SCHEDULED MONUMENT CONSENT STATEMENT

Repair works

Knightswood Viaduct, Glasgow

Contents

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1. Introduction

Photo 1 – Anniesland Portal Entrance



Knightswood Tunnel

1.1. This Statement has been prepared by Network Rail in support of an application for Scheduled Monument Consent (SMC) for works of brickwork repair, to treat areas of water ingress and to install associated drainage at Knightswood Tunnel. The tunnel has suffered from water ingression and several attempts have been made to remediate the issue such as grouting the tunnel walls and waterproofing trials with hydrophobic foam. This application represents the current method of resolving these issues.

1.2. The Knightswood Tunnel runs under the Glasgow, Dumbarton and Helensburgh Railway, the Switchback Road and the Forth and Clyde Canal for approximately 280m.

1.3. The tunnel itself has no designated status however the Forth and Clyde Canal is a Scheduled Monument (SM) Netherton Farm - Cleveden Road, Reference: SM6774

1.4. The Scheduled monument comprises that length of inland waterway forming part of the Forth and Clyde Canal falling across the boundaries of the City of Glasgow District and East Dunbartonshire. The monument includes the entire length in water together with the banks on either side and includes the towing path running along one side. In addition, the monument includes the following canal structures:

- Lock 27;

- Knightswood Railway Tunnel Aqueduct;
- Lock 26;
- Stobcross Railway Tunnel Aqueduct;

1.5. It is the Knightswood Railway Tunnel Aqueduct which concerns this application for Scheduled Monument Consent. This statement, along with the accompanying drawings and documents set out the proposals and the justification for granting consent.

2. Proposed works

Repair of Observable Defects

2.1. This Scheduled Monument consent application is supported by the document called the Form 001 Approval in Principle from July 2015, this is contained at appendix 1. This document contains details of the proposed works and annexes the defects reports which specifically describe the issues that have been identified and the document contains proposed fixes.

2.2. These works are:

- Install a water management system
- Repairs to spalled and missing brickwork throughout
- Cleaning vegetation form the western portal headwall and Anniesland wingwall
- Remove protruding steel drill bit and repair crown

3. Proposed Consent

3.1. The works which are subject of this application require Scheduled Monument Consent only concern the works to the Knightswood Railway Tunnel Aqueduct.

3.2. The works to the tunnel are on Network Rail's operational land and will be permitted development under part 11 of the Town and Country Planning (General Permitted Development) (Scotland) Order 1992 (as amended) (GPDO). We will write separately to the Local Planning Authorities to confirm this position.

3.3. Permitted development rights conferred under part 11 are exempt from EIA regulations.

3.4. Temporary compounds will be put in place to facilitate the works; this will be with the agreement of land owners and will not impact upon the scheduled monument. This is permitted development under class 14 of the above GPDO.

3.5. Permitted development rights conferred under class 14 can be impacted by EIA regulations. This work is not a type of development found in either schedules 1 or 2 of the above EIA regulations and as such no screening is required.

4. Consultation

4.1. Network Rail contacted Simon Stronach, Senior Heritage Management Officer about the proposal on the 14th of January 2016. The response reference: 201506546 detailed that consent was necessary and described the additional supporting information that was required.

5. Policy Support

5.1. Although the works are permitted development the assessment has been undertaken with reference to relevant legislation, National Planning Policy and Guidance, and Regional and Local Planning Policy relating to Cultural Heritage.

Legislation

5.2. Scheduled Monuments are protected by statute. Legislation regarding Scheduled Monuments is contained within The Ancient Monuments and Archaeological Areas Act 1979, with technical amendments contained in The Historic Environment (Amendment) (Scotland) Act 2011. Under this legislation it is an offence to carry out works which affect the fabric of a Scheduled Monument without the prior written consent of the Scottish Ministers.

Planning Policy and Guidance

5.3. Scheduled Monuments and their settings are also protected through planning policy.

5.4. The Scottish Government's planning policies in relation to Valuing the Historic Environment are set out in paragraphs 135-151 of Scottish Planning Policy (The Scottish Government, June 2014), and covered in more detail in Scottish Historic Environment Policy (Historic Scotland, December 2011) and Planning Advice Note 2/2011: Planning and Archaeology.

5.5. SHEP acknowledges that work on scheduled monuments also has to take account of other requirements, for example those covering health & safety, and access.

5.6. Glasgow City Council's City Plan 2 policy DES3 – Protecting and enhancing the City's historic environment sets out that development proposals will be required to retain, protect, preserve and enhance the City's Scheduled Ancient Monuments, existing archaeological heritage in line with the guidance provided in policy ENV 13.

5.7. Glasgow City Council's City Plan 2 Policy ENV 13: Ancient Monuments and Scheduled Ancient Monuments. Proposals which may impact on a scheduled ancient monument will require to have information which enables full evaluation of the proposals in relation to their impact, the importance of the monument, its cultural significance and its setting and set out how any potential damaging actions will be mitigated. They must be sympathetic, in design and construction, to the scheduled ancient monument and conform to any brief or design guide for the monument.

5.8. Policy HE 4 of the East Dunbartonshire Local Plan 2 October 2011, covers Scheduled Monuments. It describes that developments which have an adverse effect on scheduled monuments or the integrity of their setting shall not be

permitted unless there are exceptional circumstances. The planning authority will weigh the significance of the archaeological resources and of any impacts upon them and their settings against other merits of the development proposals in the determination of planning applications.

Summary

5.9. The works do not require an application for planning consent to be made and hence the consideration under these policies is curtailed however it is our opinion that the works proposed to the tunnel are minor repair works; they should have only negligible impact upon the Scheduled Monument. The proposed works are long term maintenance and repair proposals which should be positive for both structures. The setting of the monument will remain unaffected.

6. Conclusion

6.1. Our proposals form the type of works which are repairs, improvement and alterations which form repairs using modern materials. The works are limited in scope and have a very minimal impact upon the tunnel or the above canal structure. We do not believe the works will result in any harm to the architectural or historic nature of the Forth and Clyde Canal.

6.2. Given the limited options for undertaking such works and the benefits which it will bring in terms of improved lifespan of the structure we urge Historic Environment Scotland to support the proposal and to grant scheduled monument consent.

Appendices

Appendix 1

Form 001 Approval in Principle, 109055 Knightswood Tunnel

July 2015

Appendix 2

Drawings

109055 Knightswood Tunnel

Form 001 Approval in Principle

July 2015

FAIRHURST

CONTROL SHEET

CLIENT: Amalgamated Construction Ltd

PROJECT TITLE: Knightswood Tunnel

DOCUMENT TITLE: Form 001 Approval in Principle

PROJECT REFERENCE: 109055/GLA/F001/01

Issue and Approval Schedule:

ISSUE 1	Name	Signature	Date
Prepared by	David Emery	DE (Signed copy held by Fairhurst)	20 July 2015
Reviewed by	Grant Scholes	GSDS (Signed copy held by Fairhurst)	22 July 2015
Approved by	Grant Scholes	GSDS (Signed copy held by Fairhurst)	23 July 2015

Revision Record:

Issue	Date	Status	Description	By	Chk	App
1						
2						
3						
4						

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Appendix C	**Drawings**
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Project title	Knightswood Tunnel		
Project Number	109055		
PRS Reference Number	n/a		
Location	Anniesland, Glasgow		
ELR	NEM4	Mileage	00m 0480-0750 yds
OS reference	NS 551693	Structure Number	240/142

PART 1: DETAILS

1.1 Proposed works

The tunnel is located on the double track SC123 between Anniesland and Westerton stations. The tunnel is approximately 247m in length and passes beneath the Forth and Clyde Canal, Temple Road and Bearsden Road. The north portal at the Westerton end is constructed from sandstone and the main sections throughout the tunnel are lined with brickwork. At the Anniesland end of the tunnel the soffit has been re-constructed with pre-stressed concrete M Beams supporting the canal section. Initially this section was of cast iron but was strengthened in 1984 with the concrete beams.

Remedial works will be targeted in areas where the TCMI scores are below 60 in which successful works will increase score to greater than 80. These works will be based primarily on the structural detailed examination report and supported with direct site observations made during the preparation of this Form 001.

A summary of the assets affected and proposed works is presented in Appendix A with related drawing proposals, including use of Network Rail standard details where feasible, presented in Appendix C.

The site observations, proposed design approach and proposals are contained within the Knightswood Tunnel Inspection Report (Appendix B), which includes site photographs.

Fairhurst Design Risk Assessments Forms for the proposed works are presented in Appendix D and a copy of the Project Manager's Remit is included in Appendix F.

1.1.1 Network Rail's Structural Detailed Examination Report

Refer to the current Structures Detailed Examination Report in Appendix E (Network Rail, 2013) for the detailed breakdown of all tunnel defects and TCMI scores

Report Title	**Date**
Network Rail Structural Detailed Examination Report	Signed, September 2014

This form is referred to as "the examination report" in the following text.

The recommendations on maintenance and repair arising from the Examination report have been included as part of this Form 001 proposal. Note that, while the proposals appear to be appropriate for improving the TCMI score, no verification or independent checks have been carried out at this stage. Detailed design will be undertaken to facilitate the Form 003 submission.

1.1.2 Repair of observed defects

A site inspection of the tunnel was carried out by Fairhurst to record new or worsening defects using the examination report as a baseline for the current condition. The location of the defects and the extent of recommended repairs can be found on drawing 109055/4000 in appendix C. Although defects were observed throughout the tunnel, the areas highlighted on the drawing focuses on locations where the TCMI score is below 60. Consideration should be given to repair other areas which are not within the scope of works of improving areas below a TCMI score of 60.

A summary of the recommended maintenance and repairs due to observed defects and the examination report are as follows:

1. *Install a Water management system*

   An injected water proofing system will be installed at the back of the brickwork lining at the crown and haunches in areas affected by water ingress. At the top of the side walls, perforated collector pipes collect water into a drainage channel from where it is discharged into existing drains. The specification of the waterproofing system should be advised and installed by a specialist contractor. Additional site inspection with the preferred installer will be required to agree a scope of works for the system.

2. *Repairs to spalled and missing Brickwork throughout*

   Areas of missing brickwork and spalling have been identified thought out and key areas highlighted on the drawing. The repairs consist of missing holes in the crown, spalling from crown to side walls and missing bricks in refuges.

   Anniesland end at the M-beams, water was running in between gaps in the stonework. These gaps could be infilled as part of a water management system.

3. Cleaning vegetation form the Western Portal headwall and Anniesland Wingwall

   Vegetation will lead to further deterioration of the brickwork. The portals and wingwalls should be cleared of vegetation and any remaining roots treated to prevent re-growth.

4. Remove protruding steel drill bit and repair crown

   A steel drill rod was observed hanging from the crown with missing brickwork surround it. This should be removed or cut back and brickwork repaired.

1.1.3 Overall summary for proposed works

This Form 001 submission combines the recommendations of the previous detailed assessment reports and the form A to provide a suitable combination of actions to extend the life of this structure. The general sequence of work will be as follows:

- De-vegetate portals and wingwalls including treatment of roots
- Conduct additional inspection with waterproofing contractors to agree scope
- Install new water management system
- Repair brickwork to agreed extent

1.2 Assets affected

See Appendix A.

PART 2: DESIGNER'S SUBMISSION

I confirm that the criteria specified in **NR/L2/CIV/003** have been considered, and the Design is submitted for Approval in Principle on behalf of

Fairhurst, 225 Bath Street, Glasgow, G2 4GZ.

Signed [redacted]	Title Technical Director and CRE
Name (print) GRANT SCHOLES	Date 24 JULY 2015
To be signed by the Contractor's Responsible Engineer	

PART 3: CONSTRUCTION ORGANISATION'S ACKNOWLEDGEMENT OF SUBMISSION BY A SUB-CONTRACT DESIGNER

The Design organisation named in **PART 1** is engaged as a sub-contractor to the organisation stated below. I formally acknowledge the submission of this Certificate to Network Rail in support of our contract obligation for provision of the Design on behalf of Amalgamated Construction Ltd

Signed	Title
Name (print)	Date
To be signed by the Contractor's Responsible Engineer appointed for the Construction phase.	

PART 4: PROJECT ENGINEER'S COMMENTS

I have considered this submission for Approval in Principle and I am satisfied that this has adequately addressed the criteria specified in **NR/L2/CIV/003**, and confirm that the Design of the Permanent ~~and Temporary Work~~s is to be checked in accordance with the Categories listed in Appendix A of **NR/L2/CIV/003**.

My comments on the submission are given below. Provided that these comments are addressed, I hereby give Approval in Principle to the proposals.

Signed	Title
Name (print)	Date
To be signed by the Project Engineer (Building and Civil Engineering)	

Signed	Title
Name (print)	Date
To be signed by other responsible person	

PART 5: ASSET MANAGER'S APPROVAL

I have considered the submission and confirm that this is approved subject to any comments given below being addressed within the detailed Design.

Signed	Title
Name (print)	Date
To be signed by the Asset Manager (Structures)	

Signed	Title
Name (print)	Date
To be signed by the Asset Manager (Geotechnical)	

Signed	Title
Name (print)	Date
To be signed by the Asset Manager (Buildings)	

Appendix A

Assets Affected

A1 List of Buildings and Civil Engineering assets affected by the proposal

Asset No 1

Project title	Knightswood Tunnel		
Project Number	109055		
PRS Reference Number	n/a		
Location	Anniesland, Glasgow		
ELR	NEM4	Mileage	00m 0480-0750 yds
OS reference	NS 551693	Structure Number	240/142

A1.1 DRAWINGS OF PROPOSALS

The following drawings show outline proposals for remedial works:

- Site Location and Layout (Drawing No. 109055/0001)
- Surface Development Plan Showing Recommended Repairs to Tunnel Lining (Drawing No. 109055/0002)

The drawings are presented in Appendix C.

A1.2 DESIGN CRITERIA

A1.2.1 Remit and Design Life

No design life has been specified.

Improve any section TCMI scores below 60 to a score of at least 80.

A1.2.2 Design Deliverables

The following Design deliverables are presented along with this Form 001 (NR/L2/CIV/003/F001: Approval in Principle):

- Knightswood Tunnel inspection (presented in Appendix B)
- Proposed Maintenance and Repair Drawings (presented in Appendix C)
- Designer's Risk Assessment (Design Risk Assessment Forms presented in Appendix D)
- Previous assessment information (Structures Detailed Examination Report, presented in Appendix E)

A1.2.3 Design Considerations and Standards

The standard manuals and specifications used are listed below:

- BD63/07 (DMRB 3.1.4): The Inspection of Highway Structures
- The Inspection Manual for Highway Structures Volumes 1 and 2: TSO, May 2007
- Handbook for the examination of Structures Part4C: Recording of Tunnel examinations and condition marking index score.

A1.3 ANTICIPATED DEVIATIONS FROM STANDARDS

No deviations are anticipated from Network Rail standards.

A1.4 GEOTECHNICAL CONSIDERATIONS

None

A1.5 ACCOMPANYING DRAWINGS AND OTHER DOCUMENTS

Drawings are included in Appendix C and listed in section A1.1 above.

In addition to the design documentation, a supporting Design Risk Assessment Form has been prepared for the proposed remedial solutions and is included in Appendix D.

A1.6 OTHER RELEVANT INFORMATION

None

A1.7 SPECIAL ACCESS ARRANGEMENTS/ REQUIREMENTS FOR EXAMINATION, INSPECTION, REPAIR, RENEWAL OR REMOVAL

The following should be considered:

Waterproofing/ Sealing details

Additional examinations are required to agree an appropriate water management system. Specialist waterproofing consultants will be required to attend.

Requirements for Examination/ Inspection

Once de-vegetated, additional areas may be exposed that require remedial work.

Special Access

All works to be undertaken during possessions or line blockages.

Adjacent Landowners and Permissions/ Wayleaves

Not considered to be applicable to this site.

A1.8 CHECKING CATEGORY

The Design of the permanent works is to be checked in accordance with Category **Ib** of NR/L3/CIV/003 (insert Ia, Ib, II or III).

~~The Design of the Temporary Works is to be checked in accordance with Category ..... of NR/L3/CIV/003 (insert Ia, Ib, II or III).~~

Appendix B

Knightswood Tunnel Inspection

109055 Knightswood Tunnel

Inspection Report

July 2015







FAIRHURST

CONTROL SHEET

CLIENT: Amalgamated Construction Ltd

PROJECT TITLE: Knightswood Tunnel

REPORT TITLE: Knightswood Tunnel Inspection Report

PROJECT REFERENCE: 109055/GLA/IR01

Issue and Approval Schedule:

ISSUE 1	Name	Signature	Date
Prepared by	David Emery	DE (original held by Fairhurst)	20/07/15
Reviewed by	Grant Scholes	GSDS (original held by Fairhurst)	22/07/15
Approved by	Grant Scholes	GSDS (original held by Fairhurst)	22/07/15

Revision Record:

Issue	Date	Status	Description	By	Chk	App
2						
3						
4						
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This report has been prepared in accordance with procedure OP/P02 of Fairhurst's integrated Quality and Environmental Management System (QEMS)

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Appendix A: Drawings

Appendix B: Interim Report on Water Ingress

1.0 Information

1.1 General Information

Fairhurst were commissioned by Amalgamated Construction Ltd (AMCO) to carry out an inspection of Knightswood Tunnel situated in Anniesland, Glasgow and report on the condition and propose repair works to be carried out.

This Inspection Report is intended to be included as an appendix to the Form 001 submission and allow further description of the existing condition and elaboration on the design philosophy of the proposed remedial works. Remedial works will be targeted in areas where the TCMI scores are below 60 in which successful works will increase score to greater than 80.

The inspection recorded new or worsening defects using the 2013 detailed examination report as a baseline for the current condition. The inspection was carried out at night during a full line blockage. The initial inspection was visual only and undertaken from track level where features and works were recorded in notebook form with photographic records taken. No specialist access techniques were available or intrusive investigations were carried out.

1.2 References

The inspection was carried out generally in accordance with the following:

- BD63/07 (DMRB 3.1.4): The Inspection of Highway Structures
- The Inspection Manual for Highway Structures Volumes 1 and 2: TSO, May 2007
- Handbook for the examination of Structures Part4C: Recording of Tunnel examinations and condition marking index score.

Detailed assessments on the condition of the structure can be determined from the Examination Reports. The following is the most recent relevant report which was provided for information with a copy included in the F001 submission.

- Structural Detailed Examination Report dated September 2013.

2.0 Inspection

2.1 General Information

Date of Inspection:	12th April 2015
Weather:	Wet, night time visibility, unlit tunnel.

2.2 Construction

Network Rail asset T 240/142 is located on the double track SC123 between Anniesland and Westerton stations at National Grid Reference NS 551693 and at track mileage 000 miles, 0480 yards 21.82 chainage.

The tunnel is approximately 247metres in length and passes under the Forth and Clyde Canal, Temple Road and Bearsden Road. The north portal at the Westerton end is constructed from sandstone and the main sections throughout the tunnel are brickwork lined. At the Anniesland end the tunnel soffit has been re-constructed with pre-stressed precast concrete M Beams under the canal section. Originally this section was of cast iron but was strengthened in 1984 with the concrete beams.

The tunnel has suffered from water ingression and several attempts have been made to remediate the issue such as grouting the tunnel walls and waterproofing trials with hydrophobic foam.

2.3 General Condition

The tunnel was found to be in a generally poor condition. Water ingress and spalling was noted throughout the length of the tunnel. Based on the 2013 Network Rail structures detailed examination report the tunnel had not significantly deteriorated and the conditions noted in the report are still valid. A number of specific defect were noted and are highlighted in section 2.4 that were not recorded in the initial examination report

General Tunnel photos can be found in section 2.6.

2.4 Specific Defects

Appendix A provides a typical plan showing the locations of the specific defects that were observed. The drawing has subdivided the tunnel into 20m chainages and shows the location relative to the surface. The specific defects are described below:

- At the Anniesland portal on the Down line sidewall at around chainage 20m water was observed to be running between gaps in the masonry wall (Photo 1 and 2)
- Refuges were found in poor condition. Brickwork around perimeter had fallen away (Photo 3 and 4)
- At chainage 180m around the area below Bearsden Road, water was observed running from the centre crown. Water was roughly over a 10m^2 area and was running down the hunches and sidewall. (Photo 5 and 6)

2.5 Design Repair Summary

Recommended areas observed during the inspection that requires action:

- The water running in from the Anniesland end at the location of the Canal. Improved water management system and infilling repointing stonework should be considered.
- At chainage 180m the tunnel cuts under Bearsden Road. The observation of water running from the soffit would suggest that the source maybe from a utilities pipe. It is recommended that Scottish Water is advised and the location of any water pipes near Bearsden Road recorded. The Interim Report included in appendix B was prepared to allow such consultation.
- Nearly all the refuges where in a poor condition where the most significant have been highlighted in this report. Any future brickwork repairs should include the repair and restoration of these sections.

Based in the 2013 examination report and verified during this inspection, the following remedial works were recommended:

- The installation of a waterproofing system. An injected water proofing system should be inserted through the lining of the brickwork at the crown and haunches in areas affected by water ingress. At the sidewalls a drainage channel can collect the water and discharged into existing drains. The specification of the waterproofing system should be advised and installed by a specialist contractor. Additional site inspection will be required to agree a scope of works for the system.
- General repairs to spalled and missing brickworks areas.
- Remove of the protruding drill bit from the Crown and section of brickwork repaired
- Repair and reinstatement of brickwork at holes in crown section.
- Removal of moss from Portals and wingwalls

Locations of proposed repairs following the recent inspection and Project Manager's Remit can be found in Appendix A drawing:

- 109055: Surface development plan showing recommended repairs to tunnel lining

2.6 Photographs

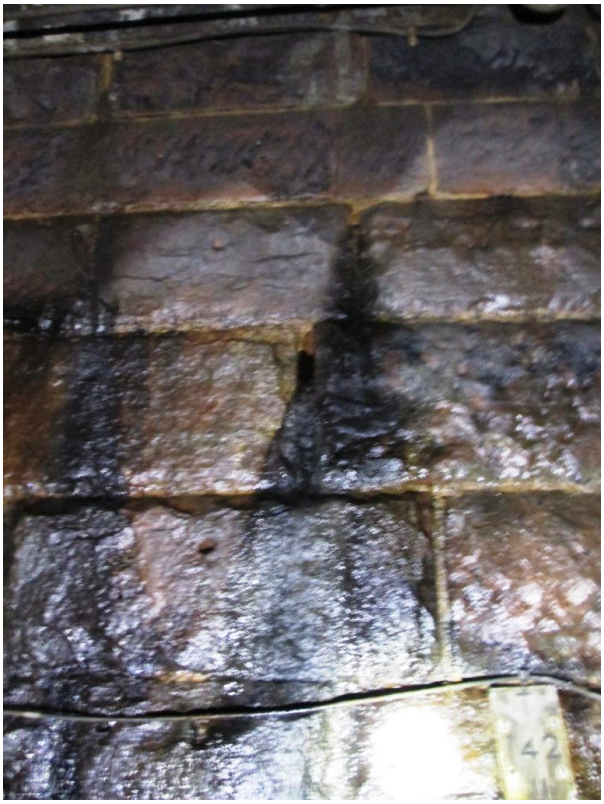


Photo 1: Water Ingress at Anniesland End



Photo 2: Water Ingress at Anniesland End



Photo 3: Damaged Refuge



Photo 4: Damaged Refuge



Photo 5: Water Ingress from Crown at Bearsden Road intersection



Photo 6: Water Ingress from Crown at Bearsden Road intersection



Photo 7: Wet and Spalling masonry wall



Photo 8: Wet and Spalling masonry wall



Photo 9: Westerton exit, moss covering crown



Photo 10: Westerton exit, moss covering crown and side walls



Photo 11: Westerton End looking south. Spalling Masonry



Photo 12: Westerton End looking south. Spalling Masonry

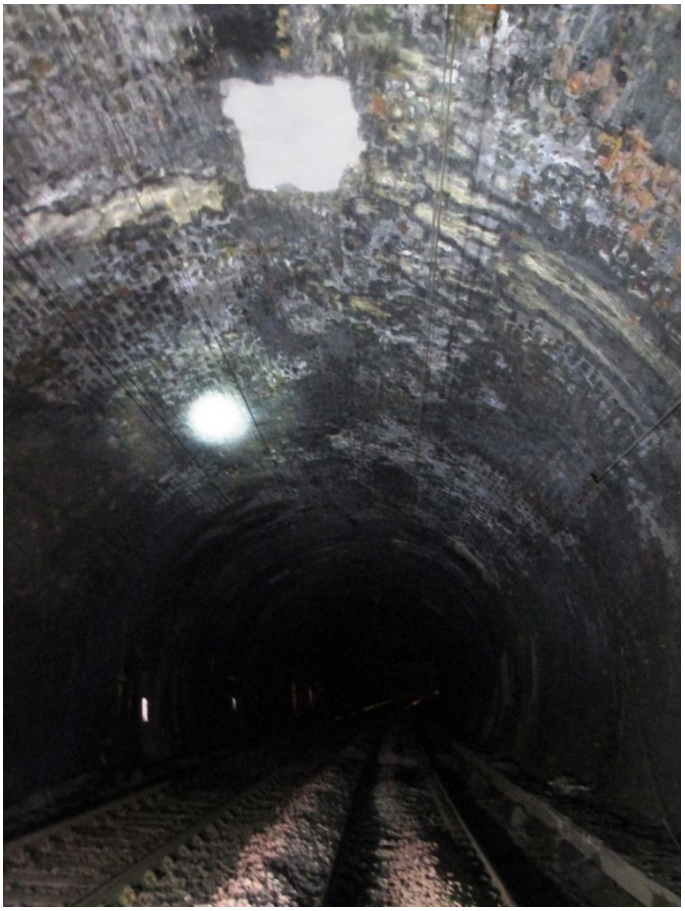


Photo 13: Spalling on Crown



Photo 14: Steel Drill bit protruding from crown

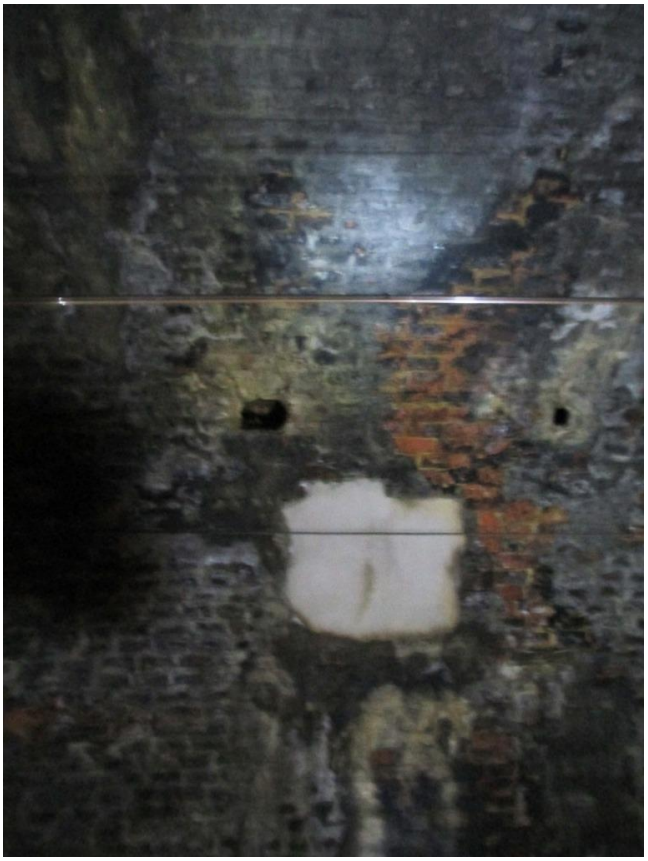


Photo 15: Square Holes in Crown at Mineshaft location



Photo 16: Water Ingress at Anniesland End

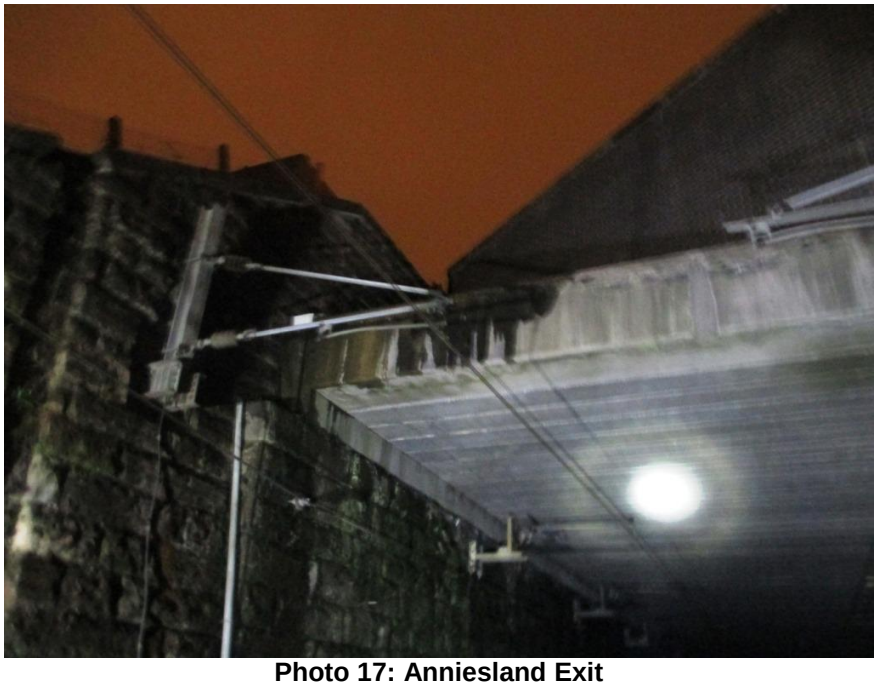


Photo 17: Anniesland Exit









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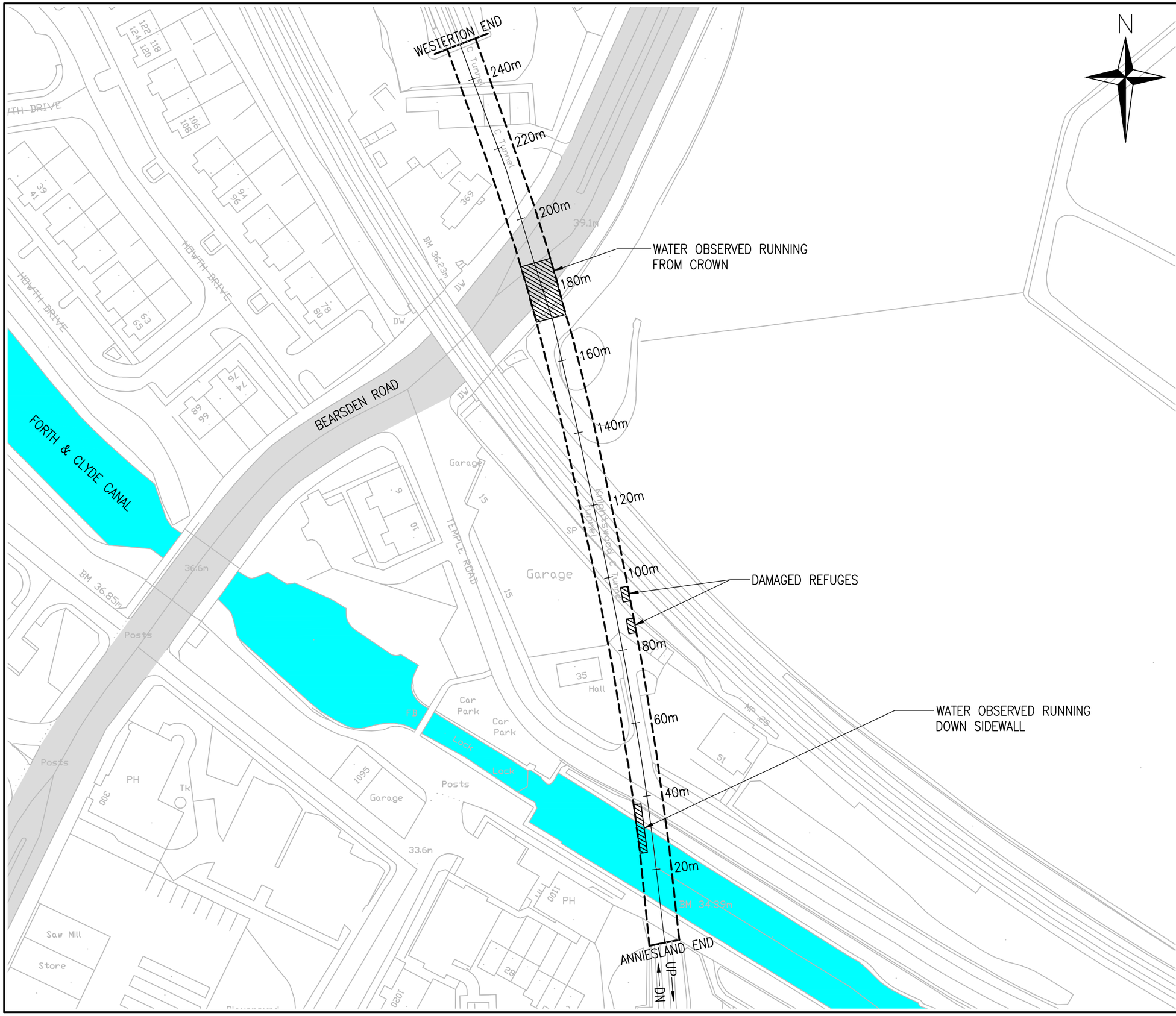
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DEVELOPMENT • WATER SERVICES • CDM COORDINATOR SERVICES

Appendix C

Drawings



Do not scale from this drawing.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARD/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING RISKS AND INFORMATION.

RISKS LISTED HERE ARE NOT EXHAUSTIVE. REFER TO DESIGN ASSESSMENT FORM NO.

CONSTRUCTION

DEMOLITION

FOR INFORMATION RELATING TO USE, CLEANING AND MAINTENANCE SEE THE HEALTH AND SAFETY FILE

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT.

NOTES:

Rev.	Date	Description	Drwn.	Chkd.	Appd.

FAIRHURST

225 Bath Street
GLASGOW
G2 4GZ

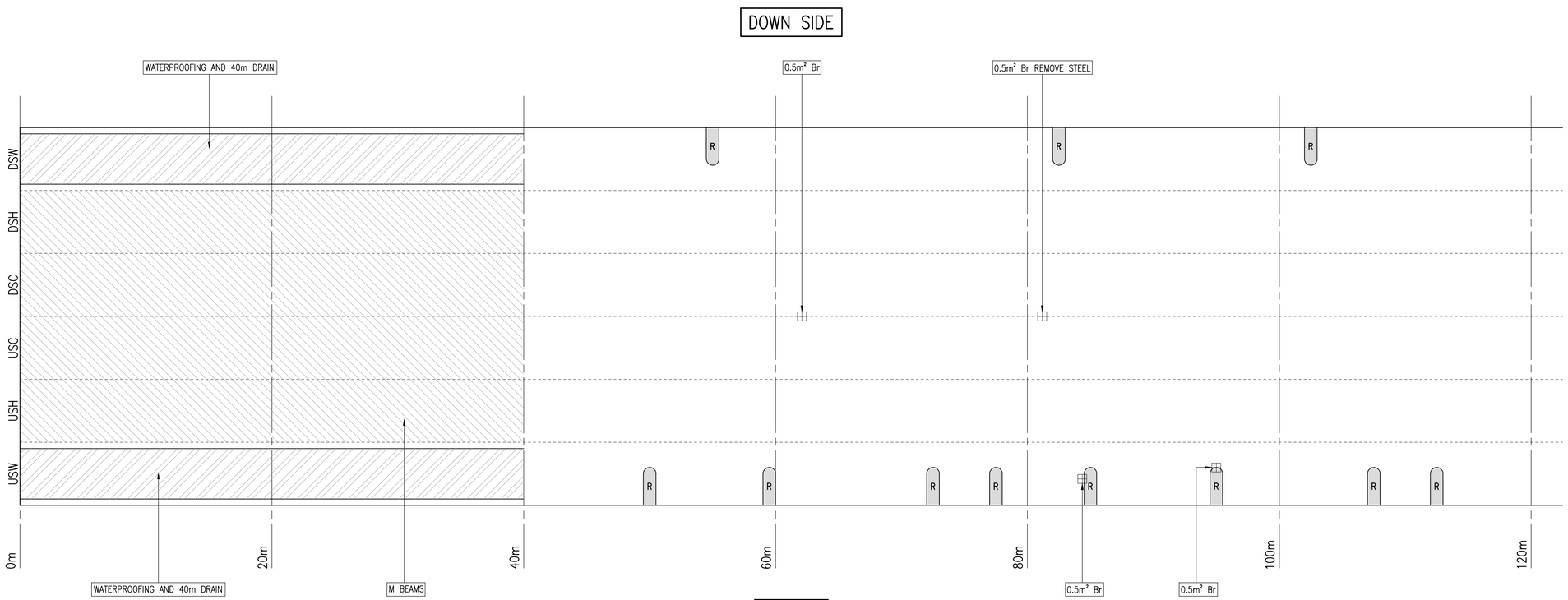
Tel: 0141 204 8800
Fax: 0141 204 8801

Client:

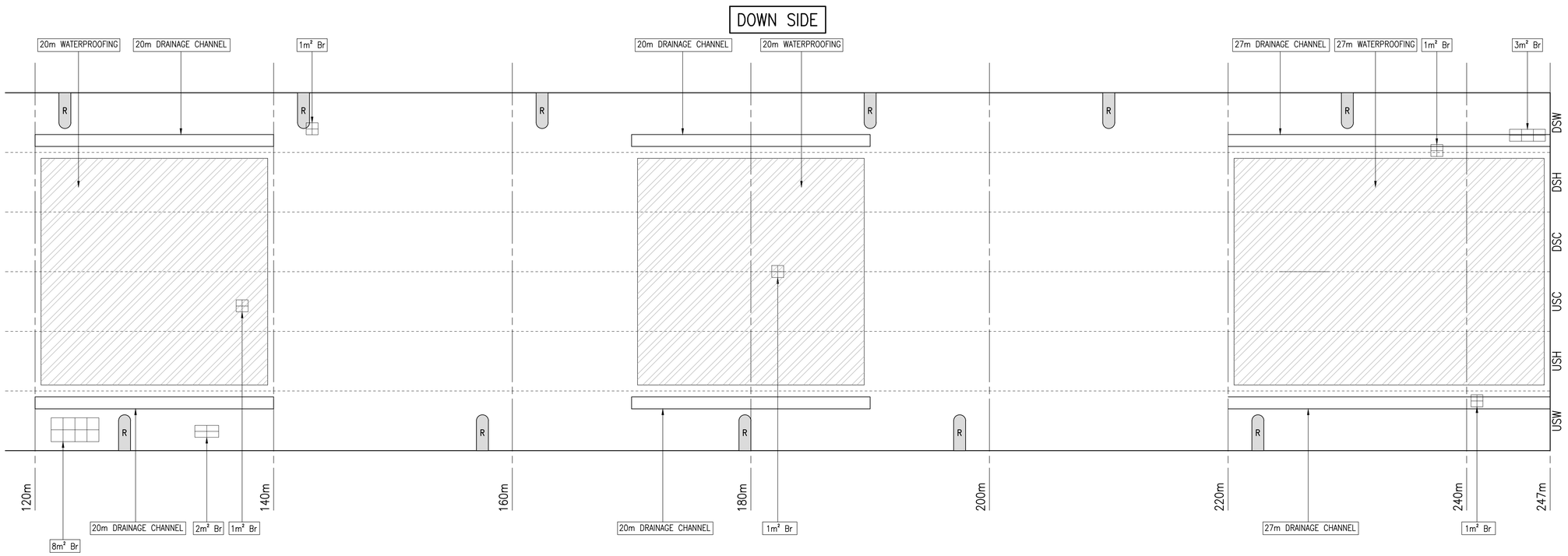
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KNIGHTSWOOD TUNNEL

Drawing Title:
SITE LOCATION & LAYOUT

Scale at A3:	Status:		
1:1000	For Information		
Drawn:	Checked:	Approved:	
BDJ			
Date:	Date:	Date:	
15/06/15			
Drawing No.:			Revision:
109055/0001			



CHAINAGE 0 – 120m



CHAINAGE 120 – 247m

Do not scale from this drawing.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

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IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT.

NOTES

1. WATERPROOFING AND DRAINAGE CHANNEL SPECIFICATION TO BE ADVISED.

LEGEND:

R REFUGE

Br BRICK REPAIR

Rev.	Date	Description	Drwn.	Chkd.	Appd.

FAIRHURST
225 Bath Street
GLASGOW
G2 4GZ
Tel: 0141 204 8800
Fax: 0141 204 8801

Client: NetworkRail — Working in Partnership — AMCOrail

Project Title:
KNIGHTSWOOD TUNNEL

Drawing Title:
SURFACE DEVELOPMENT PLAN SHOWING RECOMMENDED REPAIRS TO TUNNEL LINING

Scale at A1:	Status:	
AS SHOWN	For Information	
Drawn: CMcL	Checked: DE	Approved:
Date: 24/06/15	Date:	Date:

Drawing No.: 109055/0002 Revision: –

Appendix D

Design Risk Assessment Forms

DESIGN ASSESSMENT FORM

The design assessment form is as follows.

Project: Knightswood Tunnel	**Job No.**	109055
	Document No.	Form 001 Appendix D
	Prepared by/Date	DE / June 2015
	Checked by/Date	GSDS / July 2015
	Approved by/Date	GSDS / July 2015

Fairhurst Scope of Works
Improve TCMI score of Knightswood Tunnel at sections below 60 to above 80 through maintenance and repairs works

Design Philosophy

Following an inspection to assess the condition of the footbridge, a Form 001 Approval in Principle has been compiled for remedial works. A detailed examination report from 2013 was used as the baseline for existing condition

The anticipated works due to the condition include:

- Installing of a new water management system.
- Repair to missing brickwork and spalling

The Form 001 includes maintenance and repair works based on earlier Examination reports by others and a visual inspection of the tunnel.

Standard Network Rail repair solutions are proposed as far as practical. The implementation methods for such work is well established by experienced contractors. Waterproofing of tunnels is dependent on the technique adopted and the appropriate supplier/specialist should develop an appropriate DRA once appointed.

Due to the location of the works, all site rules and safety protocols as required by Network Rail must be observed. It is not possible to avoid railway working; however the risks may be minimised by working while the line is blocked. Similarly working at height and within confined, poorly ventilated areas cannot be avoided and the contractor's risk assessment should address these issues.

Rev	Date	Description	By	Chk.d	App.d

FAIRHURST

Project: Knightswood Tunnel	**Job No.**	109055
	Prepared by/Date	DE / June 2015
	Checked by/Date	GSDS / July 2015
	Approved by/Date	GSDS / July 2015

Checklist of potential operations and hazards

Potential Hazards	Present (tick)	Key Significant Hazards to be Addressed
Client operations	Y	**Hazard 1:** Operational NR site
Adjacent activities		
Restricted site	Y	**Hazard 1:** Operational NR site
Traffic		
Interface with public		
Near to highways		
Near to railways	Y	**Hazard 1:** Operational NR site
Near to waterways		
Tidal working		
Ground instability	Y	**Hazard 2:** Temporary works requirement
Contamination/ soil gas		
Excavations		
Ground water		
Inundation		
Sewage		
Fuel tanks		
Services	Y	**Hazard 1:** Operational NR site
Overhead cables	Y	**Hazard 1:** Operational NR site
Demolition		
Unstable structures	Y	**Hazard 2:** Temporary works requirement
Explosives		
Asbestos		
Bird droppings		
Dust		
Hazardous materials		Possible ballast contamination underfoot and soot deposits on soffit.
Radiation		
Hot working		
Confined spaces		
Working at height	Y	Based on location of defects. No alternative, contractor to lead access and working methodology.
Manual handling		
Lifting operations	Y	Based on location of defects. No alternative, contractor to lead access and working methodology.
Vibration	Y	Drilling and other machine operations unavoidable.
Noise	Y	Drilling and other machine operations unavoidable.

FAIRHURST

Project: Knightswood Tunnel	**Job No.**	109055	
	Prepared by/Date	DE / June 2015	
	Checked by/Date	GSDS / July 2015	
	Approved by/Date	GSDS / July 2015	

Rev	Date	Description	By	Chk.d	App.d

Stage – *Construction*

Hazard	Action by Designer	Residual Hazard
(1) Network Rail site: trains and other vehicles may be running, and other maintenance activities carried out in the vicinity of the site.	1 To eliminate hazard Hazards cannot be eliminated through design.	Schedule and specify works taking into account limited availability of construction time on site. Where possible, adopt waterproofing system with minimum interventions on tunnel lining and a method that does not temporarily destabilise the tunnel structure.
	2 To reduce hazard Potential to select techniques that are simpler to install and minimise risk to structure.	
(2) Temporary works By main contractor	1 To eliminate hazard Hazards cannot be eliminated through design.	Brickwork repairs use standard construction techniques. Waterproofing system will require temporary access to soffit. Design of system to be done with specialist supplier to ensure safe and effective and construction methodology does not compromise the tunnel.
	2 To reduce hazard Potential to select techniques that are simpler to install and minimise risk to structure.	

Rev	Date	Description	By	Chk.d	App.d

Appendix E

Structures Detailed Examination Report

NETWORK RAIL

Structures Detailed Examination Report

ELR: NEM4	*Contract Mileage:* 000 *m* 0480 *yds* 21.82 *chs*	*Struc. Ref* 240/142

Examination Type:	**Structures Detailed**	**NR ID:**	**11011166**	**Exam Date:**	**13-Sep-2013**
Area:	**Scotland West**	**BRS:**	**0**	**OS Ref:**	**NS551693**
Structure Name:	**KNIGHTSWOOD TUNNEL**	**Type:**	**TB**	**Exam ID**	**2456159**
Route:	**Drumgelloch - Helensburgh (via Singer)**			**Complete Examination:**	**Yes**

Section A: To Be Completed By The Examining Organisation

HIDDEN PARTS NOT EXAMINED (EXCLUDING FOUNDATIONS)	**Part**	**Reason**

ITEM	DESCRIPTION	LOCATION	Est. Cost £ +/- 20%	Priority Within	Quantity	Severity	Probability	Risk Score	Works Category
1	Consider installing a water management system	throughout	0.00			2	4	E8	Water Control
2	Consider repairs to spalled & missing brickwork	throughout	0.00			2	4	E8	Brickwork/Stone Repairs
3	Consider clearing vegetation	Westerton portal headwall & Anniesland portal wingwall	0.00			2	4	M8	Vegetation
4	Consider replacing missing section of down pipe	Anniesland portal	0.00			2	3	S6	Drainage
5	Consider removing redundant rails	four foot	0.00			5	2	S10	Other
6	Consider replacing missing/damaged duct covers	throughout	0.00			2	3	S6	Other
7	Remove protruding steel drill bit	Crown @ Ch.4+00m	0.00			5	2	S10	Other

NETWORK RAIL

Structures Detailed Examination Report

ELR: NEM4	Contract Mileage: 000 m 0480 yds 21.82 chs	Struc. Ref 240/142

History of Live Significant Defects

No	Description	Location	Exam Date	Access Gained	Exam Type	Rec Raised	Risk Score	Access Req'd	Deter - ioration	Repaired	Flagged for Closure	Engineer Comments
1	water ingress	throughout (except Ist 2 chains)	23/07/10	N	D	NV	8	N/A	Baseline	N	N	
1	water ingress	throughout (except Ist 2 chains)	09/10/12	Y	D	Y	8	Y	N	N	N	Install water management system
1	water ingress	throughout (except Ist 2 chains)	13/09/13	Y	D	Y	8	Y	N	N	N	.
2	spalled and missing brickwork.	throughout tunnel (mainly at refuges)	23/07/10	N	D	NV	8	N/A	Baseline	N	N	
2	spalled and missing brickwork.	throughout tunnel (mainly at refuges)	09/10/12	Y	D	Y	8	Y	N	N	N	Repair
2	spalled and missing brickwork.	throughout tunnel (mainly at refuges)	13/09/13	Y	D	Y	8	Y	N	N	N	.
3	Vegetation	Westerton portal headwall, Anniesland portal wingwall.	23/07/10	N	D	NV	6	N/A	Baseline	N	N	
3	Vegetation	Westerton portal headwall, Anniesland portal wingwall.	09/10/12	Y	D	Y	8	Y	Y	N	N	Clear
3	Vegetation	Westerton portal headwall, Anniesland portal wingwall.	13/09/13	Y	D	Y	8	Y	Y	N	N	.
4	missing section of down pipe.	Anniesland portal.	23/07/10	N	D	NV	6	N/A	Baseline	N	N	
4	missing section of down pipe.	Anniesland portal.	09/10/12	Y	D	Y	6	Y	N	N	N	Replace
4	missing section of down pipe.	Anniesland portal.	13/09/13	Y	D	Y	6	Y	N	N	N	.
5	redundant rails.	four foot	09/10/12	Y	D	Y	10	Y	Baseline	N	N	Remove
5	redundant rails.	four foot	13/09/13	Y	D	Y	10	Y	N	N	N	.
6	missing/damaged duct covers.	Various locations throughout tunnel.	09/10/12	Y	D	Y	6	Y	Baseline	N	N	Replace.
6	missing/damaged duct covers.	Various locations throughout tunnel.	13/09/13	Y	D	Y	6	Y	N	N	N	.
7	protruding steel drill bit.	Crown @ Ch.4+00m	09/10/12	Y	D	Y	10	Y	Baseline	N	N	Remove.
7	protruding steel drill bit.	Crown @ Ch.4+00m	13/09/13	Y	D	Y	10	Y	N	N	N	.

Engineers Notes

I confirm that a quality check (only) has been undertaken on this report and the items included in the Tunnel Engineering Review Checklist (as shown in the Continuation Page of this report) have been complied with.

Signed For Employer	Name Iain McCabe	Date 19-Sep-2013

Version 3.4 29-11-12

NETWORK RAIL

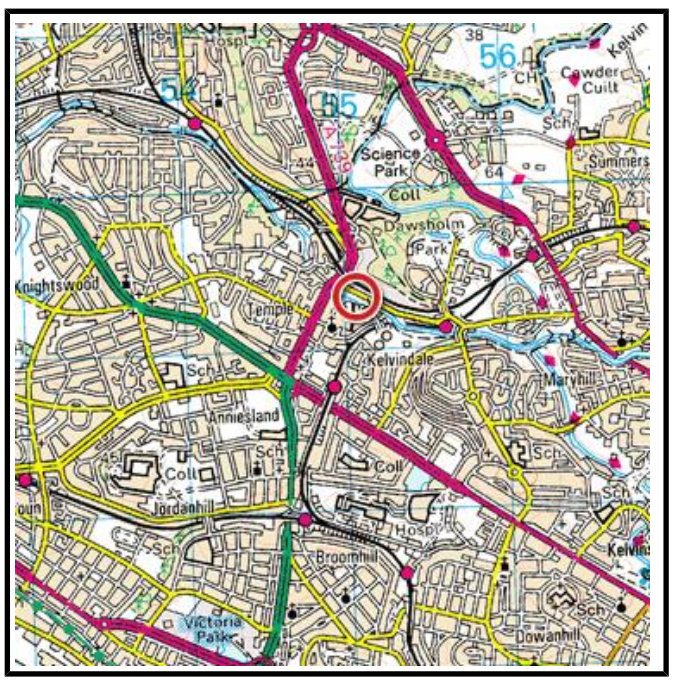
Structures Detailed Examination Report

ELR: NEM4	*Contract Mileage:* 000 *m* 0480 *yds* 21.82 *chs*	*Struc. Ref* 240/142
Structure Type TB	NR ID 11011166	Rpt ID 1262	Exam ID 0
OS Ref: NS551693	*Contract Mileage:* 000 *m* 0480 *yds* 21.82 *chs*	**Exam Date** 13/9/2013
Line: Drumgelloch - Helensburgh (via Singer)	*Name:* KNIGHTSWOOD TUNNEL	Last Detailed 9/10/2012
		Last Visual

Site Sketch / Elevation Photograph



Location Plan



NETWORK RAIL

Structures Detailed Examination Report

ELR: NEM4	Contract Mileage: 000 m 0480 yds 21.82 chs	Struc. Ref 240/142

Name of Part	
Main Girders	Good
Cross Girders	-
Rail Bearers	-
- Floor	-
Rivets & Bolts	-
Arch Ring	Fair
Spandrels	Good
Abutments	-
Piers	-
Wing & retaining Walls	Fair
Pointing	Fair
Parapets & Pilasters	-
Columns & Cylinders	-
Trestles & Crossheads	-
Bedstones & Cills	-
Bearings	-
Ballast Plates/Boards	-
Longitudinal Timbers	-
Waterproofing	-
Drainage	-
Gutters & Downpipes	-
Handrails	-
Painting	-
Track & Road Condition	-
Revetment Walls	-
Vegetation	NO
Debris	NO
Visibility of Signs	-
Rubbish	NO
-	-
-	-
-	-
-	-
Insert 'X' for	
Change of Construction	
Closed Line	
C.W.R.	
Rail Joints	
25T Axle/Abnormal Rd Loads	
Weight Restriction Plates	
Inaccessible Parts	
Tell Tales/Avonguards	
Plumbing Points	

N/E = Not Examined
N/A = Not Applicable

Examiner's General Comments

Refer to Appendix for Tunnel Report.

Has all the structure been viewed? Yes

Has the structure been viewed under live load? Yes

SIGNED [redacted]

EXAMINERS NAME James McCafferty

DATE 19-Sep-2013

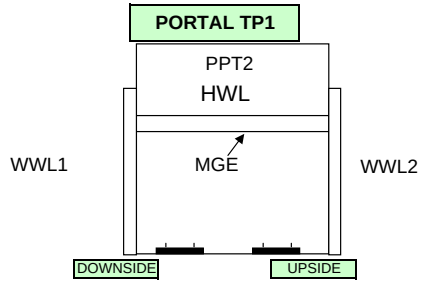
ELR: NEM4	Contract Mileage: 000 m 0480 yds 21.82 chs	Struc. Ref 240/142

Tunnel Engineering Review Checklist

The Engineering review of this report is to confirm that the following items have been considered,

- Items for consideration identified in the Tunnel Management Strategy have been addressed
- The Tunnel Management Strategy referred to is noted, by date
- The recommendations made by the Tunnel Examiner are appropriate to the defects identified.
- The previously recorded defects have been reported on appropriately, in particular current condition, which will enable the rate of deterioration to be determined
- Risk Scores for recommendations are consistent and appropriate to the deterioration of the defect
- As far as can be determined any new defects have been recorded
- All parts, including attachments and other structures within the tunnel have been examined
- Where parts have not been examined they are identified, with reason recorded
- Unexamined parts are risk assessed and an appropriate recommendation made to rectify the situation

TUNNEL NAME :	KNIGHTSWOOD TUNNEL	ELR : NEM4	TUNNEL No. 240/142	EXAM DATE 13/09/2013	PAGE 3 OF 20



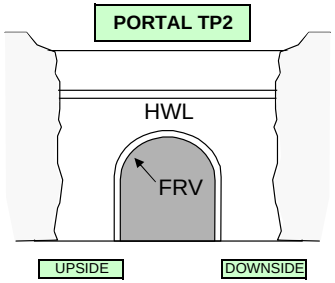
Anniesland @ LOW MILEAGE END
Track mileage @ Portal = 0m 480yds

ABBREVIATIONS & DEFINITIONS

SM	SECTION MARKER	USC	UP CROWN
TS	TUNNEL SECTION LENGTH	DSC	DOWN CROWN
TP	PORTAL	USH	UP HAUNCH
PPT	PARAPET	DSH	DOWN HAUNCH
HWL	HEADWALL	USW	UP SIDEWALL
WWL	WINGWALL	DSW	DOWN SIDEWALL
FRV	FACE RING VOUSSOIR	CRN	CROWN
CP	CROSS PASSAGE	HSW	SIDEWALL HIGH MILEAGE SIDE
AD	ADIT	LSW	SIDEWALL LOW MILEAGE SIDE
SV	SIDE VOUSSIOR	EB	BLIND SHAFT EYE
EO	OPEN SHAFT EYE		

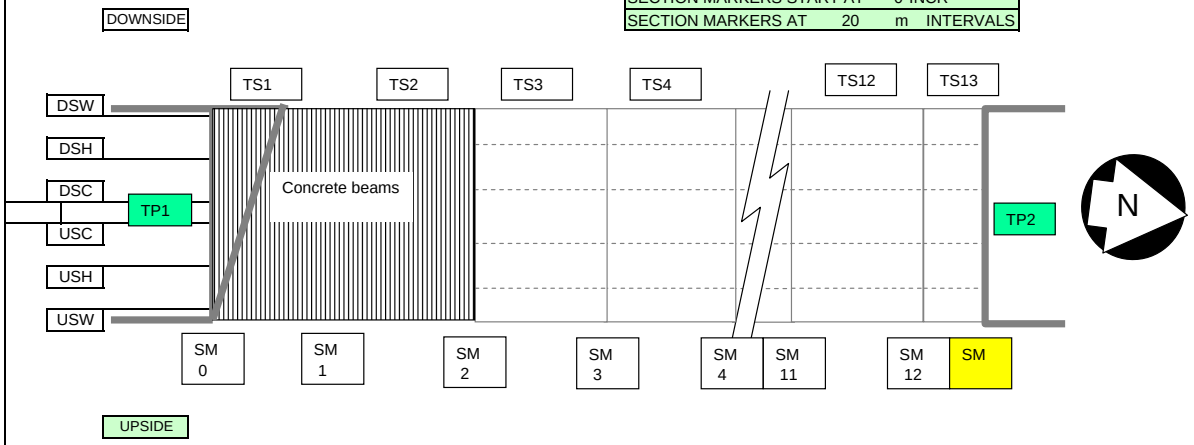
Orientation Definition For Defects and Features in Tunnels



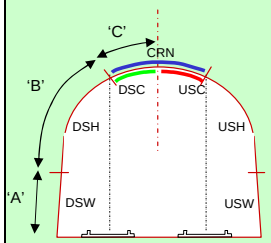


Westerton @ HIGH MILEAGE END
Track mileage @ Portal = 0m 749yds

CROWN REPRESENTED AS	DOUBLE		
SECTION MARKERS START AT	0	INCR	
SECTION MARKERS AT	20	m	INTERVALS



DIMENSIONS 'A' 'B' AND 'C' FOR TCMI



SECTION MARKERS					'A'	B'	C'
Start	End	M	Len	Type	(m)	(m)	(m)
0	2	Co	20	Section	5.81	0.01	0.01
2	12.4	Br	20	Section	2.4	5	1.5

NOTES :
Where there is no defining feature to identify the top of the sidewall assume 'A' = 2.4m.
Where tunnel not twin track or track cannot be used as constant point of reference, assume 'C' =

TABLE OF MAJOR ELEMENTS/KEY FEATURES

Rail ID.	TYPE	M	DESCRIPTION	INC	SM ref		LOC (m)

TABLE OF MAJOR ELEMENTS/KEY FEATURES (Cont.')

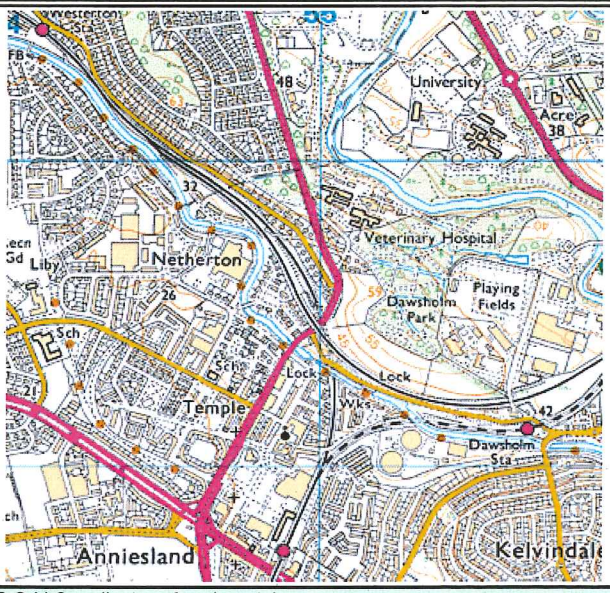
Rail ID.	TYPE	M	DESCRIPTION	INC	SM ref		LOC (m)

TUNNEL EXAMINATION REPORT	DESCRIPTION (TUNNEL NAME)	ELR	RAILWAY ID (TUNNEL No.)	TUNNEL DATA	
TYPE OF EXAM : **DETAILED**	**KNIGHTSWOOD TUNNEL**	**NEM4**	**240/142**	EXAM DATE:	**13/09/2013**
NETWORK RAIL TERRITORY	EXAMINATION CONTRACTOR	PAGE	OF	REQUESTED DATE:	**27/08/2013**
Scotland	**Amey**	**1**	**20**	LAST EXAM :	**09/10/2012**

TRACK ID	SC123
YEAR OF CONSTRUCTION	1886
OPERATIONAL STATUS	Operational
SME AREA	Scotland West

SUMMARY TCMI (Tunnel Condition Marking Index) SCORE	
TUNNEL BORE - TCMI	**81**
PORTAL TP1 - TCMI	**100**
PORTAL TP2 - TCMI	**100**

OWNING PARTY	Network Rail		
STATIONS BETWEEN	Anniesland	&	Westerton
START MILEAGE / YARDS	0 Miles	480	Yards
LOW MILEAGE END	Anniesland		
LOW SECTION MARKER END	Anniesland	At Section Marker:	0
TUNNEL LENGTH	270 Yards	247	(m)
SECTIONS / LENGTHS	12 Sections	20	m Sections
No. TRACKS	2		
ELECTRIFICATION OHLE ?, 3rd Rail ?, None ?	OHLE		



Nos. SHAFTS, ADDITS, CROSS PASSAGES and SIDE VOUSSOIRS		
	Open Shafts	0
	Blind Shafts	0
	Hidden Shafts	0
	Suspected Shafts	0
	Cross Passages	0
	Adits	0
	Side Voussoirs	0

ANY SHEETING ? (If Yes, note tunnel sections containing sheeting.)		
	No	

OS Grid Coordinates of each portal :

TP1	Anniesland	NS55006920
TP2	Westerton	NS55006940

LISTED STATUS (specify grade for each of :- portal, shaft top construction etc.)	Yes

TUNNEL CONSTRUCTION		
	Cut n Cover	Yes. The First 2 chains are constructed from prestressed concrete M Beams
	Bored	unknown
	Fully Lined	From Ch.2 to the end of the Tunnel fully lined
	Full Profile Unlined	N/A
	Partly Lined	N/A
	Has Invert ?	Brickwork and Natural Rock 9 (ref TMS report 03/04)
	Thickness Of Lining	

CONSTRUCTION MATERIAL

Material Codes for Defect Pages:-

Brick	**Br**
Stone	**St**
Metal	**Me**
Natural Rock	**Ro**
Concrete Segmental	**Cs**
Metal Segmental	**Ms**
Concrete In-Situ Cast / Reinforced / UnReinforced and Sprayed	**Co**

Note : See Tunnel Section Pages for material of each minor element. Code to be taken as material that predominates in the elements.

TCMI TUNNEL GENERIC MATERIAL TYPE	Select one of the following : METAL / CONCRETE / BRICK / STONE		Brick
LINING	Generally in fair condition with areas of spalling and wetness throughout the tunnel.		
PORTAL 1 (TP1) **Anniesland**	Material	**Co**	The first 2 chains of the tunnel are constructed from masonry side walls and prestressed concrete beams supporting the Forth and Clyde canal above.
Including Elements : **-,PPT2,-,WWL1,HWL1,WWL2,**	Included	**Y**	
PORTAL 1 (TP2) **Westerton**	Material	**St**	Sandstone portal with a Cable Ladder rack attached to the spandrel and headwall areas.
Including Elements : **-,-,-,-,HWL1,-,FRV1**	Included	[redacted]	

Carrs Exam I.D.	J McCafferty	[redacted]	19/09/2013	**Report I.D.**
	Examiner	Signature	Date	

TUNNEL EXAMINATION REPORT	DESCRIPTION (TUNNEL NAME)	ELR	RAILWAY ID (TUNNEL No.)	EXAM DETAILS	
TYPE OF EXAM : **DETAILED**	**KNIGHTSWOOD TUNNEL**	**NEM4**	**240/142**	ACTUAL DATE :	**13/09/2013**
NETWORK RAIL TERRITORY :	EXAMINATION CONTRACTOR	PAGE	OF	REQUESTED DATE :	**27/08/2013**
Scotland	**Amey**	**2**	**20**	PREVIOUS EXAM :	**09/10/2012**

PORTAL PHOTOGRAPH - TP1	Anniesland	PORTAL PHOTOGRAPH - TP2	Westerton





DATE OF PHOTOGRAPH………..	13 September 2013	DATE OF PHOTOGRAPH………..	13 September 2013

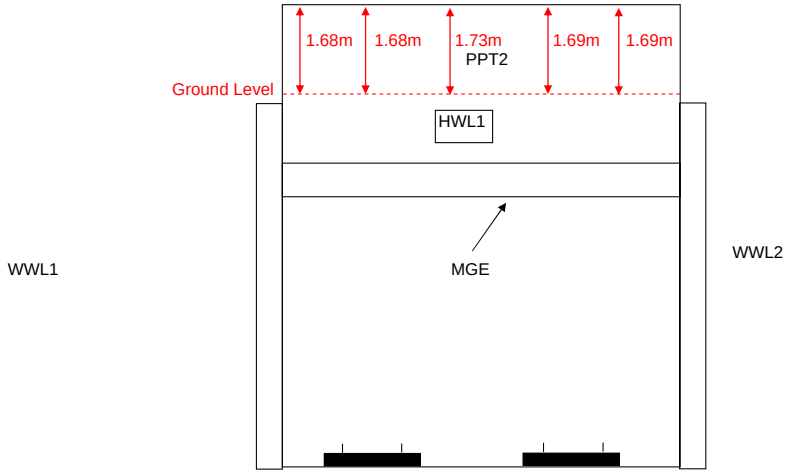
LEAD EXAMINER or EXAMINING ENGINEER	J McCafferty	ASSISTING EXAMINERS	C. O'Hare
NETWORK RAIL ENGINEER PRESENT DURING EXAM	No		

MODE OF EXAM	CROWN & HAUNCHES	RRV Mewp
	SIDWALLS	Walk through
	SURFACE	Walkover
DIRECTION OF EXAM		DSW, USH & USC Anniesland to Westerton USW, DSH & DSC Westerton to Anniesland
COMPLETE EXAM?	YES/NO	Yes
	REASON NOT EXAMINED	N/A
	AREAS WHERE SHEETING REMOVED FOR EXAM	N/A
	AREAS OF SHEETING TO BE REMOVED FOR NEXT EXAM	N/A
ANY MONITORING RECORDED?		No
ANY AREAS IDENTIFIED DURING THIS EXAM THAT REQUIRE FUTURE MONITORING?		No
ANY EMERGENCY ACTION TAKEN DURING EXAM?		No
ANY SECTION MARKERS, SIGNS OR REFUGE REFLECTOR PLATES MISSING, DAMAGED, UNLCLEAR OR IN NEED OF REPLACEMENT?		No
ANY DRAINAGE OR DRAINAGE FEATURE EXAMINED DURING THIS EXAM?	DOWN PIPES	None
	SHAFT GARLANDS	None
	OTHER DRAINAGE FEATURES	None
WEATHER CONDITIONS AT TIME OF EXAM		Dry during examination.

PARTS NOT EXAMINED			
MaE	MiEl	Section Starting @ SM	AREA

TUNNEL NAME :	KNIGHTSWOOD TUNNEL	ELR :	NEM4	TUNNEL No. :	240/142	EXAM DATE :	13/09/2013	PAGE	4	OF	20

PRINCIPAL DIMENSIONS AND DEFECT RECORDING PAGE



PORTAL DRAINAGE

Yes. A section of drainage pipe is missing, see P1.

PORTAL 1 : Anniesland

PNR's		Height 1	Width 1	Height 2	Width 2
Dimensions					
TCMI					

PNR's		PPT2			
Dimensions		Height 1 4.5	Width 1 12.0	Height 2	Width 2
W	0	Masonry parapet built on a skew atop headwall.			
S	0				
J	0				
H	0				
B	0				
D	0				
C	0				
St	54.0				
TCMI	100				

PNR's		Height 1	Width 1	Height 2	Width 2
Dimensions					
TCMI					

PNR's		WWL1			
Dimensions		Height 1 8.0	Width 1 8.0	Height 2	Width 2
W	0	Moderate vegetation above. The drainage pipe on the down side of the tunnel portal has a section missing, see P1.			
S	0				
J	0				
H	0				
B	0				
D	0				
C	0				
St	64.0				
TCMI	100				

PNR's		HWL1			
Dimensions		Height 1	Width 1	Height 2	Width 2
W	Y	Blue engineering brick headwall built on a skew over the Tunnel entrance atop concrete beams. The beams are positioned at 90° to the abutments. See P11.			
S	0				
J	0				
H	0				
B	0				
D	0				
C	0				
Br		3W3			
TCMI					

PNR's		WWL2			
Dimensions		Height 1 8.0	Width 1 8.0	Height 2	Width 2
W	0				
S	0				
J	0				
H	0				
B	0				
D	0				
C	0				
St	64.0				
TCMI	100				

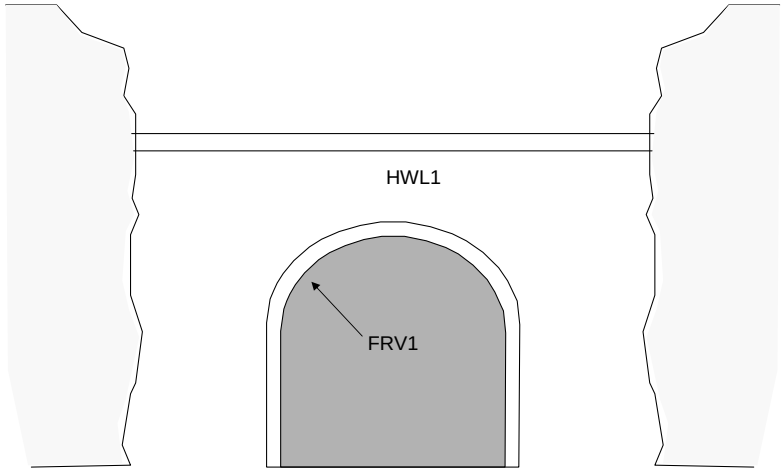
PNR's					
Dimensions		SW Ht	FRV Width	Bore Ht	Bore Width
TCMI					

DOWNSIDE

UPSIDE

TUNNEL NAME :	KNIGHTSWOOD TUNNEL	ELR :	NEM4	TUNNEL No. :	240/142	EXAM DATE :	13/09/2013	PAGE	5	OF	20

PRINCIPAL DIMENSIONS AND DEFECT RECORDING PAGE



NB: No parapet.

PORTAL DRAINAGE

No

PORTAL 2 : Westerton

PNR's					
Dimensions	Height 1	Width 1	Height 2	Width 2	
TCMI					

PNR's					
Dimensions	Height 1	Width 1	Height 2	Width 2	
TCMI					

PNR's					
Dimensions	Height 1	Width 1	Height 2	Width 2	
TCMI					

PNR's					
Dimensions	Height 1	Width 1	Height 2	Width 2	
TCMI					

PNR's	HWL1				
Dimensions	Height 1	1.0	Width 1	10.0	Height 2		Width 2	
W	0							
S	0							
J	0							
H	0							
B	0							
D	0							
C	0							
St	5.0							
TCMI	100							

Heavy vegetation covering the majority of the headwall and also heavy vegetation atop. A cable ladder track is fixed across the face of the headwall, see P5,P6 and P7.

PNR's					
Dimensions	Height 1	Width 1	Height 2	Width 2	
TCMI					

PNR's	FRV1							
Dimensions	SW Ht	2.4	FRV Wid	0.4	Bore Ht	5.9	Bore Wid	8.3
W	0							
S	0							
J	0							
H	0							
B	0							
D	0							
C	0							
St	7.2							
TCMI	100							

Good condition.

UPSIDE

DOWNSIDE

TUNNEL NAME :	KNIGHTSWOOD TUNNEL	ELR :	NEM4	TUNNEL No.	240/142	EXAM DATE:	13/09/2013	PAGE	6	OF	20

Anniesland END

SECTION MARKERS AT 20 m INTERVALS

VIEW PAGE AS A PLAN OF THE TUNNEL IN **EXTERNAL PROJECTION** (NOT TO SCALE)

℄

SM 0

Positive Nil Return

USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	St	TCMI	W	S	B	C	H			Co	TCMI	W	S	B	C	H			Co	TCMI	W	S	B	C	H			Co	TCMI	W	S	B	C	H			Co	TCMI	W	S	J	H	B	D	C	St	TCMI
Y	0	0	Y	0	0	0	116	78.1	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	100	Y	0	Y	Y	0	0	Y	116	60.4

Moss on s/wall

1HN

#1W2

1HN 60W4

UPSIDE

20.0 m

TS Length

The Soffit of the tunnel is constructed from Concrete beams extending from the tunnel portal to the Ch.2+00m marker.
All of the beams are in good condition

4mm fracture to top stone 5W3

Moss on s/wall

CC1.0AP3ST0SH0

4J2

60W4 1HN

DOWNSIDE

Broken duct covers

3mm step fracture to top 5 stones

See P3 #1W1

#1W1

SM 1

Positive Nil Return

USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	St	TCMI	W	S	B	C	H			Co	TCMI	W	S	B	C	H			Co	TCMI	W	S	B	C	H			Co	TCMI	W	S	B	C	H			Co	TCMI	W	S	J	H	B	D	C	St	TCMI
Y	Y	0	Y	0	0	0	116	80.3	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	100	Y	0	0	0	0	0	0	116	81

1HN

Broken duct cover

10W4

UPSIDE

20.0 m

TS Length

1HN 1HS

0.5S2

1HN

The Soffit of the tunnel is constructed from Concrete beams extending from the tunnel portal to the Ch. 2+00m marker.
All of the beams are in good condition.

#1W1

See P2

#1W1

Broken duct covers

110W4

#1W1

#1W1

DOWNSIDE

Temple Road

SM 2

Positive Nil Return

USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI
Y	Y	0	Y	0	0	0	48	65	0	Y	0	Y	0	0	0	100	83.7	Y	Y	0	Y	0	0	0	30	82.4	0	0	0	0	0	0	0	30	100	Y	Y	0	0	0	0	0	100	85.4	Y	Y	0	Y	0	0	0	48	72.8

2S2

47W4

2HS

1S2

R

1HN 1S2

In refuge

Concrete repair

3S2 1HN

1HN 1HN

R

0.5S2

2S2

Change of construction at Ch.2+00m

1W2

1HN

1S2

Concrete repair

1HN

2S1

3S2

1HN

70W4

38W44S2

to voussoir, see P12

1S2

R

Concrete repair

2S2 2HS

Mine shaft

UPSIDE

20.0 m

TS Length

DOWNSIDE

SM 3

Positive Nil Return

USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI
Y	Y	0	Y	0	0	0	48	64.2	Y	Y	0	Y	Y	0	0	100	68	Y	Y	0	0	0	0	0	30	87	0	0	0	0	0	0	0	30	100	Y	Y	0	Y	0	0	0	100	79.9	Y	Y	0	Y	0	0	0	48	62.6

3S1

2HN

24W4

Spalling around quoins & arch

1S1

R

1S1

3S2

Debris in

R

100W4

1HN

4BS

1HN 1S2

200mm square hole in crown 0.75m deep.

1W2

1S2

1W2

1W3

4S2

2HN

Calcite deposits 1S1 2S1

50W4

5S1

24W4

4S2

1HS

1HN

UPSIDE

20.0 m

TS Length

DOWNSIDE

SM 4

Positive Nil Return

USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI
Y	Y	0	Y	0	Y	0	48	58.4	Y	Y	0	Y	0	0	0	100	73.1	Y	0	0	0	0	0	0	30	93.1	0	0	0	Y	0	0	0	30	88	Y	Y	0	Y	0	0	0	100	76.5	Y	Y	0	0	0	0	0	48	83.7

1S2 Calcite deposits

R

2S2

2W3 in Refuge

Broken duct cover

1W3 in refuge

to quoin see P9

1S2 46W4

R

#6DM

1HN

2S2

10W3

90W4

1HN

Hole with steel drill bit protruding see P4

1W2

1W3

Concrete repair

1HN

#3W3

60W4

2HN

2S2

1S2

R

1S2 to backwall

Concrete repair

3S2

6S2 48W4

Concrete repair

UPSIDE

20.0 m

TS Length

DOWNSIDE

SM 5

Westerton END

TUNNEL NAME :	KNIGHTSWOOD TUNNEL	ELR :	NEM4	TUNNEL No.	240/142	EXAM DATE:	13/09/2013	PAGE	7	OF	20

Anniesland END

SECTION MARKERS AT 20 m INTERVALS

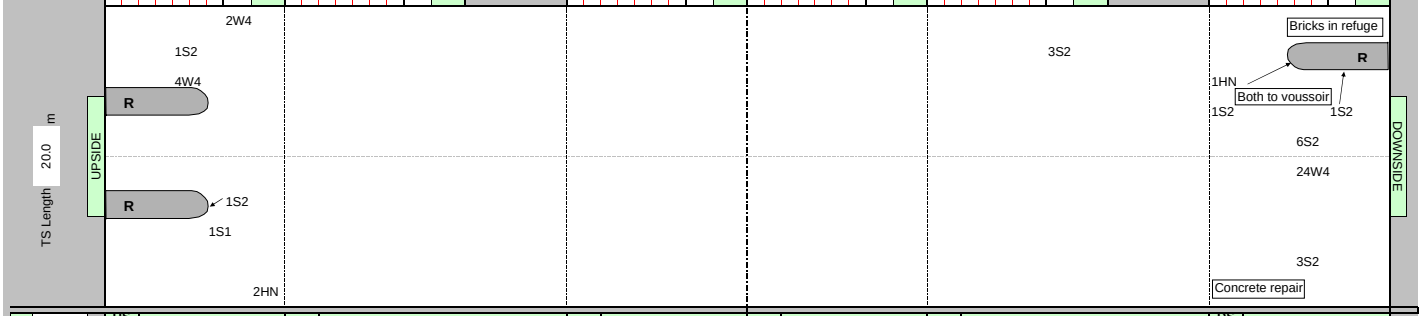
VIEW PAGE AS A PLAN OF THE TUNNEL IN **EXTERNAL PROJECTION** (NOT TO SCALE)

℄

SM 5

Positive Nil Return

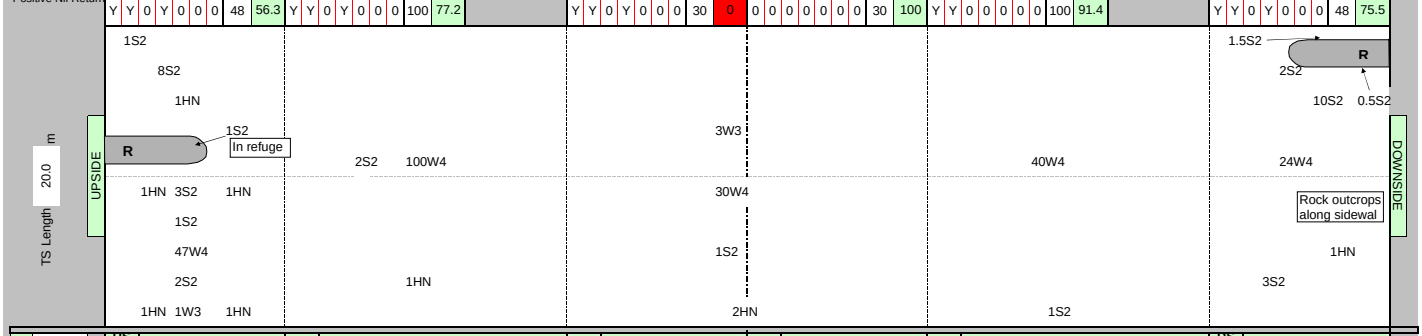
USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI
Y	Y	0	Y	0	0	0	48	75.8	0	0	0	0	0	0	0	100	100	0	0	0	0	0	0	0	30	100	0	0	0	0	0	0	0	30	100	0	Y	0	0	0	0	0	100	97.5	Y	Y	0	Y	0	0	0	48	76.2



SM 6

Positive Nil Return

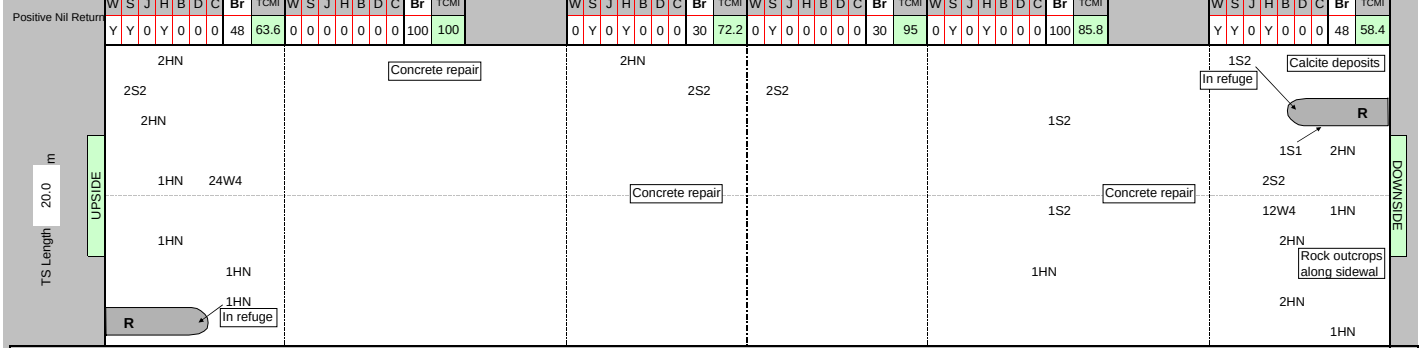
USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI
Y	Y	0	Y	0	0	0	48	56.3	Y	Y	0	Y	0	0	0	100	77.2	Y	Y	0	Y	0	0	0	30	0	0	0	0	0	0	0	0	30	100	Y	Y	0	0	0	0	0	100	91.4	Y	Y	0	Y	0	0	0	48	75.5



SM 7

Positive Nil Return

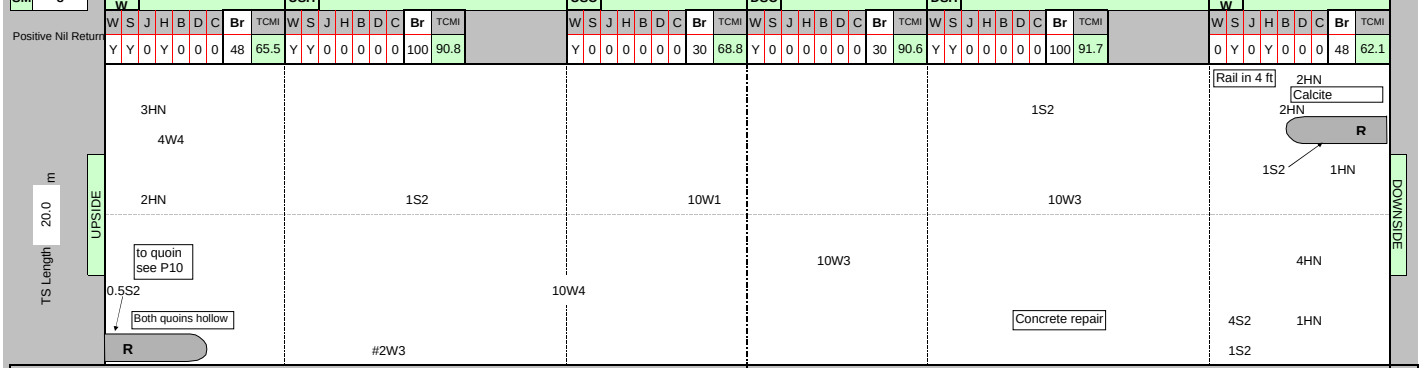
USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI
Y	Y	0	Y	0	0	0	48	63.6	0	0	0	0	0	0	0	100	100	0	Y	0	Y	0	0	0	30	72.2	0	Y	0	0	0	0	0	30	95	0	Y	0	Y	0	0	0	100	85.8	Y	Y	0	Y	0	0	0	48	58.4



SM 8

Positive Nil Return

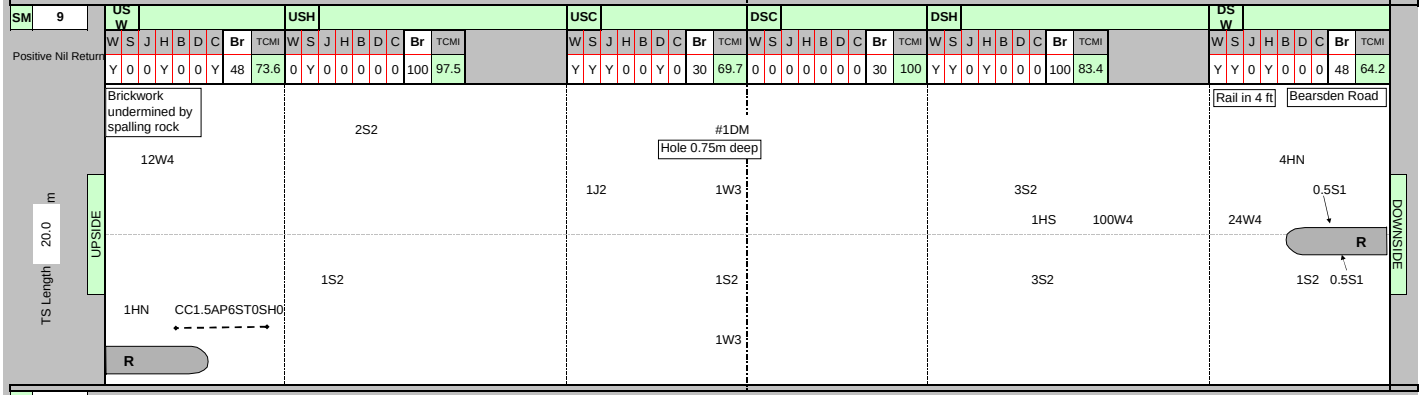
USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI
Y	Y	0	Y	0	0	0	48	65.5	Y	Y	0	0	0	0	0	100	90.8	Y	0	0	0	0	0	0	30	68.8	Y	0	0	0	0	0	0	30	90.6	Y	Y	0	0	0	0	0	100	91.7	0	Y	0	Y	0	0	0	48	62.1



SM 9

Positive Nil Return

USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI
Y	0	0	Y	0	0	Y	48	73.6	0	Y	0	0	0	0	0	100	97.5	Y	Y	Y	0	0	Y	0	30	69.7	0	0	0	0	0	0	0	30	100	Y	Y	0	Y	0	0	0	100	83.4	Y	Y	0	Y	0	0	0	48	64.2



SM 10

Westerton END

TUNNEL NAME :	KNIGHTSWOOD TUNNEL	ELR :	NEM4	TUNNEL No.	240/142	EXAM DATE:	13/09/2013	PAGE	8	OF	20

Anniesland END

SECTION MARKERS AT 20 m INTERVALS

VIEW PAGE AS A PLAN OF THE TUNNEL IN **EXTERNAL PROJECTION** (NOT TO SCALE)

℄

SM 10

Positive Nil Return

USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI
Y	0	0	Y	0	0	0	48	68.4	Y	Y	0	0	0	0	0	100	83.7	Y	Y	0	Y	0	0	0	30	70.1	Y	0	0	Y	0	0	0	30	79.2	Y	Y	0	Y	0	0	0	100	74.3	Y	Y	0	Y	0	0	0	48	77.5

m 20.0 TS Length

UPSIDE

DOWNSIDE

2HN
16S2
1HN
48W4
Calcite deposits
100W4
Rock outcrops along sidewal
1S2
Broken duct cover
4S2
2S2
5W3
25W4
Concrete repair
30W4
1HN
1HN
10S2
4S2
100W4
2HN
Concrete repair
1HN
2S2
Rail in 4 ft
1S1
1HS
1S2
48W4
2S2
0.5S1
R
0.5S1

SM 11

Positive Nil Return

USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI
Y	Y	0	Y	0	0	0	48	63.6	Y	Y	0	Y	0	0	0	100	74.3	Y	Y	0	0	0	0	0	30	0	Y	0	0	Y	0	0	0	30	79.2	Y	Y	0	Y	0	0	0	100	77.2	Y	Y	0	Y	0	0	0	48	64.1

m 20.0 TS Length

UPSIDE

DOWNSIDE

R
1S1
1HN
Concrete repair
6S2
2S2
7W3
3S2
2S2
1HN
10W3
48W4
100W4
20W4
30W4
100W4
1S2
Concrete repair
10S2
3S2
Concrete repair
2HN
1HN
3HN
1HN
1S2
1S2
In refuge
1S2
48W4
R
2S2
Rail in 4 ft
1HN
3HN
5S2

SM 12

Positive Nil Return

USW									USH									USC									DSC									DSH									DSW								
W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI	W	S	J	H	B	D	C	Br	TCMI
Y	Y	0	Y	0	0	0	17	54.2	Y	Y	0	Y	0	0	0	35	65	Y	0	0	0	0	0	0	11	90	Y	0	0	0	0	0	0	11	90	Y	Y	Y	0	0	0	0	35	68.9	Y	Y	0	Y	0	0	0	17	50.6

m 7.0 TS Length

UPSIDE

DOWNSIDE

1HN
1S1
1HN
16W4
Moss on sidewall
Cable troughing along sidewall
2HN
Concrete repair
3S2
35W4
10W4
10W4
4S2
Concrete repair
1J2
35W4
2S1
2HN
1S1
16W4
Moss on sidewall
to portal quoin
3S1

SM 12.35

Positive Nil Return

USW									USH									USC									DSC									DSH									DSW								
								TCMI									TCMI									TCMI									TCMI									TCMI								

m TS Length

UPSIDE

DOWNSIDE

SM

Positive Nil Return

USW									USH									USC									DSC									DSH									DSW								
								TCMI									TCMI									TCMI									TCMI									TCMI								

m TS Length

UPSIDE

DOWNSIDE

SM

Westerton END

TUNNEL EXAMINATION REPORT TYPE OF EXAM : **DETAILED**	TUNNEL NAME **KNIGHTSWOOD TUNNEL**	ELR **NEM4**	TUNNEL No **240/142**	**DEFECT PHOTOGRAPHS**
NETWORK RAIL TERRITORY : **Scotland**	EXAMINATION CONTRACTOR **Amey**	PAGE **9**	OF **20**	**1** EXAM DATE : **13/09/2013**

Description of Defect Shown in Photograph	Section of drainage pipe missing @ Anniesland portal



Photo Reference	P1	DATE OF PHOTOGRAPH…….	13-Sep-13

Description of Defect Shown in Photograph	Water ingress at Dn sidewall Ch.1+04m



Photo Reference	P2	DATE OF PHOTOGRAPH…….	13-Sep-13

TUNNEL EXAMINATION REPORT TYPE OF EXAM : **DETAILED**	TUNNEL NAME **KNIGHTSWOOD TUNNEL**	ELR **NEM4**	TUNNEL No **240/142**	**DEFECT PHOTOGRAPHS**
NETWORK RAIL TERRITORY : **Scotland**	EXAMINATION CONTRACTOR **Amey**	PAGE **10**	OF **20**	**2** EXAM DATE : **13/09/2013**

Description of Defect Shown in Photograph	Water ingress at Dn sidewall Ch.0+18m



Photo Reference	P3	DATE OF PHOTOGRAPH……..	13-Sep-13

Description of Defect Shown in Photograph	Hole in crown @ Ch.4+00m with steel drill bit protruding (rigid at time of exam).



Photo Reference	P4	DATE OF PHOTOGRAPH……..	13-Sep-13

TUNNEL EXAMINATION REPORT TYPE OF EXAM : **DETAILED**	TUNNEL NAME **KNIGHTSWOOD TUNNEL**	ELR **NEM4**	TUNNEL No **240/142**	**DEFECT PHOTOGRAPHS**
NETWORK RAIL TERRITORY : **Scotland**	EXAMINATION CONTRACTOR **Amey**	PAGE **11**	OF **20**	**3** EXAM DATE : **13/09/2013**

Description of Defect Shown in Photograph	Vegetation atop Westerton portal, also showing cable ladder track.



Photo Reference	P5	DATE OF PHOTOGRAPH…….	13-Sep-13

Description of Defect Shown in Photograph	Heavy vegetation atop Westerton portal.



Photo Reference	P6	DATE OF PHOTOGRAPH…….	13-Sep-13

TUNNEL EXAMINATION REPORT TYPE OF EXAM : **DETAILED**	TUNNEL NAME **KNIGHTSWOOD TUNNEL**	ELR **NEM4**	TUNNEL No **240/142**	**DEFECT PHOTOGRAPHS**
NETWORK RAIL TERRITORY : **Scotland**	EXAMINATION CONTRACTOR **Amey**	PAGE **12**	OF **20**	**4** EXAM DATE : **13/09/2013**

Description of Defect Shown in Photograph	Heavy vegetation atop Westerton portal.



Photo Reference	P7	DATE OF PHOTOGRAPH…….	13-Sep-13

Description of Defect Shown in Photograph	Access Point Information Sign with Up & Down lines shown incorrectly.

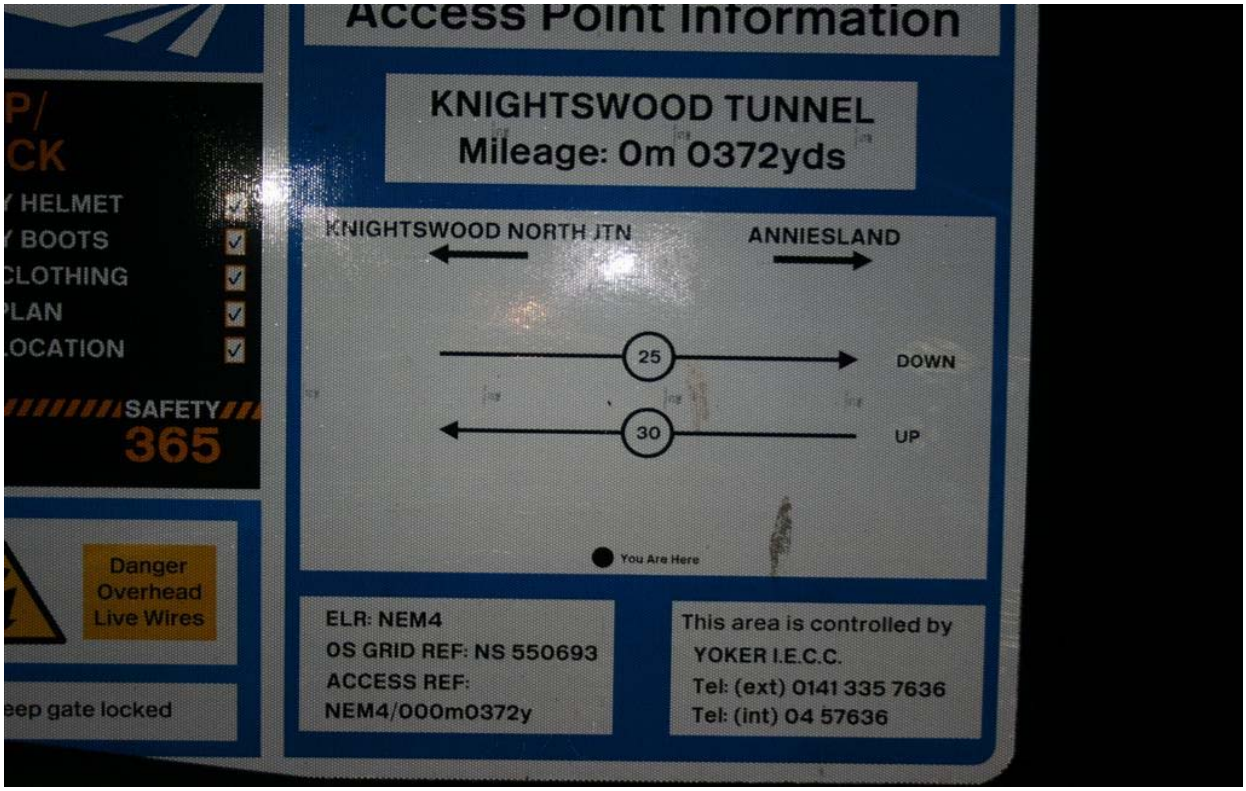


Photo Reference	P8	DATE OF PHOTOGRAPH…….	13-Sep-13

TUNNEL EXAMINATION REPORT TYPE OF EXAM : **DETAILED**	TUNNEL NAME **KNIGHTSWOOD TUNNEL**	ELR **NEM4**	TUNNEL No **240/142**	**DEFECT PHOTOGRAPHS**
NETWORK RAIL TERRITORY : **Scotland**	EXAMINATION CONTRACTOR **Amey**	PAGE **13**	OF **20**	**5** EXAM DATE : **13/09/2013**

Description of Defect Shown in Photograph	Spalling to quoin of Upside refuge @ Ch. 4+16m



Photo Reference	P9	DATE OF PHOTOGRAPH…….	09-Oct-12

Description of Defect Shown in Photograph	Spalling to quoin of Upside refuge @ Ch. 9+00m



Photo Reference	P10	DATE OF PHOTOGRAPH…….	09-Oct-12

TUNNEL EXAMINATION REPORT TYPE OF EXAM : **DETAILED**	TUNNEL NAME **KNIGHTSWOOD TUNNEL**	ELR **NEM4**	TUNNEL No **240/142**	**DEFECT PHOTOGRAPHS**
NETWORK RAIL TERRITORY : **Scotland**	EXAMINATION CONTRACTOR **Amey**	PAGE **14**	OF **20**	**6** EXAM DATE : **13/09/2013**

Description of Defect Shown in Photograph	Blue engineering brick headwall atop prestressed concrete beams @ Anniesland Portal.



Photo Reference	P11	DATE OF PHOTOGRAPH…….	13-Sep-13

Description of Defect Shown in Photograph	Spalling to voussoir of Downside refuge @ Ch. 2+12m



Photo Reference	P12	DATE OF PHOTOGRAPH…….	09-Oct-12

TUNNEL EXAMINATION REPORT TYPE OF EXAM : **DETAILED**	TUNNEL NAME **KNIGHTSWOOD TUNNEL**	ELR **NEM4**	TUNNEL No **240/142**	**WALKOVER PHOTOGRAPHS**
NETWORK RAIL TERRITORY : **Scotland**	EXAMINATION CONTRACTOR **Amey**	PAGE **15**	OF **20**	**1** EXAM DATE : **13/09/2013**

Description of Defect Shown in Photograph	Walkover and photo plan

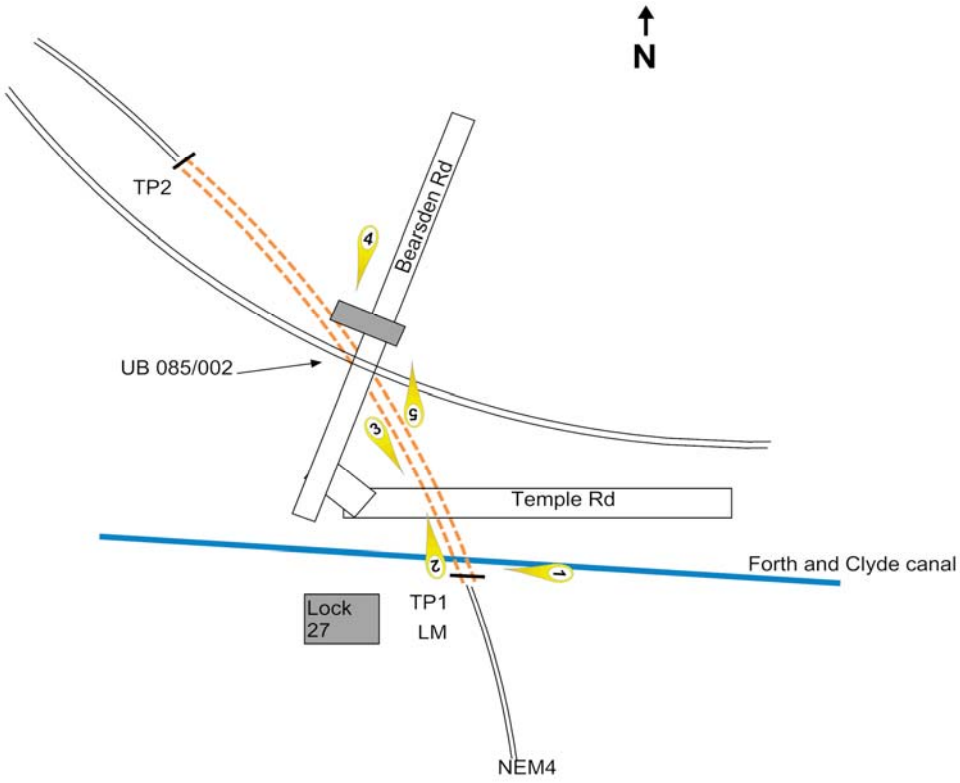


Photo Reference		DATE OF PHOTOGRAPH…….	15-Aug-13

Description of Defect Shown in Photograph	Anniesland portal parapet.



Photo Reference	WP1	DATE OF PHOTOGRAPH…….	15-Aug-13

TUNNEL EXAMINATION REPORT TYPE OF EXAM : **DETAILED**	TUNNEL NAME **KNIGHTSWOOD TUNNEL**	ELR **NEM4**	TUNNEL No **240/142**	**WALKOVER PHOTOGRAPHS**
NETWORK RAIL TERRITORY : **Scotland**	EXAMINATION CONTRACTOR **Amey**	PAGE **16**	OF **20**	**2** EXAM DATE : **13/09/2013**

Description of Defect Shown in Photograph	View over line of tunnel towards Westerton portal.



Photo Reference	WP2	DATE OF PHOTOGRAPH…….	15-Aug-13

Description of Defect Shown in Photograph	View towards Anniesland portal.



Photo Reference	WP3	DATE OF PHOTOGRAPH…….	15-Aug-13

TUNNEL EXAMINATION REPORT TYPE OF EXAM : **DETAILED**	TUNNEL NAME **KNIGHTSWOOD TUNNEL**	ELR **NEM4**	TUNNEL No **240/142**	**WALKOVER PHOTOGRAPHS**
NETWORK RAIL TERRITORY : **Scotland**	EXAMINATION CONTRACTOR **Amey**	PAGE **17**	OF **20**	**3** EXAM DATE : **13/09/2013**

Description of Defect Shown in Photograph	View of Bearsden Road above tunnel Southwards.



Photo Reference	WP4	DATE OF PHOTOGRAPH…….	15-Aug-13

Description of Defect Shown in Photograph	View of Bearsden Road above tunnel Northwards.



Photo Reference	WP5	DATE OF PHOTOGRAPH…….	15-Aug-13

EXAMINATION DETAILS

The detailed examination was carried out during a midweek nightshift T3 possessions, using an RRV MEWP.
The weather at the time of examination was dry and dry on preceding days.

The examination was carried out in the following order:-
1. Down sidewall, Up haunch and crown Anniesland towards Westerton.
2. Up sidewall, Down haunch and crown Westerton towards Anniesland.

GENERAL DESCRIPTION

Knightswood Tunnel is located on the Drumgelloch to Helensburgh (North Electric Main Line) line. The tunnel carries public roads, residential properties, MRL railway line & the Forth & Clyde canal. It is a bore of 247m long carrying two tracks with overhead electrification.
The tunnel consists of two main construction sections. From the Anniesland portal the first 2 chains are constructed from prestressed concrete M beams supported on masonry abutments. This section of the tunnel carries the Forth & Clyde canal. The remainder of the tunnel is constructed of a brickwork arch throughout. From Ch.6+00m the sidewalls are sprung off rock.
The wingwalls & portals are constructed of stone and brick. There is #1 hidden mine shaft @ Ch.3 within the tunnel.
Tablet markers are signed from the Anniesland portal.There is drainage running the length of the tunnel both in the 6 foot & 4 foot.

CONDITION OF TUNNEL

The tunnel has had some concrete patch repairs carried out in recent years and shows little change from the previous examination.
The concrete beams are in good condition.
The brick arch section is generally poor (due to the water ingress) and there are several areas of open joints & spalling throughout the tunnel as noted in the report along with isolated missing bricks. The Westerton portal has heavy vegetation on and atop.

WATER INGRESS AND LINING DEPOSITS

The tunnel bore is generally wet with heavy water ingress at Downside wall in the vicinity of Ch.1+00m and other areas as noted in the report.
A section of the drainage pipe @ the Anniesland portal is missing.

TUNNEL WALKOVER

A tunnel walkover was undertaken on 15 August 2013, see WP's 1 to 5.
No ground depressions were visible and no construction works were noted at this time.

FUTURE MAINTENANCE AND REPAIR

Generally the tunnel is in fair condition, although the following maintenance issues should be addressed:-

1. Consider installing a water management system. E2x4
2. Consider repairs to spalled & missing brickwork throughout. E2x4
3. Consider clearing vegetation from the Westerton portal headwall & Anniesland portal wingwall. M2x4
4. Consider replacing missing section of down pipe. S2x3
5. Consider removing redundant rails from four foot. S5x2
6. Consider replacing missing/damaged duct covers. S2x3
7. Remove protruding steel drill bit. S5x2

NB: The Access Point Information board at the LM (Anniesland) end of the tunnel still shows the Up & Down lines incorrectly, see P8. This was reported to NR Control on the day of the examination.

TUNNEL NAME :	KNIGHTSWOOD TUNNEL	ELR :	NEM4	TUNNEL No.	240/142	EXAM DATE	13/09/2013	PAGE	19	OF	20

SUMMARY TCMI SCORES	
BORE	81
PORTAL 1	100
PORTAL 2	100

Lowest Scores & Locations	
0	TS12 USC ; TS7 USC
51	TS13 DSW
54	TS13 USW

Key:	>=	<
	0	40
	40	80
	80	100

Major element scores in bold

Minor element scores in normal font

Portal scores

TP1	TP2
100	100

PPT2	
100	

WWL1	WWL2
100	100

HWL1
100

FRV1
100

Shaft Eye Scores

Side Ring Voussoirs

Cross Passages & Adits

Tunnel Section Scores

	TS1	TS2	TS3	TS4	TS5	TS6	TS7	TS8	TS9	TS10	TS11	TS12	TS13
	94	**96**	**85**	**82**	**82**	**95**	**63**	**82**	**80**	**83**	**76**	**55**	**76**
USW	78	80	65	64	58	76	56	64	66	74	68	64	54
USH	100	100	84	68	73	100	77	100	91	98	84	74	65
USC	100	100	82	87	93	100	0	72	69	70	70	0	90
DSC	100	100	100	100	88	100	100	95	91	100	79	79	90
DSH	100	100	85	80	76	98	91	86	92	83	74	77	69
DSW	60	81	73	63	84	76	76	58	62	64	78	64	51

TUNNEL NAME	ELR	TUNNEL No.	EXAM DATE	PAGE
KNIGHTSWOOD TUNNEL	***NEM4***	***240/142***	***13/09/2013***	***20 of 20***

Major Element		Minor Element						Defect areas/crack lengths																																																						Min EI	Maj EI	Tunnel
Code	No	Code	No	Mat	Length	Circum	Area																																																												
ME	MEn	MI	MIn	Mat	Len	Cir	Area	BC	BH	BS	CC1	CC2	CC3	CC4	CD1	CD2	CD3	CD4	CH1	CH2	CH3	CH4	CL1	CL2	CL3	CL4	CS1	CS2	CS3	CS4	CU1	CU2	CU3	CU4	CV1	CV2	CV3	CV4	DL	DM	DN	HN	HS	J1	J2	J3	MC1	MC2	MC3	MC4	NE	S1	S2	S3	SR1	SR2	SR3	SS1	SS2	SS3	W1	W2	W3	W4	W5	TCMI	TCMI	TCMI
TP	1	PPT	2	St	12.0	12.0	54.0																																																											100.0	100.0	100.0
TP	1	WWL	1	St	8.0	8.0	64.0																																																											100.0		
TP	1	WWL	2	St	8.0	8.0	64.0																																																											100.0		
TP	2	HWL	1	St	10.0	10.0	5.0																																																											100.0	100.0	
TP	2	FRV	1	St	0.4	13.1	7.2																																																											100.0		
TS	1	USW	1	St	20.0	5.8	116.2																																			2.0																				0.1		60.0		78.1	93.9	80.6
TS	1	USH	1	Co	20.0	0.0	0.2																																																											100.0		
TS	1	USC	1	Co	20.0	0.0	0.2																																																											100.0		
TS	1	DSC	1	Co	20.0	0.0	0.2																																																											100.0		
TS	1	DSH	1	Co	20.0	0.0	0.2																																																											100.0		
TS	1	DSW	1	St	20.0	5.8	116.2						1.0																													1.0			4.0																	0.2		5.0	60.0		60.4		
TS	2	USW	1	St	20.0	5.8	116.2																																			3.0	1.0										0.5												10.0		80.3	96.1	
TS	2	USH	1	Co	20.0	0.0	0.2																																																											100.0		
TS	2	USC	1	Co	20.0	0.0	0.2																																																											100.0		
TS	2	DSC	1	Co	20.0	0.0	0.2																																																											100.0		
TS	2	DSH	1	Co	20.0	0.0	0.2																																																											100.0		
TS	2	DSW	1	St	20.0	5.8	116.2																																																							0.4			110.0		81.0		
TS	3	USW	1	Br	20.0	2.4	48.0																																			4.0											4.5												47.0		65.0	84.7	
TS	3	USH	1	Br	20.0	5.0	100.0																																			1.0	2.0										5.0														83.7		
TS	3	USC	1	Br	20.0	1.5	30.0																																			1.0											1.0										1.0				82.4		
TS	3	DSC	1	Br	20.0	1.5	30.0																																																											100.0		
TS	3	DSH	1	Br	20.0	5.0	100.0																																													2.0													70.0		85.4		
TS	3	DSW	1	Br	20.0	2.4	48.0																																			1.0	2.0										10.0												38.0		72.8		
TS	4	USW	1	Br	20.0	2.4	48.0																																			2.0										5.0	3.0												24.0		64.2	81.6	
TS	4	USH	1	Br	20.0	5.0	100.0			4.0																																2.0											1.0												100.0		68.0		
TS	4	USC	1	Br	20.0	1.5	30.0																																														1.0										2.0	1.0			87.0		
TS	4	DSC	1	Br	20.0	1.5	30.0																																																											100.0		
TS	4	DSH	1	Br	20.0	5.0	100.0																																			1.0											4.0												50.0		79.9		
TS	4	DSW	1	Br	20.0	2.4	48.0																																			2.0	1.0									8.0	4.0												24.0		62.6		
TS	5	USW	1	Br	20.0	2.4	48.0																																	1.2		1.0											4.0											2.0	46.0		58.4	81.9	
TS	5	USH	1	Br	20.0	5.0	100.0																																			1.0											2.0											10.0	90.0		73.1		
TS	5	USC	1	Br	20.0	1.5	30.0																																																								1.0	1.0			93.1		
TS	5	DSC	1	Br	20.0	1.5	30.0																																			1.0																									88.0		
TS	5	DSH	1	Br	20.0	5.0	100.0																																			2.0											2.0											0.3	60.0		76.5		
TS	5	DSW	1	Br	20.0	2.4	48.0																																														11.0												48.0		83.7		
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TS	6	USH	1	Br	20.0	5.0	100.0																																																											100.0		
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TS	6	DSC	1	Br	20.0	1.5	30.0																																																											100.0		
TS	6	DSH	1	Br	20.0	5.0	100.0																																														3.0														97.5		
TS	6	DSW	1	Br	20.0	2.4	48.0																																			1.0											11.0												24.0		76.2		
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TS	7	USH	1	Br	20.0	5.0	100.0																																			1.0											2.0												100.0		77.2		
TS	7	USC	1	Br	20.0	1.5	30.0																																			2.0											1.0											3.0	30.0		0.0		
TS	7	DSC	1	Br	20.0	1.5	30.0																																																											100.0		
TS	7	DSH	1	Br	20.0	5.0	100.0																																														1.0												40.0		91.4		
TS	7	DSW	1	Br	20.0	2.4	48.0																																			1.0											17.0												24.0		75.5		
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TS	8	USC	1	Br	20.0	1.5	30.0																																			2.0											2.0														72.2		
TS	8	DSC	1	Br	20.0	1.5	30.0																																														2.0														95.0		
TS	8	DSH	1	Br	20.0	5.0	100.0																																			1.0											2.0														85.8		
TS	8	DSW	1	Br	20.0	2.4	48.0																																			8.0										1.0	3.0												12.0		58.4		
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TS	9	USC	1	Br	20.0	1.5	30.0																																																							10.0					68.8		
TS	9	DSC	1	Br	20.0	1.5	30.0																																																									10.0			90.6		
TS	9	DSH	1	Br	20.0	5.0	100.0																																														1.0											10.0			91.7		
TS	9	DSW	1	Br	20.0	2.4	48.0																																			10.0											6.0														62.1		
TS	10	USW	1	Br	20.0	2.4	48.0					1.5																														1.0																							12.0		73.6	83.3	
TS	10	USH	1	Br	20.0	5.0	100.0																																														3.0														97.5		
TS	10	USC	1	Br	20.0	1.5	30.0																																	0.2					1.0								1.0											2.0			69.7		
TS	10	DSC	1	Br	20.0	1.5	30.0																																																											100.0		
TS	10	DSH	1	Br	20.0	5.0	100.0																																				1.0										6.0												100.0		83.4		
TS	10	DSW	1	Br	20.0	2.4	48.0																																			4.0										1.0	1.0												24.0		64.2		
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TS	11	USH	1	Br	20.0	5.0	100.0																																														21.0												100.0		83.7		
TS	11	USC	1	Br	20.0	1.5	30.0																																			1.0											2.0											5.0	25.0		70.1		
TS	11	DSC	1	Br	20.0	1.5	30.0																																			1.0																							30.0		79.2		
TS	11	DSH	1	Br	20.0	5.0	100.0																																			3.0											20.0												100.0		74.3		
TS	11	DSW	1	Br	20.0	2.4	48.0																																				1.0									2.0	3.0												48.0		77.5		
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TS	12	USH	1	Br	20.0	5.0	100.0																																			1.0											20.0												100.0		74.3		
TS	12	USC	1	Br	20.0	1.5	30.0																																														6.0											17.0	20.0		0.0		
TS	12	DSC	1	Br	20.0	1.5	30.0																																			1.0																							30.0		79.2		
TS	12	DSH	1	Br	20.0	5.0	100.0																																			2.0											2.0												100.0		77.2		
TS	12	DSW	1	Br	20.0	2.4	48.0																																			4.0											9.0												48.0		64.1		
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TS	13	USC	1	Br	7.0	1.5	10.5																																																										10.0		90.0		

Appendix F

Project Manager's Remit

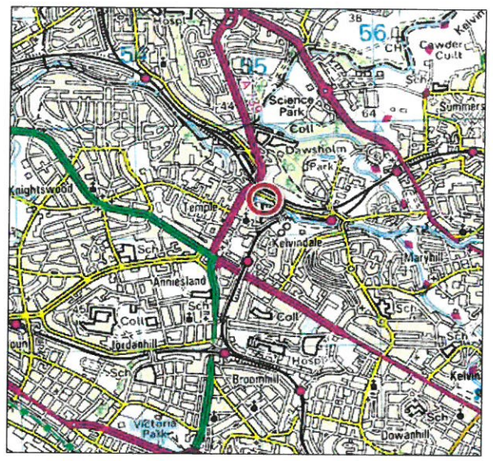
T 240/142 Knightswood Tunnel: Repairs and Water Management Works

Project Manager's Remit

Version 1: Issued for Design Development Approval

Project Name;	T 240/142 Knightswood Tunnel Repairs & Water Management Works
Asset Description;	Cut and Cover lined tunnel. Lined with brickwork from chain 2.. First 2 chains are constructed from pre-stressed concrete M beams. Double track. Carries public roads, residential properties, MRL railway line, and Canal. Electrified. Portal 1 (Anniesland) consists of masonry sidewalls, and the concrete beams, which support the Forth & Clyde canal above. Portal 2 (Westerton) is contructed with sandstone, with a cable ladder rack attached to the spandrell and headwall areas. The tunnel is 270 yards in length (247m). There is 1 shaft below track level, which was capped in 1943. Possible mine shaft above the crown - MW item raised to investigate this. During construction, tunnel intersected with former Garscube No3 coal pit shaft (approx 60 from souther portal). In 1984 cast iron section under the canal was replaced with the concrete M beams, in the early 2000, the canals ingress was such that extensive remediation works were carried out with British Waterways. Works included draining of canal sections, several times, lowering the lock gates and grouting tunnel walls following discovery of scour holes. TAM carried out a waterproofing trial using hydrophobic foam in 2007. It was a success in the areas selected. Some areas of works to undertake lining repairs were left incomplete due to water ingress issues.
Asset type (RWI;	Tunnel
Activity definition (SACP Worktype);	Primary: Repair Secondary: Preventative





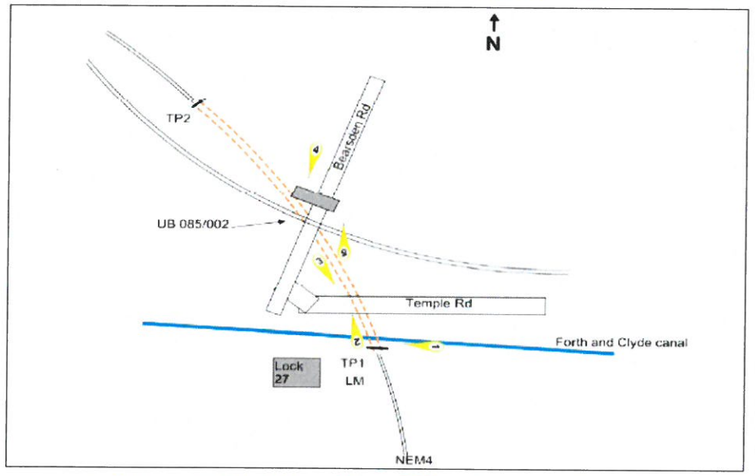
	Mileage / Chains	
ELR	**From**	**To**
NEM4	0.0480	0.0750

BP UID	OP Ref	OS Grid Ref	Railway ID

Volume					
Qty	**Units**	**GRIP Complexity**	**Prioritisation Score**	**Corporate risk score**	**Implementation Year**
Primary: 100 Secondary: 50	m2 internal treated area				2016/2017

Work Item Description (Problem statement)	The tunnel suffers from heavy water ingress issues, which is having a detrimental effect on the brickwork lining. The TCMI scores are low on some elements as a result of this. Additionally, non-Structures assets within the tunnel are at risk of being compromised due to water ingress, and potential performance issues.	**ROGS Category**	
Driver	Primary: 2a - Performance Secondary: 4b – Condition - WLC	**Site Visited (indicate by Asset Mgt, IP or both)**	AM
Time		**Abnormal Possessions**	See Time
Last detailed exam	13/09/2014	**Notes; (relevant background)**	Various MW listed that possibly should be incoprporated in BP scheme. Access shared with Lock 27 bar and restaurant - route is often strewn with dog mess, and steps down pump hose are very overgrown with vegetation. Care should be taken if veiwin while traffic rinning (unlikley) as curve does not allow for adequate sighting. New GSM mast , now means track cannot be accessed at this point. Information sign at gate has now been removed as up and down lines were noted as incorrect.

Scope
GRIP 2-3: Produce a schedule of brickwork repairs and repointing for agreement with the Sponsor. Particular areas to note can be found at Ch06+13m and Ch05+14m. Carry out any intrusive site investigation necessary to confirm the scope / remediation technique for water management works (likely to include grouting works). Provide proposal for managing water ingress in tunnel sidewall and wingwall at Anniesland portal. GRIP 4-8: Implement agreed brickwork repairs and repointing, water management measures. Devegetate portals and wingwalls, including treatment of all remaining roots. The project team are to liaise with the CEFA Contract Management Team to arrange a post works TCMI score for the structure. This should be programmed to maximise efficiency in use of site access equipment. TCMI score examination will be procured and funded through the CEFA Contract.



SH000382

SH000382

LAING MANAGEMENT (SCOTLAND) LTD - RAILTRACK
PROJECT DELIVERY

STRUCTURES MAINTENANCE AND RENEWALS

DMFP10004518

STRUCTURE REFERENCE: OB 240/142

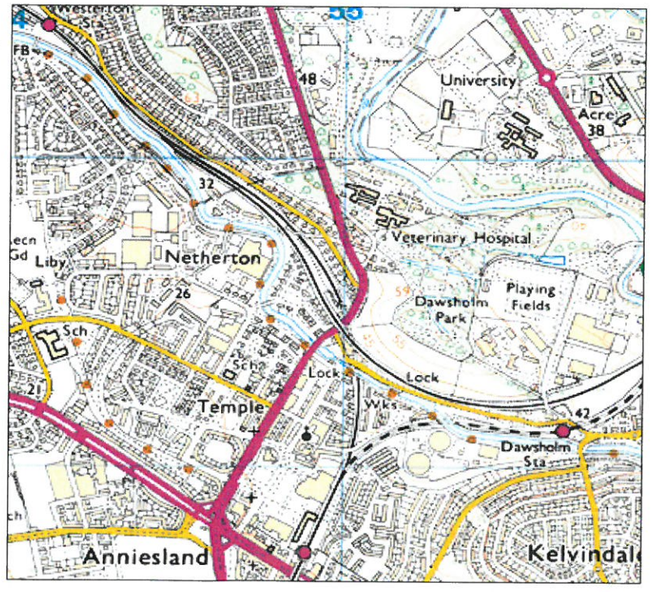
KNIGHTSWOOD TUNNEL REFURBISHMENT

MAY 1998 TO OCTOBER 1998

DESIGN CONTRACTOR: DONALDSON ASSOCIATES LTD

WORKS CONTRACTOR: JOHN MOWLEM PLC

HANDBACK PACKAGE
FILE NUMBER 1 OF 1



Key Project Constraints

Success criteria	(i) Improved overall TCMI score for tunnel bore. (ii) Improve all tunnel segments with a BCMI score <60 in latest Detailed Exam to >80.	**Funding**	£248k provision made in RAM Structures BP with DD funding in 14/15 & Imp funding in 16/17. AFC is pre-efficient based on BVRT Unit Rates inc inflation	**Geometry**	
CDM Clients' Duties		**Paint lead content?**		**Asbestos?**	
Confined Spaces?		**Other Safety Risks**			
Ancient Mines or drilling and remediation over coal areas. Based on the Mining Report		**Environmental**	Runs underneath the Forth and Clyde canal (Ancient Monument)		

At Single Option (state option to be developed)		**Option Determination Method**	
CDM Designers' Duties	N/A		
AIP Required?	N/A		

Design Criteria	Design Loading	Design annual tonnage	Traffic type for fatigue	Vertical clearances	Lateral clearances
See Work Item Description	See Work Item Description	N/A	N/A		

Ballast depth	Line speed / road speed	Bearing / articulation	parapet containment / height	Collision loading	Signalling requirements
	40mph Linespeed	Arching Action	See Work Item Description	See Work Item Description	See Work Item Description

Electrification requirements	Special access / inspeciton / mtce	Materials / finishes	Depatures from standards	Design Life
See Work Item Description	See Work Item Description	See Work Item Description	See Work Item Description	60yrs

Development Delivery Route	Proposed RCDP Package SCOT 001
Implementation Delivery Route	Proposed RCDP Package SCOT 001
Comments	Review at Workbank Planning Meeting (23/06/14): Shotcrete & Water Management, not waterproofing. Succesful historic use of grout? Queen Street? NR Asset Engineer will attend joint tunnel walkthrough with RCDP Contractor to firm up scope prior to design development commencing. From Workbank Review Meeting (23/06/14): Sponsor to provide electronic copies of Tunnel Management Strategy documents.
CDM Responsibilities	**Client:** Network Rail Infrastructure Ltd., 1 Eversholt Street, London, NW1 2DN. **Client's Representative:** Ben Edwards (Director - Route Asset Management [Scotland]) **CDM Co-ordinator:** Network Rail Infrastructure Ltd., 1 Eversholt Street, London, NW1 2DN. **CDM Co-ordinator's Representative:** Owen Ferry (Project Manager, IP SNE) **Sponsor:** Andrew Anderson (Route Asset Manager [Structures]) **Project Manager:** Owen Ferry

Project Manager's Remit

SCOTRAIL

TUNNEL CONDITION REPORT

240/142

DMFP10036868

CONTRACT No. J410443

KNIGHTSWOOD TUNNEL

KNIGHTSWOODS TUNNEL
TUNNEL CONDITION SURVEY
C.H.W. NOVEMBER 1994

NOVEMBER 1994

Scotrail
Civil Engineer, West
Scotrail House
Glasgow
G4 OHG

Crouch Hogg Waterman
The Octagon
35 Baird Street
Glasgow
G4 OEE

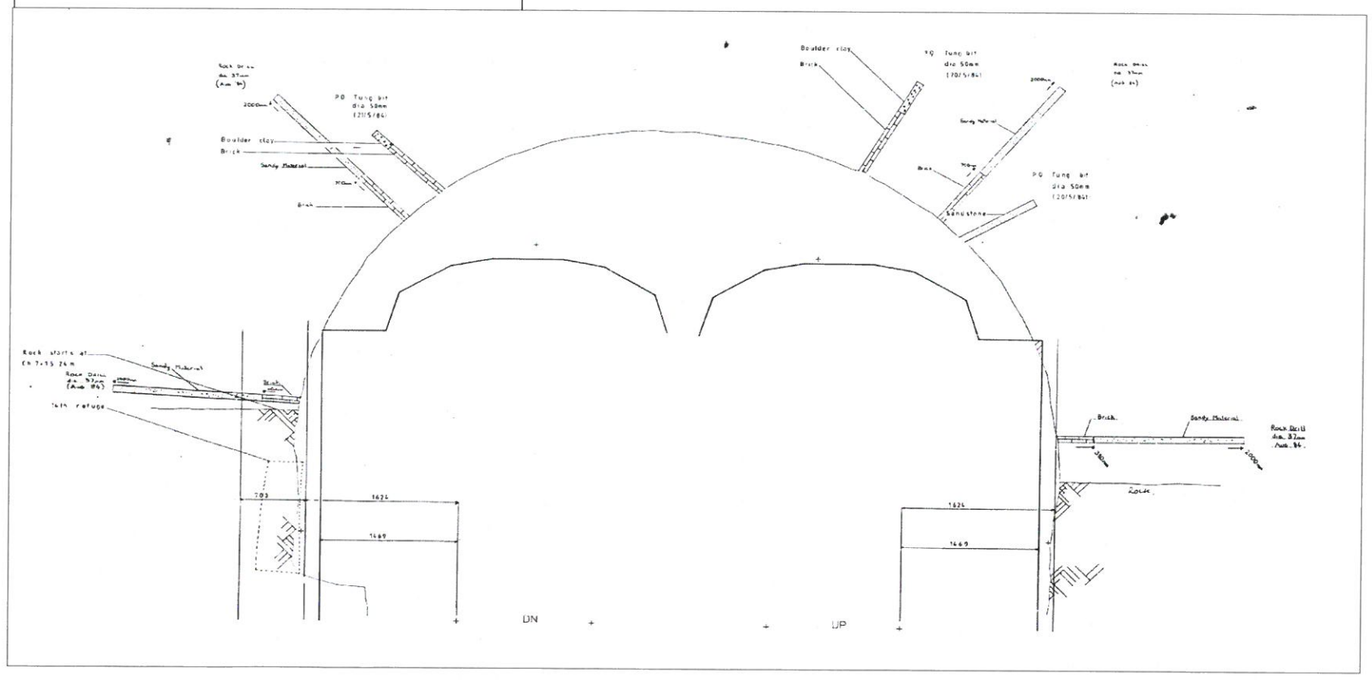
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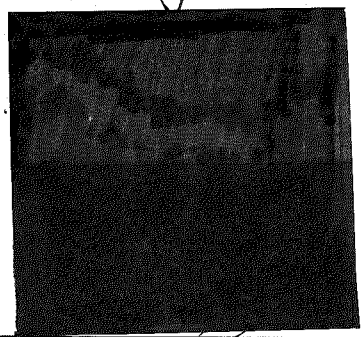
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2.0	Findings	1
3.0	Conclusion	5

Appendix A - Trial Pits/Borehole Logs
Appendix B - Photographs
Appendix C - Drawings
Appendix D - Database Input Sheet
Appendix E - Tunnel examination reports 1991, 92, 93
Appendix F - Background Information
Appendix G - Impulse Geophysics Records
Appendix H - IGS Report 1981



Project Manager's Remit



DM.

Position Development Manager
Date 11/05/2015.

Position Senior Asset Engineer (Structures)
Date 26/05/2015

Position Sponsor
Date 25/5/2015

Position Project Manager
Date 08/06/15.

Records Available (at Remit issue date)	Record search made of available systems on 20/06/2014. Exams: Detailed Exam September 2013 - Tunnel Bore + Portals + Hidden Shaft; Sep 2013 TCMI Assessment: Month Year; Extra e.g. Initial Scour Assessment Month Year From CCMS2 Archive: inc. e.g. H&S File + Record Drawings + Historic Bridge Files + Historic Tunnel Examinations

Appendix G

Interim Report on Water Ingress

Knightswood Tunnel

Interim report - Water Ingress

July 2015







Network Rail

FAIRHURST

AMCOrail

CONTROL SHEET

CLIENT: Amalgamated Construction Ltd

PROJECT TITLE: Knightswood Tunnel

REPORT TITLE: Knightswood Tunnel
Water Ingress

PROJECT REFERENCE: 109055

Issue and Approval Schedule:

ISSUE 1	Name	Signature	Date
Prepared by	David Emery	DE (Note 1)	09/07/15
Reviewed by	Grant Scholes	GS (Note 1)	09/07/15
Approved by	Grant Scholes	GS (Note 1)	09/07/15

Note 1: Signed copies held by Fairhurst

Revision Record:

Issue	Date	Status	Description	By	Chk	App
2						
3						
4						
5						
6						

This report has been prepared in accordance with procedure OP/P02 of Fairhurst's integrated Quality and Environmental Management System (QEMS)

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1.3 Photographs 4

Appendix A: Drawings

1.0 Information

1.1 General Information

Fairhurst were commissioned by Amalgamated Construction Ltd (AMCO) to carry out an inspection of Knightswood Tunnel situated in Anniesland, Glasgow with a view to proposing remedial works to be carried out. Initial submission will be a Form 001 Approval in Principle which will be followed by design and subsequent construction drawings to allow works to be carried out.

This interim report has been prepared to highlight water ingress at one particular location in the tunnel that may be associated with Scottish Water infrastructure.

Using the 2013 Detailed Examination report as a baseline, our recent inspection highlighted little or no change in the previously reported condition. The inspection was carried out at night during a full line blockage. The inspection was visual and undertaken from track level with photographic records taken. No specialist access techniques were used or intrusive investigations were carried out.

1.2 Findings

Water ingress and spalling was noted at various locations in the tunnel. Based on the 2013 Network Rail Structures Detailed Examination report, the tunnel did not appear to have significantly deteriorated and the conditions noted in the report are still valid. At chainage 180m around the area below Bearsden road, water was observed running from the crown of the tunnel. The wet area is approximately 10m^2 area and water was running down the hunches and sidewall (Photos 1 and 2). The water ingress from the crown suggested a source directly above which may be from a utilities pipe running along the road.

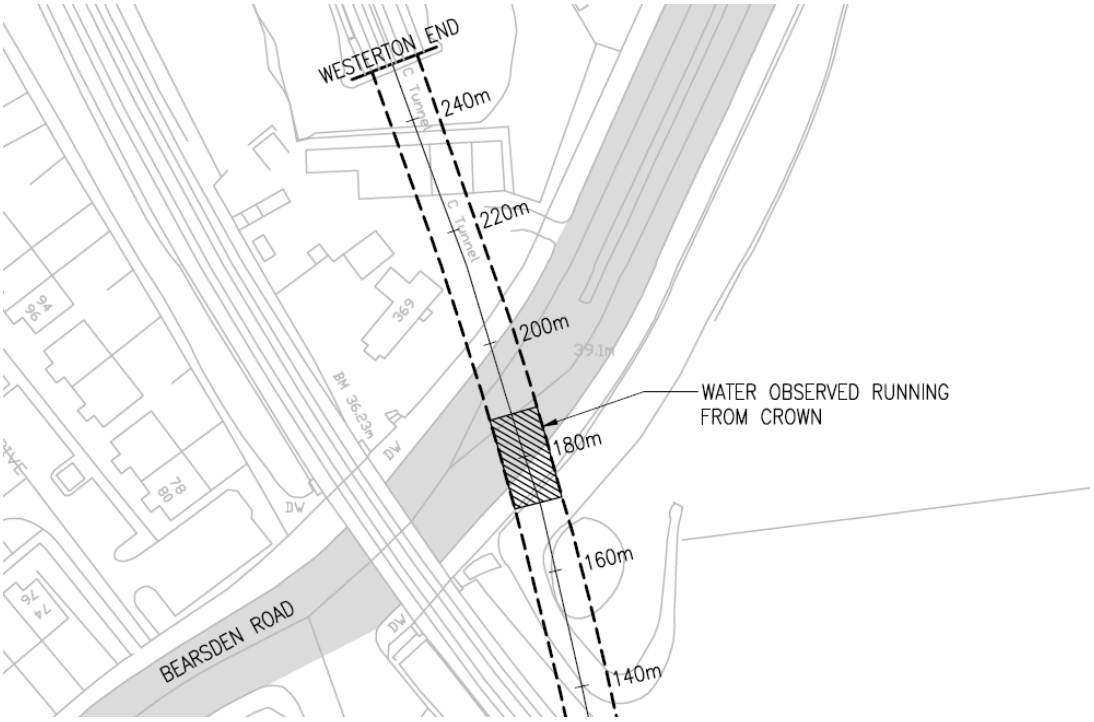


Figure 1 Approximate Location of Water Ingress under Bearsden Road

It is recommended that Scottish Water is advised and any local water pipes identified as a potential source.

Figure 1 above is an extract from the location plan drawing included in Appendix A. The drawing has subdivided the tunnel into 20m chainages and shows the location relative to the surface.

Figure 2 is an extract from the Examination Report on the Examination carried out on 13 September 2013. This is a schematic developed plan of the tunnel lining with features noted using a defined notation system for type, severity and extent.

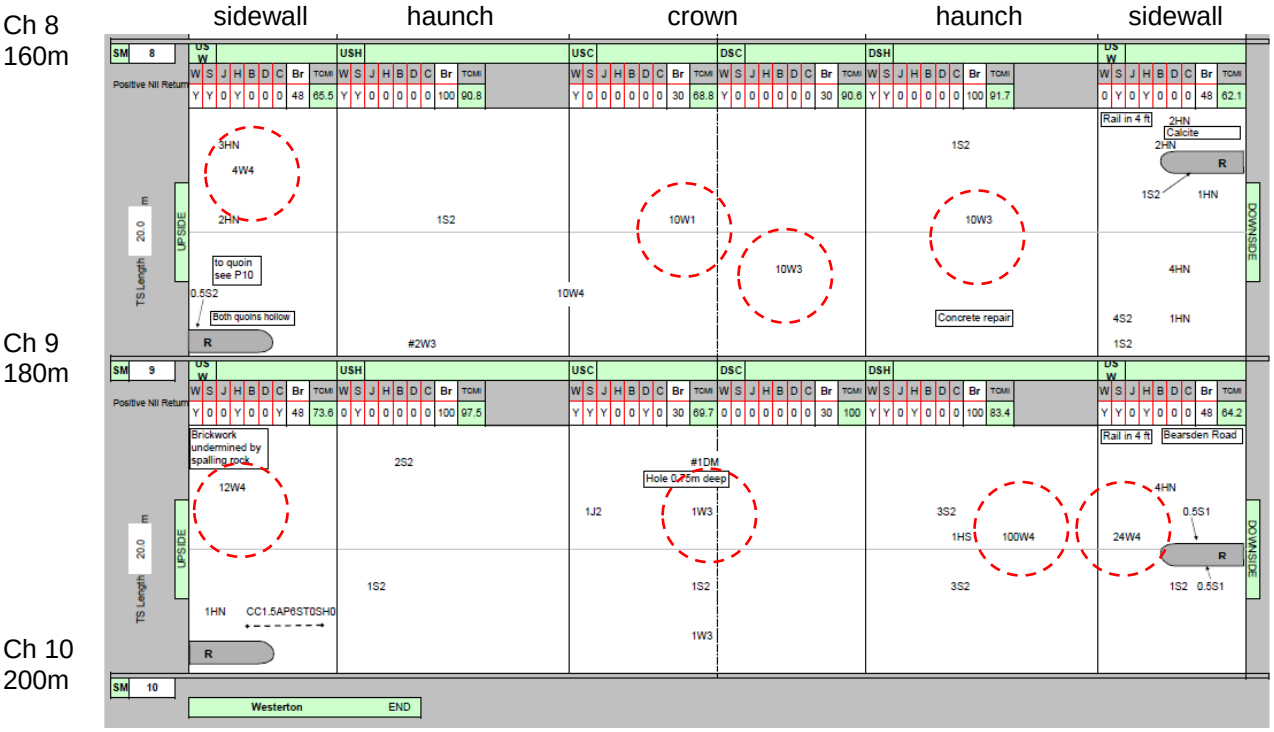


Figure 2 Extract from Examination Report. This shows schematically defects and issues with the tunnel lining. Water ingress features are circled.

Key

*x*W1 denotes *x* square metres with water ingress under pressure
*x*W2 denotes *x* square metres with wet running water
*x*W2 denotes *x* square metres with wet dripping water
*x*W2 denotes *x* square metres damp or wet with no water movement

1.3 Photographs

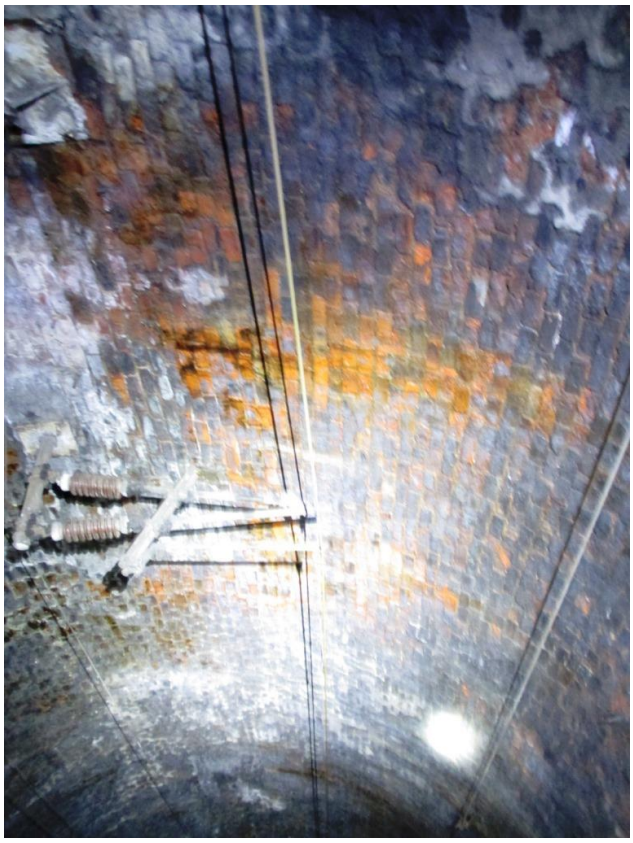


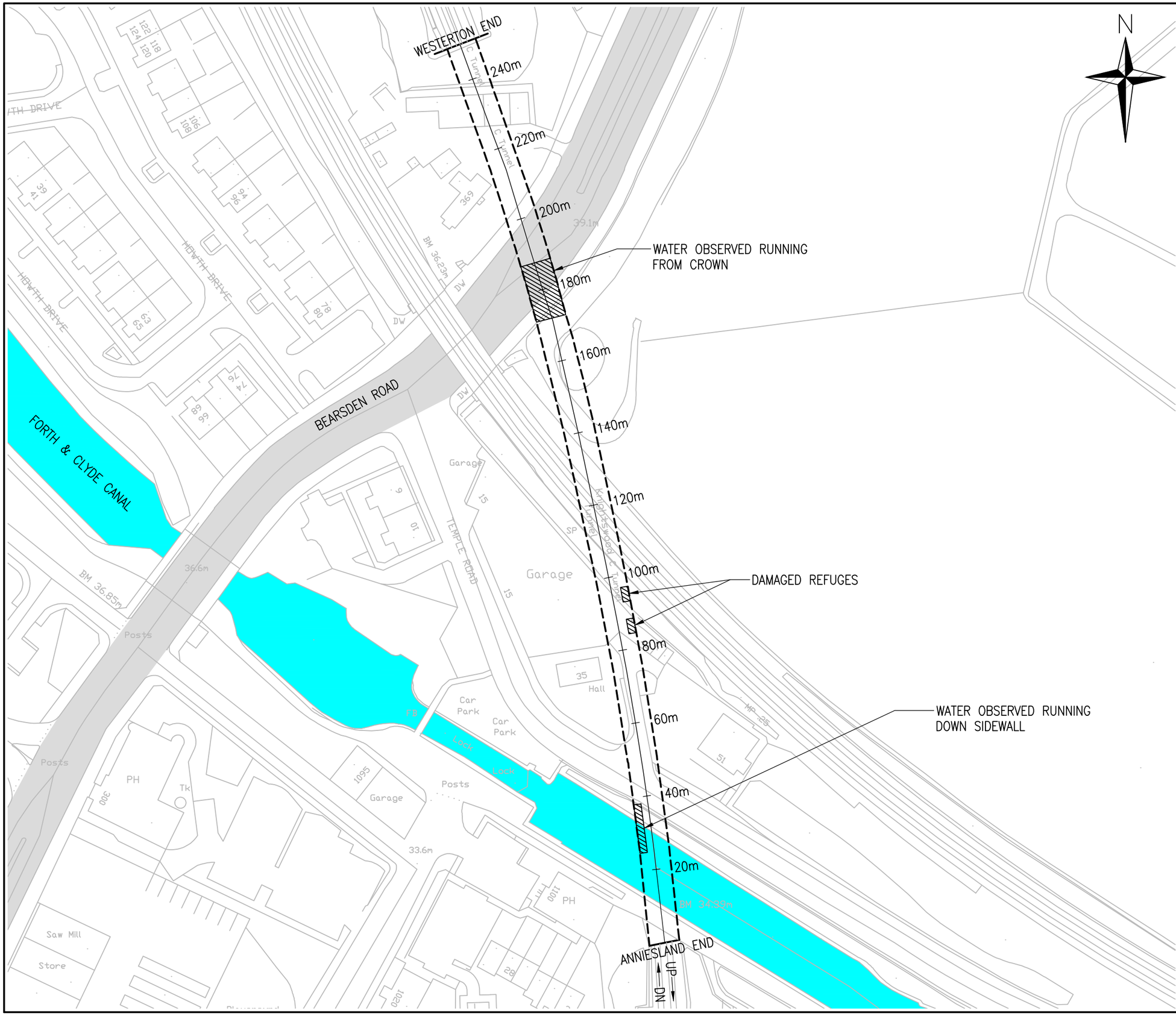
Photo 1: Water Ingress from Crown at Bearsden Road intersection



Photo 2: Water Ingress from Crown at Bearsden Road intersection

Appendix A

Drawings



Do not scale from this drawing.

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARD/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING RISKS AND INFORMATION.

RISKS LISTED HERE ARE NOT EXHAUSTIVE. REFER TO DESIGN ASSESSMENT FORM NO.

CONSTRUCTION

DEMOLITION

FOR INFORMATION RELATING TO USE, CLEANING AND MAINTENANCE SEE THE HEALTH AND SAFETY FILE

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROVED METHOD STATEMENT.

NOTES:

Rev.	Date	Description	Drwn.	Chkd.	Appd.

FAIRHURST

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Client:

Project Title:
KNIGHTSWOOD TUNNEL

Drawing Title:
SITE LOCATION & LAYOUT

Scale at A3:	Status:		
1:1000	For Information		
Drawn:	Checked:	Approved:	
BDJ			
Date:	Date:	Date:	
15/06/15			
Drawing No.:			Revision:
109055/0001			









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