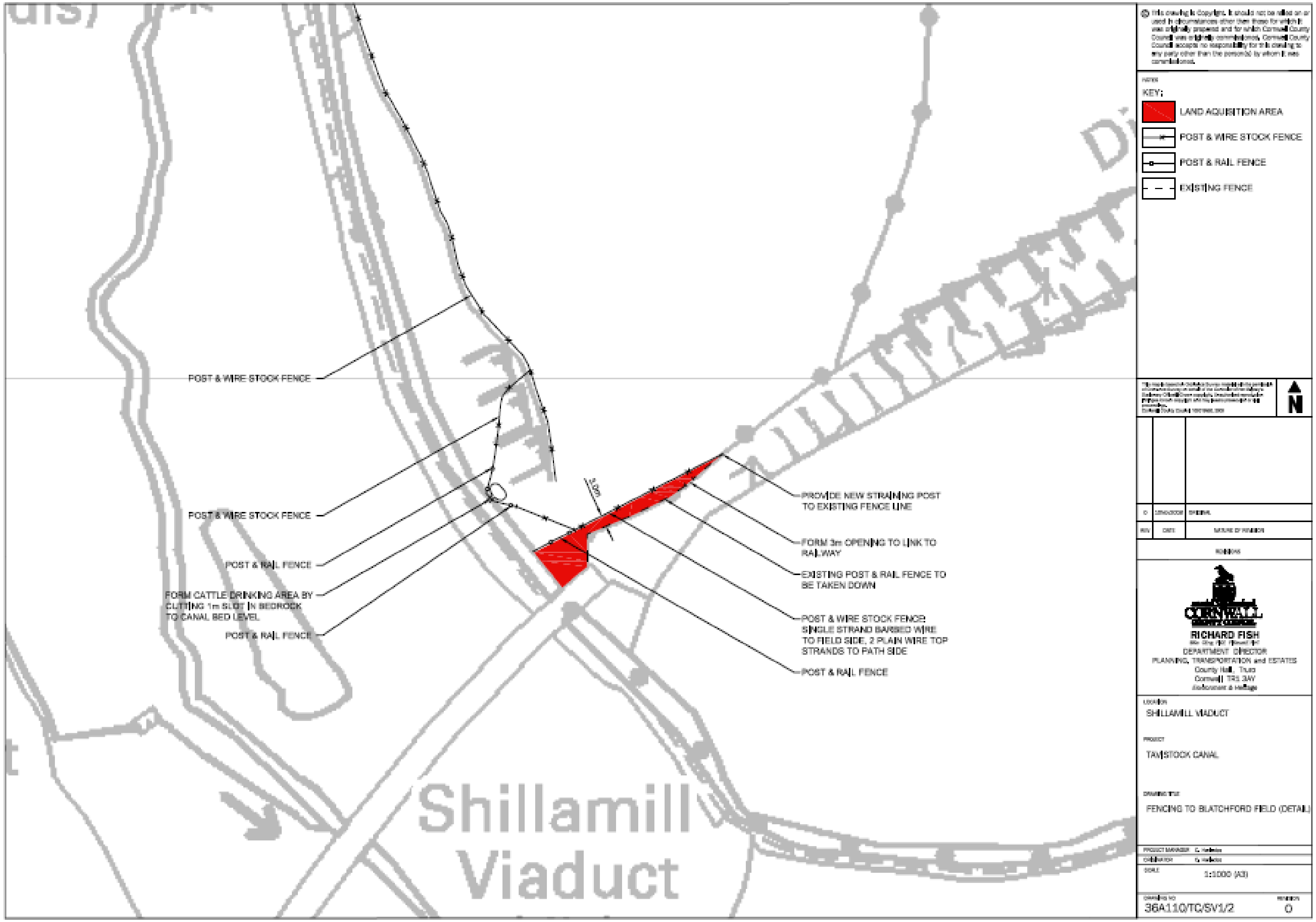

Figure 6 Detail plan showing the cattle drinking area west of the Shillamill Viaduct

Figure 7 A view of the Tavistock Canal east bank before works © CC HE Projects

Figure 8 A view of the Tavistock Canal east bank after works © CC HE Projects

Figure 9 A view of a Cattle Drinking site before works (SX 47257 72705) © CC HE Projects

Figure 10 A view of the same Cattle Drinking site after works © CC HE Projects

Figure 11 A view of the canal towpath after re-surfacing works © CC HE Projects

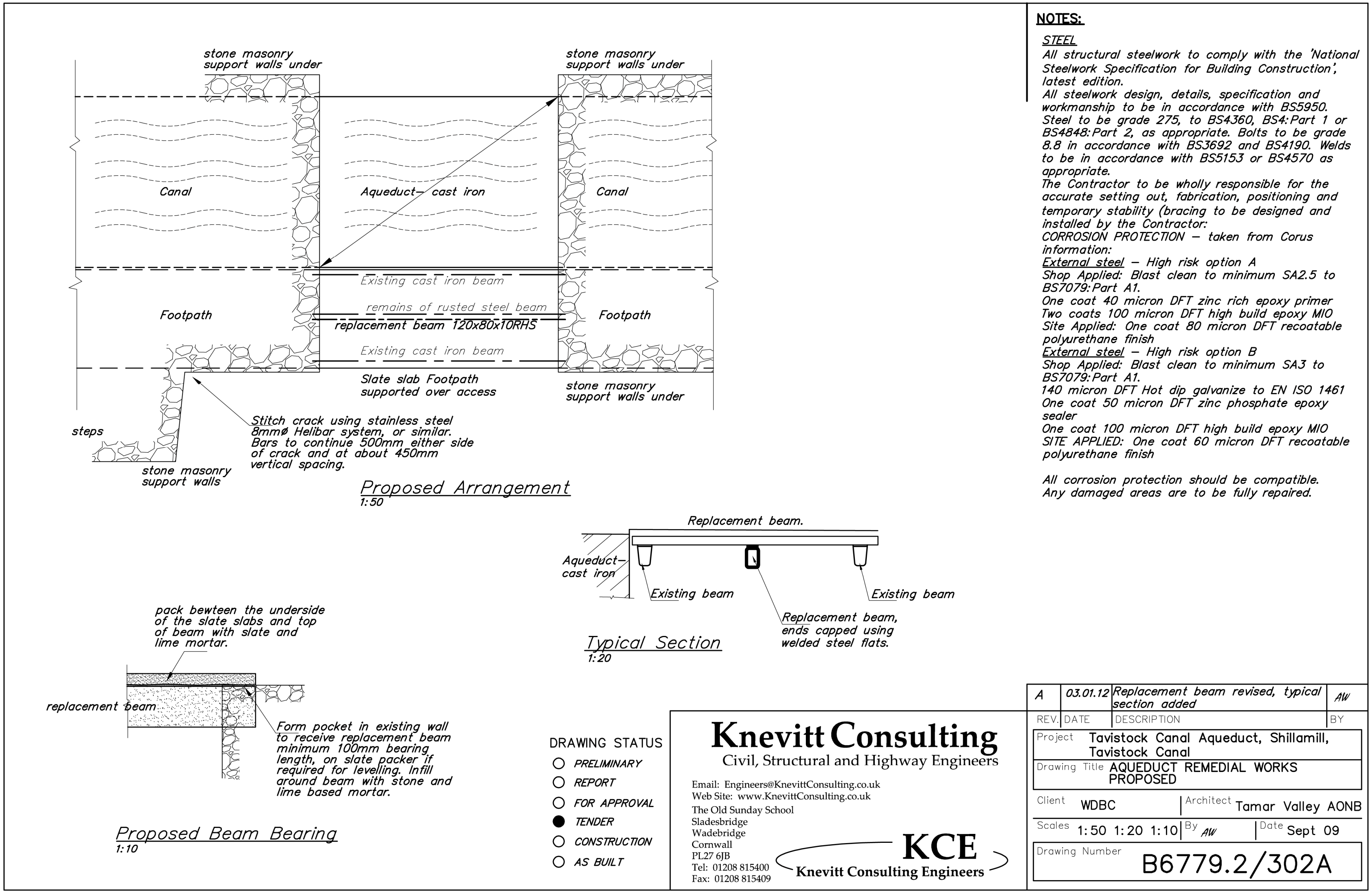

Figure 12 Specifications plan for repair of the aqueduct bridge

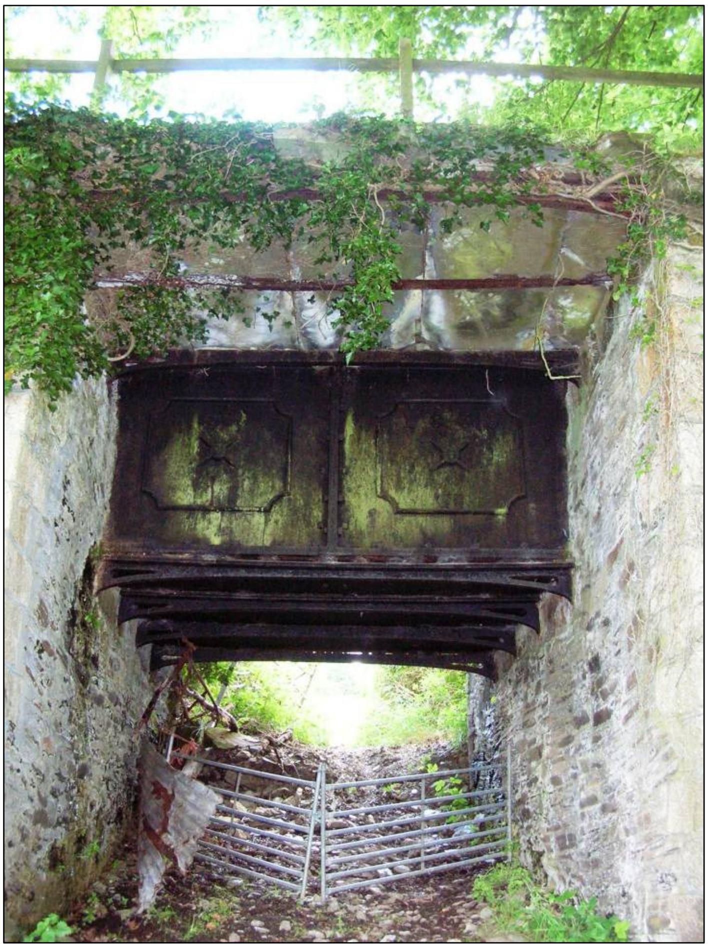

Figure 13 A view of the canal aqueduct bridge before works © CC HE Projects

Figure 14 A view of the canal aqueduct bridge after works © CC HE Projects

Figure 15 A view of the canal lock gate and bridge before works © CC HE Projects

Figure 16 A view of the canal lock gate and bridge after works © CC HE Projects

Appendix 1: TAVISTOCK CANAL BANK REPAIR WORK SCHEDULE

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
20		Side out path and hedge (140m length)
76		1.5m infill behind c $2m^3$
118		1.5m infill behind c $1m^3$
140-150	10	Minor wall top repair
159-160	1	End of hedge
162-163	1	1m infill behind $0.25m^3$
166-179	13	
225-247	22	
253-308	55	Break out conc block
314-323	9	
328-330	2	
394-418	24	
433-461	29	Take off conc
P A T H		
467-469	2	Break out conc
472-473	1	Good example, flat stone
485-488	3	Remove conc, Repair bank
494-513	19	Remove section of conc
530-541	11	
557-558	1	
563-573	10	
577-578	1	
581-584	3	
591-592	1	
600-650	50	
664-673	29	
691-694	3	
703-704	1	
714-718]	4	Soft path, build up levels (ch 14-27)
722-727]	5	
730-735	5	
744-745	1	
751-754	3	
755-760	5	
771-773	2	
779-780	1	
782-798	16	800 ⇒path surface 80ft
800-804	4	
804-806	2	Build up path surface to fall to canal

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
		(ch 800-902)
808-809	1	
813-814	1	
819-820	1	Lay hedge, remove barbed wire (ch 800-902)
823-826	3	
839-842	3	
875-876	1	
892-894	2	
902-903	1	Remove gate, overhanging branch
902-907	5	
970-971	1	Gate and post and rail across path
975-976	1	Surface ok
985-990	5	In deep
1009-1010	1	
1019-1020	1	Take out tree growing out from opposite bank
1068-1069	1	Path surface repair
1093-1094	1	Under bridge
1099-1100	1	Bridge coping repairs 4m copings in canal
1130-1131	1	Boulders ⇑ make up path ⇓ scrape leaf mould
1158-1159	1	
1165-1166	1	
1169-1170	1	
1187-1192	5	
1197-1199	2	
1202-1207	5	
1208-1209	1	
1225-1232	7	
1260-1268	8	
1271-1272	1	
1279-1280	1	
1282-1283	1	
1295-1298	3	
1308-1309	1	
1317-1319	2	
1334-1342	8	
1353-1356	3	
1409-1414	5	
1421-1422	1	
1424-1425	1	

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
1441-1442	1	
1454-1456	2	
1514-1515	1	
1546-1548	2	
1573-1574	1	
1581-1582	1	
1603-1604	1	
1600		Path falls away from canal. (1.5m width)
1691-1692	1	
1718-1719	1	
1721-1722	1	
1726-1729	3	
1820-1821	1	
1856		AQUADUCT (Clear vegetation, Take out gate)
1958-1968	10	Under viaduct
1970-1972	2	
2020-2023	3	
2151-2152	1	
2220-2221	1	
2316-2318	2	WHEEL SLUICE Interpretation Barrier (Take down concrete posts and blocks)
2463-2464	1	
2534-2535	1	
2541-2543	2	Replace Bascule bridge
		Lumburn Valley Turning area at lock (excavate)
2586-2600	214	Opposite bank
TOTAL		

Note:

An additional 87 linear metres of repairs were undertaken by the site contractors as they deemed them necessary. These additional repairs are not reflected in the above schedule chainage list, which was originally compiled by Chris Hariades (in consultation with Colin Buck and SWW (Laura Wotton) in April 2009 to inform tender information and site specifications prior to the start of works. The location of the small swing bridge in Tavistock (from which the chainages are measured) is at SX 47348 73503.

Tavistock Canal - Canal Bank Repair Works Schedule

Item	Description	Qty	Unit	Rate (£)	Cost (£)
1	Provide site welfare facilities to comprise as a minimum porta-loo with handwashing facilities, maintain and take down on completion	Item			
2	Provide all necessary fencing, barriers, signage, maintain for duration of contract and take down on completion	Item			
3	Break out concrete capping (provisional)	50	lm		
4	Clear rubbish from canal bed and dispose to licensed tip (Provisional)	10	m3		
5	Repair identified sections of failed or colapsing drystone facings to canal bank to match adjoining sections using stone salvaged from canal bed	250	m2		
6	Tie and marry in each repair to adjacent sound sections.	100	no.		
7	Extra to bed bottom course of stone on 50mm depth drymix sand/lime/cement bed in ratio 6:2:1 where laying directly onto bed rock.(Provisional)	50	l.m		
8	Extra to import suitable matching stone to make up shortfall in site salvaged material (Provisional)	50	tonnes		
8	Backfill voids behind stone facing to level with top of bank with imported scalpings compacted in layers not exceeding 200mm depth (provisional)	10	tonnes		

Report No: 2013R046

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CORNWALL COUNCIL

Tavistock Canal, Devon

Archaeological impact and recording report

Historic Environment Projects

Report No	Report Name	Report Author
2013R046	Tavistock Canal – Impact assessment and archaeological recording during a program of repair works	Colin Buck

Event Type

Site consultancy	Archaeological impact assessment	Archaeological watching brief	

Client Organisation	Client Contact
TVMHP (West Devon Borough Council)	Chris Hariades (TVMHP)

Monuments (MonUID)

DHER 3879 (Tavistock canal)	18721	4069	3882	5449	3956

Fieldwork dates (From)	(To)	(Created By)	(Create Date)
05/05/09 05/05/12	29/05/09 05/09/12	Colin Buck	13/05/13

Location (postal address; or general location and parish)

Tavistock Canal (northern section from Tavistock to Lumburn), Tavistock, West Devon

(Town – for urban sites)	(Postcode)
Tavistock	

(Easting) X co-ord	(Northing) Y co-ord		
From: SX 47367 To: SX 46183	73572 72589		

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

List of Figures

Abbreviations

AONB	Area of Outstanding Natural Beauty
CC	Cornwall Council
DCC	Devon County Council
DHER	Devon Historic Environment Record
DRO	Devon Record Office
HES	Historic Environment Service
OS	Ordnance Survey
SWW	South West Water
TVMHP	Tamar Valley Mines Heritage Project
WHS	World Heritage Site

Acknowledgements

Thanks are due to Robert Waterhouse for providing some primary survey data and information files from his research relating to a forthcoming book about the Tavistock Canal. Chris Hariades (Tamar Valley Project Manager), and Bill Horner were involved in the project throughout its entirety. Andrew White of Knevitts Cons. Engs. was involved in preparing the specifications of the aqueduct bridge.

Front cover image: a copy of the Tavistock Canal Company Seal.

1. Project background

The Tamar Valley Mining Heritage Project (TVMHP – 2005 to 2013), a £7 million Heritage Lottery Fund project focusing on the World Heritage Site landscapes of West Devon in the Tamar Valley, is co-ordinated by the Tamar Valley Area of Outstanding Natural Beauty (AONB). The TVMHP was approved for Stage 2 consent by HLF in 2003. It involves the conservation of former mine sites and trail creation along the Devon side of the Tamar Valley (from Devon Great Consols to Morwellham). These sites include Devon Great Consols, the largest mine in Europe during the 19th century. The project also included conservation and repair works to the Bere Alston to Tavistock railway line (Buck 2011), the Tavistock Canal, and parts of Morwellham Quay itself (other contractors). This project covers works undertaken along the Tavistock Canal (Fig 1).

The Historic Environment Service (HES), Cornwall Council was commissioned in July 2007 by the Tamar Valley Mining Heritage Project (Chris Hariades as TVMHP Project Manager), to undertake an archaeological impact assessment, archaeological recording and site consultancy, photographic building recording of affected sites impacted by the works. An impact assessment project brief had not been produced, but it follows a similar project design by Historic Environment Service, Cornwall Council; *'Project design for production of archaeological recording, as part of the Tamar Valley Mining Heritage Project (2006-2009)',* dated 23/06/06. A Project Design for this site and other building conservation schemes in the TVMHP was produced on 21/07/2006, and was subsequently approved by Bill Horner (Devon County Archaeologist).

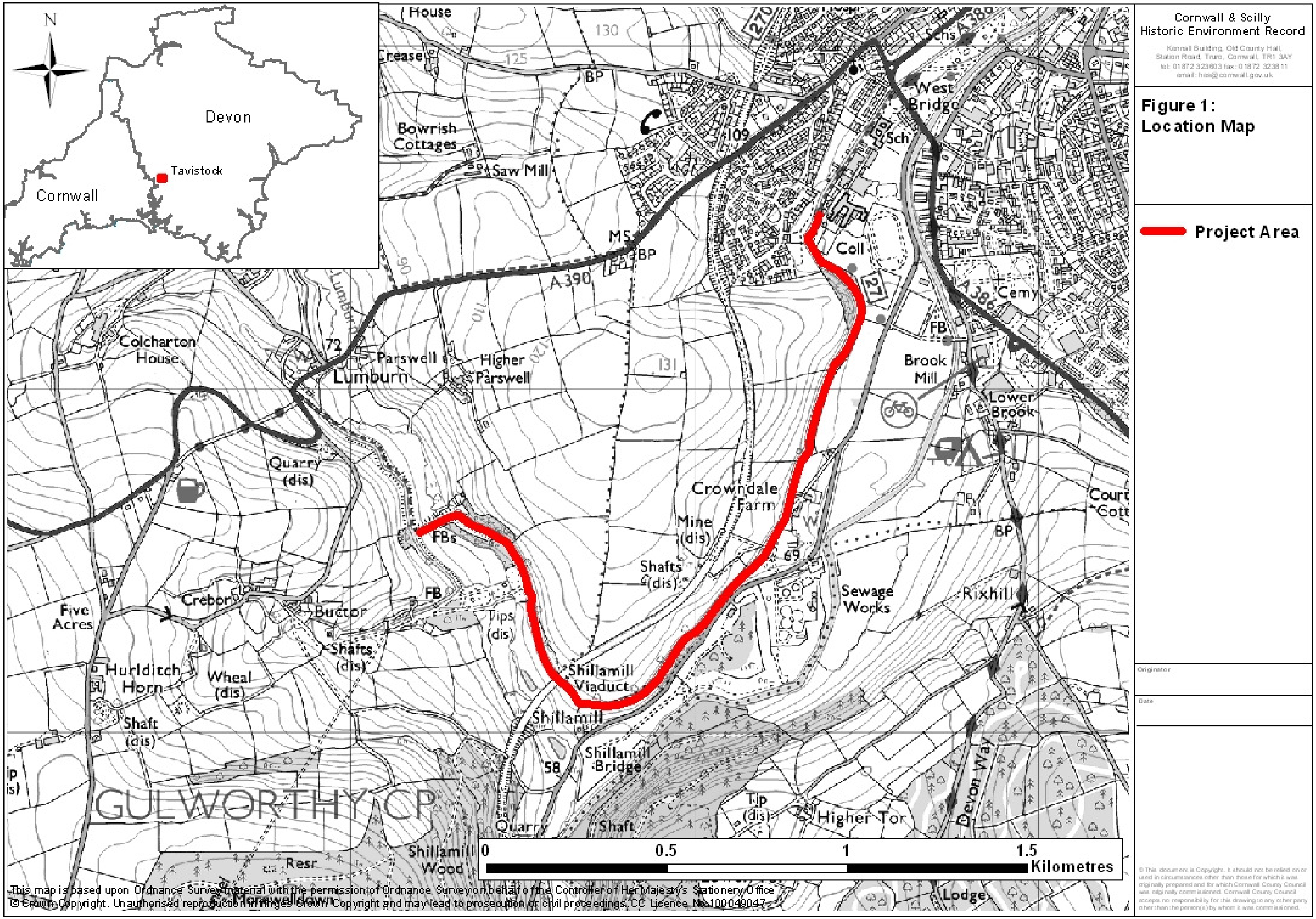
The conservation and management of features relating to the TVMHP's mining heritage and enablement of safe public access forms the basis for the Tamar Valley site conservation scheme. This report will assess the impact of the proposed conservation works on the Tavistock Canal's significant assets (canal within the WHS), describe the mitigation undertaken and also a description of the archaeological record for the (intermittent) works from May 2009 to May 2012. Following the first phase of works in the summer of 2009 (to describe and record the repair works and the minimal impacts to the canal sides), an interim report was produced for Bill Horner (Devon archaeology – Buck 2009).

In a joint project with SWW, the TVMHP agreed to fund cattle fencing along all of the west side of the canal, in order to stop further damage being caused to both sides by cattle drinking the water and wandering (on one occasion into Tavistock!), and to create four cattle drinking sites. SWW agreed to fund the repair of the sides of the canal bed. Furthermore the TVMHP agreed to re-bed and re-seed where necessary the canal towpath later in the autumn of 2009, and at a later stage (2011), to repair the damaged lock gates. In addition, the TVMHP agreed to undertake small-scale structural repairs to the small aqueduct bridge in 2012, and a small amount of repointing.

2. Aims and objectives

The aims of the project were as follows:

- To ensure that site works are undertaken in such a way as to maintain the integrity and authenticity of the historic resource, minimising adverse impact upon the resource.
- To ensure that the Devon County Historic Environment Service (DCHES – Bill Horner) are appraised of all site works.
- To ensure that the highest possible standards of the historic environment conservation works are maintained, which must be carried out to recognised current best standards in this discipline.
- To ensure that works are undertaken in such a way as to allow adequate recording of remains affected by the works.
- To record sites, features, deposits and artefacts affected by or uncovered by the works.



Cornwall & Scilly
Historic Environment Record
Figure 1:
Location Map
Project Area
N
Devon
Cornwall
Tavistock
Colcharton House
Lumburn
Parswell
Higher Parswell
Bowrish Cottages
Saw Mill
A 390
West Bridge
Coll
Cemy
Brook Mill
Lower Brook
Crowndale Farm
Mine (dis)
Shafts (dis)
FBs
FB
Quarry (dis)
Crebor
Buctor
Five Acres
Hurlditch Horn
Wheal (dis)
Shaft (dis)
Tips (dis)
Shafts (dis)
Shillamill Viaduct
Shillamill
Shillamill Bridge
Shillamill Wood
Sewage Works
Rixhill
Court Cott
Higher Tor
Devon Way
Lodge
Quarry
Shaft
Resr
GULWORTHY CP
0
0.5
1
1.5
Kilometres
This map is based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office
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- To record the character and extent of works to the sites.
- To inform the Devon County Archaeologist of the nature, condition and significance of the canal and towpath, and describe the proposed impacts and a mitigation strategy (agreeable with the Devon County Archaeologist).
- To disseminate the results of the project appropriately and arrange for the deposition of the project archive (within IfA Guidelines).

It was proposed that the building conservation and repair programme will address the following:

- The protection and consolidation of significant archaeological remains in their settings.
- Health and safety aspects of the site relating to public access.
- Provision of low-key public amenity use where appropriate, incorporating access.
- Interpretation of the site to the public, including on-site and written materials.
- Linking the site into the local economic, social, tourism and recreational contexts.

In terms of the management of archaeological features, engineering works were kept to a minimum, but in view of the fact that the entire site is part of the Tamar Valley component (Area 10) of the Cornwall and West Devon World Heritage Site mining landscape, particular attention was paid to suggestions for the best mitigation of any such works.

3. Historical background

This subject matter has already been written in far more detail than is necessary for this report, notably by Hadfield (1967), Booker (1971, who reproduces the tonnages in Appendix 2), Hedges (1975), Woodcock (1995, Vol 6; 2005), and more recently a publication by Robert Waterhouse (2012), and a forthcoming detailed book. The text below is a summary history and construction account of the Tavistock Canal extracted from all of the above sources.

The medieval borough of Tavistock has always been closely linked to its port, Morwellham. That link was dramatically improved by the construction of the Tavistock Canal from 1803 to 1817. The main structural features of this major construction throughout its full length can still be seen today, over two hundred years later; the wharves at Tavistock and Morwellham, the aqueduct over the River Lumburn, the 1.5 mile long tunnel under Morwell Down, and the remnants of the incline plane down to Morwellham.

The historical chronology for the canal can be summarised as follows:

1796 The opening of Wheal Friendship Copper Mine, Mary Tavy, unintentionally led to the construction of this canal. The export of ore and import of coal and other materials needed to be cost effective – its transport costs by horse and cart must have been prohibitive. The young mine's engineer (in his twenties), John Taylor, had the idea of linking the Tavy and Tamar valleys, whilst using Morwellham to export the ore (via sea going ships); the nearest active port to Tavistock.

1800 By the turn of the 19th century, the country had been at war with France for a few years. Demand for metallic ore, and therefore the need for a canal were high.

1802 Survey of the proposed canal route (presumably with the blessing of the Duke of Bedford) by John Taylor, the mining engineer of Wheal Friendship copper mine.

1803 (March) A canal company, funded by shares from the London Stock Exchange (see front cover seal image), was formed. Work began on the route in 1803, following the passing of an Act of Parliament. The canal was to be 16ft wide and 3ft deep, with a branch to the slate quarries at Millhill. It is likely that the first section of the canal route followed an earlier leat from the River Tavy to Crowndale Mine. Raising funds on the stock exchange gained stock interest from adventurers to exploit known lodes whilst tunnelling through the granite of Morwell Down, and for additional shares to be

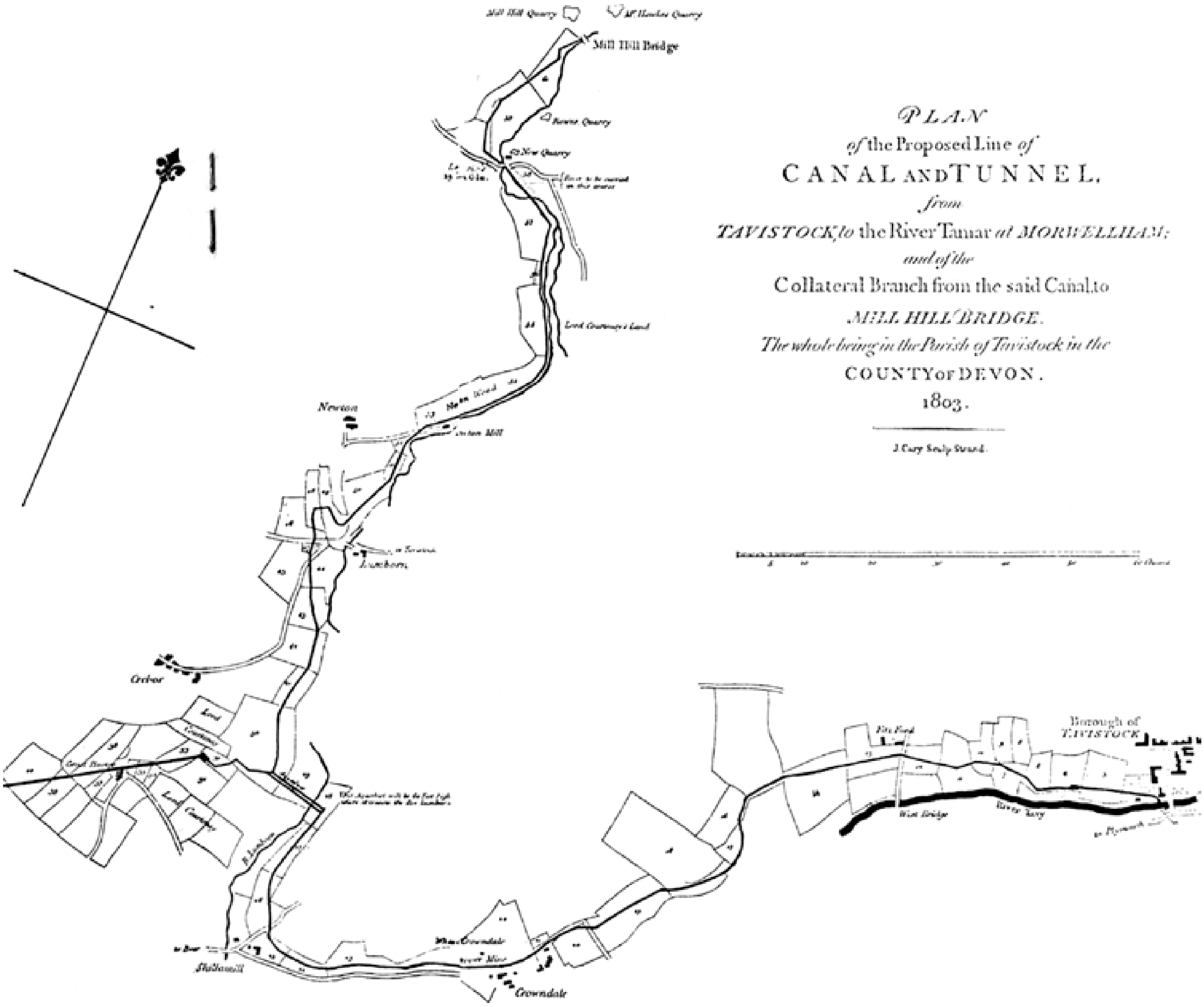

Figure 2 Excerpt of the 1803 survey plan (within the study area) of the proposed Canal route from Tavistock to Morwell Tunnel (Hedges 1975)

purchased by other mines and Tavistock businesses along its course, all recipients of the canal's cheaper transport costs. However, Hedges (1975) hints that Taylor's real motivation for the project was not primarily to build the canal, rather the opportunity to exploit known lodes under Morwelldown, a mining speculation.

Figure 2 shows the original planned 1803 route. The provision of water via leats from the western end of the canal (top of the Morwellham incline) for other mines in the Tamar Valley as far north as Gunnislake to power water wheels was also planned. The original cost estimate for the canal was £40,000 (including testing for ore lodes), at £100 per share. The Duke of Bedford, who owned all the land along the canal's course, also purchased 1/8 of the shares and took dues for use of Morwellham Quay. He also agreed to a request to make a grant of a Mining Set: (for working all Lodes discovered in the Course of the Canal, Embankment, Tunnel and collateral branch for copper, tin and lead to the extent of 500 fathoms East and West of the canal for every Lode discovered), for the sum of 1/10 dues and a term of 42 years.

The principal engineering features being the aqueduct over the River Lumburn, the 2,540 yard tunnel through Morwelldown, and the inclined plane west of the western end of the tunnel down to Morwellham – a fall of 237 ft, the greatest in southern England at that time.

Figure 3 Excerpt of the 1867 Bedford Estates survey plan (DRO T1258M) showing the canal within the study area.

1803 (23rd August) Work began on the tunnel. Almost immediately copper was struck at the Tavistock end of the tunnel, and the lode developed to realise what later became Wheal Crebor (see Fig 3). Men were employed to work both concerns – the accounts separated. The Canal Committee managed both concerns until 1812 when a separate Committee was appointed after further copper ore discoveries in the tunnel under Morwelldown (Hadfield (1967, 128).

1808 The waste rock and ground from the tunnel excavation was boated eastwards back to the tunnel entrance and used to infill and form the Lumburn Aqueduct over the valley, with a central spanning arch.

1809 Work progressed slowly in the tunnel (by this date it was half finished), as the canal section from Tavistock to the tunnel was finished (ie, this project's study area). This was built more permanently with stone sides (on edge) rather than puddle clay. The tunnel rock was granite, its depth 160 yards below the top of the hill. Pumping/ventilation/winding and access shafts (at least four – the main one being Bray Shaft), had to be sunk from the top of Morwelldown to the underground canal. John Taylor designed the power source for the shaft workings by utilising flat rods (for lengths up to 1.5 miles) powered from a large 40′ water wheel. He also designed a ventilation fan for improving the air quality, for which the company was awarded the medal of the Society of Arts in 1809 (Hedges 1975).

1810 The tunnel advanced at a rate of about 150 fathoms (six feet per fathom) per year until this year when three granitic dykes were cut, slowing the work rate to nearly a third that amount for two years. 30 to 40 workmen were continually employed, with some authors suggesting French prisoners of War used as 'navvies' (Barton 1964, 93 and Booker 1971, 108).

1815 From this year there were shipments of manganese from mines around Brentor and Milton Abbot carried by the canal. These were the principal sources of manganese in the country at a time when it was used in the manufacture of glass. For example, 13,335 tons were shipped to Plymouth in 1819. The ore was ground in a mill powered by the Morwellham water wheel (Booker 1976, 19), and exported in casks.

1816 (August) Tunnels were cut from both ends (simultaneously), to form a working area and to align both ends. They connected on the 21st August. Then the tunnel was enlarged (downwards and wider) throughout its length.

The demand for metallic ores to feed the Napoleonic war years (1793 – 1815) slumped as the soldiers returned, as markets waned. The canal committee, sensing further financial difficulties in September stated *'That the Tonnage will fall very short of the original estimate cannot be doubted; at the time when this was made the Mines in the neighbourhood were in their most flourishing condition, or rapidly advancing to it. Agriculture encouraged by high prices was improving everywhere, and the use of lime, so essential … was very great and increasing. Slate quarries, then making large returns, were in full activity, and new ones opening. In all these sources of oecumenical mode of carriage, the greatest reverses have taken place, and at present a stagnation of enterprise and consequent inactivity prevails'* (Hadfield 1967, 130). However, the population of Tavistock had increased from 1801 to 1821 by over 62%, reflecting the growth in the area, primarily a result of mining operations and related tertiary expansion.

1817 The tunnel was finally completed early in the year, with the official opening ceremony held on 24th June. Thousands attended the event, with over 300 going in boats (with a band) through the tunnel – to be met (with obvious relief) by thousands more at the Morwellham side. All were then given a demonstration of the workings of the incline railway mechanism and tramway down to Morwellham (see Buck 2005 – Sites 58 to 64), powered by a large water wheel and the canal water – which was also recently completed. The boats (specially designed and built by the Tavistock foundries from 1811 to replace an earlier wooden design), were *c*30 feet long, 5 feet wide and towed along the slow moving open canal by horses. They were worked through the long tunnel by two men using iron bars against the rock face.

The canal had taken 13 years to build. Its final cost was £62,000, the excess over the authorised capital of £40,000 having been raised by calling £155 on each £100 share.

1819 Although the economic outlook for the area was not good, the company decided to press ahead with the Millhill canal branch to the slate quarry. It was 2 miles long and cost £8000. It rose by 19.5ft to Millhill, with an inclined plane for the final section due to the scarcity of water (double tracked with two cradles counterbalanced with loaded boats going down pulling the empty ones up with the help of three horses).

1820s The expected tolls were halved from their pre-construction estimates – due to the gloomy economic climate. Over the next three decades the canal carried between 15,000 to 20,000 tons per year, earning an annual profit of approximately £600.

1831-2 A Cholera epidemic in the locality severely affected the workforce, the local economy and (temporarily), the canal's fortunes.

1841 Great Western Railway completed.

1844 Discovery of the main copper lode (40' wide) at Wheal Maria later Devon Great Consols – reversing the fortunes of Tavistock over the next 30 years, but reducing those of the canal. The Mill Hill Tramway was constructed this year (replacing the earlier section of the canal which had been closed after 1831), at a cost of £1,381 (Hadfield 1967, 132).

1847 20,132 tons were carried on the canal (Woodcock 1995, 23).

1848–9 Another Cholera epidemic.

1850 The goods carried on the canal were (tons): Sundries (7548), Limestone (3130), Copper ore (2.499), Slate (676), Granite (83) and Mundic (pyrites) (94). Tonnage carried fluctuated from year to year, reflecting the area's economic woes (or successes). In a bid to maintain revenue, at various times throughout this period, the company reduced tolls, or raised them again when economic conditions improved. But dividends, throughout the life of the canal were always modest, and profits turned out to be at a level 1/3 predicted at the outset.

1851 In the 1851 census, there were 27 barge men working for their various employers regularly using the canal.

1857 Shares that had changed hands at £100 in 1803 were now changing hands at £5.

1859 Construction of the Devon Great Consols railway from the mine to Morwellham with a separate incline section down to the port finished this year. Also the South Devon & Tavistock Railway from Plymouth to Tavistock opened (later extended to Launceston) – in direct competition to the canal. Due to this competition, the company further reduced its tolls after the opening of the railway. However, in the same year it expended more capital on renewing the inclined plane mechanism, and investing funds on a steam mechanism to pull loaded barges through the tunnel against the water flow (it often took a couple of hours or more to undertake this manually!). This was not successful.

There is no doubt that the waning fortunes of the Tavistock and Tavy copper mines, working for the past half century, were no competition for the resurgence of the Tamar Valley copper mines from the mid 19th century. Whilst the former utilised the Tavistock Canal as a transport medium during this period, the latter formed its own railway equivalent; but both used Morwellham as the export destination. Given the rapidly changing transport infrastructure due to the construction of mainline railways to the south west from the mid 19th century (consequently resulting in dramatic changes to market influences), across Devon and Cornwall at this formative period, so the fortunes of this old transport route was found wanting and uneconomic.

1860 In the previous year, the canal tonnage was 17,455. In this year it fell to 13,500. From 1863 onwards there was a steady decline in the tonnage until, in the early 1870s it dwindled to nothing (Hedges 1975, 28).

1862 A shareholder from Birmingham wrote to Mr Gill, representative of the Canal Company and said: *'I am afraid there is little hope of the canal rising in its fortunes with the railway for a rival. Here we have in several cases united the canal with the railway with advantage to both – you know best whether such an arrangement with the Tavistock canal would be advisable'* (Hedges 1975, 28).

1866 In September, the canal committee recorded; *'That a very considerable reduction having taken place in the traffic and dues of the Tavistock Canal Company since the opening of the Tavistock and Launceston branch of the South Devon Railway it was resolved that His Grace the Duke of Bedford be applied to kindly assist the Tavistock Canal Company to compete with the Railway Company by reducing the Canal Dock dues at Morwellham'.* The Duke was evasive (Hadfield 1967, 134).

1870 Only 783 tons were carried on the canal (Woodcock 1995, 24).

1872 Presumably the economic situation became even direr. At a meeting on 2nd September the Duke offered to buy all the shares at £8 each, and to pay half the cost of an Act to transfer the canal to him. Within the month, the committee accepted his terms. Since the summer there had been no traffic on the canal. However, this was not a localised occurrence; the impact of the railways had dealt a death blow to innumerable canals all over the country.

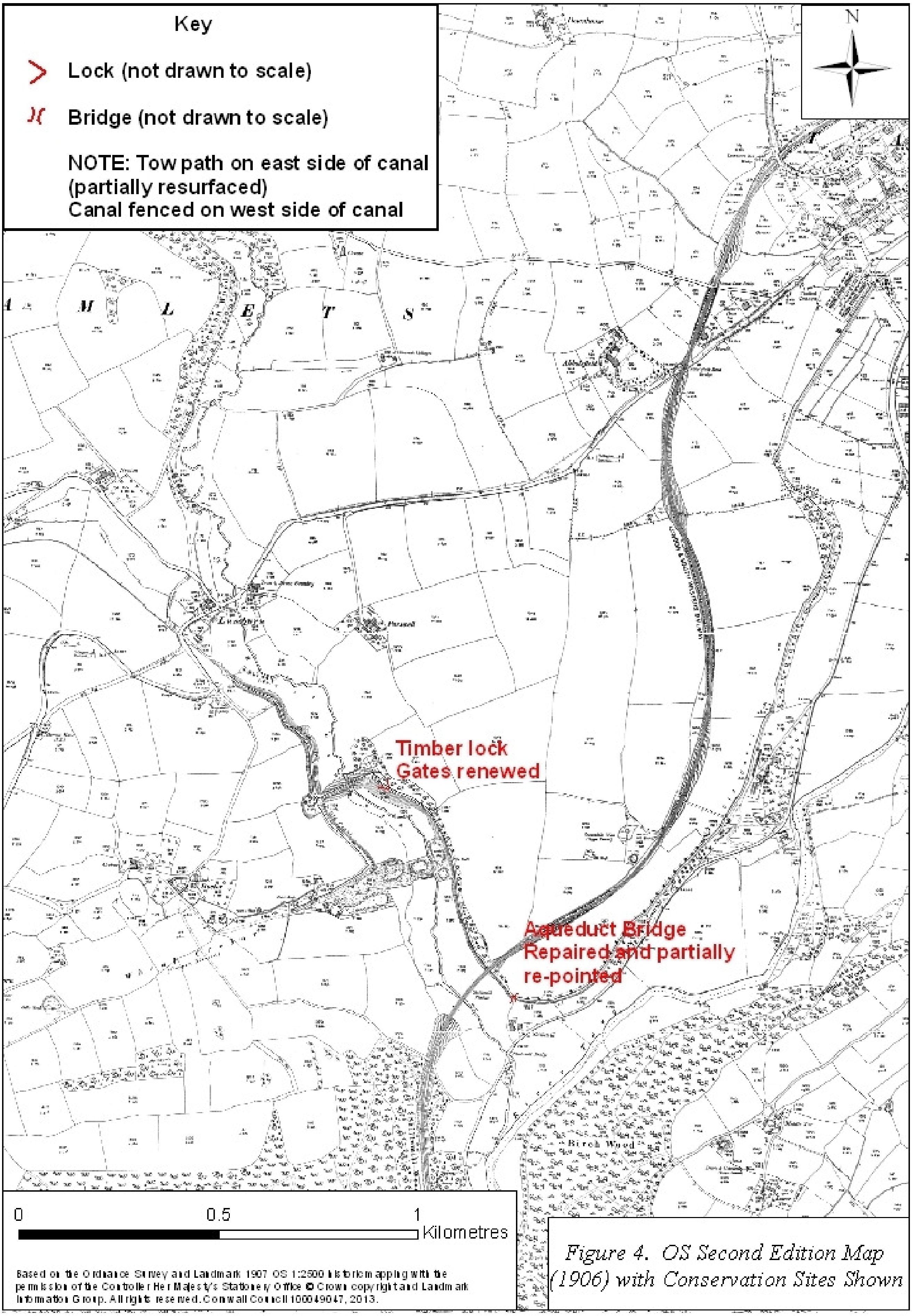

Figure 4. OS Second Edition Map (1906) with Conservation Sites Shown

1873 In May the Act was passed and the Tavistock Canal and land returned to the Duke of Bedford for £3,200, there being no obligation on the Duke to maintain the canal. It is uncertain what use the canal had for the next twenty five years.

1896 This perhaps was made clear in May of this year when the Tavistock Gazette reported that on Whit Monday the basin of the Tavistock Canal was to be cleaned out (it appears a regular activity on this day). *'The cleaning is wanted more now than when it was a hive of industry … a resident noted ... A great deal of sewage was emptied into it, and the water does not run at a greater rate than half a mile an hour. I have seen dead dogs, cats and rats in the canal'* (Woodcock 2005, 26).

1898 The Tavistock Canal was not included the Canal Returns.

1933 After cleaning the canal bed (which must have been quite onerous!), the West Devon Electric Supply Company built a sluice gate near the west end of the tunnel portal, to convey water to a header pond (Forebay) to go down to hydro electric turbines via large tubes at Morwellham Power Station, next to the River Tamar.

In 1923 and 1933, mining geologists Cloke and Barclay carefully assessed the lodes intersected by the tunnel during a tunnel assessment and clearance scheme (CRO AD58-26). They confirmed that the tunnel intersected eight or nine lodes and three cross-courses, but only two of these (East Russell and Georgenia Lodes), had any stoping accessed by the canal. The only repairs necessary were to the Morwellham portal end retaining wall.

Footnote:

The canal has been maintained and managed by the owners of Morwellham Power Station since 1933. For some time this work has been undertaken by South West Water and British Waterways, the former now monitors and maintains the canal, carefully regulating the flow to utilise the instant generating capacity of the hydro-electric power station at times of peak demand (to provide a cost effective monetary return). It is poignant perhaps that the canal still exists today due to its economic usefulness.

4. Impact assessment

This summary impact assessment is intended to inform and guide Devon County Council Historic Environment Service of the impact of the canal repair works, the aqueduct bridge repair and lock gates replacement. This section of the report summarises the archaeological resource, and describes the impact and mitigation of the canal works as part of a mitigation strategy. However, it should be noted that the mitigation procedure was undertaken during the project (due to the lack of advanced project specifications), by efficient communication between the report author (as site archaeologist), Bill Horner (DCC archaeologist), Chris Hariades (TVMHP Project manager), and South West Water. A structural engineer, Andrew White of Knevitts Ltd produced specifications for the aqueduct bridge structural repair (see Fig 12).

The sites impacted by the repair works are shown in Figures 5, 6 and 12 and reproduced on plan in Figure 4. The main sites include repair works to the sides of the canal itself, structural repairs to the aqueduct bridge, and repairs to the lock gates. The impact of the repair and conservation works on each site is then described, and a final section details the impact remediation measures.

The potential impacts during works are described below. Impacts are described in the text section for each site on a feature-by-feature basis. The following site impact terms are used within each site identification description:

Major positive	Site continues in, or is restored to, its original design and use
Moderate positive	Site restored as far as possible respecting its original function, but its use is altered
Minor positive	Site partially restored; interpretation introduced
Negligible positive	Stabilisation/maintenance of site
Negligible negative	Benign neglect – losses of fabric over a long period of time

Minor negative	Site suffers areas of alteration or damage, which contribute to loss of meaning
Moderate negative	Significant loss of fabric or alteration, leading to erosion of original character
Major negative	Complete demolition/removal

Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the end of the Lumburn Aqueduct **SX 46237 72628,** see Fig 1).

Description

The canal section impacted by the repair works was built between 1803 and finished by 1809 (as described in the historical background section). This section of the canal may well follow the course of a mine leat from the River Tavy to Crowndale Mine, which pre-dates construction of the canal. For much of its length the canal's west side (see Fig 4), cuts into the valley side – revealing vertical bed-rock and also frequently forming the bed of the canal. Excess stone material from the rock cut was used to form the rounded profile edge of the east side of the canal – using slate/killas stones set on edge. The tow path was formed along this eastern side. The canal is approximately 4.0m wide, 0.3m to 0.5m deep, with the east side approximately 0.6m to 0.8m deep from tow path surface to water level.

Repair works to the canal's east side (and towpath) has been undertaken in the past, sometimes inappropriately using cement and concrete formwork. The 2009 repair work to both sides of the canal and re-surfacing parts of the towpath continued with this theme of patching the damaged sections (Fig 11).

Site works impact (2009)

The repair works relate to identifying areas of the canal sides that needed to be patched with new (similar specification) stone within the section of canal identified above. This should immediately stop progressive damage to the canal sides and help to support the well used canal towpath. There is no site plan showing each small repair section, rather a canal bank repair work schedule (Appendix 1).

Other works to the canal itself that were proposed include patching and re-surfacing the tow path. South West Water (SWW) undertook its own Risk Assessment for each tree close to the tow path. Mitigation works resulting from that survey (i.e. branch or tree removal) was undertaken by SWW.

The overall impact of the works on the canal can be defined as '*Negligible positive'.* The works reduced collapse of parts of the canal's east side to maintain structural stability, provided more tow path stability and a higher degree of Health and Safety for increased public access for at least another generation. However, it is hoped that the track is adequately annually maintained.

Residual impact (2009)

There have not been significant residual impacts in the medium term – apart from the visual aspect of the replacement stone looking newer than the original stone surrounds.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of replacement stone (to match existing), reduced the visual impact of patching the sides of the canal. Other reduction impact measures included the tendering for appropriately qualified and experienced contractors to reduce the visual effect of repair sections to the canal, and for the quality of the work, which was of a good standard (reflecting the original construction style). This project should reduce the need for this work to be undertaken for at least another generation.

Aqueduct Bridge SX 46630 72090

Description

The aqueduct bridge carries the canal over an access lane to fields north of Shillamill Farm – whose access was cut by construction of the canal. The iron plated trough structure seen today was built in 1839 by Gill & Co of Mount Foundry, Tavistock (Buck 2007), replacing an earlier structure. The bolted sections of the trough extend to either side of the granite quoined masonry, and are supported by four wrought iron lintels (widening into the masonry sides) set into the granite masonry. Three other similarly styled lintels (see Fig 13) provide the support for large slates under the tow path on the south side of the canal. The middle lintel however has rusted to the extent of being ineffectual. A structural survey by Knevitts Ltd has recommended its replacement, as the aqueduct is not only used by tow path walkers, but is proposed to be accessed via the adjacent fields, in order to link up the railway (Buck 2009) with the canal – by a new DCC footpath route under the aqueduct – formerly used for access to the upper field.

Patch repointing to the sides of the bridge under the aqueduct in recent years has occurred, however more often than not this has been using cement, using a variety of styles. At the northern end of the side walls the stonework has been leaking for some time where water is leaking from the junction of the wrought iron plates with the canal bed. This has caused the masonry to be soft, and the stonework made weak – causing a noticeable dip on either side.

On the south west side of the aqueduct a high vertical retaining wall supports the tow path and masonry for retaining remnants of steps, to allow pedestrians walking the towpath to access the lower field. Some of this vertical retaining wall has areas of lime mortar pointing that is loose.

Site works impact (2012)

After dialogue with the TVMHP manager, the structural engineer, the landowner of Shillamill Farm, the Devon County Archaeologist and consulting project archaeologist; the TVMHP agreed to fund replacement of the centrally located rusty wrought iron lintel, and to undertake limited lime mortar repointing where structural stability of the adjacent walling could be compromised.

Site impact of the replacement lintel was minimised by matching most of the original profile of the replacement item as far as could be possible from an 'off the shelf' steel equivalent (in order for the project to be cost-effective), with the original wrought iron lintel.

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works have reduced the potential for collapse of the tow path as it runs next to the canal aqueduct. This project will provide a higher degree of Health and Safety for increased public access for at least another generation.

Residual impact (2009)

There are unlikely to be significant residual impacts in the medium term – apart from the aspect of the replacement iron lintel and repointed masonry looking newer than the adjacent (cement) based repairs.

Reduction of impact (2009)

Site consultancy with the project manager and structural engineer will minimise any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors should mitigate the visual effect of a new structural item, and for the quality of the work to be of a good standard, reducing the need for this work to be undertaken for at least another generation.

Lock Gates and timber lifting bridge SX 46327 72628

Description

The construction of the adjacent Canal cottage for operation of the lock gates, the lifting bridge and the visible remnants of the semi-circular trans-shipment basin (or turning/waiting area) is indicative that this part of the canal was quite busy! The latter

(sited close to the lock gates) is now infilled, but the tops of some of its vertical timbers still visible. The necessity of keeping the water at the correct level was important for the tunnel – this lock gate possibly forming this function also for the Lumburn Aqueduct (SX 46311 72632 to SX 46184 72581), with its single arch to the south. According to Waterhouse (forthcoming) the timber lifting bridge is of a Dutch design common on canals in the Welsh borders, and may not be contemporary with the canal's construction.

The lock gate and lift bridge was previously restored by October 1998, funded by South West Water and British Waterways. However, as Figure 15 shows, one of the timber arms of the lift bridge had snapped and parts of the timber walkway rotted. In addition the lower parts of the swing lock gate has rotted where it is in contact with the canal water.

Site works impact (2012)

The TVMHP agreed to fund replacement of the timber components that were rotted or had broken or snapped off. This includes the large timbers to open the bridge and the Lock gate. The TVMHP tendered for experienced Carpenters to assess both features and to price for the production of making and erecting replacements.

Site impact for the replacement timbers was minimised by specifying exact replacements with the existing timbers (previously replaced in 1998).

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works reduced the potential for further timber rotting and collapse, an important Health & Safety measure so close to the well-used canal towpath. This project has provided a higher degree of Health and Safety for bridge use and public access for at least another generation.

Residual impact (2009)

There are unlikely no significant residual impacts in the short term.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors mitigated any possible mistakes, the quality of the work was of a good standard, and reduced the need for this work to be undertaken for at least another generation (Fig 16).

5. Impact mitigation strategy

The impact mitigation strategy is divided into three stages: The pre-works consultancy, the Historic Buildings Consultancy during works and the archaeological recording record (during and after works). This mechanism demonstrates the steps that have been taken to avoid or minimise adverse impacts, and confirms that the proposed works have been designed in close liaison with the historic environment consultant. Consultation is based on a clear understanding of the significance of the site using appropriate methods and techniques for site monitoring and recording.

HES Projects (Project number 20070793) was commissioned to undertake the three components described as the impact mitigation strategy. The project was based on a project design produced by Colin Buck (21/07/06), and recording specifications defined by Bill Horner (DCC archaeologist).

6. Working method

The following text summarises the general WSI for all archaeological consultancy and archaeological recording for projects relating to the TVMHP (Tamar Valley Mines Heritage Project: Written Scheme of Investigation: Historic Building and Archaeological Recording Consultancy 21/07/06).

- A brief historical survey was compiled from existing Devon County sources (DCHER, DRO, and local libraries and historians (including Robert Waterhouse's recent published work on the canal).
- A walk-over survey was undertaken of the entire length of the canal for sites impacted by the TVMHP.
- An impact assessment described and mitigated the proposed work as part of a Mitigation Strategy to minimise the works affecting the site's character.
- General working methods for archaeological recording, treatment of finds, photographic surveying and report production are described in detail in the Tamar trails WB WSI produced in 21/07/06.

All archaeological recording work was undertaken according to the Institute for Archaeologists (IfA) *Standards and Guidance for Archaeological Investigation and Recording. Staff follow the IfA Code of Conduct* and *Code of Approved Practice for the Regulation of Contractual Arrangements in Archaeology.*

The principal factor in effective project delivery was the employment of key project staff who are expert in the management and recording of the industrial heritage. Cornwall Historic Environment Service project staff can draw upon a substantial track record in undertaking similar work throughout Cornwall, as well as a detailed knowledge of the project area and its sites.

Historic buildings consultancy

- HES (Senior Archaeologist) liaised with the Devon County Historic Environment Service - DCHES (Bill Horner), and the TVMHP Project Manager (Chris Hariades).
- The HES Senior Archaeologist attended regular site meetings when appropriate during the duration of the project.
- HES ensured that site conservation works are carried out to standards recommended by English Heritage best practice.
- **Fieldwork: archaeological recording**
- There were no newly exposed archaeological features revealed through excavation.
- Where appropriate, measured survey was carried out by hand measurements (using offset techniques at a scale of 1:50.
- The resulting survey output was a revised measured survey drawing showing all conservation works that had been undertaken. This was reproduced at a scale of either 1:50 or 1:100 (appropriate to the size of area recorded) and will form part of this archive watching brief report.
- Analysis of the building fabric was recorded in the form of field notes and written up in this archive report production stage.
- DCHES (Bill Horner) advised that archaeological recording should be undertaken during any excavation that revealed archaeological features. Recording was undertaken using a mix of direct measurement, sketch plotting and photography, as appropriate (constrained by safety factors).
- Where significant remains were encountered the site archaeologist was given the opportunity to make an appropriate form of record before work proceeds.
- The chosen site archaeologist adhered to Health and Safety Policies (see below), under the direction of the designated Site Safety Officer.

Site recording (general)

- Site drawings (plans, sections, locations of finds) were made by pencil (4H) on drafting film; all plans were linked to the Ordnance Survey landline map; all drawings included standard information: site details, personnel, date, scale, north-point.

- The site archaeologist undertook the recording in line with recommendations given by IfA. Sections and plans were drawn on site at appropriate scales which adequately recorded structures or features at appropriate levels of detail, and appropriate sections reproduced in the archive report at either 1:50 or 1:100 to adequately demonstrate revealed archaeological features.
- All features and finds were accurately located by means of a National Grid reference and all archaeological contexts will be described using a standard format and linked to a continuous numbering sequence.
- The archaeological watching brief report detailed all forms of archaeological recording that had been undertaken at each of the mine sites. Each major mine site had a single archaeological watching brief report that details all project related work to that site (i.e. trails works, building conservation works, interpretation works, etc).

For Treatment of finds, Photographic recording specifications, report production and archiving specifications refer to the TVMHP WSI (2006).

7. Results

Unfortunately, there was insufficient time (following receipt of a detailed plan and description of the canal repair works from the TVMHP), prior to the start of works on site to produce an impact and mitigation report for DCC (Bill Horner). A decision was therefore taken to minimise impacts and mitigate directly with the TVMHP and site contractors on site as works were progressing as part of a weekly site recording and consultancy. SWW funded the stone and path repairs to the canal bed whilst the TVMHP funded fencing of the north and west sides of the canal, to stop encroaching animals from the adjacent fields from directly accessing the canal (and walking up the towpath!). An interim archaeological recording report of these works was produced by the author on 17/06/2009. This report supersedes that report.

Repair works to the bed and towpath of the Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the start of the Lumburn Aqueduct **SX 46237 72628**)

In early 2009, the TVMHP tendered for stone masons (on behalf of SWW) experienced in rebuilding stone walls, etc, to undertake these works within a narrow time-scale of three weeks, when SWW were willing to reduce the water flow through the canal (which would stop the electricity generating turbine). The turbine normally operates all year round, often at short notice when generation rates for electricity peak (the turbine can instantly generate electricity). Clemens Stonemasons of North Cornwall were successful in winning the contract. Prior to this, the TVMHP Manager, the archaeological consultant and SWW projects officer, produced a repair work specification schedule (measured from the small swing bridge at Tavistock: SX 47348 73503), which focussed on identifying the repair of collapsed sections of canal bank on the south or east sides. Appendix 1 is a reproduction of this original document.

Site work started on 05/05/09 at the northern end of the canal and progressively worked southwards towards the lock gates at the Lumburn Valley. With the reduced water level in the canal (and its slow movement when full), many stones that had fallen out of place were found in the canal bed not far from their original bank location. When the canal was constructed the stones were originally set on edge, a minimum of two/three stones height (approximately 0.6m to 0.8m above water level). During the repair project, where there was insufficient stone to replace the collapsed sections, a similar stone was imported from Trebarwith Quarry, North Cornwall (purchased from the local quarry at Millhill). These stones were reset on edge, following the original profile of the canal bank, and tightly tamped down in position (tops and sides). Earth was backfilled into the top sides of the stone to re-form the edge of the towpath. This was then at a later date, re-seeded. Figures 7 and 8 show examples of before and after photographs of the repaired canal bank. The work has been sensitively undertaken and reflected the style and character of the original construction a century ago.

Weekly site meetings were arranged to view the previous week's repairs and to discuss any foreseeable problems within the following weeks programmed work. A granite towpath stone under the Crowndale bridge at SX 47194 72541 had become dislodged (into the canal), and some quoin stones from the bridge parapet wall had fallen into the canal. The former was repaired by contractors; the latter will be removed from the river by SWW to be replaced on the bridge parapet wall at a later date. A small section of old 2" timber (2m long) set in the lower part of the bank was replaced back into its original position following repair of the wall at this location (SX 47270 72707).

The canal bank repair works (see Appendix 1), were finished on 28/05/09, including an additional element of work totalling 87 metres, which the contractors identified whilst on site. A total of 337 linear metres of canal bank was repaired (only on the south/west side), using a total of 86 tons of additional Trebarwith stone. The canal repair works were funded by South West Water.

Figure 5 is a site plan and specification document for the installation of timber post and wire stock fencing along the west/north side of the canal and construction of three cattle drinking areas to minimise any future erosion of the opposite (north/west) side of the canal bed. The cattle drinking sites are located at SX 47384 73064, SX 47257 72705, and SX 47078 72415. A concrete pad (min 0.3m thick), varying from 3m to 4m wide and approximately 5m long, has been created to at each of these sites to form the post and rail fenced cattle drinking areas that should minimise further damage to the banks (on either side). An additional cattle drinking area was constructed on bedrock immediately on the west side of the Shillamill Viaduct (see Fig 6). Figures 9 and 10 show before and after views of a cattle drinking site (SX 47384 73064).

Approximately four months later, the surface of the canal towpath was patched with crushed stone (803 specification) where the path was potholed or muddy, then sections covered with finely ground stone (6mm to dust) from Meldon Quarry.

During construction of the cattle drinking sites and during the canal repair works there has been minimal archaeological impact, nor any finds recorded.

Aqueduct Bridge SX 46630 72090

Knevitts Ltd was commissioned by the TVMHP in 2011, to undertake a structural survey of the aqueduct bridge at this location. Their report and structural drawing (see Fig 12), recommended that a rusty wrought iron support (middle one of three similar supports – see Fig 13) sited under wide slates below the towpath next to the canal, be replaced with a modern equivalent. In addition, it was recommended that the tall retaining wall on the south west side of the aqueduct bridge be repointed and structural ties inserted (using 7mm diameter stainless steel helibars) into the masonry bedding joints to strengthen a structural crack in the masonry.

This work was not started until May 2012, following an extensive dialogue with SWW and the site owner. Figure 13 shows the failed rusty element needed to be replaced. The original lintel was 50mm x 50mm for most of its length but widened to 100mm at both ends (and set in the side walls). Unfortunately the original wrought iron section specification was impossible to replace, and an 'off the shelf' item had to be found due to budgetary constraints. Figure 14 shows the new steel replacement *in situ*. Scaffolding had to be erected to remove the original rusty support and to replace it with the new 50mm wide x 115mm deep iron profile steel section. A slightly wider opening had to be made into each granite quoined side of the bridge for insertion of this new structural element. The localised setting was then repointed with lime. The steel was painted with a red primer and then painted black.

Other works to this site included removal of a tree growing out of the west side of the north end of the aqueduct bridge and treatment of the stump, as its unchecked growth had caused structural issues to the masonry at this point. On the opposite side of the bridge opening, the top flanking stones over the east side revetment walling had become dislodged. These were moved back to their original position. TVMHP funded the project.

At the north end of the structure under the aqueduct section, it appears that water has been leaking from the canal at the intersection of the metal 'trough' profile bolted plates and the canal bed – on both sides, through the stone masonry. This has caused the masonry and water at this point lower down under the aqueduct to be constantly wet.

Consequently, the foundations masonry and pointing in this area have softened to the extent that the masonry is collapsing and arching downwards. SWW attempted to add some clay to the leaking intersection point in the bed of the canal, but this has not worked. Structural deterioration will continue unless this issue is resolved. This is a significant feature of the canal which is in places, is now a Scheduled Monument. It is a recommendation of this report that the aqueduct bridge be considered for Listing.

Finally, the vertical retaining walling on the south west side of the aqueduct was repointed and the structural crack that had been identified by the structural engineer, repaired with the use of helibar reinforcing. This work finished in mid June 2012. The repointed wall acted to retain not only the towpath running along the south side of the canal, but also steps that allowed access from the towpath down into the adjacent field. These steps have badly deteriorated, leaving a steep slippery slope. It is recommended that they need to be rebuilt before use of them can be made by a new DCC footpath from the nearby railway linking up with the canal footpath.

Lock Gates and timber lifting bridge SX 46327 72628

The timber lock gate and timber lift bridge was 'restored' in 1998 by SWW and British Waterways. It is not know what the restoration replaced, but parts of the timber lift bridge (mainly the western timber arm), had rotted resulting in collapse (see Fig 15). Other parts of the bridge were showing that many timber items were rotting. In addition, the section of timber lock gate that was in constant contact with canal water had also rotted during the last 14 years. SWW and the TVMHP decided to replace the rotted and unsafe timber items as being a Health and Safety issue, given the frequent public use of the towpath. SWW funded the project.

The project of dismantling the bridge and lock gate, replacement of the main and structural timbers, and re-assembling and fixing on site was tendered. The contract was won by Will Sterling and Son, a traditional timber boat builder and carpenter who worked at Morwellham Quay (repairing and building boats, etc). The work was started in July 2012 and finally finished in September 2012.

Figure 16 is an 'after' view of the works on these features, and should be compared to its preceding figure. It is hoped that this repair will last longer than its predecessor!

Note:

In 2013, the TVMHP constructed a new footpath from near Morwell Rocks (SX 44128 70435) to above George & Charlotte Mine (SX 45101 69962). This new route links the main route of the railway line from Devon Great Consols to Morwellham and the forestry tracks north of Morwellham. Scheduled Monument Consent was obtained in 2012 for construction of a new timber footbridge over the Tavistock Canal (the section from the west end of the Morwell Down tunnel to the incline railway cottage was Scheduled in 2011, SM No. 30973). As part of this project, an impact assessment report was produced (Buck 2012). The results of the new footpath creation and footbridge construction will be produced within the main body of the TVMHP archaeological recording report (Buck forthcoming).

8. References

8.1 Primary sources

CRO AD 58-26 Tunnel Lodes (1923-33) Report by F Cloke and CF Barclay.

DRO T1258M-14B Bedford Estate Map

8.2 Secondary sources

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Hadfield, C., 1967, *The Canals of South West England*, David & Charles, Newton Abbott

Hedges, C., 1975, The Tavistock Canal, DART Publication No. 16

Waterhouse, R., 2012, *Tavistock Canal, Surveying a forgotten marvel of the industrial age*, Current Archaeology, Issue 273 December

Waterhouse, R., Forthcoming publication on 'Tavistock Canal'.

Woodcock, G., 1995, 2005, Booklets on the 'History of Tavistock'.

9. Project archive

The HE project number is **20070793**

The project's documentary, photographic and drawn archive is housed at the offices of Historic Environment, Cornwall Council, Fal Building, New County Hall, 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 (20070793).
2. Black and white photographs archived under the following index numbers:

   GBP 2091/12-21; 2207/12-22; 2250/1-17; 2253/19-22.
3. Digital photographs stored in the directory R:\HE images\Sites\Devon\Tavistock\Tavistock Canal
4. This report text is held in digital form as: G:\HE Documents\HE Projects\Sites\Devon\Tavistock Canal IA WB report 20070793
5. English Heritage/ADS OASIS online reference: cornwall2-154344

No artefacts or environmental material was retrieved during the project.

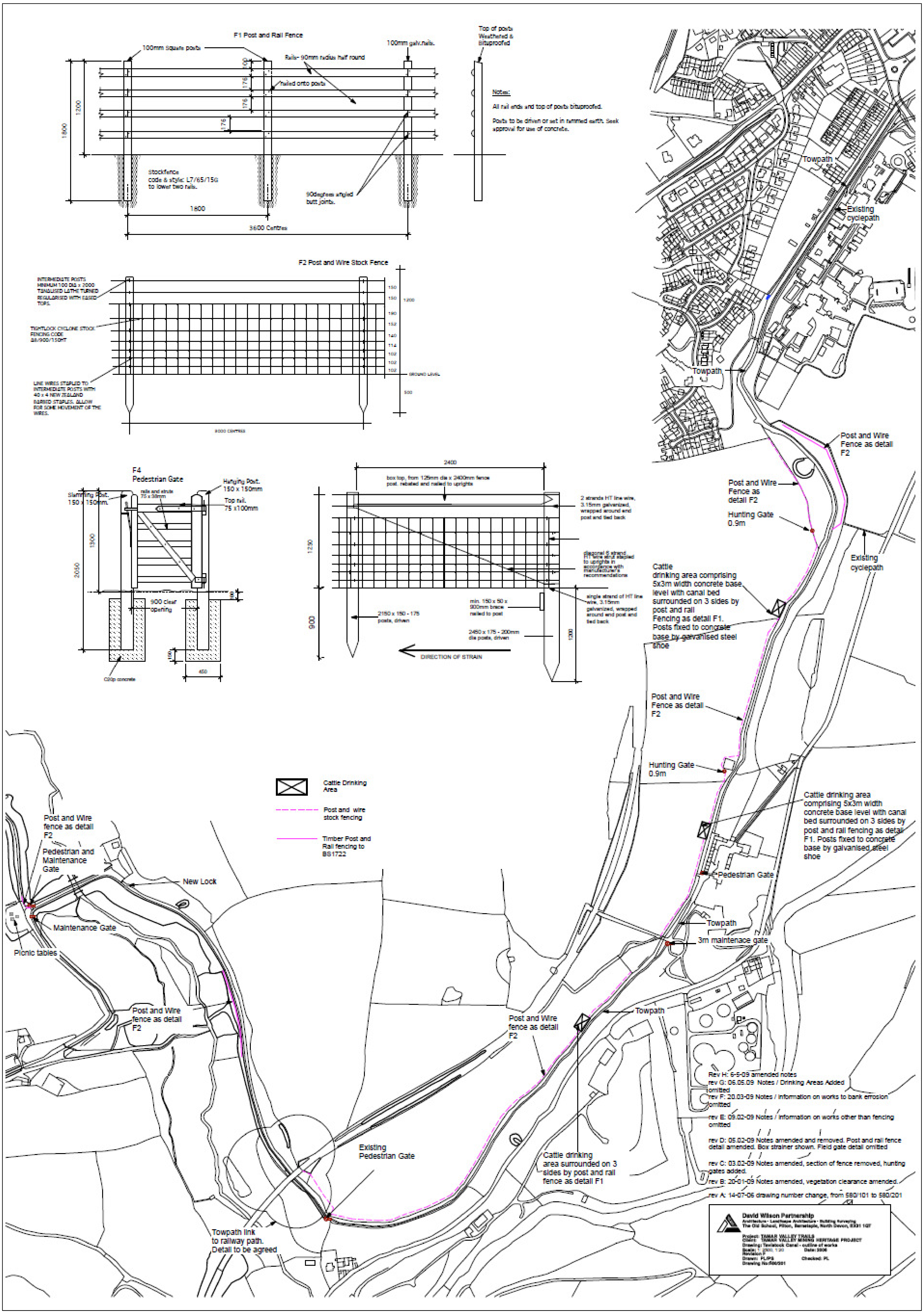

Figure 5   Specifications and plan showing fencing and three cattle drinking areas at the Tavistock Canal(East section)

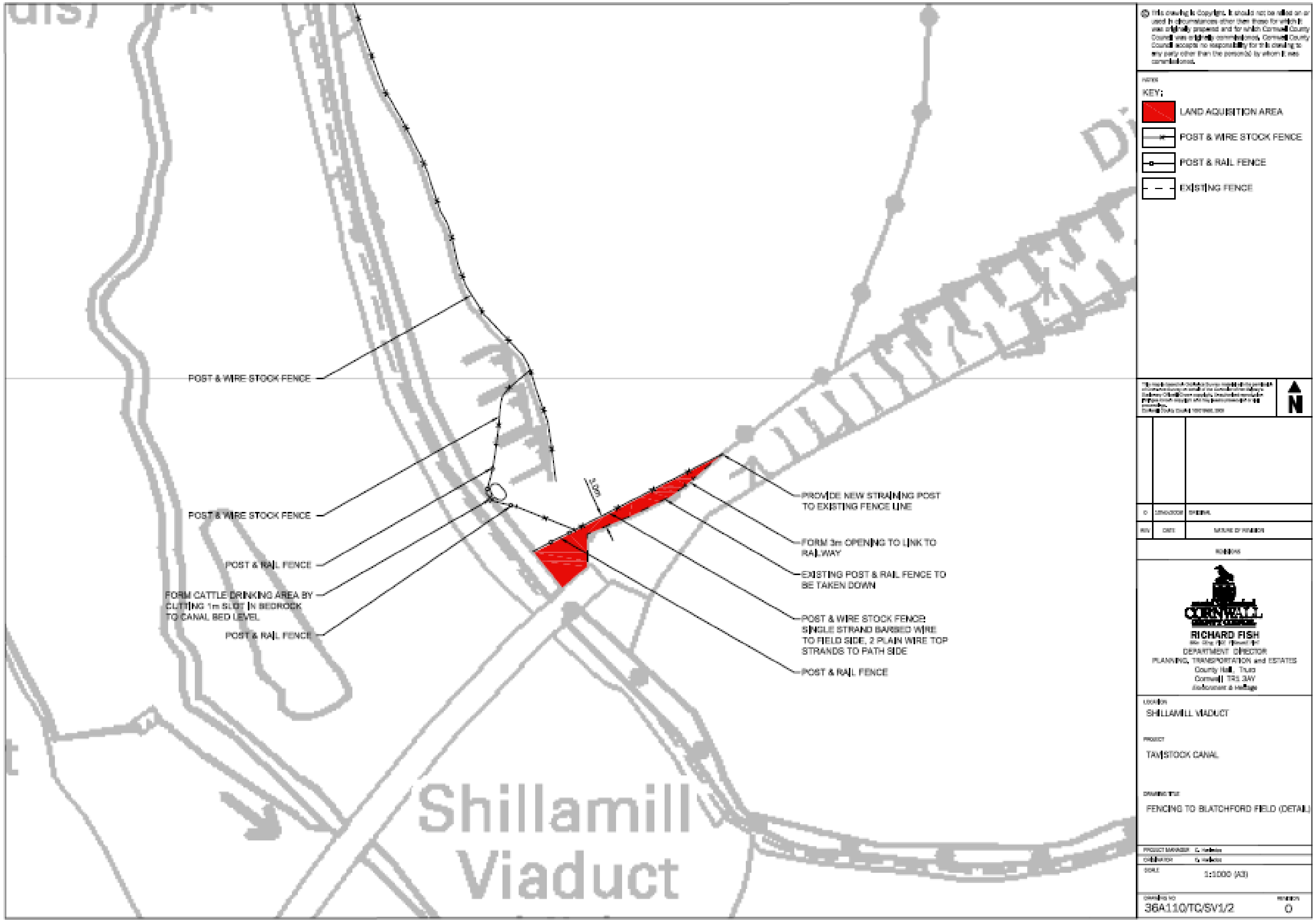

Figure 6 Detail plan showing the cattle drinking area west of the Shillamill Viaduct

Figure 7 A view of the Tavistock Canal east bank before works © CC HE Projects

Figure 8 A view of the Tavistock Canal east bank after works © CC HE Projects

Figure 9 A view of a Cattle Drinking site before works (SX 47257 72705) © CC HE Projects

Figure 10 A view of the same Cattle Drinking site after works © CC HE Projects

Figure 11 A view of the canal towpath after re-surfacing works © CC HE Projects

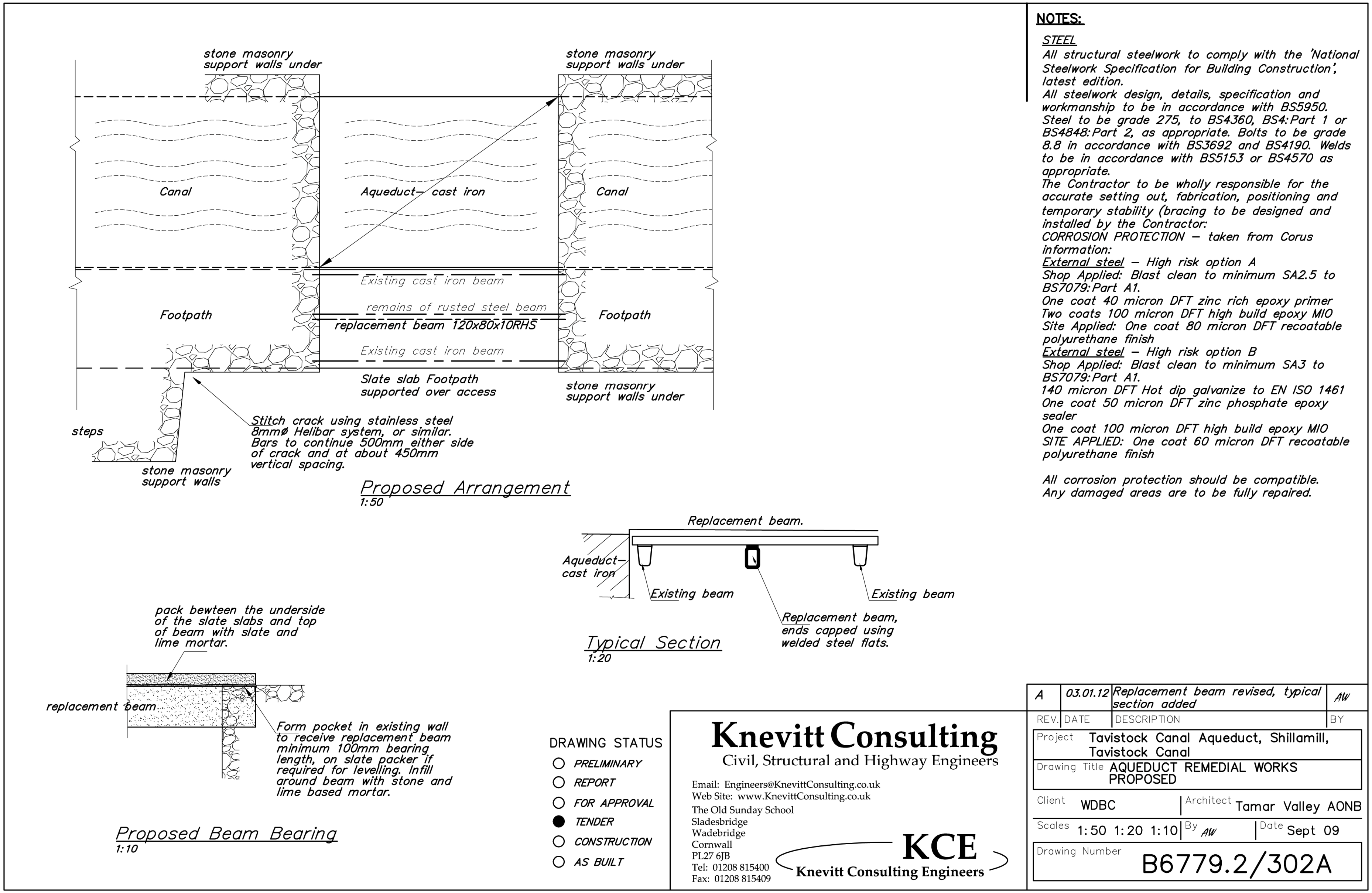

Figure 12 Specifications plan for repair of the aqueduct bridge

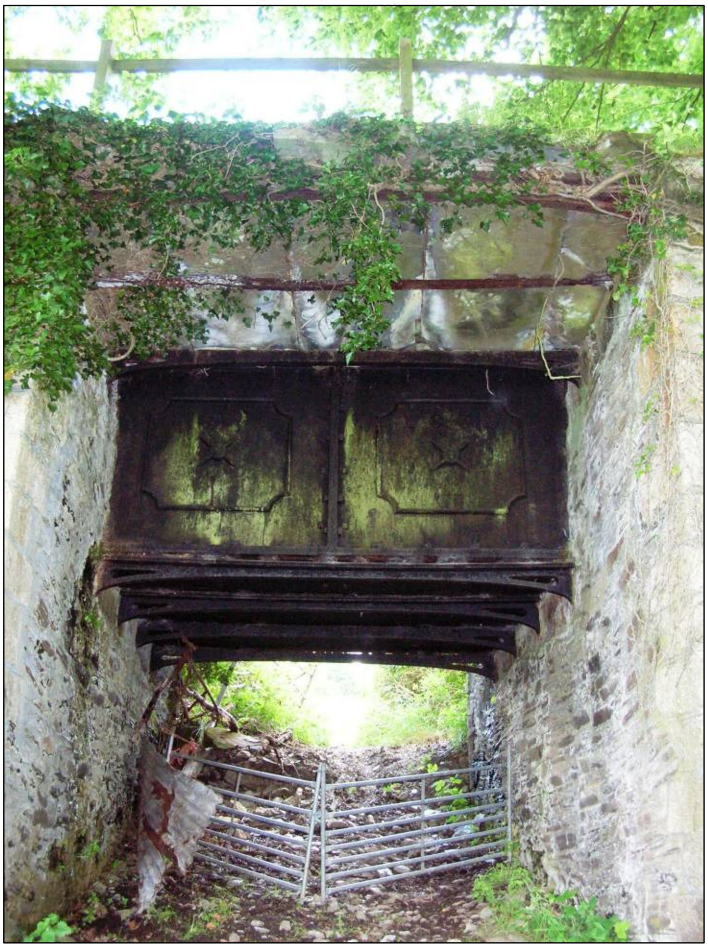

Figure 13 A view of the canal aqueduct bridge before works © CC HE Projects

Figure 14 A view of the canal aqueduct bridge after works © CC HE Projects

Figure 15 A view of the canal lock gate and bridge before works © CC HE Projects

Figure 16 A view of the canal lock gate and bridge after works © CC HE Projects

Appendix 1: TAVISTOCK CANAL BANK REPAIR WORK SCHEDULE

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
20		Side out path and hedge (140m length)
76		1.5m infill behind c $2m^3$
118		1.5m infill behind c $1m^3$
140-150	10	Minor wall top repair
159-160	1	End of hedge
162-163	1	1m infill behind $0.25m^3$
166-179	13	
225-247	22	
253-308	55	Break out conc block
314-323	9	
328-330	2	
394-418	24	
433-461	29	Take off conc
P A T H		
467-469	2	Break out conc
472-473	1	Good example, flat stone
485-488	3	Remove conc, Repair bank
494-513	19	Remove section of conc
530-541	11	
557-558	1	
563-573	10	
577-578	1	
581-584	3	
591-592	1	
600-650	50	
664-673	29	
691-694	3	
703-704	1	
714-718]	4	Soft path, build up levels (ch 14-27)
722-727]	5	
730-735	5	
744-745	1	
751-754	3	
755-760	5	
771-773	2	
779-780	1	
782-798	16	800 ⇒path surface 80ft
800-804	4	
804-806	2	Build up path surface to fall to canal

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
		(ch 800-902)
808-809	1	
813-814	1	
819-820	1	Lay hedge, remove barbed wire (ch 800-902)
823-826	3	
839-842	3	
875-876	1	
892-894	2	
902-903	1	Remove gate, overhanging branch
902-907	5	
970-971	1	Gate and post and rail across path
975-976	1	Surface ok
985-990	5	In deep
1009-1010	1	
1019-1020	1	Take out tree growing out from opposite bank
1068-1069	1	Path surface repair
1093-1094	1	Under bridge
1099-1100	1	Bridge coping repairs 4m copings in canal
1130-1131	1	Boulders ⇑ make up path ⇓ scrape leaf mould
1158-1159	1	
1165-1166	1	
1169-1170	1	
1187-1192	5	
1197-1199	2	
1202-1207	5	
1208-1209	1	
1225-1232	7	
1260-1268	8	
1271-1272	1	
1279-1280	1	
1282-1283	1	
1295-1298	3	
1308-1309	1	
1317-1319	2	
1334-1342	8	
1353-1356	3	
1409-1414	5	
1421-1422	1	
1424-1425	1	

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
1441-1442	1	
1454-1456	2	
1514-1515	1	
1546-1548	2	
1573-1574	1	
1581-1582	1	
1603-1604	1	
1600		Path falls away from canal. (1.5m width)
1691-1692	1	
1718-1719	1	
1721-1722	1	
1726-1729	3	
1820-1821	1	
1856		AQUADUCT (Clear vegetation, Take out gate)
1958-1968	10	Under viaduct
1970-1972	2	
2020-2023	3	
2151-2152	1	
2220-2221	1	
2316-2318	2	WHEEL SLUICE Interpretation Barrier (Take down concrete posts and blocks)
2463-2464	1	
2534-2535	1	
2541-2543	2	Replace Bascule bridge
		Lumburn Valley Turning area at lock (excavate)
2586-2600	214	Opposite bank
TOTAL		

Note:

An additional 87 linear metres of repairs were undertaken by the site contractors as they deemed them necessary. These additional repairs are not reflected in the above schedule chainage list, which was originally compiled by Chris Hariades (in consultation with Colin Buck and SWW (Laura Wotton) in April 2009 to inform tender information and site specifications prior to the start of works. The location of the small swing bridge in Tavistock (from which the chainages are measured) is at SX 47348 73503.

Tavistock Canal - Canal Bank Repair Works Schedule

Item	Description	Qty	Unit	Rate (£)	Cost (£)
1	Provide site welfare facilities to comprise as a minimum porta-loo with handwashing facilities, maintain and take down on completion	Item			
2	Provide all necessary fencing, barriers, signage, maintain for duration of contract and take down on completion	Item			
3	Break out concrete capping (provisional)	50	lm		
4	Clear rubbish from canal bed and dispose to licensed tip (Provisional)	10	m3		
5	Repair identified sections of failed or colapsing drystone facings to canal bank to match adjoining sections using stone salvaged from canal bed	250	m2		
6	Tie and marry in each repair to adjacent sound sections.	100	no.		
7	Extra to bed bottom course of stone on 50mm depth drymix sand/lime/cement bed in ratio 6:2:1 where laying directly onto bed rock.(Provisional)	50	l.m		
8	Extra to import suitable matching stone to make up shortfall in site salvaged material (Provisional)	50	tonnes		
8	Backfill voids behind stone facing to level with top of bank with imported scalpings compacted in layers not exceeding 200mm depth (provisional)	10	tonnes		

Report No: 2013R046

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CORNWALL
COUNCIL

Tavistock Canal, Devon

Archaeological impact and recording report

Historic Environment Projects

Report No	Report Name	Report Author
2013R046	Tavistock Canal – Impact assessment and archaeological recording during a program of repair works	Colin Buck

Event Type

Site consultancy	Archaeological impact assessment	Archaeological watching brief	

Client Organisation	Client Contact
TVMHP (West Devon Borough Council)	Chris Hariades (TVMHP)

Monuments (MonUID)

DHER 3879 (Tavistock canal)	18721	4069	3882	5449	3956

Fieldwork dates (From)	(To)	(Created By)	(Create Date)
05/05/09 05/05/12	29/05/09 05/09/12	Colin Buck	13/05/13

Location (postal address; or general location and parish)

Tavistock Canal (northern section from Tavistock to Lumburn), Tavistock, West Devon

(Town – for urban sites)	(Postcode)
Tavistock	

(Easting) X co-ord	(Northing) Y co-ord		
From: SX 47367 To: SX 46183	 73572 72589		

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

List of Figures

Abbreviations

AONB	Area of Outstanding Natural Beauty
CC	Cornwall Council
DCC	Devon County Council
DHER	Devon Historic Environment Record
DRO	Devon Record Office
HES	Historic Environment Service
OS	Ordnance Survey
SWW	South West Water
TVMHP	Tamar Valley Mines Heritage Project
WHS	World Heritage Site

Acknowledgements

Thanks are due to Robert Waterhouse for providing some primary survey data and information files from his research relating to a forthcoming book about the Tavistock Canal. Chris Hariades (Tamar Valley Project Manager), and Bill Horner were involved in the project throughout its entirety. Andrew White of Knevitts Cons. Engs. was involved in preparing the specifications of the aqueduct bridge.

Front cover image: a copy of the Tavistock Canal Company Seal.

1. Project background

The Tamar Valley Mining Heritage Project (TVMHP – 2005 to 2013), a £7 million Heritage Lottery Fund project focusing on the World Heritage Site landscapes of West Devon in the Tamar Valley, is co-ordinated by the Tamar Valley Area of Outstanding Natural Beauty (AONB). The TVMHP was approved for Stage 2 consent by HLF in 2003. It involves the conservation of former mine sites and trail creation along the Devon side of the Tamar Valley (from Devon Great Consols to Morwellham). These sites include Devon Great Consols, the largest mine in Europe during the 19th century. The project also included conservation and repair works to the Bere Alston to Tavistock railway line (Buck 2011), the Tavistock Canal, and parts of Morwellham Quay itself (other contractors). This project covers works undertaken along the Tavistock Canal (Fig 1).

The Historic Environment Service (HES), Cornwall Council was commissioned in July 2007 by the Tamar Valley Mining Heritage Project (Chris Hariades as TVMHP Project Manager), to undertake an archaeological impact assessment, archaeological recording and site consultancy, photographic building recording of affected sites impacted by the works. An impact assessment project brief had not been produced, but it follows a similar project design by Historic Environment Service, Cornwall Council; *'Project design for production of archaeological recording, as part of the Tamar Valley Mining Heritage Project (2006-2009)',* dated 23/06/06. A Project Design for this site and other building conservation schemes in the TVMHP was produced on 21/07/2006, and was subsequently approved by Bill Horner (Devon County Archaeologist).

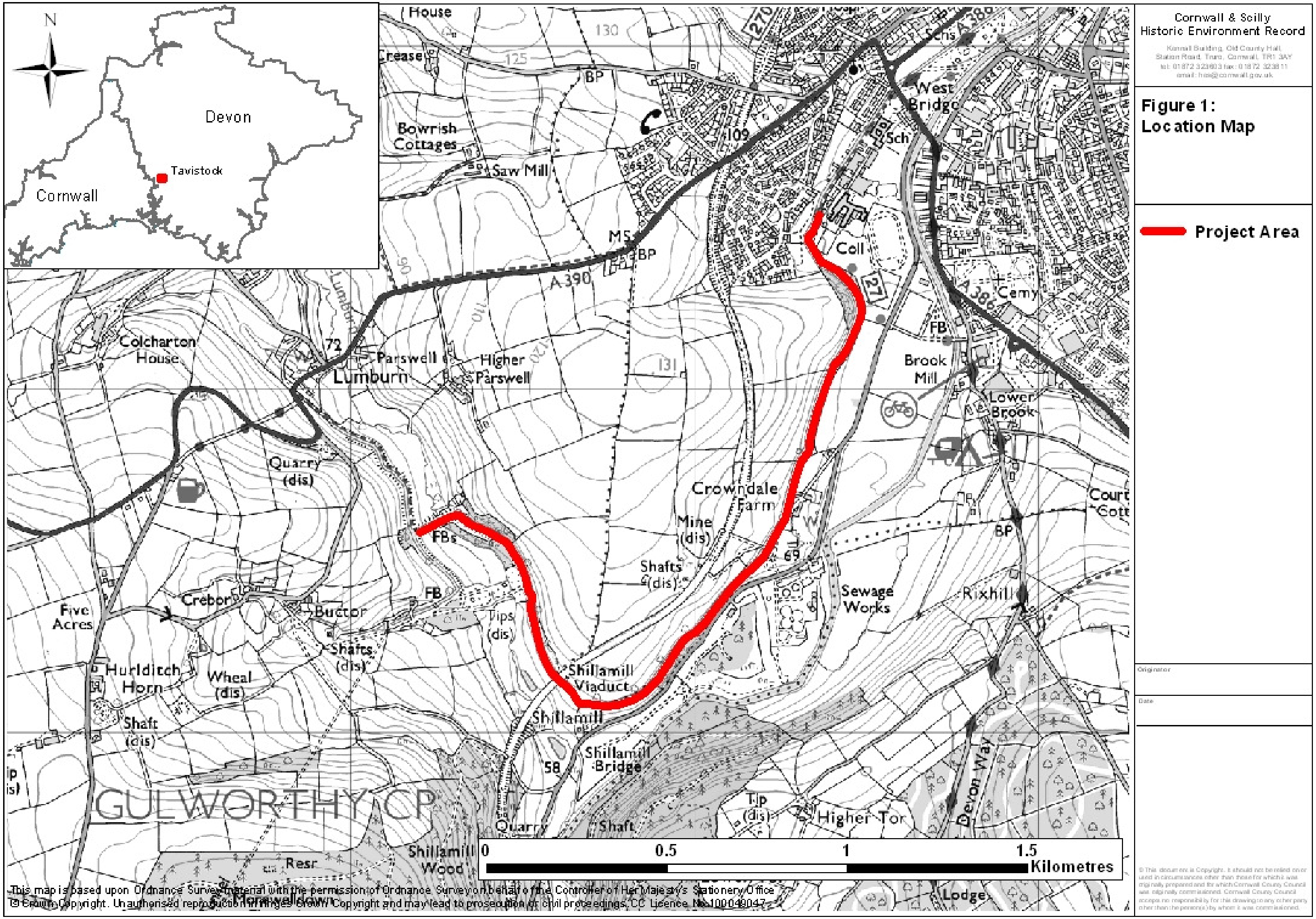
The conservation and management of features relating to the TVMHP's mining heritage and enablement of safe public access forms the basis for the Tamar Valley site conservation scheme. This report will assess the impact of the proposed conservation works on the Tavistock Canal's significant assets (canal within the WHS), describe the mitigation undertaken and also a description of the archaeological record for the (intermittent) works from May 2009 to May 2012. Following the first phase of works in the summer of 2009 (to describe and record the repair works and the minimal impacts to the canal sides), an interim report was produced for Bill Horner (Devon archaeology – Buck 2009).

In a joint project with SWW, the TVMHP agreed to fund cattle fencing along all of the west side of the canal, in order to stop further damage being caused to both sides by cattle drinking the water and wandering (on one occasion into Tavistock!), and to create four cattle drinking sites. SWW agreed to fund the repair of the sides of the canal bed. Furthermore the TVMHP agreed to re-bed and re-seed where necessary the canal towpath later in the autumn of 2009, and at a later stage (2011), to repair the damaged lock gates. In addition, the TVMHP agreed to undertake small-scale structural repairs to the small aqueduct bridge in 2012, and a small amount of repointing.

2. Aims and objectives

The aims of the project were as follows:

- To ensure that site works are undertaken in such a way as to maintain the integrity and authenticity of the historic resource, minimising adverse impact upon the resource.
- To ensure that the Devon County Historic Environment Service (DCHES – Bill Horner) are appraised of all site works.
- To ensure that the highest possible standards of the historic environment conservation works are maintained, which must be carried out to recognised current best standards in this discipline.
- To ensure that works are undertaken in such a way as to allow adequate recording of remains affected by the works.
- To record sites, features, deposits and artefacts affected by or uncovered by the works.



Cornwall & Scilly
Historic Environment Record
Figure 1:
Location Map
Project Area
Originator
Date
N
Devon
Cornwall
Tavistock
House
Crease
Bowrish
Cottages
Saw Mill
BP
MS
A 390
Colcharton
House
Lumburn
Parswell
Higher
Parswell
Quarry
(dis)
FBs
FB
Crebor
Buctor
Five
Acres
Hurlditch
Horn
Wheal
(dis)
Shaft
(dis)
Shafts
(dis)
Tips
(dis)
Shillamill
Viaduct
Shillamill
Shillamill
Bridge
Shillamill
Wood
Resr
Quarry
Shaft
Tip
(dis)
Higher Tor
Crowndale
Farm
Mine
(dis)
Sewage
Works
Coll
West
Bridge
Sch
Cemy
Brook
Mill
Lower
Brook
Court
Cott
Rixhill
Devon Way
Lodge
A 386
GULWORTHY CP
0
0.5
1
1.5
Kilometres
This map is based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office
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- To record the character and extent of works to the sites.
- To inform the Devon County Archaeologist of the nature, condition and significance of the canal and towpath, and describe the proposed impacts and a mitigation strategy (agreeable with the Devon County Archaeologist).
- To disseminate the results of the project appropriately and arrange for the deposition of the project archive (within IfA Guidelines).

It was proposed that the building conservation and repair programme will address the following:

- The protection and consolidation of significant archaeological remains in their settings.
- Health and safety aspects of the site relating to public access.
- Provision of low-key public amenity use where appropriate, incorporating access.
- Interpretation of the site to the public, including on-site and written materials.
- Linking the site into the local economic, social, tourism and recreational contexts.

In terms of the management of archaeological features, engineering works were kept to a minimum, but in view of the fact that the entire site is part of the Tamar Valley component (Area 10) of the Cornwall and West Devon World Heritage Site mining landscape, particular attention was paid to suggestions for the best mitigation of any such works.

3. Historical background

This subject matter has already been written in far more detail than is necessary for this report, notably by Hadfield (1967), Booker (1971, who reproduces the tonnages in Appendix 2), Hedges (1975), Woodcock (1995, Vol 6; 2005), and more recently a publication by Robert Waterhouse (2012), and a forthcoming detailed book. The text below is a summary history and construction account of the Tavistock Canal extracted from all of the above sources.

The medieval borough of Tavistock has always been closely linked to its port, Morwellham. That link was dramatically improved by the construction of the Tavistock Canal from 1803 to 1817. The main structural features of this major construction throughout its full length can still be seen today, over two hundred years later; the wharves at Tavistock and Morwellham, the aqueduct over the River Lumburn, the 1.5 mile long tunnel under Morwell Down, and the remnants of the incline plane down to Morwellham.

The historical chronology for the canal can be summarised as follows:

1796 The opening of Wheal Friendship Copper Mine, Mary Tavy, unintentionally led to the construction of this canal. The export of ore and import of coal and other materials needed to be cost effective – its transport costs by horse and cart must have been prohibitive. The young mine's engineer (in his twenties), John Taylor, had the idea of linking the Tavy and Tamar valleys, whilst using Morwellham to export the ore (via sea going ships); the nearest active port to Tavistock.

1800 By the turn of the 19th century, the country had been at war with France for a few years. Demand for metallic ore, and therefore the need for a canal were high.

1802 Survey of the proposed canal route (presumably with the blessing of the Duke of Bedford) by John Taylor, the mining engineer of Wheal Friendship copper mine.

1803 (March) A canal company, funded by shares from the London Stock Exchange (see front cover seal image), was formed. Work began on the route in 1803, following the passing of an Act of Parliament. The canal was to be 16ft wide and 3ft deep, with a branch to the slate quarries at Millhill. It is likely that the first section of the canal route followed an earlier leat from the River Tavy to Crowndale Mine. Raising funds on the stock exchange gained stock interest from adventurers to exploit known lodes whilst tunnelling through the granite of Morwell Down, and for additional shares to be

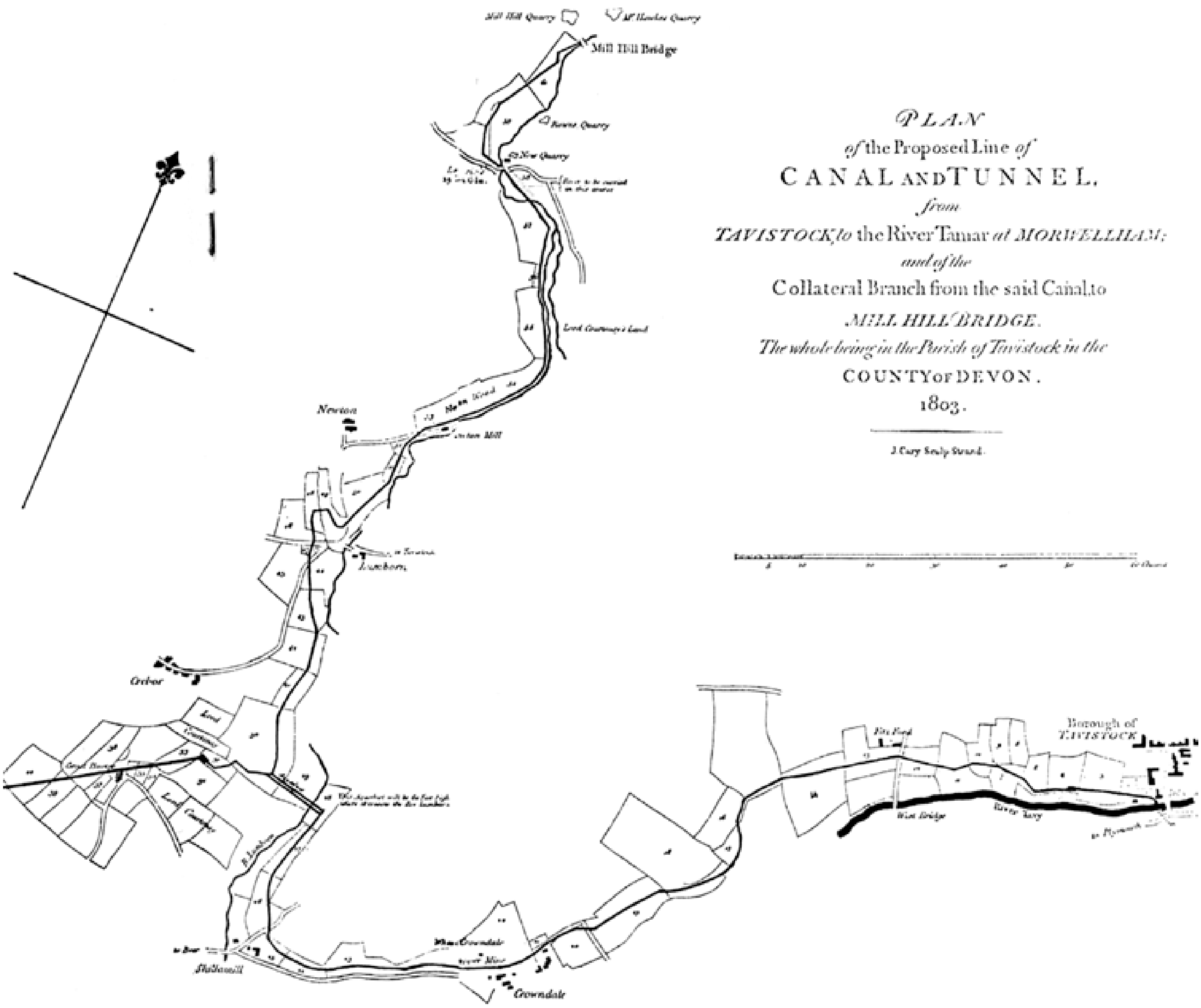

Figure 2 Excerpt of the 1803 survey plan (within the study area) of the proposed Canal route from Tavistock to Morwell Tunnel (Hedges 1975)

purchased by other mines and Tavistock businesses along its course, all recipients of the canal's cheaper transport costs. However, Hedges (1975) hints that Taylor's real motivation for the project was not primarily to build the canal, rather the opportunity to exploit known lodes under Morwelldown, a mining speculation.

Figure 2 shows the original planned 1803 route. The provision of water via leats from the western end of the canal (top of the Morwellham incline) for other mines in the Tamar Valley as far north as Gunnislake to power water wheels was also planned. The original cost estimate for the canal was £40,000 (including testing for ore lodes), at £100 per share. The Duke of Bedford, who owned all the land along the canal's course, also purchased 1/8 of the shares and took dues for use of Morwellham Quay. He also agreed to a request to make a grant of a Mining Set: (for working all Lodes discovered in the Course of the Canal, Embankment, Tunnel and collateral branch for copper, tin and lead to the extent of 500 fathoms East and West of the canal for every Lode discovered), for the sum of 1/10 dues and a term of 42 years.

The principal engineering features being the aqueduct over the River Lumburn, the 2,540 yard tunnel through Morwelldown, and the inclined plane west of the western end of the tunnel down to Morwellham – a fall of 237 ft, the greatest in southern England at that time.

Figure 3 Excerpt of the 1867 Bedford Estates survey plan (DRO T1258M) showing the canal within the study area.

1803 (23rd August) Work began on the tunnel. Almost immediately copper was struck at the Tavistock end of the tunnel, and the lode developed to realise what later became Wheal Crebor (see Fig 3). Men were employed to work both concerns – the accounts separated. The Canal Committee managed both concerns until 1812 when a separate Committee was appointed after further copper ore discoveries in the tunnel under Morwelldown (Hadfield (1967, 128).

1808 The waste rock and ground from the tunnel excavation was boated eastwards back to the tunnel entrance and used to infill and form the Lumburn Aqueduct over the valley, with a central spanning arch.

1809 Work progressed slowly in the tunnel (by this date it was half finished), as the canal section from Tavistock to the tunnel was finished (ie, this project's study area). This was built more permanently with stone sides (on edge) rather than puddle clay. The tunnel rock was granite, its depth 160 yards below the top of the hill. Pumping/ventilation/winding and access shafts (at least four – the main one being Bray Shaft), had to be sunk from the top of Morwelldown to the underground canal. John Taylor designed the power source for the shaft workings by utilising flat rods (for lengths up to 1.5 miles) powered from a large 40′ water wheel. He also designed a ventilation fan for improving the air quality, for which the company was awarded the medal of the Society of Arts in 1809 (Hedges 1975).

1810 The tunnel advanced at a rate of about 150 fathoms (six feet per fathom) per year until this year when three granitic dykes were cut, slowing the work rate to nearly a third that amount for two years. 30 to 40 workmen were continually employed, with some authors suggesting French prisoners of War used as 'navvies' (Barton 1964, 93 and Booker 1971, 108).

1815 From this year there were shipments of manganese from mines around Brentor and Milton Abbot carried by the canal. These were the principal sources of manganese in the country at a time when it was used in the manufacture of glass. For example, 13,335 tons were shipped to Plymouth in 1819. The ore was ground in a mill powered by the Morwellham water wheel (Booker 1976, 19), and exported in casks.

1816 (August) Tunnels were cut from both ends (simultaneously), to form a working area and to align both ends. They connected on the 21st August. Then the tunnel was enlarged (downwards and wider) throughout its length.

The demand for metallic ores to feed the Napoleonic war years (1793 – 1815) slumped as the soldiers returned, as markets waned. The canal committee, sensing further financial difficulties in September stated *'That the Tonnage will fall very short of the original estimate cannot be doubted; at the time when this was made the Mines in the neighbourhood were in their most flourishing condition, or rapidly advancing to it. Agriculture encouraged by high prices was improving everywhere, and the use of lime, so essential … was very great and increasing. Slate quarries, then making large returns, were in full activity, and new ones opening. In all these sources of oecumenical mode of carriage, the greatest reverses have taken place, and at present a stagnation of enterprise and consequent inactivity prevails'* (Hadfield 1967, 130). However, the population of Tavistock had increased from 1801 to 1821 by over 62%, reflecting the growth in the area, primarily a result of mining operations and related tertiary expansion.

1817 The tunnel was finally completed early in the year, with the official opening ceremony held on 24th June. Thousands attended the event, with over 300 going in boats (with a band) through the tunnel – to be met (with obvious relief) by thousands more at the Morwellham side. All were then given a demonstration of the workings of the incline railway mechanism and tramway down to Morwellham (see Buck 2005 – Sites 58 to 64), powered by a large water wheel and the canal water – which was also recently completed. The boats (specially designed and built by the Tavistock foundries from 1811 to replace an earlier wooden design), were *c*30 feet long, 5 feet wide and towed along the slow moving open canal by horses. They were worked through the long tunnel by two men using iron bars against the rock face.

The canal had taken 13 years to build. Its final cost was £62,000, the excess over the authorised capital of £40,000 having been raised by calling £155 on each £100 share.

1819 Although the economic outlook for the area was not good, the company decided to press ahead with the Millhill canal branch to the slate quarry. It was 2 miles long and cost £8000. It rose by 19.5ft to Millhill, with an inclined plane for the final section due to the scarcity of water (double tracked with two cradles counterbalanced with loaded boats going down pulling the empty ones up with the help of three horses).

1820s The expected tolls were halved from their pre-construction estimates – due to the gloomy economic climate. Over the next three decades the canal carried between 15,000 to 20,000 tons per year, earning an annual profit of approximately £600.

1831-2 A Cholera epidemic in the locality severely affected the workforce, the local economy and (temporarily), the canal's fortunes.

1841 Great Western Railway completed.

1844 Discovery of the main copper lode (40' wide) at Wheal Maria later Devon Great Consols – reversing the fortunes of Tavistock over the next 30 years, but reducing those of the canal. The Mill Hill Tramway was constructed this year (replacing the earlier section of the canal which had been closed after 1831), at a cost of £1,381 (Hadfield 1967, 132).

1847 20,132 tons were carried on the canal (Woodcock 1995, 23).

1848–9 Another Cholera epidemic.

1850 The goods carried on the canal were (tons): Sundries (7548), Limestone (3130), Copper ore (2.499), Slate (676), Granite (83) and Mundic (pyrites) (94). Tonnage carried fluctuated from year to year, reflecting the area's economic woes (or successes). In a bid to maintain revenue, at various times throughout this period, the company reduced tolls, or raised them again when economic conditions improved. But dividends, throughout the life of the canal were always modest, and profits turned out to be at a level 1/3 predicted at the outset.

1851 In the 1851 census, there were 27 barge men working for their various employers regularly using the canal.

1857 Shares that had changed hands at £100 in 1803 were now changing hands at £5.

1859 Construction of the Devon Great Consols railway from the mine to Morwellham with a separate incline section down to the port finished this year. Also the South Devon & Tavistock Railway from Plymouth to Tavistock opened (later extended to Launceston) – in direct competition to the canal. Due to this competition, the company further reduced its tolls after the opening of the railway. However, in the same year it expended more capital on renewing the inclined plane mechanism, and investing funds on a steam mechanism to pull loaded barges through the tunnel against the water flow (it often took a couple of hours or more to undertake this manually!). This was not successful.

There is no doubt that the waning fortunes of the Tavistock and Tavy copper mines, working for the past half century, were no competition for the resurgence of the Tamar Valley copper mines from the mid 19th century. Whilst the former utilised the Tavistock Canal as a transport medium during this period, the latter formed its own railway equivalent; but both used Morwellham as the export destination. Given the rapidly changing transport infrastructure due to the construction of mainline railways to the south west from the mid 19th century (consequently resulting in dramatic changes to market influences), across Devon and Cornwall at this formative period, so the fortunes of this old transport route was found wanting and uneconomic.

1860 In the previous year, the canal tonnage was 17,455. In this year it fell to 13,500. From 1863 onwards there was a steady decline in the tonnage until, in the early 1870s it dwindled to nothing (Hedges 1975, 28).

1862 A shareholder from Birmingham wrote to Mr Gill, representative of the Canal Company and said: *'I am afraid there is little hope of the canal rising in its fortunes with the railway for a rival. Here we have in several cases united the canal with the railway with advantage to both – you know best whether such an arrangement with the Tavistock canal would be advisable'* (Hedges 1975, 28).

1866 In September, the canal committee recorded; *'That a very considerable reduction having taken place in the traffic and dues of the Tavistock Canal Company since the opening of the Tavistock and Launceston branch of the South Devon Railway it was resolved that His Grace the Duke of Bedford be applied to kindly assist the Tavistock Canal Company to compete with the Railway Company by reducing the Canal Dock dues at Morwellham'.* The Duke was evasive (Hadfield 1967, 134).

1870 Only 783 tons were carried on the canal (Woodcock 1995, 24).

1872 Presumably the economic situation became even direr. At a meeting on 2nd September the Duke offered to buy all the shares at £8 each, and to pay half the cost of an Act to transfer the canal to him. Within the month, the committee accepted his terms. Since the summer there had been no traffic on the canal. However, this was not a localised occurrence; the impact of the railways had dealt a death blow to innumerable canals all over the country.

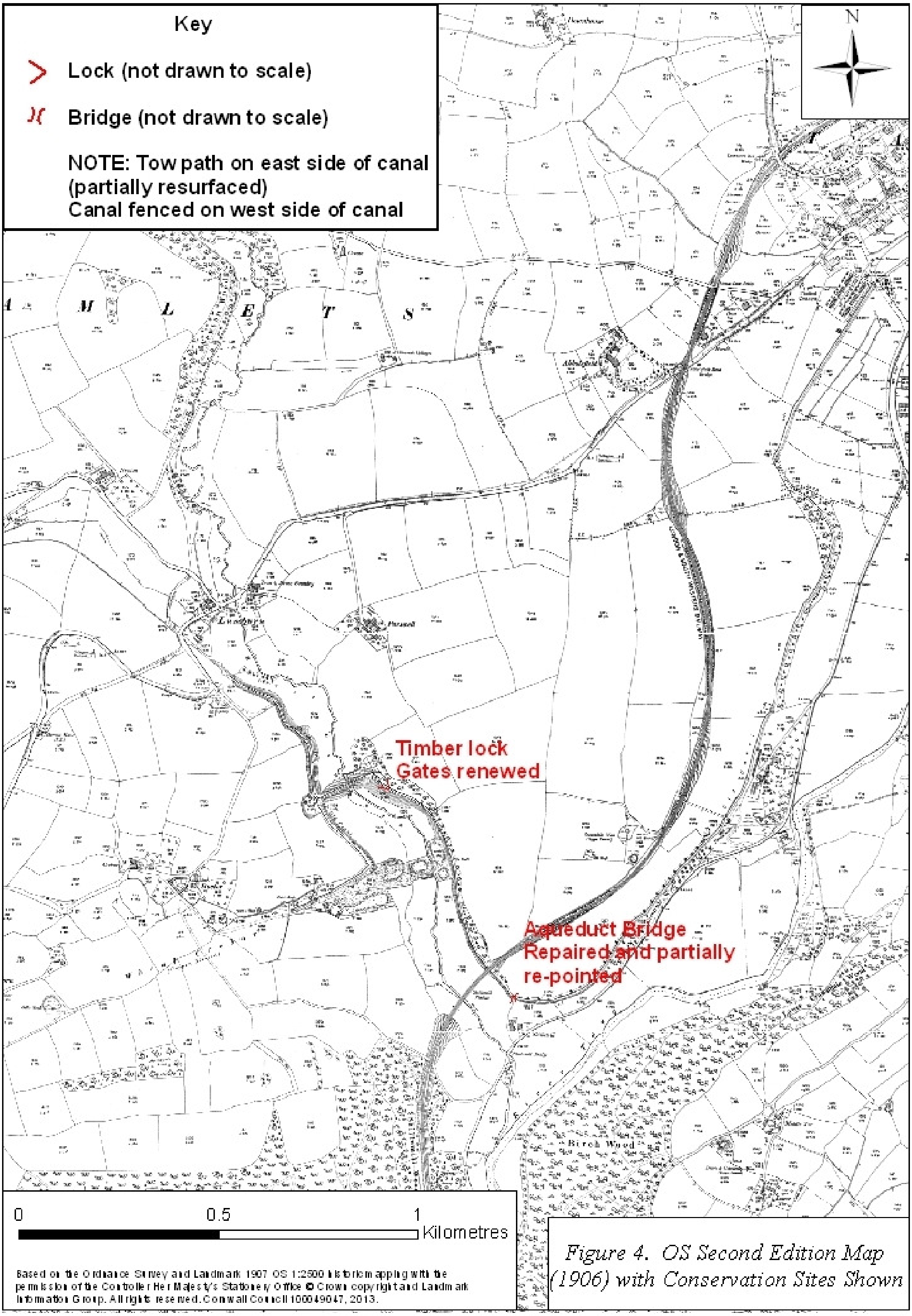

Figure 4. OS Second Edition Map (1906) with Conservation Sites Shown

1873 In May the Act was passed and the Tavistock Canal and land returned to the Duke of Bedford for £3,200, there being no obligation on the Duke to maintain the canal. It is uncertain what use the canal had for the next twenty five years.

1896 This perhaps was made clear in May of this year when the Tavistock Gazette reported that on Whit Monday the basin of the Tavistock Canal was to be cleaned out (it appears a regular activity on this day). *'The cleaning is wanted more now than when it was a hive of industry … a resident noted ... A great deal of sewage was emptied into it, and the water does not run at a greater rate than half a mile an hour. I have seen dead dogs, cats and rats in the canal'* (Woodcock 2005, 26).

1898 The Tavistock Canal was not included the Canal Returns.

1933 After cleaning the canal bed (which must have been quite onerous!), the West Devon Electric Supply Company built a sluice gate near the west end of the tunnel portal, to convey water to a header pond (Forebay) to go down to hydro electric turbines via large tubes at Morwellham Power Station, next to the River Tamar.

In 1923 and 1933, mining geologists Cloke and Barclay carefully assessed the lodes intersected by the tunnel during a tunnel assessment and clearance scheme (CRO AD58-26). They confirmed that the tunnel intersected eight or nine lodes and three cross-courses, but only two of these (East Russell and Georgenia Lodes), had any stoping accessed by the canal. The only repairs necessary were to the Morwellham portal end retaining wall.

Footnote:

The canal has been maintained and managed by the owners of Morwellham Power Station since 1933. For some time this work has been undertaken by South West Water and British Waterways, the former now monitors and maintains the canal, carefully regulating the flow to utilise the instant generating capacity of the hydro-electric power station at times of peak demand (to provide a cost effective monetary return). It is poignant perhaps that the canal still exists today due to its economic usefulness.

4. Impact assessment

This summary impact assessment is intended to inform and guide Devon County Council Historic Environment Service of the impact of the canal repair works, the aqueduct bridge repair and lock gates replacement. This section of the report summarises the archaeological resource, and describes the impact and mitigation of the canal works as part of a mitigation strategy. However, it should be noted that the mitigation procedure was undertaken during the project (due to the lack of advanced project specifications), by efficient communication between the report author (as site archaeologist), Bill Horner (DCC archaeologist), Chris Hariades (TVMHP Project manager), and South West Water. A structural engineer, Andrew White of Knevitts Ltd produced specifications for the aqueduct bridge structural repair (see Fig 12).

The sites impacted by the repair works are shown in Figures 5, 6 and 12 and reproduced on plan in Figure 4. The main sites include repair works to the sides of the canal itself, structural repairs to the aqueduct bridge, and repairs to the lock gates. The impact of the repair and conservation works on each site is then described, and a final section details the impact remediation measures.

The potential impacts during works are described below. Impacts are described in the text section for each site on a feature-by-feature basis. The following site impact terms are used within each site identification description:

Major positive	Site continues in, or is restored to, its original design and use
Moderate positive	Site restored as far as possible respecting its original function, but its use is altered
Minor positive	Site partially restored; interpretation introduced
Negligible positive	Stabilisation/maintenance of site
Negligible negative	Benign neglect – losses of fabric over a long period of time

Minor negative	Site suffers areas of alteration or damage, which contribute to loss of meaning
Moderate negative	Significant loss of fabric or alteration, leading to erosion of original character
Major negative	Complete demolition/removal

Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the end of the Lumburn Aqueduct **SX 46237 72628,** see Fig 1).

Description

The canal section impacted by the repair works was built between 1803 and finished by 1809 (as described in the historical background section). This section of the canal may well follow the course of a mine leat from the River Tavy to Crowndale Mine, which pre-dates construction of the canal. For much of its length the canal's west side (see Fig 4), cuts into the valley side – revealing vertical bed-rock and also frequently forming the bed of the canal. Excess stone material from the rock cut was used to form the rounded profile edge of the east side of the canal – using slate/killas stones set on edge. The tow path was formed along this eastern side. The canal is approximately 4.0m wide, 0.3m to 0.5m deep, with the east side approximately 0.6m to 0.8m deep from tow path surface to water level.

Repair works to the canal's east side (and towpath) has been undertaken in the past, sometimes inappropriately using cement and concrete formwork. The 2009 repair work to both sides of the canal and re-surfacing parts of the towpath continued with this theme of patching the damaged sections (Fig 11).

Site works impact (2009)

The repair works relate to identifying areas of the canal sides that needed to be patched with new (similar specification) stone within the section of canal identified above. This should immediately stop progressive damage to the canal sides and help to support the well used canal towpath. There is no site plan showing each small repair section, rather a canal bank repair work schedule (Appendix 1).

Other works to the canal itself that were proposed include patching and re-surfacing the tow path. South West Water (SWW) undertook its own Risk Assessment for each tree close to the tow path. Mitigation works resulting from that survey (i.e. branch or tree removal) was undertaken by SWW.

The overall impact of the works on the canal can be defined as '*Negligible positive'.* The works reduced collapse of parts of the canal's east side to maintain structural stability, provided more tow path stability and a higher degree of Health and Safety for increased public access for at least another generation. However, it is hoped that the track is adequately annually maintained.

Residual impact (2009)

There have not been significant residual impacts in the medium term – apart from the visual aspect of the replacement stone looking newer than the original stone surrounds.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of replacement stone (to match existing), reduced the visual impact of patching the sides of the canal. Other reduction impact measures included the tendering for appropriately qualified and experienced contractors to reduce the visual effect of repair sections to the canal, and for the quality of the work, which was of a good standard (reflecting the original construction style). This project should reduce the need for this work to be undertaken for at least another generation.

Aqueduct Bridge SX 46630 72090

Description

The aqueduct bridge carries the canal over an access lane to fields north of Shillamill Farm – whose access was cut by construction of the canal. The iron plated trough structure seen today was built in 1839 by Gill & Co of Mount Foundry, Tavistock (Buck 2007), replacing an earlier structure. The bolted sections of the trough extend to either side of the granite quoined masonry, and are supported by four wrought iron lintels (widening into the masonry sides) set into the granite masonry. Three other similarly styled lintels (see Fig 13) provide the support for large slates under the tow path on the south side of the canal. The middle lintel however has rusted to the extent of being ineffectual. A structural survey by Knevitts Ltd has recommended its replacement, as the aqueduct is not only used by tow path walkers, but is proposed to be accessed via the adjacent fields, in order to link up the railway (Buck 2009) with the canal – by a new DCC footpath route under the aqueduct – formerly used for access to the upper field.

Patch repointing to the sides of the bridge under the aqueduct in recent years has occurred, however more often than not this has been using cement, using a variety of styles. At the northern end of the side walls the stonework has been leaking for some time where water is leaking from the junction of the wrought iron plates with the canal bed. This has caused the masonry to be soft, and the stonework made weak – causing a noticeable dip on either side.

On the south west side of the aqueduct a high vertical retaining wall supports the tow path and masonry for retaining remnants of steps, to allow pedestrians walking the towpath to access the lower field. Some of this vertical retaining wall has areas of lime mortar pointing that is loose.

Site works impact (2012)

After dialogue with the TVMHP manager, the structural engineer, the landowner of Shillamill Farm, the Devon County Archaeologist and consulting project archaeologist; the TVMHP agreed to fund replacement of the centrally located rusty wrought iron lintel, and to undertake limited lime mortar repointing where structural stability of the adjacent walling could be compromised.

Site impact of the replacement lintel was minimised by matching most of the original profile of the replacement item as far as could be possible from an 'off the shelf' steel equivalent (in order for the project to be cost-effective), with the original wrought iron lintel.

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works have reduced the potential for collapse of the tow path as it runs next to the canal aqueduct. This project will provide a higher degree of Health and Safety for increased public access for at least another generation.

Residual impact (2009)

There are unlikely to be significant residual impacts in the medium term – apart from the aspect of the replacement iron lintel and repointed masonry looking newer than the adjacent (cement) based repairs.

Reduction of impact (2009)

Site consultancy with the project manager and structural engineer will minimise any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors should mitigate the visual effect of a new structural item, and for the quality of the work to be of a good standard, reducing the need for this work to be undertaken for at least another generation.

Lock Gates and timber lifting bridge SX 46327 72628

Description

The construction of the adjacent Canal cottage for operation of the lock gates, the lifting bridge and the visible remnants of the semi-circular trans-shipment basin (or turning/waiting area) is indicative that this part of the canal was quite busy! The latter

(sited close to the lock gates) is now infilled, but the tops of some of its vertical timbers still visible. The necessity of keeping the water at the correct level was important for the tunnel – this lock gate possibly forming this function also for the Lumburn Aqueduct (SX 46311 72632 to SX 46184 72581), with its single arch to the south. According to Waterhouse (forthcoming) the timber lifting bridge is of a Dutch design common on canals in the Welsh borders, and may not be contemporary with the canal's construction.

The lock gate and lift bridge was previously restored by October 1998, funded by South West Water and British Waterways. However, as Figure 15 shows, one of the timber arms of the lift bridge had snapped and parts of the timber walkway rotted. In addition the lower parts of the swing lock gate has rotted where it is in contact with the canal water.

Site works impact (2012)

The TVMHP agreed to fund replacement of the timber components that were rotted or had broken or snapped off. This includes the large timbers to open the bridge and the Lock gate. The TVMHP tendered for experienced Carpenters to assess both features and to price for the production of making and erecting replacements.

Site impact for the replacement timbers was minimised by specifying exact replacements with the existing timbers (previously replaced in 1998).

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works reduced the potential for further timber rotting and collapse, an important Health & Safety measure so close to the well-used canal towpath. This project has provided a higher degree of Health and Safety for bridge use and public access for at least another generation.

Residual impact (2009)

There are unlikely no significant residual impacts in the short term.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors mitigated any possible mistakes, the quality of the work was of a good standard, and reduced the need for this work to be undertaken for at least another generation (Fig 16).

5. Impact mitigation strategy

The impact mitigation strategy is divided into three stages: The pre-works consultancy, the Historic Buildings Consultancy during works and the archaeological recording record (during and after works). This mechanism demonstrates the steps that have been taken to avoid or minimise adverse impacts, and confirms that the proposed works have been designed in close liaison with the historic environment consultant. Consultation is based on a clear understanding of the significance of the site using appropriate methods and techniques for site monitoring and recording.

HES Projects (Project number 20070793) was commissioned to undertake the three components described as the impact mitigation strategy. The project was based on a project design produced by Colin Buck (21/07/06), and recording specifications defined by Bill Horner (DCC archaeologist).

6. Working method

The following text summarises the general WSI for all archaeological consultancy and archaeological recording for projects relating to the TVMHP (Tamar Valley Mines Heritage Project: Written Scheme of Investigation: Historic Building and Archaeological Recording Consultancy 21/07/06).

- A brief historical survey was compiled from existing Devon County sources (DCHER, DRO, and local libraries and historians (including Robert Waterhouse's recent published work on the canal).
- A walk-over survey was undertaken of the entire length of the canal for sites impacted by the TVMHP.
- An impact assessment described and mitigated the proposed work as part of a Mitigation Strategy to minimise the works affecting the site's character.
- General working methods for archaeological recording, treatment of finds, photographic surveying and report production are described in detail in the Tamar trails WB WSI produced in 21/07/06.

All archaeological recording work was undertaken according to the Institute for Archaeologists (IfA) *Standards and Guidance for Archaeological Investigation and Recording. Staff follow the IfA Code of Conduct* and *Code of Approved Practice for the Regulation of Contractual Arrangements in Archaeology.*

The principal factor in effective project delivery was the employment of key project staff who are expert in the management and recording of the industrial heritage. Cornwall Historic Environment Service project staff can draw upon a substantial track record in undertaking similar work throughout Cornwall, as well as a detailed knowledge of the project area and its sites.

Historic buildings consultancy

- HES (Senior Archaeologist) liaised with the Devon County Historic Environment Service - DCHES (Bill Horner), and the TVMHP Project Manager (Chris Hariades).
- The HES Senior Archaeologist attended regular site meetings when appropriate during the duration of the project.
- HES ensured that site conservation works are carried out to standards recommended by English Heritage best practice.
- **Fieldwork: archaeological recording**
- There were no newly exposed archaeological features revealed through excavation.
- Where appropriate, measured survey was carried out by hand measurements (using offset techniques at a scale of 1:50.
- The resulting survey output was a revised measured survey drawing showing all conservation works that had been undertaken. This was reproduced at a scale of either 1:50 or 1:100 (appropriate to the size of area recorded) and will form part of this archive watching brief report.
- Analysis of the building fabric was recorded in the form of field notes and written up in this archive report production stage.
- DCHES (Bill Horner) advised that archaeological recording should be undertaken during any excavation that revealed archaeological features. Recording was undertaken using a mix of direct measurement, sketch plotting and photography, as appropriate (constrained by safety factors).
- Where significant remains were encountered the site archaeologist was given the opportunity to make an appropriate form of record before work proceeds.
- The chosen site archaeologist adhered to Health and Safety Policies (see below), under the direction of the designated Site Safety Officer.

Site recording (general)

- Site drawings (plans, sections, locations of finds) were made by pencil (4H) on drafting film; all plans were linked to the Ordnance Survey landline map; all drawings included standard information: site details, personnel, date, scale, north-point.

- The site archaeologist undertook the recording in line with recommendations given by IfA. Sections and plans were drawn on site at appropriate scales which adequately recorded structures or features at appropriate levels of detail, and appropriate sections reproduced in the archive report at either 1:50 or 1:100 to adequately demonstrate revealed archaeological features.
- All features and finds were accurately located by means of a National Grid reference and all archaeological contexts will be described using a standard format and linked to a continuous numbering sequence.
- The archaeological watching brief report detailed all forms of archaeological recording that had been undertaken at each of the mine sites. Each major mine site had a single archaeological watching brief report that details all project related work to that site (i.e. trails works, building conservation works, interpretation works, etc).

For Treatment of finds, Photographic recording specifications, report production and archiving specifications refer to the TVMHP WSI (2006).

7. Results

Unfortunately, there was insufficient time (following receipt of a detailed plan and description of the canal repair works from the TVMHP), prior to the start of works on site to produce an impact and mitigation report for DCC (Bill Horner). A decision was therefore taken to minimise impacts and mitigate directly with the TVMHP and site contractors on site as works were progressing as part of a weekly site recording and consultancy. SWW funded the stone and path repairs to the canal bed whilst the TVMHP funded fencing of the north and west sides of the canal, to stop encroaching animals from the adjacent fields from directly accessing the canal (and walking up the towpath!). An interim archaeological recording report of these works was produced by the author on 17/06/2009. This report supersedes that report.

Repair works to the bed and towpath of the Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the start of the Lumburn Aqueduct **SX 46237 72628**)

In early 2009, the TVMHP tendered for stone masons (on behalf of SWW) experienced in rebuilding stone walls, etc, to undertake these works within a narrow time-scale of three weeks, when SWW were willing to reduce the water flow through the canal (which would stop the electricity generating turbine). The turbine normally operates all year round, often at short notice when generation rates for electricity peak (the turbine can instantly generate electricity). Clemens Stonemasons of North Cornwall were successful in winning the contract. Prior to this, the TVMHP Manager, the archaeological consultant and SWW projects officer, produced a repair work specification schedule (measured from the small swing bridge at Tavistock: SX 47348 73503), which focussed on identifying the repair of collapsed sections of canal bank on the south or east sides. Appendix 1 is a reproduction of this original document.

Site work started on 05/05/09 at the northern end of the canal and progressively worked southwards towards the lock gates at the Lumburn Valley. With the reduced water level in the canal (and its slow movement when full), many stones that had fallen out of place were found in the canal bed not far from their original bank location. When the canal was constructed the stones were originally set on edge, a minimum of two/three stones height (approximately 0.6m to 0.8m above water level). During the repair project, where there was insufficient stone to replace the collapsed sections, a similar stone was imported from Trebarwith Quarry, North Cornwall (purchased from the local quarry at Millhill). These stones were reset on edge, following the original profile of the canal bank, and tightly tamped down in position (tops and sides). Earth was backfilled into the top sides of the stone to re-form the edge of the towpath. This was then at a later date, re-seeded. Figures 7 and 8 show examples of before and after photographs of the repaired canal bank. The work has been sensitively undertaken and reflected the style and character of the original construction a century ago.

Weekly site meetings were arranged to view the previous week's repairs and to discuss any foreseeable problems within the following weeks programmed work. A granite towpath stone under the Crowndale bridge at SX 47194 72541 had become dislodged (into the canal), and some quoin stones from the bridge parapet wall had fallen into the canal. The former was repaired by contractors; the latter will be removed from the river by SWW to be replaced on the bridge parapet wall at a later date. A small section of old 2" timber (2m long) set in the lower part of the bank was replaced back into its original position following repair of the wall at this location (SX 47270 72707).

The canal bank repair works (see Appendix 1), were finished on 28/05/09, including an additional element of work totalling 87 metres, which the contractors identified whilst on site. A total of 337 linear metres of canal bank was repaired (only on the south/west side), using a total of 86 tons of additional Trebarwith stone. The canal repair works were funded by South West Water.

Figure 5 is a site plan and specification document for the installation of timber post and wire stock fencing along the west/north side of the canal and construction of three cattle drinking areas to minimise any future erosion of the opposite (north/west) side of the canal bed. The cattle drinking sites are located at SX 47384 73064, SX 47257 72705, and SX 47078 72415. A concrete pad (min 0.3m thick), varying from 3m to 4m wide and approximately 5m long, has been created to at each of these sites to form the post and rail fenced cattle drinking areas that should minimise further damage to the banks (on either side). An additional cattle drinking area was constructed on bedrock immediately on the west side of the Shillamill Viaduct (see Fig 6). Figures 9 and 10 show before and after views of a cattle drinking site (SX 47384 73064).

Approximately four months later, the surface of the canal towpath was patched with crushed stone (803 specification) where the path was potholed or muddy, then sections covered with finely ground stone (6mm to dust) from Meldon Quarry.

During construction of the cattle drinking sites and during the canal repair works there has been minimal archaeological impact, nor any finds recorded.

Aqueduct Bridge SX 46630 72090

Knevitts Ltd was commissioned by the TVMHP in 2011, to undertake a structural survey of the aqueduct bridge at this location. Their report and structural drawing (see Fig 12), recommended that a rusty wrought iron support (middle one of three similar supports – see Fig 13) sited under wide slates below the towpath next to the canal, be replaced with a modern equivalent. In addition, it was recommended that the tall retaining wall on the south west side of the aqueduct bridge be repointed and structural ties inserted (using 7mm diameter stainless steel helibars) into the masonry bedding joints to strengthen a structural crack in the masonry.

This work was not started until May 2012, following an extensive dialogue with SWW and the site owner. Figure 13 shows the failed rusty element needed to be replaced. The original lintel was 50mm x 50mm for most of its length but widened to 100mm at both ends (and set in the side walls). Unfortunately the original wrought iron section specification was impossible to replace, and an 'off the shelf' item had to be found due to budgetary constraints. Figure 14 shows the new steel replacement *in situ*. Scaffolding had to be erected to remove the original rusty support and to replace it with the new 50mm wide x 115mm deep iron profile steel section. A slightly wider opening had to be made into each granite quoined side of the bridge for insertion of this new structural element. The localised setting was then repointed with lime. The steel was painted with a red primer and then painted black.

Other works to this site included removal of a tree growing out of the west side of the north end of the aqueduct bridge and treatment of the stump, as its unchecked growth had caused structural issues to the masonry at this point. On the opposite side of the bridge opening, the top flanking stones over the east side revetment walling had become dislodged. These were moved back to their original position. TVMHP funded the project.

At the north end of the structure under the aqueduct section, it appears that water has been leaking from the canal at the intersection of the metal 'trough' profile bolted plates and the canal bed – on both sides, through the stone masonry. This has caused the masonry and water at this point lower down under the aqueduct to be constantly wet.

Consequently, the foundations masonry and pointing in this area have softened to the extent that the masonry is collapsing and arching downwards. SWW attempted to add some clay to the leaking intersection point in the bed of the canal, but this has not worked. Structural deterioration will continue unless this issue is resolved. This is a significant feature of the canal which is in places, is now a Scheduled Monument. It is a recommendation of this report that the aqueduct bridge be considered for Listing.

Finally, the vertical retaining walling on the south west side of the aqueduct was repointed and the structural crack that had been identified by the structural engineer, repaired with the use of helibar reinforcing. This work finished in mid June 2012. The repointed wall acted to retain not only the towpath running along the south side of the canal, but also steps that allowed access from the towpath down into the adjacent field. These steps have badly deteriorated, leaving a steep slippery slope. It is recommended that they need to be rebuilt before use of them can be made by a new DCC footpath from the nearby railway linking up with the canal footpath.

Lock Gates and timber lifting bridge SX 46327 72628

The timber lock gate and timber lift bridge was 'restored' in 1998 by SWW and British Waterways. It is not know what the restoration replaced, but parts of the timber lift bridge (mainly the western timber arm), had rotted resulting in collapse (see Fig 15). Other parts of the bridge were showing that many timber items were rotting. In addition, the section of timber lock gate that was in constant contact with canal water had also rotted during the last 14 years. SWW and the TVMHP decided to replace the rotted and unsafe timber items as being a Health and Safety issue, given the frequent public use of the towpath. SWW funded the project.

The project of dismantling the bridge and lock gate, replacement of the main and structural timbers, and re-assembling and fixing on site was tendered. The contract was won by Will Sterling and Son, a traditional timber boat builder and carpenter who worked at Morwellham Quay (repairing and building boats, etc). The work was started in July 2012 and finally finished in September 2012.

Figure 16 is an 'after' view of the works on these features, and should be compared to its preceding figure. It is hoped that this repair will last longer than its predecessor!

Note:

In 2013, the TVMHP constructed a new footpath from near Morwell Rocks (SX 44128 70435) to above George & Charlotte Mine (SX 45101 69962). This new route links the main route of the railway line from Devon Great Consols to Morwellham and the forestry tracks north of Morwellham. Scheduled Monument Consent was obtained in 2012 for construction of a new timber footbridge over the Tavistock Canal (the section from the west end of the Morwell Down tunnel to the incline railway cottage was Scheduled in 2011, SM No. 30973). As part of this project, an impact assessment report was produced (Buck 2012). The results of the new footpath creation and footbridge construction will be produced within the main body of the TVMHP archaeological recording report (Buck forthcoming).

8. References

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9. Project archive

The HE project number is **20070793**

The project's documentary, photographic and drawn archive is housed at the offices of Historic Environment, Cornwall Council, Fal Building, New County Hall, 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 (20070793).
2. Black and white photographs archived under the following index numbers:

   GBP 2091/12-21; 2207/12-22; 2250/1-17; 2253/19-22.
3. Digital photographs stored in the directory R:\HE images\Sites\Devon\Tavistock\Tavistock Canal
4. This report text is held in digital form as: G:\HE Documents\HE Projects\Sites\Devon\Tavistock Canal IA WB report 20070793
5. English Heritage/ADS OASIS online reference: cornwall2-154344

No artefacts or environmental material was retrieved during the project.

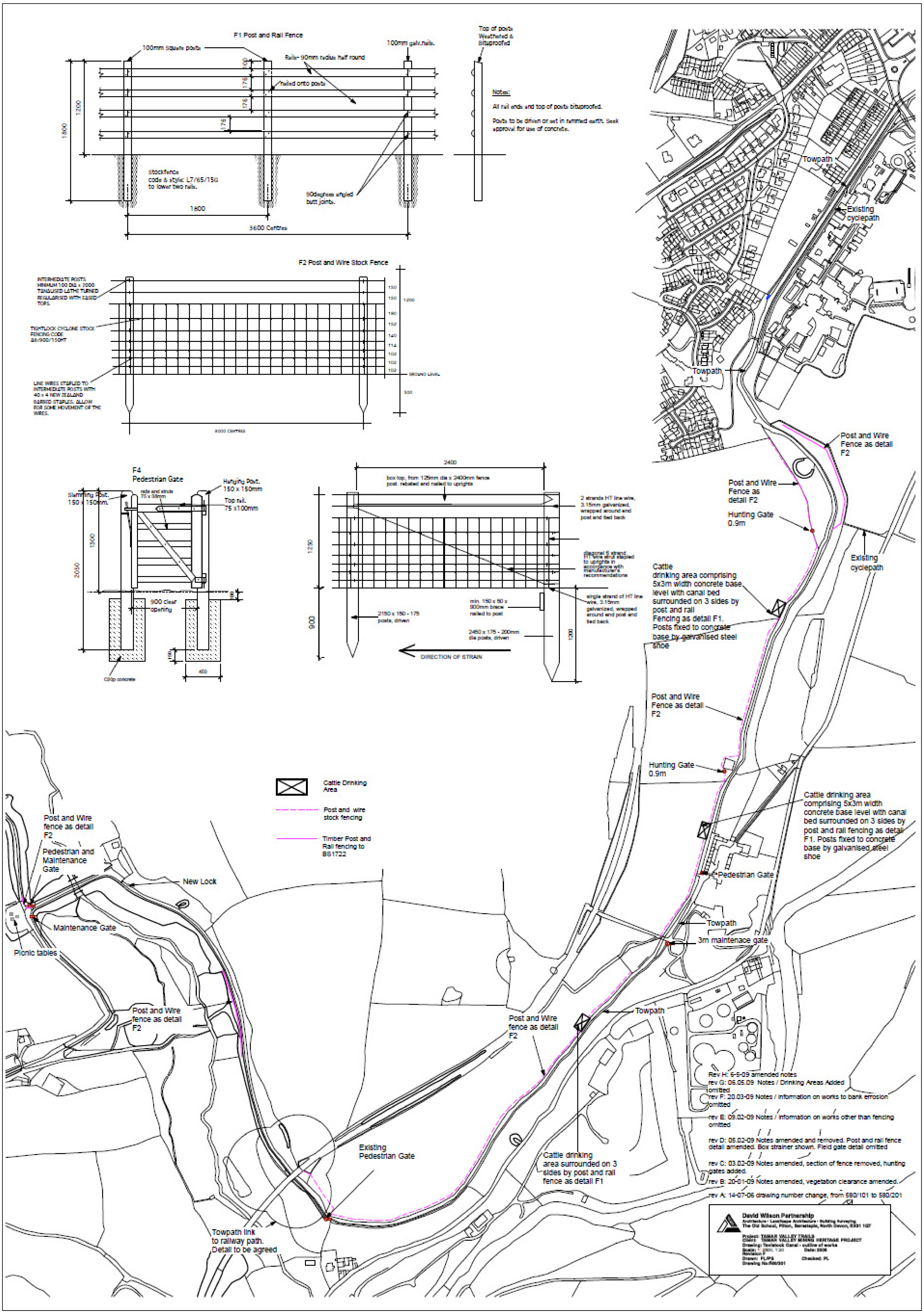

Figure 5 Specifications and plan showing fencing and three cattle drinking areas at the Tavistock Canal(East section)

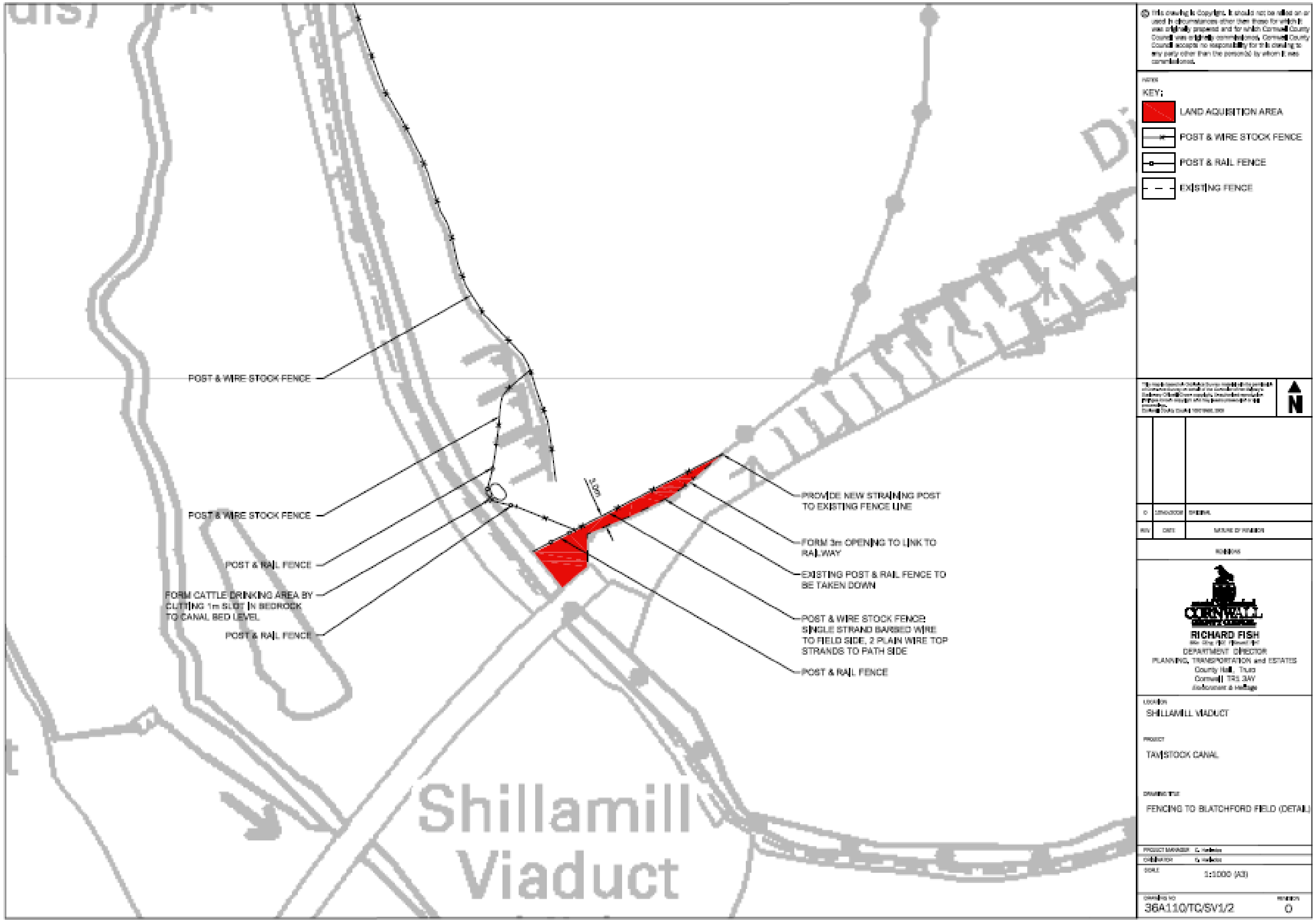

Figure 6 Detail plan showing the cattle drinking area west of the Shillamill Viaduct

Figure 7 A view of the Tavistock Canal east bank before works © CC HE Projects

Figure 8 A view of the Tavistock Canal east bank after works © CC HE Projects

Figure 9 A view of a Cattle Drinking site before works (SX 47257 72705) © CC HE Projects

Figure 10 A view of the same Cattle Drinking site after works © CC HE Projects

Figure 11 A view of the canal towpath after re-surfacing works © CC HE Projects

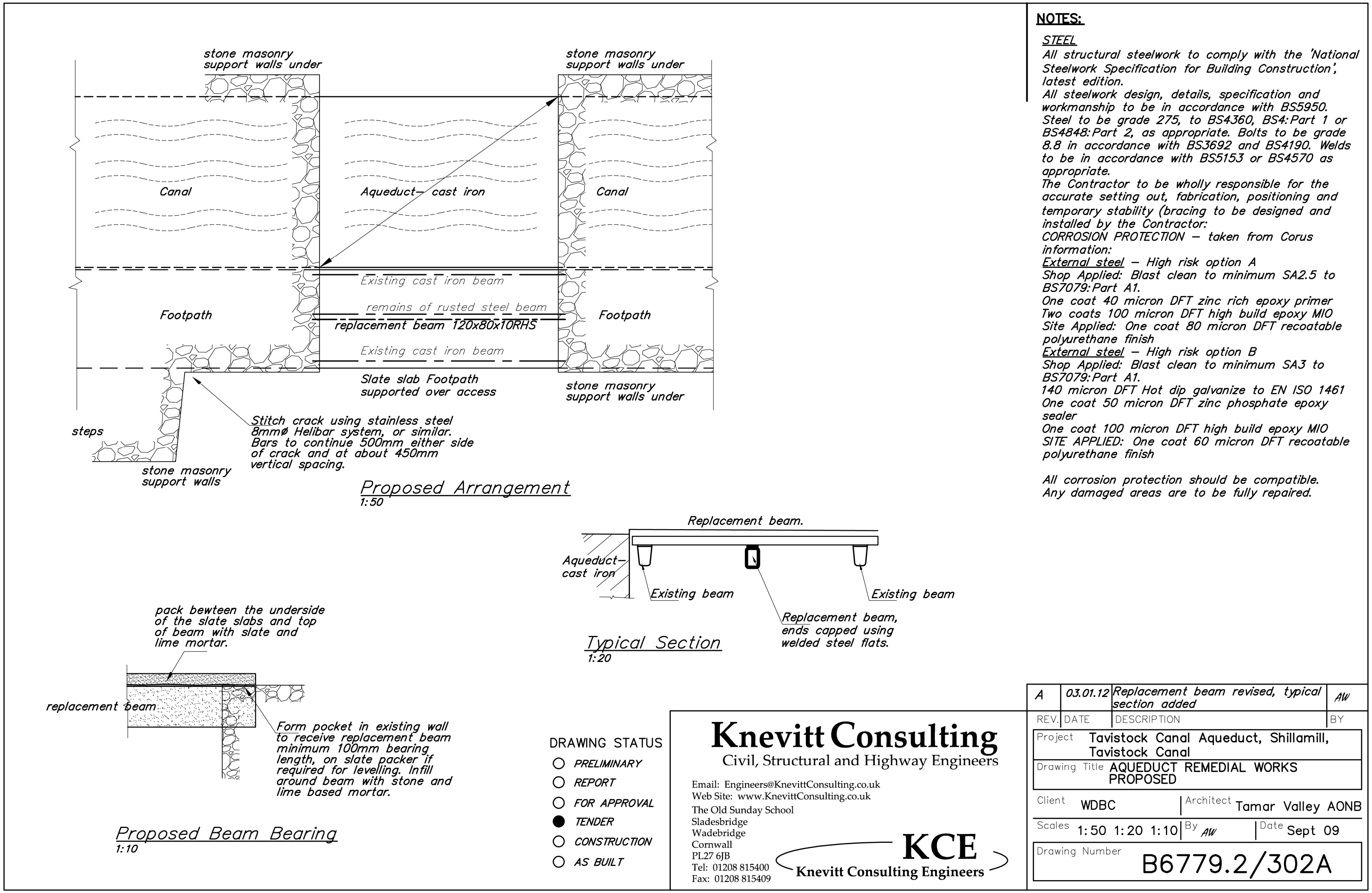

Figure 12 Specifications plan for repair of the aqueduct bridge

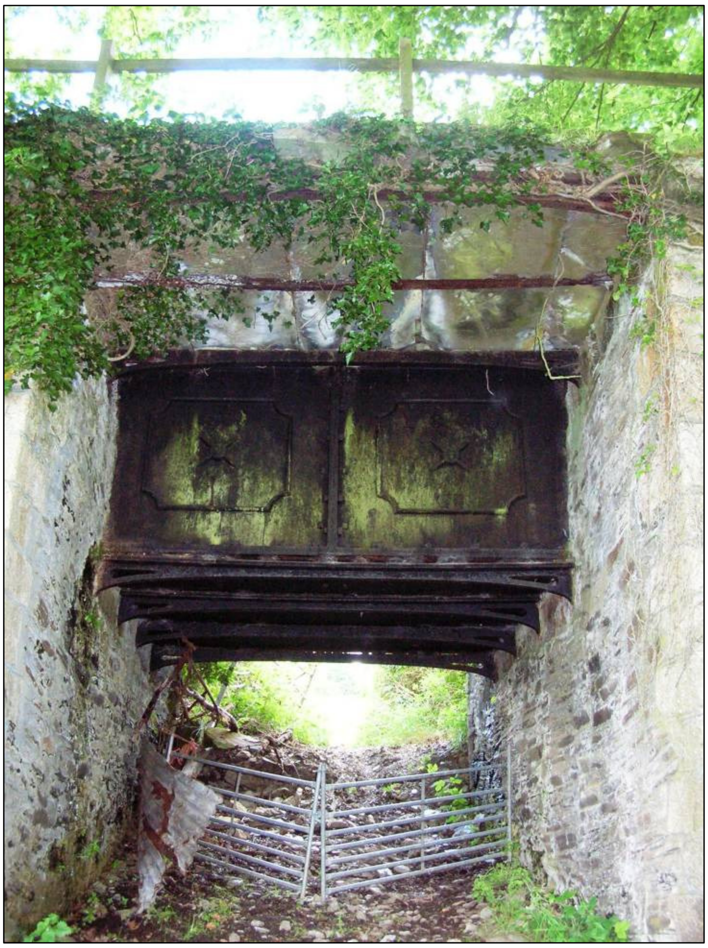

Figure 13 A view of the canal aqueduct bridge before works © CC HE Projects

Figure 14 A view of the canal aqueduct bridge after works © CC HE Projects

Figure 15 A view of the canal lock gate and bridge before works © CC HE Projects

Figure 16 A view of the canal lock gate and bridge after works © CC HE Projects

Appendix 1: TAVISTOCK CANAL BANK REPAIR WORK SCHEDULE

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
20		Side out path and hedge (140m length)
76		1.5m infill behind c $2m^3$
118		1.5m infill behind c $1m^3$
140-150	10	Minor wall top repair
159-160	1	End of hedge
162-163	1	1m infill behind $0.25m^3$
166-179	13	
225-247	22	
253-308	55	Break out conc block
314-323	9	
328-330	2	
394-418	24	
433-461	29	Take off conc
P A T H		
467-469	2	Break out conc
472-473	1	Good example, flat stone
485-488	3	Remove conc, Repair bank
494-513	19	Remove section of conc
530-541	11	
557-558	1	
563-573	10	
577-578	1	
581-584	3	
591-592	1	
600-650	50	
664-673	29	
691-694	3	
703-704	1	
714-718]	4	Soft path, build up levels (ch 14-27)
722-727]	5	
730-735	5	
744-745	1	
751-754	3	
755-760	5	
771-773	2	
779-780	1	
782-798	16	800 ⇒path surface 80ft
800-804	4	
804-806	2	Build up path surface to fall to canal

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
		(ch 800-902)
808-809	1	
813-814	1	
819-820	1	Lay hedge, remove barbed wire (ch 800-902)
823-826	3	
839-842	3	
875-876	1	
892-894	2	
902-903	1	Remove gate, overhanging branch
902-907	5	
970-971	1	Gate and post and rail across path
975-976	1	Surface ok
985-990	5	In deep
1009-1010	1	
1019-1020	1	Take out tree growing out from opposite bank
1068-1069	1	Path surface repair
1093-1094	1	Under bridge
1099-1100	1	Bridge coping repairs 4m copings in canal
1130-1131	1	Boulders ⇑ make up path ⇓ scrape leaf mould
1158-1159	1	
1165-1166	1	
1169-1170	1	
1187-1192	5	
1197-1199	2	
1202-1207	5	
1208-1209	1	
1225-1232	7	
1260-1268	8	
1271-1272	1	
1279-1280	1	
1282-1283	1	
1295-1298	3	
1308-1309	1	
1317-1319	2	
1334-1342	8	
1353-1356	3	
1409-1414	5	
1421-1422	1	
1424-1425	1	

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
1441-1442	1	
1454-1456	2	
1514-1515	1	
1546-1548	2	
1573-1574	1	
1581-1582	1	
1603-1604	1	
1600		Path falls away from canal. (1.5m width)
1691-1692	1	
1718-1719	1	
1721-1722	1	
1726-1729	3	
1820-1821	1	
1856		AQUADUCT (Clear vegetation, Take out gate)
1958-1968	10	Under viaduct
1970-1972	2	
2020-2023	3	
2151-2152	1	
2220-2221	1	
2316-2318	2	WHEEL SLUICE Interpretation Barrier (Take down concrete posts and blocks)
2463-2464	1	
2534-2535	1	
2541-2543	2	Replace Bascule bridge
		Lumburn Valley Turning area at lock (excavate)
2586-2600	214	Opposite bank
TOTAL		

Note:

An additional 87 linear metres of repairs were undertaken by the site contractors as they deemed them necessary. These additional repairs are not reflected in the above schedule chainage list, which was originally compiled by Chris Hariades (in consultation with Colin Buck and SWW (Laura Wotton) in April 2009 to inform tender information and site specifications prior to the start of works. The location of the small swing bridge in Tavistock (from which the chainages are measured) is at SX 47348 73503.

Tavistock Canal - Canal Bank Repair Works Schedule

Item	Description	Qty	Unit	Rate (£)	Cost (£)
1	Provide site welfare facilities to comprise as a minimum porta-loo with handwashing facilities, maintain and take down on completion	Item			
2	Provide all necessary fencing, barriers, signage, maintain for duration of contract and take down on completion	Item			
3	Break out concrete capping (provisional)	50	lm		
4	Clear rubbish from canal bed and dispose to licensed tip (Provisional)	10	m3		
5	Repair identified sections of failed or colapsing drystone facings to canal bank to match adjoining sections using stone salvaged from canal bed	250	m2		
6	Tie and marry in each repair to adjacent sound sections.	100	no.		
7	Extra to bed bottom course of stone on 50mm depth drymix sand/lime/cement bed in ratio 6:2:1 where laying directly onto bed rock.(Provisional)	50	l.m		
8	Extra to import suitable matching stone to make up shortfall in site salvaged material (Provisional)	50	tonnes		
8	Backfill voids behind stone facing to level with top of bank with imported scalpings compacted in layers not exceeding 200mm depth (provisional)	10	tonnes		

Report No: 2013R046

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CORNWALL COUNCIL

Tavistock Canal, Devon

Archaeological impact and recording report

Historic Environment Projects

Report No	Report Name	Report Author
2013R046	Tavistock Canal – Impact assessment and archaeological recording during a program of repair works	Colin Buck

Event Type

Site consultancy	Archaeological impact assessment	Archaeological watching brief	

Client Organisation	Client Contact
TVMHP (West Devon Borough Council)	Chris Hariades (TVMHP)

Monuments (MonUID)

DHER 3879 (Tavistock canal)	18721	4069	3882	5449	3956

Fieldwork dates (From)	(To)	(Created By)	(Create Date)
05/05/09 05/05/12	29/05/09 05/09/12	Colin Buck	13/05/13

Location (postal address; or general location and parish)

Tavistock Canal (northern section from Tavistock to Lumburn), Tavistock, West Devon

(Town – for urban sites)	(Postcode)
Tavistock	

(Easting) X co-ord	(Northing) Y co-ord		
From: SX 47367 To: SX 46183	 73572 72589		

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

List of Figures

Abbreviations

AONB	Area of Outstanding Natural Beauty
CC	Cornwall Council
DCC	Devon County Council
DHER	Devon Historic Environment Record
DRO	Devon Record Office
HES	Historic Environment Service
OS	Ordnance Survey
SWW	South West Water
TVMHP	Tamar Valley Mines Heritage Project
WHS	World Heritage Site

Acknowledgements

Thanks are due to Robert Waterhouse for providing some primary survey data and information files from his research relating to a forthcoming book about the Tavistock Canal. Chris Hariades (Tamar Valley Project Manager), and Bill Horner were involved in the project throughout its entirety. Andrew White of Knevitts Cons. Engs. was involved in preparing the specifications of the aqueduct bridge.

Front cover image: a copy of the Tavistock Canal Company Seal.

1. Project background

The Tamar Valley Mining Heritage Project (TVMHP – 2005 to 2013), a £7 million Heritage Lottery Fund project focusing on the World Heritage Site landscapes of West Devon in the Tamar Valley, is co-ordinated by the Tamar Valley Area of Outstanding Natural Beauty (AONB). The TVMHP was approved for Stage 2 consent by HLF in 2003. It involves the conservation of former mine sites and trail creation along the Devon side of the Tamar Valley (from Devon Great Consols to Morwellham). These sites include Devon Great Consols, the largest mine in Europe during the 19th century. The project also included conservation and repair works to the Bere Alston to Tavistock railway line (Buck 2011), the Tavistock Canal, and parts of Morwellham Quay itself (other contractors). This project covers works undertaken along the Tavistock Canal (Fig 1).

The Historic Environment Service (HES), Cornwall Council was commissioned in July 2007 by the Tamar Valley Mining Heritage Project (Chris Hariades as TVMHP Project Manager), to undertake an archaeological impact assessment, archaeological recording and site consultancy, photographic building recording of affected sites impacted by the works. An impact assessment project brief had not been produced, but it follows a similar project design by Historic Environment Service, Cornwall Council; *'Project design for production of archaeological recording, as part of the Tamar Valley Mining Heritage Project (2006-2009)',* dated 23/06/06. A Project Design for this site and other building conservation schemes in the TVMHP was produced on 21/07/2006, and was subsequently approved by Bill Horner (Devon County Archaeologist).

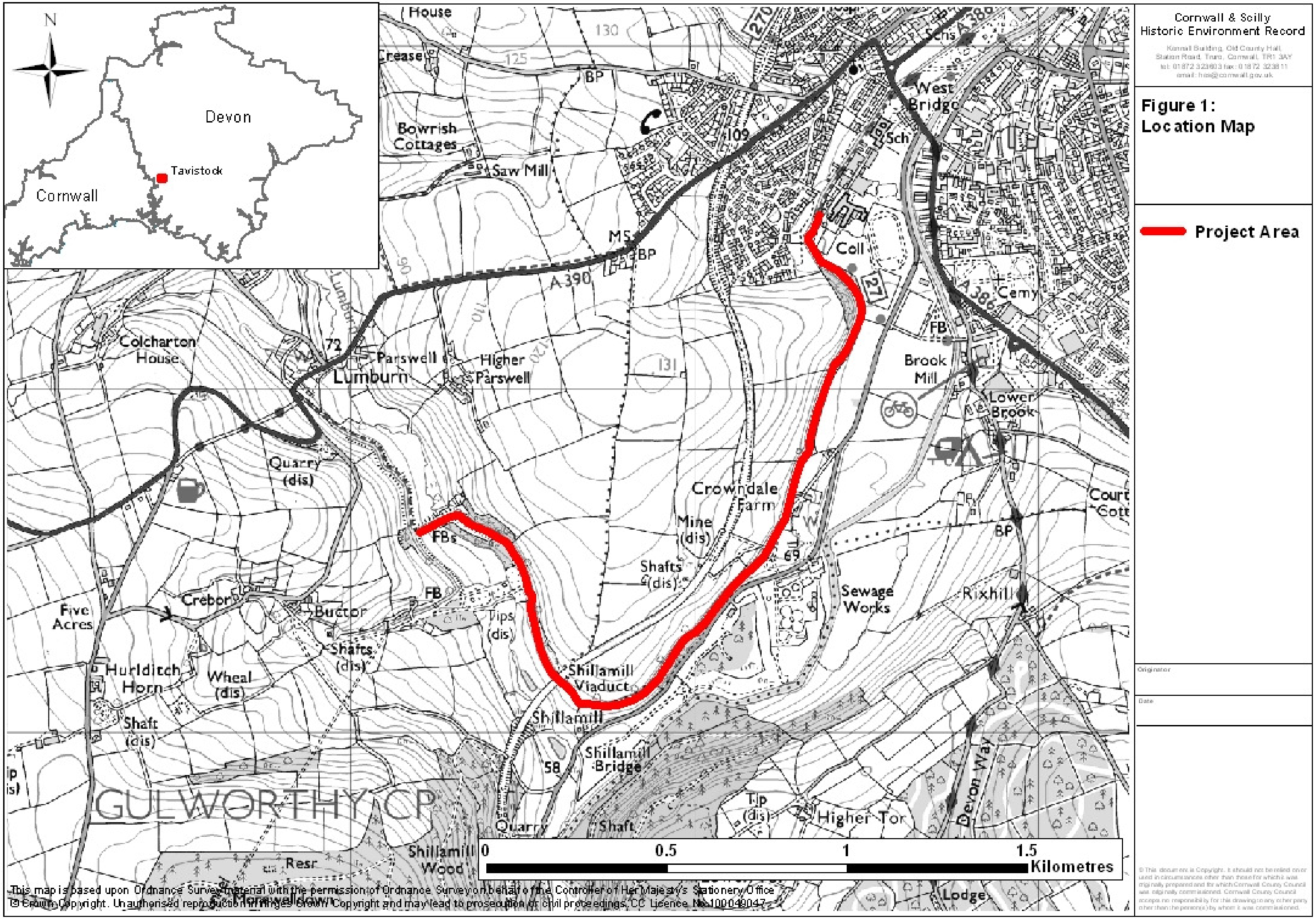
The conservation and management of features relating to the TVMHP's mining heritage and enablement of safe public access forms the basis for the Tamar Valley site conservation scheme. This report will assess the impact of the proposed conservation works on the Tavistock Canal's significant assets (canal within the WHS), describe the mitigation undertaken and also a description of the archaeological record for the (intermittent) works from May 2009 to May 2012. Following the first phase of works in the summer of 2009 (to describe and record the repair works and the minimal impacts to the canal sides), an interim report was produced for Bill Horner (Devon archaeology – Buck 2009).

In a joint project with SWW, the TVMHP agreed to fund cattle fencing along all of the west side of the canal, in order to stop further damage being caused to both sides by cattle drinking the water and wandering (on one occasion into Tavistock!), and to create four cattle drinking sites. SWW agreed to fund the repair of the sides of the canal bed. Furthermore the TVMHP agreed to re-bed and re-seed where necessary the canal towpath later in the autumn of 2009, and at a later stage (2011), to repair the damaged lock gates. In addition, the TVMHP agreed to undertake small-scale structural repairs to the small aqueduct bridge in 2012, and a small amount of repointing.

2. Aims and objectives

The aims of the project were as follows:

- To ensure that site works are undertaken in such a way as to maintain the integrity and authenticity of the historic resource, minimising adverse impact upon the resource.
- To ensure that the Devon County Historic Environment Service (DCHES – Bill Horner) are appraised of all site works.
- To ensure that the highest possible standards of the historic environment conservation works are maintained, which must be carried out to recognised current best standards in this discipline.
- To ensure that works are undertaken in such a way as to allow adequate recording of remains affected by the works.
- To record sites, features, deposits and artefacts affected by or uncovered by the works.



Cornwall & Scilly
Historic Environment Record
Figure 1:
Location Map
Project Area
Originator
Date
N
Devon
Cornwall
Tavistock
Lumburn
Colcharton House
Parswell
Higher Parswell
Bowrish Cottages
Saw Mill
A 390
West Bridge
Coll
Cemy
Brook Mill
Lower Brook
Crowndale Farm
Mine (dis)
Shafts (dis)
Sewage Works
Rixhill
Court Cott
Quarry (dis)
FBs
FB
Crebor
Buctor
Five Acres
Tips (dis)
Shafts (dis)
Hurlditch Horn
Wheal (dis)
Shaft (dis)
Shillamill Viaduct
Shillamill
Shillamill Bridge
Shillamill Wood
GULWORTHY CP
Higher Tor
Devon Way
Resr
Lodge
0
0.5
1
1.5
Kilometres
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- To record the character and extent of works to the sites.
- To inform the Devon County Archaeologist of the nature, condition and significance of the canal and towpath, and describe the proposed impacts and a mitigation strategy (agreeable with the Devon County Archaeologist).
- To disseminate the results of the project appropriately and arrange for the deposition of the project archive (within IfA Guidelines).

It was proposed that the building conservation and repair programme will address the following:

- The protection and consolidation of significant archaeological remains in their settings.
- Health and safety aspects of the site relating to public access.
- Provision of low-key public amenity use where appropriate, incorporating access.
- Interpretation of the site to the public, including on-site and written materials.
- Linking the site into the local economic, social, tourism and recreational contexts.

In terms of the management of archaeological features, engineering works were kept to a minimum, but in view of the fact that the entire site is part of the Tamar Valley component (Area 10) of the Cornwall and West Devon World Heritage Site mining landscape, particular attention was paid to suggestions for the best mitigation of any such works.

3. Historical background

This subject matter has already been written in far more detail than is necessary for this report, notably by Hadfield (1967), Booker (1971, who reproduces the tonnages in Appendix 2), Hedges (1975), Woodcock (1995, Vol 6; 2005), and more recently a publication by Robert Waterhouse (2012), and a forthcoming detailed book. The text below is a summary history and construction account of the Tavistock Canal extracted from all of the above sources.

The medieval borough of Tavistock has always been closely linked to its port, Morwellham. That link was dramatically improved by the construction of the Tavistock Canal from 1803 to 1817. The main structural features of this major construction throughout its full length can still be seen today, over two hundred years later; the wharves at Tavistock and Morwellham, the aqueduct over the River Lumburn, the 1.5 mile long tunnel under Morwell Down, and the remnants of the incline plane down to Morwellham.

The historical chronology for the canal can be summarised as follows:

1796 The opening of Wheal Friendship Copper Mine, Mary Tavy, unintentionally led to the construction of this canal. The export of ore and import of coal and other materials needed to be cost effective – its transport costs by horse and cart must have been prohibitive. The young mine's engineer (in his twenties), John Taylor, had the idea of linking the Tavy and Tamar valleys, whilst using Morwellham to export the ore (via sea going ships); the nearest active port to Tavistock.

1800 By the turn of the 19^{th} century, the country had been at war with France for a few years. Demand for metallic ore, and therefore the need for a canal were high.

1802 Survey of the proposed canal route (presumably with the blessing of the Duke of Bedford) by John Taylor, the mining engineer of Wheal Friendship copper mine.

1803 (March) A canal company, funded by shares from the London Stock Exchange (see front cover seal image), was formed. Work began on the route in 1803, following the passing of an Act of Parliament. The canal was to be 16ft wide and 3ft deep, with a branch to the slate quarries at Millhill. It is likely that the first section of the canal route followed an earlier leat from the River Tavy to Crowndale Mine. Raising funds on the stock exchange gained stock interest from adventurers to exploit known lodes whilst tunnelling through the granite of Morwell Down, and for additional shares to be

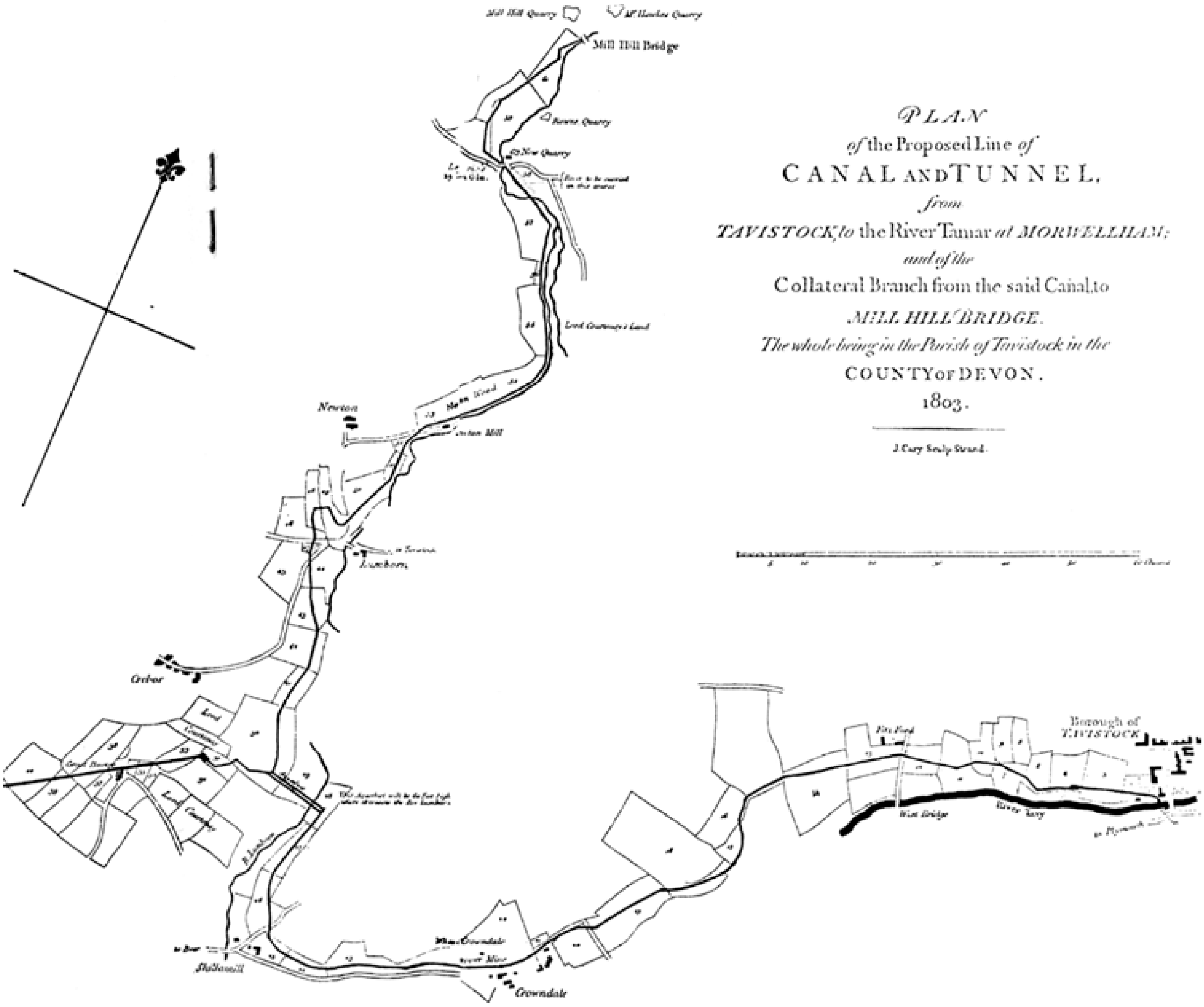

Figure 2 Excerpt of the 1803 survey plan (within the study area) of the proposed Canal route from Tavistock to Morwell Tunnel (Hedges 1975)

purchased by other mines and Tavistock businesses along its course, all recipients of the canal's cheaper transport costs. However, Hedges (1975) hints that Taylor's real motivation for the project was not primarily to build the canal, rather the opportunity to exploit known lodes under Morwelldown, a mining speculation.

Figure 2 shows the original planned 1803 route. The provision of water via leats from the western end of the canal (top of the Morwellham incline) for other mines in the Tamar Valley as far north as Gunnislake to power water wheels was also planned. The original cost estimate for the canal was £40,000 (including testing for ore lodes), at £100 per share. The Duke of Bedford, who owned all the land along the canal's course, also purchased 1/8 of the shares and took dues for use of Morwellham Quay. He also agreed to a request to make a grant of a Mining Set: (for working all Lodes discovered in the Course of the Canal, Embankment, Tunnel and collateral branch for copper, tin and lead to the extent of 500 fathoms East and West of the canal for every Lode discovered), for the sum of 1/10 dues and a term of 42 years.

The principal engineering features being the aqueduct over the River Lumburn, the 2,540 yard tunnel through Morwelldown, and the inclined plane west of the western end of the tunnel down to Morwellham – a fall of 237 ft, the greatest in southern England at that time.

Figure 3 Excerpt of the 1867 Bedford Estates survey plan (DRO T1258M) showing the canal within the study area.

1803 (23rd August) Work began on the tunnel. Almost immediately copper was struck at the Tavistock end of the tunnel, and the lode developed to realise what later became Wheal Crebor (see Fig 3). Men were employed to work both concerns – the accounts separated. The Canal Committee managed both concerns until 1812 when a separate Committee was appointed after further copper ore discoveries in the tunnel under Morwelldown (Hadfield (1967, 128).

1808 The waste rock and ground from the tunnel excavation was boated eastwards back to the tunnel entrance and used to infill and form the Lumburn Aqueduct over the valley, with a central spanning arch.

1809 Work progressed slowly in the tunnel (by this date it was half finished), as the canal section from Tavistock to the tunnel was finished (ie, this project's study area). This was built more permanently with stone sides (on edge) rather than puddle clay. The tunnel rock was granite, its depth 160 yards below the top of the hill. Pumping/ventilation/winding and access shafts (at least four – the main one being Bray Shaft), had to be sunk from the top of Morwelldown to the underground canal. John Taylor designed the power source for the shaft workings by utilising flat rods (for lengths up to 1.5 miles) powered from a large 40′ water wheel. He also designed a ventilation fan for improving the air quality, for which the company was awarded the medal of the Society of Arts in 1809 (Hedges 1975).

1810 The tunnel advanced at a rate of about 150 fathoms (six feet per fathom) per year until this year when three granitic dykes were cut, slowing the work rate to nearly a third that amount for two years. 30 to 40 workmen were continually employed, with some authors suggesting French prisoners of War used as 'navvies' (Barton 1964, 93 and Booker 1971, 108).

1815 From this year there were shipments of manganese from mines around Brentor and Milton Abbot carried by the canal. These were the principal sources of manganese in the country at a time when it was used in the manufacture of glass. For example, 13,335 tons were shipped to Plymouth in 1819. The ore was ground in a mill powered by the Morwellham water wheel (Booker 1976, 19), and exported in casks.

1816 (August) Tunnels were cut from both ends (simultaneously), to form a working area and to align both ends. They connected on the 21st August. Then the tunnel was enlarged (downwards and wider) throughout its length.

The demand for metallic ores to feed the Napoleonic war years (1793 – 1815) slumped as the soldiers returned, as markets waned. The canal committee, sensing further financial difficulties in September stated *'That the Tonnage will fall very short of the original estimate cannot be doubted; at the time when this was made the Mines in the neighbourhood were in their most flourishing condition, or rapidly advancing to it. Agriculture encouraged by high prices was improving everywhere, and the use of lime, so essential … was very great and increasing. Slate quarries, then making large returns, were in full activity, and new ones opening. In all these sources of oecumenical mode of carriage, the greatest reverses have taken place, and at present a stagnation of enterprise and consequent inactivity prevails'* (Hadfield 1967, 130). However, the population of Tavistock had increased from 1801 to 1821 by over 62%, reflecting the growth in the area, primarily a result of mining operations and related tertiary expansion.

1817 The tunnel was finally completed early in the year, with the official opening ceremony held on 24th June. Thousands attended the event, with over 300 going in boats (with a band) through the tunnel – to be met (with obvious relief) by thousands more at the Morwellham side. All were then given a demonstration of the workings of the incline railway mechanism and tramway down to Morwellham (see Buck 2005 – Sites 58 to 64), powered by a large water wheel and the canal water – which was also recently completed. The boats (specially designed and built by the Tavistock foundries from 1811 to replace an earlier wooden design), were *c*30 feet long, 5 feet wide and towed along the slow moving open canal by horses. They were worked through the long tunnel by two men using iron bars against the rock face.

The canal had taken 13 years to build. Its final cost was £62,000, the excess over the authorised capital of £40,000 having been raised by calling £155 on each £100 share.

1819 Although the economic outlook for the area was not good, the company decided to press ahead with the Millhill canal branch to the slate quarry. It was 2 miles long and cost £8000. It rose by 19.5ft to Millhill, with an inclined plane for the final section due to the scarcity of water (double tracked with two cradles counterbalanced with loaded boats going down pulling the empty ones up with the help of three horses).

1820s The expected tolls were halved from their pre-construction estimates – due to the gloomy economic climate. Over the next three decades the canal carried between 15,000 to 20,000 tons per year, earning an annual profit of approximately £600.

1831-2 A Cholera epidemic in the locality severely affected the workforce, the local economy and (temporarily), the canal's fortunes.

1841 Great Western Railway completed.

1844 Discovery of the main copper lode (40′ wide) at Wheal Maria later Devon Great Consols – reversing the fortunes of Tavistock over the next 30 years, but reducing those of the canal. The Mill Hill Tramway was constructed this year (replacing the earlier section of the canal which had been closed after 1831), at a cost of £1,381 (Hadfield 1967, 132).

1847 20,132 tons were carried on the canal (Woodcock 1995, 23).

1848–9 Another Cholera epidemic.

1850 The goods carried on the canal were (tons): Sundries (7548), Limestone (3130), Copper ore (2.499), Slate (676), Granite (83) and Mundic (pyrites) (94). Tonnage carried fluctuated from year to year, reflecting the area's economic woes (or successes). In a bid to maintain revenue, at various times throughout this period, the company reduced tolls, or raised them again when economic conditions improved. But dividends, throughout the life of the canal were always modest, and profits turned out to be at a level 1/3 predicted at the outset.

1851 In the 1851 census, there were 27 barge men working for their various employers regularly using the canal.

1857 Shares that had changed hands at £100 in 1803 were now changing hands at £5.

1859 Construction of the Devon Great Consols railway from the mine to Morwellham with a separate incline section down to the port finished this year. Also the South Devon & Tavistock Railway from Plymouth to Tavistock opened (later extended to Launceston) – in direct competition to the canal. Due to this competition, the company further reduced its tolls after the opening of the railway. However, in the same year it expended more capital on renewing the inclined plane mechanism, and investing funds on a steam mechanism to pull loaded barges through the tunnel against the water flow (it often took a couple of hours or more to undertake this manually!). This was not successful.

There is no doubt that the waning fortunes of the Tavistock and Tavy copper mines, working for the past half century, were no competition for the resurgence of the Tamar Valley copper mines from the mid 19th century. Whilst the former utilised the Tavistock Canal as a transport medium during this period, the latter formed its own railway equivalent; but both used Morwellham as the export destination. Given the rapidly changing transport infrastructure due to the construction of mainline railways to the south west from the mid 19th century (consequently resulting in dramatic changes to market influences), across Devon and Cornwall at this formative period, so the fortunes of this old transport route was found wanting and uneconomic.

1860 In the previous year, the canal tonnage was 17,455. In this year it fell to 13,500. From 1863 onwards there was a steady decline in the tonnage until, in the early 1870s it dwindled to nothing (Hedges 1975, 28).

1862 A shareholder from Birmingham wrote to Mr Gill, representative of the Canal Company and said: *'I am afraid there is little hope of the canal rising in its fortunes with the railway for a rival. Here we have in several cases united the canal with the railway with advantage to both – you know best whether such an arrangement with the Tavistock canal would be advisable'* (Hedges 1975, 28).

1866 In September, the canal committee recorded; *'That a very considerable reduction having taken place in the traffic and dues of the Tavistock Canal Company since the opening of the Tavistock and Launceston branch of the South Devon Railway it was resolved that His Grace the Duke of Bedford be applied to kindly assist the Tavistock Canal Company to compete with the Railway Company by reducing the Canal Dock dues at Morwellham'.* The Duke was evasive (Hadfield 1967, 134).

1870 Only 783 tons were carried on the canal (Woodcock 1995, 24).

1872 Presumably the economic situation became even direr. At a meeting on 2nd September the Duke offered to buy all the shares at £8 each, and to pay half the cost of an Act to transfer the canal to him. Within the month, the committee accepted his terms. Since the summer there had been no traffic on the canal. However, this was not a localised occurrence; the impact of the railways had dealt a death blow to innumerable canals all over the country.

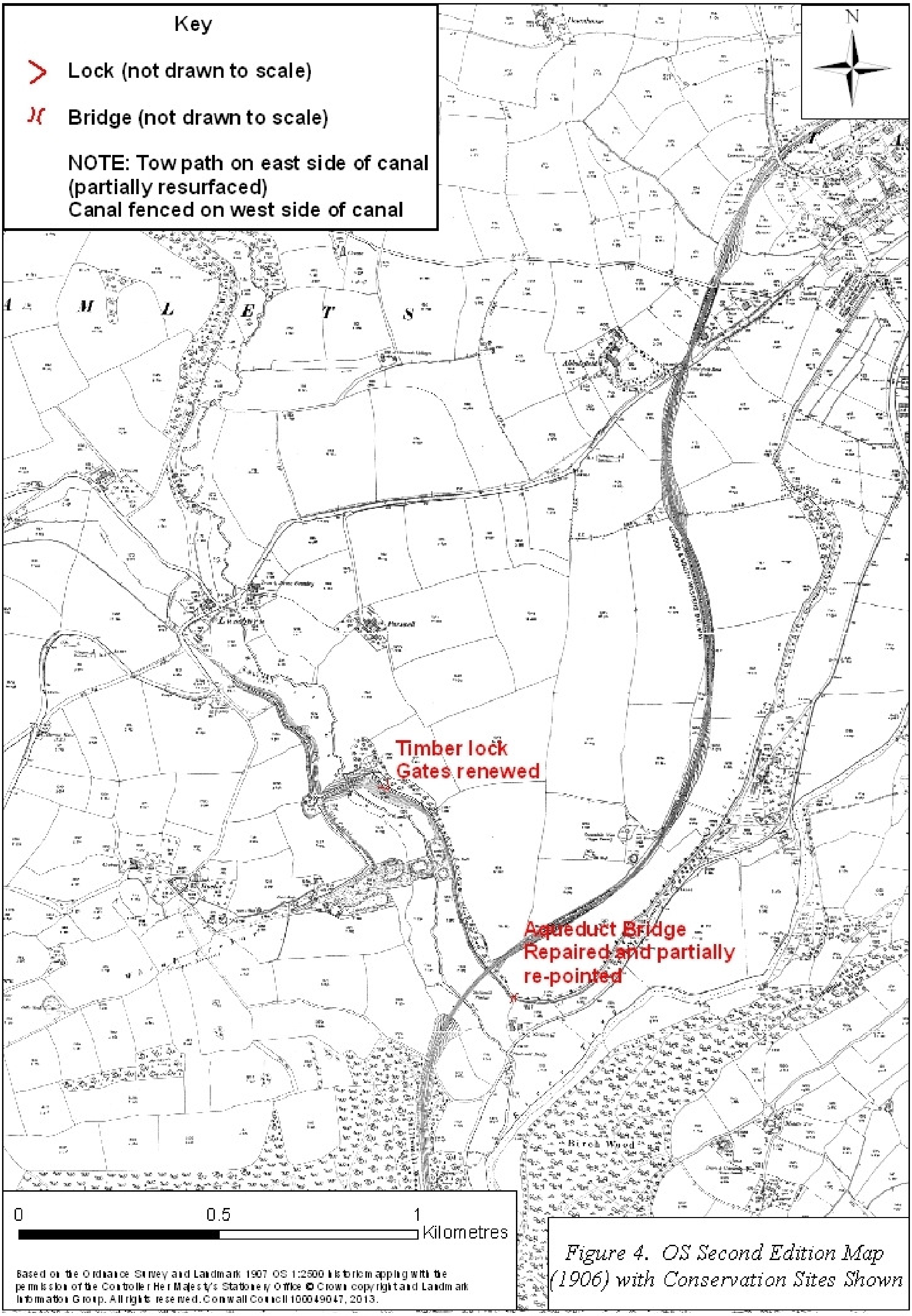

Figure 4. OS Second Edition Map (1906) with Conservation Sites Shown

1873 In May the Act was passed and the Tavistock Canal and land returned to the Duke of Bedford for £3,200, there being no obligation on the Duke to maintain the canal. It is uncertain what use the canal had for the next twenty five years.

1896 This perhaps was made clear in May of this year when the Tavistock Gazette reported that on Whit Monday the basin of the Tavistock Canal was to be cleaned out (it appears a regular activity on this day). *'The cleaning is wanted more now than when it was a hive of industry … a resident noted ... A great deal of sewage was emptied into it, and the water does not run at a greater rate than half a mile an hour. I have seen dead dogs, cats and rats in the canal'* (Woodcock 2005, 26).

1898 The Tavistock Canal was not included the Canal Returns.

1933 After cleaning the canal bed (which must have been quite onerous!), the West Devon Electric Supply Company built a sluice gate near the west end of the tunnel portal, to convey water to a header pond (Forebay) to go down to hydro electric turbines via large tubes at Morwellham Power Station, next to the River Tamar.

In 1923 and 1933, mining geologists Cloke and Barclay carefully assessed the lodes intersected by the tunnel during a tunnel assessment and clearance scheme (CRO AD58-26). They confirmed that the tunnel intersected eight or nine lodes and three cross-courses, but only two of these (East Russell and Georgenia Lodes), had any stoping accessed by the canal. The only repairs necessary were to the Morwellham portal end retaining wall.

Footnote:

The canal has been maintained and managed by the owners of Morwellham Power Station since 1933. For some time this work has been undertaken by South West Water and British Waterways, the former now monitors and maintains the canal, carefully regulating the flow to utilise the instant generating capacity of the hydro-electric power station at times of peak demand (to provide a cost effective monetary return). It is poignant perhaps that the canal still exists today due to its economic usefulness.

4. Impact assessment

This summary impact assessment is intended to inform and guide Devon County Council Historic Environment Service of the impact of the canal repair works, the aqueduct bridge repair and lock gates replacement. This section of the report summarises the archaeological resource, and describes the impact and mitigation of the canal works as part of a mitigation strategy. However, it should be noted that the mitigation procedure was undertaken during the project (due to the lack of advanced project specifications), by efficient communication between the report author (as site archaeologist), Bill Horner (DCC archaeologist), Chris Hariades (TVMHP Project manager), and South West Water. A structural engineer, Andrew White of Knevitts Ltd produced specifications for the aqueduct bridge structural repair (see Fig 12).

The sites impacted by the repair works are shown in Figures 5, 6 and 12 and reproduced on plan in Figure 4. The main sites include repair works to the sides of the canal itself, structural repairs to the aqueduct bridge, and repairs to the lock gates. The impact of the repair and conservation works on each site is then described, and a final section details the impact remediation measures.

The potential impacts during works are described below. Impacts are described in the text section for each site on a feature-by-feature basis. The following site impact terms are used within each site identification description:

Major positive	Site continues in, or is restored to, its original design and use
Moderate positive	Site restored as far as possible respecting its original function, but its use is altered
Minor positive	Site partially restored; interpretation introduced
Negligible positive	Stabilisation/maintenance of site
Negligible negative	Benign neglect – losses of fabric over a long period of time

Minor negative	Site suffers areas of alteration or damage, which contribute to loss of meaning
Moderate negative	Significant loss of fabric or alteration, leading to erosion of original character
Major negative	Complete demolition/removal

Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the end of the Lumburn Aqueduct **SX 46237 72628,** see Fig 1).

Description

The canal section impacted by the repair works was built between 1803 and finished by 1809 (as described in the historical background section). This section of the canal may well follow the course of a mine leat from the River Tavy to Crowndale Mine, which pre-dates construction of the canal. For much of its length the canal's west side (see Fig 4), cuts into the valley side – revealing vertical bed-rock and also frequently forming the bed of the canal. Excess stone material from the rock cut was used to form the rounded profile edge of the east side of the canal – using slate/killas stones set on edge. The tow path was formed along this eastern side. The canal is approximately 4.0m wide, 0.3m to 0.5m deep, with the east side approximately 0.6m to 0.8m deep from tow path surface to water level.

Repair works to the canal's east side (and towpath) has been undertaken in the past, sometimes inappropriately using cement and concrete formwork. The 2009 repair work to both sides of the canal and re-surfacing parts of the towpath continued with this theme of patching the damaged sections (Fig 11).

Site works impact (2009)

The repair works relate to identifying areas of the canal sides that needed to be patched with new (similar specification) stone within the section of canal identified above. This should immediately stop progressive damage to the canal sides and help to support the well used canal towpath. There is no site plan showing each small repair section, rather a canal bank repair work schedule (Appendix 1).

Other works to the canal itself that were proposed include patching and re-surfacing the tow path. South West Water (SWW) undertook its own Risk Assessment for each tree close to the tow path. Mitigation works resulting from that survey (i.e. branch or tree removal) was undertaken by SWW.

The overall impact of the works on the canal can be defined as '*Negligible positive'.* The works reduced collapse of parts of the canal's east side to maintain structural stability, provided more tow path stability and a higher degree of Health and Safety for increased public access for at least another generation. However, it is hoped that the track is adequately annually maintained.

Residual impact (2009)

There have not been significant residual impacts in the medium term – apart from the visual aspect of the replacement stone looking newer than the original stone surrounds.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of replacement stone (to match existing), reduced the visual impact of patching the sides of the canal. Other reduction impact measures included the tendering for appropriately qualified and experienced contractors to reduce the visual effect of repair sections to the canal, and for the quality of the work, which was of a good standard (reflecting the original construction style). This project should reduce the need for this work to be undertaken for at least another generation.

Aqueduct Bridge SX 46630 72090

Description

The aqueduct bridge carries the canal over an access lane to fields north of Shillamill Farm – whose access was cut by construction of the canal. The iron plated trough structure seen today was built in 1839 by Gill & Co of Mount Foundry, Tavistock (Buck 2007), replacing an earlier structure. The bolted sections of the trough extend to either side of the granite quoined masonry, and are supported by four wrought iron lintels (widening into the masonry sides) set into the granite masonry. Three other similarly styled lintels (see Fig 13) provide the support for large slates under the tow path on the south side of the canal. The middle lintel however has rusted to the extent of being ineffectual. A structural survey by Knevitts Ltd has recommended its replacement, as the aqueduct is not only used by tow path walkers, but is proposed to be accessed via the adjacent fields, in order to link up the railway (Buck 2009) with the canal – by a new DCC footpath route under the aqueduct – formerly used for access to the upper field.

Patch repointing to the sides of the bridge under the aqueduct in recent years has occurred, however more often than not this has been using cement, using a variety of styles. At the northern end of the side walls the stonework has been leaking for some time where water is leaking from the junction of the wrought iron plates with the canal bed. This has caused the masonry to be soft, and the stonework made weak – causing a noticeable dip on either side.

On the south west side of the aqueduct a high vertical retaining wall supports the tow path and masonry for retaining remnants of steps, to allow pedestrians walking the towpath to access the lower field. Some of this vertical retaining wall has areas of lime mortar pointing that is loose.

Site works impact (2012)

After dialogue with the TVMHP manager, the structural engineer, the landowner of Shillamill Farm, the Devon County Archaeologist and consulting project archaeologist; the TVMHP agreed to fund replacement of the centrally located rusty wrought iron lintel, and to undertake limited lime mortar repointing where structural stability of the adjacent walling could be compromised.

Site impact of the replacement lintel was minimised by matching most of the original profile of the replacement item as far as could be possible from an 'off the shelf' steel equivalent (in order for the project to be cost-effective), with the original wrought iron lintel.

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works have reduced the potential for collapse of the tow path as it runs next to the canal aqueduct. This project will provide a higher degree of Health and Safety for increased public access for at least another generation.

Residual impact (2009)

There are unlikely to be significant residual impacts in the medium term – apart from the aspect of the replacement iron lintel and repointed masonry looking newer than the adjacent (cement) based repairs.

Reduction of impact (2009)

Site consultancy with the project manager and structural engineer will minimise any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors should mitigate the visual effect of a new structural item, and for the quality of the work to be of a good standard, reducing the need for this work to be undertaken for at least another generation.

Lock Gates and timber lifting bridge SX 46327 72628

Description

The construction of the adjacent Canal cottage for operation of the lock gates, the lifting bridge and the visible remnants of the semi-circular trans-shipment basin (or turning/waiting area) is indicative that this part of the canal was quite busy! The latter

(sited close to the lock gates) is now infilled, but the tops of some of its vertical timbers still visible. The necessity of keeping the water at the correct level was important for the tunnel – this lock gate possibly forming this function also for the Lumburn Aqueduct (SX 46311 72632 to SX 46184 72581), with its single arch to the south. According to Waterhouse (forthcoming) the timber lifting bridge is of a Dutch design common on canals in the Welsh borders, and may not be contemporary with the canal's construction.

The lock gate and lift bridge was previously restored by October 1998, funded by South West Water and British Waterways. However, as Figure 15 shows, one of the timber arms of the lift bridge had snapped and parts of the timber walkway rotted. In addition the lower parts of the swing lock gate has rotted where it is in contact with the canal water.

Site works impact (2012)

The TVMHP agreed to fund replacement of the timber components that were rotted or had broken or snapped off. This includes the large timbers to open the bridge and the Lock gate. The TVMHP tendered for experienced Carpenters to assess both features and to price for the production of making and erecting replacements.

Site impact for the replacement timbers was minimised by specifying exact replacements with the existing timbers (previously replaced in 1998).

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works reduced the potential for further timber rotting and collapse, an important Health & Safety measure so close to the well-used canal towpath. This project has provided a higher degree of Health and Safety for bridge use and public access for at least another generation.

Residual impact (2009)

There are unlikely no significant residual impacts in the short term.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors mitigated any possible mistakes, the quality of the work was of a good standard, and reduced the need for this work to be undertaken for at least another generation (Fig 16).

5. Impact mitigation strategy

The impact mitigation strategy is divided into three stages: The pre-works consultancy, the Historic Buildings Consultancy during works and the archaeological recording record (during and after works). This mechanism demonstrates the steps that have been taken to avoid or minimise adverse impacts, and confirms that the proposed works have been designed in close liaison with the historic environment consultant. Consultation is based on a clear understanding of the significance of the site using appropriate methods and techniques for site monitoring and recording.

HES Projects (Project number 20070793) was commissioned to undertake the three components described as the impact mitigation strategy. The project was based on a project design produced by Colin Buck (21/07/06), and recording specifications defined by Bill Horner (DCC archaeologist).

6. Working method

The following text summarises the general WSI for all archaeological consultancy and archaeological recording for projects relating to the TVMHP (Tamar Valley Mines Heritage Project: Written Scheme of Investigation: Historic Building and Archaeological Recording Consultancy 21/07/06).

- A brief historical survey was compiled from existing Devon County sources (DCHER, DRO, and local libraries and historians (including Robert Waterhouse's recent published work on the canal).
- A walk-over survey was undertaken of the entire length of the canal for sites impacted by the TVMHP.
- An impact assessment described and mitigated the proposed work as part of a Mitigation Strategy to minimise the works affecting the site's character.
- General working methods for archaeological recording, treatment of finds, photographic surveying and report production are described in detail in the Tamar trails WB WSI produced in 21/07/06.

All archaeological recording work was undertaken according to the Institute for Archaeologists (IfA) *Standards and Guidance for Archaeological Investigation and Recording. Staff follow the IfA Code of Conduct* and *Code of Approved Practice for the Regulation of Contractual Arrangements in Archaeology.*

The principal factor in effective project delivery was the employment of key project staff who are expert in the management and recording of the industrial heritage. Cornwall Historic Environment Service project staff can draw upon a substantial track record in undertaking similar work throughout Cornwall, as well as a detailed knowledge of the project area and its sites.

Historic buildings consultancy

- HES (Senior Archaeologist) liaised with the Devon County Historic Environment Service - DCHES (Bill Horner), and the TVMHP Project Manager (Chris Hariades).
- The HES Senior Archaeologist attended regular site meetings when appropriate during the duration of the project.
- HES ensured that site conservation works are carried out to standards recommended by English Heritage best practice.
- **Fieldwork: archaeological recording**
- There were no newly exposed archaeological features revealed through excavation.
- Where appropriate, measured survey was carried out by hand measurements (using offset techniques at a scale of 1:50.
- The resulting survey output was a revised measured survey drawing showing all conservation works that had been undertaken. This was reproduced at a scale of either 1:50 or 1:100 (appropriate to the size of area recorded) and will form part of this archive watching brief report.
- Analysis of the building fabric was recorded in the form of field notes and written up in this archive report production stage.
- DCHES (Bill Horner) advised that archaeological recording should be undertaken during any excavation that revealed archaeological features. Recording was undertaken using a mix of direct measurement, sketch plotting and photography, as appropriate (constrained by safety factors).
- Where significant remains were encountered the site archaeologist was given the opportunity to make an appropriate form of record before work proceeds.
- The chosen site archaeologist adhered to Health and Safety Policies (see below), under the direction of the designated Site Safety Officer.

Site recording (general)

- Site drawings (plans, sections, locations of finds) were made by pencil (4H) on drafting film; all plans were linked to the Ordnance Survey landline map; all drawings included standard information: site details, personnel, date, scale, north-point.

- The site archaeologist undertook the recording in line with recommendations given by IfA. Sections and plans were drawn on site at appropriate scales which adequately recorded structures or features at appropriate levels of detail, and appropriate sections reproduced in the archive report at either 1:50 or 1:100 to adequately demonstrate revealed archaeological features.
- All features and finds were accurately located by means of a National Grid reference and all archaeological contexts will be described using a standard format and linked to a continuous numbering sequence.
- The archaeological watching brief report detailed all forms of archaeological recording that had been undertaken at each of the mine sites. Each major mine site had a single archaeological watching brief report that details all project related work to that site (i.e. trails works, building conservation works, interpretation works, etc).

For Treatment of finds, Photographic recording specifications, report production and archiving specifications refer to the TVMHP WSI (2006).

7. Results

Unfortunately, there was insufficient time (following receipt of a detailed plan and description of the canal repair works from the TVMHP), prior to the start of works on site to produce an impact and mitigation report for DCC (Bill Horner). A decision was therefore taken to minimise impacts and mitigate directly with the TVMHP and site contractors on site as works were progressing as part of a weekly site recording and consultancy. SWW funded the stone and path repairs to the canal bed whilst the TVMHP funded fencing of the north and west sides of the canal, to stop encroaching animals from the adjacent fields from directly accessing the canal (and walking up the towpath!). An interim archaeological recording report of these works was produced by the author on 17/06/2009. This report supersedes that report.

Repair works to the bed and towpath of the Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the start of the Lumburn Aqueduct **SX 46237 72628**)

In early 2009, the TVMHP tendered for stone masons (on behalf of SWW) experienced in rebuilding stone walls, etc, to undertake these works within a narrow time-scale of three weeks, when SWW were willing to reduce the water flow through the canal (which would stop the electricity generating turbine). The turbine normally operates all year round, often at short notice when generation rates for electricity peak (the turbine can instantly generate electricity). Clemens Stonemasons of North Cornwall were successful in winning the contract. Prior to this, the TVMHP Manager, the archaeological consultant and SWW projects officer, produced a repair work specification schedule (measured from the small swing bridge at Tavistock: SX 47348 73503), which focussed on identifying the repair of collapsed sections of canal bank on the south or east sides. Appendix 1 is a reproduction of this original document.

Site work started on 05/05/09 at the northern end of the canal and progressively worked southwards towards the lock gates at the Lumburn Valley. With the reduced water level in the canal (and its slow movement when full), many stones that had fallen out of place were found in the canal bed not far from their original bank location. When the canal was constructed the stones were originally set on edge, a minimum of two/three stones height (approximately 0.6m to 0.8m above water level). During the repair project, where there was insufficient stone to replace the collapsed sections, a similar stone was imported from Trebarwith Quarry, North Cornwall (purchased from the local quarry at Millhill). These stones were reset on edge, following the original profile of the canal bank, and tightly tamped down in position (tops and sides). Earth was backfilled into the top sides of the stone to re-form the edge of the towpath. This was then at a later date, re-seeded. Figures 7 and 8 show examples of before and after photographs of the repaired canal bank. The work has been sensitively undertaken and reflected the style and character of the original construction a century ago.

Weekly site meetings were arranged to view the previous week's repairs and to discuss any foreseeable problems within the following weeks programmed work. A granite towpath stone under the Crowndale bridge at SX 47194 72541 had become dislodged (into the canal), and some quoin stones from the bridge parapet wall had fallen into the canal. The former was repaired by contractors; the latter will be removed from the river by SWW to be replaced on the bridge parapet wall at a later date. A small section of old 2" timber (2m long) set in the lower part of the bank was replaced back into its original position following repair of the wall at this location (SX 47270 72707).

The canal bank repair works (see Appendix 1), were finished on 28/05/09, including an additional element of work totalling 87 metres, which the contractors identified whilst on site. A total of 337 linear metres of canal bank was repaired (only on the south/west side), using a total of 86 tons of additional Trebarwith stone. The canal repair works were funded by South West Water.

Figure 5 is a site plan and specification document for the installation of timber post and wire stock fencing along the west/north side of the canal and construction of three cattle drinking areas to minimise any future erosion of the opposite (north/west) side of the canal bed. The cattle drinking sites are located at SX 47384 73064, SX 47257 72705, and SX 47078 72415. A concrete pad (min 0.3m thick), varying from 3m to 4m wide and approximately 5m long, has been created to at each of these sites to form the post and rail fenced cattle drinking areas that should minimise further damage to the banks (on either side). An additional cattle drinking area was constructed on bedrock immediately on the west side of the Shillamill Viaduct (see Fig 6). Figures 9 and 10 show before and after views of a cattle drinking site (SX 47384 73064).

Approximately four months later, the surface of the canal towpath was patched with crushed stone (803 specification) where the path was potholed or muddy, then sections covered with finely ground stone (6mm to dust) from Meldon Quarry.

During construction of the cattle drinking sites and during the canal repair works there has been minimal archaeological impact, nor any finds recorded.

Aqueduct Bridge SX 46630 72090

Knevitts Ltd was commissioned by the TVMHP in 2011, to undertake a structural survey of the aqueduct bridge at this location. Their report and structural drawing (see Fig 12), recommended that a rusty wrought iron support (middle one of three similar supports – see Fig 13) sited under wide slates below the towpath next to the canal, be replaced with a modern equivalent. In addition, it was recommended that the tall retaining wall on the south west side of the aqueduct bridge be repointed and structural ties inserted (using 7mm diameter stainless steel helibars) into the masonry bedding joints to strengthen a structural crack in the masonry.

This work was not started until May 2012, following an extensive dialogue with SWW and the site owner. Figure 13 shows the failed rusty element needed to be replaced. The original lintel was 50mm x 50mm for most of its length but widened to 100mm at both ends (and set in the side walls). Unfortunately the original wrought iron section specification was impossible to replace, and an 'off the shelf' item had to be found due to budgetary constraints. Figure 14 shows the new steel replacement *in situ*. Scaffolding had to be erected to remove the original rusty support and to replace it with the new 50mm wide x 115mm deep iron profile steel section. A slightly wider opening had to be made into each granite quoined side of the bridge for insertion of this new structural element. The localised setting was then repointed with lime. The steel was painted with a red primer and then painted black.

Other works to this site included removal of a tree growing out of the west side of the north end of the aqueduct bridge and treatment of the stump, as its unchecked growth had caused structural issues to the masonry at this point. On the opposite side of the bridge opening, the top flanking stones over the east side revetment walling had become dislodged. These were moved back to their original position. TVMHP funded the project.

At the north end of the structure under the aqueduct section, it appears that water has been leaking from the canal at the intersection of the metal 'trough' profile bolted plates and the canal bed – on both sides, through the stone masonry. This has caused the masonry and water at this point lower down under the aqueduct to be constantly wet.

Consequently, the foundations masonry and pointing in this area have softened to the extent that the masonry is collapsing and arching downwards. SWW attempted to add some clay to the leaking intersection point in the bed of the canal, but this has not worked. Structural deterioration will continue unless this issue is resolved. This is a significant feature of the canal which is in places, is now a Scheduled Monument. It is a recommendation of this report that the aqueduct bridge be considered for Listing.

Finally, the vertical retaining walling on the south west side of the aqueduct was repointed and the structural crack that had been identified by the structural engineer, repaired with the use of helibar reinforcing. This work finished in mid June 2012. The repointed wall acted to retain not only the towpath running along the south side of the canal, but also steps that allowed access from the towpath down into the adjacent field. These steps have badly deteriorated, leaving a steep slippery slope. It is recommended that they need to be rebuilt before use of them can be made by a new DCC footpath from the nearby railway linking up with the canal footpath.

Lock Gates and timber lifting bridge SX 46327 72628

The timber lock gate and timber lift bridge was 'restored' in 1998 by SWW and British Waterways. It is not know what the restoration replaced, but parts of the timber lift bridge (mainly the western timber arm), had rotted resulting in collapse (see Fig 15). Other parts of the bridge were showing that many timber items were rotting. In addition, the section of timber lock gate that was in constant contact with canal water had also rotted during the last 14 years. SWW and the TVMHP decided to replace the rotted and unsafe timber items as being a Health and Safety issue, given the frequent public use of the towpath. SWW funded the project.

The project of dismantling the bridge and lock gate, replacement of the main and structural timbers, and re-assembling and fixing on site was tendered. The contract was won by Will Sterling and Son, a traditional timber boat builder and carpenter who worked at Morwellham Quay (repairing and building boats, etc). The work was started in July 2012 and finally finished in September 2012.

Figure 16 is an 'after' view of the works on these features, and should be compared to its preceding figure. It is hoped that this repair will last longer than its predecessor!

Note:

In 2013, the TVMHP constructed a new footpath from near Morwell Rocks (SX 44128 70435) to above George & Charlotte Mine (SX 45101 69962). This new route links the main route of the railway line from Devon Great Consols to Morwellham and the forestry tracks north of Morwellham. Scheduled Monument Consent was obtained in 2012 for construction of a new timber footbridge over the Tavistock Canal (the section from the west end of the Morwell Down tunnel to the incline railway cottage was Scheduled in 2011, SM No. 30973). As part of this project, an impact assessment report was produced (Buck 2012). The results of the new footpath creation and footbridge construction will be produced within the main body of the TVMHP archaeological recording report (Buck forthcoming).

8. References

8.1 Primary sources

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DRO T1258M-14B Bedford Estate Map

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Woodcock, G., 1995, 2005, Booklets on the 'History of Tavistock'.

9. Project archive

The HE project number is **20070793**

The project's documentary, photographic and drawn archive is housed at the offices of Historic Environment, Cornwall Council, Fal Building, New County Hall, 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 (20070793).
2. Black and white photographs archived under the following index numbers:

   GBP 2091/12-21; 2207/12-22; 2250/1-17; 2253/19-22.
3. Digital photographs stored in the directory R:\HE images\Sites\Devon\Tavistock\Tavistock Canal
4. This report text is held in digital form as: G:\HE Documents\HE Projects\Sites\Devon\Tavistock Canal IA WB report 20070793
5. English Heritage/ADS OASIS online reference: cornwall2-154344

No artefacts or environmental material was retrieved during the project.

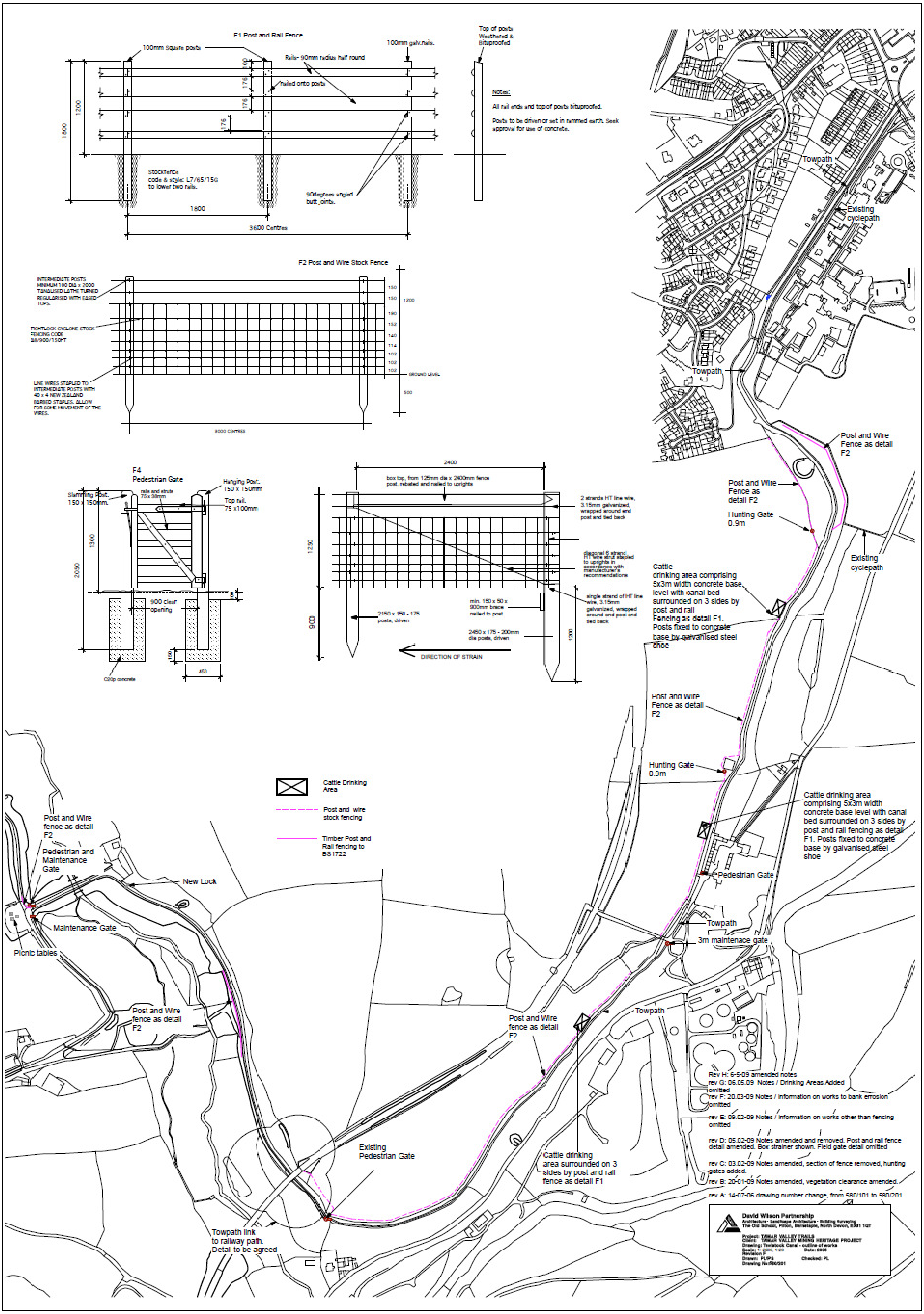

Figure 5   Specifications and plan showing fencing and three cattle drinking areas at the Tavistock Canal(East section)

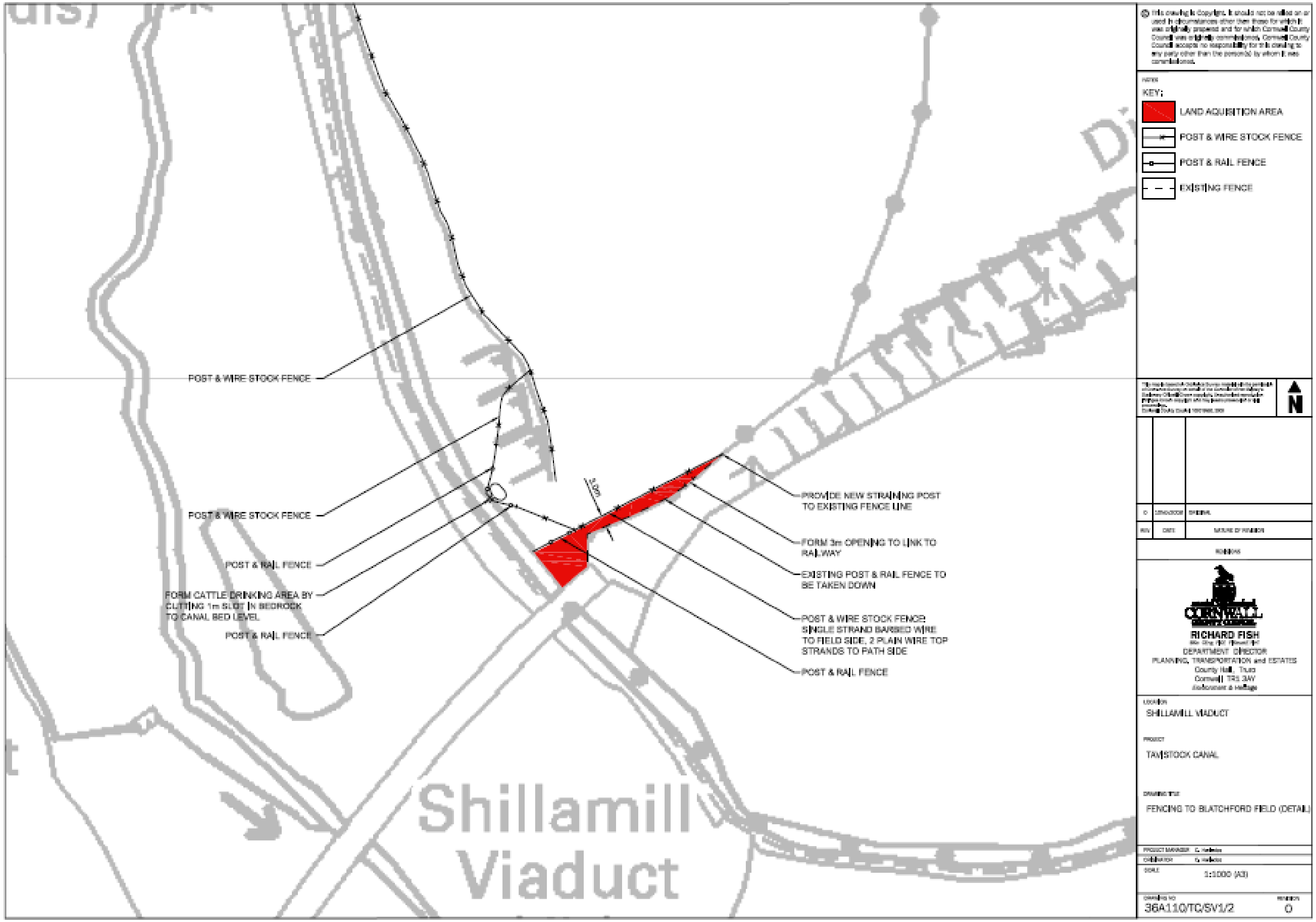

Figure 6 Detail plan showing the cattle drinking area west of the Shillamill Viaduct

Figure 7 A view of the Tavistock Canal east bank before works © CC HE Projects

Figure 8 A view of the Tavistock Canal east bank after works © CC HE Projects

Figure 9 A view of a Cattle Drinking site before works (SX 47257 72705) © CC HE Projects

Figure 10 A view of the same Cattle Drinking site after works © CC HE Projects

Figure 11 A view of the canal towpath after re-surfacing works © CC HE Projects

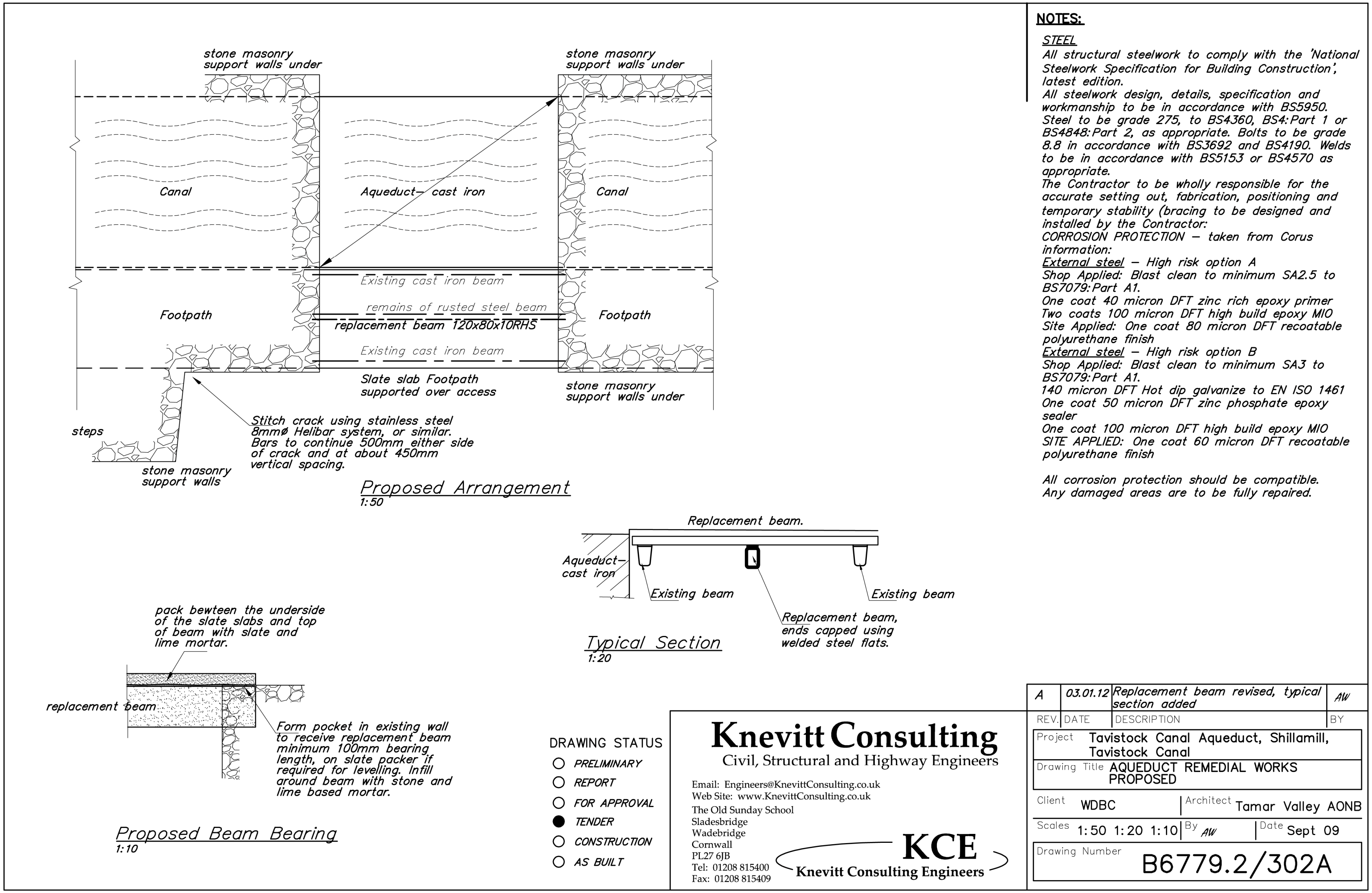

Figure 12 Specifications plan for repair of the aqueduct bridge

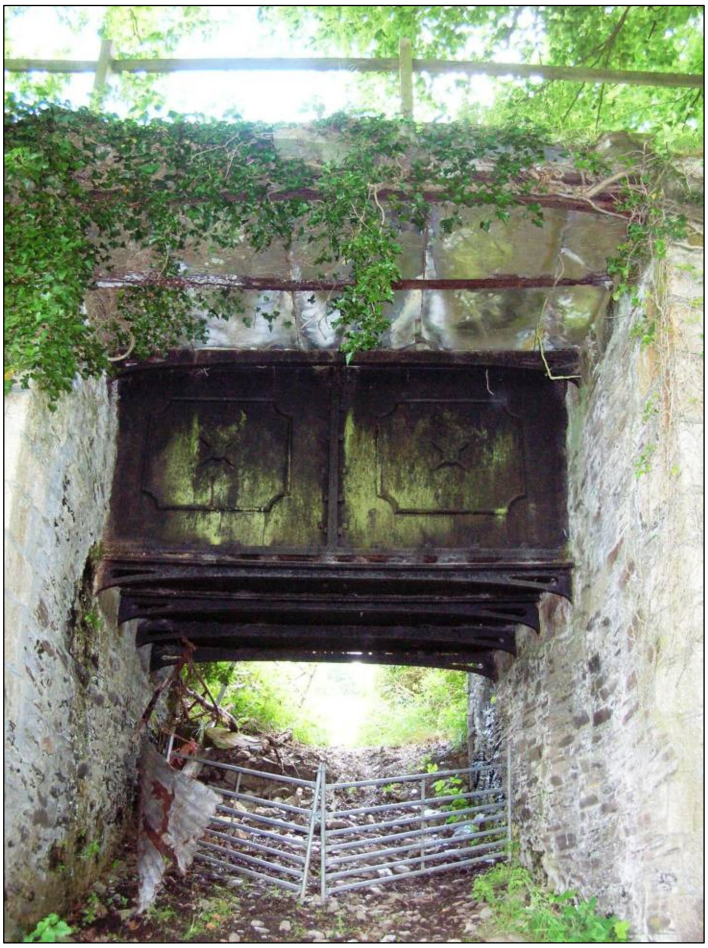

Figure 13 A view of the canal aqueduct bridge before works © CC HE Projects

Figure 14 A view of the canal aqueduct bridge after works © CC HE Projects

Figure 15 A view of the canal lock gate and bridge before works © CC HE Projects

Figure 16 A view of the canal lock gate and bridge after works © CC HE Projects

Appendix 1: TAVISTOCK CANAL BANK REPAIR WORK SCHEDULE

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
20		Side out path and hedge (140m length)
76		1.5m infill behind c $2m^3$
118		1.5m infill behind c $1m^3$
140-150	10	Minor wall top repair
159-160	1	End of hedge
162-163	1	1m infill behind $0.25m^3$
166-179	13	
225-247	22	
253-308	55	Break out conc block
314-323	9	
328-330	2	
394-418	24	
433-461	29	Take off conc
P A T H		
467-469	2	Break out conc
472-473	1	Good example, flat stone
485-488	3	Remove conc, Repair bank
494-513	19	Remove section of conc
530-541	11	
557-558	1	
563-573	10	
577-578	1	
581-584	3	
591-592	1	
600-650	50	
664-673	29	
691-694	3	
703-704	1	
714-718]	4	Soft path, build up levels (ch 14-27)
722-727]	5	
730-735	5	
744-745	1	
751-754	3	
755-760	5	
771-773	2	
779-780	1	
782-798	16	800 ⇒path surface 80ft
800-804	4	
804-806	2	Build up path surface to fall to canal

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
		(ch 800-902)
808-809	1	
813-814	1	
819-820	1	Lay hedge, remove barbed wire (ch 800-902)
823-826	3	
839-842	3	
875-876	1	
892-894	2	
902-903	1	Remove gate, overhanging branch
902-907	5	
970-971	1	Gate and post and rail across path
975-976	1	Surface ok
985-990	5	In deep
1009-1010	1	
1019-1020	1	Take out tree growing out from opposite bank
1068-1069	1	Path surface repair
1093-1094	1	Under bridge
1099-1100	1	Bridge coping repairs 4m copings in canal
1130-1131	1	Boulders ⇑ make up path ⇓ scrape leaf mould
1158-1159	1	
1165-1166	1	
1169-1170	1	
1187-1192	5	
1197-1199	2	
1202-1207	5	
1208-1209	1	
1225-1232	7	
1260-1268	8	
1271-1272	1	
1279-1280	1	
1282-1283	1	
1295-1298	3	
1308-1309	1	
1317-1319	2	
1334-1342	8	
1353-1356	3	
1409-1414	5	
1421-1422	1	
1424-1425	1	

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
1441-1442	1	
1454-1456	2	
1514-1515	1	
1546-1548	2	
1573-1574	1	
1581-1582	1	
1603-1604	1	
1600		Path falls away from canal. (1.5m width)
1691-1692	1	
1718-1719	1	
1721-1722	1	
1726-1729	3	
1820-1821	1	
1856		AQUADUCT (Clear vegetation, Take out gate)
1958-1968	10	Under viaduct
1970-1972	2	
2020-2023	3	
2151-2152	1	
2220-2221	1	
2316-2318	2	WHEEL SLUICE Interpretation Barrier (Take down concrete posts and blocks)
2463-2464	1	
2534-2535	1	
2541-2543	2	Replace Bascule bridge
		Lumburn Valley Turning area at lock (excavate)
2586-2600	214	Opposite bank
TOTAL		

Note:

An additional 87 linear metres of repairs were undertaken by the site contractors as they deemed them necessary. These additional repairs are not reflected in the above schedule chainage list, which was originally compiled by Chris Hariades (in consultation with Colin Buck and SWW (Laura Wotton) in April 2009 to inform tender information and site specifications prior to the start of works. The location of the small swing bridge in Tavistock (from which the chainages are measured) is at SX 47348 73503.

Tavistock Canal - Canal Bank Repair Works Schedule

Item	Description	Qty	Unit	Rate (£)	Cost (£)
1	Provide site welfare facilities to comprise as a minimum porta-loo with handwashing facilities, maintain and take down on completion	Item			
2	Provide all necessary fencing, barriers, signage, maintain for duration of contract and take down on completion	Item			
3	Break out concrete capping (provisional)	50	lm		
4	Clear rubbish from canal bed and dispose to licensed tip (Provisional)	10	m3		
5	Repair identified sections of failed or colapsing drystone facings to canal bank to match adjoining sections using stone salvaged from canal bed	250	m2		
6	Tie and marry in each repair to adjacent sound sections.	100	no.		
7	Extra to bed bottom course of stone on 50mm depth drymix sand/lime/cement bed in ratio 6:2:1 where laying directly onto bed rock.(Provisional)	50	l.m		
8	Extra to import suitable matching stone to make up shortfall in site salvaged material (Provisional)	50	tonnes		
8	Backfill voids behind stone facing to level with top of bank with imported scalpings compacted in layers not exceeding 200mm depth (provisional)	10	tonnes		

Report No: 2013R046

Tavistock Canal, Devon

Archaeological impact and recording report

Historic Environment Projects

Report No	Report Name	Report Author
2013R046	Tavistock Canal – Impact assessment and archaeological recording during a program of repair works	Colin Buck

Event Type

Site consultancy	Archaeological impact assessment	Archaeological watching brief	

Client Organisation	Client Contact
TVMHP (West Devon Borough Council)	Chris Hariades (TVMHP)

Monuments (MonUID)

DHER 3879 (Tavistock canal)	18721	4069	3882	5449	3956

Fieldwork dates (From)	(To)	(Created By)	(Create Date)
05/05/09 05/05/12	29/05/09 05/09/12	Colin Buck	13/05/13

Location (postal address; or general location and parish)

Tavistock Canal (northern section from Tavistock to Lumburn), Tavistock, West Devon

(Town – for urban sites)	(Postcode)
Tavistock	

(Easting) X co-ord	(Northing) Y co-ord		
From: SX 47367 To: SX 46183	73572 72589		

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

List of Figures

Abbreviations

AONB	Area of Outstanding Natural Beauty
CC	Cornwall Council
DCC	Devon County Council
DHER	Devon Historic Environment Record
DRO	Devon Record Office
HES	Historic Environment Service
OS	Ordnance Survey
SWW	South West Water
TVMHP	Tamar Valley Mines Heritage Project
WHS	World Heritage Site

Acknowledgements

Thanks are due to Robert Waterhouse for providing some primary survey data and information files from his research relating to a forthcoming book about the Tavistock Canal. Chris Hariades (Tamar Valley Project Manager), and Bill Horner were involved in the project throughout its entirety. Andrew White of Knevitts Cons. Engs. was involved in preparing the specifications of the aqueduct bridge.

Front cover image: a copy of the Tavistock Canal Company Seal.

1. Project background

The Tamar Valley Mining Heritage Project (TVMHP – 2005 to 2013), a £7 million Heritage Lottery Fund project focusing on the World Heritage Site landscapes of West Devon in the Tamar Valley, is co-ordinated by the Tamar Valley Area of Outstanding Natural Beauty (AONB). The TVMHP was approved for Stage 2 consent by HLF in 2003. It involves the conservation of former mine sites and trail creation along the Devon side of the Tamar Valley (from Devon Great Consols to Morwellham). These sites include Devon Great Consols, the largest mine in Europe during the 19th century. The project also included conservation and repair works to the Bere Alston to Tavistock railway line (Buck 2011), the Tavistock Canal, and parts of Morwellham Quay itself (other contractors). This project covers works undertaken along the Tavistock Canal (Fig 1).

The Historic Environment Service (HES), Cornwall Council was commissioned in July 2007 by the Tamar Valley Mining Heritage Project (Chris Hariades as TVMHP Project Manager), to undertake an archaeological impact assessment, archaeological recording and site consultancy, photographic building recording of affected sites impacted by the works. An impact assessment project brief had not been produced, but it follows a similar project design by Historic Environment Service, Cornwall Council; *'Project design for production of archaeological recording, as part of the Tamar Valley Mining Heritage Project (2006-2009)',* dated 23/06/06. A Project Design for this site and other building conservation schemes in the TVMHP was produced on 21/07/2006, and was subsequently approved by Bill Horner (Devon County Archaeologist).

The conservation and management of features relating to the TVMHP's mining heritage and enablement of safe public access forms the basis for the Tamar Valley site conservation scheme. This report will assess the impact of the proposed conservation works on the Tavistock Canal's significant assets (canal within the WHS), describe the mitigation undertaken and also a description of the archaeological record for the (intermittent) works from May 2009 to May 2012. Following the first phase of works in the summer of 2009 (to describe and record the repair works and the minimal impacts to the canal sides), an interim report was produced for Bill Horner (Devon archaeology – Buck 2009).

In a joint project with SWW, the TVMHP agreed to fund cattle fencing along all of the west side of the canal, in order to stop further damage being caused to both sides by cattle drinking the water and wandering (on one occasion into Tavistock!), and to create four cattle drinking sites. SWW agreed to fund the repair of the sides of the canal bed. Furthermore the TVMHP agreed to re-bed and re-seed where necessary the canal towpath later in the autumn of 2009, and at a later stage (2011), to repair the damaged lock gates. In addition, the TVMHP agreed to undertake small-scale structural repairs to the small aqueduct bridge in 2012, and a small amount of repointing.

2. Aims and objectives

The aims of the project were as follows:

- To ensure that site works are undertaken in such a way as to maintain the integrity and authenticity of the historic resource, minimising adverse impact upon the resource.
- To ensure that the Devon County Historic Environment Service (DCHES – Bill Horner) are appraised of all site works.
- To ensure that the highest possible standards of the historic environment conservation works are maintained, which must be carried out to recognised current best standards in this discipline.
- To ensure that works are undertaken in such a way as to allow adequate recording of remains affected by the works.
- To record sites, features, deposits and artefacts affected by or uncovered by the works.

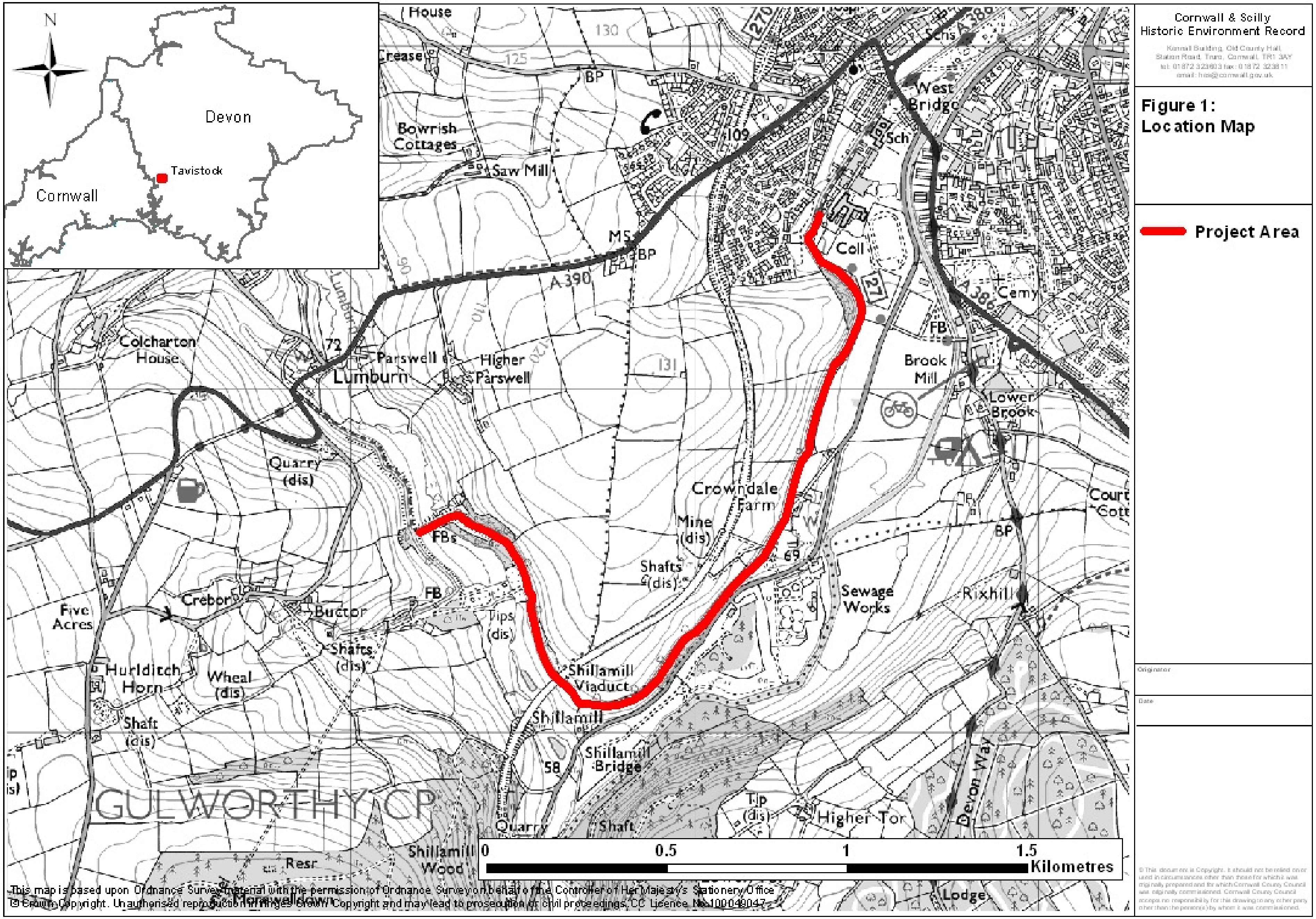

Figure 1: Location Map

- To record the character and extent of works to the sites.
- To inform the Devon County Archaeologist of the nature, condition and significance of the canal and towpath, and describe the proposed impacts and a mitigation strategy (agreeable with the Devon County Archaeologist).
- To disseminate the results of the project appropriately and arrange for the deposition of the project archive (within IfA Guidelines).

It was proposed that the building conservation and repair programme will address the following:

- The protection and consolidation of significant archaeological remains in their settings.
- Health and safety aspects of the site relating to public access.
- Provision of low-key public amenity use where appropriate, incorporating access.
- Interpretation of the site to the public, including on-site and written materials.
- Linking the site into the local economic, social, tourism and recreational contexts.

In terms of the management of archaeological features, engineering works were kept to a minimum, but in view of the fact that the entire site is part of the Tamar Valley component (Area 10) of the Cornwall and West Devon World Heritage Site mining landscape, particular attention was paid to suggestions for the best mitigation of any such works.

3. Historical background

This subject matter has already been written in far more detail than is necessary for this report, notably by Hadfield (1967), Booker (1971, who reproduces the tonnages in Appendix 2), Hedges (1975), Woodcock (1995, Vol 6; 2005), and more recently a publication by Robert Waterhouse (2012), and a forthcoming detailed book. The text below is a summary history and construction account of the Tavistock Canal extracted from all of the above sources.

The medieval borough of Tavistock has always been closely linked to its port, Morwellham. That link was dramatically improved by the construction of the Tavistock Canal from 1803 to 1817. The main structural features of this major construction throughout its full length can still be seen today, over two hundred years later; the wharves at Tavistock and Morwellham, the aqueduct over the River Lumburn, the 1.5 mile long tunnel under Morwell Down, and the remnants of the incline plane down to Morwellham.

The historical chronology for the canal can be summarised as follows:

1796 The opening of Wheal Friendship Copper Mine, Mary Tavy, unintentionally led to the construction of this canal. The export of ore and import of coal and other materials needed to be cost effective – its transport costs by horse and cart must have been prohibitive. The young mine's engineer (in his twenties), John Taylor, had the idea of linking the Tavy and Tamar valleys, whilst using Morwellham to export the ore (via sea going ships); the nearest active port to Tavistock.

1800 By the turn of the 19th century, the country had been at war with France for a few years. Demand for metallic ore, and therefore the need for a canal were high.

1802 Survey of the proposed canal route (presumably with the blessing of the Duke of Bedford) by John Taylor, the mining engineer of Wheal Friendship copper mine.

1803 (March) A canal company, funded by shares from the London Stock Exchange (see front cover seal image), was formed. Work began on the route in 1803, following the passing of an Act of Parliament. The canal was to be 16ft wide and 3ft deep, with a branch to the slate quarries at Millhill. It is likely that the first section of the canal route followed an earlier leat from the River Tavy to Crowndale Mine. Raising funds on the stock exchange gained stock interest from adventurers to exploit known lodes whilst tunnelling through the granite of Morwell Down, and for additional shares to be

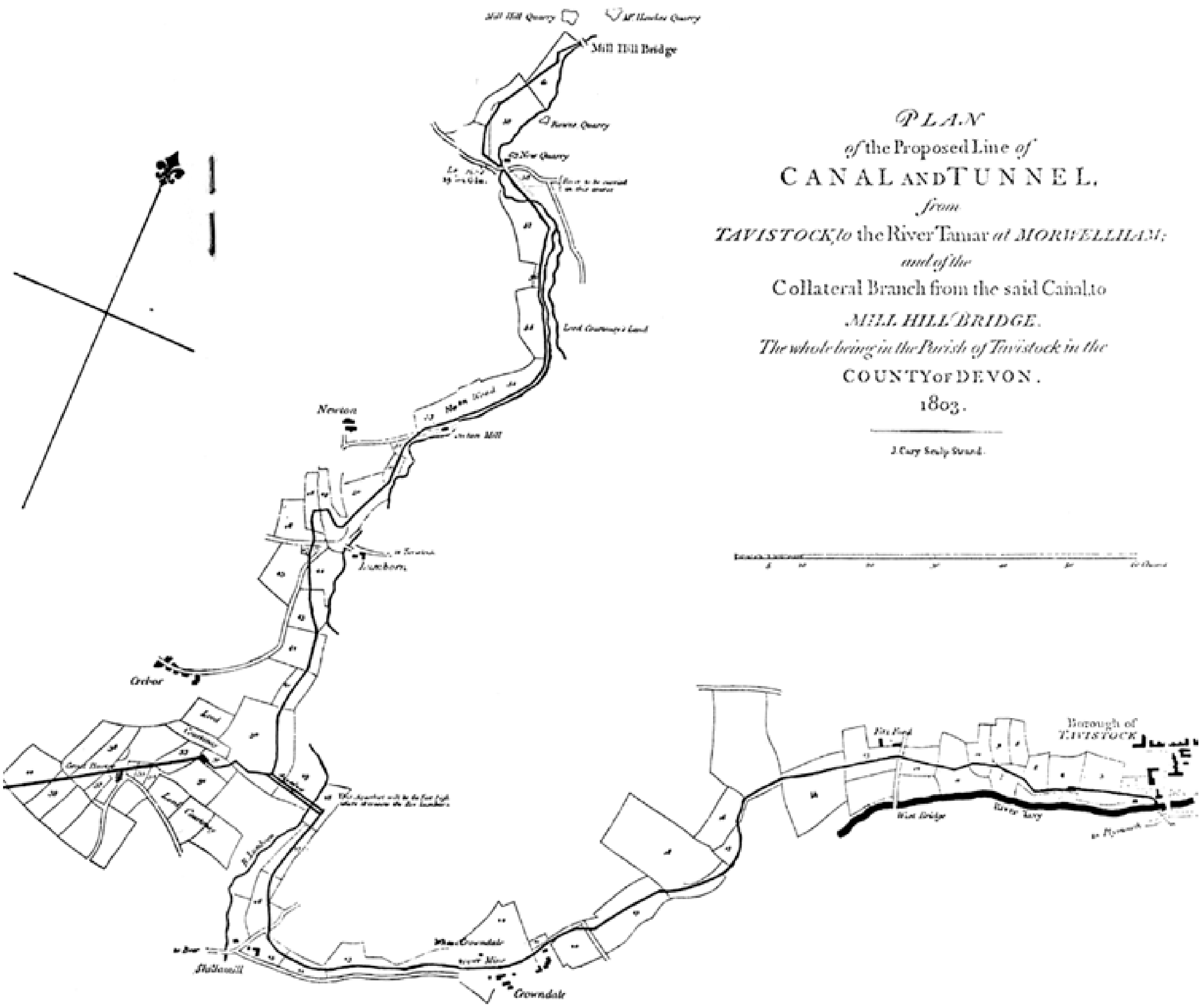

Figure 2 Excerpt of the 1803 survey plan (within the study area) of the proposed Canal route from Tavistock to Morwell Tunnel (Hedges 1975)

purchased by other mines and Tavistock businesses along its course, all recipients of the canal’s cheaper transport costs. However, Hedges (1975) hints that Taylor’s real motivation for the project was not primarily to build the canal, rather the opportunity to exploit known lodes under Morwelldown, a mining speculation.

Figure 2 shows the original planned 1803 route. The provision of water via leats from the western end of the canal (top of the Morwellham incline) for other mines in the Tamar Valley as far north as Gunnislake to power water wheels was also planned. The original cost estimate for the canal was £40,000 (including testing for ore lodes), at £100 per share. The Duke of Bedford, who owned all the land along the canal’s course, also purchased 1/8 of the shares and took dues for use of Morwellham Quay. He also agreed to a request to make a grant of a Mining Set: (for working all Lodes discovered in the Course of the Canal, Embankment, Tunnel and collateral branch for copper, tin and lead to the extent of 500 fathoms East and West of the canal for every Lode discovered), for the sum of 1/10 dues and a term of 42 years.

The principal engineering features being the aqueduct over the River Lumburn, the 2,540 yard tunnel through Morwelldown, and the inclined plane west of the western end of the tunnel down to Morwellham – a fall of 237 ft, the greatest in southern England at that time.

Figure 3 Excerpt of the 1867 Bedford Estates survey plan (DRO T1258M) showing the canal within the study area.

1803 (23rd August) Work began on the tunnel. Almost immediately copper was struck at the Tavistock end of the tunnel, and the lode developed to realise what later became Wheal Crebor (see Fig 3). Men were employed to work both concerns – the accounts separated. The Canal Committee managed both concerns until 1812 when a separate Committee was appointed after further copper ore discoveries in the tunnel under Morwelldown (Hadfield (1967, 128).

1808 The waste rock and ground from the tunnel excavation was boated eastwards back to the tunnel entrance and used to infill and form the Lumburn Aqueduct over the valley, with a central spanning arch.

1809 Work progressed slowly in the tunnel (by this date it was half finished), as the canal section from Tavistock to the tunnel was finished (ie, this project's study area). This was built more permanently with stone sides (on edge) rather than puddle clay. The tunnel rock was granite, its depth 160 yards below the top of the hill. Pumping/ventilation/winding and access shafts (at least four – the main one being Bray Shaft), had to be sunk from the top of Morwelldown to the underground canal. John Taylor designed the power source for the shaft workings by utilising flat rods (for lengths up to 1.5 miles) powered from a large 40' water wheel. He also designed a ventilation fan for improving the air quality, for which the company was awarded the medal of the Society of Arts in 1809 (Hedges 1975).

1810 The tunnel advanced at a rate of about 150 fathoms (six feet per fathom) per year until this year when three granitic dykes were cut, slowing the work rate to nearly a third that amount for two years. 30 to 40 workmen were continually employed, with some authors suggesting French prisoners of War used as 'navvies' (Barton 1964, 93 and Booker 1971, 108).

1815 From this year there were shipments of manganese from mines around Brentor and Milton Abbot carried by the canal. These were the principal sources of manganese in the country at a time when it was used in the manufacture of glass. For example, 13,335 tons were shipped to Plymouth in 1819. The ore was ground in a mill powered by the Morwellham water wheel (Booker 1976, 19), and exported in casks.

1816 (August) Tunnels were cut from both ends (simultaneously), to form a working area and to align both ends. They connected on the 21st August. Then the tunnel was enlarged (downwards and wider) throughout its length.

The demand for metallic ores to feed the Napoleonic war years (1793 – 1815) slumped as the soldiers returned, as markets waned. The canal committee, sensing further financial difficulties in September stated *'That the Tonnage will fall very short of the original estimate cannot be doubted; at the time when this was made the Mines in the neighbourhood were in their most flourishing condition, or rapidly advancing to it. Agriculture encouraged by high prices was improving everywhere, and the use of lime, so essential … was very great and increasing. Slate quarries, then making large returns, were in full activity, and new ones opening. In all these sources of oecumenical mode of carriage, the greatest reverses have taken place, and at present a stagnation of enterprise and consequent inactivity prevails'* (Hadfield 1967, 130). However, the population of Tavistock had increased from 1801 to 1821 by over 62%, reflecting the growth in the area, primarily a result of mining operations and related tertiary expansion.

1817 The tunnel was finally completed early in the year, with the official opening ceremony held on 24th June. Thousands attended the event, with over 300 going in boats (with a band) through the tunnel – to be met (with obvious relief) by thousands more at the Morwellham side. All were then given a demonstration of the workings of the incline railway mechanism and tramway down to Morwellham (see Buck 2005 – Sites 58 to 64), powered by a large water wheel and the canal water – which was also recently completed. The boats (specially designed and built by the Tavistock foundries from 1811 to replace an earlier wooden design), were *c*30 feet long, 5 feet wide and towed along the slow moving open canal by horses. They were worked through the long tunnel by two men using iron bars against the rock face.

The canal had taken 13 years to build. Its final cost was £62,000, the excess over the authorised capital of £40,000 having been raised by calling £155 on each £100 share.

1819 Although the economic outlook for the area was not good, the company decided to press ahead with the Millhill canal branch to the slate quarry. It was 2 miles long and cost £8000. It rose by 19.5ft to Millhill, with an inclined plane for the final section due to the scarcity of water (double tracked with two cradles counterbalanced with loaded boats going down pulling the empty ones up with the help of three horses).

1820s The expected tolls were halved from their pre-construction estimates – due to the gloomy economic climate. Over the next three decades the canal carried between 15,000 to 20,000 tons per year, earning an annual profit of approximately £600.

1831-2 A Cholera epidemic in the locality severely affected the workforce, the local economy and (temporarily), the canal's fortunes.

1841 Great Western Railway completed.

1844 Discovery of the main copper lode (40' wide) at Wheal Maria later Devon Great Consols – reversing the fortunes of Tavistock over the next 30 years, but reducing those of the canal. The Mill Hill Tramway was constructed this year (replacing the earlier section of the canal which had been closed after 1831), at a cost of £1,381 (Hadfield 1967, 132).

1847 20,132 tons were carried on the canal (Woodcock 1995, 23).

1848–9 Another Cholera epidemic.

1850 The goods carried on the canal were (tons): Sundries (7548), Limestone (3130), Copper ore (2.499), Slate (676), Granite (83) and Mundic (pyrites) (94). Tonnage carried fluctuated from year to year, reflecting the area's economic woes (or successes). In a bid to maintain revenue, at various times throughout this period, the company reduced tolls, or raised them again when economic conditions improved. But dividends, throughout the life of the canal were always modest, and profits turned out to be at a level 1/3 predicted at the outset.

1851 In the 1851 census, there were 27 barge men working for their various employers regularly using the canal.

1857 Shares that had changed hands at £100 in 1803 were now changing hands at £5.

1859 Construction of the Devon Great Consols railway from the mine to Morwellham with a separate incline section down to the port finished this year. Also the South Devon & Tavistock Railway from Plymouth to Tavistock opened (later extended to Launceston) – in direct competition to the canal. Due to this competition, the company further reduced its tolls after the opening of the railway. However, in the same year it expended more capital on renewing the inclined plane mechanism, and investing funds on a steam mechanism to pull loaded barges through the tunnel against the water flow (it often took a couple of hours or more to undertake this manually!). This was not successful.

There is no doubt that the waning fortunes of the Tavistock and Tavy copper mines, working for the past half century, were no competition for the resurgence of the Tamar Valley copper mines from the mid 19th century. Whilst the former utilised the Tavistock Canal as a transport medium during this period, the latter formed its own railway equivalent; but both used Morwellham as the export destination. Given the rapidly changing transport infrastructure due to the construction of mainline railways to the south west from the mid 19th century (consequently resulting in dramatic changes to market influences), across Devon and Cornwall at this formative period, so the fortunes of this old transport route was found wanting and uneconomic.

1860 In the previous year, the canal tonnage was 17,455. In this year it fell to 13,500. From 1863 onwards there was a steady decline in the tonnage until, in the early 1870s it dwindled to nothing (Hedges 1975, 28).

1862 A shareholder from Birmingham wrote to Mr Gill, representative of the Canal Company and said: *'I am afraid there is little hope of the canal rising in its fortunes with the railway for a rival. Here we have in several cases united the canal with the railway with advantage to both – you know best whether such an arrangement with the Tavistock canal would be advisable'* (Hedges 1975, 28).

1866 In September, the canal committee recorded; *'That a very considerable reduction having taken place in the traffic and dues of the Tavistock Canal Company since the opening of the Tavistock and Launceston branch of the South Devon Railway it was resolved that His Grace the Duke of Bedford be applied to kindly assist the Tavistock Canal Company to compete with the Railway Company by reducing the Canal Dock dues at Morwellham'.* The Duke was evasive (Hadfield 1967, 134).

1870 Only 783 tons were carried on the canal (Woodcock 1995, 24).

1872 Presumably the economic situation became even direr. At a meeting on 2nd September the Duke offered to buy all the shares at £8 each, and to pay half the cost of an Act to transfer the canal to him. Within the month, the committee accepted his terms. Since the summer there had been no traffic on the canal. However, this was not a localised occurrence; the impact of the railways had dealt a death blow to innumerable canals all over the country.

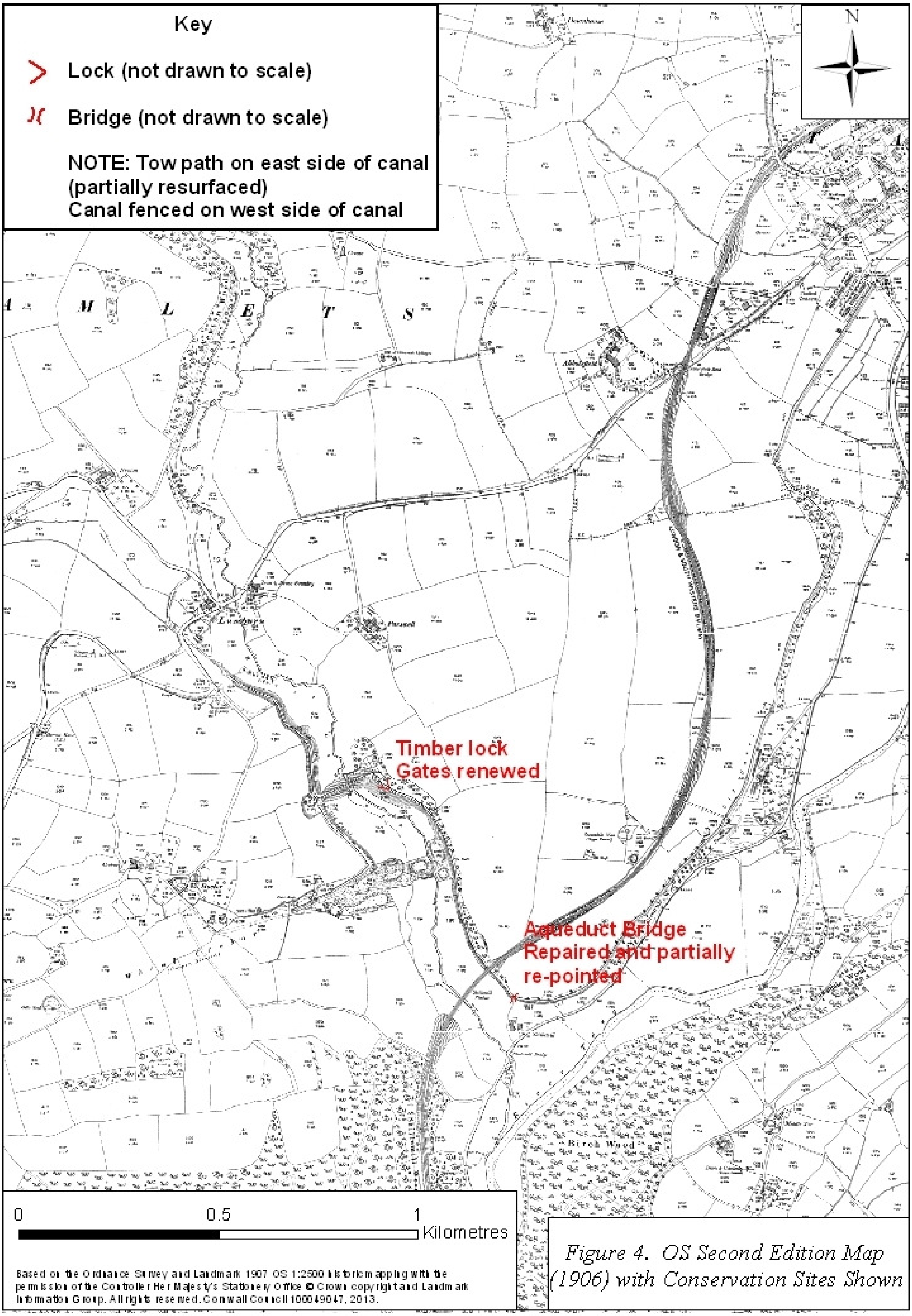

Figure 4. OS Second Edition Map (1906) with Conservation Sites Shown

1873 In May the Act was passed and the Tavistock Canal and land returned to the Duke of Bedford for £3,200, there being no obligation on the Duke to maintain the canal. It is uncertain what use the canal had for the next twenty five years.

1896 This perhaps was made clear in May of this year when the Tavistock Gazette reported that on Whit Monday the basin of the Tavistock Canal was to be cleaned out (it appears a regular activity on this day). *'The cleaning is wanted more now than when it was a hive of industry … a resident noted ... A great deal of sewage was emptied into it, and the water does not run at a greater rate than half a mile an hour. I have seen dead dogs, cats and rats in the canal'* (Woodcock 2005, 26).

1898 The Tavistock Canal was not included the Canal Returns.

1933 After cleaning the canal bed (which must have been quite onerous!), the West Devon Electric Supply Company built a sluice gate near the west end of the tunnel portal, to convey water to a header pond (Forebay) to go down to hydro electric turbines via large tubes at Morwellham Power Station, next to the River Tamar.

In 1923 and 1933, mining geologists Cloke and Barclay carefully assessed the lodes intersected by the tunnel during a tunnel assessment and clearance scheme (CRO AD58-26). They confirmed that the tunnel intersected eight or nine lodes and three cross-courses, but only two of these (East Russell and Georgenia Lodes), had any stoping accessed by the canal. The only repairs necessary were to the Morwellham portal end retaining wall.

Footnote:

The canal has been maintained and managed by the owners of Morwellham Power Station since 1933. For some time this work has been undertaken by South West Water and British Waterways, the former now monitors and maintains the canal, carefully regulating the flow to utilise the instant generating capacity of the hydro-electric power station at times of peak demand (to provide a cost effective monetary return). It is poignant perhaps that the canal still exists today due to its economic usefulness.

4. Impact assessment

This summary impact assessment is intended to inform and guide Devon County Council Historic Environment Service of the impact of the canal repair works, the aqueduct bridge repair and lock gates replacement. This section of the report summarises the archaeological resource, and describes the impact and mitigation of the canal works as part of a mitigation strategy. However, it should be noted that the mitigation procedure was undertaken during the project (due to the lack of advanced project specifications), by efficient communication between the report author (as site archaeologist), Bill Horner (DCC archaeologist), Chris Hariades (TVMHP Project manager), and South West Water. A structural engineer, Andrew White of Knevitts Ltd produced specifications for the aqueduct bridge structural repair (see Fig 12).

The sites impacted by the repair works are shown in Figures 5, 6 and 12 and reproduced on plan in Figure 4. The main sites include repair works to the sides of the canal itself, structural repairs to the aqueduct bridge, and repairs to the lock gates. The impact of the repair and conservation works on each site is then described, and a final section details the impact remediation measures.

The potential impacts during works are described below. Impacts are described in the text section for each site on a feature-by-feature basis. The following site impact terms are used within each site identification description:

Major positive	Site continues in, or is restored to, its original design and use
Moderate positive	Site restored as far as possible respecting its original function, but its use is altered
Minor positive	Site partially restored; interpretation introduced
Negligible positive	Stabilisation/maintenance of site
Negligible negative	Benign neglect – losses of fabric over a long period of time

Minor negative	Site suffers areas of alteration or damage, which contribute to loss of meaning
Moderate negative	Significant loss of fabric or alteration, leading to erosion of original character
Major negative	Complete demolition/removal

Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the end of the Lumburn Aqueduct **SX 46237 72628,** see Fig 1).

Description

The canal section impacted by the repair works was built between 1803 and finished by 1809 (as described in the historical background section). This section of the canal may well follow the course of a mine leat from the River Tavy to Crowndale Mine, which pre-dates construction of the canal. For much of its length the canal's west side (see Fig 4), cuts into the valley side – revealing vertical bed-rock and also frequently forming the bed of the canal. Excess stone material from the rock cut was used to form the rounded profile edge of the east side of the canal – using slate/killas stones set on edge. The tow path was formed along this eastern side. The canal is approximately 4.0m wide, 0.3m to 0.5m deep, with the east side approximately 0.6m to 0.8m deep from tow path surface to water level.

Repair works to the canal's east side (and towpath) has been undertaken in the past, sometimes inappropriately using cement and concrete formwork. The 2009 repair work to both sides of the canal and re-surfacing parts of the towpath continued with this theme of patching the damaged sections (Fig 11).

Site works impact (2009)

The repair works relate to identifying areas of the canal sides that needed to be patched with new (similar specification) stone within the section of canal identified above. This should immediately stop progressive damage to the canal sides and help to support the well used canal towpath. There is no site plan showing each small repair section, rather a canal bank repair work schedule (Appendix 1).

Other works to the canal itself that were proposed include patching and re-surfacing the tow path. South West Water (SWW) undertook its own Risk Assessment for each tree close to the tow path. Mitigation works resulting from that survey (i.e. branch or tree removal) was undertaken by SWW.

The overall impact of the works on the canal can be defined as '*Negligible positive'.* The works reduced collapse of parts of the canal's east side to maintain structural stability, provided more tow path stability and a higher degree of Health and Safety for increased public access for at least another generation. However, it is hoped that the track is adequately annually maintained.

Residual impact (2009)

There have not been significant residual impacts in the medium term – apart from the visual aspect of the replacement stone looking newer than the original stone surrounds.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of replacement stone (to match existing), reduced the visual impact of patching the sides of the canal. Other reduction impact measures included the tendering for appropriately qualified and experienced contractors to reduce the visual effect of repair sections to the canal, and for the quality of the work, which was of a good standard (reflecting the original construction style). This project should reduce the need for this work to be undertaken for at least another generation.

Aqueduct Bridge SX 46630 72090

Description

The aqueduct bridge carries the canal over an access lane to fields north of Shillamill Farm – whose access was cut by construction of the canal. The iron plated trough structure seen today was built in 1839 by Gill & Co of Mount Foundry, Tavistock (Buck 2007), replacing an earlier structure. The bolted sections of the trough extend to either side of the granite quoined masonry, and are supported by four wrought iron lintels (widening into the masonry sides) set into the granite masonry. Three other similarly styled lintels (see Fig 13) provide the support for large slates under the tow path on the south side of the canal. The middle lintel however has rusted to the extent of being ineffectual. A structural survey by Knevitts Ltd has recommended its replacement, as the aqueduct is not only used by tow path walkers, but is proposed to be accessed via the adjacent fields, in order to link up the railway (Buck 2009) with the canal – by a new DCC footpath route under the aqueduct – formerly used for access to the upper field.

Patch repointing to the sides of the bridge under the aqueduct in recent years has occurred, however more often than not this has been using cement, using a variety of styles. At the northern end of the side walls the stonework has been leaking for some time where water is leaking from the junction of the wrought iron plates with the canal bed. This has caused the masonry to be soft, and the stonework made weak – causing a noticeable dip on either side.

On the south west side of the aqueduct a high vertical retaining wall supports the tow path and masonry for retaining remnants of steps, to allow pedestrians walking the towpath to access the lower field. Some of this vertical retaining wall has areas of lime mortar pointing that is loose.

Site works impact (2012)

After dialogue with the TVMHP manager, the structural engineer, the landowner of Shillamill Farm, the Devon County Archaeologist and consulting project archaeologist; the TVMHP agreed to fund replacement of the centrally located rusty wrought iron lintel, and to undertake limited lime mortar repointing where structural stability of the adjacent walling could be compromised.

Site impact of the replacement lintel was minimised by matching most of the original profile of the replacement item as far as could be possible from an 'off the shelf' steel equivalent (in order for the project to be cost-effective), with the original wrought iron lintel.

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works have reduced the potential for collapse of the tow path as it runs next to the canal aqueduct. This project will provide a higher degree of Health and Safety for increased public access for at least another generation.

Residual impact (2009)

There are unlikely to be significant residual impacts in the medium term – apart from the aspect of the replacement iron lintel and repointed masonry looking newer than the adjacent (cement) based repairs.

Reduction of impact (2009)

Site consultancy with the project manager and structural engineer will minimise any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors should mitigate the visual effect of a new structural item, and for the quality of the work to be of a good standard, reducing the need for this work to be undertaken for at least another generation.

Lock Gates and timber lifting bridge SX 46327 72628

Description

The construction of the adjacent Canal cottage for operation of the lock gates, the lifting bridge and the visible remnants of the semi-circular trans-shipment basin (or turning/waiting area) is indicative that this part of the canal was quite busy! The latter

(sited close to the lock gates) is now infilled, but the tops of some of its vertical timbers still visible. The necessity of keeping the water at the correct level was important for the tunnel – this lock gate possibly forming this function also for the Lumburn Aqueduct (SX 46311 72632 to SX 46184 72581), with its single arch to the south. According to Waterhouse (forthcoming) the timber lifting bridge is of a Dutch design common on canals in the Welsh borders, and may not be contemporary with the canal's construction.

The lock gate and lift bridge was previously restored by October 1998, funded by South West Water and British Waterways. However, as Figure 15 shows, one of the timber arms of the lift bridge had snapped and parts of the timber walkway rotted. In addition the lower parts of the swing lock gate has rotted where it is in contact with the canal water.

Site works impact (2012)

The TVMHP agreed to fund replacement of the timber components that were rotted or had broken or snapped off. This includes the large timbers to open the bridge and the Lock gate. The TVMHP tendered for experienced Carpenters to assess both features and to price for the production of making and erecting replacements.

Site impact for the replacement timbers was minimised by specifying exact replacements with the existing timbers (previously replaced in 1998).

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works reduced the potential for further timber rotting and collapse, an important Health & Safety measure so close to the well-used canal towpath. This project has provided a higher degree of Health and Safety for bridge use and public access for at least another generation.

Residual impact (2009)

There are unlikely no significant residual impacts in the short term.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors mitigated any possible mistakes, the quality of the work was of a good standard, and reduced the need for this work to be undertaken for at least another generation (Fig 16).

5. Impact mitigation strategy

The impact mitigation strategy is divided into three stages: The pre-works consultancy, the Historic Buildings Consultancy during works and the archaeological recording record (during and after works). This mechanism demonstrates the steps that have been taken to avoid or minimise adverse impacts, and confirms that the proposed works have been designed in close liaison with the historic environment consultant. Consultation is based on a clear understanding of the significance of the site using appropriate methods and techniques for site monitoring and recording.

HES Projects (Project number 20070793) was commissioned to undertake the three components described as the impact mitigation strategy. The project was based on a project design produced by Colin Buck (21/07/06), and recording specifications defined by Bill Horner (DCC archaeologist).

6. Working method

The following text summarises the general WSI for all archaeological consultancy and archaeological recording for projects relating to the TVMHP (Tamar Valley Mines Heritage Project: Written Scheme of Investigation: Historic Building and Archaeological Recording Consultancy 21/07/06).

- A brief historical survey was compiled from existing Devon County sources (DCHER, DRO, and local libraries and historians (including Robert Waterhouse's recent published work on the canal).
- A walk-over survey was undertaken of the entire length of the canal for sites impacted by the TVMHP.
- An impact assessment described and mitigated the proposed work as part of a Mitigation Strategy to minimise the works affecting the site's character.
- General working methods for archaeological recording, treatment of finds, photographic surveying and report production are described in detail in the Tamar trails WB WSI produced in 21/07/06.

All archaeological recording work was undertaken according to the Institute for Archaeologists (IfA) *Standards and Guidance for Archaeological Investigation and Recording. Staff follow the IfA Code of Conduct* and *Code of Approved Practice for the Regulation of Contractual Arrangements in Archaeology*.

The principal factor in effective project delivery was the employment of key project staff who are expert in the management and recording of the industrial heritage. Cornwall Historic Environment Service project staff can draw upon a substantial track record in undertaking similar work throughout Cornwall, as well as a detailed knowledge of the project area and its sites.

Historic buildings consultancy

- HES (Senior Archaeologist) liaised with the Devon County Historic Environment Service - DCHES (Bill Horner), and the TVMHP Project Manager (Chris Hariades).
- The HES Senior Archaeologist attended regular site meetings when appropriate during the duration of the project.
- HES ensured that site conservation works are carried out to standards recommended by English Heritage best practice.
- **Fieldwork: archaeological recording**
- There were no newly exposed archaeological features revealed through excavation.
- Where appropriate, measured survey was carried out by hand measurements (using offset techniques at a scale of 1:50.
- The resulting survey output was a revised measured survey drawing showing all conservation works that had been undertaken. This was reproduced at a scale of either 1:50 or 1:100 (appropriate to the size of area recorded) and will form part of this archive watching brief report.
- Analysis of the building fabric was recorded in the form of field notes and written up in this archive report production stage.
- DCHES (Bill Horner) advised that archaeological recording should be undertaken during any excavation that revealed archaeological features. Recording was undertaken using a mix of direct measurement, sketch plotting and photography, as appropriate (constrained by safety factors).
- Where significant remains were encountered the site archaeologist was given the opportunity to make an appropriate form of record before work proceeds.
- The chosen site archaeologist adhered to Health and Safety Policies (see below), under the direction of the designated Site Safety Officer.

Site recording (general)

- Site drawings (plans, sections, locations of finds) were made by pencil (4H) on drafting film; all plans were linked to the Ordnance Survey landline map; all drawings included standard information: site details, personnel, date, scale, north-point.

- The site archaeologist undertook the recording in line with recommendations given by IfA. Sections and plans were drawn on site at appropriate scales which adequately recorded structures or features at appropriate levels of detail, and appropriate sections reproduced in the archive report at either 1:50 or 1:100 to adequately demonstrate revealed archaeological features.
- All features and finds were accurately located by means of a National Grid reference and all archaeological contexts will be described using a standard format and linked to a continuous numbering sequence.
- The archaeological watching brief report detailed all forms of archaeological recording that had been undertaken at each of the mine sites. Each major mine site had a single archaeological watching brief report that details all project related work to that site (i.e. trails works, building conservation works, interpretation works, etc).

For Treatment of finds, Photographic recording specifications, report production and archiving specifications refer to the TVMHP WSI (2006).

7. Results

Unfortunately, there was insufficient time (following receipt of a detailed plan and description of the canal repair works from the TVMHP), prior to the start of works on site to produce an impact and mitigation report for DCC (Bill Horner). A decision was therefore taken to minimise impacts and mitigate directly with the TVMHP and site contractors on site as works were progressing as part of a weekly site recording and consultancy. SWW funded the stone and path repairs to the canal bed whilst the TVMHP funded fencing of the north and west sides of the canal, to stop encroaching animals from the adjacent fields from directly accessing the canal (and walking up the towpath!). An interim archaeological recording report of these works was produced by the author on 17/06/2009. This report supersedes that report.

Repair works to the bed and towpath of the Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the start of the Lumburn Aqueduct **SX 46237 72628**)

In early 2009, the TVMHP tendered for stone masons (on behalf of SWW) experienced in rebuilding stone walls, etc, to undertake these works within a narrow time-scale of three weeks, when SWW were willing to reduce the water flow through the canal (which would stop the electricity generating turbine). The turbine normally operates all year round, often at short notice when generation rates for electricity peak (the turbine can instantly generate electricity). Clemens Stonemasons of North Cornwall were successful in winning the contract. Prior to this, the TVMHP Manager, the archaeological consultant and SWW projects officer, produced a repair work specification schedule (measured from the small swing bridge at Tavistock: SX 47348 73503), which focussed on identifying the repair of collapsed sections of canal bank on the south or east sides. Appendix 1 is a reproduction of this original document.

Site work started on 05/05/09 at the northern end of the canal and progressively worked southwards towards the lock gates at the Lumburn Valley. With the reduced water level in the canal (and its slow movement when full), many stones that had fallen out of place were found in the canal bed not far from their original bank location. When the canal was constructed the stones were originally set on edge, a minimum of two/three stones height (approximately 0.6m to 0.8m above water level). During the repair project, where there was insufficient stone to replace the collapsed sections, a similar stone was imported from Trebarwith Quarry, North Cornwall (purchased from the local quarry at Millhill). These stones were reset on edge, following the original profile of the canal bank, and tightly tamped down in position (tops and sides). Earth was backfilled into the top sides of the stone to re-form the edge of the towpath. This was then at a later date, re-seeded. Figures 7 and 8 show examples of before and after photographs of the repaired canal bank. The work has been sensitively undertaken and reflected the style and character of the original construction a century ago.

Weekly site meetings were arranged to view the previous week's repairs and to discuss any foreseeable problems within the following weeks programmed work. A granite towpath stone under the Crowndale bridge at SX 47194 72541 had become dislodged (into the canal), and some quoin stones from the bridge parapet wall had fallen into the canal. The former was repaired by contractors; the latter will be removed from the river by SWW to be replaced on the bridge parapet wall at a later date. A small section of old 2" timber (2m long) set in the lower part of the bank was replaced back into its original position following repair of the wall at this location (SX 47270 72707).

The canal bank repair works (see Appendix 1), were finished on 28/05/09, including an additional element of work totalling 87 metres, which the contractors identified whilst on site. A total of 337 linear metres of canal bank was repaired (only on the south/west side), using a total of 86 tons of additional Trebarwith stone. The canal repair works were funded by South West Water.

Figure 5 is a site plan and specification document for the installation of timber post and wire stock fencing along the west/north side of the canal and construction of three cattle drinking areas to minimise any future erosion of the opposite (north/west) side of the canal bed. The cattle drinking sites are located at SX 47384 73064, SX 47257 72705, and SX 47078 72415. A concrete pad (min 0.3m thick), varying from 3m to 4m wide and approximately 5m long, has been created to at each of these sites to form the post and rail fenced cattle drinking areas that should minimise further damage to the banks (on either side). An additional cattle drinking area was constructed on bedrock immediately on the west side of the Shillamill Viaduct (see Fig 6). Figures 9 and 10 show before and after views of a cattle drinking site (SX 47384 73064).

Approximately four months later, the surface of the canal towpath was patched with crushed stone (803 specification) where the path was potholed or muddy, then sections covered with finely ground stone (6mm to dust) from Meldon Quarry.

During construction of the cattle drinking sites and during the canal repair works there has been minimal archaeological impact, nor any finds recorded.

Aqueduct Bridge SX 46630 72090

Knevitts Ltd was commissioned by the TVMHP in 2011, to undertake a structural survey of the aqueduct bridge at this location. Their report and structural drawing (see Fig 12), recommended that a rusty wrought iron support (middle one of three similar supports – see Fig 13) sited under wide slates below the towpath next to the canal, be replaced with a modern equivalent. In addition, it was recommended that the tall retaining wall on the south west side of the aqueduct bridge be repointed and structural ties inserted (using 7mm diameter stainless steel helibars) into the masonry bedding joints to strengthen a structural crack in the masonry.

This work was not started until May 2012, following an extensive dialogue with SWW and the site owner. Figure 13 shows the failed rusty element needed to be replaced. The original lintel was 50mm x 50mm for most of its length but widened to 100mm at both ends (and set in the side walls). Unfortunately the original wrought iron section specification was impossible to replace, and an 'off the shelf' item had to be found due to budgetary constraints. Figure 14 shows the new steel replacement *in situ*. Scaffolding had to be erected to remove the original rusty support and to replace it with the new 50mm wide x 115mm deep iron profile steel section. A slightly wider opening had to be made into each granite quoined side of the bridge for insertion of this new structural element. The localised setting was then repointed with lime. The steel was painted with a red primer and then painted black.

Other works to this site included removal of a tree growing out of the west side of the north end of the aqueduct bridge and treatment of the stump, as its unchecked growth had caused structural issues to the masonry at this point. On the opposite side of the bridge opening, the top flanking stones over the east side revetment walling had become dislodged. These were moved back to their original position. TVMHP funded the project.

At the north end of the structure under the aqueduct section, it appears that water has been leaking from the canal at the intersection of the metal 'trough' profile bolted plates and the canal bed – on both sides, through the stone masonry. This has caused the masonry and water at this point lower down under the aqueduct to be constantly wet.

Consequently, the foundations masonry and pointing in this area have softened to the extent that the masonry is collapsing and arching downwards. SWW attempted to add some clay to the leaking intersection point in the bed of the canal, but this has not worked. Structural deterioration will continue unless this issue is resolved. This is a significant feature of the canal which is in places, is now a Scheduled Monument. It is a recommendation of this report that the aqueduct bridge be considered for Listing.

Finally, the vertical retaining walling on the south west side of the aqueduct was repointed and the structural crack that had been identified by the structural engineer, repaired with the use of helibar reinforcing. This work finished in mid June 2012. The repointed wall acted to retain not only the towpath running along the south side of the canal, but also steps that allowed access from the towpath down into the adjacent field. These steps have badly deteriorated, leaving a steep slippery slope. It is recommended that they need to be rebuilt before use of them can be made by a new DCC footpath from the nearby railway linking up with the canal footpath.

Lock Gates and timber lifting bridge SX 46327 72628

The timber lock gate and timber lift bridge was 'restored' in 1998 by SWW and British Waterways. It is not know what the restoration replaced, but parts of the timber lift bridge (mainly the western timber arm), had rotted resulting in collapse (see Fig 15). Other parts of the bridge were showing that many timber items were rotting. In addition, the section of timber lock gate that was in constant contact with canal water had also rotted during the last 14 years. SWW and the TVMHP decided to replace the rotted and unsafe timber items as being a Health and Safety issue, given the frequent public use of the towpath. SWW funded the project.

The project of dismantling the bridge and lock gate, replacement of the main and structural timbers, and re-assembling and fixing on site was tendered. The contract was won by Will Sterling and Son, a traditional timber boat builder and carpenter who worked at Morwellham Quay (repairing and building boats, etc). The work was started in July 2012 and finally finished in September 2012.

Figure 16 is an 'after' view of the works on these features, and should be compared to its preceding figure. It is hoped that this repair will last longer than its predecessor!

Note:

In 2013, the TVMHP constructed a new footpath from near Morwell Rocks (SX 44128 70435) to above George & Charlotte Mine (SX 45101 69962). This new route links the main route of the railway line from Devon Great Consols to Morwellham and the forestry tracks north of Morwellham. Scheduled Monument Consent was obtained in 2012 for construction of a new timber footbridge over the Tavistock Canal (the section from the west end of the Morwell Down tunnel to the incline railway cottage was Scheduled in 2011, SM No. 30973). As part of this project, an impact assessment report was produced (Buck 2012). The results of the new footpath creation and footbridge construction will be produced within the main body of the TVMHP archaeological recording report (Buck forthcoming).

8. References

8.1 Primary sources

CRO AD 58-26 Tunnel Lodes (1923-33) Report by F Cloke and CF Barclay.

DRO T1258M-14B Bedford Estate Map

8.2 Secondary sources

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Waterhouse, R., 2012, *Tavistock Canal, Surveying a forgotten marvel of the industrial age*, Current Archaeology, Issue 273 December

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Woodcock, G., 1995, 2005, Booklets on the 'History of Tavistock'.

9. Project archive

The HE project number is **20070793**

The project's documentary, photographic and drawn archive is housed at the offices of Historic Environment, Cornwall Council, Fal Building, New County Hall, 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 (20070793).
2. Black and white photographs archived under the following index numbers:

   GBP 2091/12-21; 2207/12-22; 2250/1-17; 2253/19-22.
3. Digital photographs stored in the directory R:\HE images\Sites\Devon\Tavistock\Tavistock Canal
4. This report text is held in digital form as: G:\HE Documents\HE Projects\Sites\Devon\Tavistock Canal IA WB report 20070793
5. English Heritage/ADS OASIS online reference: cornwall2-154344

No artefacts or environmental material was retrieved during the project.

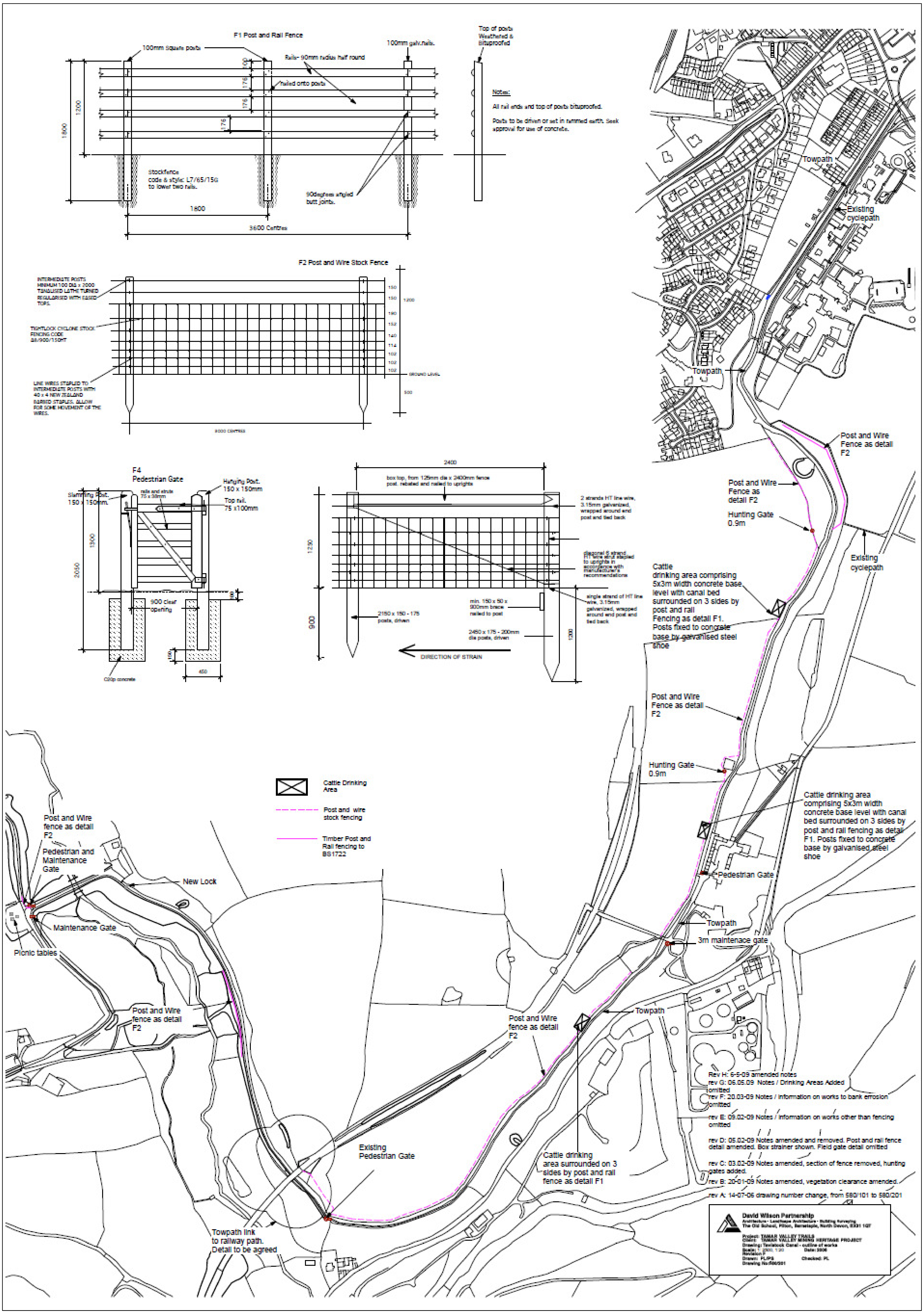

Figure 5 Specifications and plan showing fencing and three cattle drinking areas at the Tavistock Canal(East section)

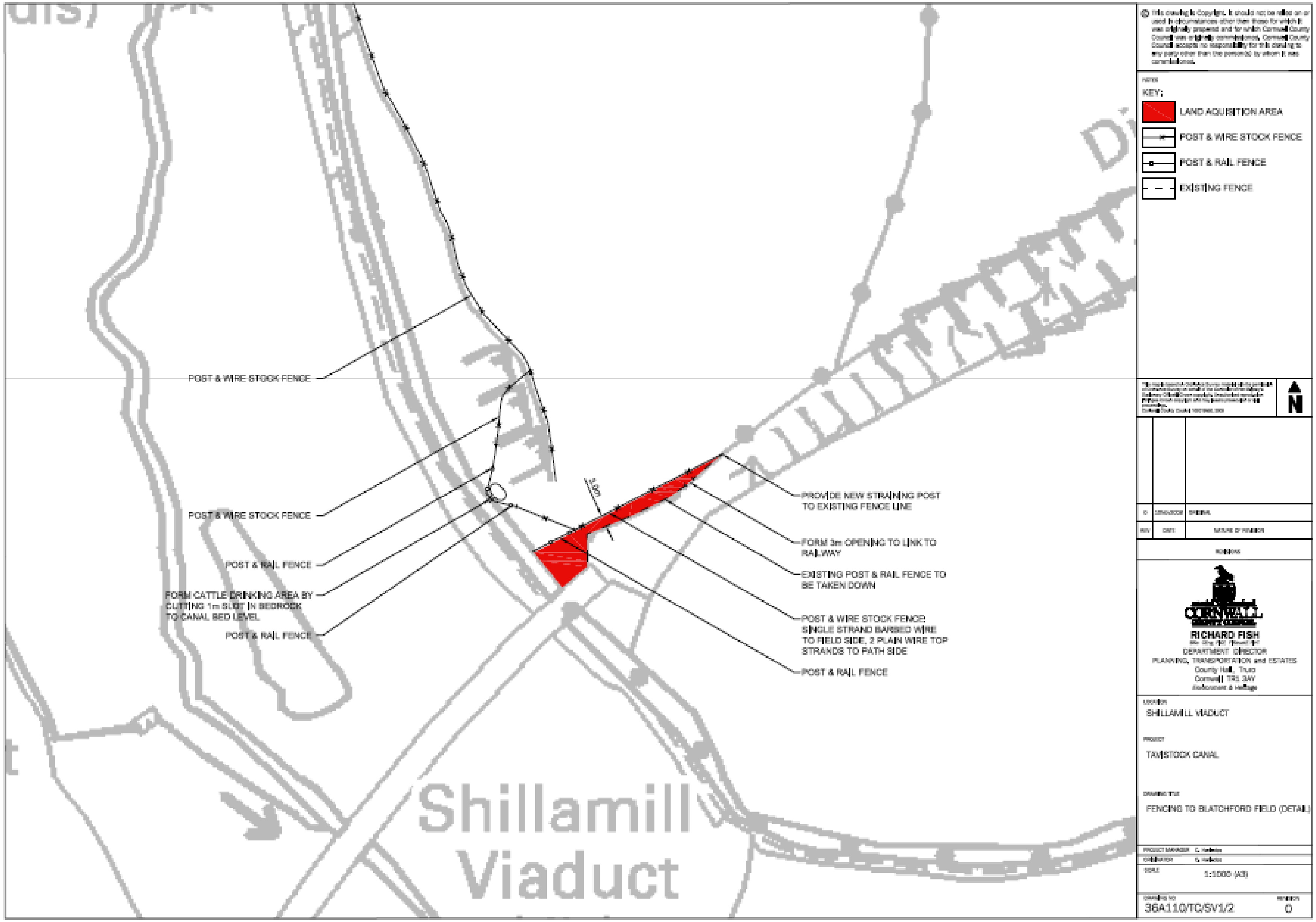

Figure 6 Detail plan showing the cattle drinking area west of the Shillamill Viaduct

Figure 7 A view of the Tavistock Canal east bank before works © CC HE Projects

Figure 8 A view of the Tavistock Canal east bank after works © CC HE Projects

Figure 9 A view of a Cattle Drinking site before works (SX 47257 72705) © CC HE Projects

Figure 10 A view of the same Cattle Drinking site after works © CC HE Projects

Figure 11 A view of the canal towpath after re-surfacing works © CC HE Projects

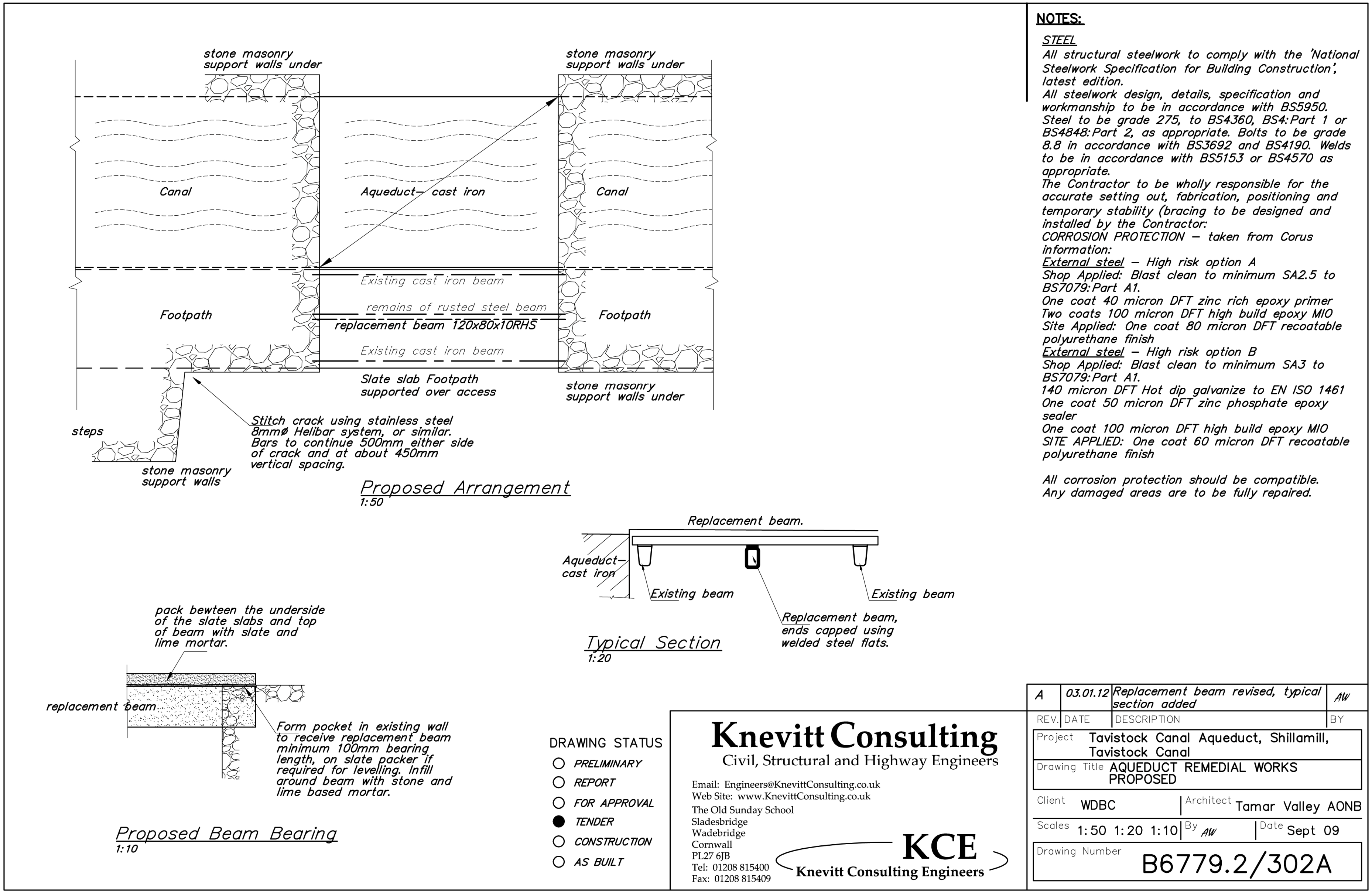

Figure 12 Specifications plan for repair of the aqueduct bridge

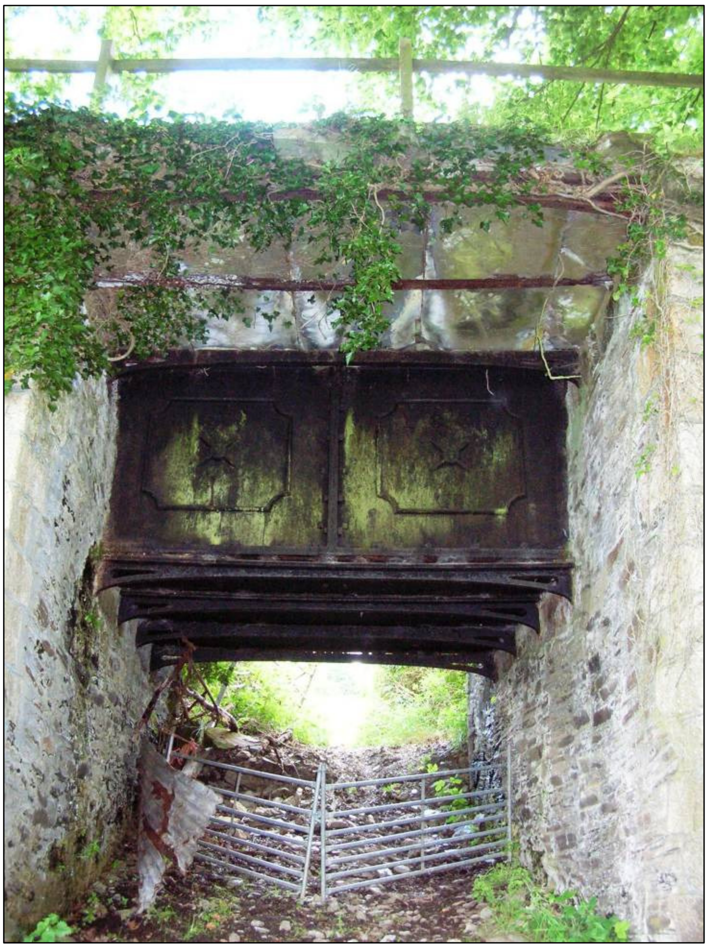

Figure 13 A view of the canal aqueduct bridge before works © CC HE Projects

Figure 14 A view of the canal aqueduct bridge after works © CC HE Projects

Figure 15 A view of the canal lock gate and bridge before works © CC HE Projects

Figure 16 A view of the canal lock gate and bridge after works © CC HE Projects

Appendix 1: TAVISTOCK CANAL BANK REPAIR WORK SCHEDULE

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
20		Side out path and hedge (140m length)
76		1.5m infill behind c $2m^3$
118		1.5m infill behind c $1m^3$
140-150	10	Minor wall top repair
159-160	1	End of hedge
162-163	1	1m infill behind $0.25m^3$
166-179	13	
225-247	22	
253-308	55	Break out conc block
314-323	9	
328-330	2	
394-418	24	
433-461	29	Take off conc
P A T H		
467-469	2	Break out conc
472-473	1	Good example, flat stone
485-488	3	Remove conc, Repair bank
494-513	19	Remove section of conc
530-541	11	
557-558	1	
563-573	10	
577-578	1	
581-584	3	
591-592	1	
600-650	50	
664-673	29	
691-694	3	
703-704	1	
714-718]	4	Soft path, build up levels (ch 14-27)
722-727]	5	
730-735	5	
744-745	1	
751-754	3	
755-760	5	
771-773	2	
779-780	1	
782-798	16	800 ⇒path surface 80ft
800-804	4	
804-806	2	Build up path surface to fall to canal

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
		(ch 800-902)
808-809	1	
813-814	1	
819-820	1	Lay hedge, remove barbed wire (ch 800-902)
823-826	3	
839-842	3	
875-876	1	
892-894	2	
902-903	1	Remove gate, overhanging branch
902-907	5	
970-971	1	Gate and post and rail across path
975-976	1	Surface ok
985-990	5	In deep
1009-1010	1	
1019-1020	1	Take out tree growing out from opposite bank
1068-1069	1	Path surface repair
1093-1094	1	Under bridge
1099-1100	1	Bridge coping repairs 4m copings in canal
1130-1131	1	Boulders ⇑ make up path ⇓ scrape leaf mould
1158-1159	1	
1165-1166	1	
1169-1170	1	
1187-1192	5	
1197-1199	2	
1202-1207	5	
1208-1209	1	
1225-1232	7	
1260-1268	8	
1271-1272	1	
1279-1280	1	
1282-1283	1	
1295-1298	3	
1308-1309	1	
1317-1319	2	
1334-1342	8	
1353-1356	3	
1409-1414	5	
1421-1422	1	
1424-1425	1	

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
1441-1442	1	
1454-1456	2	
1514-1515	1	
1546-1548	2	
1573-1574	1	
1581-1582	1	
1603-1604	1	
1600		Path falls away from canal. (1.5m width)
1691-1692	1	
1718-1719	1	
1721-1722	1	
1726-1729	3	
1820-1821	1	
1856		AQUADUCT (Clear vegetation, Take out gate)
1958-1968	10	Under viaduct
1970-1972	2	
2020-2023	3	
2151-2152	1	
2220-2221	1	
2316-2318	2	WHEEL SLUICE Interpretation Barrier (Take down concrete posts and blocks)
2463-2464	1	
2534-2535	1	
2541-2543	2	Replace Bascule bridge
		Lumburn Valley Turning area at lock (excavate)
2586-2600	214	Opposite bank
TOTAL		

Note:

An additional 87 linear metres of repairs were undertaken by the site contractors as they deemed them necessary. These additional repairs are not reflected in the above schedule chainage list, which was originally compiled by Chris Hariades (in consultation with Colin Buck and SWW (Laura Wotton) in April 2009 to inform tender information and site specifications prior to the start of works. The location of the small swing bridge in Tavistock (from which the chainages are measured) is at SX 47348 73503.

Tavistock Canal - Canal Bank Repair Works Schedule

Item	Description	Qty	Unit	Rate (£)	Cost (£)
1	Provide site welfare facilities to comprise as a minimum porta-loo with handwashing facilities, maintain and take down on completion	Item			
2	Provide all necessary fencing, barriers, signage, maintain for duration of contract and take down on completion	Item			
3	Break out concrete capping (provisional)	50	lm		
4	Clear rubbish from canal bed and dispose to licensed tip (Provisional)	10	m3		
5	Repair identified sections of failed or colapsing drystone facings to canal bank to match adjoining sections using stone salvaged from canal bed	250	m2		
6	Tie and marry in each repair to adjacent sound sections.	100	no.		
7	Extra to bed bottom course of stone on 50mm depth drymix sand/lime/cement bed in ratio 6:2:1 where laying directly onto bed rock.(Provisional)	50	l.m		
8	Extra to import suitable matching stone to make up shortfall in site salvaged material (Provisional)	50	tonnes		
8	Backfill voids behind stone facing to level with top of bank with imported scalpings compacted in layers not exceeding 200mm depth (provisional)	10	tonnes		

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CORNWALL COUNCIL

Tavistock Canal, Devon

Archaeological impact and recording report

Historic Environment Projects

Report No	Report Name	Report Author
2013R046	Tavistock Canal – Impact assessment and archaeological recording during a program of repair works	Colin Buck

Event Type

Site consultancy	Archaeological impact assessment	Archaeological watching brief	

Client Organisation	Client Contact
TVMHP (West Devon Borough Council)	Chris Hariades (TVMHP)

Monuments (MonUID)

DHER 3879 (Tavistock canal)	18721	4069	3882	5449	3956

Fieldwork dates (From)	(To)	(Created By)	(Create Date)
05/05/09 05/05/12	29/05/09 05/09/12	Colin Buck	13/05/13

Location (postal address; or general location and parish)

Tavistock Canal (northern section from Tavistock to Lumburn), Tavistock, West Devon

(Town – for urban sites)	(Postcode)
Tavistock	

(Easting) X co-ord	(Northing) Y co-ord		
From: SX 47367 To: SX 46183	73572 72589		

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

List of Figures

Abbreviations

AONB	Area of Outstanding Natural Beauty
CC	Cornwall Council
DCC	Devon County Council
DHER	Devon Historic Environment Record
DRO	Devon Record Office
HES	Historic Environment Service
OS	Ordnance Survey
SWW	South West Water
TVMHP	Tamar Valley Mines Heritage Project
WHS	World Heritage Site

Acknowledgements

Thanks are due to Robert Waterhouse for providing some primary survey data and information files from his research relating to a forthcoming book about the Tavistock Canal. Chris Hariades (Tamar Valley Project Manager), and Bill Horner were involved in the project throughout its entirety. Andrew White of Knevitts Cons. Engs. was involved in preparing the specifications of the aqueduct bridge.

Front cover image: a copy of the Tavistock Canal Company Seal.

1. Project background

The Tamar Valley Mining Heritage Project (TVMHP – 2005 to 2013), a £7 million Heritage Lottery Fund project focusing on the World Heritage Site landscapes of West Devon in the Tamar Valley, is co-ordinated by the Tamar Valley Area of Outstanding Natural Beauty (AONB). The TVMHP was approved for Stage 2 consent by HLF in 2003. It involves the conservation of former mine sites and trail creation along the Devon side of the Tamar Valley (from Devon Great Consols to Morwellham). These sites include Devon Great Consols, the largest mine in Europe during the 19th century. The project also included conservation and repair works to the Bere Alston to Tavistock railway line (Buck 2011), the Tavistock Canal, and parts of Morwellham Quay itself (other contractors). This project covers works undertaken along the Tavistock Canal (Fig 1).

The Historic Environment Service (HES), Cornwall Council was commissioned in July 2007 by the Tamar Valley Mining Heritage Project (Chris Hariades as TVMHP Project Manager), to undertake an archaeological impact assessment, archaeological recording and site consultancy, photographic building recording of affected sites impacted by the works. An impact assessment project brief had not been produced, but it follows a similar project design by Historic Environment Service, Cornwall Council; *'Project design for production of archaeological recording, as part of the Tamar Valley Mining Heritage Project (2006-2009)',* dated 23/06/06. A Project Design for this site and other building conservation schemes in the TVMHP was produced on 21/07/2006, and was subsequently approved by Bill Horner (Devon County Archaeologist).

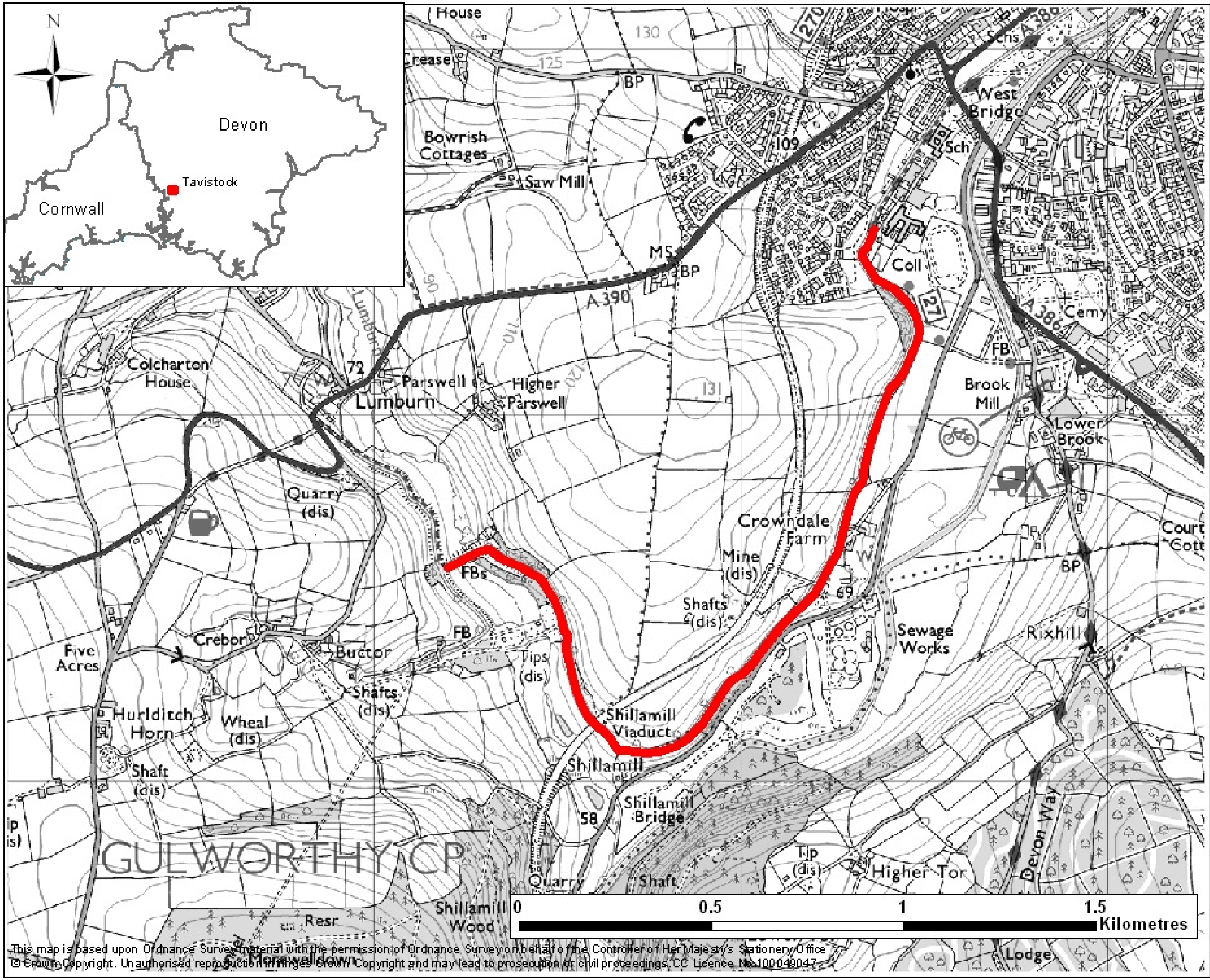
The conservation and management of features relating to the TVMHP's mining heritage and enablement of safe public access forms the basis for the Tamar Valley site conservation scheme. This report will assess the impact of the proposed conservation works on the Tavistock Canal's significant assets (canal within the WHS), describe the mitigation undertaken and also a description of the archaeological record for the (intermittent) works from May 2009 to May 2012. Following the first phase of works in the summer of 2009 (to describe and record the repair works and the minimal impacts to the canal sides), an interim report was produced for Bill Horner (Devon archaeology – Buck 2009).

In a joint project with SWW, the TVMHP agreed to fund cattle fencing along all of the west side of the canal, in order to stop further damage being caused to both sides by cattle drinking the water and wandering (on one occasion into Tavistock!), and to create four cattle drinking sites. SWW agreed to fund the repair of the sides of the canal bed. Furthermore the TVMHP agreed to re-bed and re-seed where necessary the canal towpath later in the autumn of 2009, and at a later stage (2011), to repair the damaged lock gates. In addition, the TVMHP agreed to undertake small-scale structural repairs to the small aqueduct bridge in 2012, and a small amount of repointing.

2. Aims and objectives

The aims of the project were as follows:

- To ensure that site works are undertaken in such a way as to maintain the integrity and authenticity of the historic resource, minimising adverse impact upon the resource.
- To ensure that the Devon County Historic Environment Service (DCHES – Bill Horner) are appraised of all site works.
- To ensure that the highest possible standards of the historic environment conservation works are maintained, which must be carried out to recognised current best standards in this discipline.
- To ensure that works are undertaken in such a way as to allow adequate recording of remains affected by the works.
- To record sites, features, deposits and artefacts affected by or uncovered by the works.



Cornwall & Scilly
Historic Environment Record
Kennall Building, Old County Hall,
Station Road, Truro, Cornwall, TR1 3AY
tel: 01872 323603 fax: 01872 323811
email: hes@cornwall.gov.uk

**Figure 1:
Location Map**

Project Area

Originator

Date

- To record the character and extent of works to the sites.
- To inform the Devon County Archaeologist of the nature, condition and significance of the canal and towpath, and describe the proposed impacts and a mitigation strategy (agreeable with the Devon County Archaeologist).
- To disseminate the results of the project appropriately and arrange for the deposition of the project archive (within IfA Guidelines).

It was proposed that the building conservation and repair programme will address the following:

- The protection and consolidation of significant archaeological remains in their settings.
- Health and safety aspects of the site relating to public access.
- Provision of low-key public amenity use where appropriate, incorporating access.
- Interpretation of the site to the public, including on-site and written materials.
- Linking the site into the local economic, social, tourism and recreational contexts.

In terms of the management of archaeological features, engineering works were kept to a minimum, but in view of the fact that the entire site is part of the Tamar Valley component (Area 10) of the Cornwall and West Devon World Heritage Site mining landscape, particular attention was paid to suggestions for the best mitigation of any such works.

3. Historical background

This subject matter has already been written in far more detail than is necessary for this report, notably by Hadfield (1967), Booker (1971, who reproduces the tonnages in Appendix 2), Hedges (1975), Woodcock (1995, Vol 6; 2005), and more recently a publication by Robert Waterhouse (2012), and a forthcoming detailed book. The text below is a summary history and construction account of the Tavistock Canal extracted from all of the above sources.

The medieval borough of Tavistock has always been closely linked to its port, Morwellham. That link was dramatically improved by the construction of the Tavistock Canal from 1803 to 1817. The main structural features of this major construction throughout its full length can still be seen today, over two hundred years later; the wharves at Tavistock and Morwellham, the aqueduct over the River Lumburn, the 1.5 mile long tunnel under Morwell Down, and the remnants of the incline plane down to Morwellham.

The historical chronology for the canal can be summarised as follows:

1796 The opening of Wheal Friendship Copper Mine, Mary Tavy, unintentionally led to the construction of this canal. The export of ore and import of coal and other materials needed to be cost effective – its transport costs by horse and cart must have been prohibitive. The young mine’s engineer (in his twenties), John Taylor, had the idea of linking the Tavy and Tamar valleys, whilst using Morwellham to export the ore (via sea going ships); the nearest active port to Tavistock.

1800 By the turn of the 19th century, the country had been at war with France for a few years. Demand for metallic ore, and therefore the need for a canal were high.

1802 Survey of the proposed canal route (presumably with the blessing of the Duke of Bedford) by John Taylor, the mining engineer of Wheal Friendship copper mine.

1803 (March) A canal company, funded by shares from the London Stock Exchange (see front cover seal image), was formed. Work began on the route in 1803, following the passing of an Act of Parliament. The canal was to be 16ft wide and 3ft deep, with a branch to the slate quarries at Millhill. It is likely that the first section of the canal route followed an earlier leat from the River Tavy to Crowndale Mine. Raising funds on the stock exchange gained stock interest from adventurers to exploit known lodes whilst tunnelling through the granite of Morwell Down, and for additional shares to be

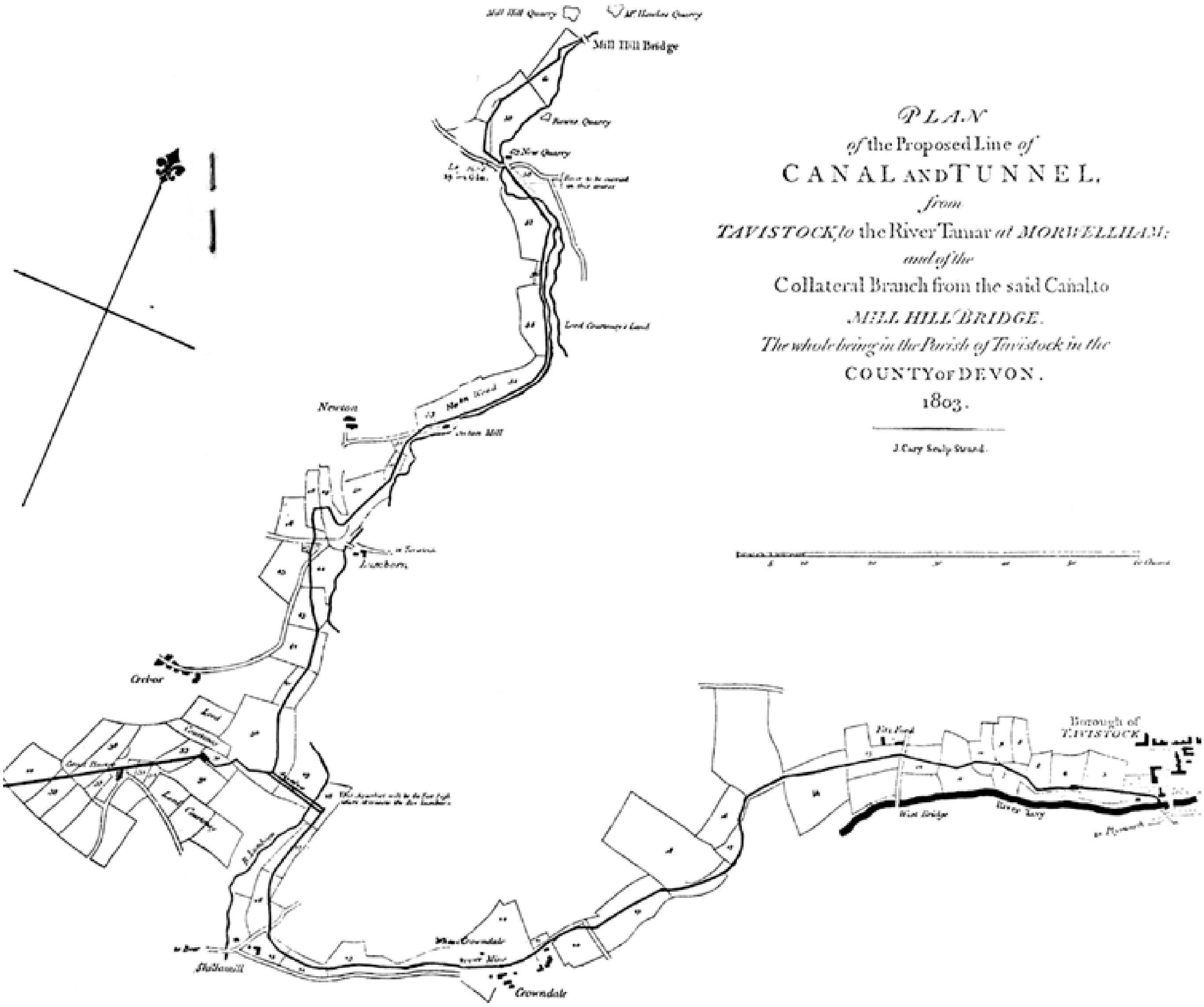


Figure 2 Excerpt of the 1803 survey plan (within the study area) of the proposed Canal route from Tavistock to Morwell Tunnel (Hedges 1975)

purchased by other mines and Tavistock businesses along its course, all recipients of the canal's cheaper transport costs. However, Hedges (1975) hints that Taylor's real motivation for the project was not primarily to build the canal, rather the opportunity to exploit known lodes under Morwelldown, a mining speculation.

Figure 2 shows the original planned 1803 route. The provision of water via leats from the western end of the canal (top of the Morwellham incline) for other mines in the Tamar Valley as far north as Gunnislake to power water wheels was also planned. The original cost estimate for the canal was £40,000 (including testing for ore lodes), at £100 per share. The Duke of Bedford, who owned all the land along the canal's course, also purchased 1/8 of the shares and took dues for use of Morwellham Quay. He also agreed to a request to make a grant of a Mining Set: (for working all Lodes discovered in the Course of the Canal, Embankment, Tunnel and collateral branch for copper, tin and lead to the extent of 500 fathoms East and West of the canal for every Lode discovered), for the sum of 1/10 dues and a term of 42 years.

The principal engineering features being the aqueduct over the River Lumburn, the 2,540 yard tunnel through Morwelldown, and the inclined plane west of the western end of the tunnel down to Morwellham – a fall of 237 ft, the greatest in southern England at that time.

Figure 3 Excerpt of the 1867 Bedford Estates survey plan (DRO T1258M) showing the canal within the study area.

1803 (23rd August) Work began on the tunnel. Almost immediately copper was struck at the Tavistock end of the tunnel, and the lode developed to realise what later became Wheal Crebor (see Fig 3). Men were employed to work both concerns – the accounts separated. The Canal Committee managed both concerns until 1812 when a separate Committee was appointed after further copper ore discoveries in the tunnel under Morwelldown (Hadfield (1967, 128).

1808 The waste rock and ground from the tunnel excavation was boated eastwards back to the tunnel entrance and used to infill and form the Lumburn Aqueduct over the valley, with a central spanning arch.

1809 Work progressed slowly in the tunnel (by this date it was half finished), as the canal section from Tavistock to the tunnel was finished (ie, this project's study area). This was built more permanently with stone sides (on edge) rather than puddle clay. The tunnel rock was granite, its depth 160 yards below the top of the hill. Pumping/ventilation/winding and access shafts (at least four – the main one being Bray Shaft), had to be sunk from the top of Morwelldown to the underground canal. John Taylor designed the power source for the shaft workings by utilising flat rods (for lengths up to 1.5 miles) powered from a large 40′ water wheel. He also designed a ventilation fan for improving the air quality, for which the company was awarded the medal of the Society of Arts in 1809 (Hedges 1975).

1810 The tunnel advanced at a rate of about 150 fathoms (six feet per fathom) per year until this year when three granitic dykes were cut, slowing the work rate to nearly a third that amount for two years. 30 to 40 workmen were continually employed, with some authors suggesting French prisoners of War used as 'navvies' (Barton 1964, 93 and Booker 1971, 108).

1815 From this year there were shipments of manganese from mines around Brentor and Milton Abbot carried by the canal. These were the principal sources of manganese in the country at a time when it was used in the manufacture of glass. For example, 13,335 tons were shipped to Plymouth in 1819. The ore was ground in a mill powered by the Morwellham water wheel (Booker 1976, 19), and exported in casks.

1816 (August) Tunnels were cut from both ends (simultaneously), to form a working area and to align both ends. They connected on the 21st August. Then the tunnel was enlarged (downwards and wider) throughout its length.

The demand for metallic ores to feed the Napoleonic war years (1793 – 1815) slumped as the soldiers returned, as markets waned. The canal committee, sensing further financial difficulties in September stated *'That the Tonnage will fall very short of the original estimate cannot be doubted; at the time when this was made the Mines in the neighbourhood were in their most flourishing condition, or rapidly advancing to it. Agriculture encouraged by high prices was improving everywhere, and the use of lime, so essential … was very great and increasing. Slate quarries, then making large returns, were in full activity, and new ones opening. In all these sources of oecumenical mode of carriage, the greatest reverses have taken place, and at present a stagnation of enterprise and consequent inactivity prevails'* (Hadfield 1967, 130). However, the population of Tavistock had increased from 1801 to 1821 by over 62%, reflecting the growth in the area, primarily a result of mining operations and related tertiary expansion.

1817 The tunnel was finally completed early in the year, with the official opening ceremony held on 24th June. Thousands attended the event, with over 300 going in boats (with a band) through the tunnel – to be met (with obvious relief) by thousands more at the Morwellham side. All were then given a demonstration of the workings of the incline railway mechanism and tramway down to Morwellham (see Buck 2005 – Sites 58 to 64), powered by a large water wheel and the canal water – which was also recently completed. The boats (specially designed and built by the Tavistock foundries from 1811 to replace an earlier wooden design), were *c*30 feet long, 5 feet wide and towed along the slow moving open canal by horses. They were worked through the long tunnel by two men using iron bars against the rock face.

The canal had taken 13 years to build. Its final cost was £62,000, the excess over the authorised capital of £40,000 having been raised by calling £155 on each £100 share.

1819 Although the economic outlook for the area was not good, the company decided to press ahead with the Millhill canal branch to the slate quarry. It was 2 miles long and cost £8000. It rose by 19.5ft to Millhill, with an inclined plane for the final section due to the scarcity of water (double tracked with two cradles counterbalanced with loaded boats going down pulling the empty ones up with the help of three horses).

1820s The expected tolls were halved from their pre-construction estimates – due to the gloomy economic climate. Over the next three decades the canal carried between 15,000 to 20,000 tons per year, earning an annual profit of approximately £600.

1831-2 A Cholera epidemic in the locality severely affected the workforce, the local economy and (temporarily), the canal's fortunes.

1841 Great Western Railway completed.

1844 Discovery of the main copper lode (40' wide) at Wheal Maria later Devon Great Consols – reversing the fortunes of Tavistock over the next 30 years, but reducing those of the canal. The Mill Hill Tramway was constructed this year (replacing the earlier section of the canal which had been closed after 1831), at a cost of £1,381 (Hadfield 1967, 132).

1847 20,132 tons were carried on the canal (Woodcock 1995, 23).

1848–9 Another Cholera epidemic.

1850 The goods carried on the canal were (tons): Sundries (7548), Limestone (3130), Copper ore (2.499), Slate (676), Granite (83) and Mundic (pyrites) (94). Tonnage carried fluctuated from year to year, reflecting the area's economic woes (or successes). In a bid to maintain revenue, at various times throughout this period, the company reduced tolls, or raised them again when economic conditions improved. But dividends, throughout the life of the canal were always modest, and profits turned out to be at a level 1/3 predicted at the outset.

1851 In the 1851 census, there were 27 barge men working for their various employers regularly using the canal.

1857 Shares that had changed hands at £100 in 1803 were now changing hands at £5.

1859 Construction of the Devon Great Consols railway from the mine to Morwellham with a separate incline section down to the port finished this year. Also the South Devon & Tavistock Railway from Plymouth to Tavistock opened (later extended to Launceston) – in direct competition to the canal. Due to this competition, the company further reduced its tolls after the opening of the railway. However, in the same year it expended more capital on renewing the inclined plane mechanism, and investing funds on a steam mechanism to pull loaded barges through the tunnel against the water flow (it often took a couple of hours or more to undertake this manually!). This was not successful.

There is no doubt that the waning fortunes of the Tavistock and Tavy copper mines, working for the past half century, were no competition for the resurgence of the Tamar Valley copper mines from the mid 19th century. Whilst the former utilised the Tavistock Canal as a transport medium during this period, the latter formed its own railway equivalent; but both used Morwellham as the export destination. Given the rapidly changing transport infrastructure due to the construction of mainline railways to the south west from the mid 19th century (consequently resulting in dramatic changes to market influences), across Devon and Cornwall at this formative period, so the fortunes of this old transport route was found wanting and uneconomic.

1860 In the previous year, the canal tonnage was 17,455. In this year it fell to 13,500. From 1863 onwards there was a steady decline in the tonnage until, in the early 1870s it dwindled to nothing (Hedges 1975, 28).

1862 A shareholder from Birmingham wrote to Mr Gill, representative of the Canal Company and said: '*I am afraid there is little hope of the canal rising in its fortunes with the railway for a rival. Here we have in several cases united the canal with the railway with advantage to both – you know best whether such an arrangement with the Tavistock canal would be advisable*' (Hedges 1975, 28).

1866 In September, the canal committee recorded; '*That a very considerable reduction having taken place in the traffic and dues of the Tavistock Canal Company since the opening of the Tavistock and Launceston branch of the South Devon Railway it was resolved that His Grace the Duke of Bedford be applied to kindly assist the Tavistock Canal Company to compete with the Railway Company by reducing the Canal Dock dues at Morwellham'.* The Duke was evasive (Hadfield 1967, 134).

1870 Only 783 tons were carried on the canal (Woodcock 1995, 24).

1872 Presumably the economic situation became even direr. At a meeting on 2nd September the Duke offered to buy all the shares at £8 each, and to pay half the cost of an Act to transfer the canal to him. Within the month, the committee accepted his terms. Since the summer there had been no traffic on the canal. However, this was not a localised occurrence; the impact of the railways had dealt a death blow to innumerable canals all over the country.

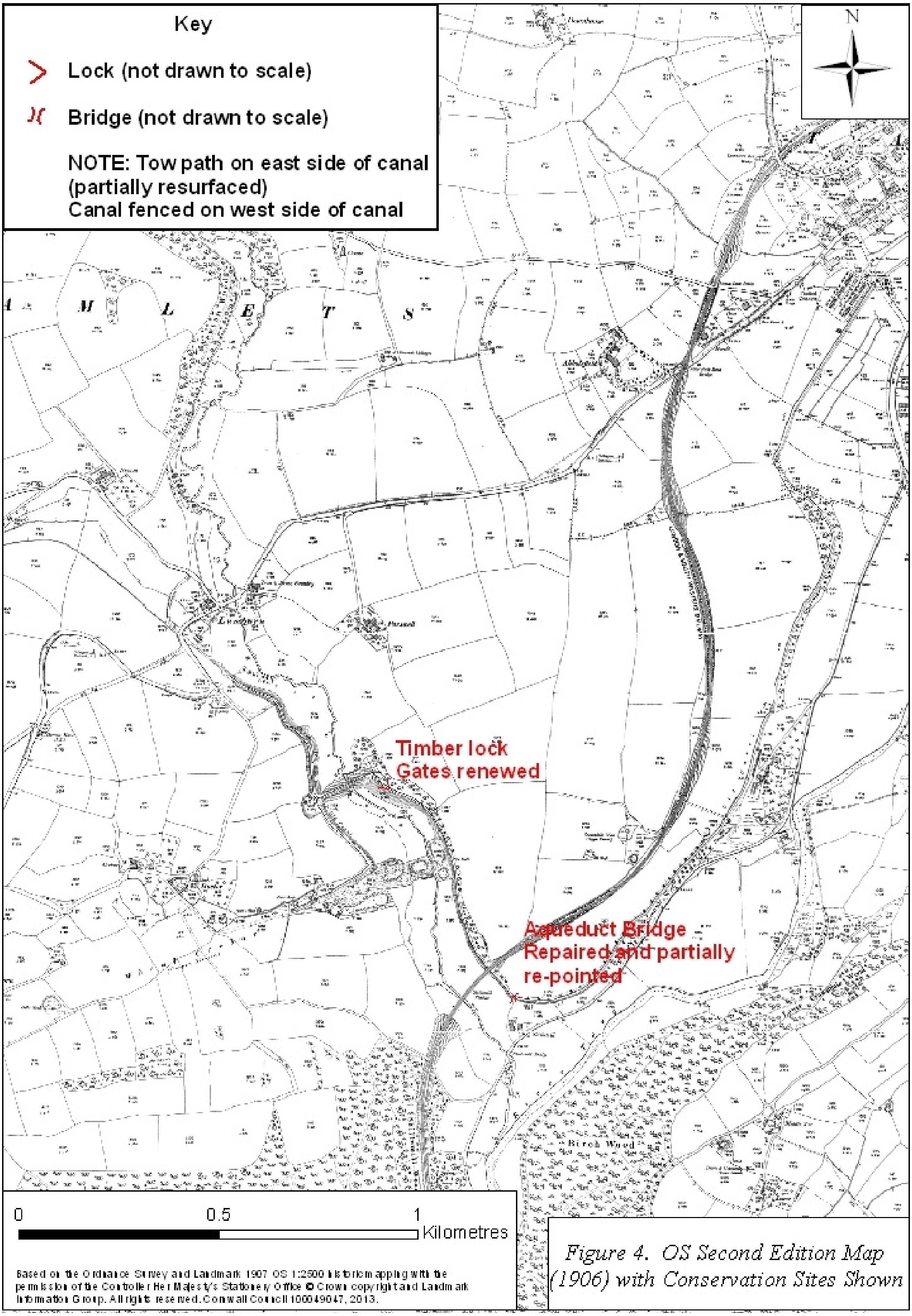


Figure 4. OS Second Edition Map (1906) with Conservation Sites Shown

1873 In May the Act was passed and the Tavistock Canal and land returned to the Duke of Bedford for £3,200, there being no obligation on the Duke to maintain the canal. It is uncertain what use the canal had for the next twenty five years.

1896 This perhaps was made clear in May of this year when the Tavistock Gazette reported that on Whit Monday the basin of the Tavistock Canal was to be cleaned out (it appears a regular activity on this day). *'The cleaning is wanted more now than when it was a hive of industry … a resident noted ... A great deal of sewage was emptied into it, and the water does not run at a greater rate than half a mile an hour. I have seen dead dogs, cats and rats in the canal'* (Woodcock 2005, 26).

1898 The Tavistock Canal was not included the Canal Returns.

1933 After cleaning the canal bed (which must have been quite onerous!), the West Devon Electric Supply Company built a sluice gate near the west end of the tunnel portal, to convey water to a header pond (Forebay) to go down to hydro electric turbines via large tubes at Morwellham Power Station, next to the River Tamar.

In 1923 and 1933, mining geologists Cloke and Barclay carefully assessed the lodes intersected by the tunnel during a tunnel assessment and clearance scheme (CRO AD58-26). They confirmed that the tunnel intersected eight or nine lodes and three cross-courses, but only two of these (East Russell and Georgenia Lodes), had any stoping accessed by the canal. The only repairs necessary were to the Morwellham portal end retaining wall.

Footnote:

The canal has been maintained and managed by the owners of Morwellham Power Station since 1933. For some time this work has been undertaken by South West Water and British Waterways, the former now monitors and maintains the canal, carefully regulating the flow to utilise the instant generating capacity of the hydro-electric power station at times of peak demand (to provide a cost effective monetary return). It is poignant perhaps that the canal still exists today due to its economic usefulness.

4. Impact assessment

This summary impact assessment is intended to inform and guide Devon County Council Historic Environment Service of the impact of the canal repair works, the aqueduct bridge repair and lock gates replacement. This section of the report summarises the archaeological resource, and describes the impact and mitigation of the canal works as part of a mitigation strategy. However, it should be noted that the mitigation procedure was undertaken during the project (due to the lack of advanced project specifications), by efficient communication between the report author (as site archaeologist), Bill Horner (DCC archaeologist), Chris Hariades (TVMHP Project manager), and South West Water. A structural engineer, Andrew White of Knevitts Ltd produced specifications for the aqueduct bridge structural repair (see Fig 12).

The sites impacted by the repair works are shown in Figures 5, 6 and 12 and reproduced on plan in Figure 4. The main sites include repair works to the sides of the canal itself, structural repairs to the aqueduct bridge, and repairs to the lock gates. The impact of the repair and conservation works on each site is then described, and a final section details the impact remediation measures.

The potential impacts during works are described below. Impacts are described in the text section for each site on a feature-by-feature basis. The following site impact terms are used within each site identification description:

Major positive	Site continues in, or is restored to, its original design and use
Moderate positive	Site restored as far as possible respecting its original function, but its use is altered
Minor positive	Site partially restored; interpretation introduced
Negligible positive	Stabilisation/maintenance of site
Negligible negative	Benign neglect – losses of fabric over a long period of time

Minor negative	Site suffers areas of alteration or damage, which contribute to loss of meaning
Moderate negative	Significant loss of fabric or alteration, leading to erosion of original character
Major negative	Complete demolition/removal

Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the end of the Lumburn Aqueduct **SX 46237 72628,** see Fig 1).

Description

The canal section impacted by the repair works was built between 1803 and finished by 1809 (as described in the historical background section). This section of the canal may well follow the course of a mine leat from the River Tavy to Crowndale Mine, which pre-dates construction of the canal. For much of its length the canal's west side (see Fig 4), cuts into the valley side – revealing vertical bed-rock and also frequently forming the bed of the canal. Excess stone material from the rock cut was used to form the rounded profile edge of the east side of the canal – using slate/killas stones set on edge. The tow path was formed along this eastern side. The canal is approximately 4.0m wide, 0.3m to 0.5m deep, with the east side approximately 0.6m to 0.8m deep from tow path surface to water level.

Repair works to the canal's east side (and towpath) has been undertaken in the past, sometimes inappropriately using cement and concrete formwork. The 2009 repair work to both sides of the canal and re-surfacing parts of the towpath continued with this theme of patching the damaged sections (Fig 11).

Site works impact (2009)

The repair works relate to identifying areas of the canal sides that needed to be patched with new (similar specification) stone within the section of canal identified above. This should immediately stop progressive damage to the canal sides and help to support the well used canal towpath. There is no site plan showing each small repair section, rather a canal bank repair work schedule (Appendix 1).

Other works to the canal itself that were proposed include patching and re-surfacing the tow path. South West Water (SWW) undertook its own Risk Assessment for each tree close to the tow path. Mitigation works resulting from that survey (i.e. branch or tree removal) was undertaken by SWW.

The overall impact of the works on the canal can be defined as '*Negligible positive'.* The works reduced collapse of parts of the canal's east side to maintain structural stability, provided more tow path stability and a higher degree of Health and Safety for increased public access for at least another generation. However, it is hoped that the track is adequately annually maintained.

Residual impact (2009)

There have not been significant residual impacts in the medium term – apart from the visual aspect of the replacement stone looking newer than the original stone surrounds.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of replacement stone (to match existing), reduced the visual impact of patching the sides of the canal. Other reduction impact measures included the tendering for appropriately qualified and experienced contractors to reduce the visual effect of repair sections to the canal, and for the quality of the work, which was of a good standard (reflecting the original construction style). This project should reduce the need for this work to be undertaken for at least another generation.

Aqueduct Bridge SX 46630 72090

Description

The aqueduct bridge carries the canal over an access lane to fields north of Shillamill Farm – whose access was cut by construction of the canal. The iron plated trough structure seen today was built in 1839 by Gill & Co of Mount Foundry, Tavistock (Buck 2007), replacing an earlier structure. The bolted sections of the trough extend to either side of the granite quoined masonry, and are supported by four wrought iron lintels (widening into the masonry sides) set into the granite masonry. Three other similarly styled lintels (see Fig 13) provide the support for large slates under the tow path on the south side of the canal. The middle lintel however has rusted to the extent of being ineffectual. A structural survey by Knevitts Ltd has recommended its replacement, as the aqueduct is not only used by tow path walkers, but is proposed to be accessed via the adjacent fields, in order to link up the railway (Buck 2009) with the canal – by a new DCC footpath route under the aqueduct – formerly used for access to the upper field.

Patch repointing to the sides of the bridge under the aqueduct in recent years has occurred, however more often than not this has been using cement, using a variety of styles. At the northern end of the side walls the stonework has been leaking for some time where water is leaking from the junction of the wrought iron plates with the canal bed. This has caused the masonry to be soft, and the stonework made weak – causing a noticeable dip on either side.

On the south west side of the aqueduct a high vertical retaining wall supports the tow path and masonry for retaining remnants of steps, to allow pedestrians walking the towpath to access the lower field. Some of this vertical retaining wall has areas of lime mortar pointing that is loose.

Site works impact (2012)

After dialogue with the TVMHP manager, the structural engineer, the landowner of Shillamill Farm, the Devon County Archaeologist and consulting project archaeologist; the TVMHP agreed to fund replacement of the centrally located rusty wrought iron lintel, and to undertake limited lime mortar repointing where structural stability of the adjacent walling could be compromised.

Site impact of the replacement lintel was minimised by matching most of the original profile of the replacement item as far as could be possible from an 'off the shelf' steel equivalent (in order for the project to be cost-effective), with the original wrought iron lintel.

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works have reduced the potential for collapse of the tow path as it runs next to the canal aqueduct. This project will provide a higher degree of Health and Safety for increased public access for at least another generation.

Residual impact (2009)

There are unlikely to be significant residual impacts in the medium term – apart from the aspect of the replacement iron lintel and repointed masonry looking newer than the adjacent (cement) based repairs.

Reduction of impact (2009)

Site consultancy with the project manager and structural engineer will minimise any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors should mitigate the visual effect of a new structural item, and for the quality of the work to be of a good standard, reducing the need for this work to be undertaken for at least another generation.

Lock Gates and timber lifting bridge SX 46327 72628

Description

The construction of the adjacent Canal cottage for operation of the lock gates, the lifting bridge and the visible remnants of the semi-circular trans-shipment basin (or turning/waiting area) is indicative that this part of the canal was quite busy! The latter

(sited close to the lock gates) is now infilled, but the tops of some of its vertical timbers still visible. The necessity of keeping the water at the correct level was important for the tunnel – this lock gate possibly forming this function also for the Lumburn Aqueduct (SX 46311 72632 to SX 46184 72581), with its single arch to the south. According to Waterhouse (forthcoming) the timber lifting bridge is of a Dutch design common on canals in the Welsh borders, and may not be contemporary with the canal's construction.

The lock gate and lift bridge was previously restored by October 1998, funded by South West Water and British Waterways. However, as Figure 15 shows, one of the timber arms of the lift bridge had snapped and parts of the timber walkway rotted. In addition the lower parts of the swing lock gate has rotted where it is in contact with the canal water.

Site works impact (2012)

The TVMHP agreed to fund replacement of the timber components that were rotted or had broken or snapped off. This includes the large timbers to open the bridge and the Lock gate. The TVMHP tendered for experienced Carpenters to assess both features and to price for the production of making and erecting replacements.

Site impact for the replacement timbers was minimised by specifying exact replacements with the existing timbers (previously replaced in 1998).

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works reduced the potential for further timber rotting and collapse, an important Health & Safety measure so close to the well-used canal towpath. This project has provided a higher degree of Health and Safety for bridge use and public access for at least another generation.

Residual impact (2009)

There are unlikely no significant residual impacts in the short term.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors mitigated any possible mistakes, the quality of the work was of a good standard, and reduced the need for this work to be undertaken for at least another generation (Fig 16).

5. Impact mitigation strategy

The impact mitigation strategy is divided into three stages: The pre-works consultancy, the Historic Buildings Consultancy during works and the archaeological recording record (during and after works). This mechanism demonstrates the steps that have been taken to avoid or minimise adverse impacts, and confirms that the proposed works have been designed in close liaison with the historic environment consultant. Consultation is based on a clear understanding of the significance of the site using appropriate methods and techniques for site monitoring and recording.

HES Projects (Project number 20070793) was commissioned to undertake the three components described as the impact mitigation strategy. The project was based on a project design produced by Colin Buck (21/07/06), and recording specifications defined by Bill Horner (DCC archaeologist).

6. Working method

The following text summarises the general WSI for all archaeological consultancy and archaeological recording for projects relating to the TVMHP (Tamar Valley Mines Heritage Project: Written Scheme of Investigation: Historic Building and Archaeological Recording Consultancy 21/07/06).

- A brief historical survey was compiled from existing Devon County sources (DCHER, DRO, and local libraries and historians (including Robert Waterhouse's recent published work on the canal).
- A walk-over survey was undertaken of the entire length of the canal for sites impacted by the TVMHP.
- An impact assessment described and mitigated the proposed work as part of a Mitigation Strategy to minimise the works affecting the site's character.
- General working methods for archaeological recording, treatment of finds, photographic surveying and report production are described in detail in the Tamar trails WB WSI produced in 21/07/06.

All archaeological recording work was undertaken according to the Institute for Archaeologists (IfA) *Standards and Guidance for Archaeological Investigation and Recording. Staff follow the IfA Code of Conduct* and *Code of Approved Practice for the Regulation of Contractual Arrangements in Archaeology.*

The principal factor in effective project delivery was the employment of key project staff who are expert in the management and recording of the industrial heritage. Cornwall Historic Environment Service project staff can draw upon a substantial track record in undertaking similar work throughout Cornwall, as well as a detailed knowledge of the project area and its sites.

Historic buildings consultancy

- HES (Senior Archaeologist) liaised with the Devon County Historic Environment Service - DCHES (Bill Horner), and the TVMHP Project Manager (Chris Hariades).
- The HES Senior Archaeologist attended regular site meetings when appropriate during the duration of the project.
- HES ensured that site conservation works are carried out to standards recommended by English Heritage best practice.
- **Fieldwork: archaeological recording**
- There were no newly exposed archaeological features revealed through excavation.
- Where appropriate, measured survey was carried out by hand measurements (using offset techniques at a scale of 1:50.
- The resulting survey output was a revised measured survey drawing showing all conservation works that had been undertaken. This was reproduced at a scale of either 1:50 or 1:100 (appropriate to the size of area recorded) and will form part of this archive watching brief report.
- Analysis of the building fabric was recorded in the form of field notes and written up in this archive report production stage.
- DCHES (Bill Horner) advised that archaeological recording should be undertaken during any excavation that revealed archaeological features. Recording was undertaken using a mix of direct measurement, sketch plotting and photography, as appropriate (constrained by safety factors).
- Where significant remains were encountered the site archaeologist was given the opportunity to make an appropriate form of record before work proceeds.
- The chosen site archaeologist adhered to Health and Safety Policies (see below), under the direction of the designated Site Safety Officer.

Site recording (general)

- Site drawings (plans, sections, locations of finds) were made by pencil (4H) on drafting film; all plans were linked to the Ordnance Survey landline map; all drawings included standard information: site details, personnel, date, scale, north-point.

- The site archaeologist undertook the recording in line with recommendations given by IfA. Sections and plans were drawn on site at appropriate scales which adequately recorded structures or features at appropriate levels of detail, and appropriate sections reproduced in the archive report at either 1:50 or 1:100 to adequately demonstrate revealed archaeological features.
- All features and finds were accurately located by means of a National Grid reference and all archaeological contexts will be described using a standard format and linked to a continuous numbering sequence.
- The archaeological watching brief report detailed all forms of archaeological recording that had been undertaken at each of the mine sites. Each major mine site had a single archaeological watching brief report that details all project related work to that site (i.e. trails works, building conservation works, interpretation works, etc).

For Treatment of finds, Photographic recording specifications, report production and archiving specifications refer to the TVMHP WSI (2006).

7. Results

Unfortunately, there was insufficient time (following receipt of a detailed plan and description of the canal repair works from the TVMHP), prior to the start of works on site to produce an impact and mitigation report for DCC (Bill Horner). A decision was therefore taken to minimise impacts and mitigate directly with the TVMHP and site contractors on site as works were progressing as part of a weekly site recording and consultancy. SWW funded the stone and path repairs to the canal bed whilst the TVMHP funded fencing of the north and west sides of the canal, to stop encroaching animals from the adjacent fields from directly accessing the canal (and walking up the towpath!). An interim archaeological recording report of these works was produced by the author on 17/06/2009. This report supersedes that report.

Repair works to the bed and towpath of the Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the start of the Lumburn Aqueduct **SX 46237 72628**)

In early 2009, the TVMHP tendered for stone masons (on behalf of SWW) experienced in rebuilding stone walls, etc, to undertake these works within a narrow time-scale of three weeks, when SWW were willing to reduce the water flow through the canal (which would stop the electricity generating turbine). The turbine normally operates all year round, often at short notice when generation rates for electricity peak (the turbine can instantly generate electricity). Clemens Stonemasons of North Cornwall were successful in winning the contract. Prior to this, the TVMHP Manager, the archaeological consultant and SWW projects officer, produced a repair work specification schedule (measured from the small swing bridge at Tavistock: SX 47348 73503), which focussed on identifying the repair of collapsed sections of canal bank on the south or east sides. Appendix 1 is a reproduction of this original document.

Site work started on 05/05/09 at the northern end of the canal and progressively worked southwards towards the lock gates at the Lumburn Valley. With the reduced water level in the canal (and its slow movement when full), many stones that had fallen out of place were found in the canal bed not far from their original bank location. When the canal was constructed the stones were originally set on edge, a minimum of two/three stones height (approximately 0.6m to 0.8m above water level). During the repair project, where there was insufficient stone to replace the collapsed sections, a similar stone was imported from Trebarwith Quarry, North Cornwall (purchased from the local quarry at Millhill). These stones were reset on edge, following the original profile of the canal bank, and tightly tamped down in position (tops and sides). Earth was backfilled into the top sides of the stone to re-form the edge of the towpath. This was then at a later date, re-seeded. Figures 7 and 8 show examples of before and after photographs of the repaired canal bank. The work has been sensitively undertaken and reflected the style and character of the original construction a century ago.

Weekly site meetings were arranged to view the previous week's repairs and to discuss any foreseeable problems within the following weeks programmed work. A granite towpath stone under the Crowndale bridge at SX 47194 72541 had become dislodged (into the canal), and some quoin stones from the bridge parapet wall had fallen into the canal. The former was repaired by contractors; the latter will be removed from the river by SWW to be replaced on the bridge parapet wall at a later date. A small section of old 2" timber (2m long) set in the lower part of the bank was replaced back into its original position following repair of the wall at this location (SX 47270 72707).

The canal bank repair works (see Appendix 1), were finished on 28/05/09, including an additional element of work totalling 87 metres, which the contractors identified whilst on site. A total of 337 linear metres of canal bank was repaired (only on the south/west side), using a total of 86 tons of additional Trebarwith stone. The canal repair works were funded by South West Water.

Figure 5 is a site plan and specification document for the installation of timber post and wire stock fencing along the west/north side of the canal and construction of three cattle drinking areas to minimise any future erosion of the opposite (north/west) side of the canal bed. The cattle drinking sites are located at SX 47384 73064, SX 47257 72705, and SX 47078 72415. A concrete pad (min 0.3m thick), varying from 3m to 4m wide and approximately 5m long, has been created to at each of these sites to form the post and rail fenced cattle drinking areas that should minimise further damage to the banks (on either side). An additional cattle drinking area was constructed on bedrock immediately on the west side of the Shillamill Viaduct (see Fig 6). Figures 9 and 10 show before and after views of a cattle drinking site (SX 47384 73064).

Approximately four months later, the surface of the canal towpath was patched with crushed stone (803 specification) where the path was potholed or muddy, then sections covered with finely ground stone (6mm to dust) from Meldon Quarry.

During construction of the cattle drinking sites and during the canal repair works there has been minimal archaeological impact, nor any finds recorded.

Aqueduct Bridge SX 46630 72090

Knevitts Ltd was commissioned by the TVMHP in 2011, to undertake a structural survey of the aqueduct bridge at this location. Their report and structural drawing (see Fig 12), recommended that a rusty wrought iron support (middle one of three similar supports – see Fig 13) sited under wide slates below the towpath next to the canal, be replaced with a modern equivalent. In addition, it was recommended that the tall retaining wall on the south west side of the aqueduct bridge be repointed and structural ties inserted (using 7mm diameter stainless steel helibars) into the masonry bedding joints to strengthen a structural crack in the masonry.

This work was not started until May 2012, following an extensive dialogue with SWW and the site owner. Figure 13 shows the failed rusty element needed to be replaced. The original lintel was 50mm x 50mm for most of its length but widened to 100mm at both ends (and set in the side walls). Unfortunately the original wrought iron section specification was impossible to replace, and an 'off the shelf' item had to be found due to budgetary constraints. Figure 14 shows the new steel replacement *in situ*. Scaffolding had to be erected to remove the original rusty support and to replace it with the new 50mm wide x 115mm deep iron profile steel section. A slightly wider opening had to be made into each granite quoined side of the bridge for insertion of this new structural element. The localised setting was then repointed with lime. The steel was painted with a red primer and then painted black.

Other works to this site included removal of a tree growing out of the west side of the north end of the aqueduct bridge and treatment of the stump, as its unchecked growth had caused structural issues to the masonry at this point. On the opposite side of the bridge opening, the top flanking stones over the east side revetment walling had become dislodged. These were moved back to their original position. TVMHP funded the project.

At the north end of the structure under the aqueduct section, it appears that water has been leaking from the canal at the intersection of the metal 'trough' profile bolted plates and the canal bed – on both sides, through the stone masonry. This has caused the masonry and water at this point lower down under the aqueduct to be constantly wet.

Consequently, the foundations masonry and pointing in this area have softened to the extent that the masonry is collapsing and arching downwards. SWW attempted to add some clay to the leaking intersection point in the bed of the canal, but this has not worked. Structural deterioration will continue unless this issue is resolved. This is a significant feature of the canal which is in places, is now a Scheduled Monument. It is a recommendation of this report that the aqueduct bridge be considered for Listing.

Finally, the vertical retaining walling on the south west side of the aqueduct was repointed and the structural crack that had been identified by the structural engineer, repaired with the use of helibar reinforcing. This work finished in mid June 2012. The repointed wall acted to retain not only the towpath running along the south side of the canal, but also steps that allowed access from the towpath down into the adjacent field. These steps have badly deteriorated, leaving a steep slippery slope. It is recommended that they need to be rebuilt before use of them can be made by a new DCC footpath from the nearby railway linking up with the canal footpath.

Lock Gates and timber lifting bridge SX 46327 72628

The timber lock gate and timber lift bridge was 'restored' in 1998 by SWW and British Waterways. It is not know what the restoration replaced, but parts of the timber lift bridge (mainly the western timber arm), had rotted resulting in collapse (see Fig 15). Other parts of the bridge were showing that many timber items were rotting. In addition, the section of timber lock gate that was in constant contact with canal water had also rotted during the last 14 years. SWW and the TVMHP decided to replace the rotted and unsafe timber items as being a Health and Safety issue, given the frequent public use of the towpath. SWW funded the project.

The project of dismantling the bridge and lock gate, replacement of the main and structural timbers, and re-assembling and fixing on site was tendered. The contract was won by Will Sterling and Son, a traditional timber boat builder and carpenter who worked at Morwellham Quay (repairing and building boats, etc). The work was started in July 2012 and finally finished in September 2012.

Figure 16 is an 'after' view of the works on these features, and should be compared to its preceding figure. It is hoped that this repair will last longer than its predecessor!

Note:

In 2013, the TVMHP constructed a new footpath from near Morwell Rocks (SX 44128 70435) to above George & Charlotte Mine (SX 45101 69962). This new route links the main route of the railway line from Devon Great Consols to Morwellham and the forestry tracks north of Morwellham. Scheduled Monument Consent was obtained in 2012 for construction of a new timber footbridge over the Tavistock Canal (the section from the west end of the Morwell Down tunnel to the incline railway cottage was Scheduled in 2011, SM No. 30973). As part of this project, an impact assessment report was produced (Buck 2012). The results of the new footpath creation and footbridge construction will be produced within the main body of the TVMHP archaeological recording report (Buck forthcoming).

8. References

8.1 Primary sources

CRO AD 58-26 Tunnel Lodes (1923-33) Report by F Cloke and CF Barclay.

DRO T1258M-14B Bedford Estate Map

8.2 Secondary sources

Barton, D.B., 1964, *Historical Survey of the mines and mineral railways of East Cornwall and West Devon*, Truro

Booker, F., 1970, *Morwellham – a history*, DART Publication No. 2

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Buck, C., (Forthcoming) *Tamar Valley Mines Heritage Project – Archaeological recording report,* HE Projects

Hadfield, C., 1967, *The Canals of South West England*, David & Charles, Newton Abbott

Hedges, C., 1975, The Tavistock Canal, DART Publication No. 16

Waterhouse, R., 2012, *Tavistock Canal, Surveying a forgotten marvel of the industrial age*, Current Archaeology, Issue 273 December

Waterhouse, R., Forthcoming publication on 'Tavistock Canal'.

Woodcock, G., 1995, 2005, Booklets on the 'History of Tavistock'.

9. Project archive

The HE project number is **20070793**

The project's documentary, photographic and drawn archive is housed at the offices of Historic Environment, Cornwall Council, Fal Building, New County Hall, 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 (20070793).
2. Black and white photographs archived under the following index numbers:

   GBP 2091/12-21; 2207/12-22; 2250/1-17; 2253/19-22.
3. Digital photographs stored in the directory R:\HE images\Sites\Devon\Tavistock\Tavistock Canal
4. This report text is held in digital form as: G:\HE Documents\HE Projects\Sites\Devon\Tavistock Canal IA WB report 20070793
5. English Heritage/ADS OASIS online reference: cornwall2-154344

No artefacts or environmental material was retrieved during the project.

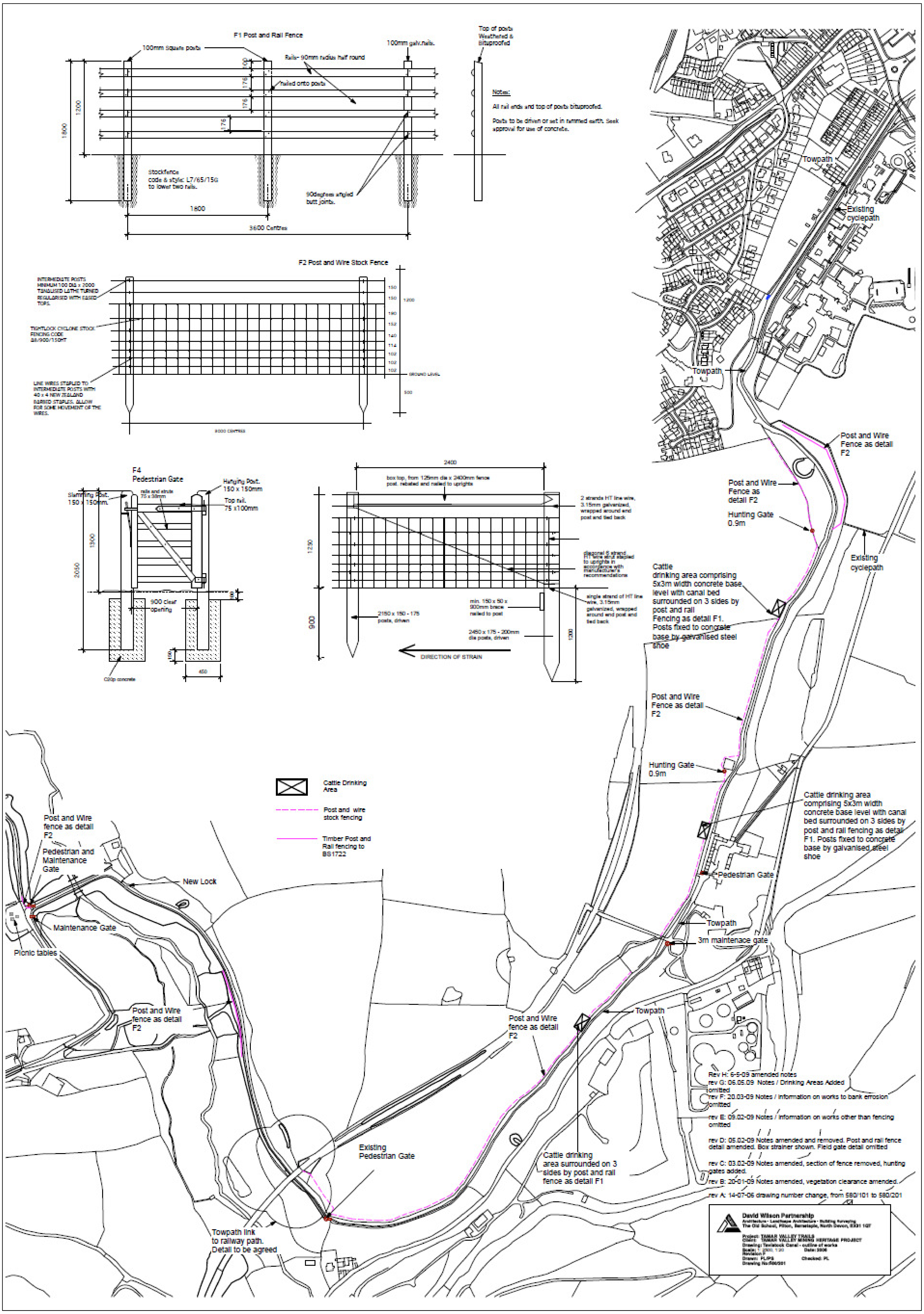


Figure 5 Specifications and plan showing fencing and three cattle drinking areas at the Tavistock Canal(East section)

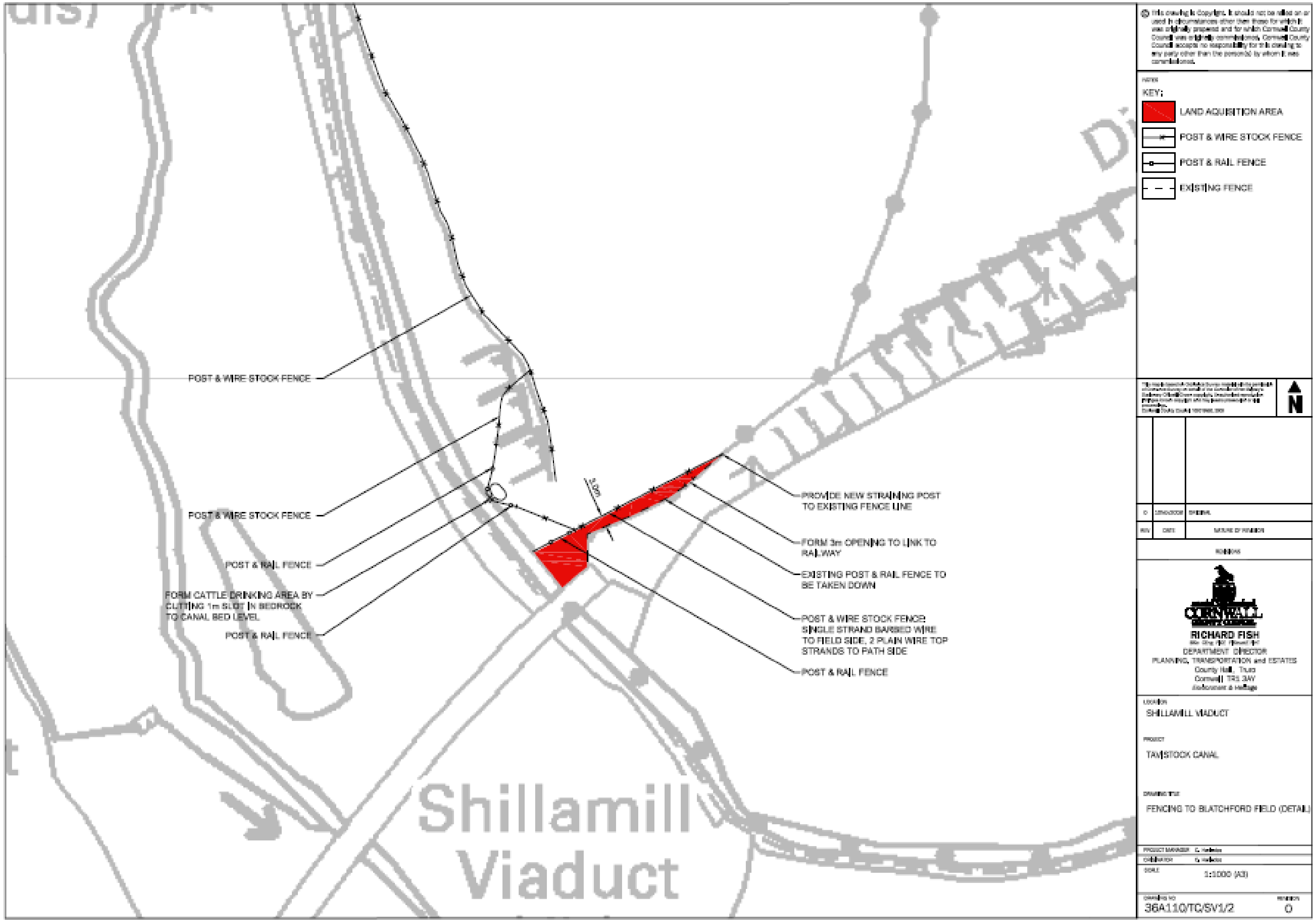


Figure 6 Detail plan showing the cattle drinking area west of the Shillamill Viaduct

Figure 7 A view of the Tavistock Canal east bank before works © CC HE Projects

Figure 8 A view of the Tavistock Canal east bank after works © CC HE Projects

Figure 9 A view of a Cattle Drinking site before works (SX 47257 72705) © CC HE Projects

Figure 10 A view of the same Cattle Drinking site after works © CC HE Projects

Figure 11 A view of the canal towpath after re-surfacing works © CC HE Projects

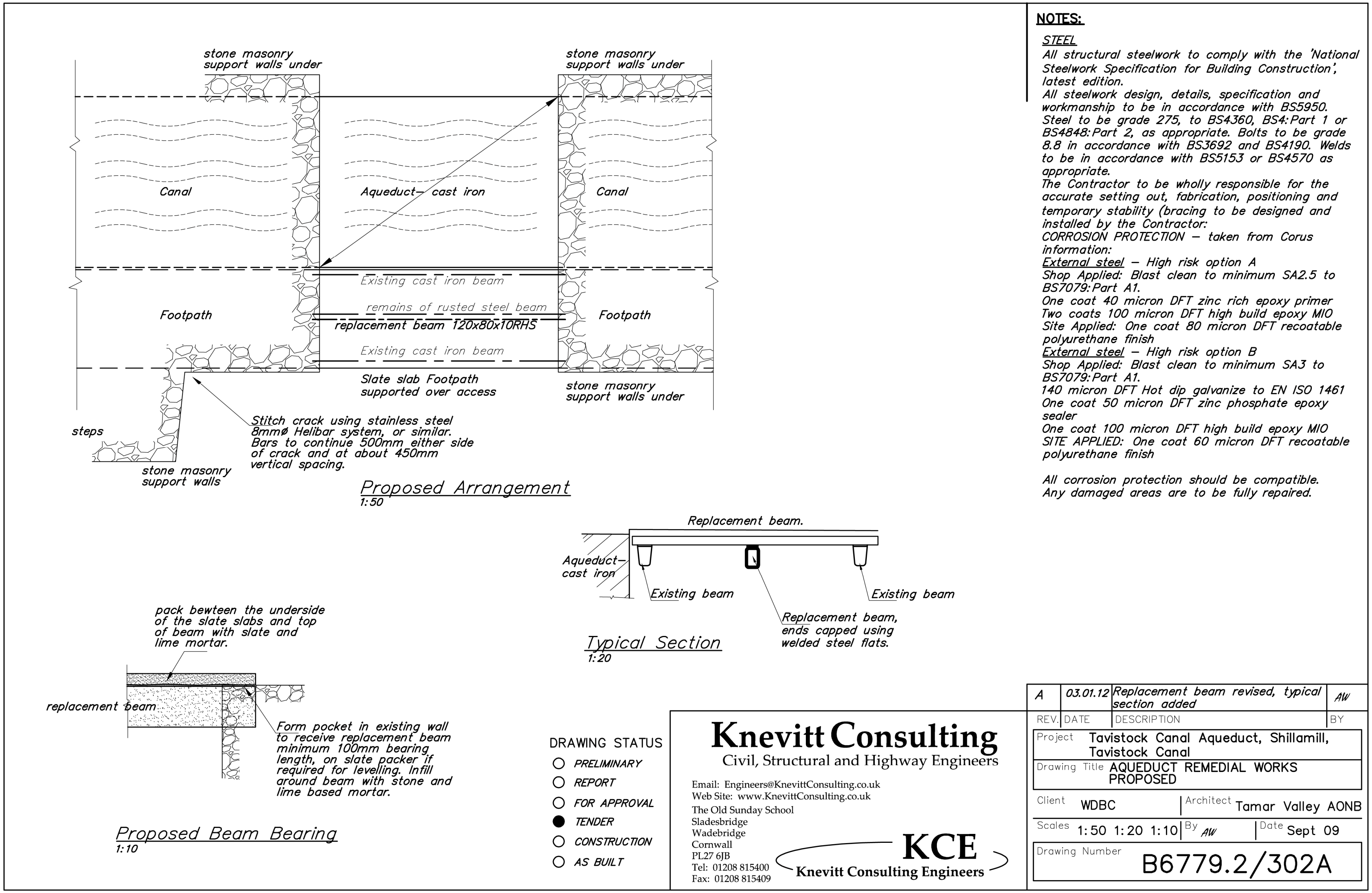


Figure 12 Specifications plan for repair of the aqueduct bridge

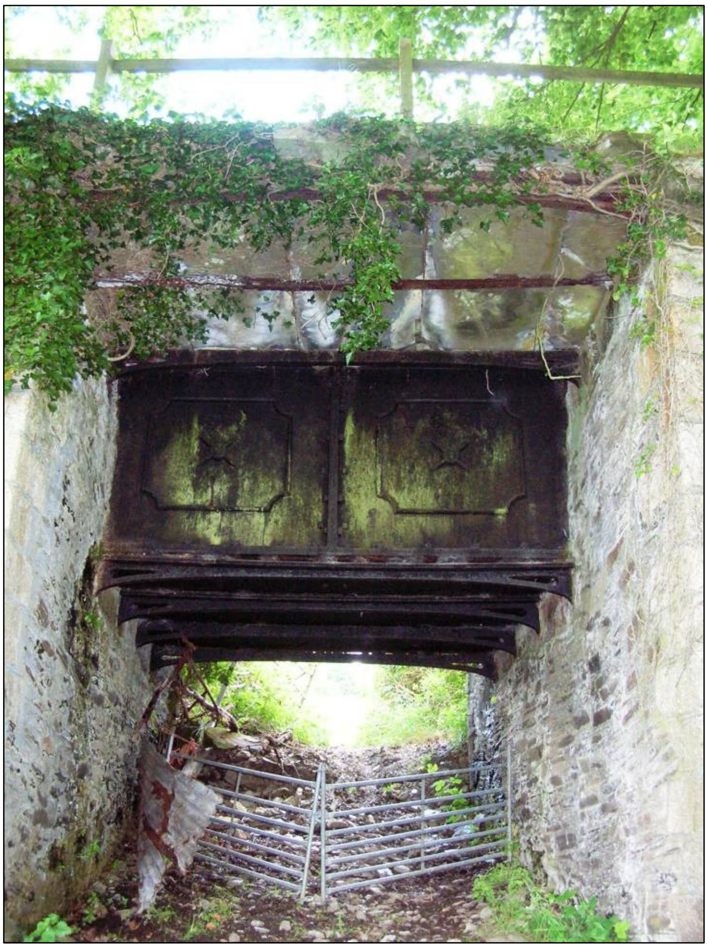


Figure 13 A view of the canal aqueduct bridge before works © CC HE Projects

Figure 14 A view of the canal aqueduct bridge after works © CC HE Projects

Figure 15 A view of the canal lock gate and bridge before works © CC HE Projects

Figure 16 A view of the canal lock gate and bridge after works © CC HE Projects

Appendix 1: TAVISTOCK CANAL BANK REPAIR WORK SCHEDULE

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
20		Side out path and hedge (140m length)
76		1.5m infill behind c $2m^3$
118		1.5m infill behind c $1m^3$
140-150	10	Minor wall top repair
159-160	1	End of hedge
162-163	1	1m infill behind $0.25m^3$
166-179	13	
225-247	22	
253-308	55	Break out conc block
314-323	9	
328-330	2	
394-418	24	
433-461	29	Take off conc
P A T H		
467-469	2	Break out conc
472-473	1	Good example, flat stone
485-488	3	Remove conc, Repair bank
494-513	19	Remove section of conc
530-541	11	
557-558	1	
563-573	10	
577-578	1	
581-584	3	
591-592	1	
600-650	50	
664-673	29	
691-694	3	
703-704	1	
714-718]	4	Soft path, build up levels (ch 14-27)
722-727]	5	
730-735	5	
744-745	1	
751-754	3	
755-760	5	
771-773	2	
779-780	1	
782-798	16	800 ⇒path surface 80ft
800-804	4	
804-806	2	Build up path surface to fall to canal

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
		(ch 800-902)
808-809	1	
813-814	1	
819-820	1	Lay hedge, remove barbed wire (ch 800-902)
823-826	3	
839-842	3	
875-876	1	
892-894	2	
902-903	1	Remove gate, overhanging branch
902-907	5	
970-971	1	Gate and post and rail across path
975-976	1	Surface ok
985-990	5	In deep
1009-1010	1	
1019-1020	1	Take out tree growing out from opposite bank
1068-1069	1	Path surface repair
1093-1094	1	Under bridge
1099-1100	1	Bridge coping repairs 4m copings in canal
1130-1131	1	Boulders ⇑ make up path ⇓ scrape leaf mould
1158-1159	1	
1165-1166	1	
1169-1170	1	
1187-1192	5	
1197-1199	2	
1202-1207	5	
1208-1209	1	
1225-1232	7	
1260-1268	8	
1271-1272	1	
1279-1280	1	
1282-1283	1	
1295-1298	3	
1308-1309	1	
1317-1319	2	
1334-1342	8	
1353-1356	3	
1409-1414	5	
1421-1422	1	
1424-1425	1	

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
1441-1442	1	
1454-1456	2	
1514-1515	1	
1546-1548	2	
1573-1574	1	
1581-1582	1	
1603-1604	1	
1600		Path falls away from canal. (1.5m width)
1691-1692	1	
1718-1719	1	
1721-1722	1	
1726-1729	3	
1820-1821	1	
1856		AQUADUCT (Clear vegetation, Take out gate)
1958-1968	10	Under viaduct
1970-1972	2	
2020-2023	3	
2151-2152	1	
2220-2221	1	
2316-2318	2	WHEEL SLUICE Interpretation Barrier (Take down concrete posts and blocks)
2463-2464	1	
2534-2535	1	
2541-2543	2	Replace Bascule bridge
		Lumburn Valley Turning area at lock (excavate)
2586-2600	214	Opposite bank
TOTAL		

Note:

An additional 87 linear metres of repairs were undertaken by the site contractors as they deemed them necessary. These additional repairs are not reflected in the above schedule chainage list, which was originally compiled by Chris Hariades (in consultation with Colin Buck and SWW (Laura Wotton) in April 2009 to inform tender information and site specifications prior to the start of works. The location of the small swing bridge in Tavistock (from which the chainages are measured) is at SX 47348 73503.

Tavistock Canal - Canal Bank Repair Works Schedule

Item	Description	Qty	Unit	Rate (£)	Cost (£)
1	Provide site welfare facilities to comprise as a minimum porta-loo with handwashing facilities, maintain and take down on completion	Item			
2	Provide all necessary fencing, barriers, signage, maintain for duration of contract and take down on completion	Item			
3	Break out concrete capping (provisional)	50	lm		
4	Clear rubbish from canal bed and dispose to licensed tip (Provisional)	10	m3		
5	Repair identified sections of failed or colapsing drystone facings to canal bank to match adjoining sections using stone salvaged from canal bed	250	m2		
6	Tie and marry in each repair to adjacent sound sections.	100	no.		
7	Extra to bed bottom course of stone on 50mm depth drymix sand/lime/cement bed in ratio 6:2:1 where laying directly onto bed rock.(Provisional)	50	l.m		
8	Extra to import suitable matching stone to make up shortfall in site salvaged material (Provisional)	50	tonnes		
8	Backfill voids behind stone facing to level with top of bank with imported scalpings compacted in layers not exceeding 200mm depth (provisional)	10	tonnes		

Report No: 2013R046

Tavistock Canal, Devon

Archaeological impact and recording report

Historic Environment Projects

Report No	Report Name	Report Author
2013R046	Tavistock Canal – Impact assessment and archaeological recording during a program of repair works	Colin Buck

Event Type

Site consultancy	Archaeological impact assessment	Archaeological watching brief	

Client Organisation	Client Contact
TVMHP (West Devon Borough Council)	Chris Hariades (TVMHP)

Monuments (MonUID)

DHER 3879 (Tavistock canal)	18721	4069	3882	5449	3956

Fieldwork dates (From)	(To)	(Created By)	(Create Date)
05/05/09 05/05/12	29/05/09 05/09/12	Colin Buck	13/05/13

Location (postal address; or general location and parish)

Tavistock Canal (northern section from Tavistock to Lumburn), Tavistock, West Devon

(Town – for urban sites)	(Postcode)
Tavistock	

(Easting) X co-ord	(Northing) Y co-ord		
From: SX 47367 To: SX 46183	73572 72589		

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

List of Figures

Abbreviations

AONB	Area of Outstanding Natural Beauty
CC	Cornwall Council
DCC	Devon County Council
DHER	Devon Historic Environment Record
DRO	Devon Record Office
HES	Historic Environment Service
OS	Ordnance Survey
SWW	South West Water
TVMHP	Tamar Valley Mines Heritage Project
WHS	World Heritage Site

Acknowledgements

Thanks are due to Robert Waterhouse for providing some primary survey data and information files from his research relating to a forthcoming book about the Tavistock Canal. Chris Hariades (Tamar Valley Project Manager), and Bill Horner were involved in the project throughout its entirety. Andrew White of Knevitts Cons. Engs. was involved in preparing the specifications of the aqueduct bridge.

Front cover image: a copy of the Tavistock Canal Company Seal.

1. Project background

The Tamar Valley Mining Heritage Project (TVMHP – 2005 to 2013), a £7 million Heritage Lottery Fund project focusing on the World Heritage Site landscapes of West Devon in the Tamar Valley, is co-ordinated by the Tamar Valley Area of Outstanding Natural Beauty (AONB). The TVMHP was approved for Stage 2 consent by HLF in 2003. It involves the conservation of former mine sites and trail creation along the Devon side of the Tamar Valley (from Devon Great Consols to Morwellham). These sites include Devon Great Consols, the largest mine in Europe during the 19th century. The project also included conservation and repair works to the Bere Alston to Tavistock railway line (Buck 2011), the Tavistock Canal, and parts of Morwellham Quay itself (other contractors). This project covers works undertaken along the Tavistock Canal (Fig 1).

The Historic Environment Service (HES), Cornwall Council was commissioned in July 2007 by the Tamar Valley Mining Heritage Project (Chris Hariades as TVMHP Project Manager), to undertake an archaeological impact assessment, archaeological recording and site consultancy, photographic building recording of affected sites impacted by the works. An impact assessment project brief had not been produced, but it follows a similar project design by Historic Environment Service, Cornwall Council; *'Project design for production of archaeological recording, as part of the Tamar Valley Mining Heritage Project (2006-2009)',* dated 23/06/06. A Project Design for this site and other building conservation schemes in the TVMHP was produced on 21/07/2006, and was subsequently approved by Bill Horner (Devon County Archaeologist).

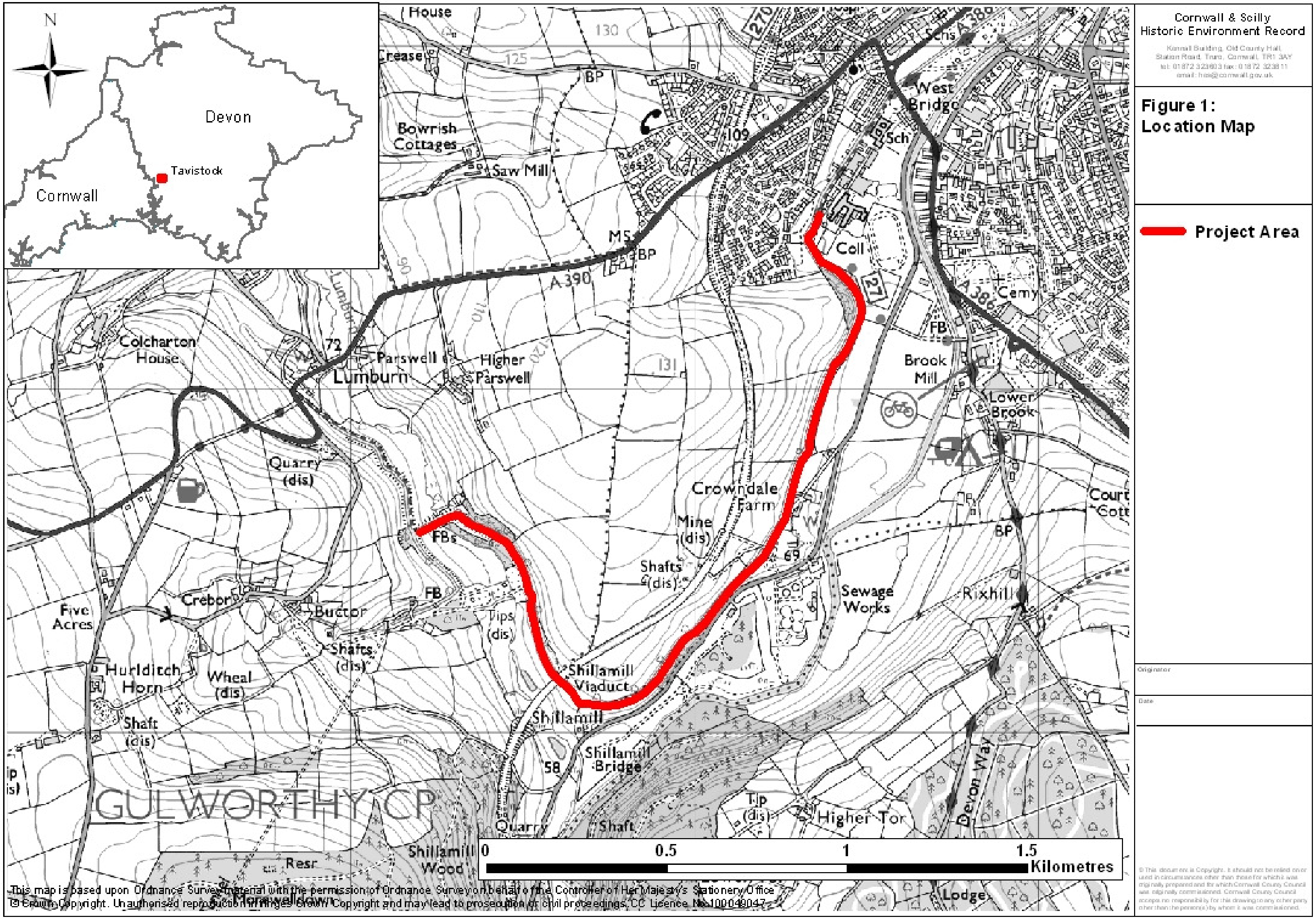
The conservation and management of features relating to the TVMHP's mining heritage and enablement of safe public access forms the basis for the Tamar Valley site conservation scheme. This report will assess the impact of the proposed conservation works on the Tavistock Canal's significant assets (canal within the WHS), describe the mitigation undertaken and also a description of the archaeological record for the (intermittent) works from May 2009 to May 2012. Following the first phase of works in the summer of 2009 (to describe and record the repair works and the minimal impacts to the canal sides), an interim report was produced for Bill Horner (Devon archaeology – Buck 2009).

In a joint project with SWW, the TVMHP agreed to fund cattle fencing along all of the west side of the canal, in order to stop further damage being caused to both sides by cattle drinking the water and wandering (on one occasion into Tavistock!), and to create four cattle drinking sites. SWW agreed to fund the repair of the sides of the canal bed. Furthermore the TVMHP agreed to re-bed and re-seed where necessary the canal towpath later in the autumn of 2009, and at a later stage (2011), to repair the damaged lock gates. In addition, the TVMHP agreed to undertake small-scale structural repairs to the small aqueduct bridge in 2012, and a small amount of repointing.

2. Aims and objectives

The aims of the project were as follows:

- To ensure that site works are undertaken in such a way as to maintain the integrity and authenticity of the historic resource, minimising adverse impact upon the resource.
- To ensure that the Devon County Historic Environment Service (DCHES – Bill Horner) are appraised of all site works.
- To ensure that the highest possible standards of the historic environment conservation works are maintained, which must be carried out to recognised current best standards in this discipline.
- To ensure that works are undertaken in such a way as to allow adequate recording of remains affected by the works.
- To record sites, features, deposits and artefacts affected by or uncovered by the works.



Cornwall & Scilly
Historic Environment Record
Figure 1:
Location Map
Project Area
N
Devon
Cornwall
Tavistock
House
Crease
Bowrish Cottages
Saw Mill
BP
MS
A 390
West Bridge
Sch
Coll
Cemy
A 386
FB
Brook Mill
Lower Brook
Colcharton House
Lumburn
Parswell
Higher Parswell
Quarry (dis)
Crowndale Farm
Mine (dis)
Shafts (dis)
Court Cott
FBs
FB
Buctor
Crebor
Five Acres
Tips (dis)
Sewage Works
Rixhill
Hurlditch Horn
Wheal (dis)
Shaft (dis)
Shillamill Viaduct
Shillamill
Shillamill Bridge
Tip (dis)
Higher Tor
Devon Way
GULWORTHY CP
Quarry
Shaft
Shillamill Wood
Resr
Lodge
0
0.5
1
1.5
Kilometres
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Originator
Date
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- To record the character and extent of works to the sites.
- To inform the Devon County Archaeologist of the nature, condition and significance of the canal and towpath, and describe the proposed impacts and a mitigation strategy (agreeable with the Devon County Archaeologist).
- To disseminate the results of the project appropriately and arrange for the deposition of the project archive (within IfA Guidelines).

It was proposed that the building conservation and repair programme will address the following:

- The protection and consolidation of significant archaeological remains in their settings.
- Health and safety aspects of the site relating to public access.
- Provision of low-key public amenity use where appropriate, incorporating access.
- Interpretation of the site to the public, including on-site and written materials.
- Linking the site into the local economic, social, tourism and recreational contexts.

In terms of the management of archaeological features, engineering works were kept to a minimum, but in view of the fact that the entire site is part of the Tamar Valley component (Area 10) of the Cornwall and West Devon World Heritage Site mining landscape, particular attention was paid to suggestions for the best mitigation of any such works.

3. Historical background

This subject matter has already been written in far more detail than is necessary for this report, notably by Hadfield (1967), Booker (1971, who reproduces the tonnages in Appendix 2), Hedges (1975), Woodcock (1995, Vol 6; 2005), and more recently a publication by Robert Waterhouse (2012), and a forthcoming detailed book. The text below is a summary history and construction account of the Tavistock Canal extracted from all of the above sources.

The medieval borough of Tavistock has always been closely linked to its port, Morwellham. That link was dramatically improved by the construction of the Tavistock Canal from 1803 to 1817. The main structural features of this major construction throughout its full length can still be seen today, over two hundred years later; the wharves at Tavistock and Morwellham, the aqueduct over the River Lumburn, the 1.5 mile long tunnel under Morwell Down, and the remnants of the incline plane down to Morwellham.

The historical chronology for the canal can be summarised as follows:

1796 The opening of Wheal Friendship Copper Mine, Mary Tavy, unintentionally led to the construction of this canal. The export of ore and import of coal and other materials needed to be cost effective – its transport costs by horse and cart must have been prohibitive. The young mine's engineer (in his twenties), John Taylor, had the idea of linking the Tavy and Tamar valleys, whilst using Morwellham to export the ore (via sea going ships); the nearest active port to Tavistock.

1800 By the turn of the 19th century, the country had been at war with France for a few years. Demand for metallic ore, and therefore the need for a canal were high.

1802 Survey of the proposed canal route (presumably with the blessing of the Duke of Bedford) by John Taylor, the mining engineer of Wheal Friendship copper mine.

1803 (March) A canal company, funded by shares from the London Stock Exchange (see front cover seal image), was formed. Work began on the route in 1803, following the passing of an Act of Parliament. The canal was to be 16ft wide and 3ft deep, with a branch to the slate quarries at Millhill. It is likely that the first section of the canal route followed an earlier leat from the River Tavy to Crowndale Mine. Raising funds on the stock exchange gained stock interest from adventurers to exploit known lodes whilst tunnelling through the granite of Morwell Down, and for additional shares to be

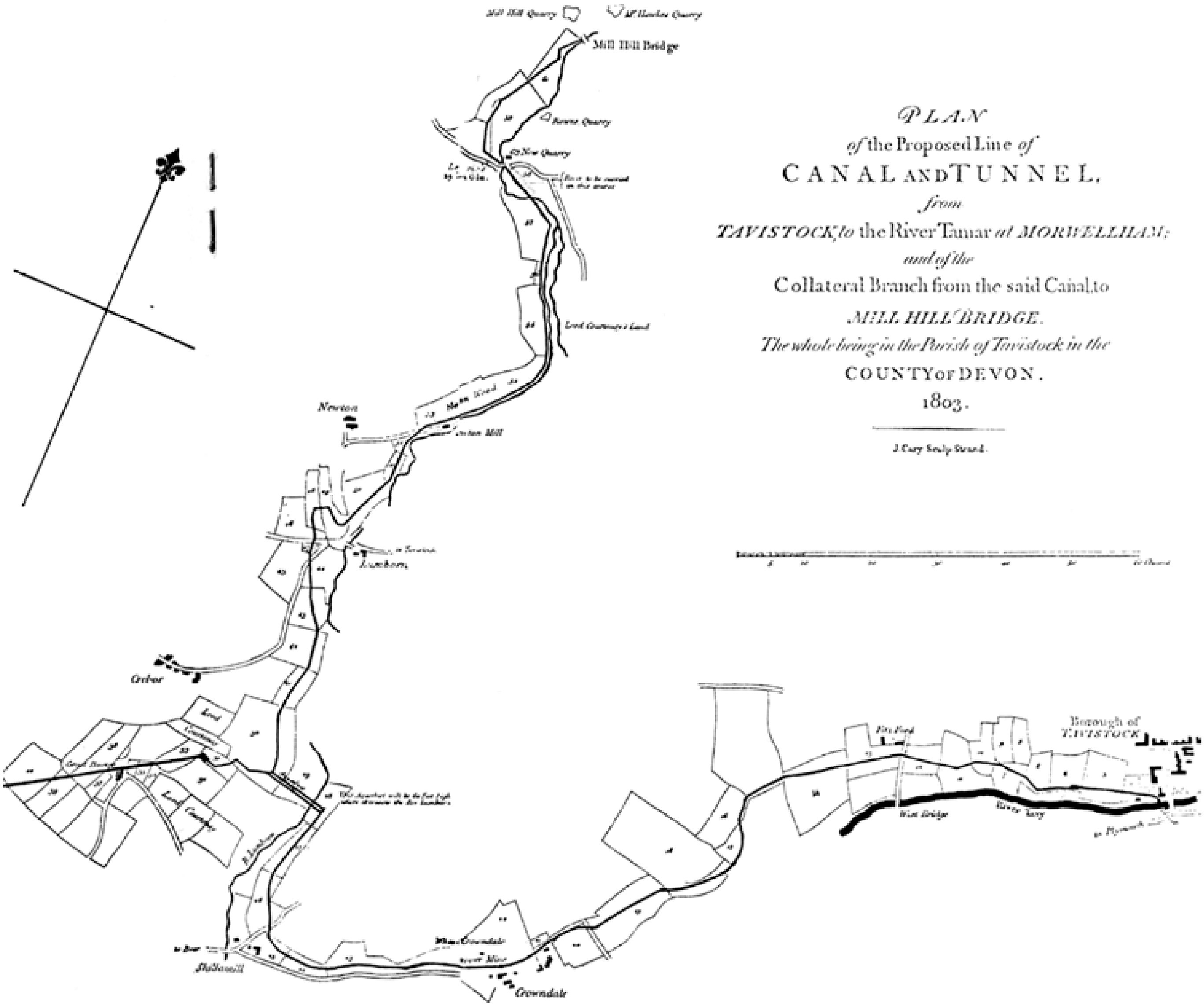

Figure 2 Excerpt of the 1803 survey plan (within the study area) of the proposed Canal route from Tavistock to Morwell Tunnel (Hedges 1975)

purchased by other mines and Tavistock businesses along its course, all recipients of the canal's cheaper transport costs. However, Hedges (1975) hints that Taylor's real motivation for the project was not primarily to build the canal, rather the opportunity to exploit known lodes under Morwelldown, a mining speculation.

Figure 2 shows the original planned 1803 route. The provision of water via leats from the western end of the canal (top of the Morwellham incline) for other mines in the Tamar Valley as far north as Gunnislake to power water wheels was also planned. The original cost estimate for the canal was £40,000 (including testing for ore lodes), at £100 per share. The Duke of Bedford, who owned all the land along the canal's course, also purchased 1/8 of the shares and took dues for use of Morwellham Quay. He also agreed to a request to make a grant of a Mining Set: (for working all Lodes discovered in the Course of the Canal, Embankment, Tunnel and collateral branch for copper, tin and lead to the extent of 500 fathoms East and West of the canal for every Lode discovered), for the sum of 1/10 dues and a term of 42 years.

The principal engineering features being the aqueduct over the River Lumburn, the 2,540 yard tunnel through Morwelldown, and the inclined plane west of the western end of the tunnel down to Morwellham – a fall of 237 ft, the greatest in southern England at that time.

Figure 3 Excerpt of the 1867 Bedford Estates survey plan (DRO T1258M) showing the canal within the study area.

1803 (23rd August) Work began on the tunnel. Almost immediately copper was struck at the Tavistock end of the tunnel, and the lode developed to realise what later became Wheal Crebor (see Fig 3). Men were employed to work both concerns – the accounts separated. The Canal Committee managed both concerns until 1812 when a separate Committee was appointed after further copper ore discoveries in the tunnel under Morwelldown (Hadfield (1967, 128).

1808 The waste rock and ground from the tunnel excavation was boated eastwards back to the tunnel entrance and used to infill and form the Lumburn Aqueduct over the valley, with a central spanning arch.

1809 Work progressed slowly in the tunnel (by this date it was half finished), as the canal section from Tavistock to the tunnel was finished (ie, this project's study area). This was built more permanently with stone sides (on edge) rather than puddle clay. The tunnel rock was granite, its depth 160 yards below the top of the hill. Pumping/ventilation/winding and access shafts (at least four – the main one being Bray Shaft), had to be sunk from the top of Morwelldown to the underground canal. John Taylor designed the power source for the shaft workings by utilising flat rods (for lengths up to 1.5 miles) powered from a large 40' water wheel. He also designed a ventilation fan for improving the air quality, for which the company was awarded the medal of the Society of Arts in 1809 (Hedges 1975).

1810 The tunnel advanced at a rate of about 150 fathoms (six feet per fathom) per year until this year when three granitic dykes were cut, slowing the work rate to nearly a third that amount for two years. 30 to 40 workmen were continually employed, with some authors suggesting French prisoners of War used as 'navvies' (Barton 1964, 93 and Booker 1971, 108).

1815 From this year there were shipments of manganese from mines around Brentor and Milton Abbot carried by the canal. These were the principal sources of manganese in the country at a time when it was used in the manufacture of glass. For example, 13,335 tons were shipped to Plymouth in 1819. The ore was ground in a mill powered by the Morwellham water wheel (Booker 1976, 19), and exported in casks.

1816 (August) Tunnels were cut from both ends (simultaneously), to form a working area and to align both ends. They connected on the 21st August. Then the tunnel was enlarged (downwards and wider) throughout its length.

The demand for metallic ores to feed the Napoleonic war years (1793 – 1815) slumped as the soldiers returned, as markets waned. The canal committee, sensing further financial difficulties in September stated *'That the Tonnage will fall very short of the original estimate cannot be doubted; at the time when this was made the Mines in the neighbourhood were in their most flourishing condition, or rapidly advancing to it. Agriculture encouraged by high prices was improving everywhere, and the use of lime, so essential … was very great and increasing. Slate quarries, then making large returns, were in full activity, and new ones opening. In all these sources of oecumenical mode of carriage, the greatest reverses have taken place, and at present a stagnation of enterprise and consequent inactivity prevails'* (Hadfield 1967, 130). However, the population of Tavistock had increased from 1801 to 1821 by over 62%, reflecting the growth in the area, primarily a result of mining operations and related tertiary expansion.

1817 The tunnel was finally completed early in the year, with the official opening ceremony held on 24th June. Thousands attended the event, with over 300 going in boats (with a band) through the tunnel – to be met (with obvious relief) by thousands more at the Morwellham side. All were then given a demonstration of the workings of the incline railway mechanism and tramway down to Morwellham (see Buck 2005 – Sites 58 to 64), powered by a large water wheel and the canal water – which was also recently completed. The boats (specially designed and built by the Tavistock foundries from 1811 to replace an earlier wooden design), were *c*30 feet long, 5 feet wide and towed along the slow moving open canal by horses. They were worked through the long tunnel by two men using iron bars against the rock face.

The canal had taken 13 years to build. Its final cost was £62,000, the excess over the authorised capital of £40,000 having been raised by calling £155 on each £100 share.

1819 Although the economic outlook for the area was not good, the company decided to press ahead with the Millhill canal branch to the slate quarry. It was 2 miles long and cost £8000. It rose by 19.5ft to Millhill, with an inclined plane for the final section due to the scarcity of water (double tracked with two cradles counterbalanced with loaded boats going down pulling the empty ones up with the help of three horses).

1820s The expected tolls were halved from their pre-construction estimates – due to the gloomy economic climate. Over the next three decades the canal carried between 15,000 to 20,000 tons per year, earning an annual profit of approximately £600.

1831-2 A Cholera epidemic in the locality severely affected the workforce, the local economy and (temporarily), the canal's fortunes.

1841 Great Western Railway completed.

1844 Discovery of the main copper lode (40' wide) at Wheal Maria later Devon Great Consols – reversing the fortunes of Tavistock over the next 30 years, but reducing those of the canal. The Mill Hill Tramway was constructed this year (replacing the earlier section of the canal which had been closed after 1831), at a cost of £1,381 (Hadfield 1967, 132).

1847 20,132 tons were carried on the canal (Woodcock 1995, 23).

1848–9 Another Cholera epidemic.

1850 The goods carried on the canal were (tons): Sundries (7548), Limestone (3130), Copper ore (2.499), Slate (676), Granite (83) and Mundic (pyrites) (94). Tonnage carried fluctuated from year to year, reflecting the area's economic woes (or successes). In a bid to maintain revenue, at various times throughout this period, the company reduced tolls, or raised them again when economic conditions improved. But dividends, throughout the life of the canal were always modest, and profits turned out to be at a level 1/3 predicted at the outset.

1851 In the 1851 census, there were 27 barge men working for their various employers regularly using the canal.

1857 Shares that had changed hands at £100 in 1803 were now changing hands at £5.

1859 Construction of the Devon Great Consols railway from the mine to Morwellham with a separate incline section down to the port finished this year. Also the South Devon & Tavistock Railway from Plymouth to Tavistock opened (later extended to Launceston) – in direct competition to the canal. Due to this competition, the company further reduced its tolls after the opening of the railway. However, in the same year it expended more capital on renewing the inclined plane mechanism, and investing funds on a steam mechanism to pull loaded barges through the tunnel against the water flow (it often took a couple of hours or more to undertake this manually!). This was not successful.

There is no doubt that the waning fortunes of the Tavistock and Tavy copper mines, working for the past half century, were no competition for the resurgence of the Tamar Valley copper mines from the mid 19th century. Whilst the former utilised the Tavistock Canal as a transport medium during this period, the latter formed its own railway equivalent; but both used Morwellham as the export destination. Given the rapidly changing transport infrastructure due to the construction of mainline railways to the south west from the mid 19th century (consequently resulting in dramatic changes to market influences), across Devon and Cornwall at this formative period, so the fortunes of this old transport route was found wanting and uneconomic.

1860 In the previous year, the canal tonnage was 17,455. In this year it fell to 13,500. From 1863 onwards there was a steady decline in the tonnage until, in the early 1870s it dwindled to nothing (Hedges 1975, 28).

1862 A shareholder from Birmingham wrote to Mr Gill, representative of the Canal Company and said: *'I am afraid there is little hope of the canal rising in its fortunes with the railway for a rival. Here we have in several cases united the canal with the railway with advantage to both – you know best whether such an arrangement with the Tavistock canal would be advisable'* (Hedges 1975, 28).

1866 In September, the canal committee recorded; *'That a very considerable reduction having taken place in the traffic and dues of the Tavistock Canal Company since the opening of the Tavistock and Launceston branch of the South Devon Railway it was resolved that His Grace the Duke of Bedford be applied to kindly assist the Tavistock Canal Company to compete with the Railway Company by reducing the Canal Dock dues at Morwellham'.* The Duke was evasive (Hadfield 1967, 134).

1870 Only 783 tons were carried on the canal (Woodcock 1995, 24).

1872 Presumably the economic situation became even direr. At a meeting on 2nd September the Duke offered to buy all the shares at £8 each, and to pay half the cost of an Act to transfer the canal to him. Within the month, the committee accepted his terms. Since the summer there had been no traffic on the canal. However, this was not a localised occurrence; the impact of the railways had dealt a death blow to innumerable canals all over the country.

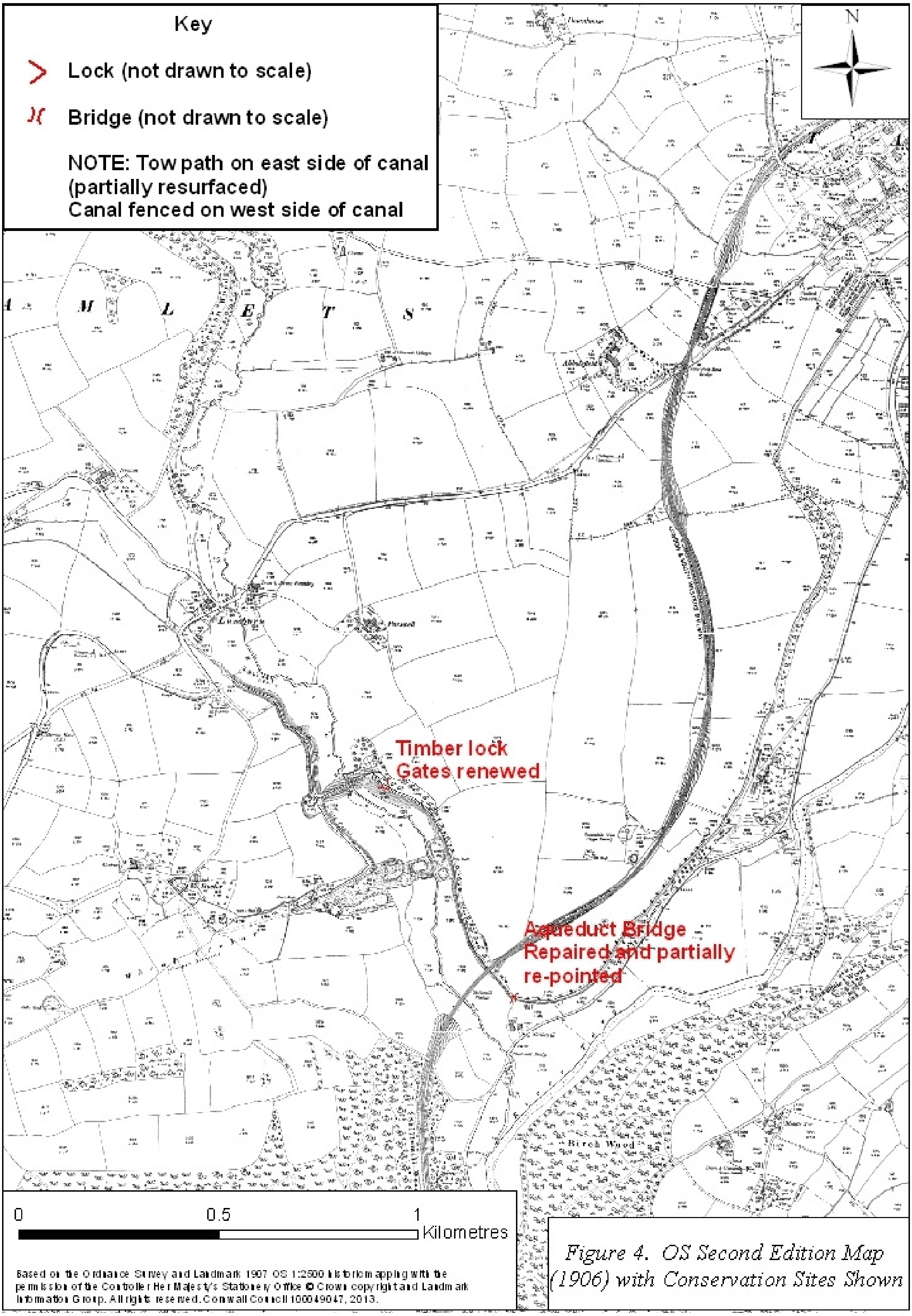

Figure 4. OS Second Edition Map (1906) with Conservation Sites Shown

1873 In May the Act was passed and the Tavistock Canal and land returned to the Duke of Bedford for £3,200, there being no obligation on the Duke to maintain the canal. It is uncertain what use the canal had for the next twenty five years.

1896 This perhaps was made clear in May of this year when the Tavistock Gazette reported that on Whit Monday the basin of the Tavistock Canal was to be cleaned out (it appears a regular activity on this day). *'The cleaning is wanted more now than when it was a hive of industry … a resident noted ... A great deal of sewage was emptied into it, and the water does not run at a greater rate than half a mile an hour. I have seen dead dogs, cats and rats in the canal'* (Woodcock 2005, 26).

1898 The Tavistock Canal was not included the Canal Returns.

1933 After cleaning the canal bed (which must have been quite onerous!), the West Devon Electric Supply Company built a sluice gate near the west end of the tunnel portal, to convey water to a header pond (Forebay) to go down to hydro electric turbines via large tubes at Morwellham Power Station, next to the River Tamar.

In 1923 and 1933, mining geologists Cloke and Barclay carefully assessed the lodes intersected by the tunnel during a tunnel assessment and clearance scheme (CRO AD58-26). They confirmed that the tunnel intersected eight or nine lodes and three cross-courses, but only two of these (East Russell and Georgenia Lodes), had any stoping accessed by the canal. The only repairs necessary were to the Morwellham portal end retaining wall.

Footnote:

The canal has been maintained and managed by the owners of Morwellham Power Station since 1933. For some time this work has been undertaken by South West Water and British Waterways, the former now monitors and maintains the canal, carefully regulating the flow to utilise the instant generating capacity of the hydro-electric power station at times of peak demand (to provide a cost effective monetary return). It is poignant perhaps that the canal still exists today due to its economic usefulness.

4. Impact assessment

This summary impact assessment is intended to inform and guide Devon County Council Historic Environment Service of the impact of the canal repair works, the aqueduct bridge repair and lock gates replacement. This section of the report summarises the archaeological resource, and describes the impact and mitigation of the canal works as part of a mitigation strategy. However, it should be noted that the mitigation procedure was undertaken during the project (due to the lack of advanced project specifications), by efficient communication between the report author (as site archaeologist), Bill Horner (DCC archaeologist), Chris Hariades (TVMHP Project manager), and South West Water. A structural engineer, Andrew White of Knevitts Ltd produced specifications for the aqueduct bridge structural repair (see Fig 12).

The sites impacted by the repair works are shown in Figures 5, 6 and 12 and reproduced on plan in Figure 4. The main sites include repair works to the sides of the canal itself, structural repairs to the aqueduct bridge, and repairs to the lock gates. The impact of the repair and conservation works on each site is then described, and a final section details the impact remediation measures.

The potential impacts during works are described below. Impacts are described in the text section for each site on a feature-by-feature basis. The following site impact terms are used within each site identification description:

Major positive	Site continues in, or is restored to, its original design and use
Moderate positive	Site restored as far as possible respecting its original function, but its use is altered
Minor positive	Site partially restored; interpretation introduced
Negligible positive	Stabilisation/maintenance of site
Negligible negative	Benign neglect – losses of fabric over a long period of time

Minor negative	Site suffers areas of alteration or damage, which contribute to loss of meaning
Moderate negative	Significant loss of fabric or alteration, leading to erosion of original character
Major negative	Complete demolition/removal

Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the end of the Lumburn Aqueduct **SX 46237 72628,** see Fig 1).

Description

The canal section impacted by the repair works was built between 1803 and finished by 1809 (as described in the historical background section). This section of the canal may well follow the course of a mine leat from the River Tavy to Crowndale Mine, which pre-dates construction of the canal. For much of its length the canal's west side (see Fig 4), cuts into the valley side – revealing vertical bed-rock and also frequently forming the bed of the canal. Excess stone material from the rock cut was used to form the rounded profile edge of the east side of the canal – using slate/killas stones set on edge. The tow path was formed along this eastern side. The canal is approximately 4.0m wide, 0.3m to 0.5m deep, with the east side approximately 0.6m to 0.8m deep from tow path surface to water level.

Repair works to the canal's east side (and towpath) has been undertaken in the past, sometimes inappropriately using cement and concrete formwork. The 2009 repair work to both sides of the canal and re-surfacing parts of the towpath continued with this theme of patching the damaged sections (Fig 11).

Site works impact (2009)

The repair works relate to identifying areas of the canal sides that needed to be patched with new (similar specification) stone within the section of canal identified above. This should immediately stop progressive damage to the canal sides and help to support the well used canal towpath. There is no site plan showing each small repair section, rather a canal bank repair work schedule (Appendix 1).

Other works to the canal itself that were proposed include patching and re-surfacing the tow path. South West Water (SWW) undertook its own Risk Assessment for each tree close to the tow path. Mitigation works resulting from that survey (i.e. branch or tree removal) was undertaken by SWW.

The overall impact of the works on the canal can be defined as '*Negligible positive'.* The works reduced collapse of parts of the canal's east side to maintain structural stability, provided more tow path stability and a higher degree of Health and Safety for increased public access for at least another generation. However, it is hoped that the track is adequately annually maintained.

Residual impact (2009)

There have not been significant residual impacts in the medium term – apart from the visual aspect of the replacement stone looking newer than the original stone surrounds.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of replacement stone (to match existing), reduced the visual impact of patching the sides of the canal. Other reduction impact measures included the tendering for appropriately qualified and experienced contractors to reduce the visual effect of repair sections to the canal, and for the quality of the work, which was of a good standard (reflecting the original construction style). This project should reduce the need for this work to be undertaken for at least another generation.

Aqueduct Bridge SX 46630 72090

Description

The aqueduct bridge carries the canal over an access lane to fields north of Shillamill Farm – whose access was cut by construction of the canal. The iron plated trough structure seen today was built in 1839 by Gill & Co of Mount Foundry, Tavistock (Buck 2007), replacing an earlier structure. The bolted sections of the trough extend to either side of the granite quoined masonry, and are supported by four wrought iron lintels (widening into the masonry sides) set into the granite masonry. Three other similarly styled lintels (see Fig 13) provide the support for large slates under the tow path on the south side of the canal. The middle lintel however has rusted to the extent of being ineffectual. A structural survey by Knevitts Ltd has recommended its replacement, as the aqueduct is not only used by tow path walkers, but is proposed to be accessed via the adjacent fields, in order to link up the railway (Buck 2009) with the canal – by a new DCC footpath route under the aqueduct – formerly used for access to the upper field.

Patch repointing to the sides of the bridge under the aqueduct in recent years has occurred, however more often than not this has been using cement, using a variety of styles. At the northern end of the side walls the stonework has been leaking for some time where water is leaking from the junction of the wrought iron plates with the canal bed. This has caused the masonry to be soft, and the stonework made weak – causing a noticeable dip on either side.

On the south west side of the aqueduct a high vertical retaining wall supports the tow path and masonry for retaining remnants of steps, to allow pedestrians walking the towpath to access the lower field. Some of this vertical retaining wall has areas of lime mortar pointing that is loose.

Site works impact (2012)

After dialogue with the TVMHP manager, the structural engineer, the landowner of Shillamill Farm, the Devon County Archaeologist and consulting project archaeologist; the TVMHP agreed to fund replacement of the centrally located rusty wrought iron lintel, and to undertake limited lime mortar repointing where structural stability of the adjacent walling could be compromised.

Site impact of the replacement lintel was minimised by matching most of the original profile of the replacement item as far as could be possible from an 'off the shelf' steel equivalent (in order for the project to be cost-effective), with the original wrought iron lintel.

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works have reduced the potential for collapse of the tow path as it runs next to the canal aqueduct. This project will provide a higher degree of Health and Safety for increased public access for at least another generation.

Residual impact (2009)

There are unlikely to be significant residual impacts in the medium term – apart from the aspect of the replacement iron lintel and repointed masonry looking newer than the adjacent (cement) based repairs.

Reduction of impact (2009)

Site consultancy with the project manager and structural engineer will minimise any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors should mitigate the visual effect of a new structural item, and for the quality of the work to be of a good standard, reducing the need for this work to be undertaken for at least another generation.

Lock Gates and timber lifting bridge SX 46327 72628

Description

The construction of the adjacent Canal cottage for operation of the lock gates, the lifting bridge and the visible remnants of the semi-circular trans-shipment basin (or turning/waiting area) is indicative that this part of the canal was quite busy! The latter

(sited close to the lock gates) is now infilled, but the tops of some of its vertical timbers still visible. The necessity of keeping the water at the correct level was important for the tunnel – this lock gate possibly forming this function also for the Lumburn Aqueduct (SX 46311 72632 to SX 46184 72581), with its single arch to the south. According to Waterhouse (forthcoming) the timber lifting bridge is of a Dutch design common on canals in the Welsh borders, and may not be contemporary with the canal's construction.

The lock gate and lift bridge was previously restored by October 1998, funded by South West Water and British Waterways. However, as Figure 15 shows, one of the timber arms of the lift bridge had snapped and parts of the timber walkway rotted. In addition the lower parts of the swing lock gate has rotted where it is in contact with the canal water.

Site works impact (2012)

The TVMHP agreed to fund replacement of the timber components that were rotted or had broken or snapped off. This includes the large timbers to open the bridge and the Lock gate. The TVMHP tendered for experienced Carpenters to assess both features and to price for the production of making and erecting replacements.

Site impact for the replacement timbers was minimised by specifying exact replacements with the existing timbers (previously replaced in 1998).

The overall impact of the proposed works on this feature can be defined as *'Negligible positive'.* The works reduced the potential for further timber rotting and collapse, an important Health & Safety measure so close to the well-used canal towpath. This project has provided a higher degree of Health and Safety for bridge use and public access for at least another generation.

Residual impact (2009)

There are unlikely no significant residual impacts in the short term.

Reduction of impact (2009)

Site consultancy with the project manager (Chris Hariades) minimised any negative impacts. Close site supervision, and a careful choice of appropriately qualified and experienced contractors mitigated any possible mistakes, the quality of the work was of a good standard, and reduced the need for this work to be undertaken for at least another generation (Fig 16).

5. Impact mitigation strategy

The impact mitigation strategy is divided into three stages: The pre-works consultancy, the Historic Buildings Consultancy during works and the archaeological recording record (during and after works). This mechanism demonstrates the steps that have been taken to avoid or minimise adverse impacts, and confirms that the proposed works have been designed in close liaison with the historic environment consultant. Consultation is based on a clear understanding of the significance of the site using appropriate methods and techniques for site monitoring and recording.

HES Projects (Project number 20070793) was commissioned to undertake the three components described as the impact mitigation strategy. The project was based on a project design produced by Colin Buck (21/07/06), and recording specifications defined by Bill Horner (DCC archaeologist).

6. Working method

The following text summarises the general WSI for all archaeological consultancy and archaeological recording for projects relating to the TVMHP (Tamar Valley Mines Heritage Project: Written Scheme of Investigation: Historic Building and Archaeological Recording Consultancy 21/07/06).

- A brief historical survey was compiled from existing Devon County sources (DCHER, DRO, and local libraries and historians (including Robert Waterhouse's recent published work on the canal).
- A walk-over survey was undertaken of the entire length of the canal for sites impacted by the TVMHP.
- An impact assessment described and mitigated the proposed work as part of a Mitigation Strategy to minimise the works affecting the site's character.
- General working methods for archaeological recording, treatment of finds, photographic surveying and report production are described in detail in the Tamar trails WB WSI produced in 21/07/06.

All archaeological recording work was undertaken according to the Institute for Archaeologists (IfA) *Standards and Guidance for Archaeological Investigation and Recording. Staff follow the IfA Code of Conduct* and *Code of Approved Practice for the Regulation of Contractual Arrangements in Archaeology.*

The principal factor in effective project delivery was the employment of key project staff who are expert in the management and recording of the industrial heritage. Cornwall Historic Environment Service project staff can draw upon a substantial track record in undertaking similar work throughout Cornwall, as well as a detailed knowledge of the project area and its sites.

Historic buildings consultancy

- HES (Senior Archaeologist) liaised with the Devon County Historic Environment Service - DCHES (Bill Horner), and the TVMHP Project Manager (Chris Hariades).
- The HES Senior Archaeologist attended regular site meetings when appropriate during the duration of the project.
- HES ensured that site conservation works are carried out to standards recommended by English Heritage best practice.
- **Fieldwork: archaeological recording**
- There were no newly exposed archaeological features revealed through excavation.
- Where appropriate, measured survey was carried out by hand measurements (using offset techniques at a scale of 1:50.
- The resulting survey output was a revised measured survey drawing showing all conservation works that had been undertaken. This was reproduced at a scale of either 1:50 or 1:100 (appropriate to the size of area recorded) and will form part of this archive watching brief report.
- Analysis of the building fabric was recorded in the form of field notes and written up in this archive report production stage.
- DCHES (Bill Horner) advised that archaeological recording should be undertaken during any excavation that revealed archaeological features. Recording was undertaken using a mix of direct measurement, sketch plotting and photography, as appropriate (constrained by safety factors).
- Where significant remains were encountered the site archaeologist was given the opportunity to make an appropriate form of record before work proceeds.
- The chosen site archaeologist adhered to Health and Safety Policies (see below), under the direction of the designated Site Safety Officer.

Site recording (general)

- Site drawings (plans, sections, locations of finds) were made by pencil (4H) on drafting film; all plans were linked to the Ordnance Survey landline map; all drawings included standard information: site details, personnel, date, scale, north-point.

- The site archaeologist undertook the recording in line with recommendations given by IfA. Sections and plans were drawn on site at appropriate scales which adequately recorded structures or features at appropriate levels of detail, and appropriate sections reproduced in the archive report at either 1:50 or 1:100 to adequately demonstrate revealed archaeological features.
- All features and finds were accurately located by means of a National Grid reference and all archaeological contexts will be described using a standard format and linked to a continuous numbering sequence.
- The archaeological watching brief report detailed all forms of archaeological recording that had been undertaken at each of the mine sites. Each major mine site had a single archaeological watching brief report that details all project related work to that site (i.e. trails works, building conservation works, interpretation works, etc).

For Treatment of finds, Photographic recording specifications, report production and archiving specifications refer to the TVMHP WSI (2006).

7. Results

Unfortunately, there was insufficient time (following receipt of a detailed plan and description of the canal repair works from the TVMHP), prior to the start of works on site to produce an impact and mitigation report for DCC (Bill Horner). A decision was therefore taken to minimise impacts and mitigate directly with the TVMHP and site contractors on site as works were progressing as part of a weekly site recording and consultancy. SWW funded the stone and path repairs to the canal bed whilst the TVMHP funded fencing of the north and west sides of the canal, to stop encroaching animals from the adjacent fields from directly accessing the canal (and walking up the towpath!). An interim archaeological recording report of these works was produced by the author on 17/06/2009. This report supersedes that report.

Repair works to the bed and towpath of the Tavistock Canal (section from estate swing bridge **SX 47348 73503** to the start of the Lumburn Aqueduct **SX 46237 72628**)

In early 2009, the TVMHP tendered for stone masons (on behalf of SWW) experienced in rebuilding stone walls, etc, to undertake these works within a narrow time-scale of three weeks, when SWW were willing to reduce the water flow through the canal (which would stop the electricity generating turbine). The turbine normally operates all year round, often at short notice when generation rates for electricity peak (the turbine can instantly generate electricity). Clemens Stonemasons of North Cornwall were successful in winning the contract. Prior to this, the TVMHP Manager, the archaeological consultant and SWW projects officer, produced a repair work specification schedule (measured from the small swing bridge at Tavistock: SX 47348 73503), which focussed on identifying the repair of collapsed sections of canal bank on the south or east sides. Appendix 1 is a reproduction of this original document.

Site work started on 05/05/09 at the northern end of the canal and progressively worked southwards towards the lock gates at the Lumburn Valley. With the reduced water level in the canal (and its slow movement when full), many stones that had fallen out of place were found in the canal bed not far from their original bank location. When the canal was constructed the stones were originally set on edge, a minimum of two/three stones height (approximately 0.6m to 0.8m above water level). During the repair project, where there was insufficient stone to replace the collapsed sections, a similar stone was imported from Trebarwith Quarry, North Cornwall (purchased from the local quarry at Millhill). These stones were reset on edge, following the original profile of the canal bank, and tightly tamped down in position (tops and sides). Earth was backfilled into the top sides of the stone to re-form the edge of the towpath. This was then at a later date, re-seeded. Figures 7 and 8 show examples of before and after photographs of the repaired canal bank. The work has been sensitively undertaken and reflected the style and character of the original construction a century ago.

Weekly site meetings were arranged to view the previous week's repairs and to discuss any foreseeable problems within the following weeks programmed work. A granite towpath stone under the Crowndale bridge at SX 47194 72541 had become dislodged (into the canal), and some quoin stones from the bridge parapet wall had fallen into the canal. The former was repaired by contractors; the latter will be removed from the river by SWW to be replaced on the bridge parapet wall at a later date. A small section of old 2" timber (2m long) set in the lower part of the bank was replaced back into its original position following repair of the wall at this location (SX 47270 72707).

The canal bank repair works (see Appendix 1), were finished on 28/05/09, including an additional element of work totalling 87 metres, which the contractors identified whilst on site. A total of 337 linear metres of canal bank was repaired (only on the south/west side), using a total of 86 tons of additional Trebarwith stone. The canal repair works were funded by South West Water.

Figure 5 is a site plan and specification document for the installation of timber post and wire stock fencing along the west/north side of the canal and construction of three cattle drinking areas to minimise any future erosion of the opposite (north/west) side of the canal bed. The cattle drinking sites are located at SX 47384 73064, SX 47257 72705, and SX 47078 72415. A concrete pad (min 0.3m thick), varying from 3m to 4m wide and approximately 5m long, has been created to at each of these sites to form the post and rail fenced cattle drinking areas that should minimise further damage to the banks (on either side). An additional cattle drinking area was constructed on bedrock immediately on the west side of the Shillamill Viaduct (see Fig 6). Figures 9 and 10 show before and after views of a cattle drinking site (SX 47384 73064).

Approximately four months later, the surface of the canal towpath was patched with crushed stone (803 specification) where the path was potholed or muddy, then sections covered with finely ground stone (6mm to dust) from Meldon Quarry.

During construction of the cattle drinking sites and during the canal repair works there has been minimal archaeological impact, nor any finds recorded.

Aqueduct Bridge SX 46630 72090

Knevitts Ltd was commissioned by the TVMHP in 2011, to undertake a structural survey of the aqueduct bridge at this location. Their report and structural drawing (see Fig 12), recommended that a rusty wrought iron support (middle one of three similar supports – see Fig 13) sited under wide slates below the towpath next to the canal, be replaced with a modern equivalent. In addition, it was recommended that the tall retaining wall on the south west side of the aqueduct bridge be repointed and structural ties inserted (using 7mm diameter stainless steel helibars) into the masonry bedding joints to strengthen a structural crack in the masonry.

This work was not started until May 2012, following an extensive dialogue with SWW and the site owner. Figure 13 shows the failed rusty element needed to be replaced. The original lintel was 50mm x 50mm for most of its length but widened to 100mm at both ends (and set in the side walls). Unfortunately the original wrought iron section specification was impossible to replace, and an 'off the shelf' item had to be found due to budgetary constraints. Figure 14 shows the new steel replacement *in situ*. Scaffolding had to be erected to remove the original rusty support and to replace it with the new 50mm wide x 115mm deep iron profile steel section. A slightly wider opening had to be made into each granite quoined side of the bridge for insertion of this new structural element. The localised setting was then repointed with lime. The steel was painted with a red primer and then painted black.

Other works to this site included removal of a tree growing out of the west side of the north end of the aqueduct bridge and treatment of the stump, as its unchecked growth had caused structural issues to the masonry at this point. On the opposite side of the bridge opening, the top flanking stones over the east side revetment walling had become dislodged. These were moved back to their original position. TVMHP funded the project.

At the north end of the structure under the aqueduct section, it appears that water has been leaking from the canal at the intersection of the metal 'trough' profile bolted plates and the canal bed – on both sides, through the stone masonry. This has caused the masonry and water at this point lower down under the aqueduct to be constantly wet.

Consequently, the foundations masonry and pointing in this area have softened to the extent that the masonry is collapsing and arching downwards. SWW attempted to add some clay to the leaking intersection point in the bed of the canal, but this has not worked. Structural deterioration will continue unless this issue is resolved. This is a significant feature of the canal which is in places, is now a Scheduled Monument. It is a recommendation of this report that the aqueduct bridge be considered for Listing.

Finally, the vertical retaining walling on the south west side of the aqueduct was repointed and the structural crack that had been identified by the structural engineer, repaired with the use of helibar reinforcing. This work finished in mid June 2012. The repointed wall acted to retain not only the towpath running along the south side of the canal, but also steps that allowed access from the towpath down into the adjacent field. These steps have badly deteriorated, leaving a steep slippery slope. It is recommended that they need to be rebuilt before use of them can be made by a new DCC footpath from the nearby railway linking up with the canal footpath.

Lock Gates and timber lifting bridge SX 46327 72628

The timber lock gate and timber lift bridge was 'restored' in 1998 by SWW and British Waterways. It is not know what the restoration replaced, but parts of the timber lift bridge (mainly the western timber arm), had rotted resulting in collapse (see Fig 15). Other parts of the bridge were showing that many timber items were rotting. In addition, the section of timber lock gate that was in constant contact with canal water had also rotted during the last 14 years. SWW and the TVMHP decided to replace the rotted and unsafe timber items as being a Health and Safety issue, given the frequent public use of the towpath. SWW funded the project.

The project of dismantling the bridge and lock gate, replacement of the main and structural timbers, and re-assembling and fixing on site was tendered. The contract was won by Will Sterling and Son, a traditional timber boat builder and carpenter who worked at Morwellham Quay (repairing and building boats, etc). The work was started in July 2012 and finally finished in September 2012.

Figure 16 is an 'after' view of the works on these features, and should be compared to its preceding figure. It is hoped that this repair will last longer than its predecessor!

Note:

In 2013, the TVMHP constructed a new footpath from near Morwell Rocks (SX 44128 70435) to above George & Charlotte Mine (SX 45101 69962). This new route links the main route of the railway line from Devon Great Consols to Morwellham and the forestry tracks north of Morwellham. Scheduled Monument Consent was obtained in 2012 for construction of a new timber footbridge over the Tavistock Canal (the section from the west end of the Morwell Down tunnel to the incline railway cottage was Scheduled in 2011, SM No. 30973). As part of this project, an impact assessment report was produced (Buck 2012). The results of the new footpath creation and footbridge construction will be produced within the main body of the TVMHP archaeological recording report (Buck forthcoming).

8. References

8.1 Primary sources

CRO AD 58-26 Tunnel Lodes (1923-33) Report by F Cloke and CF Barclay.

DRO T1258M-14B Bedford Estate Map

8.2 Secondary sources

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Waterhouse, R., 2012, *Tavistock Canal, Surveying a forgotten marvel of the industrial age*, Current Archaeology, Issue 273 December

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Woodcock, G., 1995, 2005, Booklets on the 'History of Tavistock'.

9. Project archive

The HE project number is **20070793**

The project's documentary, photographic and drawn archive is housed at the offices of Historic Environment, Cornwall Council, Fal Building, New County Hall, 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 (20070793).
2. Black and white photographs archived under the following index numbers:

   GBP 2091/12-21; 2207/12-22; 2250/1-17; 2253/19-22.
3. Digital photographs stored in the directory R:\HE images\Sites\Devon\Tavistock\Tavistock Canal
4. This report text is held in digital form as: G:\HE Documents\HE Projects\Sites\Devon\Tavistock Canal IA WB report 20070793
5. English Heritage/ADS OASIS online reference: cornwall2-154344

No artefacts or environmental material was retrieved during the project.

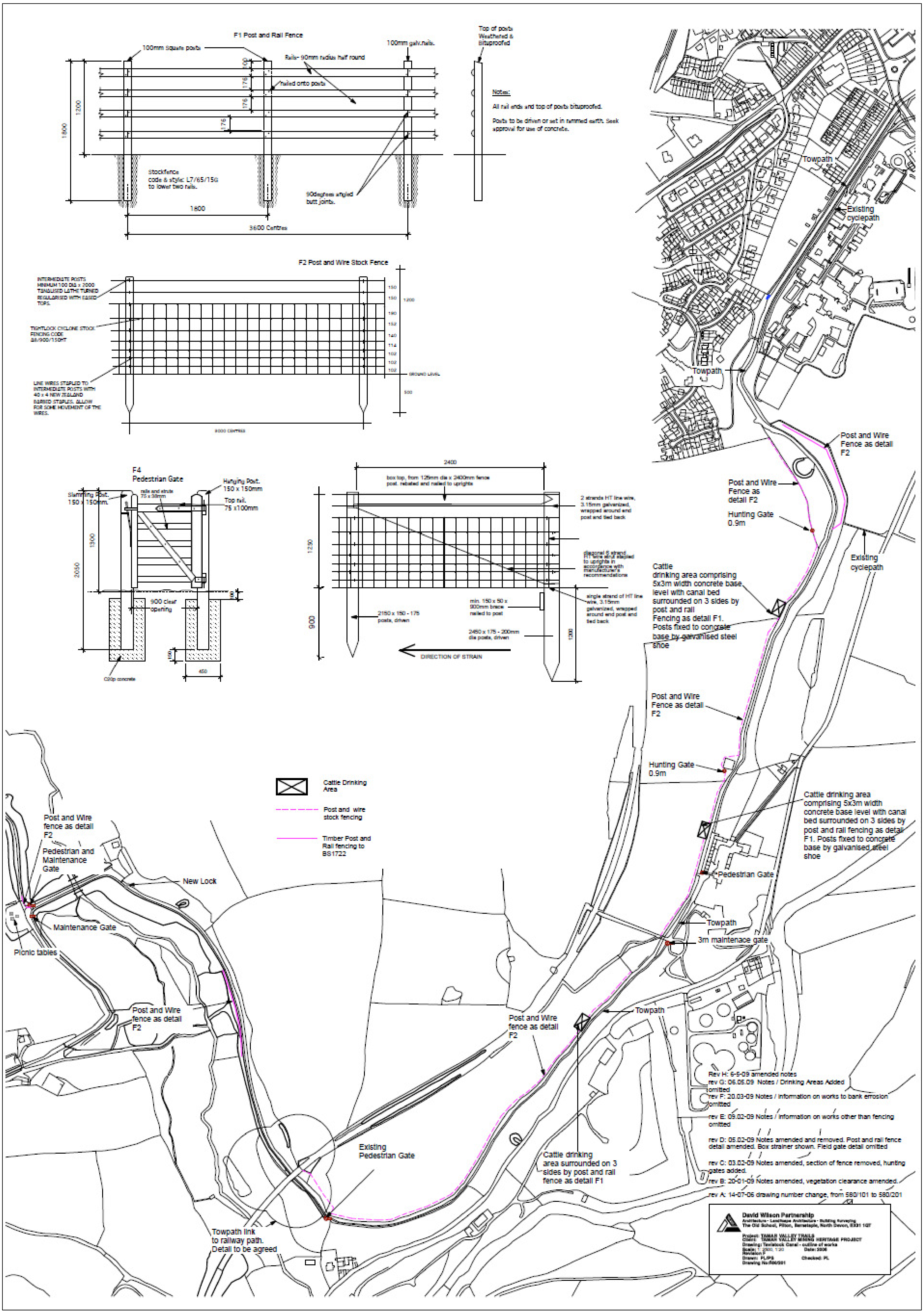

Figure 5 Specifications and plan showing fencing and three cattle drinking areas at the Tavistock Canal(East section)

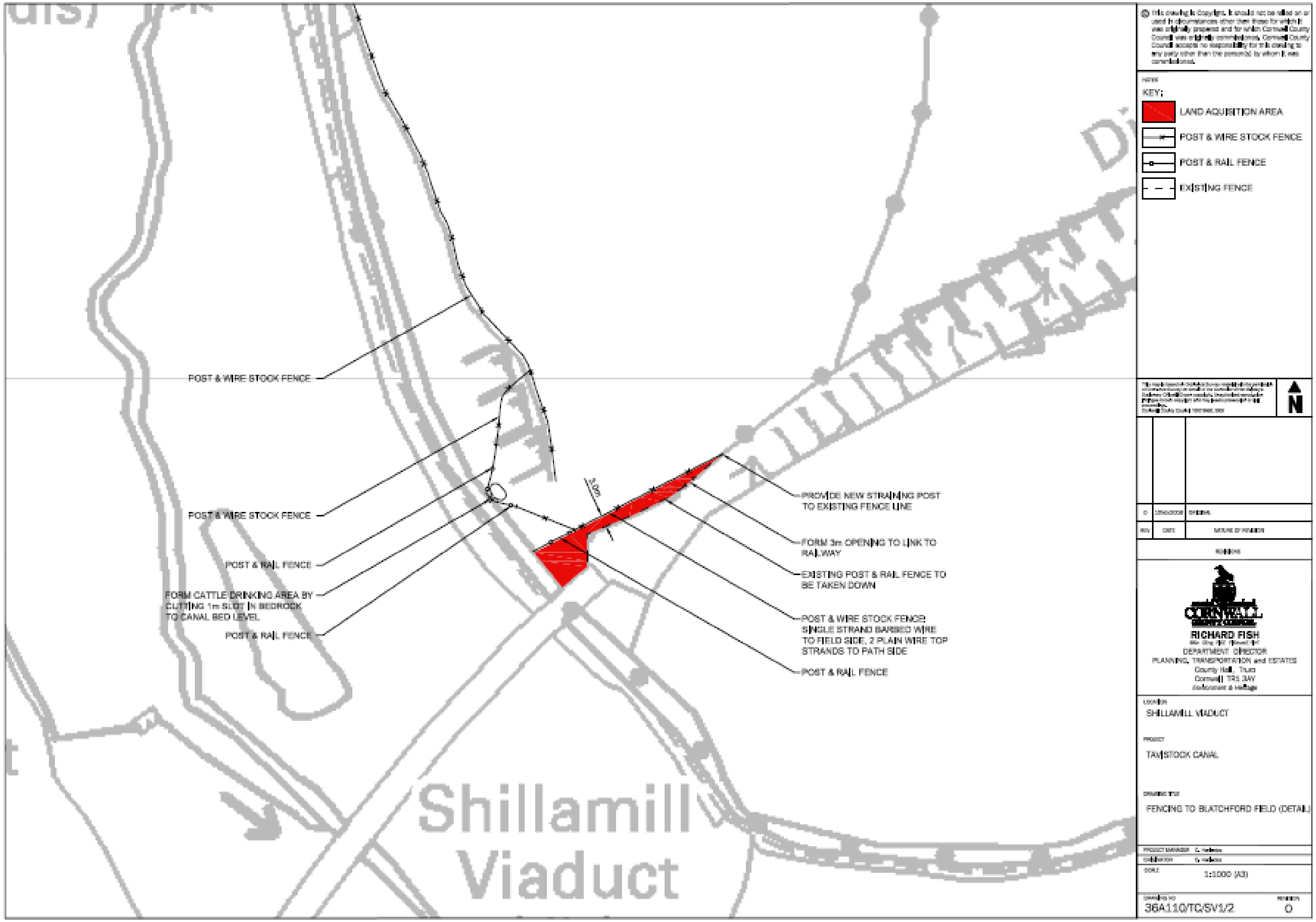

Figure 6 Detail plan showing the cattle drinking area west of the Shillamill Viaduct

Figure 7 A view of the Tavistock Canal east bank before works © CC HE Projects

Figure 8 A view of the Tavistock Canal east bank after works © CC HE Projects

Figure 9 A view of a Cattle Drinking site before works (SX 47257 72705) © CC HE Projects

Figure 10 A view of the same Cattle Drinking site after works © CC HE Projects

Figure 11 A view of the canal towpath after re-surfacing works © CC HE Projects

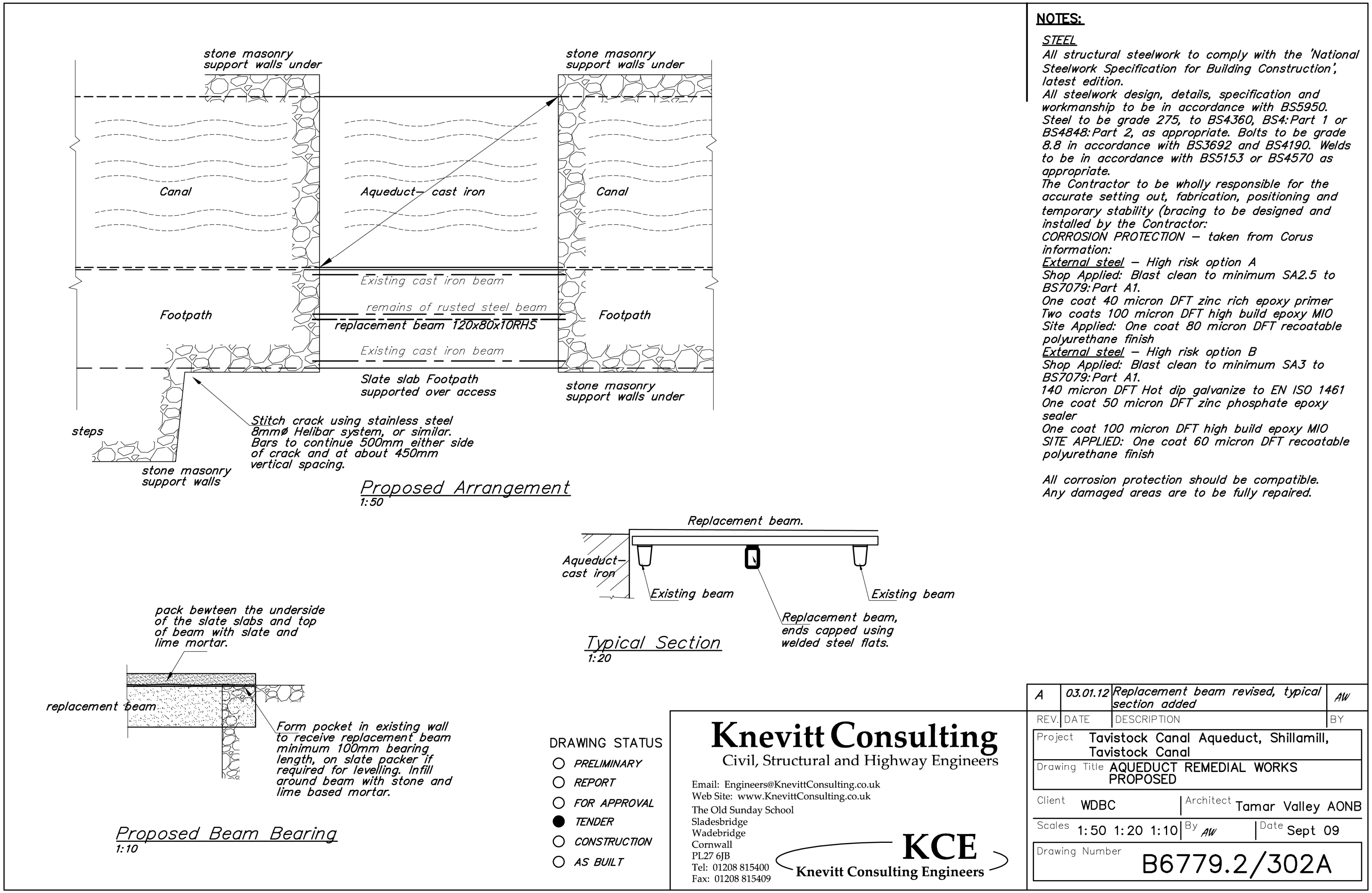

Figure 12 Specifications plan for repair of the aqueduct bridge

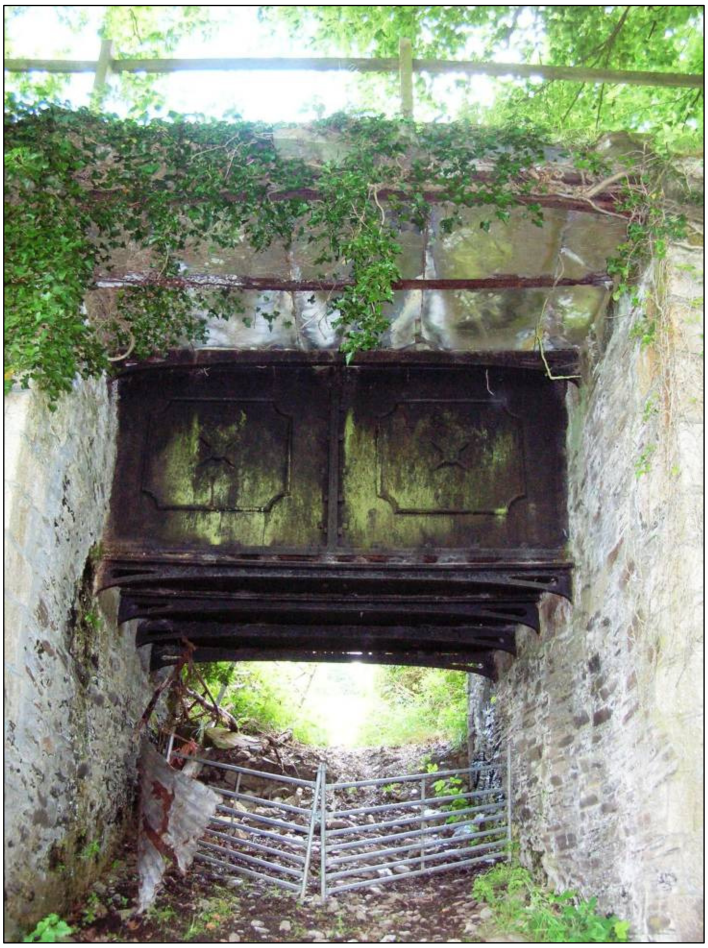

Figure 13 A view of the canal aqueduct bridge before works © CC HE Projects

Figure 14 A view of the canal aqueduct bridge after works © CC HE Projects

Figure 15 A view of the canal lock gate and bridge before works © CC HE Projects

Figure 16 A view of the canal lock gate and bridge after works © CC HE Projects

Appendix 1: TAVISTOCK CANAL BANK REPAIR WORK SCHEDULE

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
20		Side out path and hedge (140m length)
76		1.5m infill behind c $2m^3$
118		1.5m infill behind c $1m^3$
140-150	10	Minor wall top repair
159-160	1	End of hedge
162-163	1	1m infill behind $0.25m^3$
166-179	13	
225-247	22	
253-308	55	Break out conc block
314-323	9	
328-330	2	
394-418	24	
433-461	29	Take off conc
P A T H		
467-469	2	Break out conc
472-473	1	Good example, flat stone
485-488	3	Remove conc, Repair bank
494-513	19	Remove section of conc
530-541	11	
557-558	1	
563-573	10	
577-578	1	
581-584	3	
591-592	1	
600-650	50	
664-673	29	
691-694	3	
703-704	1	
714-718]	4	Soft path, build up levels (ch 14-27)
722-727]	5	
730-735	5	
744-745	1	
751-754	3	
755-760	5	
771-773	2	
779-780	1	
782-798	16	800 ⇒path surface 80ft
800-804	4	
804-806	2	Build up path surface to fall to canal

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
		(ch 800-902)
808-809	1	
813-814	1	
819-820	1	Lay hedge, remove barbed wire (ch 800-902)
823-826	3	
839-842	3	
875-876	1	
892-894	2	
902-903	1	Remove gate, overhanging branch
902-907	5	
970-971	1	Gate and post and rail across path
975-976	1	Surface ok
985-990	5	In deep
1009-1010	1	
1019-1020	1	Take out tree growing out from opposite bank
1068-1069	1	Path surface repair
1093-1094	1	Under bridge
1099-1100	1	Bridge coping repairs 4m copings in canal
1130-1131	1	Boulders ⇑ make up path ⇓ scrape leaf mould
1158-1159	1	
1165-1166	1	
1169-1170	1	
1187-1192	5	
1197-1199	2	
1202-1207	5	
1208-1209	1	
1225-1232	7	
1260-1268	8	
1271-1272	1	
1279-1280	1	
1282-1283	1	
1295-1298	3	
1308-1309	1	
1317-1319	2	
1334-1342	8	
1353-1356	3	
1409-1414	5	
1421-1422	1	
1424-1425	1	

Chainages – measured from swing bridge at Tavistock	Lengths of Wall Repair (M)	Notes
1441-1442	1	
1454-1456	2	
1514-1515	1	
1546-1548	2	
1573-1574	1	
1581-1582	1	
1603-1604	1	
1600		Path falls away from canal. (1.5m width)
1691-1692	1	
1718-1719	1	
1721-1722	1	
1726-1729	3	
1820-1821	1	
1856		AQUADUCT (Clear vegetation, Take out gate)
1958-1968	10	Under viaduct
1970-1972	2	
2020-2023	3	
2151-2152	1	
2220-2221	1	
2316-2318	2	WHEEL SLUICE Interpretation Barrier (Take down concrete posts and blocks)
2463-2464	1	
2534-2535	1	
2541-2543	2	Replace Bascule bridge
		Lumburn Valley Turning area at lock (excavate)
2586-2600	214	Opposite bank
TOTAL		

Note:

An additional 87 linear metres of repairs were undertaken by the site contractors as they deemed them necessary. These additional repairs are not reflected in the above schedule chainage list, which was originally compiled by Chris Hariades (in consultation with Colin Buck and SWW (Laura Wotton) in April 2009 to inform tender information and site specifications prior to the start of works. The location of the small swing bridge in Tavistock (from which the chainages are measured) is at SX 47348 73503.

Tavistock Canal - Canal Bank Repair Works Schedule

Item	Description	Qty	Unit	Rate (£)	Cost (£)
1	Provide site welfare facilities to comprise as a minimum porta-loo with handwashing facilities, maintain and take down on completion	Item			
2	Provide all necessary fencing, barriers, signage, maintain for duration of contract and take down on completion	Item			
3	Break out concrete capping (provisional)	50	lm		
4	Clear rubbish from canal bed and dispose to licensed tip (Provisional)	10	m3		
5	Repair identified sections of failed or colapsing drystone facings to canal bank to match adjoining sections using stone salvaged from canal bed	250	m2		
6	Tie and marry in each repair to adjacent sound sections.	100	no.		
7	Extra to bed bottom course of stone on 50mm depth drymix sand/lime/cement bed in ratio 6:2:1 where laying directly onto bed rock.(Provisional)	50	l.m		
8	Extra to import suitable matching stone to make up shortfall in site salvaged material (Provisional)	50	tonnes		
8	Backfill voids behind stone facing to level with top of bank with imported scalpings compacted in layers not exceeding 200mm depth (provisional)	10	tonnes		