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Blaenau Gwent County Borough Council

Lower Plateau, Six Bells Colliery Site Stage 3 Strategic Flood Consequence Assessment

Final
February 2011

Prepared for

Revision Schedule

Lower Plateau, Six Bells Colliery Site Stage 3 SFCA
February 2011

Rev	Date	Details	Prepared by	Reviewed by	Approved by
01	February 2011	D129363 - Draft for comment	**Patrick Goodey** Flood Risk Consultant	**Jon Robinson** Technical Director	**Jon Robinson** Technical Director
01	February 2011	D129363 – Final incorporating comments	**Patrick Goodey** Flood Risk Consultant	**Jon Robinson** Technical Director	**Jon Robinson** Technical Director

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1 Introduction

1.1 Commission

URS/Scott Wilson was commissioned by Blaenau Gwent County Borough Council (CBC) to undertake a Stage 3 Strategic Flood Consequences Assessment (SFCA) for the Lower Plateau site at Six Bells, Abertillery. The site reference within the emerging Local Development Plan (LDP) is D11.

1.2 Background

Following completion of the Stage 2 SFCA, discussion with the Environment Agency Wales (see Appendix A) has identified the potential requirement for a Stage 3 SFCA to be undertaken for site D11 at Six Bells, Abertillery. The site is proposed within the LDP to be allocated for non-resident education use.

The Environment Agency Flood Mapping indicates that the site is predominantly located within Flood Zone 3 (1% annual probability of flooding) and 2 (between a 1% and 0.1% annual probability of flooding), associated with the Ebbw Fach River. The Welsh Assembly Government (WAG) Development Advice Map (DAM) indicates that the site is predominantly located in Zone C2 (Undefended, with a 0.1% annual probability of flooding). However, the Ebbw Fach River flows within a large culvert beneath the western boundary of the site. Prior to undertaking hydraulic modelling, it was agreed that an assessment of the culvert capacity

2 Site Location and Description

2.1 Location

The Lower Plateau, Six Bells site is located within the town of Abertillery, Blaenau Gwent on the site of the former Six Bells Colliery. The approximate NGR for the site is SO 220 029. The site is bordered to the north by Chapel Road and the Six Bells Baptist Church. To the east of the site are existing residential properties. The western boundary of the site is defined by sloping ground that rises up to Six Bells Road. To the south of the site is existing open space, also associated with the colliery. As

The results from the Manning's Equation are provided in Section 4 below.

3.1.1 Hydrological Flows

In order to estimate the likely flow range within the Ebbw Fach River at Six Bells, a hydrological estimation has been completed using the industry standard Flood Estimation Handbook (FEH) statistical analysis approach. Details of the methodology used to generate the flow estimates are provided in the Hydrological Analysis Report, included in Appendix B of this report. **Table 1** below provides a summary of the various flow estimations.

Table 1 Estimated flows within the Ebbw Fach River for various design return period events, obtained from the Hydrological Analysis Report, provided in Appendix B.

Annual Probability	Return Period (1 in x years)	Flow estimate (m3/s)

4 Results and Discussion

4.1 Culvert Capacity – Results of the Manning's Equation

The results of the Manning's Equation culvert capacity estimation are provided in Table 2 below. These represent the likely capacity at various points along the culvert.

Table 2 Estimated capacity of the culvert at various locations along the culvert length

Chainage (m)	Dimensions		Capacity estimate (m3/s)
	Height from Invert to Soffit (m)	Width (m)	
0	3.82	5.12	78.2
40	3.85	5.10	78.7
60	3.78	5.15	77.7
80	3.00	3.70	34.0

4.2 Discussion

The use of the Manning's equation to generate culvert capacity estimates is a simplistic method and has been used as a first pass at this stage to provide an indication of likely capacity only.

Comparing the results in Table 2 above indicates that for over 60m of the culvert (approximately half of the total length), it is able to convey flows generated from an event of between 0.5% and 0.1% annual probability (1 in 200 and 1 in 1000 year return period). However, the downstream extent of the culvert would only be able to convey flows generated during an event of between a 4% and 2% annual probability (1 in 25 and 1 in 50 year return period). As a result, it is likely that during an event which exceeds the magnitude of the 4% annual probability, the capacity of the downstream extent of the culvert would become exceeded. At the 1% annual probability (1 in 100 year return period), it is likely that significant constriction of flows could occur.

At this outline stage and without full hydraulic modelling, it is not possible to fully conclude whether or not such constriction of flows would cause flooding to the proposed site or surrounding area. However, the topography of the area results in a high headwall above the culvert entrance, meaning any water exceeding the culvert capacity would back up rather than spill over ground in a downstream direction. In addition, the site is located at a higher topographical level than the land to the north (e.g. Chapel Road and Upper Griffin Street). Therefore, this would provide a preferential flow route for any flooding resulting from culvert exceedance. However, during high flows (i.e. bankfull), it is likely that the Chapel Road bridge could present an obstruction to the flow of water, thus potentially reducing the flow of water entering the culvert beneath the site and hence lessening the risk of a capacity exceedance.

As a result of this outline assessment, whilst the flood risk posed to the proposed site remain relatively unknown, it is believed that the risk of flooding to the site following a culvert capacity exceedance may be relatively low. It is therefore very likely that the WAG DAMs and Environment Agency Flood Zone maps at the site are likely to be exaggerated on account of them not taking into consideration the culvert beneath the site.

4.3 Recommendations

As a result of the above it is recommended that a hydraulic modelling study should be undertaken to determine whether the current flood risk mapping available can be revised and the site can then be allocated within the LDP. The study undertaken to date suggests that such modelling will support allocation. This hydraulic modelling would investigate the likelihood of the culvert becoming exceeded, along with the likely flow routes of any flooding. The FCA arising from the work would also recommend any mitigation measures required to minimise the impact of flooding at the site, if necessary.

5 Conclusions

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Appendix A – Environment Agency Correspondence

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Appendix B – Hydrological Analysis Report

Blaenau Gwent County Borough Council

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3.1 Methodology

The following sources of data and software were used for the ReFH analysis:

· FEH CD-ROM v3

C_{max}	379	384	459	1.195	453
T_p	1.7	3.44			

4

4.1 Summary of results and discussion

Table 4-1 provides a comparison of the GCFs and flow estimates derived using the methods

A i A H i i c O c i

Spreadsheet Version 1.0

Technical Reviewer Name

FEH CD-ROM Version	3		
Easting	322050	Northing	203050
Area	30.27		
Catchment Centroid			
Easting	320782	Northing	207693
FARL	0.958	RMED-1H	11.4
PROPWET	0.54	RMED-1D	52.2
ALTBAR	391	RMED-2D	68.1
ASPBAR	225	URBCONC1990	0.627
ASPVAR	0.2	URBEXT1990	0.0604
BFIHOST	0.531	URBLOC1990	0.998
DPLBAR	6.34	URBCONC2000	0.707
DPSBAR	212.4	URBEXT2000	0.0759
LDP	14.57	URBLOC2000	0.888
SAAR	1463	FPEXT	0.0395
SAAR4170	1543	FPDBAR	1.404
SPRHOST	31.08	FPLOC	1.249
C	-0.02615	C(1km)	-0.026
D1	0.46856	D1(1km)	0.482
D2	0.42887	D2(1km)	0.468
D3	0.36249	D3(1km)	0.337
E	0.28569	E(1km)	0.282
F	2.52452	F(1km)	2.525

Notes

Is the catchment small (< 5 km^2)?	NO
Is the catchment permeable (SPRHOST < 20)?	NO
Is the catchment urbanised (URBEXT > 0.03)?	

Spreadsheet Version 1.0

Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
48004 (Warleggan @ Trengoffe)	0.288	39	9.565	0.244	0.207	0.86
72007 (Brock @ U/s a6)	0.343	30	29.438	0.194	0.273	2.033
48001 (Fowey @ Trekeivesteps)	0.372	39	16.858	0.22	0.3	0.276
48009 (st Neot @ Craigshill Wood)	0.464	12	8.469	0.246	0.372	1.5
25012 (Harwood Beck @ Harwood)	0.467	39	31.368	0.176	0.264	1.003
76811 (Dacre Beck @ Dacre Bridge)	0.48	9	34.576	0.25	0.345	2.245
48010 (Seaton @ Trebrownbridge)	0.496	36	6.47	0.236	0.254	0.783
47009 (Tiddy @ Tideford)	0.507	39	5.916	0.175	0.133	0.636
48803 (Carnon @ Bissoe)	0.534	14	5.307	0.247	0.161	1.645
27032 (Hebden Beck @ Hebden)	0.543	42	3.91	0.222	0.267	0.286
21017 (Ettrick Water @ Brockhot0n)						

FEH Technical Review Sheets:
QMED CDs for Subject Site

Spreadsheet Version 1.0

Project Details	
Project Number	D129363
Project Name	Blaenau Gwent SFCA
Catchment Name	Ebbw Fach River @ Six Bells, Abertillery
User Name	Rob Sweet
Technical Reviewer Name	Peter Mansell

AREA	30.27
FARL	0.958
BFIHOST	0.531
SAAR	1463
SPRHOST	31.08
$URBEXT_{2000}$	0.0777

Calculation of rural QMED

QMED rural = 15.22

This is the revised Qmed Equation based on Science Report: SC050050 - Improving the FEH statistical procedures for flood frequency estimation. This can be accessed at:

http://publications.environment-agency.gov.uk/pdf/SCHO0608BOFF-e-e.pdf

Calculation of urban adjusted QMED applicable if catchment is urban (URBEXT2000 > 0.03).

QMED =UAF x QMED rural
where $UAF = (1+URBEXT)^{0.37}PRUAF^{2.16}$
and $PRUAF = 1 + 0.47URBEXT_{2000}((70/SPRHOST)-1)$

PRUAF = 1.046
UAF = 1.132
QMED = 17.232

To reflect $URBEXT_{2000}$ values, the UAF equation has been updated using guidance provided in report FD1919 - $URBEXT_{2000}$ A New FEH catchment descriptor and Kjeldsen, T.R. 2010 'Modelling the impact of urbanisation on flood frequency relationships in the UK', Hydrology Research, 41(5), 391-405.

As per WINFAP-FEH v3 User Guide, the use of Data Transfer methods to improve the estimate of QMED is not recommended where the catchment is urbanised (i.e. $URBEXT_{2000} > 0.03$).

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Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name	D

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

T_p derived from catchment descriptors, with a user defined donor correction factor of 1.049 applied

ReFH design standard used for U_p

ReFH design standard used for U_k /d47 Tm76-11(c)-11(r)-8(i)9(p)2(t)1(o)2(r)-8(s)-11(,)1( )1(w)19(i)9(t)1(h)2( )1(a)2( )1(u)2(s)-11(e)2(r6( )1(53.7595.7_0)Tj /Tm7699e(c)T07 i)9(e)7_0

ReFH design6ttandard uRU

ReFH design26tandard ufor U

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name	Dr Rob Sweet	Catchment name	Ebbw Fach River	Date/time modelled	28-Jan-2011 10:22
Company name	URS/Scott Wilson	Catchment easting	322050	Version	1.3
Project name	Blaenau Gwent - Six Bells	Catchment northing	203050		
		Catchment area	30.27		

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	10	C_{max} (mm)	453	T_p (hr)	1.76	BL (hr)	54.2
Duration (hr)	4.25	C_{ini} (mm)	168	U_p	0.65	BR87 0 0 1 228.3599 692.4807 Tm [/(1)2(.)-881Tf 0.99	

Revitalised FSR/FEH rainfall runoff method

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Company name	URS/Scott Wilson	Catchment easting	322050	Version	1.3
Project name	Blaenau Gwent - Six Bells	Catchment northing	203050		
		Catchment area	30.27		

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	20	C_{max} (mm)	453	T_p (hr)	1.76	BL (hr)	54.2
Duration (hr)	4.25	C_{ini} (mm)	168	U_p	0.65	BR	1.92
Timestep (hr)	0.25	a					

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Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name	Dr Rob Sweet	Catchment name	Ebbw Fach River	Date/time modelled	28-Jan-2011 10:24
Company name	URS/Scott Wilson	Catchment easting	322050	Version	1.3
Project name	Blaenau Gwent - Six Bells	Catchment northing	203050		
		Catchment area	30.27		

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	50	C_{max} (mm)	453	T_p (hr)	1.76	BL (hr)	54.2
Duration (hr)	4.25	C_{ini} (mm)	168	U_p	0.65	BR	1.92
Timestep (hr)	0.25	**a** factor	0.88	U_k	0.8	BF_0 (m^3/s)	3.4
Season	Winter						

Summary of results

FEH DDF rainfall (mm)	64.7	Peak rainfall (mm)	7.6
Design rainfall (mm)	50	Peak flow (m^3/s)	48.3

Results

Graph

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Unit	mm	mm	m^3/s	m^3/s	m^3/s
0.00	0.6	0.2	0.0	3.4	3.4
0.25	0.9	0.3	0.0	3.3	3.4
0.50	1.3	0.4	0.2	3.3	3.5
0.75	1.7	0.6	0.5	3.3	3.8
1.00	2.4	0.8	1.0	3.3	4.4
1.25	3.4	1.2	1.9	3.3	5.2
1.50	4.6	1.6	3.2	3.3	6.5
1.75	6.3	2.3	5.1	3.3	8.4
2.00	7.6	2.9	7.7	3.4	11.1
2.25	6.3	2.5	11.4	3.4	14.8
2.50	4.6	1.9	16.0	3.6	19.5
2.75	3.4	1.4	21.2	3.7	24.9
3.00	2.4	1.0	26.6	3.9	30.5
3.25	1.7	0.7	31.9	4.1	36.0
3.50	1.3	0.5	36.6	4.4	41.0
3.75	0.9	0.4	40.3	4.7	45.0
4.00	0.6	0.3	42.4	5.1	47.5
4.25	0.0	0.0	42.8	5.4	48.3
4.50	0.0	0.0	41.9	5.8	47.7
4.75	0.0	0.0	39.9	6.1	46.0
5.00	0.0	0.0	37.1	6.4	43.5
5.25	0.0	0.0	33.9	6.7	40.7
5.50	0.0	0.0	30.6	7.0	37.6
5.75	0.0	0.0	27.3	7.2	34.5
6.00	0.0	0.0	24.1	7.4	31.5
6.25	0.0	0.0	21.1	7.6	28.7
6.50	0.0	0.0	18.4	7.7	26.1
6.75	0.0	0.0	15.9	7.8	23.7
7.00	0.0	0.0	13.6	7.9	21.5
7.25	0.0	0.0	11.4	8.0	19.3
7.50	0.0	0.0	9.3	8.0	17.3
7.75	0.0	0.0	7.4	8.1	15.5
8.00	0.0	0.0	5.7	8.1	13.8
8.25	0.0	0.0	4.1	8.1	12.2
8.50	0.0	0.0	2.9	8.1	11.0
8.75	0.0	0.0	1.9	8.1	10.0
9.00	0.0	0.0	1.2	8.1	9.3
9.25	0.0	0.0	0.8	8.0	8.8
9.50	0.0	0.0	0.4	8.0	8.4
9.75	0.0	0.0	0.2	8.0	8.2
10.00	0.0	0.0	0.1	7.9	8.0
10.25	0.0	0.0			

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

T_p derived from catchment descriptors, with a user defined donor correction factor of 1.049 applied

ReFH design standard used for U_p

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Company name	URS/Scott Wilson	Catchment easting	322050	Version	1.3
Project name	Blaenau Gwent - Six Bells	Catchment northing	203050		
		Catchment area	30.27		

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	75	C_{max} (mm)	453	T_p (hr)	1.76	BL (hr)	54.2
Duration (hr)	4.25	C_{ini} (mm)	168	U_p	0.65	BR	1.92
Timestep (hr)	0.25	**a** factor	0.85	U_k	0.8	BF_0 (m^3/s)	3.4
Season	Winter						

Summary of results

FEH DDF rainfall (mm)	71.6	Peak rainfall (mm)	8.4
Design rainfall (mm)	55.4	Peak flow (m^3/s)	52.6

Results

Graph

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Unit	mm	mm	m^3/s	m^3/s	m^3/s
0.00	0.7	0.2	0.0	3.4	3.4
0.25	1.0	0.3	0.0	3.3	3.4
0.50	1.4	0.4	0.2	3.3	3.5
0.75	1.9	0.6	0.6	3.3	3.9
1.00	2.7	0.9	1.1	3.3	4.4
1.25	3.7	1.2	2.0	3.3	5.3
1.50	5.1	1.8	3.4	3.3	6.7
1.75	6.9	2.5	5.5	3.3	8.8
2.00	8.4	3.2	8.4	3.4	11.7
2.25	6.9	2.7	12.3	3.5	15.8
2.50	5.1	2.1	17.3	3.6	20.9
2.75	3.7	1.5	23.0	3.7	26.7
3.00	2.7	1.1	29.0	4.0	32.9
3.25	1.9	0.8	34.8	4.2	39.0
3.50	1.4	0.6	40.0	4.5	44.5
3.75	1.0	0.4	44.1	4.9	48.9
4.00	0.7	0.3	46.4	5.3	51.7
4.25	0.0	0.0	47.0	5.6	52.6
4.50	0.0	0.0	46.0	6.0	52.0
4.75	0.0	0.0	43.8	6.4	50.2
5.00	0.0	0.0	40.8	6.7	47.5
5.25	0.0	0.0	37.3	7.1	44.4
5.50	0.0	0.0	33.6	7.3	41.0
5.75	0.0	0.0	30.0	7.6	37.6
6.00	0.0	0.0	26.5	7.8	34.3
6.25	0.0	0.0	23.3	8.0	31.2
6.50	0.0	0.0	20.3	8.1	28.4
6.75	0.0	0.0	17.5	8.3	25.8
7.00	0.0	0.0	14.9	8.4	23.3
7.25	0.0	0.0	12.5	8.5	21.0
7.50	0.0	0.0	10.3	8.5	18.8
7.75	0.0	0.0	8.2	8.6	16.7
8.00	0.0	0.0	6.3	8.6	14.9
8.25	0.0	0.0	4.6	8.6	13.2
8.50	0.0	0.0	3.2	8.6	11.8
8.75	0.0	0.0	2.1	8.6	10.7
9.00	0.0	0.0	1.4	8.6	9.9
9.25	0.0	0.0	0.8	8.5	9.4
9.50	0.0	0.0	0.5	8.5	9.0
9.75	0.0	0.0	0.3	8.5	8.7
10.00	0.0	0.0	0.1	8.4	8.5
10.25	0.0	0.0	0.0	8.4	8.4
10.50	0.0	0.0	0.0	8.3	8.3
Total (mm)	0.0	0.1000			

Revitalised FSR/FEH rainfall runoff method

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Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

T_p derived from catchment descriptors, with a user defined donor correction factor of 1.049 applied

ReFH design standard used for U_p

ReFH design standard used for U_k /d47 Tm76-11(c)-11(r)-8(i)9(p)2(t)1(o)2(r)-8(s)-11(,)1( )1(w)19(i)9(t)1(h)2( )1(a)2( )1(u)2(s)-11(e)2(r6( )1(53.7595.7_0)Tj /Tm7699e(c)T07 i)9(e)7_0

ReFH design6ttandard uRU

ReFH design26tandard ufor U

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name	Dr Rob Sweet	Catchment name	Ebbw Fach River	Date/time modelled	28-Jan-2011 10:25
Company name	URS/Scott Wilson	Catchment easting	322050	Version	1.3
Project name	Blaenau Gwent - Six Bells	Catchment northing	203050		
		Catchment area	30.27		

0.000 0.000 m 0.000 108.135 l 0.000 108.135 0 Tp

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	200	C_{max} (mm)	453	T_p (hr)	1.76	BL (hr)	54.2
Duration (hr)	4.25	C_{ini} (mm)	168	U_p	0.65	BR	1.92
Timestep (hr)	0.25						

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Appendix C – Derivation of Values used in the Manning's Equation

Estimation of Culvert Area

In order to estimate the culvert area, wetted perimeter and hydraulic radius, the culvert parameters as provided in the Structural Inspection Report were utilised. This represents the best available data to undertake such measurements. Only one dimension measurement was provided for both the height (from invert to soffit at the arch high point) and width of the culvert. Therefore, establishing accurate dimensions of the culvert arch is not possible. As a result, the

Estimation of Manning's 'n' Value

The Manning's 'n' value represents the roughness and therefore friction forces acting upon water flowing through the culvert. The Manning's 'n' values have been derived using standard tables provided by Chow, 1959[2]