Our ref:CRS-100696
Your ref:

Peter Anderson

Sent via Email

David Parker
Historical Railways Estate
3rd Floor
37 Tanner Row
YORK
YO1 6WP

Direct Line: 0771 443 1547
3rd February 2020

Dear Mr Anderson

Freedom of Information Request – Queensbury Tunnel Correspondence

I am writing to advise you that we have completed our search for information that you requested on 4th January 2020. As your request was in three separate parts I have had to address each part in turn below.

Your Request - In relation to Queensbury Tunnel please provide me with all information pertinent to your consideration of the abandonment of tunnel earmarked for cycle route. Not limited to information from/to the contractor, Queensbury Tunnel Society, West Yorkshire Combined Authority and Bradford Council.

Our Response – The decision to permanently close the tunnel was taken by the Highways Agency in July 2014 following confirmation of a partial collapse. The decision was a matter delegated to Highways Agency. At that time there were no recognised plans to use the tunnel as part of a cycle route so no wider stakeholder involvement was undertaken. The decision was based upon a Feasibility Report undertaken by Jacobs in 2009. A copy of that report is attached.

Your Request - In relation to Queensbury Tunnel please provide me with all information about the contractor and contract pertinent to the costs involved in the undertaking, continuing, pausing or stopping the works. The payments made, penalty clauses and similar.

Our Response – Information held by Highways England in relation to the contract is attached.

Your Request – In relation to Queensbury Tunnel please provide me with all information pertinent to all approaches considered and rejected to end the abandonment.

Our Response – Information held by Highways England in relation to any approaches to ourselves to end the abandonment is attached.

If you are unhappy with the way we have handled your request you may ask for an internal review within 2 months of the date of this response for Freedom of Information requests and within 40 days for Environmental Information Regulations requests.

Our internal review process is available at:
https://www.gov.uk/government/organisations/highways-england/about/complaints-procedure

If you require a print copy, please phone the Information Line on 0300 123 5000; or e-mail info@highwaysengland.co.uk. You should contact me if you wish to complain.

If you are not content with the outcome of the internal review, you have the right to apply directly to the Information Commissioner for a decision. The Information Commissioner can be contacted at:

Information Commissioner's Office
Wycliffe House
Water Lane
Wilmslow
Cheshire
SK9 5AF

If you have any queries about this letter, please contact me. Please remember to quote reference number 100696 in any future communications.

Yours sincerely

David Parker
Historical Railways Estate
Email: dave.parker@highwaysengland.co.uk

BRB (Residuary) Ltd
Major Works Programme 2009

STRUCTURE HQU/3D (Queensbury Tunnel)
Queensbury, Halifax

FEASIBILITY STUDY OF FUTURE ASSET MANAGEMENT

October 2009

Jacobs
Northern House
Rougier Street
York
YO1 6HZ

JACOBS

Document control sheet BPP 04 F8

Client:	BRB (Residuary) Ltd		
Project:	HQU/3D (Queensbury) Major Works	Job No:	J24110-AG
Document Title:	Feasibility Study		

	Originator	Checked by	Reviewed by	Approved by
ORIGINAL	NAME **Chris Heap**	NAME **Geoff Medd**	NAME **Iain Turnbull**	NAME **Neil Kerry**
DATE **15/10/2009**	SIGNATURE [redacted]	SIGNATURE	SIGNATURE	SIGNATURE
Document Status : FOR ISSUE				

REVISION	NAME	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE
Document Status				

REVISION	NAME	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE	SIGNATURE
Document Status				

Jacobs Engineering U.K. Limited

This document has been prepared by a division, subsidiary or affiliate of *Jacobs Engineering U.K. Limited* ("Jacobs") in its professional capacity as consultants in accordance with the terms and conditions of Jacobs' contract with the commissioning party (the "Client"). Regard should be had to those terms and conditions when considering and/or placing any reliance on this document. No part of this document may be copied or reproduced by any means without prior written permission from Jacobs. If you have received this document in error, please destroy all copies in your possession or control and notify Jacobs.

Any advice, opinions, or recommendations within this document (a) should be read and relied upon only in the context of the document as a whole; (b) do not, in any way, purport to include any manner of legal advice or opinion; (c) are based upon the information made available to Jacobs at the date of this document and on current UK standards, codes, technology and construction practices as at the date of this document. It should be noted and it is expressly stated that no independent verification of any of the documents or information supplied to Jacobs has been made. No liability is accepted by Jacobs for any use of this document, other than for the purposes for which it was originally prepared and provided. Following final delivery of this document to the Client, Jacobs will have no further obligations or duty to advise the Client on any matters, including development affecting the information or advice provided in this document.

This document has been prepared for the exclusive use of the Client and unless otherwise agreed in writing by Jacobs, no other party may use, make use of or rely on the contents of this document. Should the Client wish to release this document to a third party, Jacobs may, at its discretion, agree to such release provided that (a) Jacobs' written agreement is obtained prior to such release; and (b) by release of the document to the third party, that third party does not acquire any rights, contractual or otherwise, whatsoever against Jacobs and Jacobs, accordingly, assume no duties, liabilities or obligations to that third party; and (c) Jacobs accepts no responsibility for any loss or damage incurred by the Client or for any conflict of Jacobs' interests arising out of the Client's release of this document to the third party.

JACOBS

Contents

1 Background

1.1 Location

Queensbury Tunnel, structure HQU 3D, is situated between Bradford and Halifax passing beneath the town of Queensbury.

The tunnel is aligned approximately north east to south west with the north portal (Queensbury Triangle) located at coordinates SE 103308 and the south portal (Holmfield) located at coordinates SE 087292.

The tunnel is 2502yrds (2287.8m) in length with a span of 26ft (7.93m) and is situated up to 115m below the surface.

1.2 Remit

BRB (Residuary) Ltd has commissioned Jacobs to undertake a feasibility study into the future asset management of Queensbury Tunnel, structure HQU 3D. The following is required:

1.2.1 Identify adjacent landowners using all available means

1.2.2 Establish variability of access, local authorities and landowners for all works to be carried out

1.2.3 Carry out site survey of the structure appropriate to the works proposed

1.2.4 Obtain record information including drawings, line plans, deeds and previous examination/assessment records

1.2.5 Produce estimates

1.2.6 Requirements for Site Investigations, Ecological Surveys and Environmental / planning issues and consents for each of the three options

1.2.7 A full review of the information contained within the BRB (Residuary) Ltd bridge file

1.3 Options to be considered

The client strategy and particular requirements are as follows:

1.3.1. Securing of access routes and “do nothing” option regarding the complete tunnel structure

1.3.2. Continue to examine and maintain the complete tunnel structure. This option should include the pumping away / removal of the water within the tunnel to allow for annual inspection or maintenance regimes to be fulfilled. The pump solution is to include both a temporary solution and also a permanent pump house option (costs, electricity, pipes, pump capacity etc to be included).

1.3.3. Partial infill of the tunnel portals and shafts to remove any remaining risk identified in remit item 1.3.1.

JACOBS

2 Methodology

2.1 Report Structure

The purpose of this feasibility study is to describe the following future maintenance options with regard to the structure HQU/3D Queensbury Tunnel.

This feasibility study is structured in the following manner:

- The existing condition of the BRB (Residuary) Ltd asset has been reviewed and summarised, accounting for historical repairs and changes in use. Existing risks under the current maintenance strategy are identified.

- As the asset is buried and subject varying ground conditions, the local geology has been reviewed and the results of relevant Mining, Quarrying and Industrial Processes presented. Existing risks under the current maintenance strategy are identified.

- Historically, flooding and excessive ground water ingress have been associated with the asset since its completion. The local hydrology has been reviewed and the results of relevant asset findings presented. Existing risks under the current maintenance strategy are identified.

- Future asset management options based upon the findings of the above sections have been reviewed and recommendations made. The following options have been appraised and compared for their residual risks and the relevant constraints identified for each:

    - Do nothing - Secure all immediate access points and acknowledge asset abandonment, identifying all residual risks

    - Continual Maintenance Regime - Safe entry and remedial works to prevent obstruction for ongoing maintenance

    - Partial infilling of all critical elements - Tunnel sections with low ground cover (including shafts).

- Based on the studies carried out and the appraisal of the options identified and compared, a conclusion and future asset management recommendation has been presented, highlighting the residual risks, costs and constraints associated with the strategy.

2.2 Previous Information

This document has reviewed previous studies produced by Jacobs, updating design principles where necessary in light of the developed knowledge of the structure obtained since the previous Hydrology report of 2005.

JACOBS

A desktop study of available historical, third party and maintenance records has been undertaken as part of the production of this feasibility report. Relevant findings were taken into consideration when assessing each maintenance option.

Reference No.	Document	Date
1	Queensbury Tunnel: Research Summary	08/2008
2	Jacobs UK Tunnel Flooding Assessment Report	04/2005
3	Carillion Visual Examination	03/2009
4	Carillion Detailed Examination	01/2009
5	Carillion Visual Examination	11/2005
6	Carillion Detailed Examination Shaft Reports	11/2006
7	Carillion Visual Examination	05/2004
8	Carillion Visual Examination	11/2005
9	Carillion Detailed Examination	03/2006
10	Carillion Visual Examination –	12/2006
11	Carillion Visual Examination	05/2007
12	Carillion Visual Examination	04/2008
13	First Engineering Visual Examination	05/2004
14	First Engineering Detailed Examination	06/2003
15	First Engineering Visual Examination	05/2006
16	Jarvis Detailed Examination	01/1999
17	Jarvis Visual Examination	04/1998
18	Jarvis Detailed Examination	03/1996
19	Infilling Negotiation Correspondence	2005
20	GB Geotechnical – 1991 Investigation of Tunnel Lining Grouting Tests	
21	BRB (Residuary) Ltd Bridge File	

Table 2-A Reference Documents

2.3 Site Survey

The following information covers remit item 1.2.3.

A site walkover survey was undertaken in August 2009 by Jacobs, with an agent of Balvac Ltd in attendance as part of early framework contractor involvement, to appraise the site prior to the production of this report.

2.4 Land Ownership

The following information covers remit items 1.2.1 and 1.2.2.

Due to the length of the structure and as the preferred option is yet to be decided by BRB (Residuary) Ltd, land ownership details have not been collected for the entire length of the structure at this stage. This is to be undertaken once a strategy has been finalised for the asset and lands affected by any works identified.

However, as a result of the ongoing land redevelopment taking place at Strines Cutting adjacent to the south portal (Holmfield) the landowner has previously been identified and contacted in regard to his/her intentions for the cutting.

2.4.1 Conveyance

Conveyance documents supplied to Jacobs by BRB (Residuary) Ltd were reviewed as part of this feasibility study. The following conditions were identified, which may impose restrictions upon future maintenance works:

No works are to take place within 50 yards of the southern portal. During the survey undertaken as part of this feasibility study the adjacent landowner has infilled Strines Cutting to the limits of these land boundaries.

2.5 Identifying Stakeholders

The following information covers remit item 1.2.2.

The route of the structure carries the tunnel directly below the town of Queensbury. Critical structural elements in relation to stakeholders are located as follows:

- Shafts identified as 3, 4, 5 & 6 are all located within close proximity to public properties, highways and amenities.
- The northern portal (Queensbury Triangle) is located on a rural hillside with no immediate land use.
- The southern portal (Holmfield) is located within close proximity to an industrial estate containing warehouses and cementitious works.
- The remnants of Strines Cutting are currently subject to ongoing land developments in the form of ground infilling and grading by the adjacent landowner. All that remains of the cutting is a trench approximately 50m long, 30m wide, 20m deep that is flooded with water.

2.5.1 Statutory Undertakers Plant

The following information covers remit item 1.2.2.

As the route of the structure carries the tunnel directly below the Town of Queensbury, it is assumed that a large amount Statutory Undertakers' Plant is present at surface level; details for these assets have not been collected for the entire length of the tunnel at this stage. This is to be undertaken once a strategy has been finalised for the asset and lands affected by any works identified.

2.5.2 Local Authority Enquiries

The following information covers remit item 1.2.6.

The City of Bradford Metropolitan Council planning authority governs the Queensbury region. Their contact details are:

Planning Services
City of Bradford Metropolitan District Council
3rd Floor Jacob's Well
Manchester Road
Bradford, BD1 5RW

In 2004 the planning authority carried out the 'The Queensbury Conservation Area Assessment' which contains a detailed analysis of the character of the conservation area and describes regions of special interest. Every five years, an appraisal of the assessment is carried out which considers authenticity, changes that have taken place, opportunities and threats to the Conservation Area. The appraisal also maps the key characteristics of the area and contains Management Proposals. Any changes that affect the designation of the Conservation Area will be reported to the relevant committee.

Queensbury Tunnel falls outside of the boundary of the Conservation Area and thus there should be no restriction upon maintenance works. Please refer to the Queensbury Conservation Area ground plan (dated February 2004) located within Appendix E.

2.6 Site Investigations/Environmental/Ecological Considerations

The following information covers remit item 1.2.6.

There is no record of any ecological surveys or site investigations being carried out to date. It is highly recommended that an ecological survey be undertaken in conjunction with any site investigation works under recommendations following this study.

Undertaking this work at an early stage will reduce any possible lead times imposed on applications and licences required for any proposed maintenance works if a protected species is found on site.

3 Existing Condition

3.1 General Construction Type

The following information covers remit item 1.2.7.

Queensbury Tunnel, structure HQU 3D, is situated between Bradford and Halifax passing beneath the town of Queensbury.

The tunnel is aligned approximately north east to south west with the north portal (Queensbury Triangle) located at coordinates SE 103308 and the south portal (Holmfield) located at coordinates SE 087292.

The tunnel is 2502yrds (2287.8m) in length with a span of 26ft (7.93m), height of 20ft (6.1m) and is situated up to 115m below the surface.

Location, alignment and named portals and cuttings describe the study area for this feasibility report. This also includes cover geology above the tunnel for its entire length.

3.2 Tunnel Construction/Condition

The following section summarises the general construction of the tunnel and its current condition.

Queensbury tunnel was constructed between 1877 and 1878 as part of the Halifax to Bradford line. The tunnel was bored on a falling gradient of 1 in 100, dropping towards the south portal (Holmfield) and bored by the Diamond Rock Boring Company. Water ingress was a great problem during construction of the tunnel, and continued to be a problem both during and after the operational life of the structure. Soon after the tunnel opened, significant defects were found in the sidewall lining.

The tunnel was lined with masonry sidewalls and brick arches. Historical drawings produced during shaft remedial works in 1935 note that the bored face and the extrados of the brick arches have a 1.3m 'void' comprising a packing layer of dry rubble and loose timbers filled between 0.45m thick brick pillars set at 1.37m centres.

This would suggest that the bored rock face is structurally self-supporting and that the brick arches and masonry side walls are an aesthetic finish, a drainage/debris catchment area and a structural support for the shaft eyes. However, this detail is only confirmed for the base of Shaft 3 and not the entire length of the tunnel extrados. Probing is recommended throughout the tunnel lining to confirm this condition.

The tunnel was closed to rail traffic in 1956, and the track was subsequently removed in 1960. Following closure, the tunnel was used by both Cambridge and Leeds Universities for Inhomogeneous Tidal Strain experiments on the development of wire strain gauges, to measure the effects of lunar and stellar gravity on the earth. As a result of the experiments, large pits remain within the invert, one of which still contains a large concrete block related to the strain gauge equipment. Around 1974 it was also used by Leeds University as a site for seismographs.

The present condition of the tunnel lining is recorded in the Examination Report by Carillion dated 09/01/2009 as being fair to poor; the report noted large sections of brickwork loss. These defects are being exacerbated by continual moisture ingress, perishing mortar and freeze thaw attack. Sections of brickwork appear to be failing in large areas and falling in sheets with other more localised defects exposing the bored rock face.

The large body of water held within Strines cutting at the south portal has flooded the interior of the tunnel. As a result of the further infilling works to the cutting by the adjacent landowner, which have reduced the extent of the cutting catchment area, the water has risen to crown level with in the tunnel; this extends for 150 m and then reduces in clearance for a distance due to the falling invert gradient.

Please refer to Section 5.2 for further details.

3.3 Shaft Construction/Condition

The following section outlines the general construction of the shafts and their current condition.

The number of shafts that exist at Queensbury tunnel has often been called into question during the maintenance history of the structure. Anecdotal evidence has often concluded that a number of the shafts were lined over within the tunnel. This is shown to be incorrect: by reviewing historical maintenance records it has been confirmed that 8 No. shafts were proposed to be advanced from surface level to the crown of the tunnel.

The following summarises the outcomes of each original shaft proposal:

- The shafts identified as 1,2,3,4 and 8 were completed and all five are visible from inside the structure.

- The shafts identified as 5 and 6 were undertaken, but did not reach the depth of the tunnel and are thought either to have been provided to allow an element of de-watering above the bore, or to have been stopped short due to problems with considerable water ingress, which was reported throughout the works. At a later date, agreement was reached with Messrs. Foster and Son of Black Dyke Mills to extract the water from these two shafts for industrial purposes.

- Shaft 7 was proposed but never constructed; records of the shaft still exist.

For the purpose of this report all eight shafts will be accounted for and identified in line with the historical maintenance records, identified by numbers 1 through 8 running from the south portal to the north portal. See photo 10 for a typical shaft eye.

Each shaft is summarised below:

3.3.1 Shaft 1

- 35 m deep (approx), 2.8 m dia, 112 m from south portal
- Advanced full depth, capped with concrete

- Located a short distance from School Cote Brow side road
- Eye of shaft flooded, reported high levels of Carbon Dioxide within shaft void
- Condition – Fair / high levels of moisture ingress

3.3.2 Shaft 2

- 99 m deep (approx), 2.8 m dia, 253 m from Shaft 1
- Advanced full depth, capped with concrete
- Located on the track from Roper Lane towards Strines
- Condition – Fair / high levels of moisture ingress

3.3.3 Shaft 3

- 115 m deep (approx), 2.8 m dia, 314 m from Shaft 2
- Advanced full depth, capped with concrete
- Located to the right of Roundhill Chapel and Moor Close Lane
- Condition – Fair / high levels of moisture ingress

3.3.4 Shaft 4

- 110 m deep (approx), 3.6 m dia, 387 m from Shaft 3
- Advanced full depth, capped with concrete
- Located in a hollow immediately behind Ford Hill
- Condition – Fair / high levels of moisture ingress

3.3.5 Shaft 5

- 81 m deep (approx), 3.6 m dia, distance from Shaft 4 unknown
- Not advanced to full depth, not filled (water present), capped with masonry
- Located in a field originally belonging to a Mr Samuel Pollard, the submersible pump and steel piping for water extraction are thought to still reside within the shaft.
- Condition – Unknown

3.3.6 Shaft 6

- 41m deep (approx), Unknown dia, 'Sharket Shaft' distance from Shaft 5 unknown
- Not advanced to full depth, unlikely to be filled, unknown capping type
- Located within the garden of a residential property situated within a field originally belonging to a Mr Joseph Waugh
- Drawings illustrate a horizontal adit approximately 28 m down the shaft exiting into the hill side. It is possible that this is where the water was extracted.
- Condition – Unknown

3.3.7 Shaft 7

Historically recorded and proposed to be located in a quarry belonging to a Mr John Dearden. The shaft was never constructed.

3.3.8 Shaft 8

- 38 m deep (approx), 2.8 m dia, 1096 m from Shaft 4

- Advanced full depth, capped with concrete.
- Located in a field at Hole Bottom originally belonging to a Mr John Foster
- Condition – Fair / high levels of moisture ingress

3.3.9 Shaft Maintenance Works

Historical maintenance records also note that demolition work has been carried out to 5No. shaft headwalls resulting in piles of debris below the shaft eyes. The arisings of the ventilation 'pepper pot' headwall demolition works were allowed to plummet over 100m down the shafts.

The shafts at were subsequently capped of at surface level with concrete.

In 1935, Shaft 3 was relined and received reinforced concrete bracing. See Photo 12.

See historical image 3 for cross section locations of shafts, excluding Shaft 7.

3.4 Portal Construction/Condition

The following section summarises the general construction of the portals and their current condition.

3.4.1 North Portal (Queensbury Triangle)

The north portal is a monolithic structure comprised entirely of masonry which currently exists in fair to good condition. See Photos 1 and 17.

The portal entrance is currently infilled with a masonry wall, incorporating an access opening and gaps at the apex for ventilation and possibly bat access. The steel gates are subject to constant vandalism from trespassers and tunnel enthusiasts wishing to gain entry into a clearly marked dangerous structure.

Ground water is discharging from the portal headwalls to the cutting and draining back into the tunnel.

3.4.2 South Portal (Holmfield)

The south portal is a monolithic structure comprised entirely of masonry and is currently totally submerged. See Photo 2.

The condition of this portal is unknown; however, it should be noted that the masonry and mortar are possibly subject to deterioration due to freeze thaw attack within the wet and dry zones

Refer to Section 5 for further flooding details.

3.5 Cutting Construction/Condition

The following section summarises the general construction of the cuttings and their current condition.

JACOBS

3.5.1 North Cutting (Queensbury Triangle)

The north cutting is an earth embankment arrangement lined with trees and has grass underfoot with occasional boggy patches closer to the north portal. The cutting opens to level ground where the now abandoned railway triangle once stood. The Cutting is accessible via a gate from a made cycle path. See Photo 1 and 20.

3.5.2 South Cutting (Strines)

The south cutting is currently infilled to 50 m (approx) from the south portal face with a combination of inert site waste and fill material by the adjacent landowner as part of development works.

The remainder of the cutting has now become a lagoon due to the low invert level forming a catchment area for ground water draining from the tunnel and percolating from the cutting walls, which comprise 20m (approx) high vertical rock faces of water bearing strata. See Photo 2 and 21.

What remains of the cutting is accessible via the route to the adjacent cement works and crossing the sections of now infilled cutting.

3.6 Asset Risks (Current Condition)

3.6.1 Tunnel Risks

As mentioned in Section 3.2, it is assumed that the tunnel's masonry and brickwork lining do not serve to retain the structurally self-supporting bored stratum. However, historical records depict the sidewalls as acting in a supporting structural role to the shaft eyes.

The long sidewall sections between each shaft location are suspected to act as an aesthetic finish and as a drainage/debris catchment area to prevent loose material falling from the rock face and conflicting with locomotives during the tunnel's active use.

In the asset's current un-maintained condition the ongoing ground water ingress, which discharges down the shaft linings and at localised points along the sidewalls, may result in a masonry and brickwork lining collapse. This would most likely occur in the brickwork haunches of the lining adjacent to the shaft eye, where ground water saturation and scour to the mortar are at their peak.

The loss of structural support at the crown and shaft eye intersections would be followed by the collapse of the shaft lining. Please see Section 3.6.3 for further details on shaft failure modes.

3.6.2 Shaft Risks

The shafts in their current condition are subject to continual ground water ingress which cascades down the brickwork and masonry linings, discharging at the shaft eyes onto the side walls and tunnel invert.

As mentioned in Section 3.6.1, failure of the supporting sidewall structures beneath the shaft eyes has a high potential for a global collapse of a shaft lining. However, localised failures of the lining at any point along the height of the shaft as a result of deterioration from ground water ingress could also result in a local failure within the shaft lining, eventually leading to a total collapse.

The shaft sections subjected to the highest level of moisture ingress, lack of firm supporting strata, and the highest risk of being a failure mechanism for localised collapse are the upper regions of lining within close proximity to surface level. This does not take into account the absence of routine maintenance and possible disruptive works at surface level, which could both be considered to contribute to potential lining failure.

Typically, the surrounding stratum in these regions of the shafts comprises gravel and is subject to ground water draining towards the shaft as a catchment area. In regard to disturbance from activities at ground level, Shafts 3, 4, 5 and 6 are all within urban developments.

Shaft 3 was subject to relining maintenance works as mentioned in Section 3.3.9; these works included the installation of the reinforced concrete bracing tied into the existing bored face. While these bracings help to support the structure, the age of construction would indicate that the concrete would be of questionable quality, and an approximate whole life of a further 10 to 15 years is predicated before these elements become structurally unsupportive as a result of reinforcement corrosion and lack of maintenance.

3.6.3 Surface Settlement due to Shaft Failure

A shaft lining failure is likely to produce a settlement mode at surface level; this will result in cover material migrating into the shaft void causing a large depression to form, thus destabilising the foundations of adjacent structures and buildings leading to possible collapse and loss of human life.

This form of settlement would be sudden with little warning and continue to increase in plan, radiating from the shaft as a downward cone effect (refer to image J24110/AG/FEAS/0014 within appendix B) until either one or a combination of the following actions occur:

- The lining fails to a point were the brickwork condition improves and the lining can support the surround strata
- The characteristics of surrounding strata become self-supporting
- The cover material migrating into the shaft void chokes

The structure would be highly unstable whichever settlement mode occurred.

3.6.4 Risks to Stakeholders due to Shaft Failure

As mentioned in Section 2.5, the shafts identified as 3, 4, 5 & 6 are all located within close proximity to public properties, highways and amenities.

The following tables, in conjunction with location plans J24110/AG/FEAS/0002 through to 0008 within appendix A, identify stakeholder assets at risk from potential shaft failure and subsequent depressions to surface level.

JACOBS

Shaft Number	Stakeholder Assets at Risk
1	The Shaft is located within steep grass land, currently unoccupied
	Large Pre-Cast Concrete Works adjacent to the Shaft
	Overhead electrical pylons are located along the hillside
	Buried Statutory Undertakers Plant is unlikely to be present

Table 3-A Shaft 1 Stakeholder Assets at Risk

Shaft Number	Stakeholder Assets at Risk
2	The Shaft located within grass and agricultural land
	Round Hill Lane passes immediately adjacent to the shaft
	A single telecommunication mast is located within the area
	Buried Statutory Undertakers Plant is likely to be present
	Over head electrical pylons are located along the hillside
	A small allotment area adjacent to the shaft capping

Table 3-B Shaft 2 Stakeholder Assets at Risk

Shaft Number	Stakeholder Assets at Risk
3	Shaft located within residential garden.
	Highbury Close road passes immediately adjacent to the shaft
	2 immediate residential properties adjacent to the shaft.
	5 surrounding residential properties with associated garages are located within the potential failure zone
	A large recreational field borders the garden of the shafts location.
	Buried Statutory Undertakers Plant is most likely to be present

Table 3-C Shaft 3 Stakeholder Assets at Risk

Shaft Number	Stakeholder Assets at Risk
4	Shaft located within residential garden.
	Moor Close road is adjacent to the shaft.
	4 residential properties immediately adjacent to the shaft.
	4 surrounding residential properties with associated garages are located within the potential failure zone
	Buried Statutory Undertakers Plant is most likely to be present

Table 3-D Shaft 4 Stakeholder Assets at Risk

Shaft Number	Stakeholder Assets at Risk
5	Shaft located within grounds of an electrical substation
	Ada Road passes immediately adjacent to the shaft
	Buried Statutory Undertakers Plant is most likely to be present
	1 residential property immediately adjacent to the shaft.
	4 surrounding residential properties with associated garages are located within the potential failure zone

JACOBS

Table 3-E ***Shaft 5 Stakeholder Assets at Risk***

Shaft Number	Stakeholder Assets at Risk
6	Thornton Road passes immediately adjacent to the shaft
	2 residential properties immediately adjacent to the shaft.
	3 surrounding residential properties with associated garages are located within the potential failure zone
	Buried Statutory Undertakers Plant is most likely to be present

Table 3-F ***Shaft 6 Stakeholder Assets at Risk***

Shaft Number	Stakeholder Assets at Risk
8	The Shaft is located within steep grass land, currently unoccupied
	Buried Statutory Undertakers Plant is unlikely to be present

Table 3-G ***Shaft 8 Stakeholder Assets at Risk***

4 Geology

4.1 General Geology

The following section summarises the general geology of the tunnel.

According to the British Geological Survey 1:50,000 scale Solid and Drift Sheet 77 (Huddersfield), Queensbury Tunnel passes through the Lower Coal Measures (Westphalian A Group). This formation comprises a sequence of interbedded strata of the Elland Flags and various coal seams.

The Holmfield cutting is hewn from Rough Rock Flags (Millstone Grit Series).

4.1.1 Surface Settlement due to Geological Failure

Records indicate that the condition of the bored face has remained intact for over the asset's 120 years maintenance life. It is suspected that the masonry and brick tunnel linings offer no structural support to the bored face.

The greatest risk of a tunnel collapse would be a result of the following changes to the existing geology:

- Changes in the Stress Regime caused by either a catastrophic event, such as an earthquake, or the collapse of mine workings in close proximity to the structure
- Changes in the ground water levels and water flow

The settlement assessment suggests that the tunnel sections with less than 40m of surface cover would be subject to collapse with deformation propagating to the surface. The following tunnel elements have less than the 40m of surface cover:

- Shaft 1, located 112m from the southern portal, sits at a depth of 35m from surface level.
- Shaft 8, located 128m from the northern portal, sits at a depth of 38m from surface level.
- Approximately 150m of the tunnel lining from both the northern and southern portals

If a localised failure of the cover material were to take place, with limited structural resistance offered by the lining, the collapse of the tunnel would be expected within the immediate vicinity of low surface cover. This would become a catalyst for further collapse along the path of the tunnel.

However, collapse is not likely to produce a surface deformation or crown hole due to the likelihood of the bedding planes bridging the tunnel void. The insitu ground characteristics have a 'massive' particle size and irregular shape. In the event of a collapse, this would result in a non-uniformly filled void due to the 'bulking factor' of the collapsing material. This would potentially cause voiding beneath the bridging plane and above the area of collapse stratum.

These areas of low surface cover have been calculated using the principles and guidance given by the National Coal Board in the "Subsidence Engineer's Handbook". Although the Handbook was prepared in order to estimate the damage to structures near mined areas, the principles are applicable to all kinds of excavations in rock.

The tunnel is considered to act in the same way as a seam excavated by long wall working. It is also assumed, conservatively, that no support is provided to the rock, i.e. the present support of the tunnel lining does not play any structural role.

Any surface settlement above the sections of tunnel identified as being below 40m of cover as a result of a collapse would have a limited effect on surface activity as the land above is predominantly grassland.

4.2 Mining and Quarrying

The following section summarises the mining and quarrying activities in relation to the location of the tunnel.

The area of Queensbury has been subject to extensive near-surface and deep mining activity in the past. Moreover, the Mining Report supplied by The Coal Authority states that for the Queensbury Portal section of the tunnel, "...the property (tunnel) is within the likely zone of influence on the surface from workings in two seams of coal at 40m to 100m depth, the last date of working being 1903."

It is also noted that other seams have been worked in this area at some time in the past. There are several mine entries, shafts and adits in the Queensbury Portal area.

Within the mid section of the tunnel, directly beneath the town of Queensbury itself, the Mining Report states that the tunnel is within the likely zone of influence from two seams from 100m to 150m deep. The last date of working was 1931.

The Holmfield Portal section is within the likely zone of influence of one seam of coal from shallow to 50m depth, last worked in 1941. There are several shafts and adits within close proximity to the tunnel at this location.

There is a strong likelihood that coal seams, shafts and adits are located within close proximity to the tunnel. Further information has been obtained from Mining Engineers Report to the Chief Engineer, Great Northern Railway, which reports on:

"...the Halifax Soft seam which lies at a depth of only 20yds from rail level", and "...the Halifax Hard seam which is worked adjacent to the tunnel."

It also refers to the fireclay seams: "...the headings which have been put over and above the tunnel have not yet been filled up."

No reference has been obtained as to the final condition of these workings; however, as they are below the ground water level it can be considered that those at tunnel level may be flooded.

4.3 Industrial Processes

The following section summarises the industrial processes in relation to the location of the tunnel.

At the Holmfield Portal, one seam of fireclay at shallow depth was worked until 1946. The works for this activity were situated adjacent to Holmfield cutting and now site a pre-cast concrete factory.

The shafts identified as 5 and 6 do not reach the depth of the tunnel and are thought to have been provided either to allow an element of de-watering above the bore during construction, or to have been stopped short due to problems with considerable water ingress, which was reported throughout the works.

At a later date, agreement was reached with Messrs. Foster and Son of Black Dyke Mills to extract the water from these two shafts for industrial purposes. The submersible pump and steel piping for water extraction are thought still to reside within the shaft. However, it is presumed that the agreed ground water extraction is no longer undertaken as the inspection reports indicate minimal activity.

JACOBS

5 Hydrology

The following section summarises the local Hydrology in relation to the location of the tunnel.

The April 2005 Tunnel Flooding Assessment Report produced by Jacobs UK on behalf of BRB (Residuary) Ltd is located within appendix D

5.1 North Portal

A number of springs have been recorded above the level of the Queensbury (northern) portal which are in the main picked up by two watercourses which pass the portal entrance and enter a brick culvert. Previous surveys have recorded significant flows in both these watercourses.

The brick culvert flows to the north east, against the topographic slope, across the site of the old station area to discharge to Hole Bottom Beck. As the topographic fall between the old station site and the portal is generally towards the tunnel portal, this brick culvert has an important role to play in preventing significant quantities of water entering the tunnel.

Previous studies and recorded observations note that water was entering the tunnel by virtue of a significant flow down the north west abutment slope adjacent to the portal. This water is thought to emanate either from the watercourse above or a spring. The emanating water is ponding at the tunnel entrance to a depth of approximately 150mm and flowing into the tunnel.

5.2 Southern Portal

The Holmfield (southern) portal is flooded to a depth of approximately 3m above the portal crown level. At this location the tunnel opens into a rock cutting approximately 20m deep. Previous studies record the invert level of Strines cutting continuing to fall away from the portal.

Approximately 50m downstream of the tunnel portal, the adjacent landowner has infilled Strines cutting with large quantities of inert site clearance and fill material.

This material appears to have low permeability, as the backfilling of the cutting has resulted in the stored ground water within the cutting void encroaching further within the confines of the tunnel and caused the external water level to rise higher up the vertical rock faces of the cutting.

Previous studies suggest the flood water collecting at the southern end of the tunnel due to infilling the Strines Cutting could be emanating from various sources, including the northern portal and the tunnel itself.

Some of these water sources could be removed or diverted. However, some cannot and as a consequence water will continue to collect at this location in the future.

5.3 Hydrological Risks

The flooding in Shaft 1 has no record of causing adverse effects or exacerbating the deterioration of the structure, but it is causing a polluted atmosphere, and preventing visual examination of the structure.

The effects of draw down rate upon the tunnel lining should be considered if future removal of the flood water is required.

The draw down rate should be such that the pore water pressures behind the lining have time to dissipate without causing damage to the lining.

Prior to any works to be carried out it is recommended that an Ecological survey of Holmfield cutting is carried out. This should include water testing to determine levels of contaminants in the water, so that authorisation to discharge the water from the cutting can be sought from the Environmental Agency.

6 Option 1: Do Nothing / Seal the Structure

6.1 Sealing of the Access

A particular requirement of this feasibility study looking into possible future asset management strategies is to review and make recommendations on the securing of all access points into the asset and taking a "do nothing" option approach regarding the complete tunnel structure. Remit item 1.3.1.

6.2 Tunnel

The following section summarises the works required to seal the tunnel access permanently.

6.2.1 Portal Works

To permanently seal the tunnel would require major works to the openings, as the portals are the main point of access into the asset. This could potentially be carried out as one, or a combination, of the following:

- Construction of robust portal walls tied into the linings and inverts
- Partial mass infilling of the tunnel's interior to block the portals using an structural aggregate or cementitious fill material
- Partial mass infilling of the cuttings within the boundaries of BRB (Residuary) Ltd's right to develop with quarry waste or inert construction waste

Please see sketch J24110/AG/FEAS/0012 within Appendix B.

The above works are relatively straightforward for the northern portal. However as stated in Section 5, the southern portal is currently submerged.

Access sealing works to the southern portal could potentially be carried out as one, or a combination, of the following:

- Consider the flooded section infilled due to the water preventing access and install security fencing around the cutting in conjunction with landowner.
- Extract the water, construct a monolithic water retaining structure and back fill the cutting

6.2.2 Access to North Portal

Access to the northern portal can be obtained directly by the use of a well maintained access road leading to a bridleway. The bridleway comprises asphalt paths with timber post and wire edge fencing, locked access gates into adjacent fields, including the grass land containing the northern portal.

Use of this access would require negotiations with landowners and the bridleway maintainers, who may request a restriction on vehicle size, time of working or segregation of public path users. At worst, the reinstatement of any damaged surfacing or features maybe enforced as a condition of use.

6.2.3 Access to South Portal

Access to the southern portal is restricted, with no direct route to the portal face. Land redevelopments in the form of mass back-filling to Strines cutting have resulted in a precipitous terrain, preventing direct access to the portal from the south.

Access to the north west side of the portal is restricted by the presence of Strines Beck culvert.

Access to the south east side of the portal is restricted by the topography and the precast concrete works.

Descent of the Strines hillside to access the portal from above is also restricted by the steep topography, which would be wholly unsuitable for the construction plan and volume of material required.

6.3 Sealing of Shafts

The following section summarises the works required to seal the shaft access points permanently.

6.3.1 Shaft Works

To permanently seal the tunnel would require major works to the shaft openings. This could potentially be carried out as one of the following:

- Carry out remedial works to the existing concrete caps and seal the manhole entrances

- Construction of a robust reinforced concrete buried cover slabs encapsulating the shaft linings and felt exposed to deter interference.

The above works are relative straightforward to shafts 1, 2, 3, 4 and 8. However, as stated in Sections 3.3.5 and 3.3.6, shafts 5 and 6 are not capped in a similar construction to the remaining shafts.

- Shaft 5 is recorded as being capped in an unconfirmed masonry arrangement

- Shaft 6 is recorded as capping construction unknown and buried within the garden of a residential property.

Works to the capping of Shafts 5 and 6 would require a site investigation into their construction and general arrangement.

6.3.2 Access to Shafts

Access to Shaft 1 is restricted, with no direct route to the capping. Land redevelopments in the form of mass back-filling to Strines Cutting have resulted in a precipitous terrain preventing direct access from the south. The north west side of the portal is restricted because of the presence of Strines Beck culvert. The south east side of the portal is restricted by the topography and the precast concrete works. Descending the Strines hillside to access the portal from above is restricted by the steep topography, which would be wholly unsuitable for construction plan and the volume of material required.

Access to Shafts 2, 3, and 4 is feasible, as they are located within close proximity to public properties, highways and amenities. Land access negotiations and review of rights reserved within the conveyance documents would be required were applicable.

Access to Shafts 5 and 6 would require a site investigation into their construction, general arrangement and to confirm their locations if any proposed works are to be undertaken.

Access to Shaft 8, as with Shaft 1, is restricted with no direct route to the capping. However, descending Station Road hillside to access the capping from above may be possible as the topography appears to be less abrupt.

6.4 Estimated Costs

The following section summarises the works required to seal the tunnel access permanently and abandon the structure.

Capital Construction	Cost
Northern Portal – Structural Infill Wall	£50k
Northern Portal – Internal tunnel Infilling (aggregate)	£150k
Northern Portal – Internal tunnel Infilling (cementitious)	£200k
Northern Portal – Cutting Infilling	£100k
Southern Portal – Secure Cutting & Abandon Portal	£35k
Southern Portal – Water Extraction & Dam Wall	£500k
Shafts 1,2,3,4 & 8 – Remedial Works & sealing	£10k (Each)
Shafts 1,2,3,4 & 8 – Reinforced Concrete Slab	£25k (Each)
Shafts 5 & 6 – Site Investigations	£10k
Shafts 5 & 6 – Remedial Works & sealing	£15k (Each)
Shafts 5 & 6 – Reinforced Concrete Slab	£30 (Each)

Table 6-A Option 1 Cost Estimates

6.5 Residual Risks following Asset Abandonment

The following residual risks would remain in a scenario where the asset is sealed and abandoned in its current condition.

6.5.1 Tunnel Linings

If the asset were to be abandoned and sealed in an un-maintained condition, the ongoing ground water ingress, which discharges down the shaft linings and at localised points along the sidewalls, may result in a masonry and brickwork lining collapse.

This would most likely occur in the brickwork haunches of the lining adjacent to the shaft eye where ground water saturation and scour to the mortar are at their peak.

6.5.2 Shaft Linings

Failure of the supporting sidewall structures beneath the shaft eyes has a high potential for a global collapse of a shaft lining. However, localised failure of the lining at any point along the height of the shaft as a result of deterioration from ground water ingress could also result in a sectional failure within the shaft lining, leading to a total collapse.

The shaft sections subjected to the highest level of moisture ingress, lack of firm supporting strata, and the highest risk of being a failure mechanism for localised collapse are the upper regions of lining within close proximity to surface level.

6.5.3 Tunnel Collapse

The tunnel sections with less than 40m of surface cover would be subject to collapse with potential settlement propagating to the surface (see section 4). The following tunnel elements have less than the 40m of surface cover:

- Shaft 1, located 112m from the southern portal, has a depth of 35m from surface level.
- Shaft 8, located 128m from the northern portal, has a depth of 38m from surface level.
- Approximately 150m of the tunnel lining from both the northern and southern portals

6.6 Recommendations

As identified in the BRB (Residuary) Ltd 'Tunnel Management Strategy' desktop study, Queensbury Tunnel received a high score of 127 out of a possible 161, ranking the asset as high risk.

As summarised in Section 3.6, owing to the potential risk of a shaft lining failure within close proximity to residential properties and developed areas, the option to abandon/seal the structure in its current condition is not recommended due to the high residual risk to BRB (Residuary) Ltd.

7 Option 2: Continual Maintenance Regime

7.1 Routine Maintenance

A particular requirement of this feasibility study looking into possible future asset management strategies is to review and make recommendations on the continual examination and maintenance of the complete tunnel structure. (Remit item 1.3.2)

This option includes the pumping away/removal of the water within the tunnel to allow for annual inspection or maintenance regimes to be fulfilled. The pumping solutions include both a temporary solution and also a permanent pump house option (costs, electricity, pipes, and pump capacity included).

7.2 Maintenance Regime

The ongoing requirements of a continual maintenance regime are outlined as follows:

- Routine Visual and Detailed Examinations
- Routine Maintenance/Remedial Works
- Minor Works
- Major Works
- Assessments
- Monitoring
- Site Investigations
- Asset Administration
- Duty of Care/Legal Responsibility
- Conveyance Responsibility

7.3 Maintenance Philosophy

At present, Queensbury tunnel is deemed a redundant and hazardous structure; it no longer serves a current purpose. Although being a marvel of engineering in the era it was constructed, and though significantly over engineered, it is standing well beyond its anticipated design life.

Considering short term maintenance, continual remedial work of the structure not only allows for the repairs to known defects, but will also decrease the hazards within the tunnel's environment to a satisfactory level, lowering the risk sufficiently to allow safe man entry, permitting further maintenance and routine examinations. Carrying out the required visual and detailed examinations will identify early warning indicators of potential structural failure within a critical element, leading to works that may prevent a collapse of the lining under the eye of a shaft for example.

However, as noted in earlier sections, the majority of the lining is suspected to be non-structural in regard to the bored face. Thus far, the historical records indicate the lining to be supporting the shaft eyes; any proposals to allow the lining to fail and disregard the shaft intersections could lead to potential collapse in the tunnel's current arrangement.

7.3.1 Maintenance Works

The type of repairs required to maintain Queensbury Tunnel will involve onerous traditional masonry and brickwork repair schemes. These works will be very similar to recent repairs of the same nature on other BRB (Residuary) Ltd assets, which have the same characteristics as Queensbury tunnel in length and construction type. As found on these previous schemes, the linings of old standing tunnels are quite fragile and intrusive repair works often result in new localised defects being created, further along a brickwork lining section for example. This results in a costly chasing exercise until the overall condition is deemed adequate.

A spray applied concrete repair becomes more cost effective the larger the repair area required, it also has the advantage of being applied remotely using robotic plant. It is recommended that if this option is chosen, a spray applied concrete repair be seriously considered.

7.4 Maintenance Access

At the present time, the asset is deemed an unsafe structure because of the "confined space" nature of the tunnel's environment, along with multiple unstable sections of masonry lining within the haunch sections of the side wall. Underfoot conditions are less than desirable due to ineffective drainage and the flooding of the southern portal, which has virtually submerged 150m of tunnel void and caused a further 50m to 100m of flooding at sidewall/invert depth.

In order to carry out the rectification works to the side wall defects currently posing a hazard to work force entry into the tunnel, safe access must be gained from the north portal. Remedial works will be required to improve the gated access point within the existing infill wall, and it is probable that enlargement will be necessary. Between the flooding of the southern portal and the capping of the shafts, ventilation and air circulation is negligible.

Removal and reinstatement of the concrete caps will be required, as access to the shafts will be difficult when undertaking examinations or maintenance works to the lining.

7.4.1 Confined Spaces

At the time of producing this feasibility report, all BRB (Residuary) Ltd tunnels without exception are classified as confined spaces.

The Queensbury Tunnel is over two thousand metres in length (included the flooded sections) and up to 115 m below surface level, currently with a single point of access. A confined space is defined by the Health & Safety Executive as:

"...a place which is substantially enclosed (though not always entirely), and where serious injury can occur from hazardous substances or conditions within the space or nearby (e.g. lack of oxygen)..."

In order to undertake works within a confined spaces safe system of work allowing for safe man entry into the structure with the intention of performing the continual maintenance regime tasks listed in Section 7.2, would initially require enabling activities to ensure that underfoot conditions along the tunnel invert are safe, adequate lighting is provided, a 'gas alarm' rescue arrangement is prepared and that