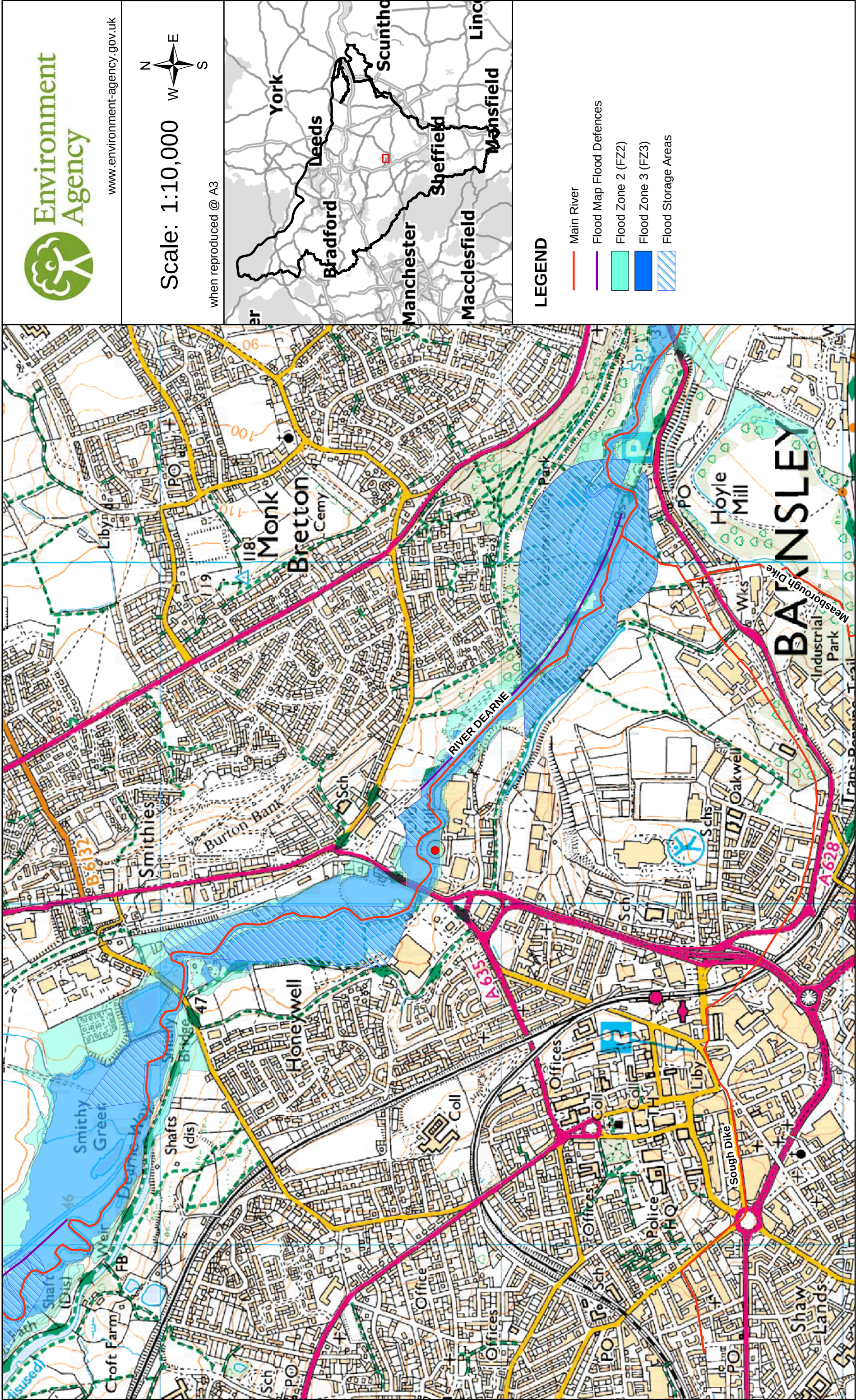


Flood Map for Old Mill Lane, Barnsley - Date Created 23/06/2011 [Ref: 17472]



Annex B: Climate Change

- B1. There is an increasing body of scientific evidence that the global climate is changing as a result of human activity. Past, present and future emissions of greenhouse gases are expected to cause significant global climate change during this century. The nature of climate change at a regional level will vary: for the UK, projections of future climate change indicate that more frequent short-duration, high-intensity rainfall and more frequent periods of long-duration rainfall of the type responsible for the 2000 floods could be expected. Sea levels will continue to rise. These kinds of changes will have implications for river flooding and also for local flash flooding. There are several indications that the climate in the UK is already changing. Central England's temperature rose by almost 1°C during the twentieth century. Heat waves have become more frequent in summer and there are now fewer frosts and winter cold spells. Winters over the last 200 years have become wetter relative to summers; a larger proportion of winter precipitation in all regions now falls on heavy rainfall days than was the case 50 years ago.
- B2. To help organisations (including local authorities and regional planning bodies) to assess their vulnerability to climate change and plan appropriate adaptation strategies, the Government established the UK Climate Impacts Programme (UKCIP).¹³ Scenarios of future climate change in the UK¹⁴ were produced for the UKCIP in 2002 and published by the Department for Environment, Food and Rural Affairs (Defra). Over the next 2-3 years, this climate change scenario information will be revised, expanded and developed to better meet stakeholder needs.
- B3. The companion guide supporting the PPS *Planning and Climate Change*¹⁵ will provide guidance on how planning should secure new development and shape places resilient to the effects of climate change.
- B4. The Foresight project on future flood risk reported in April 2004.¹⁶ The project found that, using the UKCIP02 climate change projections, together with scenarios of potential economic and social changes, annual damage from flooding may rise from around £100 million to between £460 million (under the community orientated *Local Stewardship scenario*) and £2,500 million (under the more consumerist *World Markets scenario*) by 2080.
- B5. Global sea level will continue to rise, depending on greenhouse gas emissions and the sensitivity of the climate system. The relative sea level rise in England also depends on the local vertical movement of the land, which is generally falling in the south-east and rising in the north and west. Allowances for the regional rates of relative sea level rise shown in Table B.1 should be used as a starting point for considering flooding from the sea, along with the sensitivity ranges for wave height and wind speed in Table B.2, in preparing flood risk assessments.

¹³ www.ukcip.org.uk

¹⁴ Defra, 2002. *Scenarios of future climate change in the UK*
http://www.ukcip.org.uk/scenarios/ukcip02/documentation/ukcip02_scientific_report.asp

¹⁵ see footnote 1

¹⁶ DTI, 2004. *The Foresight Future Flooding project*
www.foresight.gov.uk/Previous_Projects/Flood_and_Coastal_Defence/Reports_and_Publications/Project_Outputs/Outputs.htm

Table B.1 Recommended contingency allowances for net sea level rise

Administrative Region	Net Sea Level Rise (mm/yr) Relative to 1990			
	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
East of England, East Midlands, London, SE England (south of Flamborough Head)	4.0	8.5	12.0	15.0
South West	3.5	8.0	11.5	14.5
NW England, NE England (north of Flamborough Head)	2.5	7.0	10.0	13.0

Notes:

1. For deriving sea levels up to 2025, the 4mm/yr, 3mm/yr and 2.5mm/yr rates (covering the three groups of administrative Regions respectively), should be applied back to the 1990 base sea level year. From 2026 to 2055, the increase in sea level in this period is derived by adding the number of years on from 2025 (to 2055), multiplied by the respective rate shown in the table. Subsequent time periods 2056-2085 and 2086-2115 are treated similarly.
 2. Refer to Defra FCDPAG3 *Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts*, October 2006, for details of the derivation of this table. In particular, Annex A1 of this Note shows examples of how to calculate sea level rise.
 3. Vertical movement of the land is incorporated in the table and does not need to be calculated separately.
- B6. The rise in sea level will change the frequency of occurrence of high water levels relative to today's sea levels, assuming no change in storminess. There may also be secondary impacts such as changes in wave heights due to increased water depths, as well as possible changes in the frequency, duration and severity of storm events. A 10 per cent sensitivity allowance should be added to offshore wind speeds and wave heights by the 2080s.
- B7. Extensive, low-lying coastal lands around most British estuaries are particularly susceptible to flooding. Changes to the drivers associated with coastal erosion (surges, waves, coastal sediment supply and morphology, and relative sea level rise) will affect the probability of flooding to new developments.
- B8. The climate changes already seen in the UK are consistent with the UKCIP02 scenarios. This suggests that winters will become wetter over the whole of the UK, by as much as 20 per cent by the 2050s. A shift in the seasonal pattern of rainfall is also expected, with summers and autumn becoming much drier than at present. Snowfall amounts will

decrease significantly throughout the UK, but the number of rain-days and the average intensity of rainfall are expected to increase. Although average seasonal wind speeds could increase over most of the country, there is currently much less certainty regarding the potential for greater storminess and the consequences for sea surges or extreme wave activity on coasts.

- B9. In making an assessment of the impacts of climate change on flooding from the land, rivers and sea as part of a flood risk assessment, the sensitivity ranges in Table B.2 may provide an appropriate precautionary response to the uncertainty about climate change impacts on rainfall intensities, river flow, wave height and wind speed.

Table B.2 Recommended national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights.

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

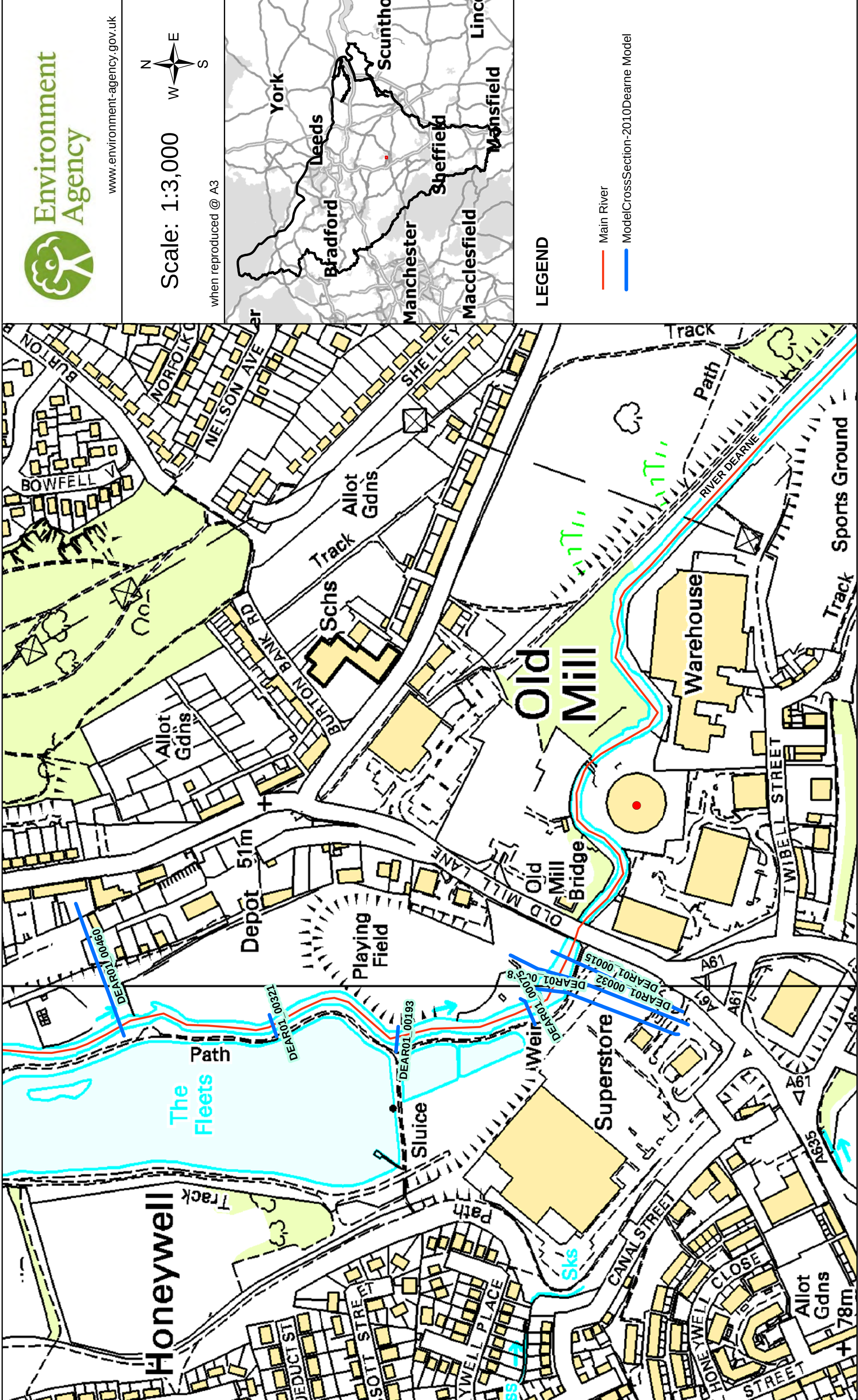
Notes:

1. Refer to *Defra FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts, October 2006*, for details of the derivation of this table.
 2. For deriving peak rainfall, for example, between 2025-2055 multiply the rainfall measurement (in mm/hour) by 10 per cent and between 2055-2085 multiply the rainfall measurement by 20 per cent. So, if there is a 10mm/hour event, for the 2025-2055 period this would equate to 11mm/hour; and for the 2055/2085 period, this would equate to 12mm/hour. Other parameters in Table B.2 are treated similarly.
- B10. Sensitivity testing of the Flood Map produced by the Environment Agency, using the 20 per cent from 2025 to 2115 allowance for peak flows, suggests that changes in the extent of inundation are negligible in well-defined floodplains, but can be dramatic in very flat areas. However, changes in the depth of flooding under the same allowance will reduce the return period of a given flood. This means that a site currently located within a lower risk zone (eg Zone 2 in Table D.1, Annex D) could in future be re-classified as lying within a higher risk zone (eg Zone 3). This in turn could have implications for the type of development that is appropriate according to its vulnerability to flooding (see Table D.2, Annex D). It will therefore be important that developers, their advisors and local authorities refer to the current Flood Map and the SFRA when preparing and considering proposals.

- B11. Flooding in estuaries may result from the combined effects of high river flows and high sea surges. When taking account of impacts of climate change in flood risk assessments covering tidal estuaries, it will be necessary for the allowances for sea level rise in Table B.1 (see para. B5) and the allowances for peak flow, wave height and wind speed in Table B.2 (see para. B9) should be combined.¹⁷
- B12. Indirect impacts of climate change on land use and land management may change future flood risk. For example, changes in crop type, methods of cultivation and harvesting could affect the porosity and surface of the ground and hence the volume, speed and direction of storm run-off.
- B13. Adaptation to climate change requires an integrated approach across different sectors including land use, water resources, transport, biodiversity and recreation. This integrated approach should be reflected in flood risk assessment.
- B14. Knowledge and understanding of climate change is continuing to grow. The next UKCIP scenarios, due in 2008, are expected to provide more detail on regional climate changes and to express this information in probabilistic terms. Other areas where further research is in progress include climate-driven risks from groundwater and sewer flooding. The most up-to-date guidance on climate change and flooding from the Environment Agency, Defra, Communities and Local Government and the UKCIP should be considered in the preparation of Regional Flood Risk Appraisals, Strategic Flood Risk Assessments and site specific Flood Risk Assessments.

¹⁷ Refer to Defra *FCDPAG3 Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts*, October 2006. Annex A2 gives details of joint probability analysis.
www.defra.gov.uk/enviro/fcd/pubs/pagn/climatechangeupdate.pdf

Model Cross Sections for Old Mill Lane, Barnsley - Date Created 23/06/2011 [Ref: 17472]

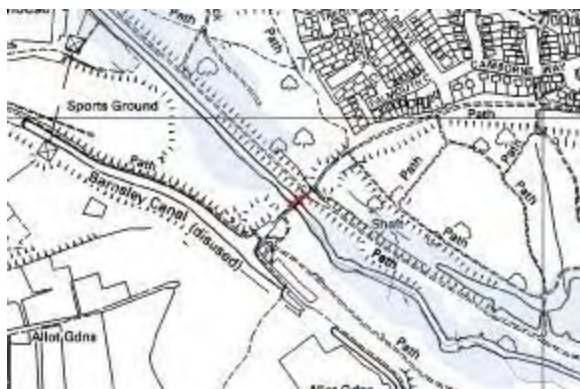


Location	Label	Chainage (km)	5 yr		10 yr		25 yr		50 yr		75 yr		100 yr		1000 yr		100 yr + CC	
			Max Stage (mAOD)	Max Flow (m ³ s ⁻¹)	Max Stage (mAOD)	Max Flow (m ³ s ⁻¹)	Max Stage (mAOD)	Max Flow (m ³ s ⁻¹)	Max Stage (mAOD)	Max Flow (m ³ s ⁻¹)	Max Stage (mAOD)	Max Flow (m ³ s ⁻¹)	Max Stage (mAOD)	Max Flow (m ³ s ⁻¹)	Max Stage (mAOD)	Max Flow (m ³ s ⁻¹)	Max Stage (mAOD)	Max Flow (m ³ s ⁻¹)
	DEA00947	0.95	45.61	45.43	45.71	51.04	45.90	62.66	46.04	73.77	46.12	80.56	46.19	88.87	46.86	166.17	46.34	105.99
	DEA00865	0.87	45.62	45.55	45.75	51.17	45.94	62.80	46.10	73.93	46.19	80.74	46.29	89.07	47.09	166.58	46.49	106.22
	DEA00838	0.84	45.55	45.58	45.66	51.21	45.83	62.84	45.98	73.99	46.06	80.80	46.16	89.13	46.94	166.70	46.35	106.30
	DEA00810	0.81	45.54	45.62	45.65	51.26	45.81	62.89	45.93	74.04	46.01	80.86	46.08	89.20	46.71	166.86	46.23	106.38
	DEA00708	0.71	45.54	35.38	45.65	37.90	45.82	46.01	45.94	55.16	46.00	61.60	46.06	69.24	46.62	131.05	46.16	86.09
	DEA00580	0.58	45.43	42.08	45.54	44.82	45.71	50.97	45.84	56.36	45.91	59.77	45.99	64.32	46.61	114.97	46.12	74.22
	DEA00460	0.46	45.33	42.23	45.44	45.01	45.61	51.17	45.75	56.59	45.82	60.03	45.89	64.52	46.60	91.05	46.02	73.34
	DEA00321	0.32	45.27	30.21	45.38	31.44	45.56	34.10	45.69	37.04	45.76	39.11	45.82	41.96	46.57	57.76	45.94	48.14
	DEA00193	0.19	45.17	37.46	45.26	39.96	45.42	46.57	45.54	52.27	45.61	53.78	45.69	55.00	46.55	57.32	45.83	56.84
	DEA00075	0.07	45.10	42.58	45.18	47.51	45.32	45.49	45.43	62.35	45.49	66.22	45.55	70.19	46.49	85.54	45.67	77.99
Barnsley Weir Gauging Station	DEA00048U	0.05	44.94	42.73	45.03	47.82	45.16	56.18	45.27	63.50	45.33	67.85	45.39	72.50	46.45	94.71	45.52	82.23
	DEA00048D	0.05	43.48	42.73	43.68	47.82	44.05	56.18	44.38	63.50	44.59	67.85	44.76	72.50	46.39	94.71	45.12	82.23
	DEA00032	0.03	43.45	45.87	43.65	51.89	44.02	62.07	44.36	71.14	44.56	76.67	44.74	82.52	46.37	120.50	45.10	94.96
	DEA00015	0.02	43.45	45.87	43.65	51.89	44.02	62.07	44.36	71.14	44.56	76.67	44.74	82.52	46.37	120.50	45.10	94.96
A61 Road Bridge	DEA00001U	0.00	43.33	45.89	43.52	52.20	43.85	64.01	44.16	75.33	44.35	82.67	44.52	90.60	46.11	170.65	44.85	108.15
Baldon Dyke Cross-sections																		
	BAI3103	3.10	133.39	2.20	133.51	2.59	133.66	3.10	133.80	3.57	133.93	3.90	134.03	4.15	134.87	7.28	134.36	4.98
	BAI3075	3.07	133.00	2.22	133.15	2.62	133.33	3.13	133.51	3.61	133.66	3.94	133.79	4.19	134.77	7.35	134.21	5.03
	BAI3023D	3.02	131.02	2.22	131.07	2.62	131.12	3.13	131.17	3.61	131.19	3.94	131.21	4.19	131.47	7.35	131.28	5.03
	BAI2985	2.99	130.43	2.25	130.48	2.65	130.55	3.18	130.60	3.66	130.63	3.99	130.65	4.25	130.93	7.46	130.73	5.10
	BAI2820	2.82	128.33	2.39	128.42	2.82	128.53	3.37	128.63	3.89	128.69	4.24	128.73	4.51	129.05	7.92	128.85	5.42
Park Gate	BAI2719	2.72	127.31	2.47	127.42	2.91	127.54	3.49	127.64	4.03	127.70	4.39	127.75	4.67	128.40	8.21	127.93	5.61
	BAI2708	2.71	127.34	2.48	127.46	2.93	127.59	3.51	127.69	4.04	127.76	4.41	127.81	4.69	128.38	8.24	127.99	5.63
	BAI2708D	2.71	127.09	2.48	127.19	2.93	127.30	3.51	127.39	4.04	127.44	4.41	127.49	4.69	127.93	8.24	127.62	5.63
	BAI2689	2.69	126.81	2.50	126.89	2.94	126.99	3.53	127.06	4.07	127.11	4.43	127.14	4.72	127.49	8.29	127.25	5.67
	BAI2556	2.56	125.49	2.61	125.54	3.07	125.59	3.68	125.63	4.25	125.66	4.63	125.68	4.93	125.84	8.67	125.73	5.92
	BAI2556D	2.56	124.38	2.61	124.64	3.07	124.71	3.68	124.76	4.25	124.80	4.63	124.82	4.93	125.11	8.67	124.91	5.92
	BAI2485	2.49	123.07	2.67	123.12	3.14	123.18	3.77	123.26	4.35	123.25	4.74	123.28	5.05	123.51	8.87	123.34	6.06
	BAI2379	2.38	121.48	2.75	121.52	3.25	121.58	3.89	121.62	4.49	121.64	4.90	121.66	5.21	121.80	9.17	121.72	6.26
	BAI2238	2.26	120.05	2.85	120.10	3.37	120.17	4.04	120.22	4.65	120.26	5.08	120.28	5.41	120.56	9.51	120.37	6.49
	BAI2111	2.11	118.87	2.98	118.99	3.51	119.12	4.21	119.21	4.86	119.26	5.29	119.30	5.64	119.68	9.93	119.43	6.77
	BAI2011	2.01	118.75	3.06	118.88	3.61	119.02	4.33	119.12	4.99	119.17	5.44	119.21	5.80	119.59	10.21	119.34	6.96
	BAI2011D	2.01	117.90	3.06	117.96	3.61	118.03	4.33	118.09	4.99	118.12	5.44	118.15	5.80	118.44	10.21	118.24	6.96
	BAI1973	1.97	117.04	3.09	117.10	3.65	117.16	4.37	117.22	5.04	117.27	5.50	117.31	5.86	117.69	10.32	117.41	7.03
	BAI1973D	1.97	117.03	3.09	117.09	3.65	117.15	4.37	117.20	5.04	117.24	5.50	117.27	5.86	117.56	10.32	117.36	7.03
	BAI1830	1.83	115.40	3.21	115.46	3.79	115.52	4.54	115.58	5.24	115.63	5.71	115.66	6.09	115.95	10.72	115.75	7.30
	BAI1674	1.67	113.93	3.34	113.99	3.94	114.07	4.73	114.14	5.45	114.18	5.95	114.22	6.34	114.55	11.17	114.34	7.60
	BAI1557	1.56	112.92	3.44	112.97	4.06	113.03	4.86	113.07	5.61	113.10	6.12	113.13	6.52	113.38	11.50	113.20	7.83
	BAI1460	1.46	112.84	3.52	112.87	4.15	112.91	4.98	112.94	5.74	112.96	6.27	112.98	6.68	113.13	11.77	113.03	8.01
	BAI1460D	1.46	111.90	3.52	111.98	4.15	112.08	4.98	112.15	5.75	112.20	6.27	112.24	6.68	112.55	11.77	112.34	8.01
	BAI1415	1.42	111.71	3.56	111.78	4.20	111.85	5.03	111.91	5.81	111.95	6.33	111.98	6.75	112.28	11.90	112.06	8.10
	BAI1333	1.33	111.51	3.62	111.58	4.28	111.66	5.13	111.73	5.92	111.77	6.46	111.80	6.88	112.08	12.13	111.89	8.25
	BAI1333D	1.33	111.45	3.62	111.53	4.28	111.61	5.13	111.68	5.92	111.72	6.46	111.75	6.88	112.03	12.13	111.84	8.25
	BAI1317	1.32	111.40	3.64	111.48	4.29	111.56	5.15	111.62	5.94	111.66	6.48	111.69	6.90	111.97	12.17	111.78	8.28
	BAI1317D	1.32	111.05	3.64	111.14	4.29	111.22	5.15	111.29	5.94	111.33	6.48	111.35	6.90	111.65	12.17	111.44	8.28
	BAI1135	1.14	109.05	3.79	109.12	4.47	109.20	5.36	109.27	6.19	109.74	6.75	109.78	7.19	110.06	12.69	109.87	8.63
	BAI1135D	1.14	109.05	3.79	109.11	4.47	109.20	5.36	109.27	6.19	109.31	6.75	109.35	7.19	109.67	12.69	109.46	8.63
	BAI1063	1.05	107.85	3.86	107.91	4.55	107.97	5.46	108.03	6.30	108.08	6.87	108.11	7.32	108.44	12.92	108.21	8.79
	BAI0948	0.95	106.83	3.95	106.92	4.66	107.02	5.58	107.09	6.44	107.13	7.03	107.16	7.49	107.49	13.22	107.26	8.99
	BAI0924	0.83	105.59	4.05	105.66	4.78	105.72	5.73	105.78	6.61	105.83	7.22	105.86	7.69	106.16	13.57	105.96	9.23
	BAI0702	0.70	104.50	4.15	104.58	4.90	104.67	5.88	104.73	6.78	104.77	7.40	104.80	7.88	105.10	13.92	104.89	9.46
	BAI0577	0.58	103.35	4.25	103.41	5.02	103.49	6.02	103.59	6.95	103.64	7.59	103.68	8.08	104.01	14.27	103.78	9.70
	BAI0458	0.46	102.24	4.35	102.37	5.14	102.50	6.16	102.64	7.12	102.72	7.76	102.79	8.27	103.22	14.61	102.95	9.93
	BAI0458D	0.46	101.86	4.35	101.96	5.14	102.05	6.16	102.16	7.11	102.23	7.76	102.28	8.27	102.74	14.61	102.44	9.93
	BAI0344	0.35	100.53	4.45	100.60	5.25	100.68	6.30	100.76	7.27	100.81	7.93	100.85	8.45	101.13	14.94	100.94	10.15
	BAI0222	0.22	99.40	4.55	99.50	5.37	99.62	6.44	99.72	7.44	99.77	8.12	99.81	8.65	100.11	15.28	99.91	10.38
	BAI0222D	0.22	99.05	4.55	99.13	5.37	99.23	6.44	99.31	7.44	99.35	8.12	99.38	8.65	99.72	15.28	99.48	10.38
	BAI0101	0.10	98.22	4.65	98.30	5.49	98.42	6.59	98.51	7.60	98.56	8.30	98.60	8.84	98.95	15.63	98.76	10.61

2004 S105 River Don Flood Model - 200yr (0.5% AEP)

Lable	Max Stage (mAOD)
DRN01_23278u	43.75
DRN01_22430u	41.41

Location Plan



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Cross Section References

River: DRN

Reach: 01

Chainage: 22430U

Section Type: BRIDGE, SECTION

OS NGR: SE 35676 06890

Survey Dwg Ref: N/A

Photograph Ref: DEAR_22430.JPG

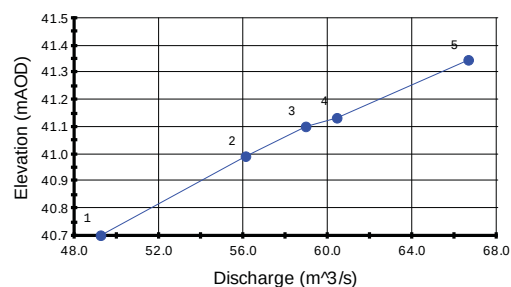
Next

Section D/s: 22257

Section U/s: 23278U



Rating Curve



Number represents model profile number

Summary of Results

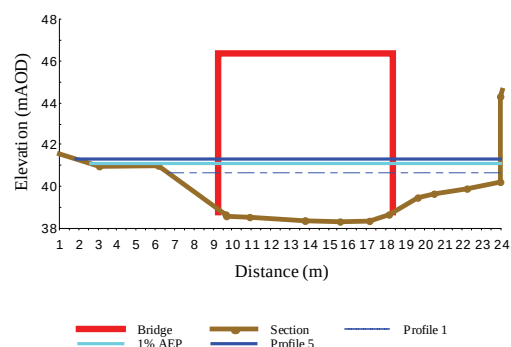
Profile No	AEP (%)	Flow (m³/s)	Water Level (mAOD)	Velocity (m/s)
1	4.00	49.3	40.704	2.03
2	2.00	56.1	40.993	2.04
3	1.33	58.9	41.102	2.04
4	1.00	60.4	41.134	2.04
5	0.67	66.6	41.346	2.04

Level of Left Bank 41.030 mAOD

Level of Right Bank 39.520 mAOD

AEP: Annual Exceedance Probability = 1/T, where T = Return Period (Years)

Cross Section Profile



DRN: 01: CROSS SECTION NUMBER 22430U



Location Plan

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Cross Section References

River:DRN

Reach:01

Chainage:23278U

Section Type:BRIDGE, SECTION

OS NGR:SE 35035 07252

Survey Dwg Ref: N/A

Photograph Ref: DEAR_23278.JPG

Next

Section D/s: 22430U

Section U/s: N/A

Rating Curve

Number represents model profile number

Summary of Results

Profile No	AEP (%)	Flow (m^3/s)	Water Level (mAOD)	Velocity (m/s)
1	4.00	49.3	43.215	2.43
2	2.00	56.1	43.412	2.52
3	1.33	59.0	43.491	2.55
4	1.00	60.3	43.528	2.57
5	0.67	66.6	43.698	2.64

Level of Left Bank43.990 mAOD

Level of Right Bank45.350 mAOD

AEP: Annual Exceedance Probability = 1/T, where T = Return Period (Years)

Cross Section Profile

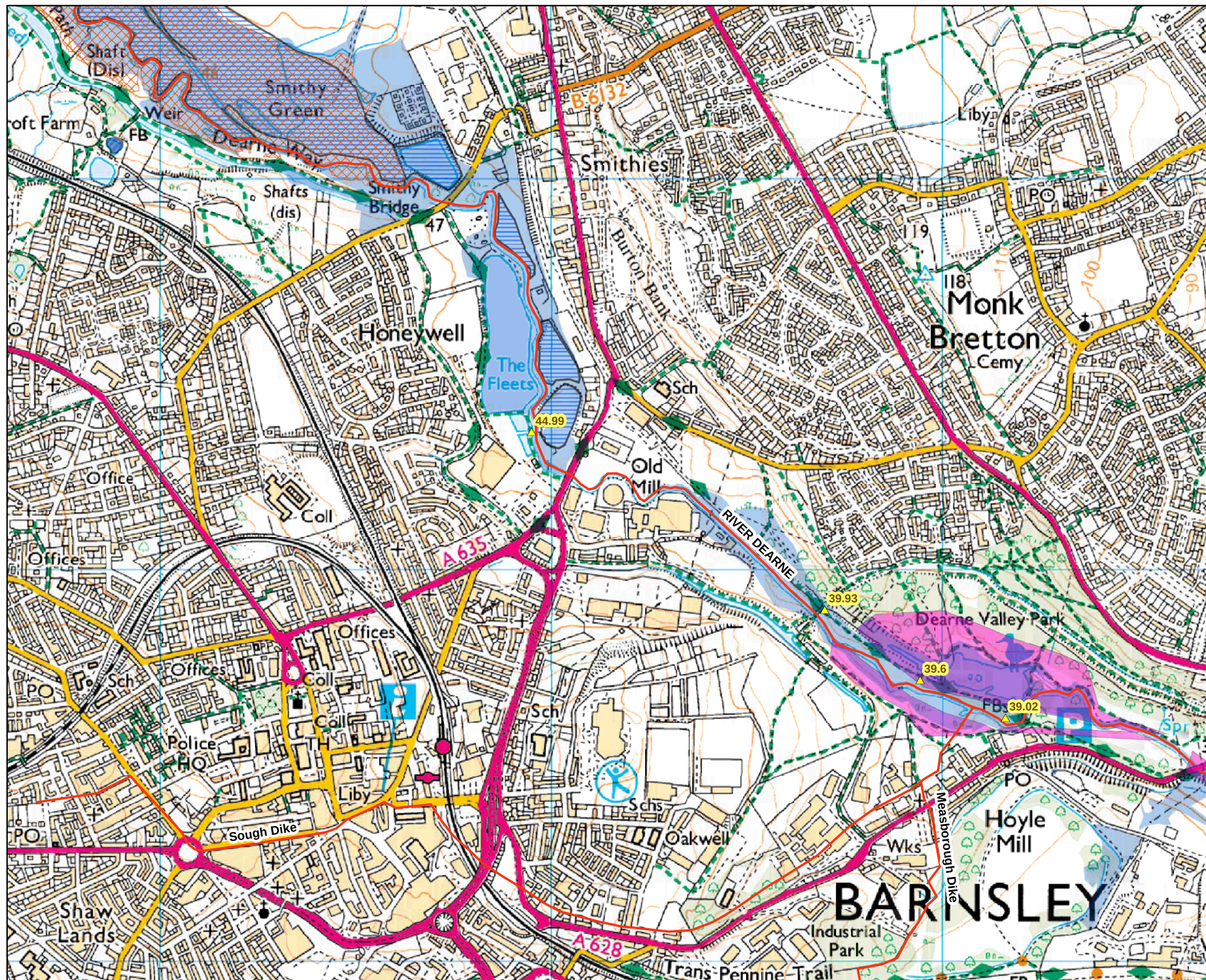
Bridge1% AEP

Section Profile 5

Profile 1

DRN: 01: CROSS SECTION NUMBER 23278U

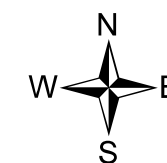
Flood History Map for Old Mill Lane, Barnsley - dated 22/06/2011 [Ref: 17472]



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Scale: 1:10,000

when reproduced @ A3



Flood Extents

Legend

- Main River
- ▲ Autumn 2000 Flood Event Flood Level (m)
- Jan 2008 Flood Event Flood Extent DRAFT
- 2007 Flood Events Flood Extent
- 2007 Flood Event Surface Water Flood Extent
- Autumn 2000 Flood Event Flood Extent
- River Don 1947 Flood Event Flood Extent