Desk study and preliminary risk assessment report

Wood Lane, Mirfield

Client: South Pennine Boat Club

SPBC-DS
11 September 2024
Version 1

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Summary

It is intended to alter and extend the structure that currently covers the dry dock at the South Pennine Boat Club, Mirfield. The dry dock is located within an area of well-maintained soft landscaping and opens onto the Battyeford Cut. It is currently covered by an open sided structure, and it is proposed to enclose two of the sides and construct a small workshop.

Historical information identifies that the dry dock was constructed pre-1851, when the larger site area was in use as a boatbuilding yard. The boatbuilding yard ceased operation pre-1958, and the Boat Club started leasing the site in 1985. At the time the lease started, the dry dock was in poor repair, but the original dry-stone walls and floor remained insitu. As part of the lease agreement, the dry dock was renovated to a high standard.

A preliminary risk assessment has identified the following issues relating to contaminated land:

- Potential contaminants associated with wooden barge construction.

Due to the extended period since the boatbuilding yard closed, the extensive excavation and levelling works adjacent to the dry dock in the 1980s during construction of the new mooring basin, and the limited extent of the proposed new works, it is considered unlikely that a targeted or general site coverage intrusive investigation would be conclusive.

As such, it is recommended that the following be implemented:

- Appropriate and adequate damping down measures where soils are exposed to prevent inhalation of potentially contaminated dust particles. This is not necessary for construction materials used in previous works however it should be noted that exposure to concrete dust can cause a range of health issues so should the breaking out of concrete be necessary damping down should be employed.
- When soils are exposed, workers to wear dust masks and overalls, to be removed at the end of each day. Any exposed skin/hair to be thoroughly washed prior to leaving site each day.
- Soil arisings from workshop construction to be placed on tarpaulin, and arisings and open soils to be covered at the end of each day's work. Construction materials not intended for reuse to be placed separately to soil arisings.
- On completion of works, any soil arisings from workshop construction to be sampled, analysed and re-used or disposed of appropriately. Based on the dimensions of the existing structure, the proposed workshop, and the required footings, it is anticipated that a maximum of 5-10m^3 arisings will be excavated. A single representative sample of the soil arisings should be analysed to determine whether the soils are safe to be re-used on site or need to be disposed of offsite.
- The installation of basic protection measures in the form of a passive ventilation layer beneath the floor slab to the new workshop.
- A watching brief to be undertaken throughout all groundworks.
- Verification to be provided to the planning authority on completion of the works.

1 Introduction

Planning permission has been granted by Kirklees Council to alter and extend the structure that currently covers the dry dock at the South Pennine Boat Club, Mirfield (planning reference 2024/62/90013/E).

The decision notice includes conditions relating to contaminated land as follows:

Condition 4. Groundworks shall not commence until actual or potential land contamination at the site has been investigated and a Preliminary Risk Assessment (Phase I Desk Study Report) by a suitably competent person has been submitted to and approved in writing by the Local Planning Authority.

Condition 5. Where further intrusive investigation is recommended in the Preliminary Risk Assessment approved pursuant to condition 4 groundworks (other than those required for a site investigation report) shall not commence until a Phase II Intrusive Site Investigation Report by a suitably competent person has been submitted to and approved in writing by the Local Planning Authority.

These were requested due to the following comments from the Environmental Health Officer after planning consultation:

According to our records the site of the proposed development is shown as being potentially contaminated due to its former use (our site ref: 153/4). Therefore, to ensure safe development we recommend conditions relating to contaminated land.

The Environmental Protection Group has been appointed by the South Pennine Boat Club (the Client) to undertake a desk study and preliminary risk assessment in order to identify whether an intrusive investigation is required.

This report has been prepared in general accordance with the following documents:

Investigation of potentially contaminated sites code of practice. BS10175:2011+A2:2017.

CLR 11: Model procedures for the management of contaminated land. Environment Agency (2004); and

LCRM: stage 1 risk assessment. Environment Agency (updated 2021).

To this end the report presents the following:

- A summary of the history of the site in terms of potential sources of land contamination;
- The results of a walk-over survey identifying any evidence of land contamination;
- Identification of the potential contaminants associated with the above;
- An initial conceptual site model of the site indicating potential sources, pathways and receptors;
- A qualitative assessment of the likely risks; and
- Recommendations for remedial and health and safety measures.

1.1 Author and competence

This report has been completed by Sarah Haines and reviewed by Steve Wilson of EPG.

Sarah is a Member of the Chartered Institution of Water and Environmental Management with over twenty-five years' experience in the investigation, assessment and remediation of contaminated land. She has worked in both regulatory and private practice roles and specialises in the investigation and quantitative risk assessment of bulk and trace gases and vapours. She is co-author of the *Local authority guide to ground gas (2008).*

It has been peer reviewed by Steve Wilson. Steve is Chartered Civil Engineer and Registered Ground Engineering Advisor, as well as being a SoBRA accredited risk assessor for permanent gases. He has 35 years' experience of investigating, assessing and remediating contaminated land, specialising in the investigation and assessment of landfill gas risk and has written numerous technical papers and guidance on the subject.

1.2 Information sources

This report has been informed via the following sources of information:

- Information provided by the Client;
- Site walkover;
- Historic maps and photographs;
- British Geological Survey geological map: Huddersfield, England and Wales Sheet 77; and
- Information sources on the internet.

1.3 The site

The site is located in the Calder Valley on the western outskirts of Mirfield, in the Borough of Kirklees, West Yorkshire, and forms part of the South Pennine Boat Club larger site leased from British Waterways (now Canal and River Trust) since October 1985. It is bounded to the south by the Battyeford Cut (a stretch of the Calder and Hebble Navigation), to the west by a mooring basin, to the north by an area of soft landscaping and the Boat Club clubhouse, with the main River Calder beyond, and to the east by soft landscaping. The location of the site is shown in Figure 1 as denoted by the red rectangle.

Figure 1: Site location

Within the site boundary there is currently a dry dock, attached via a lock gate to the Battyeford Cut, and covered by an open sided structure as shown in Figure 2.

Figure 2: Current structure

1.4 Proposed works

Planning permission was granted for the construction of low walls along the northwest and southeast sides of the existing structure and a small workshop at the northeast end, then installing windows to fill in the long sides.

The walls between the existing pillars on the north and south sides will be 900mm high and not load bearing. They will require shallow trench footings to a depth of 450mm. The workshop will require trench footings to a depth of 500mm. No service trenches are proposed, any additional power or water points will be connected to the existing main services above ground. As such all excavations will be shallow, with no risk of creating new pathways for contaminant migration should any be present.

2 Background information

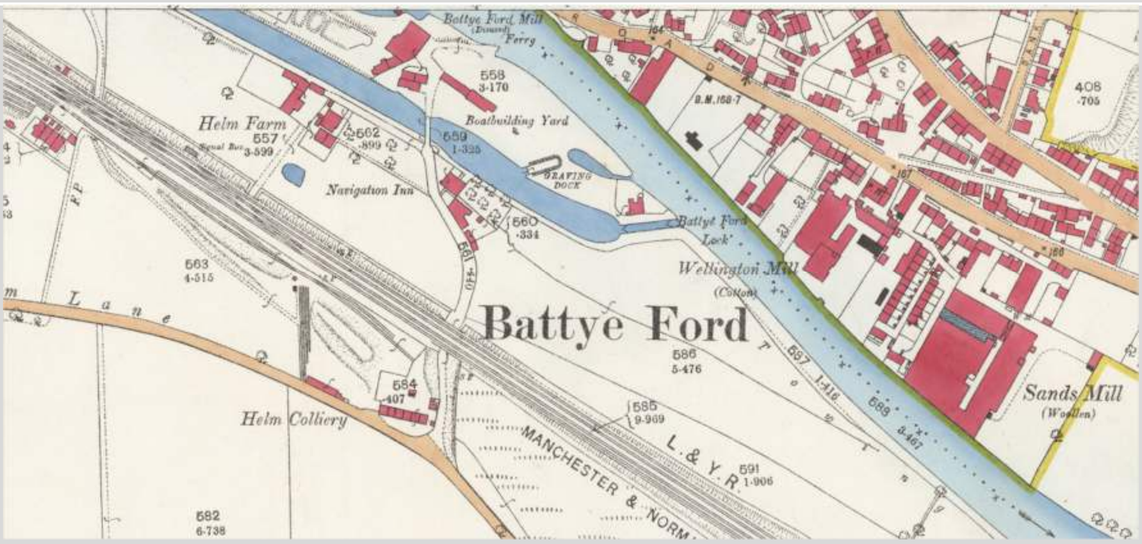
Background information from several sources has been referred to in order to gain an understanding of site conditions. Extracts are presented below, and items relevant to contamination land noted.

2.1 Historic maps

Table 1: Extracts from historic maps with commentary

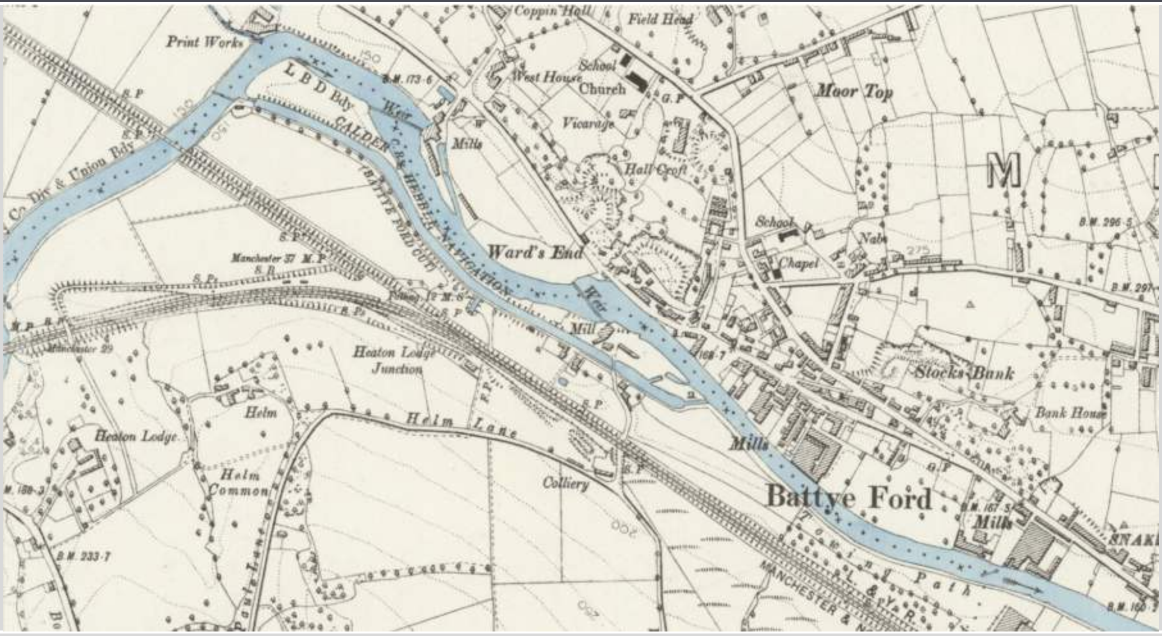
Extracts from historic maps with commentary

c.1851 1:10,560
The *Battye Ford Cut* is already in existence, as is the current day dry dock. It can be seen that the larger area is mainly rural/agricultural, however there are a number of industries. Given the presence of the dry dock, it can be assumed that the boat building yard historically located on the site has been active for some time. It is also noticeable that there is a colliery (*Helm Colliery*) some distance to the south on the other side of the Cut, and a mill (*Battye Ford Mill (Woollen)*) to the northwest. The additional water feature crossing the site north to south between the Cut and the River is likely to be associated with driving the mill wheel at the wool mill. The *Wilsons Arms Inn* is located on the 'island' adjacent to the *Battye Ford Lock* which joins the Cut to the River Calder.

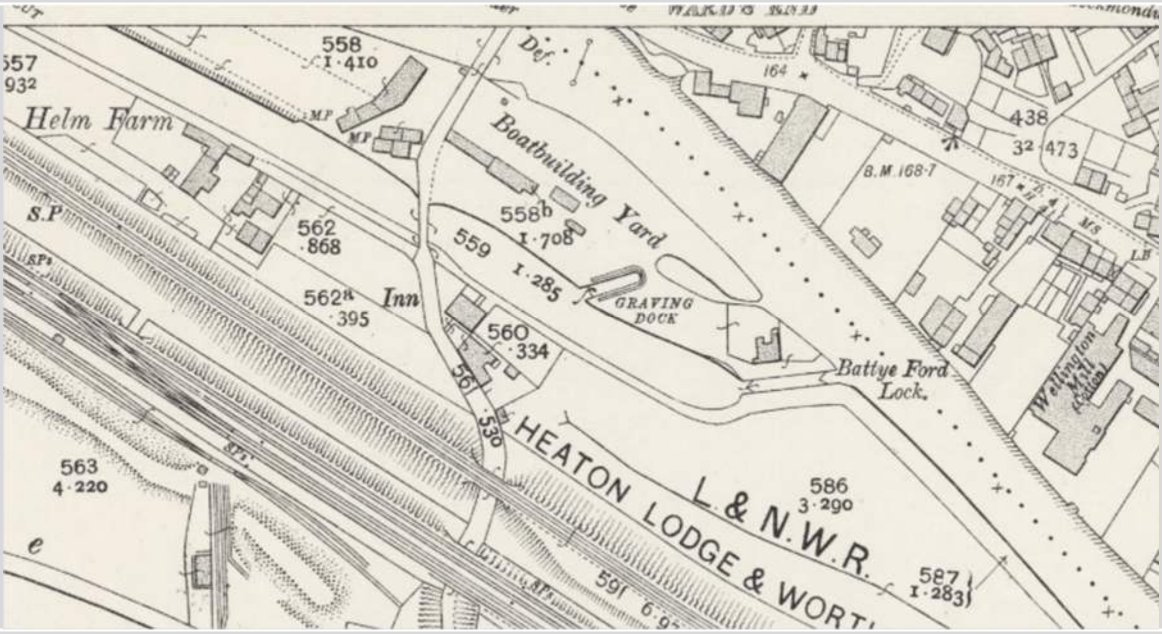


c.1893 1:2,500
The wool mill is now denoted *(Disused)* and the additional water feature is no longer shown with the exception of a lagoon to the rear of the dry dock which feeds into Calder River. The *Boatbuilding Yard* is labelled, and the dry dock is denoted a *Graving Dock,* the traditional form of a dry dock comprising a narrow basin, usually made of earthen berms and stone contained using a lock gate at the entrance and emptied via a sluice at the rear. *Helm Colliery* to the south is still denoted.

Extracts from historic maps with commentary

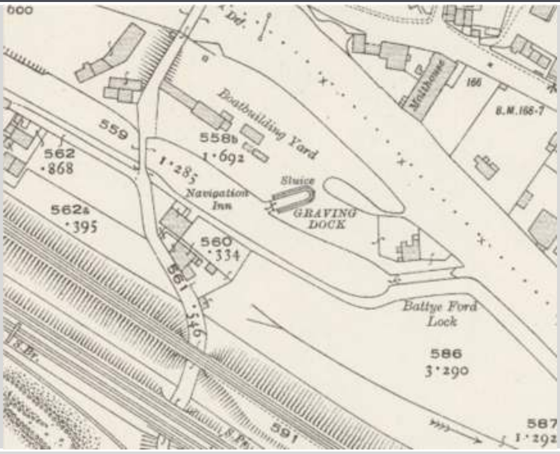


c. 1894 1:10,560
It can be seen that the larger area remains rural/agricultural in the main. Additional mills and a print works can be seen along the length of the River Calder. Indications of historic quarrying can be seen to the north of the River.

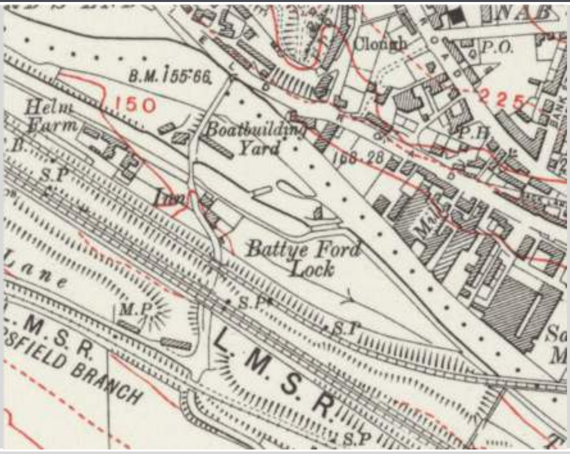


c.1907 1:2,500
Additional structures associated with the Boatbuilding Yard are shown. Colliery is still denoted to the southwest.

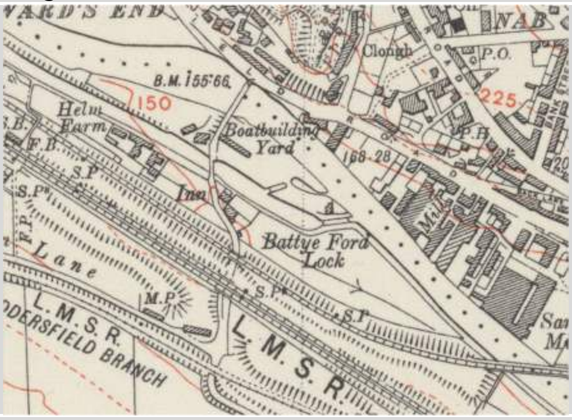
Extracts from historic maps with commentary



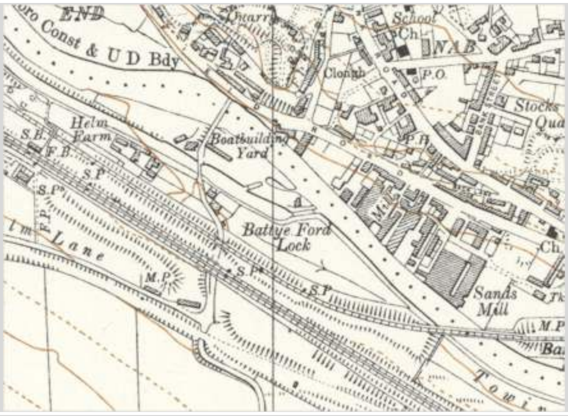
c.1922 1:2,500
No significant changes. The *Colliery* is no longer denoted.



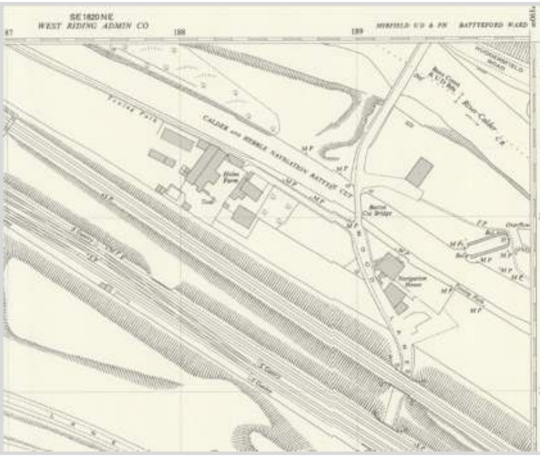
c.1930 1:10,560
The additional structures associated with the *Boatbuilding Yard* are not shown.



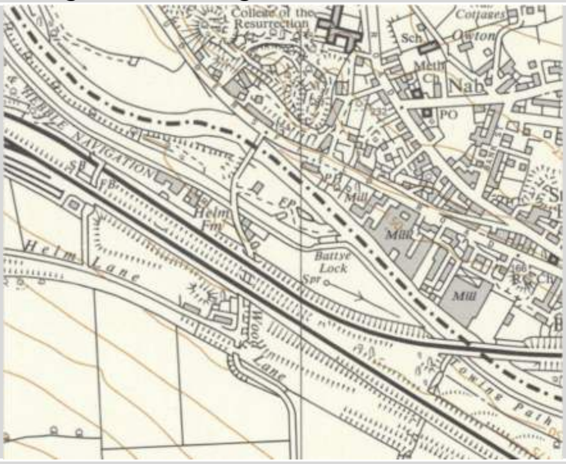
c.1948 1:10,560
No significant changes.



c.1955 1:10,560
No significant changes.



c.1958 1:1,250
The remaining structure relating to the *Boatbuilding Yard* is no longer shown or denoted, although another structure is now shown. Some land raising potentially occuring immediately to the east of the dry dock.



c.1966 1:10,560
No significant changes.

The site and land immediately to the north, west and east can in the main be considered in isolation from the remainder of the local area, due to its island status. It can be seen from the historic maps that the boatbuilding yard and dry dock were present prior to the earliest edition in 1851 until post 1955. The main building associated with the boatbuilding yard was located approximately 35m to the northwest of the dry dock.

Additional online research[1] has identified that there were three boatbuilding yards in Mirfield, and that the construction comprised timber keels known as West Country Keels, a smaller wooden barge able to navigate inland waterways to the west. The last barge to be constructed in the three boatbuilding yards in Mirfield was reportedly completed in 1955.

Construction would take place immediately adjacent to the canal (Cut), then the completed barge 'tipped' into the canal. This can be seen in a photograph of the larger site when it was active as a boat building yard, presented as Figure 3 below.

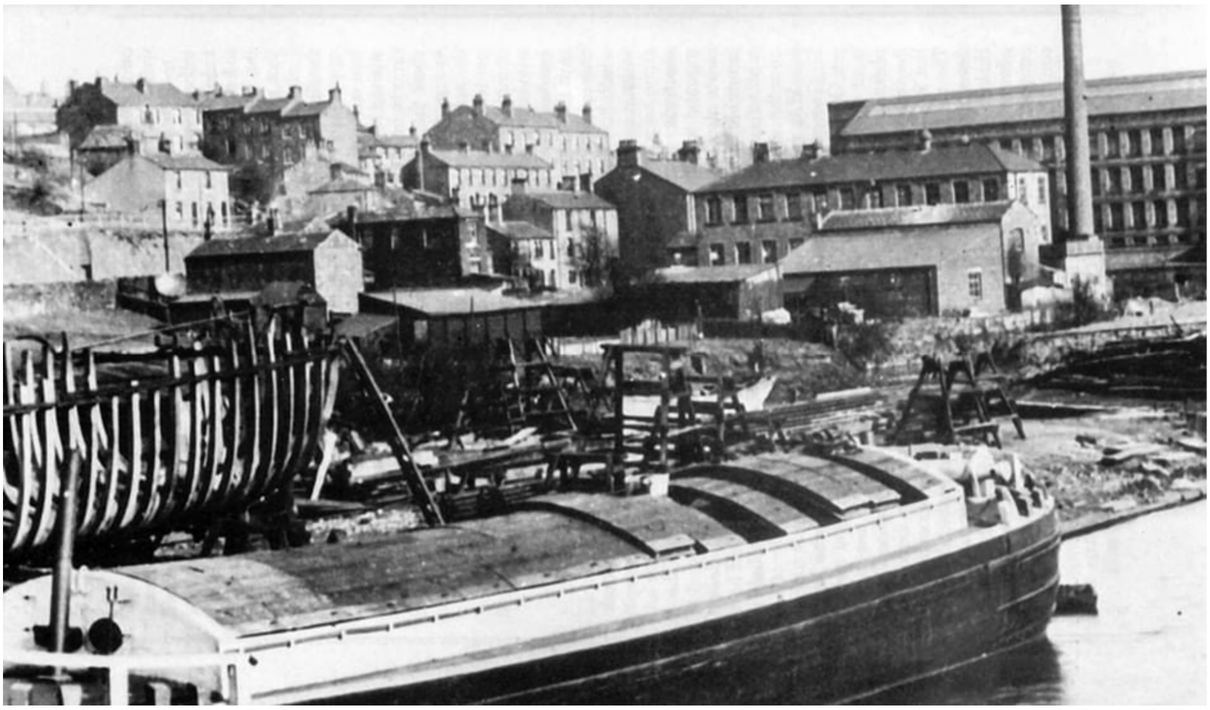


Figure 3: Battye Ford Boatbuilding Yard

An oak frame would be constructed, which would then be oak planked. To enable the planks to follow the curves of the frame, them would be steamed for many hours in large steam boxes. They would then be nailed to the frame, and the gaps between the planks made watertight by a process known as caulking, where cotton or shredded hemp rope mixed with pitch (molten black tar) was forced into the gaps. The hulls were then painted over with pitch. The dry dock was used solely for repairs.

Initially the West Country Keels were equipped with sails for use on the larger waterways, the rest of the time they were towed by horses. Steam engines were later fitted to some keels, and with the

1 Barges 3 (mirfield-2ndlook.info)

arrival of the diesel engine, the Mirfield yards found a new role converting some keels to diesel power in the 1930s and 1940s, although it is not clear if this included the Battye Ford yard.

The Department of the Environment Industry Profile for shipbuilding[2] identifies contaminants that can potentially be associated with wooden shipbuilding, which will be discussed in detail in Section 3.

2.2 Photographic history

A number of photographs are presented on the Client's website, and additional photographs have been provided relating to the restoration of the dry dock. These are presented in table 2, below, with commentary and dates provided by representatives of the South Pennine Boat Club who have been members since the lease commenced in October 1985.

Table 2: Photographs with commentary

Photographs with commentary	
 1. January 1985, first site viewing prior to decision to pursue lease, from northwest. Outline of dry dock can be seen centrally.	 2. October 1985, site from Battyeford Lock (southeast) dry dock obscured by undergrowth.
 3: Spring 1986, dry dock with steel bars (boat supports) and original stone walls, from southwest. Sluice can be seen to rear, where water was released to drain dock into River Calder via drainage ditch/pond.	 4: Spring 1986, entrance to dry dock from Cut with leaky gate, from northeast.

[2] *Engineering works: shipbuilding, repair and shipbreaking (including naval shipyards).* DoE, Industry Profile, 1995.

Photographs with commentary


5. Spring 1986, after first working party had cleared undergrowth, from northwest.


6. Spring 1986, after removal of steel bars, from northeast.


7. December 1986, excavation of new mooring basin started adjacent to the dry dock.


8. Basin excavations continued


9. Basin excavation


10. Arisings from basin excavation


11. July 1987, basin complete


12. Arisings used to infill drainage ditch and lagoon to rear of dry dock, after new culvert installed

Photographs with commentary

13. February 1987 rebuilding of walls with original stone.

14. February 1987 rebuilding of walls with original stone.

15. July 1988, new gate and boat supports installed.

16. Reinforced concrete laid over original stonework at base of dry dock. Railings and paving slabs installed around perimeter.

17. Reinforced concrete laid over original stonework at base of dry dock.

18. 2009, current day roof constructed, steel uprights clad in stone.

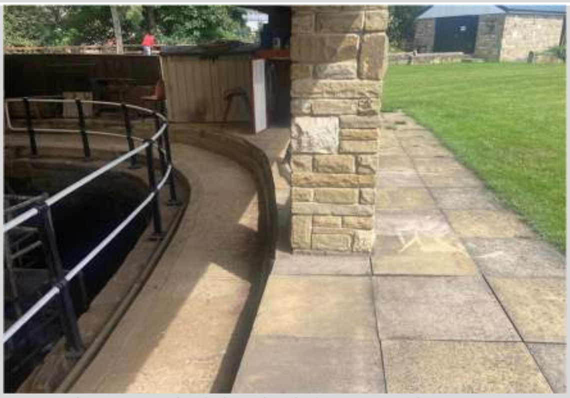
It can be seen that at the time that the lease was taken in 1985 the dry dock remained in its original form, albeit in poor condition. Restoration works undertaken as a condition of the lease involved the removal and restoration of the stone side walls and the replacement of the gate. The stone base was at no time disturbed and was subsequently overlain with reinforced concrete. It can be seen in photos 13 and 14 that there is no indication of gross contamination in the soils behind the walls when removed, and it is considered likely that these represent the original soils from when the dry dock was first constructed pre-1851, probably prior to the boatbuilding yard commencing operations. There is no evidence of the dry dock ever being used to dispose of waste or any other material.

The large excavation undertaken to create the mooring basin (photos 7 to 12) reportedly did not encounter any unexpected or unusual ground conditions, and the arisings were used to infill the ditch and lagoon to the rear of the dry dock, after installation of a culvert leading directly from the sluice to the River Calder.

2.3 Walkover

A representative of EPG undertook a walkover of the site on 3rd August 2024.

Table 3: Walkover photographs with commentary

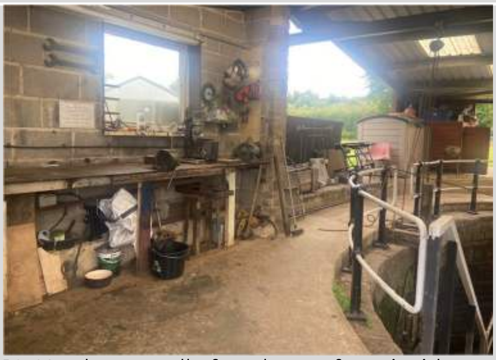
Walkover	
 1. Dry dock from gate to Cut	 2. Northwest side of dry dock, metal supports clad in stone. The black rectangle is a mat left out to dry.
 3. Gate from inside of dock enclosure.	 4. Southeast side of dry dock.
 5. Northeast end of dry dock.	 6. Northeast end of dry dock from southeast.

Walkover


7. Northeast end of dock from inside enclosure.


8. Southeast wall of dry dock from northeast.


9. Dock from southeast corner of enclosure.


10. Northeast wall of enclosure from inside.


11. Sluice gate at northeast end of dry dock. The drainage ditch and lagoon have been replaced with a culvert that feeds directly into the River Calder.


12. Boat club grounds, well maintained, no evidence of grass die-back.

Walkover

13. Northwest end of enclosure, from north. This is where the proposed workshop as detailed in the planning application will be located.

14. Northwest end of enclosure, from east. This wall will remain unchanged.

There was no indication of potential contamination apparent during the walkover. It can be seen that, with the exception of the proposed extension, all excavations will be undertaken into the paving slabs and concrete around the perimeter of the dry dock between the existing stone clad pillars. The proposed extension at the northwest end of the enclosure will extend out across the slabs and grass.

2.4 Environmental setting

2.4.1 Geology

The British Geological Survey (BGS) GeoIndex Onshore identifies that the site is underlain by superficial deposits in the form of Alluvium, overlying the Pennine Lower Coal Measures. The site is located at the base of the Calder River Valley.

2.4.2 Mining

The larger area is identified as a primary opencast coal resource area (GeoIndex Onshore). The early historic maps identify *Helm Colliery*, then *Colliery*, 130m southwest of the site, separated by Battyeford Cut, an inn and the railway between. This is no longer shown on the 1922 edition, and a detailed internet search, including records of Yorkshire mines, has not identified any additional information relating to Helm Colliery. No adits or shafts are denoted on any of the historic maps, although there is significant ground disturbance shown across the site and The Coal Authority interactive map identifies three mine entry points within the colliery. The Coal Authority interactive map does not identify the Boat Club site as being within a development high-risk area, and further research into the geology shows that the shallowest seam in the vicinity of the site is the Joan Coal, which is a thin but widely developed seam of poor quality that has rarely been mined subsurface.

2.4.3 Hydrology

The River Calder bounds the larger Boat Club site to the north, the Battyeford Cut bounds it to the south, with the mooring basin and dry dock feeding directly from the Cut. The drainage ditch and lagoon that historically fed water from the dry dock sluice to the River Calder has been replaced with a culvert that runs beneath the soft landscaping.

2.5 Discussion

The sources of information presented above identify:

- The site was historically used as a boatbuilding yard, which has associated potential contaminants; and
- There was historically a colliery located 130m southwest of the site, separated by the Cut and railway lines.

During the restoration works of the dry dock and the extensive deep excavation to create a new mooring basin, no unexpected or unusual ground conditions were identified. The arisings from the mooring basin were used to infill the existing lagoon to the rear of the sluice.

3 Preliminary risk assessment

Current UK guidance identifies the first steps of the contaminated land risk assessment process as follows:

Step 1: Define conceptual site model

Step 2: Develop risk model and qualitative assessment

Step 3: Pollutant linkage identified?

The risk model develops the conceptual model to identify potential sources of contamination, receptors that could be affected, and possible pathways by which the contaminant could reach the receptors and cause harm.

3.1 Sources

The dry dock has at no time been infilled with any material, remaining open from pre-1851. As such it does not represent a source of unknown and potentially contaminated/gassing material.

The Department of the Environment Industry Profile for shipbuilding discusses both marine and inland ships constructed of metal and wood. Given that the site is located on an inland waterway constructed to avoid difficult conditions on the River Calder, it can be assumed that no craft intended for marine use were constructed, and as such the contaminants associated with protecting materials from saline conditions can be discounted.

The industry profile details wooden shipbuilding as follows:

Wooden shipbuilding involved a number of traditional craft activities. Foremost amongst these was that of the shipwright, which involved the cutting, shaping and fixing of large timbers. Ancillary crafts included sailmaking, ropemaking, rigging and blacksmithing. Iron fixtures, brackets, chains etc may have been made on site using traditional blacksmithing techniques. Significant quantities of tar were used for caulking seams and simple paints may have been produced on site by grinding coloured pigments into natural resins and linseed oil.

It is possible that in the 1930s and 1940s some of the keels were converted from sail/horsepower to diesel power in the boatbuilding yard.

As such, there is the potential for the following contaminants to be present across the wider site:

- Coal/ash from the heating of steam boxes/tar etc. Contaminants generally comprise heavy metals.
- Complex hydrocarbons from the use of tar for caulking. Coal tar is a black/brown viscous liquid with distinctive organic odour. The pungent smell of coal tar makes it easily identifiable even in small quantities in soil.[3] Contaminants generally comprise aromatic and polycyclic aromatic hydrocarbons, phenols, cresol, organo-sulphur compounds.
- Petroleum hydrocarbons from diesel engines/diesel storage.

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[3] *Gas works, coke works and other coal carbonisation plants*. Industry Profile, DoE, 1995

During the boatbuilding yard's operational period, the main building was located approximately 35m to the northwest of the dry dock. The exception to this is the 1907 and 1922 editions, which show two smaller buildings between the main building and the dry dock, which are no longer shown on the 1930 edition. It is considered likely that the majority of potentially contaminative processes took place within the main building (for example, the manufacture of the pitch, any blacksmith works, and the steaming), with the exception of caulking and potentially painting which would have taken place adjacent to the Cut (Figure 3).

There is no indication of where any waste products such as ash were disposed of. No evidence of unusual or unexpected ground conditions were recorded during the excavation of the mooring basin or construction of the existing pillars, although it should be noted that contaminated land was not generally a consideration during construction in the 1980s/90s.

Based on: the location of the buildings present during its history as a boatbuilding yard; the fact that the construction and caulking of the barges took place in the location of the new mooring basin; and that the dry dock remained as originally constructed until restored in the 1980s, it is considered highly unlikely that any of the contaminants detailed above are present within the footprint of the existing dry dock and current structure.

Given that the arisings from the mooring basin were used to infill the historic lagoon to the rear of the sluice, there is the potential for contaminants associated with the construction and caulking of the barges to be present within this location.

During the 65+ years since the closure of the boatbuilding yard, any organo-sulphur residues will have been incorporated into the naturally occurring nitrate-sulphate-carbon-iron cycle. Sulphur plays an important role in biochemistry in the natural environment and is in fact used in wastewater treatment and some pollution bioremediation, and as such it is not considered that this represents a contaminant of concern on this site. **As such, this will not be considered further in this report.**

Alluvium (as anticipated across the site) can represent a source of bulk gases (carbon dioxide and methane) when trapped at depth beneath an impermeable stratum, however in aged alluvial deposits at ground level such as on this site, it has been demonstrated that the risk of bulk gas release is negligible. **As such, this will not be considered further in this report.**

There is also the potential that coal seams are present beneath the site, however there is no evidence that these have been worked north of the railway line to the south of the Cut. Based on the reinforced concrete slab and historical stone floor to the dry dock, and the lack of any shafts or adits within the larger site area, it is considered that the risk of coal gas migrating to within the dry dock structure is negligible. The new workshop will also be floored with reinforced concrete. **As such, this will not be considered further in this report.**

3.2 Pathways

It is proposed to construct low non-load bearing walls and a small workshop in the immediate vicinity of the dry dock. This will require the excavation of shallow (maximum depth 500mm) foundation trenches on the northwest and southeast of the existing structure, between the existing stone clad supporting pillars, and to the northeast outside of the existing footprint.

The restoration works to the dry dock undertaken in the 1980s involved the removal and restoration of the original stone side walls and the replacement of the gate. The stone base was at no time disturbed and was subsequently overlain with reinforced concrete. It can be seen from photographs taken during the site walkover that the immediate perimeter of the dry dock is concreted above the level of the original stone walls. This is then raised in two steps and covered in paving slabs between the pillars. The proposed excavation works (with the exception of the workshop extension) will take place beneath the paving slabs, which are supported by concrete on the inside, and are level with the soft landscaping on the exterior. There is no evidence of any settlement or weed growth and as such it is considered likely that the slabs are underlain by an appropriate grade of stone/gravel or by concrete rather than by soil.

The workshop extension will extend out across the paved area to the northeast of the existing enclosure, and in part across the soft landscaping. Once again, there is no evidence of any settlement in the paved area although there is some weed growth between the slabs, and the soft landscaping is well maintained and shows no evidence of grass die-back.

Should any contamination be present in the materials underlying the proposed shallow footings, the pathways of concern are direct exposure/inhalation during excavation and construction works. In terms of end-users, given that all exposed underlying materials will be covered, the only pathway of concern will be the inhalation of gas or vapours.

Gas and vapours primarily migrate via either pressure driven (advective) flow or via diffusive flow. The primary mechanism for migration of gases/vapours is generally dependent on the generation potential and stage of decomposition. The potential source of gas and vapour identified above is >65 years old. As such, given the free movement of oxygen and water throughout the underlying soils across the site, the gas/vapour generation phase will have peaked some time ago.

All the lines of evidence presented above indicate that the prevalent migration mechanism will be via diffusive flow along concentration gradients through the shallow soils.

3.3 Receptors

Given:

- The history of the site;
- The site's location within an area with much historic industrial usage;
- The larger site's location between two water bodies;
- The nature and age of the potential contamination; and
- The limited and shallow nature of the proposed ground works.

It is not considered necessary that surface or groundwater bodies are considered as potential receptors.

As such, receptors at risk from contamination include:

- Construction workers as a result of direct contact with underlying soils during groundworks; and
- End-users as a result of the inhalation of gas/vapours.

3.4 Conceptual site model

A simplistic ground model of the site based on the information presented above is illustrated in Figure 4 below.

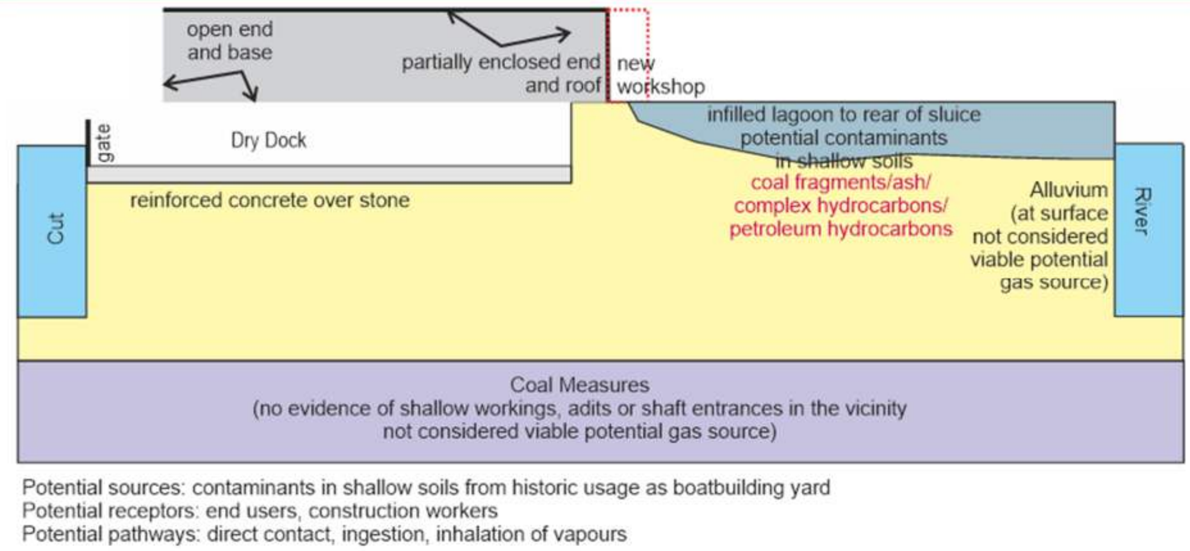

Figure 4: Simplistic ground model

3.5 Discussion

It can be seen from the preliminary risk assessment presented above that there is the potential for residual contaminants to be present within shallow soils across the site from its historic usage as a boatbuilding yard, in particular within the infilled lagoon. It is considered that the shallow strip foundations to be excavated between the existing stone clad pillars on the northwest and southeast of the existing structure will not encounter any contaminated soils, however the new workshop will in part be located over the infilled lagoon.

The location of the proposed works in the context of the boatbuilding yard and the relatively new mooring basin is schematically presented in Figure 5 below.

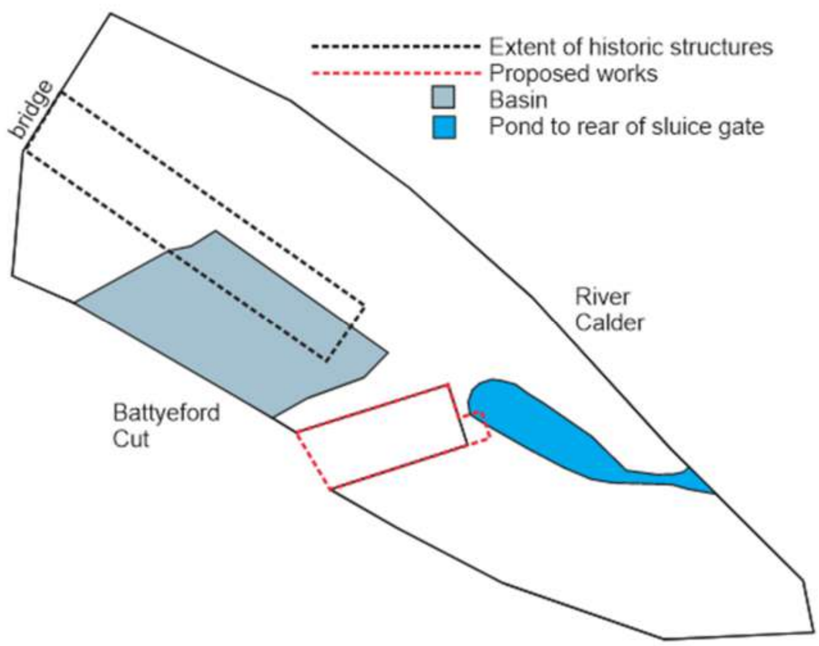

Figure 5: Schematic of larger site

The extent of buildings shown on historic maps (Table 1) can be seen to end some distance to the northwest of the proposed works, and the location of actual barge construction (Figure 3) took place within the area of the new mooring basin. It is known that arisings from the excavation of the mooring basin were used to infill the historic lagoon to the rear of the sluice. The perimeter of the dry dock comprises concrete steps, paving slabs and pillars which were constructed/placed at various times after completion of the basin excavation. It can be seen in photographs that during re-building of the dry dock walls, the soil to the rear of the original stonework remained largely undisturbed, and as such it can be assumed that none of the basin arisings were placed directly around the perimeter.

3.5.1 Contaminants

Potential contamination relating to the historic usage of the larger site as a boatbuilding yard have been identified as simple and complex hydrocarbons, and heavy metals. The last barge to be constructed in Mirfield was reportedly completed in 1955, and the boatbuilding yard and associated structures are not shown on the OS 1958 edition. As such, it can be assumed that any contamination associated with boatbuilding has been insitu for 65+ years.

Hydrocarbons can be simple or complex, volatile or non-volatile. It is considered that gross hydrocarbon contamination within the area of the proposed works is unlikely due to the fact that construction and caulking of the barges took place at some distance from the perimeter of the dry dock. Over the extended period since the closure of the boatbuilding yard, natural attenuation will have been occurring. Unless an extensive plume of complex hydrocarbons is present across the site, this process will have reached near-conclusion with any further biodegradation resulting only in the production of carbon dioxide and water. Should an extensive plume be present, this should be evident in both the River Calder and the Cut, in particular as the Environment Agency has a freshwater monitoring point within the River Calder at Battyeford Bridge[4].

3.5.2 Ventilation

The dimensions of the above ground existing structure (not taking into consideration the below ground dry dock) are as follows:

Length: approximately 24m

Width: approximately 12m

Height: between 2m (outer walls) and 3.5m (central ridge).

With the exception of the proposed workshop, this will remain as a single open space of approximately 800m^3, with open ventilation of approximately 75m^2 at the southwest and of approximately 8m^2 at the northeast.

The proposed workshop is intended predominantly for welding, and as such will have ventilation available, in the form of doors and windows that will remain open during welding.

3.6 Conclusion

Based on all the information presented above, it can be concluded that:

- The dry dock has remained open throughout its history, with no infilling occurring.

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[4] Open WIMS data

- The potential for gross contamination being present within the footprint of the proposed development is very low to negligible.
- The potential for volatile hydrocarbons in sufficient volume to represent a vapour risk being present beneath the footprint after 65+ years is considered negligible, in particular as for the majority of that period the footprint was open to all elements with the exception of a dry-stone wall/slab.
- Any hydrocarbons that still remain in soils after 65+ years will be complex and subject to very slow biodegradation. In the absence of an extensive plume, the methanogenic phase of biodegradation will have ended, and the current end-products will be carbon dioxide and water. There is also the potential for localised hydrocarbon vapours to be present beneath the footprint of the proposed workshop.
- With the exception of the proposed workshop, the structure will comprise a single open space of approximately 800m^3 with open ventilation of approximately 75m^2 at one end and 8m^2 at the other.
- Based on the history of the larger site and the limited nature of the proposed works, undertaking an intrusive investigation is unlikely to be of direct assistance to the risk assessment process.

It is considered that the risk of direct exposure to contamination during works on the northwest/southeast sides of the existing structure is negligible. There remains a low risk of direct exposure to contamination during excavation works within the workshop footprint, and a very low to negligible risk of carbon dioxide and/or hydrocarbon vapours accumulating within the enclosed workshop.

4 Recommendations

It has been identified that there is a low risk of direct exposure to contaminants in soils during groundworks within the workshop footprint, and a very low to negligible risk of carbon dioxide/vapour accumulation within the proposed enclosed workshop. The recommendations detailed below represent a conservative and sustainable approach to the mitigation of potential contamination.

4.1 Direct exposure during construction mitigation measures

As a result of the historic use of the site as a boatbuilding yard and the subsequent excavation of the mooring basin, with the arisings being used to infill the historic lagoon, it is impossible to predict if contamination will be present within shallow soils that will be excavated to implement the construction of the proposed workshop. If it is present, it will have been disturbed, separated, moved around and spread, and as such localised sampling is unlikely to prove useful.

The potential contaminants have been identified as heavy metals and complex hydrocarbons in the form of polycyclic aromatic hydrocarbons.

4.1.1 Heavy metals

Heavy metals are common pollutants in the soil environment from both natural and anthropogenic sources, mainly in the form of arsenic (As), cadmium (Cd), chromium (Cr), mercury (Hg), lead (Pb), copper (Cu), zinc (Zn) and nickel (Ni). This type of contamination is biologically toxic, widely distributed, and persists long-term in the soil environment.

Exposure can occur through ingestion, direct contact through the skin, or via inhalation of dust. This form of contamination is not generally visually or olfactorily identifiable. As such, the following health and safety measures should be implemented during groundworks associated with the workshop:

- Appropriate and adequate damping down measures where soils are exposed to prevent inhalation of potentially contaminated dust particles. This is not necessary for construction materials used in previous works however it should be noted that exposure to concrete dust can cause a range of health issues so should the breaking out of concrete be necessary damping down should be employed.
- When soils are exposed, workers to wear dust masks and overalls, to be removed at the end of each day. Any exposed skin/hair to be thoroughly washed prior to leaving site each day.
- Soil arisings to be placed on tarpaulin, and arisings and open soils to be covered at the end of each day's work. Construction materials not intended for reuse to be placed separately to soil arisings.
- On completion of groundworks associated with the workshop, any soil arisings to be sampled, analysed and re-used or disposed of appropriately. Based on the dimensions of the proposed workshop, and the required footings, it is anticipated that a maximum of 5-10m^3 arisings will be excavated. A single representative sample of the soil arisings should be analysed to determine whether the soils are safe to be re-used on site or need to be disposed of offsite.

4.1.2 Polycyclic aromatic hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous contaminants in the environment. Anthropogenic sources of PAHs include the burning of fossil fuels, coal production, oil manufacturing, oil spills, wood preservation (creosote), tobacco smoke, exhaust fumes and various forms of cooking. Natural sources include volcanoes and forest fires. PAHs are solids with low volatility at room temperature, with the inhalation of vapour being considered a negligible pathway in the allotment land use[5] (discounting the consumption of homegrown produce and attached soils, it is considered that the allotment land use is the most appropriate when considering the proposed works and relevant exposure pathways).

As such, it is considered that the health and safety measures proposed above are appropriate to protect groundworkers during any groundworks where underlying soils are exposed.

4.2 End-user exposure mitigation measures

On completion of the works, all exposed soils will be covered with construction materials in the form of concrete or paving slabs. As such, the only relevant pathway is the inhalation of vapours and/or gas. It should be understood that the dry dock is used by prior appointment only in order to undertake maintenance on privately owned canal barges. Given the internal volume and open ventilation both ends of the main dry dock, and the irregular use by individuals, it is considered that the risk to end users from accumulated vapour/gas within this space is negligible.

The proposed workshop comprises an enclosed space with a footprint of approximately 20m^2, bounded on three sides by open space and on the fourth side by the dry dock. The floor slab will be constructed of reinforced concrete, and intermittent ventilation will be provided by doors and windows. This is schematically illustrated in Figure 6 below.

[5] *The LQM/CIEH S4ULs for human health risk assessment*. CIEH, 2015.

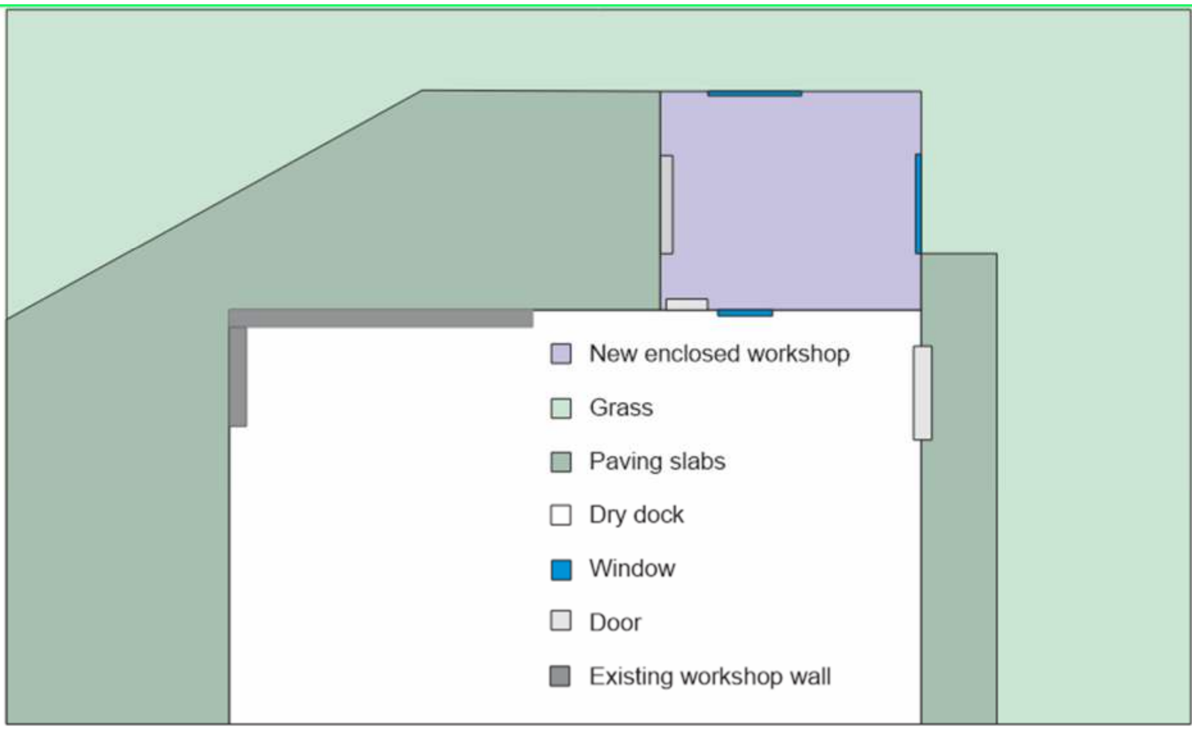

Figure 6: Schematic of proposed workshop and surroundings

The accumulation of carbon dioxide within the enclosed space could be identified using an alarm, however this is not ideal and does not make allowance for any hydrocarbon vapours. Although it is considered highly unlikely that any gas or vapour will migrate through the reinforced concrete floor, due to the uncertainties it is considered that a conservative mitigation measure would be the installation of basic protection measures in the form of a passive ventilation layer beneath the floor slab as is shown in Figure 7 below.

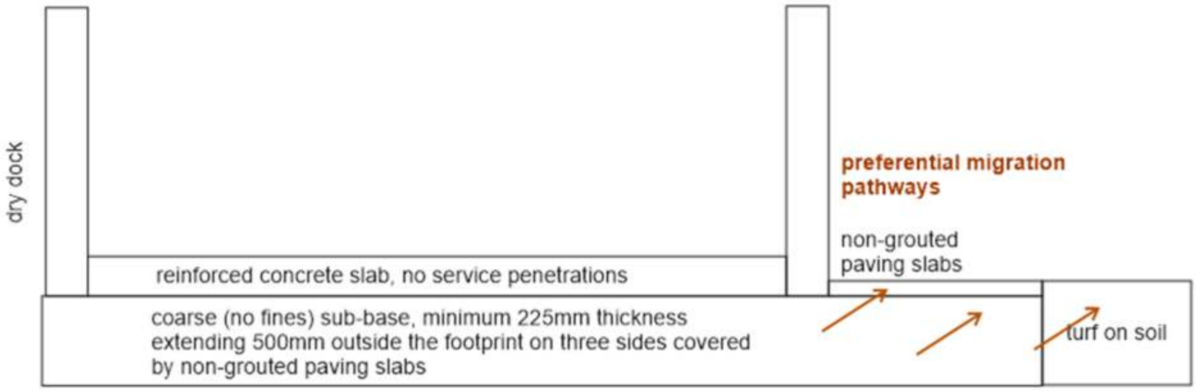

Figure 7: Schematic of passive ventilation layer (NTS)

Any carbon dioxide or hydrocarbon vapours present in the underlying soils will migrate via diffusive mechanisms (driven by concentration rather than pressure) along a concentration gradient. The extended sub-base will represent a preferential diffusive migration pathway to the external area, as opposed to forced migration through the concrete slab.

4.3 Watching Brief

Due to the uncertainties relating to the site, during all excavation works that expose underlying soils a watching brief should be undertaken. This will require an appropriate person/s identified in advance to the Local Planning Authority to inspect all exposed underlying soils in order to identify any unusual or unexpected soils that are encountered. The indicators may be visual or olfactory, and in the event that such conditions are identified the following steps should be taken:

1. Immediately stop excavation and cover identified unusual or unexpected soils with tarpaulin.
2. Contact the Environmental Health Officer (EHO) at the Local Authority.
3. Do not disturb the area again until a way forward has been agreed with the EHO.

4.4 Verification

Verification of the mitigation steps described above should be undertaken by appropriate person/s identified in advance to the Local Planning Authority. The scope of the information to be provided on completion of the works is as follows:

- Confirmation that appropriate dust control measures were used on exposed underlying soil and/or concrete breaking activities.
- Confirmation that appropriate protective clothing was worn while either working on exposed underlying soils or breaking concrete.
- Confirmation that all groundworkers removed protective clothing and washed exposed skin/hair before leaving site on each working day.
- Confirmation that any soil arisings from the workshop construction have been stored on and under tarpaulin separately to other arisings (photographic evidence).
- Confirmation of the final volume of soil arisings, analytical results from a representative sample identifying appropriate end-use or disposal, and, if applicable, paperwork confirming that the full volume has been disposed of appropriately.
- Confirmation that the passive ventilation layer detailed in section 4.2 has been implemented, with supporting documentation (photographic and purchase of no fines sub-base).
- If applicable, confirmation that the way forward agreed with the EHO has been implemented, with supporting documentation.

If the proposed works are to be undertaken in phases, then verification should be provided to the Local Planning Authority on completion of each phase.

Appendix A

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Appendix B

Continuous monitoring results

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Appendix C

VOC screening

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Appendix D

Laboratory analysis

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Appendix E

Drawings

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Appendix F

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