Grimescar Dike - Burn Road, Huddersfield – Hydraulic Modelling Exercise

Project:	SHF.1935.001.HY.R.004.A – Grimescar Dike, Huddersfield
For:	Wiggett Construction Group Ltd
Status:	Issued
Date:	8th July 2022
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NON-TECHNICAL SUMMARY

Enzygo Ltd undertook a 1D/2D hydraulic modelling exercise for Grimescar Dike at Burn Road, Huddersfield. The modelling exercise included a baseline and sensitivity model runs. Subsequent model runs included model runs for a proposed scenario, including retaining walls, bridge decks and a new highway culvert crossing.

This Technical Note reports on an additional model run, which includes a 100% blockage of a proposed highway culvert crossing under a 1 in 1000-year event, as requested by Kirklees Council (Appendix 1). This is considered a worst-case scenario, and would help understand how flood water would come out of channel and then return to channel.

The blockage scenario demonstrated that flood water would back-up on the upstream side of the proposed culvert. Once the level of the road deck is reached, flood water would spill over highway and either re-enter Grimescar Dike downstream, or flow east over Burn Road before re-entering Grimescar Dike.

Regular maintenance of the asset would be undertaken to ensure that a high-level blockage would not occur.

1. INTRODUCTION

1.1 Background

Enzygo Ltd were commissioned by Wiggett Construction Group Ltd to undertake a 1D/2D hydraulic modelling exercise for Grimescar Dike at Burn Road, Huddersfield. A Modelling Report (Document Reference: SHF.1935.001.HY.R.002.A, November 2021) was produced, which reported on the baseline and sensitivity model runs.

A Technical Note (Document Reference: SHF.1935.001.HY.R.003.A, November 2021) was subsequently produced, which reported on the proposed structures (retaining walls, bridge decks and a new highway culvert crossing) as part of a proposed scenario under a 1 in 1000-year event.

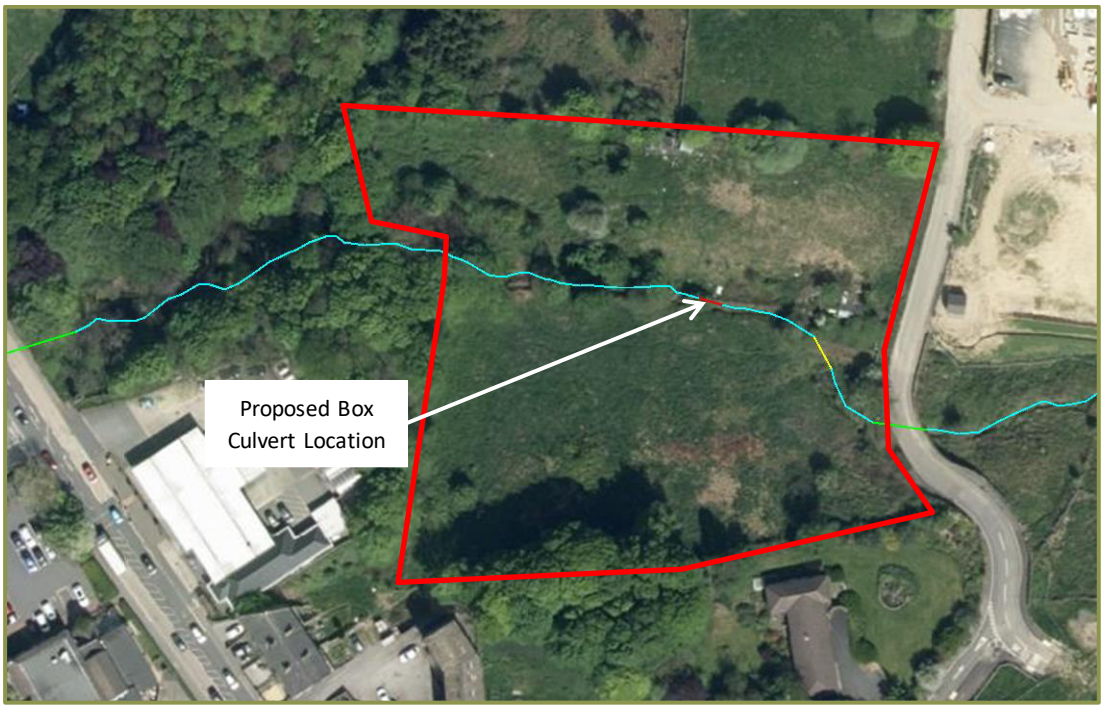
1.2 Purpose of Technical Note

This Technical Note reports on an additional model run, which includes a 100% blockage of a proposed highway culvert crossing (Figure 1.1) under a 1 in 1000-year event, as requested by Kirklees Council. This is considered a worst-case scenario and would help understand how flood water would come out of channel and then return to channel. This Technical Note should be read in conjunction with the above modelling reports.

1.3 Methodology

The model run includes the proposed residential development as per drawing 1354/P/001 – Rev N (Appendix 2 and extract in Figure 1.2). The proposed rectangular culvert (1.5m [W] x 1.0m [H] has been 100% blocked and run under a 1 in 1000-year event. .

Figure 1.1: Location of Proposed Box Culvert



Cyan Line: *Open channel.* ***Red Line:*** *Proposed Box Culvert.* ***Yellow Line:*** *Circular Culvert.* ***Green Line:*** *Irregular Culvert.*

Figure 1.2: Site Layout as per Drawing 1354/P/001 Revision N



2. ANALYSIS OF RESULTS

1.4 Introduction

Flood depth mapping was undertaken within MapInfo software. As the model is a 1D2D linked model, results are produced for the out-of-bank floodplain based upon the underlying 1m grid derived from 1m DTM LiDAR data. Results were produced in 'xmdf' format and imported into MapInfo, where the results were mapped and contoured.

The purpose of this modelling exercise is to determine the flood extent when a 100% blockage of the culvert occurs and the flood depths (if any) affecting the proposed development. The blockage run will be compared to the baseline result and 50% blockage run.

Model flood extents were cleaned by using the following criteria:

- Dry islands and polygons smaller than 200m^2 were removed from the outlines;
- Polygons disconnected from the watercourse or surrounding the flood outline where there is no flow path were removed.

A comparison drawing has been produced from the hydraulic modelling exercise:

- SHF.1935.001.HY.D.001.A - 100% Blockage Comparison

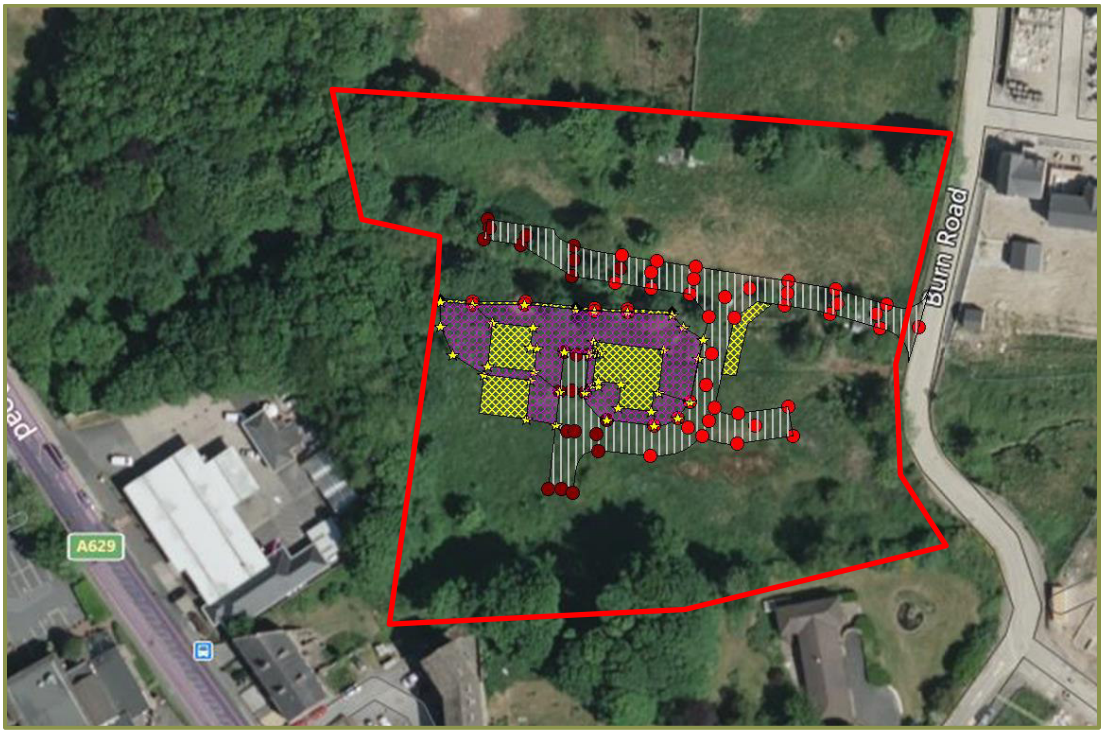
The following additional layers were created for the proposed model runs to reflect the proposals included in layout drawing 1354/P/001 :

- 1d_nwke_BRN_0012; defines in-channel network.

- 1d_WLL_BRN_012; defines in-channel water level lines.
- 1d_xs_BRN_012; defines cross-section locations.
- 2d_code_1d_BRN_012; defines 1d channel domain.
- 2d_bc_hx_BRN_012; defines 1D2D linking cells.
- 2d_zsh_BRN_Patches_012; defines values for a LiDAR patch fix within the 2D model domain.
- 2d_zsh_BRN_Houses_012; defines the finished floor levels of the proposed properties.
- 2d_zsh_BRN_Bridge_012; defines the proposed bridge deck and road levels.
- 2d_zsh_BRN_Embankment_Wall_012; defines the proposed and existing walls alongside the development.
- 2d_zsh_BRN_Slope_001; defines the regraded slopes from the proposed properties to the existing wall and proposed road.
- 2d_MAT_BRN_Roads_Tracks_Hardstanding_012; provides roughness values for the proposed roadways.
- 2d_MAT_BRN_Stability_012; provides roughness value for a patch to stabilise the model run.

The proposed model layers described in above are presented in Figure 2.1.

Figure 2.1: Proposed Model Layers



1.5 Proposed Model Run Results (Run 012)

This section provides details of the 100% blockage run and how this varies when compared to the baseline flood extent. Table 2.1 and the updated modelling log (Appendix 3) provide a

summary of the proposed model iteration/run undertaken. Due to instabilities in the model (which is a common issue when modelling high percentage blockage scenarios), the culvert and upstream watercourse section was removed from the model, though the equivalent of a 100% blockage scenario has still been modelled. The flood levels at key locations can be viewed in Figure 2.2 and Table 2.2.

Table 2.1: Run Identifiers and Description (Proposed Development Runs)

Model Run ID	Scenario Description
~e~_012	Proposed bridge deck added as per Drawing 1354/P/001 – Revision N. The proposed and existing stone retaining walls were also added to the model inclusive of the finished floor levels of properties and garden levels. Proposed box culvert added to the model with the following dimensions: • Width – 1.5m • Height – 1.0m As per a request from Kirklees Council, a 100% blockage of the culvert has been represented within the model domain.

Figure 2.2: Node Locations



Table 2.2: Water Levels

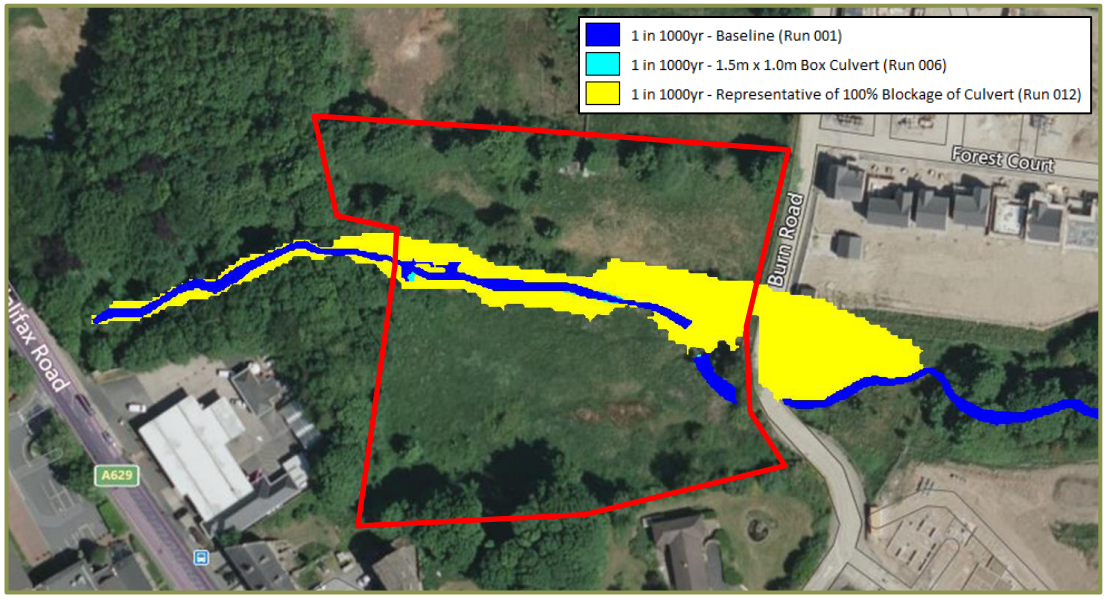
Model Node	1 in 1000-Year – Grimescar Dike in Channel Levels (m)		
	Baseline (001)	Proposed (006)	Proposed 100% Blockage (012)
GRIM_0458.1	172.83	172.81	173.04
GRIM_0458.2	170.65	170.59	171.57
GRIM_0413.1	169.38	169.36	171.57
GRIM_0384.1	168.08	168.44	171.57
GRIM_0359.1	167.71	167.70	168.07
Culvert 3.1	166.94	166.93	166.78
Culvert 3.2	166.58	166.58	166.51
Culvert 4.1	166.12	166.10	165.88

Table 2.2 shows that the introduction of the proposed box culvert (located at model node GRIM_0384.1) when compared to the baseline run (001) produces an increase in in-channel level for Run 006 of 0.36m. As expected, these in-channel levels increase again once a 100% blockage is represented in Run 012, resulting in in-channel levels to increase from Run 001 by 3.48m.

The results of Run 012 (Drawing 004) shows that when the proposed development is added to the model (inclusive of road levels, slope gradients associated with gardens and finished floor levels), due to a 100% blockage run being equivalent to there being no culvert in place, the flood mechanics in play mean that flows build up at the upstream extent of the culvert increasing the flood extent when compared to the baseline model run. Once the level is reached that flows can then spill across the proposed road deck, with flood water flowing east and re-entering the Grimescar Dike channel. Under a 100% blockage scenario, the depth of flows spilling over the proposed road deck is 0.23m. Additionally, exceedance flows follow the proposed road east, which then flows over Burn Road at a depth of 0.04m, before re-entering Grimescar Dike channel further downstream.

Run 012 represents worst-case scenario for the Site, whereby no maintenance has been undertaken for the proposed box culvert and a 100% blockage has occurred that fills the 1.5m (W) x 1.0 (H) culvert. The likelihood of this occurring is very low and any blockage scenario that may occur can be mitigated through regular maintenance of the asset.

Figure 2.3: Modelled Flood Extents (Proposed Development [Runs 001, Run 006 and 012])



3 CONCLUSIONS

This Technical Note has detailed the following:

- Should a 100% blockage of the proposed culvert occur, the flood depths expected to be experienced on the proposed road deck is 0.23m. Additionally, exceedance flows follow the proposed road east, which then flow over Burn Road at a flood depth of 0.04m and renter Grimescar Dike further downstream.
- The likelihood of a 100% blockage of the culvert occurring is very low and the likelihood of any blockage scenario occurring can be mitigated through regular maintenance of the asset.

Key

- Site Boundary
- 1000yr (Run 001)
- 1000yr (Run 006)
- 1000yr (Run 012)

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CLIENT:
Wiggett Construction Group Limited

SCALE: 1:625@A3

PROJECT REF: SHF.1935.001

DRAWN: HDR

CHECKED: DA

DATE: Jul 2022

PROJECT:
Burn Road, Huddersfield
Hydraulic Modelling

TITLE:
100% Blockage Comparison

FIGURE NO:
SHF.1935.001.HY.D.001.A

Appendix 1 – Kirklees Council Correspondence

Consultation Response from KC, **Lead Local Flood Authority**
2021/94719 Land Off, Burn Road, Birchencliffe, Huddersfield, HD3 3BT
Reserved Matters application pursuant to outline permission 2018/91838 for erection of residential development
Date Responded: 1st March 2022 **Responding Officer: Paul Farndale** **Responding Ref:**

Kirklees Flood Management & Drainage acting as Lead Local Flood Authority OBJECTS to this application until it is clearly demonstrated space has been made for water.

The outline application was for access only and therefore included several drainage and flood risk based conditions to be discharge following submission of information.

Kirklees LPA has received an application for condition 12 for which there are outstanding matters such as sizing box culverts for the diverted watercourse. A full response can be found here.

APAS Test Letter (kirklees.gov.uk)

No application has been submitted for conditions 14 or 15, that involves sizing and incorporating a sustainable drainage scheme into the layout and demonstrating safe flood routing from roof and road drainage and the watercourse through layout design. This must avoid curtilage.

Condition 16 is to be answered by Yorkshire Water as to whether a proposed layout demonstrates suitable stand off distances from their existing infrastructure.

To approve this reserved matters application for layout, must incorporate a demonstration that the final design can accommodate and satisfy several conditions yet to be discharged.

Consultation Response from KC, Lead Local Flood Authority		
2021/94706 Land Off, Burn Road, Birchencliffe, Huddersfield, HD3 3BT		
Discharge of conditions 5 (ground levels), 7 (site investigation), 11 (archaeological investigation), 12 (drainage), 16 (sewer easement) and 24 (electric vehicle charging) of previous outline permission 2018/91838 for erection of residential development		
Date Responded: 26th January 2022	**Responding Officer: Paul Farndale**	**Responding Ref:**

Condition 12 - Watercourse

A comprehensive assessment has been carried out calculating flows using FEH and Tuflow analysis to assess flood risk. This also includes suggested sizes of box culverts although none has been selected and shown on a drawing.

We suggest a discussion with ourselves, and section 38 (Farhad Khatibi) given that the new culvert is likely to be a structure (span greater than 900mm). This discussion should aim conclude part b

We understand the culvert under Burn Road has been inspected and details of the condition should be forwarded as part of this submission to conclude part a.

No long-term maintenance plan has been submitted to satisfy part c.

To satisfy part d, a simple submitted plan showing the weir levels in a full blockage scenario, in relation to retaining walls, garden and property should be submitted and tied in with submitted flood routing maps. A discussion on the need for trash and safety screens can be had at the same time.

We do not envisage that there will be a problem in satisfying this condition.

However, we do NOT recommend that this condition can be discharged at this moment in time

Condition 16 – Sewer Easements

Yorkshire Water should comment on this condition.

Appendix 2 – Site Layout

Key:

- Access road; bitmac finish
- Footpath; bitmac finish
- Paving slabs
- Grass/Lawn/Soft Landscaping
- Proposed tree
- Proposed shrubs
- Existing trees and shrubs

NB: Landscaping shown is indicative only; to be in accordance with separate landscape proposal/layout drawing and specification by specialists.

Access as agreed under application 2017/90180

Proposed access as per 2018/90151

New 2m footpath

PRIVATE DRIVE

MEWS COURT

Bin Col.

Oversized road to accommodate attenuation storage underneath

Refuse turning Area

Possible drainage easement into adjacent site

Private Drive

Shared Access

Open Space

1.2m high railway sleeper retaining structure

Mass concrete retaining wall faced with stone with 1100mm high railings on top

Existing Stone Wall

RANDOM STONE WALL

WOOD POST AND MESH FENCE

HEDGE

FENCE

TREE CANOPY

STREAM

BURN ROAD

RANDOM RTN STONE WALL

Type A

Type B

Type D

Type D1

Type D2

Type E

Type F

Type G

Gate Type G1: 1800mm high timber single leaf gate comprising of naturally finished external grade timber to match adjacent fencing.

Boundary Treatment: A 1500mm high precast concrete post and timber infill panel fencing with 1200mm high naturally finished featheredge timber infill panels with a 300mm high precast concrete kicking panel beneath. Where party fencing occurs between two properties, a 1800mm high by 2no.end vebo privacy screen is to be installed.

Boundary Treatment: B 2100mm high precast concrete post and timber infill panel fencing with 1800mm high naturally finished featheredge timber infill panels with a 300mm high precast concrete kicking panel beneath.

Boundary Treatment: C 1800mm high stone wall to match similar existing surrounding walls.

REV	DATE	AMENDMENT	BY	CHKD
M	20/06/22	Plot 12 & 22 altered, retaining structures added.	GG	GG
M	17/05/22	Private drive amended to Plots 9-11. Plot 12 House Type amended. Slight lines added.	GG	GG
L	09/05/22	Proposed scheme amended to Planning Officers comments.	GG	GG
K	03/03/22	Refuse Bin Locations and potential visitors parking added	GG	GG
J	09/02/22	Proposed trees taken out of Sewer Easement	GG	_ _

1-200 Scale Bar (metres)

HNAarchitects
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RIBA Chartered Practice

PROJECT:	Burn Road, Huddersfield
CLIENT:	Wiggett Construction
DRAWING:	Proposed Site Layout (Trees)
DRAWN BY: GC	CHECKED BY: GG
DATE: 26/10/2021	SCALE: 1:200 @ A0
STATUS: Planning	DRAWING No: 1354/P/001
	REVISION: N

Appendix 3 – Updated Modelling Log

River/Catchment Name	BuRN Road, Huddersfield
Code	BRN
Modeller	Helena Du-Roe

Model Run ID	Scenario Description	Setup	Run	Return Period	TUFLOW Control File	Geometry Control File	Boundary Condtion Control File	INBoundary Conditions Database	Estry Control File	Stability/Health	Mannings
001	Existing Freeflowing structures	Yes	Yes	Q20	BRN_~e~_001.tcf	BRN_001.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_001.ecf	OK	BRN_001.tmf
001	Existing Freeflowing structures	Yes	Yes	Q100	BRN_~e~_001.tcf	BRN_001.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_001.ecf	OK	BRN_001.tmf
001	Existing Freeflowing structures	Yes	Yes	Q100+31%CC	BRN_~e~_001.tcf	BRN_001.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_001.ecf	OK	BRN_001.tmf
001	Existing Freeflowing structures	Yes	Yes	Q100+51%CC	BRN_~e~_001.tcf	BRN_001.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_001.ecf	OK	BRN_001.tmf
001	Existing Freeflowing structures	Yes	Yes	Q1000	BRN_~e~_001.tcf	BRN_001.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_001.ecf	OK	BRN_001.tmf
002a	Existing 50% culvert blockage (Culvert 1)	Yes	Yes	Q100	BRN_~e~_002a.tcf	BRN_001.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_002a.ecf	OK	BRN_001.tmf
002b	Existing 50% culvert blockage (Culvert 4)	Yes	Yes	Q100	BRN_~e~_002b.tcf	BRN_001.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_002b.ecf	OK	BRN_001.tmf
003a	Downstream Boundary +0.5m	Yes	Yes	Q100	BRN_~e~_003a.tcf	BRN_001.tgc	BRN_003a.tbc	bc_dbase.csv	BRN_~e~_003a.ecf	OK	BRN_001.tmf
004a	Mannings Roughness +20%	Yes	Yes	Q100	BRN_~e~_004a.tcf	BRN_004a.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_004a.ecf	OK	BRN_001.tmf
004b	Mannings Roughness -20%	Yes	Yes	Q100	BRN_~e~_004b.tcf	BRN_004b.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_004b.ecf	OK	BRN_001.tmf
005	50% Inflow downstream of Halifax Road Culvert	Yes	Yes	Q1000	BRN_~e~_005.tcf	BRN_001.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_005.ecf	OK	BRN_001.tmf
006	Proposed bridge deck added as per the received from the client. The proposed and existing stone retaining walls were also added to the model. Proposed box culvert added to the model with the following dimensions: Width - 1.5m, Height - 1.0m	Yes	Yes	Q1000	BRN_~e~_006.tcf	BRN_006.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_006.ecf	OK	BRN_001.tmf
007	As per ~e~_006 with a 50% blockage applied to the proposed box culvert via the network layer attributes table	Yes	Yes	Q1000	BRN_~e~_007.tcf	BRN_006.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_007.ecf	OK	BRN_001.tmf
008	As per ~e~_006 with the width of the proposed box culvert halved to 0.75m to represent a 50% blockage	Yes	Yes	Q1000	BRN_~e~_008.tcf	BRN_006.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_008.ecf	OK	BRN_001.tmf
009	Proposed bridge deck added as per the received from the client. The proposed and existing stone retaining walls were also added to the model. Proposed box culvert added to the model with the following dimensions: Width - 2.0m, Height - 2.0m	Yes	Yes	Q1000	BRN_~e~_009.tcf	BRN_006.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_009.ecf	OK	BRN_001.tmf
010	As per ~e~_009 with a 50% blockage applied to the proposed box culvert via the network layer attributes table	Yes	Yes	Q1000	BRN_~e~_010.tcf	BRN_006.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_010.ecf	OK	BRN_001.tmf
011	As per ~e~_009 with the width of the proposed box culvert halved to 0.75m to represent a 50% blockage	Yes	Yes	Q1000	BRN_~e~_011.tcf	BRN_006.tgc	BRN_001.tbc	bc_dbase.csv	BRN_~e~_011.ecf	OK	BRN_001.tmf
012	As per ~e~_006 with a 100% blockage represented by the removal of the proposed culvert in the model.	Yes	Yes	Q1000	BRN_~e~_012.tcf	BRN_012.tgc	BRN_012.tbc	bc_dbase.csv	BRN_~e~_012.ecf	OK	BRN_001.tmf