

Wombwell WwTW

Flood Risk Assessment

Yorkshire Water

February 2023

5218001/DG/FRA/001



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This document has 60 pages including the cover.

Document history

Document title: Flood Risk Assessment

Document reference: 5218001/DG/FRA/001

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
1.0	Draft for Review	RC	HH	EJG	MS	08/02/23
1.1	Draft for Submission	RC	HH	EJG	MS	21/02/23

Client signoff

Client	Yorkshire Water
Project	Wombwell WwTW
Job number	5218001
Client signature/date	

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1. Introduction

1.1. Atkins Services

Atkins Limited has been commissioned by Yorkshire Water (hereafter referred to as 'YW') to undertake a Flood Risk Assessment (FRA) in relation to the planning application for the siting of a new Dosing Kiosk on the existing Wombwell Wastewater Treatment Works (hereafter referred to as the Scheme). The FRA report has been prepared in support of a full planning application. The following tasks have been undertaken:

- A review of existing data and information.
- An appraisal of the flood risks to the Scheme and the possible flood risks which could occur as a result of the Scheme.
- Where necessary, an appraisal of the proposed measures to reduce the flood risk to acceptable levels.

1.2. Background

This study has been carried out in accordance with the National Planning Policy Framework (NPPF)¹. As part of the planning process, the NPPF requires that all proposed development sites which are in excess of 1 hectare in area, lie within Flood Zones 2 or 3, or have critical drainage problems must be accompanied by an FRA. Environment Agency (EA) flood maps have been reviewed and show that the Scheme lies within Flood Zone 2 and therefore requires an FRA.

The broad aim of the NPPF is to reduce the number of people and properties within the natural and built environment at risk of flooding. To achieve this aim, planning authorities are required to ensure that flood risk is properly assessed during the initial planning stages of any development.

Responsibility for this assessment lies with developers and they must demonstrate the following:

- Whether the proposed development is likely to be affected by flooding.
- Whether the proposed development will increase flood risk to adjacent properties.
- That the measures proposed to deal with any flood risk are sustainable.

The developer must demonstrate to the Local Planning Authority and the EA that the existing flood risk or the flood risk associated with the proposed development can be satisfactorily managed.

1.3. Flood Risk

Flood risk includes the statistical probability of an event occurring and the scale of the potential consequences. The risk is estimated from historical data and expressed in terms of the expected frequency (or 'return period') of a flood of a given magnitude. The 10-year, 50-year and the 100-year floods have a respective 10%, 2% and 1% chance of occurring in any given year (this is termed the Annual Exceedance Probability [AEP]), however, over a longer period the probability of flooding is considerably greater. For example, for the 100-year return period flood, there is a:

- 1% chance of the 100-year flood occurring or being exceeded in any year.
- 26% chance of it occurring or being exceeded in a 30-year period.
- 51% chance of it occurring or being exceeded in a 70-year period.

Table 1.1 provides a summary of the relevant AEP and corresponding return periods.

¹ National Planning Policy Framework 2019 and Planning Practice Guidance

Table 1.1 – Definition of AEP and ‘return period’ flood events

AEP (%)	Return period (years)
50%	2
10%	10
5%	20
4%	25
2%	50
1%	100
0.5%	200
0.1%	1,000

2. Site Description

The following section describes the nature, location, type and size of the Scheme. This includes the proximity of the Scheme to any potential flood risk.

2.1. Location of Site

The Scheme is located to the east of Wombwell, on Ings Road (B6096). The Scheme is located within an existing operational Wastewater Treatment Works (WwTW) owned and operated by YW. The WwTW location is indicated by the red boundary shown on Figure 2-1.



Figure 2-1 - Location of Site (Google Maps)

The existing WwTW site is a roughly rectangular parcel of land that contains wastewater treatment assets including primary settling tanks, final settling tanks, aeration tanks, inlet works, storm tanks, digesters, pumping stations, dosing kiosks, boiler house, and more.

2.2. Proposed Scheme

The Scheme comprises a Dosing Kiosk within the southern part of the existing site as shown in Figure 2-2. The Dosing Kiosk dimensions are approximately 10m x 3.8m. The Dosing Kiosk is located partially on hardstanding and partially on unsealed land. New pipework is to be provided as part of the proposed development which connects into the wider drainage system for the existing WwTW site.

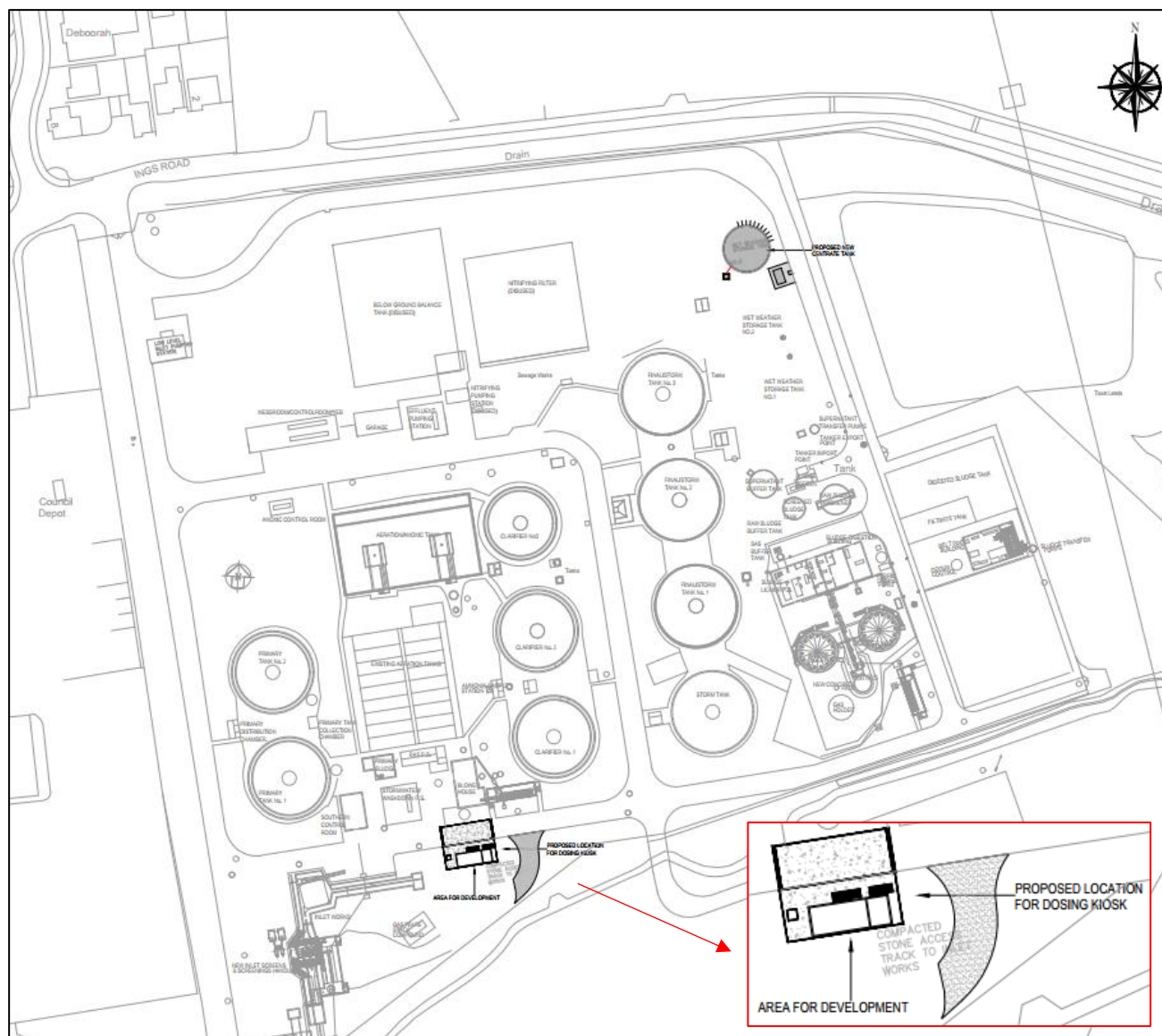


Figure 2-2 - Proposed Scheme (Yorkshire Water, 2022)

2.3. Watercourses

The closest watercourse to the Scheme is Bulling Dike running along the southern perimeter of the WwTW. To the north is the River Dove and to the east is the River Dearne, into which both the River Dove and Bulling Dike drain. See Figure 2-3 below.

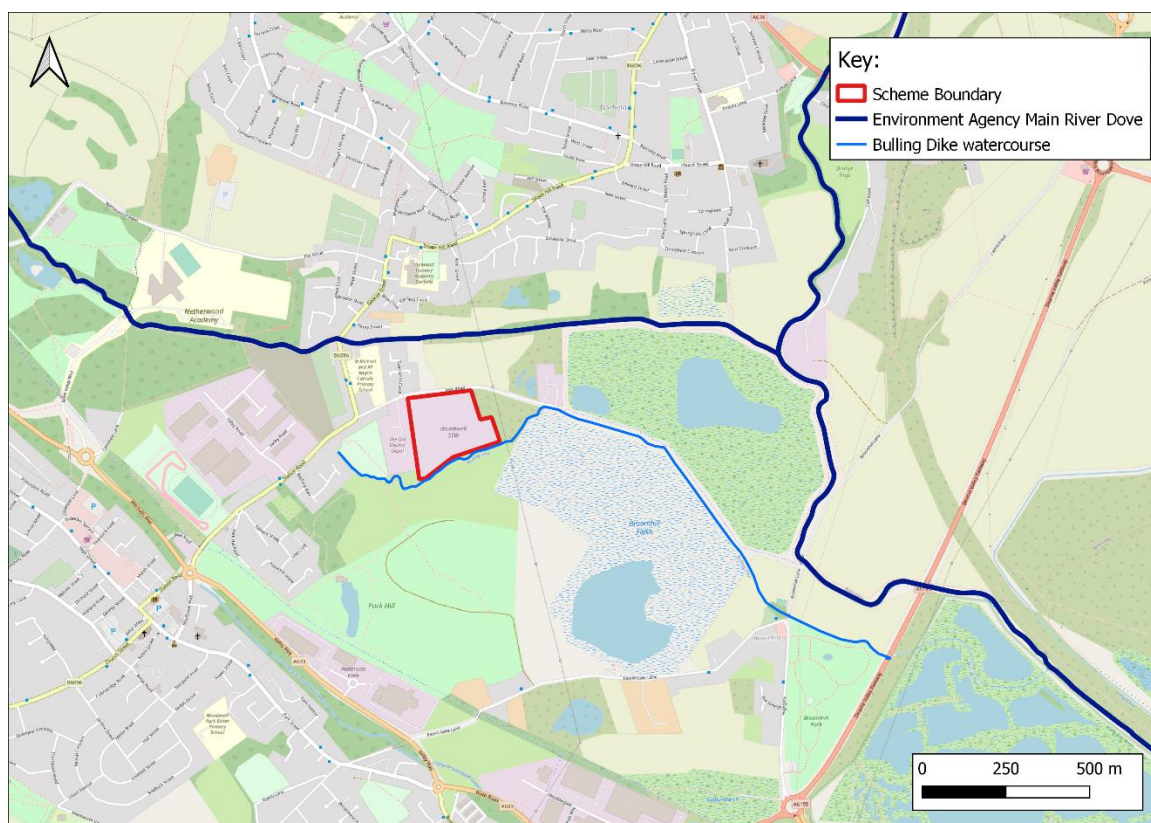


Figure 2-3 - Watercourses (Environment Agency, 2022)

2.4. Site Topography

A topographic survey has been undertaken for the proposed Scheme and is provided in Appendix A. The approximate ground elevation at the proposed Dosing Kiosk is 23.75 mAOD.

2.5. Geology

The British Geological Survey viewer² indicates the site is underlain by bedrock of Pennine Middle Coal Measures Formation comprising mudstone, siltstone and sandstone. Superficial Alluvium deposits comprising of clay, silt, sand and gravel overlies the coal measures. The bedrock geology and superficial geology are both designated as a Secondary A aquifer. The site is not within a Groundwater Source Protection Zone.

2.6. Soils

Soil information was obtained from Soilscales viewer³. The soil underlying the site is Soil Type 20 which represents loamy and clayey floodplain soils with naturally high groundwater.

² [BGS Geology Viewer - British Geological Survey](#)

³ [Soilscales soil types viewer - Cranfield Environment Centre. Cranfield University \(landis.org.uk\)](#)

3. Existing Data and Information

3.1. Environment Agency Flood Map (Flood Map for Planning)

The Flood Map published by the EA contains Flood Zones for use in accordance with the NPPF. The Flood Zones represent the risk of flooding from rivers and the sea. Flood Zone 2 delineates an extreme flood outline from both the sea and rivers and is considered to represent a 0.1% probability (1,000 year) flood event. Flood Zone 3 represents flooding from rivers with a 1% probability of flooding (100 year) occurring in any given year.

The Flood Map of the Scheme in Figure 3-1 identifies the Dosing Kiosk as being within Flood Zone 2 (0.1% AEP fluvial flood zone: Medium Risk).

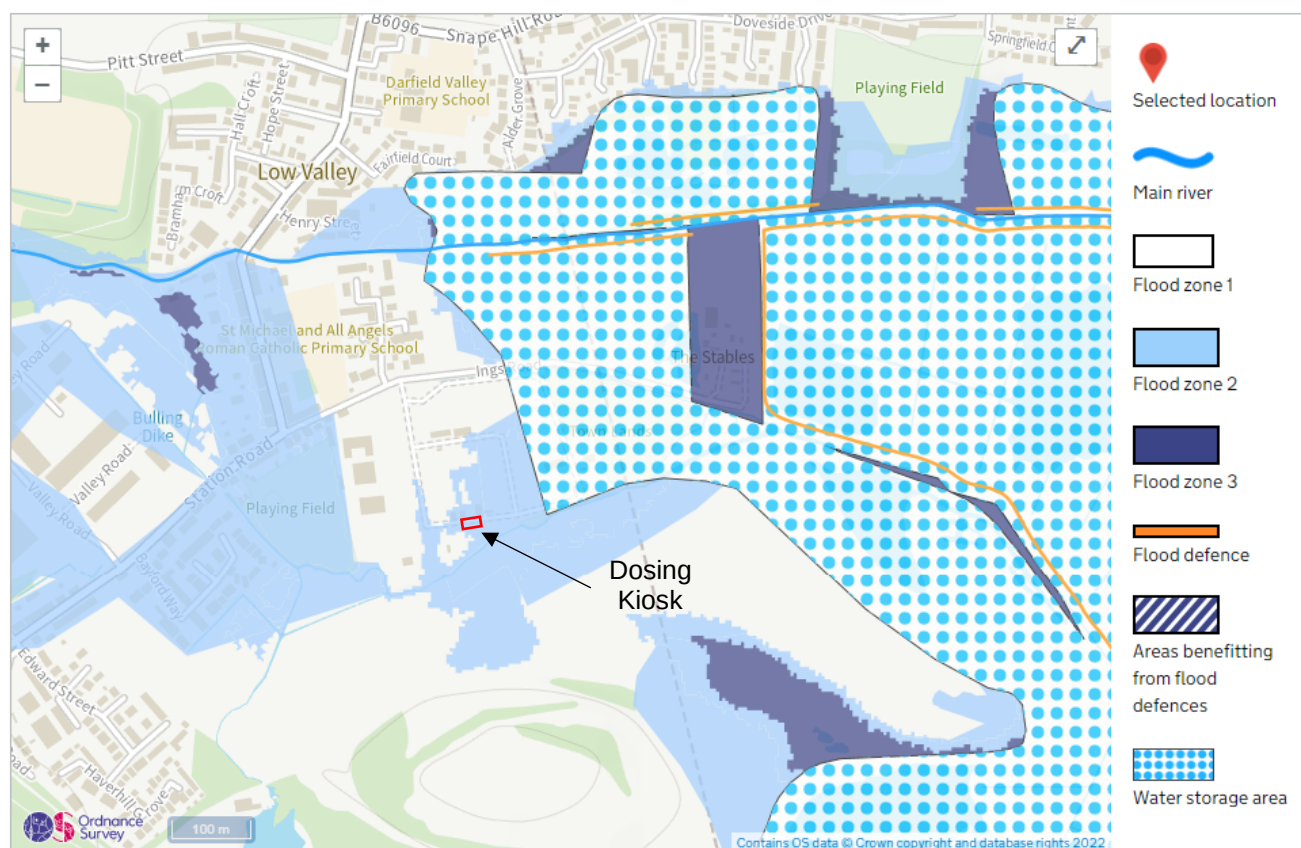


Figure 3-1 – Environment Agency Flood Map for Planning (EA Website, 2022)

3.2. Environment Agency Risk of Flooding from Rivers and Sea

The EA risk of flooding from rivers and sea map in Figure 3-2 indicates that the proposed location of the Dosing Kiosk is within a low risk area of flooding. The Risk of flooding map is based on the presence and effect of all flood defences, predicted flood levels, and ground levels.

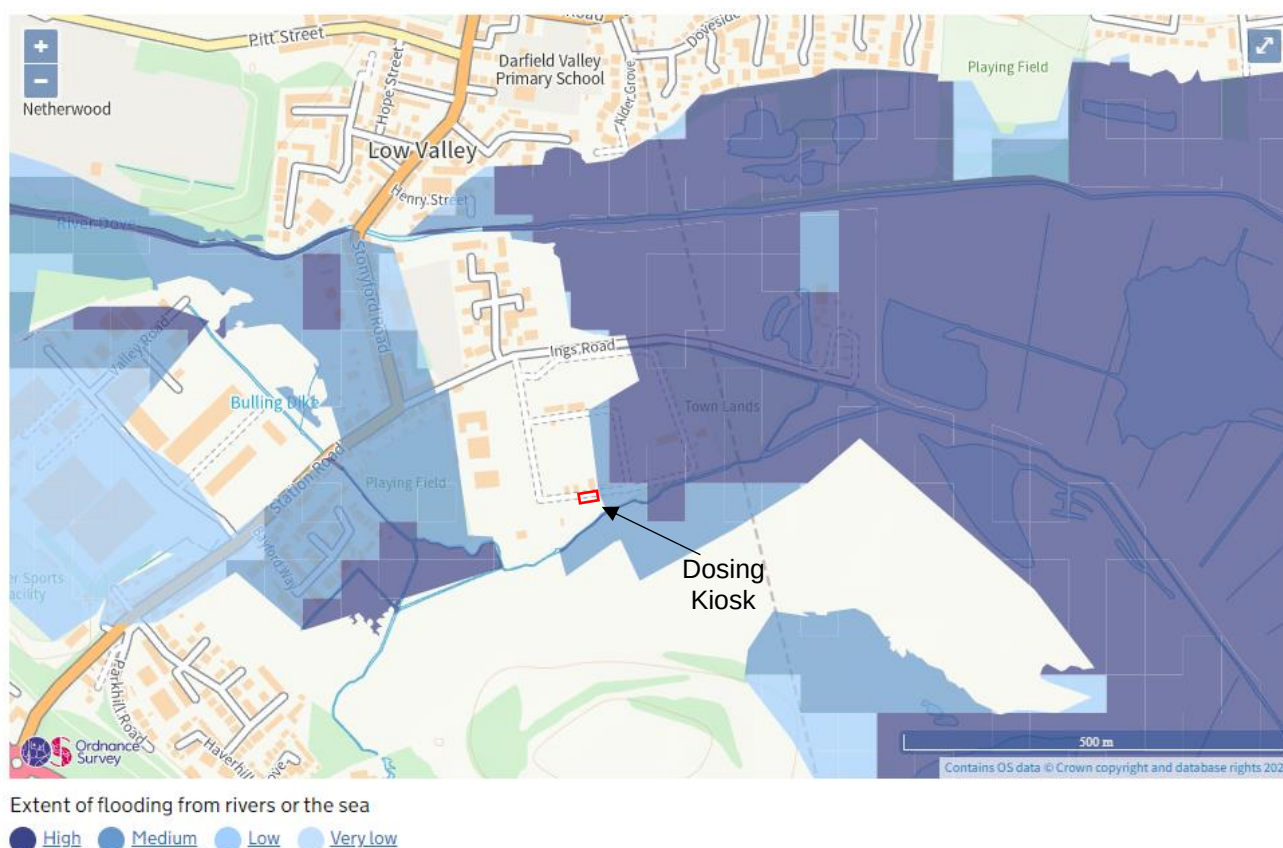


Figure 3-2 - Environment Agency Flood Risk Map from River and Sea

3.3. River Don Catchment Flood Management Plan⁴

The Don Catchment Flood Management Plan has been divided into seven sub areas which have similar physical characteristics, sources of flooding and levels of risk. These sub areas allow the EA and the Local Authority to promote flood risk management approaches, policies and actions that are most appropriate to deliver the various Government and regional strategies.

The Scheme falls within the Barnsley and Mexborough sub area. The River Dearne is the main watercourse in this sub area, it flows from Haigh in the northwest, through the largely urban areas of Barnsley and Mexborough, before joining the River Don at Conisborough. In addition to the rivers other sources of flooding include surface water and sewer flooding. The preferred approach to managing flood risk in this area is to take action to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits. Within the sub area there are 595 properties within the undefended Flood Zone 3. This could rise to 648 properties in the future. However, there are regulated and unregulated washlands which help to control flows and reduce the risk and provide an approximate standard of protection of one in 30 years (3.3 per cent).

3.4. Barnsley Council Local Flood Risk Management Strategy (2017)⁵

The Lead Local Flood Authority where the Scheme is located is Barnsley Council. Barnsley Council sets out a strategic approach to managing flood risk in the Local Flood Risk Management Strategy. This strategy outlines a 4-step strategic approach to:

1. Prevent flooding occurring through appropriate development.
2. Manage drainage systems through repairs and maintenance programmes.

⁴ [River Don Catchment Flood Management Plan.pdf \(publishing.service.gov.uk\)](#)

⁵ [Flood risk management strategy \(barnsley.gov.uk\)](#)

3. Prioritise response and recovery operations during flooding events;
4. Act on the lessons Identified when reviewing flood risk management activities.

The Strategy sets out the high-level approach to flood risk management and it is supported by:

- Implementation plans which set out the timescales for delivery of individual flood alleviation work programmes and projects.
- Community engagement activities to endeavour to collaborate with local residents, community groups and other stakeholders on flooding related matters before, during and following an event.
- Maintenance operations to maintain the operational efficiency of Council owned assets and infrastructure which provide flood risk reduction benefits.
- Operational response plans which detail the arrangements for the response activities of the Council, its partners and local communities prior to, during and after a flooding event.

3.5. Barnsley Council Preliminary Flood Risk Assessment

A Preliminary Flood Risk Assessment (PFRA) Report was produced by Barnsley Council in 2011⁶. The report conducted a high level screening exercise to locate areas in which the risk of fluvial, surface water and groundwater flooding is significant.

Within the PRFA, the WwTW was identified as an area affected by Main River flooding but was not identified as areas affected by Ordinary Watercourse flooding (see Figure 3-3).

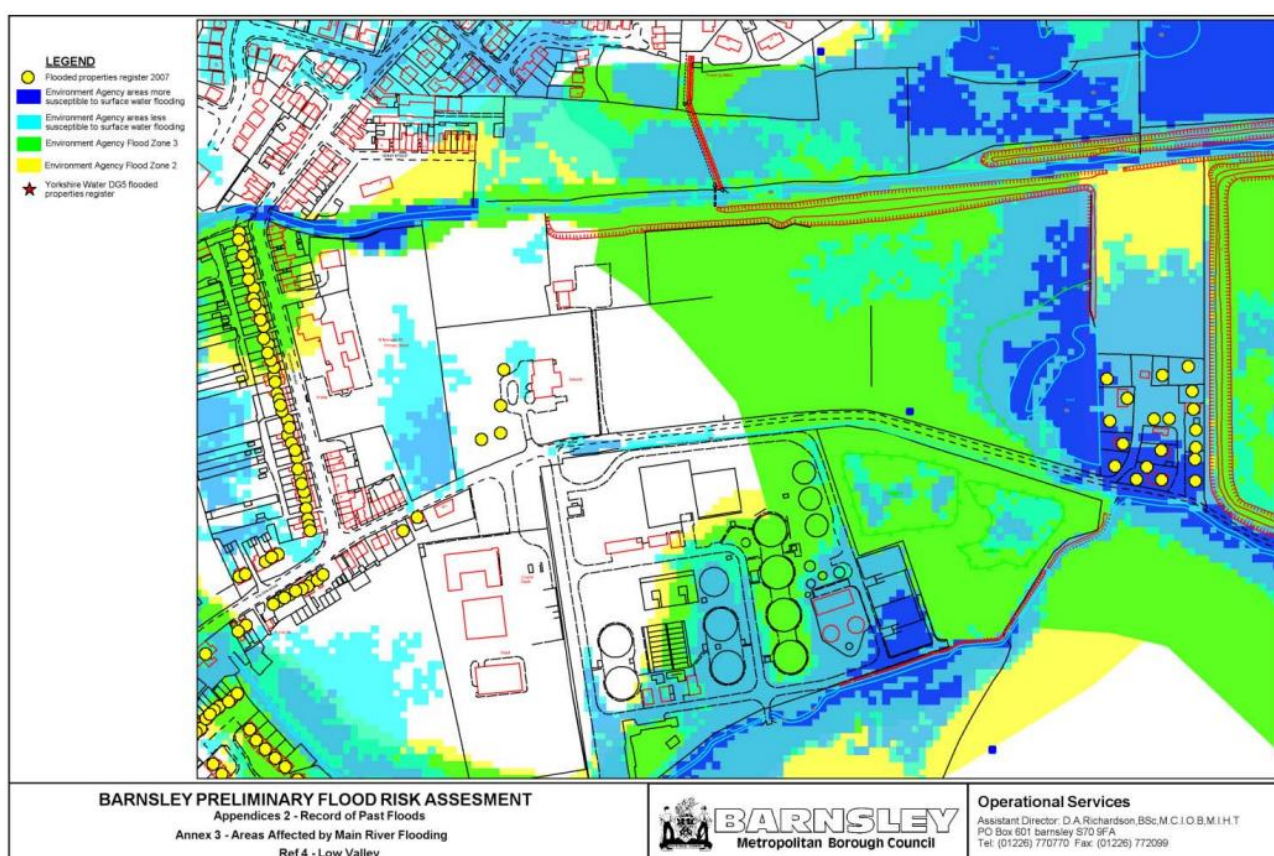


Figure 3-3 - Areas affected by Main River Flooding (Barnsley Preliminary Flood Risk Assessment)⁷

⁶ [Preliminary Flood Risk Assessment Report \(barnsley.gov.uk\)](http://barnsley.gov.uk)

⁷ [Preliminary Flood Risk Assessment Appendix 2 Annex 3 \(barnsley.gov.uk\)](http://barnsley.gov.uk)

Records show that during the 2007 flood, there was overtopping of the River Dove and overland flow routes towards the WwTW as shown in Figure 3-4.

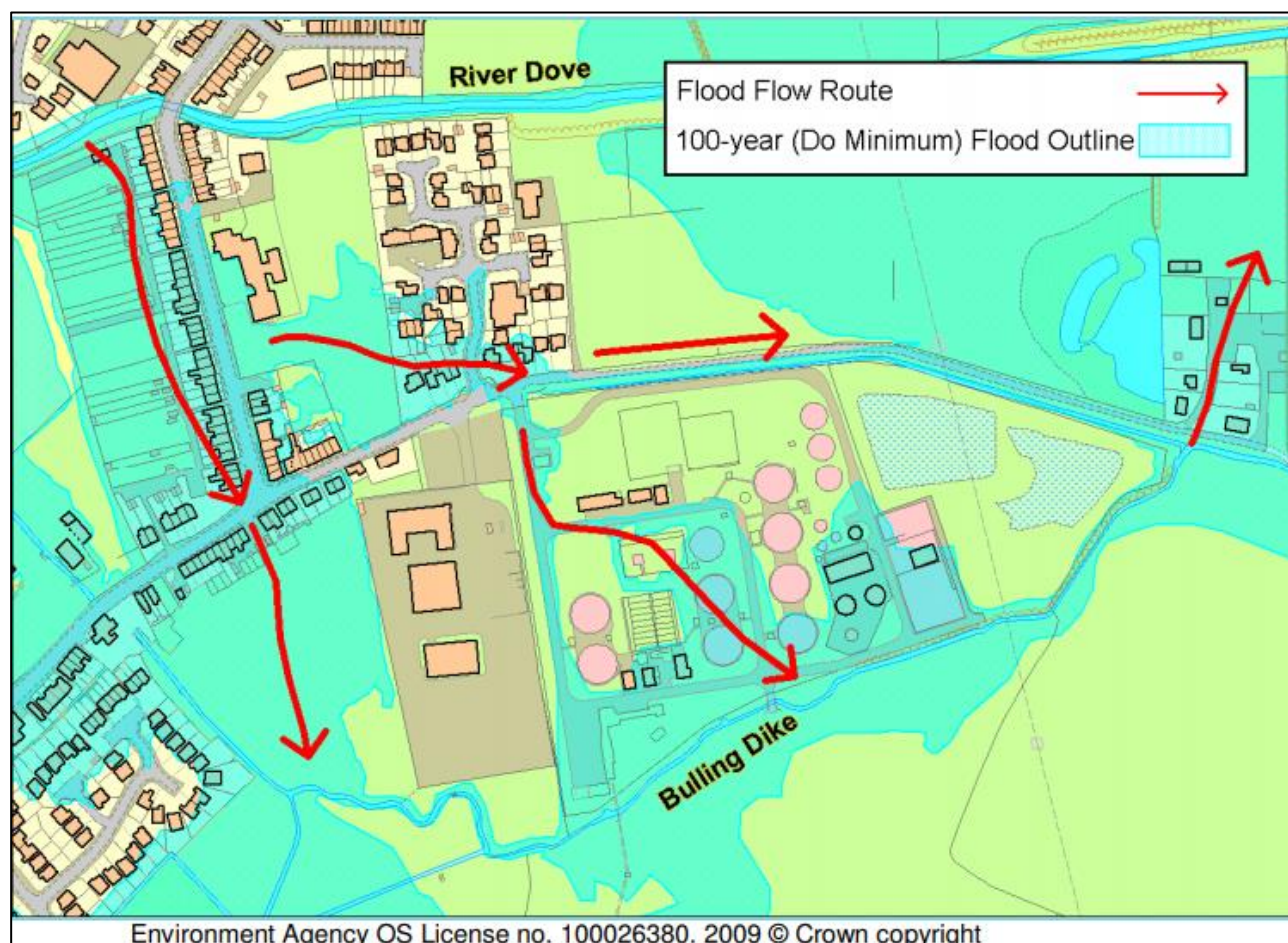


Figure 3-4 - Overland Flow Routes during 2007 event (Barnsley Preliminary Flood Risk Assessment)

3.6. Modelled Flood Risk

A number of modelling studies have been undertaken for Bulling Dike, the River Dove and Dearne catchments and outputs have been provided by the EA for this study. Modelled outputs include:

- 2009 ASM River Dove
- 2017 Lower Valley ERR
- 2018 Middle and Lower Don-Don Dearne

The model outputs have been reviewed to assess the most appropriate flood level to be used as part of the assessment of flood risk to the proposed Scheme. The 2009 River Dove and 2017 Lower Valley models include Bulling Dike adjacent to the WwTW whilst 2018 Middle and Lower Don Dearne does not include Bulling Dike but incorporates floodplain which extends to include the WwTW. Table 3-1 summarises the flood levels for representative nodes within the models and the node locations and flood outlines are provided in Appendix B. The 2009 Dove model which includes a model node on Bulling Dike just upstream of the WwTW has the highest flood level for the 1% AEP event.

In accordance with latest climate change guidance the central allowance for the peak river flows in the Don and Rother management catchment for the 2080s is 28%. No climate change allowance levels are available for the 2009 Dove Model. The model results for the 2009 Dove model show that there is very little change in flood level with flow for a given annual exceedance probability so based on the Dove modelling climate change levels are not likely to increase significantly in Bulling Dike adjacent the WwTW. However, since 2009 there has been

significant development in hydrological and hydraulic methods so there is a level of uncertainty in the 2009 model outputs.

Due to the uncertainty in the 2009 Dove model outputs and the lack of recent modelling which includes Bulling Dike a conservative approach has been undertaken to identify an appropriate design flood level to include an allowance for climate change.

Climate change levels are provided for the 2D area within the WwTW as part of the 2018 Middle and Don Dearne model for a 20%, 30% and 50% uplift of the 1% AEP event but these are all lower than the modelled flood level for the 1% AEP based on the 2009 River Dove model.

Based on the 2018 climate change modelling, flood levels could increase by c. 350mm for a 28% climate change scenario. Applying a 350mm increase to the 2009 Dove modelling for the 1% AEP event would give a flood level of 24.33 mAOD. A 0.1% AEP plus 20% climate change event level of 24.34 mAOD is available from the 2D domain within the WwTW based on the defended 2018 Middle and Don Dearne model and compares well with the assumed uplift applied to the 2009 Dove model. A 1% climate change level of 24.33 mAOD is, therefore, proposed to be used as the basis of this FRA as this provides a conservative flood level based on the available modelling information.

Table 3-1 - Modelled Flood levels (mAOD)

Model Name	Model Run	Node ID	5% AEP	2% AEP	1.33% AEP	1% AEP	0.5% AEP	0.1% AEP	1% AEP + 20%	1% AEP + 30%	1% AEP + 50%
2009 Dove ASM Model	Defended	5		23.87	23.92	23.98					
2009 Dove ASM Model	Defended	7		23.51	23.54	23.58					
2018 Middle and Don Dearne	Defended	1	22.69	22.86	23.26	23.47	23.84	24.11	23.74	23.82	23.95
2018 Middle and Don Dearne	Defended	8	22.45	22.63	23.22	23.46	23.82	24.07	23.72	23.80	23.93
2018 Middle and Don Dearne	Undefended	1				23.47		24.08			
2018 Middle and Don Dearne	Undefended	8				23.56		24.11			
2018 Middle and Don Dearne	Defended	2D					23.83	24.09	23.73	23.80	23.94
2018 Middle and Don Dearne	Undefended	2D						24.08			
2017 Low Valley ERR	Undefended	6		22.45	22.54	22.56	22.64	22.90		22.50	22.89
2017 Low Valley ERR	Undefended	8		22.41	22.53	22.55	22.51	22.56		22.50	22.61

3.7. Environment Agency Risk of Flooding from Surface Water

The EA Surface Water Flood Risk map is shown in Figure 3.5. Flow velocity, flood depth and overall surface water flood risk have been published by the EA⁸. This information has been used to assess the potential flood risk to the Scheme. The Scheme is located in areas shown as being of very low risk of flooding from surface water.

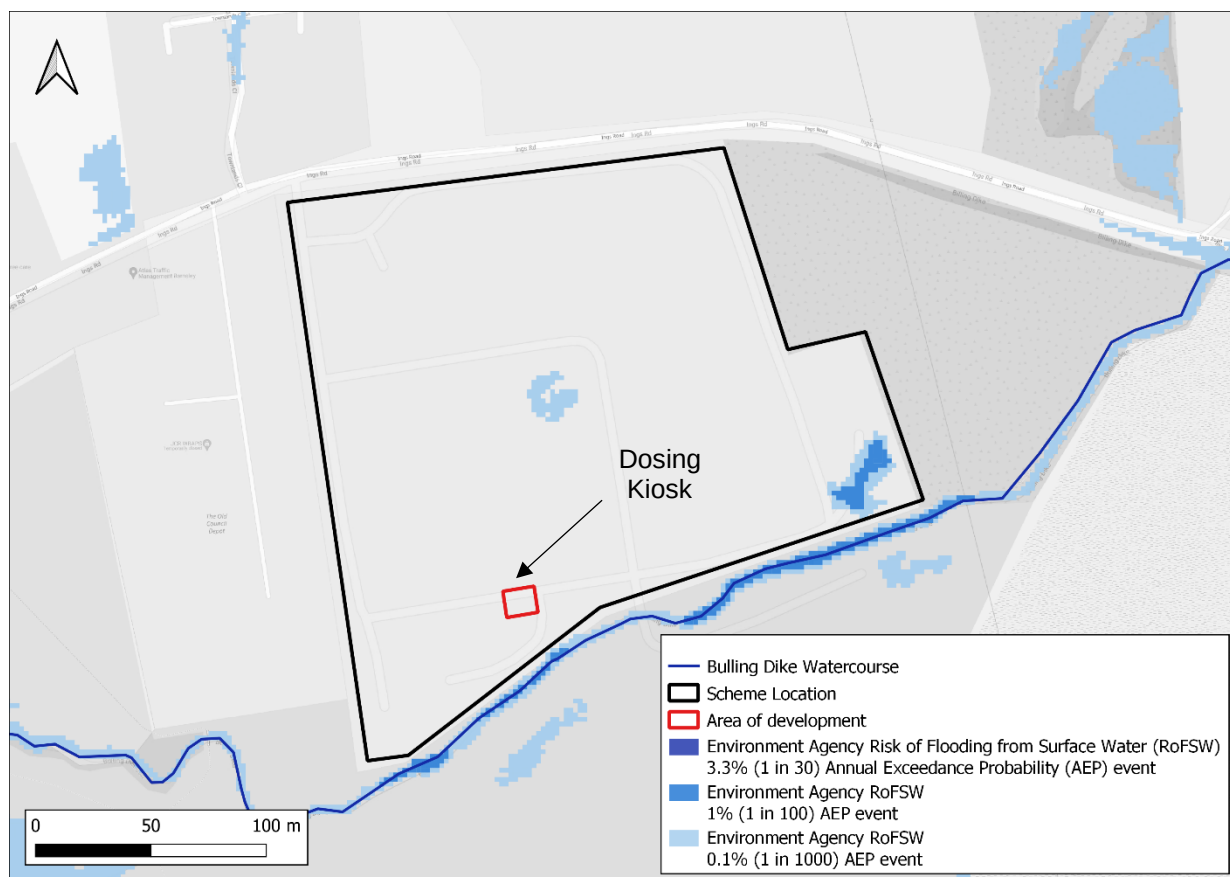


Figure 3.5 – Risk of Flooding from Surface Water (Environment Agency, 2023)

3.8. Environment Agency Risk of Flooding from Reservoirs

Figure 3.6 indicates that the proposed development is only at risk of flooding from reservoir failure when there is coincident flooding from rivers.

⁸ [Learn more about this area's flood risk - GOV.UK \(check-long-term-flood-risk.service.gov.uk\)](https://check-long-term-flood-risk.service.gov.uk/)

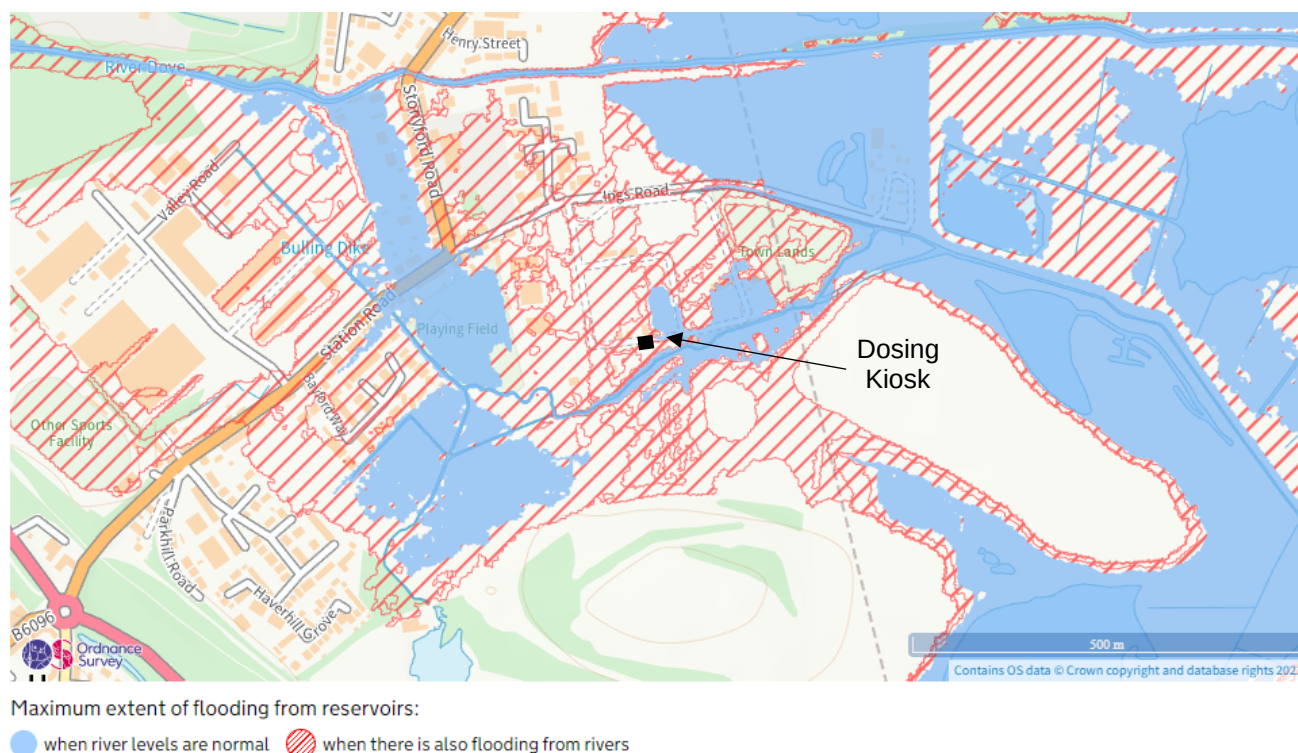


Figure 3.6 – Risk of Flooding from Reservoirs (Environment Agency, 2023)

3.9. Historical Flooding

Historical flood events have occurred within the River Dearne catchment which have affected the lower Dove floodplain. Historical flood mapping outlines are provided in Appendix C which shows that the extents of the March 1947 event impact the eastern extent of the WwTW site boundary. More recent events of October 2000, November 2000, June 2007, November 2019 and February 2020 did not impact the proposed Scheme location within the WwTW.

4. Assessment of Flood Risk

An assessment of flood risk has been undertaken examining the potential flood risk issues with the Scheme.

4.1. Fluvial Flood Risk

The Environment Agency Flood Map indicates that the proposed Dosing Kiosk is located within Flood Zone 2. According to the NPPF the proposals set out in the Scheme are considered to have a vulnerability classification of 'Less Vulnerable' (i.e. the Scheme is not required to remain operational during times of flood) and as such, is an acceptable development within Flood Zone 2.

The existing ground level at the proposed Dosing Kiosk is approximately 23.75 mAOD and there is potential 580mm depth of flooding for events up to the 1% AEP plus allowance for climate change.

4.2. Pluvial/Surface Water Flood Risk

Very heavy, high intensity rainfall may result in high surface water flows at Wombwell WwTW which may create areas of ponding. This may be as a result of rainfall intensity exceeding infiltration capacity or water logging of the ground beneath. The risk of surface water flooding map shows that there is a very low risk of surface water flooding and there are only small areas of ponding across the wider WwTW site.

The proposed Dosing Kiosk is partially located on unsealed land and a drainage system is proposed to capture and manage any surface water runoff from the kiosk which will connect into the existing underground pipework supporting the wider operational WwTW site.

4.3. Groundwater Flooding

Groundwater flooding normally occurs where the water table meets the ground surface in low lying areas which are underlain by permeable rock known as an aquifer. Groundwater flooding tends to follow long periods of sustained rainfall but can also be caused by local obstructions to groundwater flow (e.g. following the placement of engineering structures or buildings with foundations) or by the rebound of groundwater levels after a decrease in abstraction or dewatering.

This can have a direct impact on buildings and buried services, as well as an indirect impact by increasing infiltration of groundwater into sewers and soakaways (reducing their capacity to convey surface water runoff).

It is important to recognise that the risk of groundwater flooding is typically highly variable and heavily dependent on local geological, topographical and weather conditions. Groundwater flooding is hard to predict and challenging to mitigate.

As the site is underlain by alluvium the groundwater levels are likely to be in hydraulic continuity with the adjacent Bullington Dike. There has been no historical evidence of groundwater flooding at the site and the risk of groundwater flooding is considered to be low based on information available.

4.4. Flooding from Sewers

Artificial drainage systems and infrastructure within, or in close proximity to the Scheme may present a risk of flooding through the capacity of the systems being exceeded or the structural, hydraulic, geotechnical, mechanical or operational failure of the system infrastructure. The WwTW site is covered by a network of drainage systems associated with the operation of the WwTW and as such there is a medium risk of flooding from sewers.

4.5. Flooding from Reservoir failure

The risk of flooding from reservoir failure for the Scheme is low. Reservoir risk is reduced through regular maintenance by the operating authority. Reservoirs in the UK have an extremely good safety record with no reservoir failure incidents that resulted in the loss of life since 1925.

The EA is the enforcement authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs are regularly inspected and supervised by reservoir panel engineers. The Local Authority is responsible for coordinating Emergency Plans for reservoir flooding, developed in association with other members of the Local Resilience Forum and ensuring communities are well prepared. The Local Authority is also responsible for carrying out or commissioning reservoir inspections and surveys, and undertaking any works required to comply with its duties under the Reservoirs Act 1975.

Reservoirs can be managed over time, controlling inflow/outflow of water and therefore there is the capacity to control the effects of climate change in the future.

4.6. Other Sources

There is no risk of flooding from canals or other artificial infrastructure.

4.7. Climate Change

Climate change is expected to have a major influence on future flood risk. The expectations are that winter floods will happen more often and in urban areas flooding from thunderstorms will be more frequent and of increased magnitude. Future potential flood levels from the watercourses and increased rainfall have been considered for setting appropriate finished floor levels and drainage design for the Scheme.

5. Mitigation of Flood Risk

Section 4 identified the potential flood risks to the Scheme, this section sets out the principles of how these risks will be mitigated, if necessary, through appropriate design and operation of the Scheme.

5.1. Fluvial Flooding

The proposed location of the Dosing Kiosk is at risk of flooding and it is recommended that finished floor levels should be raised above 24.33 mAOD. As shown on the proposed elevation drawing for the Kiosk in Appendix D, there is stepped access from the ground level to the finished floor which raises the proposed access into the kiosk above the conservative 1% AEP climate change flood level estimate for Bulling Dike and the River Dove floodplain. It is recommended that any sensitive components of the infrastructure within the Dosing Kiosk, e.g. electric sockets, switches, etc are raised above 24.93 mAOD.

5.2. Pluvial / Surface Water Flooding

The NPPF requires that new developments do not exacerbate flood risk by reducing the current flood storage capacity of a site or by increasing the runoff from the site.

The Dosing Kiosk is partially located on an area of unsealed surface and as such, any surface water flood risk should be managed by directing overland flow away from buildings and containing/conveying flow within the site or to appropriately designed drainage systems to ensure there is no increased off-site overland flow.

5.3. Flooding from Sewers

For the purpose of this assessment, all new surface water runoff collection and conveyance systems to service the Scheme will be designed and installed in accordance with current guidance and regulations. Therefore, the risks of failure of the new onsite drainage systems are not considered significant. There is however a residual risk from the existing drainage infrastructure across the wider WwTW site.

5.4. Flooding from Groundwater

As the groundwater is likely to be in hydraulic continuity with Bulling Dike, the main influence on groundwater levels within the development site will be the river levels and mitigation proposed for fluvial flood risk, is therefore sufficient to manage any risk from elevated groundwater levels.

5.5. Flooding from Reservoir

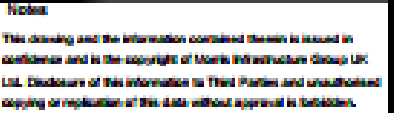
Whilst the site is at risk of inundation in the unlikely event of a reservoir failure coinciding with elevated river levels, due to regular inspection, survey, and maintenance by the operating authorities and extremely good safety record of no reservoir failure incidents resulting in the loss of life in the UK since 1925 – no mitigating action is deemed necessary.

6. Conclusions and Recommendations

- This FRA assesses the potential flood risks to and from the proposed Wombwell WwTW Dosing Kiosk in accordance with the NPPF.
- The primary source of flooding to Wombwell WwTW and the proposed Scheme is fluvial, from Bulling Dikey, River Dove and River Dearne.
- The EA Flood Map shows that the Dosing Kiosk is located in Flood Zone 2; therefore, at medium risk of fluvial flooding.
- There are a number of flood modelling studies that cover reaches of Bulling Dikey, River Dove and River Dearne within the vicinity of Wombwell WwTW. The results of the modelling studies have been used to derive a conservative estimate for the 1% AEP for inclusion of climate change impacts of 24.33 mAOD
- According to the NPPF, the proposed development associated with the wider site is categorised as 'Less Vulnerable' (i.e. the Scheme is not required to remain operational during times of flood). As such, the development is deemed acceptable within Flood Zone 2.
- Wombwell WwTW is largely situated within an area classified as having a very low susceptibility to surface water flooding.
- It is recommended that the Dosing Kiosk is set above the peak flood level associated with the 1% AEP Climate Change event of 24.33 mAOD. As shown on the proposed elevation drawing for the Kiosk in Appendix D, there is stepped access from the ground level to the finished floor which raises the proposed access into the kiosk above the conservative 1% AEP climate change flood level estimate for Bulling Dikey and the River Dove floodplain. It is recommended that any sensitive components of the infrastructure within the Dosing Kiosk, e.g. electric sockets, switches, etc are raised above 24.93 mAOD providing 600mm freeboard.
- Climate change is expected to increase rainfall intensity, and any new drainage system will be designed in accordance with current guidance to manage any increase in surface water runoff.
- A residual risk of flooding from the potential failure of drainage systems within the wider site will always remain. Therefore, the ground levels adjacent the proposed Dosing Kiosk should be graded away from the kiosk to mitigate any residual risk of flooding, by providing overland flow paths that are designed to convey flows away from the scheme.

Appendices

Appendix A. Topographic Survey



Grid : OS National Grid.
Datum : OS Level Datum.

[illegible]

		—	—	—
Rev	Date	Drawn	Description	Check



MORRIS INFRASTRUCTURE GROUP UK
11 NOBLE ROAD, Tel : 0113 454 8144
OUTWOOD, WAKEFIELD Web : www.morrisinf.co.uk
WEST YORKSHIRE E: jordan.morris@morrisinf.co.uk
WF1 3ES

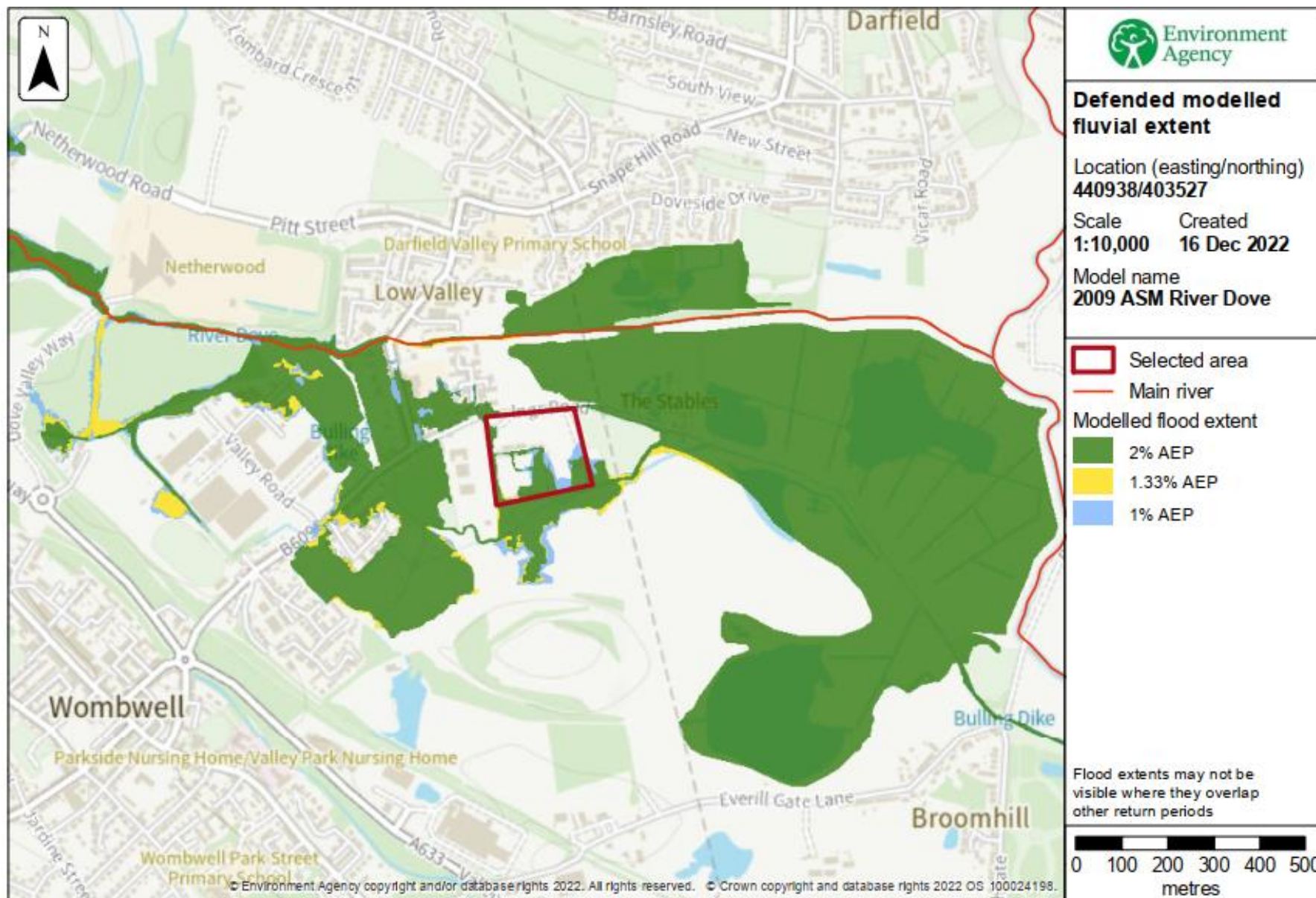
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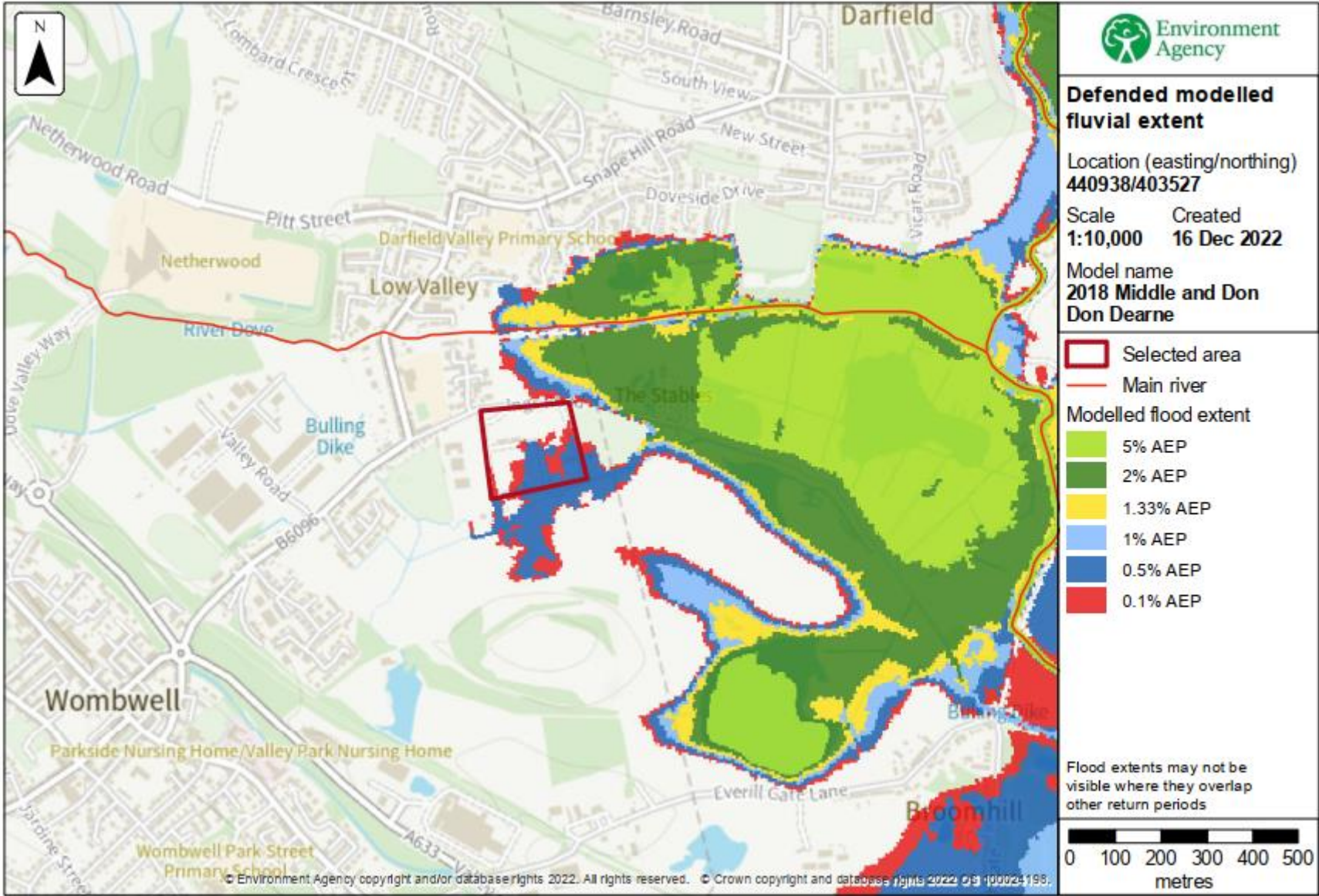
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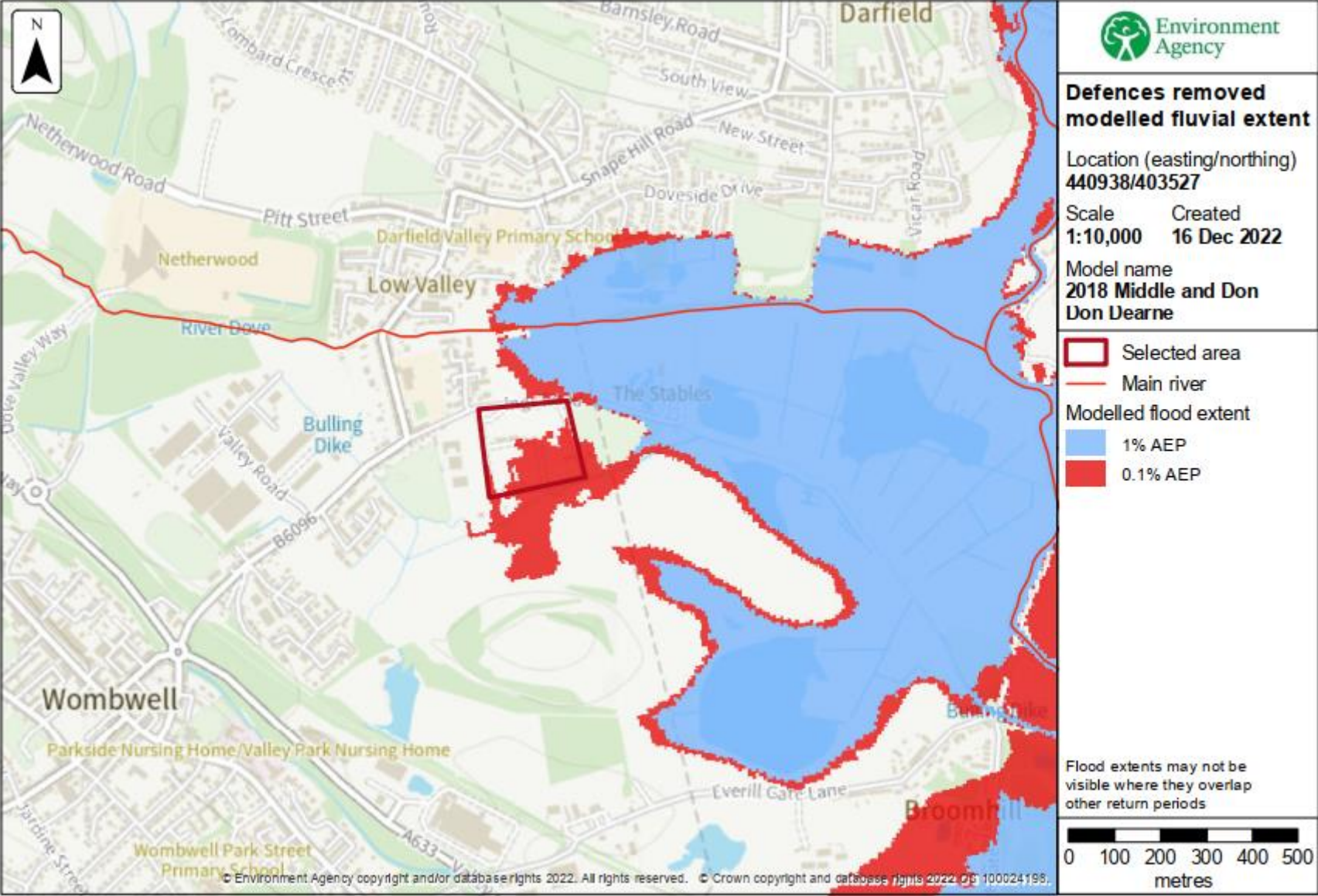
Topographical Survey

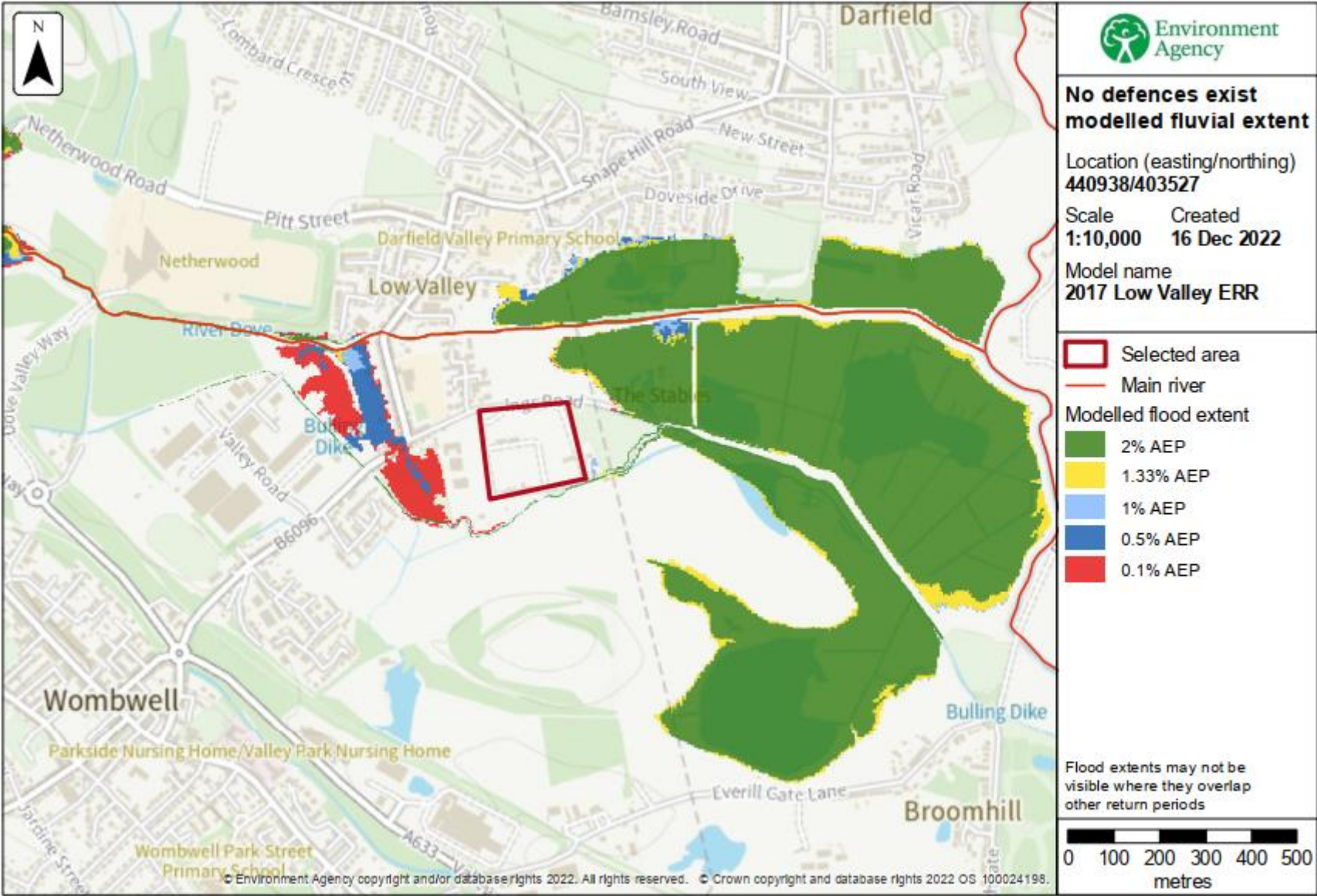
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Doc.	JM	Date	199001
Scale	M3 (Sheet)	DWG Ref. (Layer File)	Status
	1/200	MIG_250_3DT_TP	FINAL
Sub File	MIG_250	Rev	A

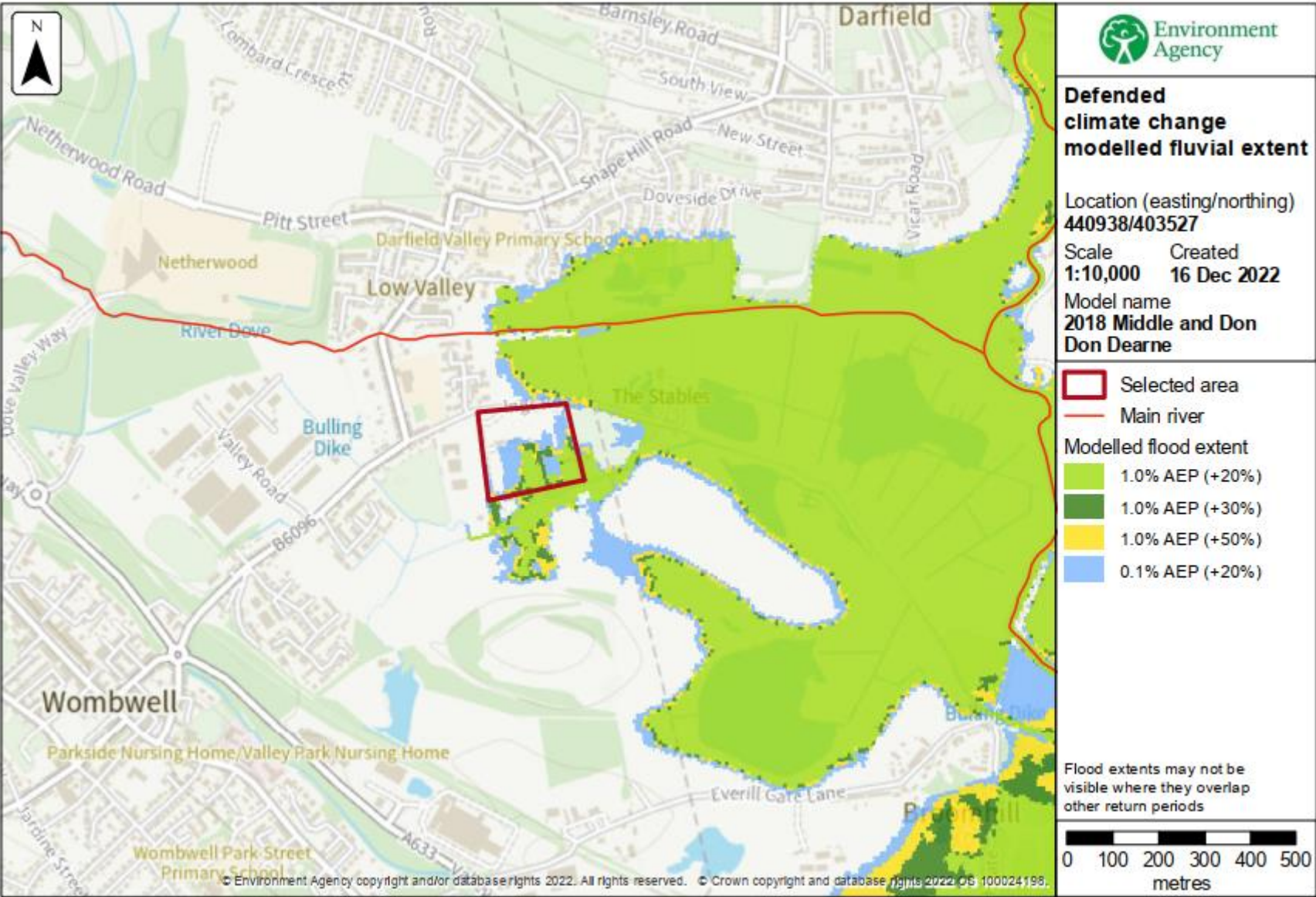
Appendix B. EA Modelling Data

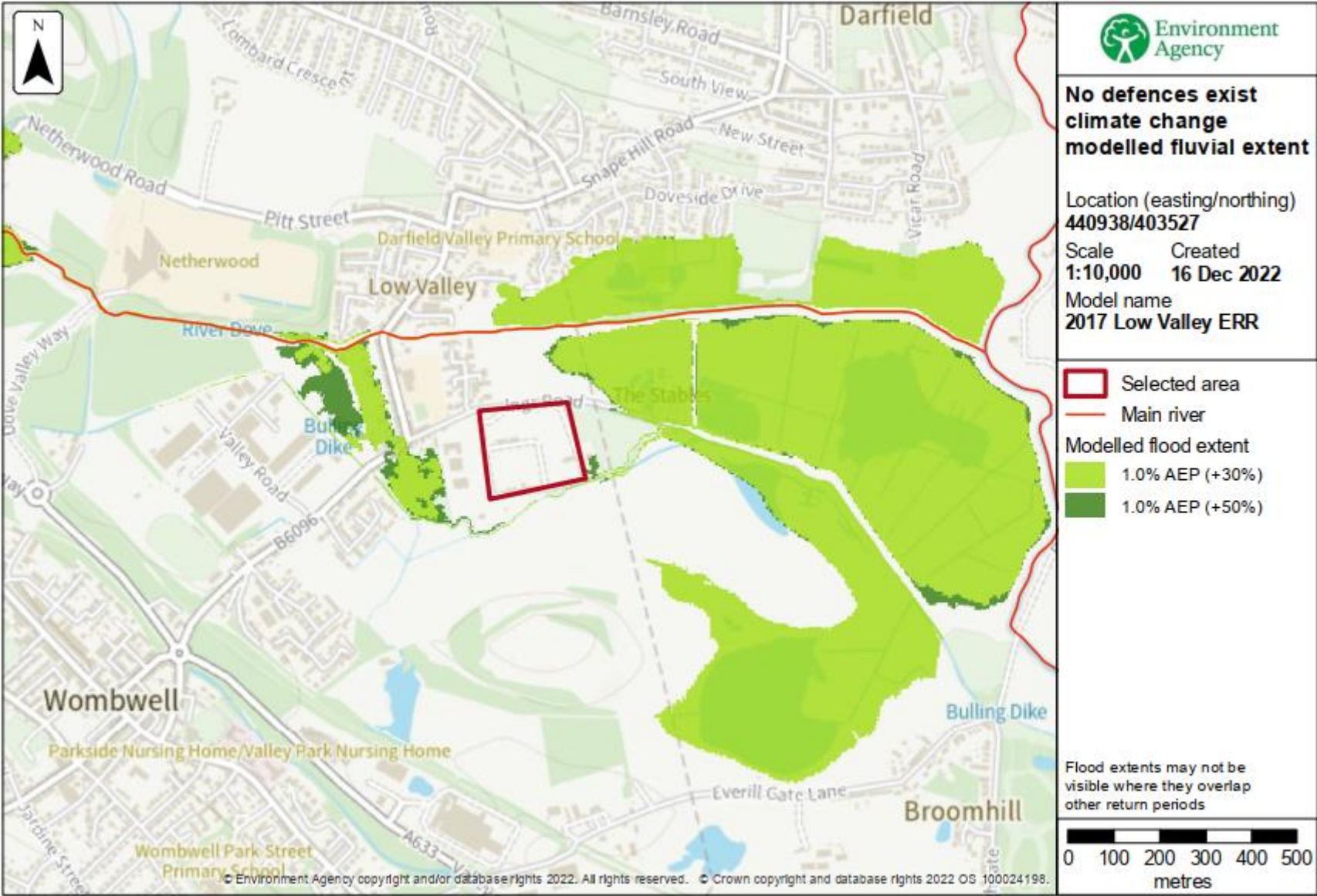


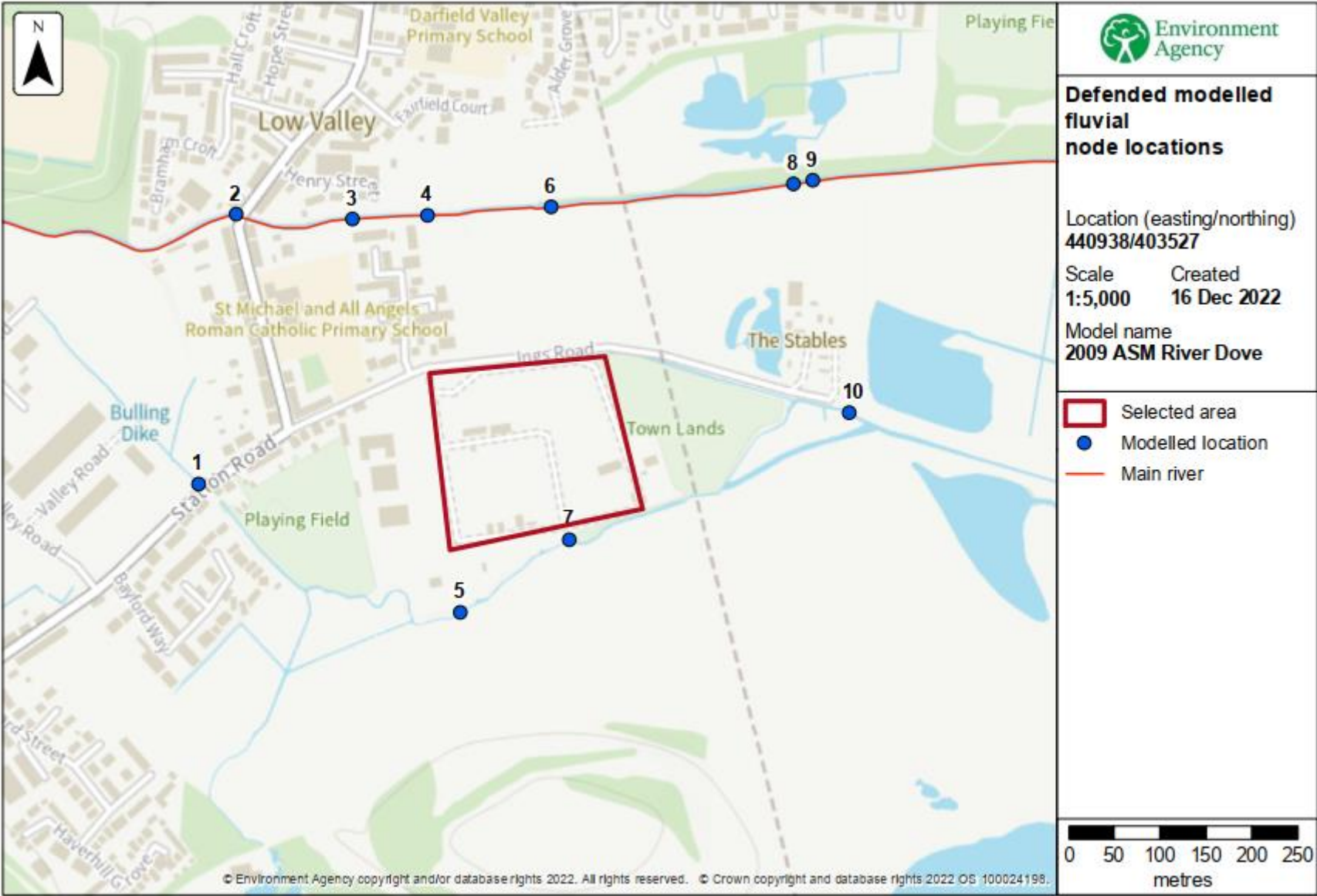












Modelled node locations data

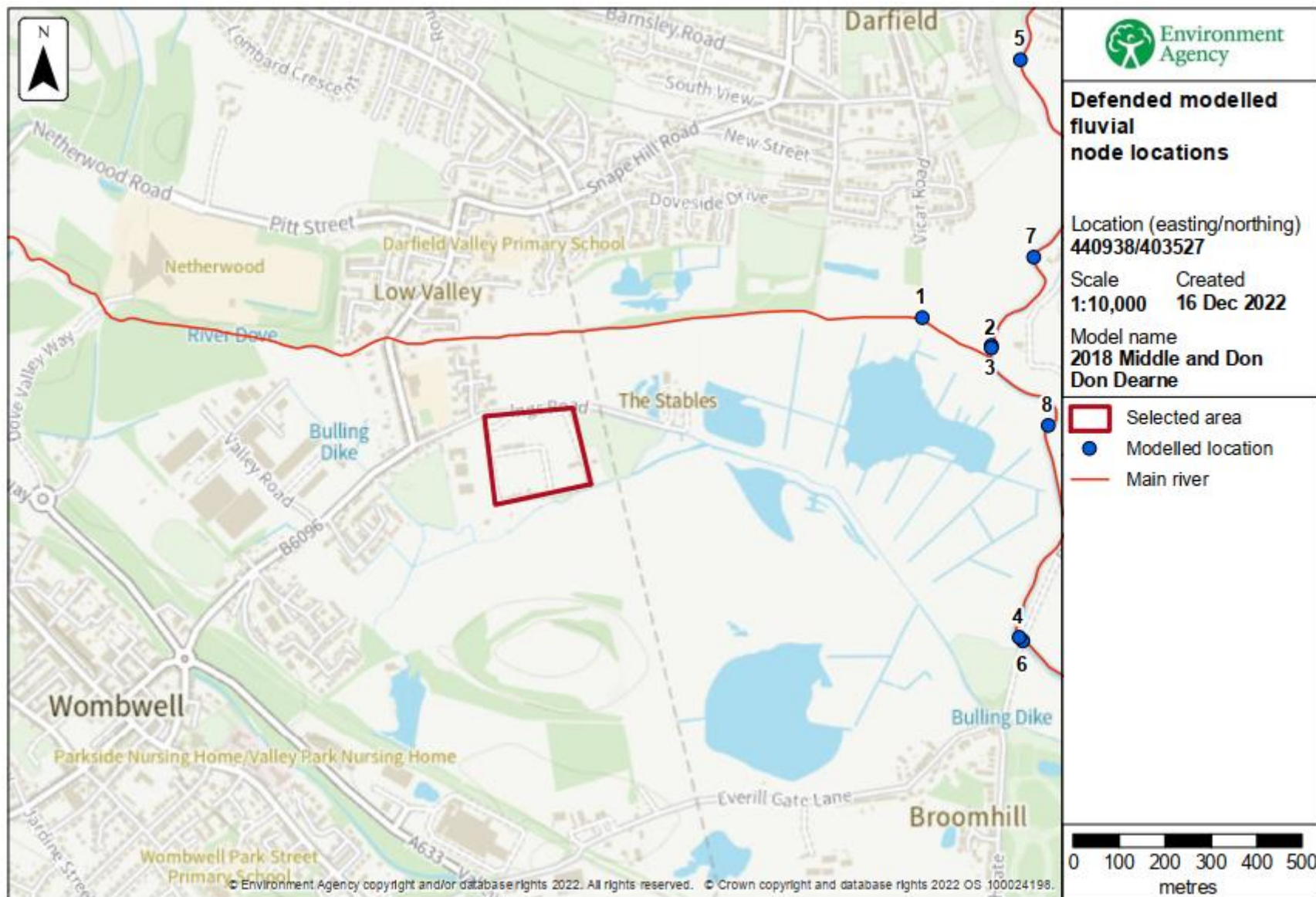
Defended

Label	Modelled location ID	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	984991	440576	403488			25.75	14.88	25.83	16.42	25.90	18.22				
2	984997	440618	403783			26.04	18.65	26.07	19.16	26.10	19.48				
3	985005	440745	403778			24.41	18.65	24.44	19.16	24.45	19.48				
4	984977	440826	403782			23.90	18.67	23.89	19.18	23.89	19.50				
5	984983	440862	403348			23.87	13.93	23.92	15.45	23.98	17.52				
6	985042	440962	403791			23.92	18.69	23.92	22.78	23.92	27.73				
7	985017	440981	403427			23.51	13.93	23.54	15.45	23.58	17.52				
8	984985	441226	403816			23.93	57.03	23.93	59.92	23.92	79.22				
9	984986	441248	403820			22.89	77.66	22.94	91.37	23.12	105.73				
10	985025	441286	403566			23.10	23.95	23.11	25.37	23.12	27.08				

Data in this table comes from the 2009 ASM River Dove model.

Level values are shown in mAOD, and flow values are shown in cubic metres per second.

Any blank cells show where a particular scenario has not been modelled for this location.

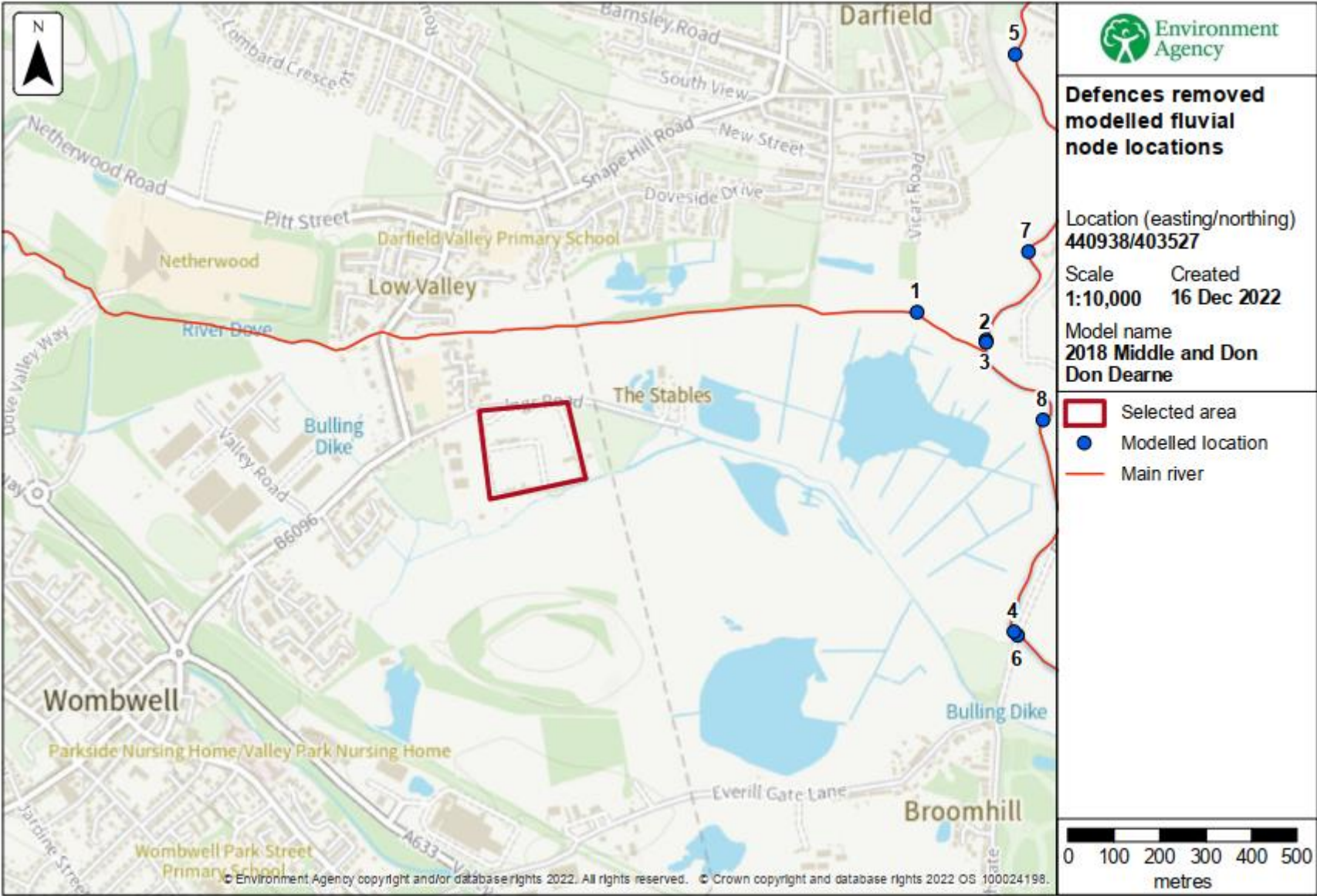


Modelled node locations data

Defended

Label	Modelled location ID	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	1226100	441784	403826	22.69	52.67	22.86	45.80	23.26	80.12	23.47	45.60	23.84	67.51	24.11	80.98
2	1226179	441936	403759	22.69	78.82	22.86	91.21	23.26	104.53	23.47	129.09	23.84	161.30	24.11	210.12
3	1226178	441937	403764	22.69	52.79	22.86	83.78	23.26	75.89	23.47	117.42	23.84	118.98	24.11	152.96
4	1226055	441997	403127	21.69	69.67	21.84	77.11	22.42	111.37	22.69	130.13	23.32	154.26	23.94	161.14
5	1226341	441998	404388	23.27	52.77	24.06	88.09	24.29	97.90	24.75	108.26	25.02	111.33	25.46	116.47
6	1226040	442005	403119	21.66	69.67	21.81	77.11	22.36	111.37	22.59	130.13	23.23	154.26	23.90	161.14
7	1226080	442027	403957	22.74	52.78	23.16	91.64	23.36	108.45	23.57	153.99	23.91	183.61	24.17	238.35
8	1226320	442061	403589	22.45	69.72	22.63	77.11	23.22	82.68	23.46	94.66	23.82	111.01	24.07	149.63

Data in this table comes from the 2018 Middle and Lower Don - Don Deame model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.

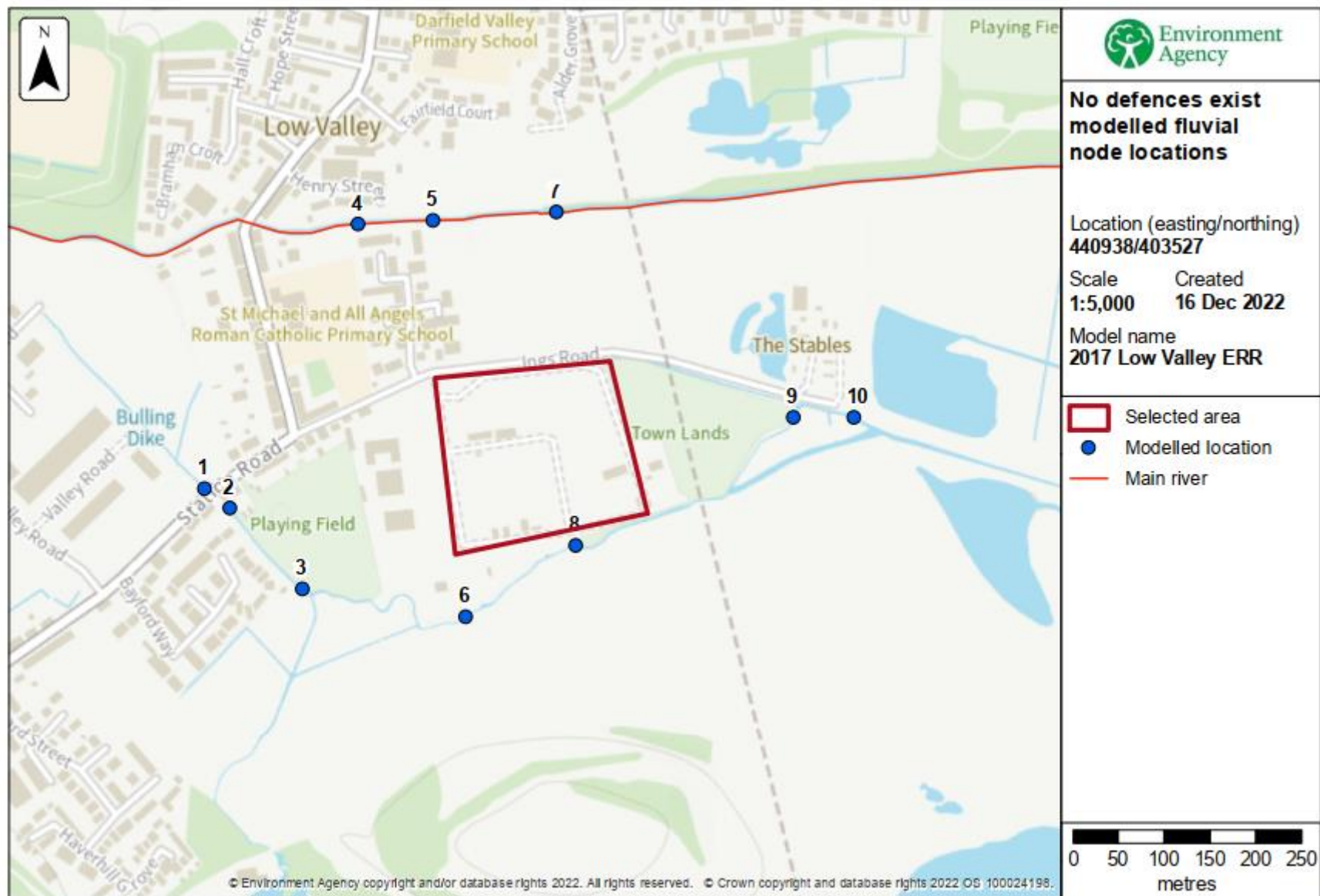


Modelled node locations data

Defences removed

Label	Modelled location ID	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	1226100	441784	403826							23.47	45.61			24.08	80.99
2	1226179	441936	403759							23.47	160.52			24.08	240.74
3	1226178	441937	403764							23.47	129.63			24.08	176.75
4	1226055	441997	403127							23.21	174.37			24.05	206.73
5	1226341	441998	404388							24.68	87.77			25.47	120.17
6	1226040	442005	403119							23.04	174.37			23.98	206.73
7	1226080	442027	403957							23.78	163.73			24.27	244.15
8	1226320	442061	403589							23.56	83.52			24.11	145.84

Data in this table comes from the 2018 Middle and Lower Don - Don Deame model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.



Modelled node locations data

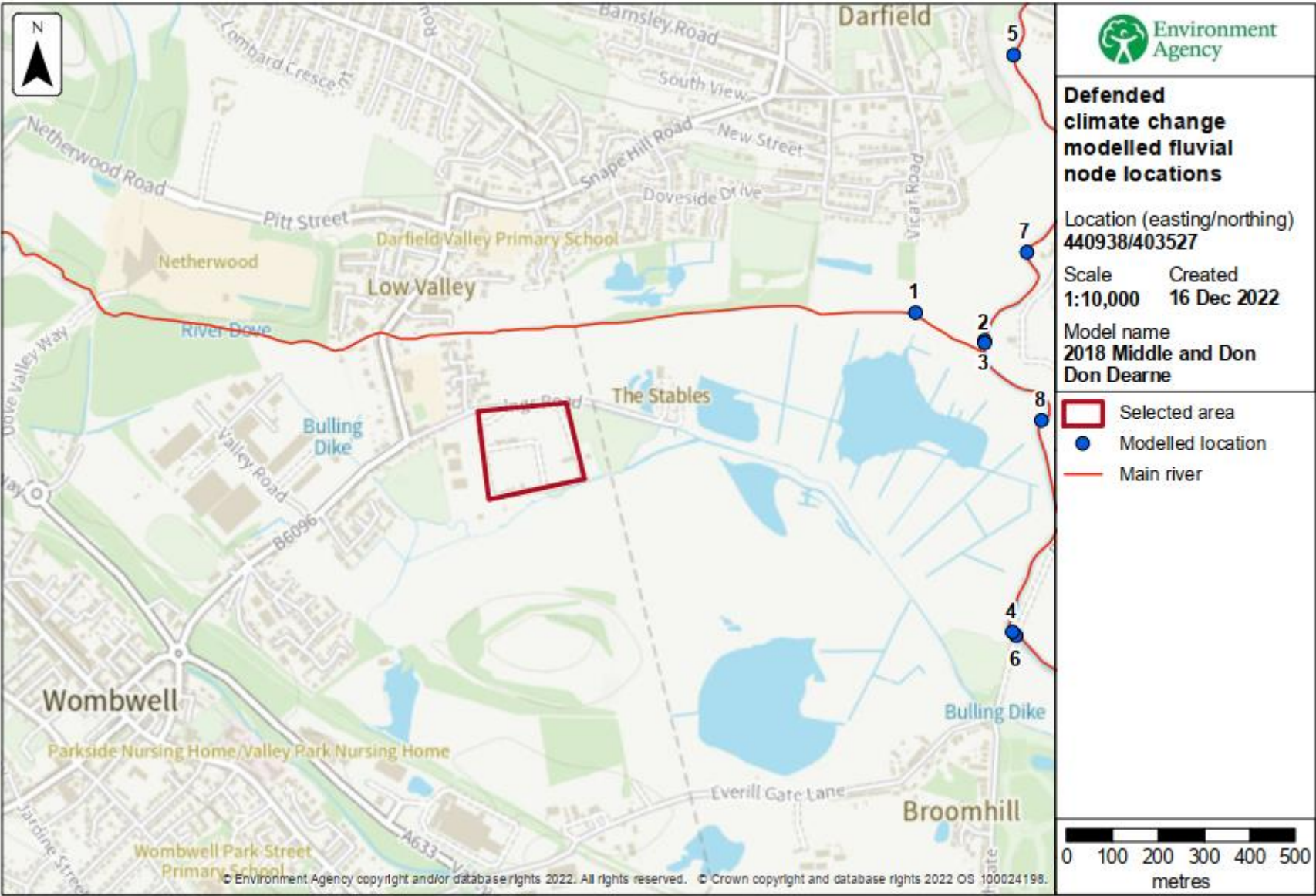
No defences exist

Label	Modelled location ID	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	1129070	440576	403488			24.28	1.58	24.34	1.83	24.37	2.02	24.47	2.47	24.79	3.94
2	1129034	440605	403467			24.20	1.58	24.26	1.84	24.30	2.02	24.39	2.48	24.65	3.94
3	1129046	440683	403378			23.25	1.58	23.32	1.84	23.36	2.02	23.46	2.47	23.76	3.94
4	1129084	440745	403778			24.19	12.45	24.27	13.84	24.31	14.72	24.52	16.86	24.66	19.44
5	1129078	440826	403782			23.96	12.45	24.02	13.83	24.07	14.73	24.31	16.97	24.43	19.49
6	1129050	440862	403348			22.45	1.59	22.54	1.85	22.56	2.03	22.64	2.50	22.90	4.13
7	1129082	440962	403791			23.61	12.82	23.61	14.18	23.62	15.76	23.64	20.62	23.63	23.29
8	1129089	440983	403426			22.41	1.60	22.53	1.86	22.55	2.05	22.51	2.51	22.56	4.15
9	1129038	441221	403566			22.40	1.96	22.53	1.95	22.54	2.11	22.49	2.58	22.43	4.23
10	1129043	441286	403566			22.40	2.32	22.53	3.17	22.54	2.61	22.48	2.57	22.43	4.41

Data in this table comes from the 2017 Low Valley ERR model.

Level values are shown in mAOD, and flow values are shown in cubic metres per second.

Any blank cells show where a particular scenario has not been modelled for this location.

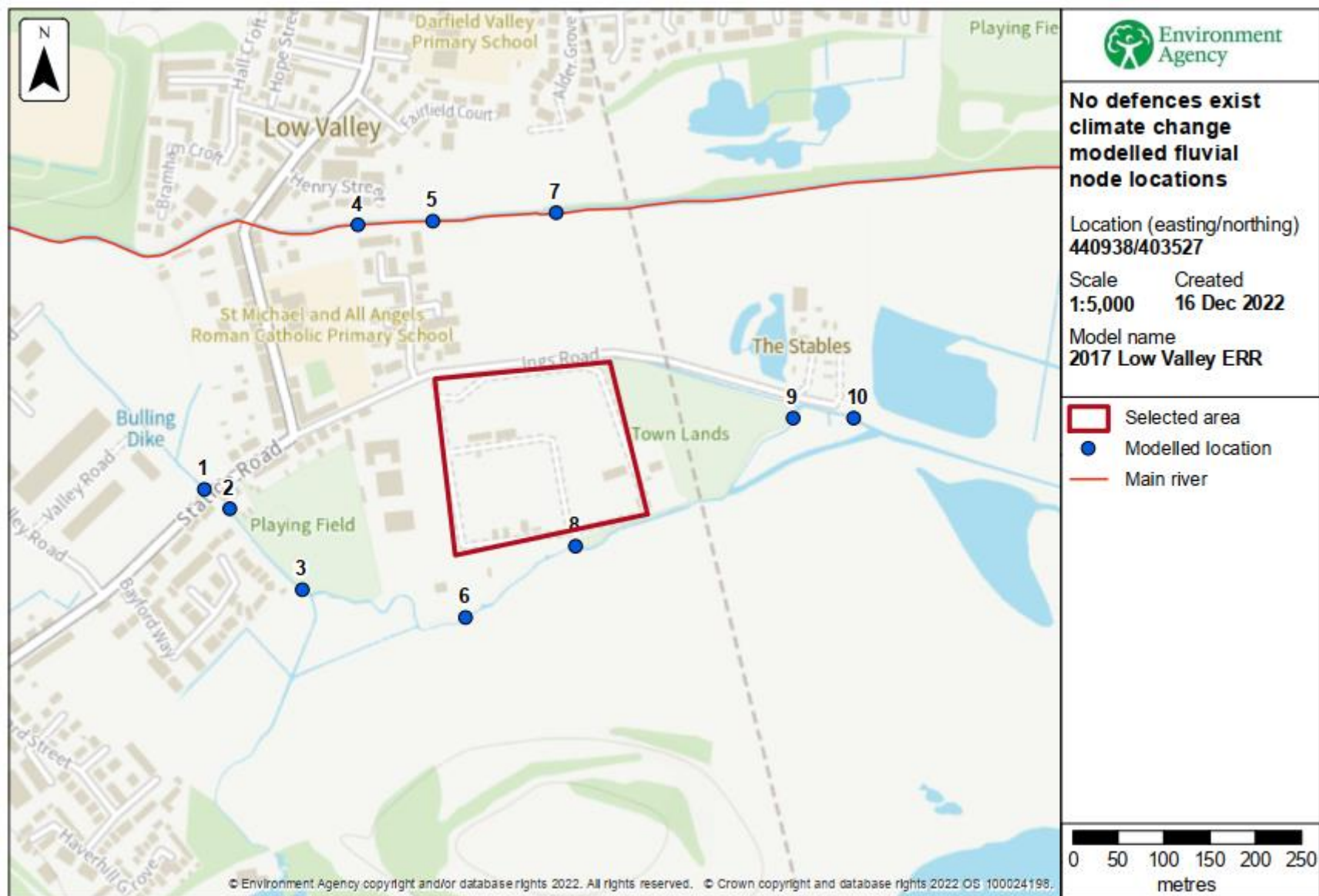


Modelled node locations data

Defended climate change

Label	Modelled location ID	Easting	Northing	1.0% AEP (+20%)		1.0% AEP (+30%)		1.0% AEP (+50%)		0.1% AEP (+20%)	
				Level	Flow	Level	Flow	Level	Flow	Level	Flow
1	1226100	441784	403826	23.74	52.76	23.82	56.47	23.95	64.19	24.37	96.42
2	1226179	441936	403759	23.74	151.60	23.82	159.01	23.95	177.93	24.37	249.68
3	1226178	441937	403764	23.74	121.26	23.82	123.39	23.95	135.18	24.37	176.80
4	1226055	441997	403127	23.10	149.35	23.29	153.04	23.62	159.19	24.30	166.45
5	1226341	441998	404388	24.93	110.42	25.04	111.94	25.23	112.99	25.80	137.94
6	1226040	442005	403119	23.0	149.35	23.20	153.04	23.54	159.19	24.25	166.45
7	1226080	442027	403957	23.82	176.83	23.90	186.97	24.03	209.37	24.40	278.08
8	1226320	442061	403589	23.72	108.28	23.80	112.46	23.93	119.17	24.30	191.89

Data in this table comes from the 2018 Middle and Lower Don - Don Deame model.
Level values are shown in mAOD, and flow values are shown in cubic metres per second.
Any blank cells show where a particular scenario has not been modelled for this location.



Modelled node locations data

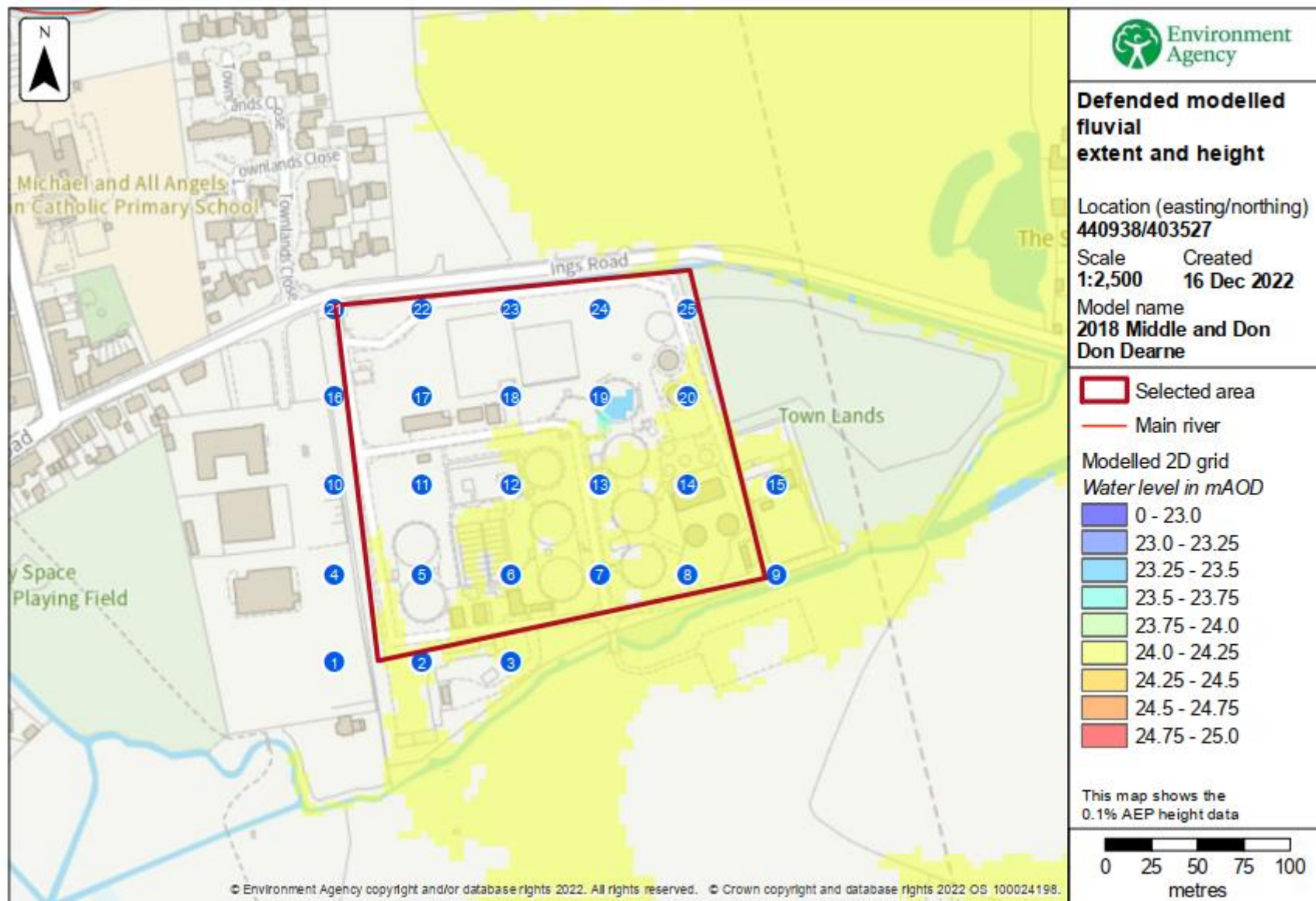
No defences exist climate change

Label	Modelled location ID	Easting	Northing	1.0% AEP (+30%)		1.0% AEP (+50%)	
				Level	Flow	Level	Flow
1	1129070	440576	403488	24.50	2.62	24.68	3.10
2	1129034	440605	403467	24.42	2.62	24.60	3.10
3	1129046	440683	403378	23.48	2.62	23.71	3.48
4	1129084	440745	403778	24.51	17.71	24.67	19.60
5	1129078	440826	403782	24.29	17.76	24.45	19.71
6	1129050	440862	403348	22.66	2.63	22.89	3.83
7	1129082	440962	403791	23.62	20.41	23.62	23.71
8	1129089	440983	403426	22.50	2.64	22.61	3.88
9	1129038	441221	403566	22.50	2.70	22.58	4.28
10	1129043	441286	403566	22.50	3.52	22.58	5.54

Data in this table comes from the 2017 Low Valley ERR model.

Level values are shown in mAOD, and flow values are shown in cubic metres per second.

Any blank cells show where a particular scenario has not been modelled for this location.



Sample point data

Defended

Label	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
1	440827	403416	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
2	440875	403416	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.02	NoData	0.18	24.09
3	440923	403416	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.20	24.09
4	440827	403464	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
5	440875	403464	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
6	440923	403464	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.00	23.83	0.16	24.09
7	440971	403464	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.40	23.83	0.66	24.09
8	441019	403464	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.50	23.83	0.71	24.09
9	441067	403464	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	1.05	23.83	1.27	24.09
10	440827	403512	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
11	440875	403512	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
12	440923	403512	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
13	440971	403512	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.08	24.09
14	441019	403512	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.20	23.83	0.47	24.09
15	441067	403512	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.23	23.83	0.44	24.09
16	440827	403560	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData

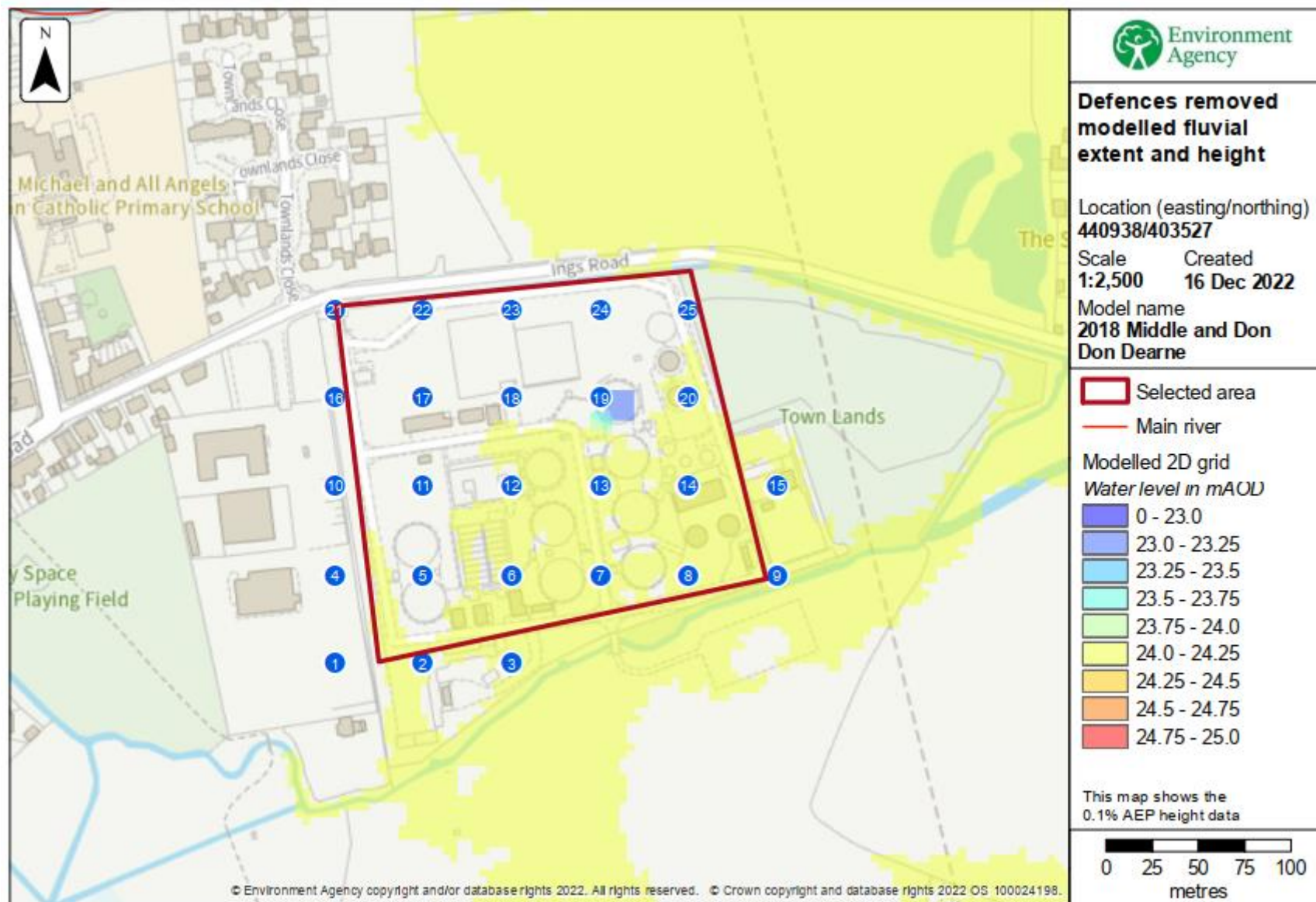
Label	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
17	440875	403560	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
18	440923	403560	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
19	440971	403560	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
20	441019	403560	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	0.06	NoData
21	440827	403608	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
22	440875	403608	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
23	440923	403608	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
24	440971	403608	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData
25	441019	403608	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData	NoData

Data in this table comes from the 2018 Middle and Lower Don - Don Deame model.

Height values are shown in mAOD, and depth values are shown in metres.

Any blank cells show where a particular scenario has not been modelled for this location.

Cells which contain text 'NoData' for a scenario show that return period has been modelled but there is no flood risk for that return period for that location.



Sample point data

Defences removed

Label	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
1	440827	403416							NoData	NoData			NoData	NoData
2	440875	403416							NoData	NoData			0.08	24.08
3	440923	403416							NoData	NoData			0.20	24.08
4	440827	403464							NoData	NoData			NoData	NoData
5	440875	403464							NoData	NoData			NoData	NoData
6	440923	403464							NoData	NoData			0.22	24.08
7	440971	403464							NoData	NoData			0.62	24.08
8	441019	403464							NoData	NoData			0.80	24.08
9	441067	403464							NoData	NoData			1.09	24.08
10	440827	403512							NoData	NoData			NoData	NoData
11	440875	403512							NoData	NoData			NoData	NoData
12	440923	403512							NoData	NoData			NoData	NoData
13	440971	403512							NoData	NoData			0.05	24.08
14	441019	403512							NoData	NoData			0.43	24.08
15	441067	403512							NoData	NoData			0.41	24.08
16	440827	403560							NoData	NoData			NoData	NoData

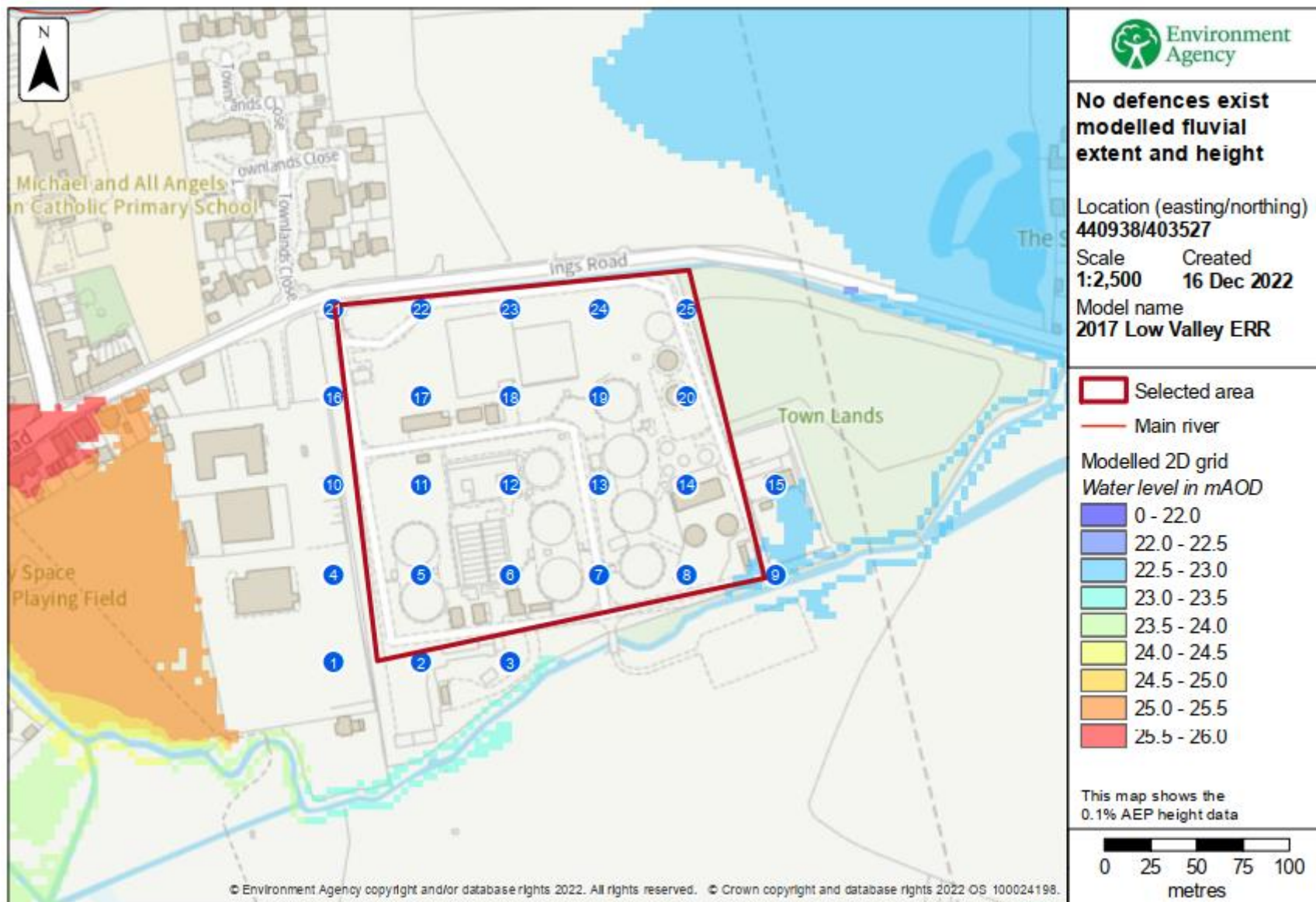
Label	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
17	440875	403560							NoData	NoData			NoData	NoData
18	440923	403560							NoData	NoData			NoData	NoData
19	440971	403560							NoData	NoData			NoData	NoData
20	441019	403560							NoData	NoData			NoData	NoData
21	440827	403608							NoData	NoData			NoData	NoData
22	440875	403608							NoData	NoData			NoData	NoData
23	440923	403608							NoData	NoData			NoData	NoData
24	440971	403608							NoData	NoData			NoData	NoData
25	441019	403608							NoData	NoData			NoData	NoData

Data in this table comes from the 2018 Middle and Lower Don - Don Deame model.

Height values are shown in mAOD, and depth values are shown in metres.

Any blank cells show where a particular scenario has not been modelled for this location.

Cells which contain text 'NoData' for a scenario show that return period has been modelled but there is no flood risk for that return period for that location.



Sample point data

No defences exist

Label	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
1	440827	403416							NoData	NoData			NoData	NoData
2	440875	403416							NoData	NoData			NoData	NoData
3	440923	403416							NoData	NoData			NoData	NoData
4	440827	403464							NoData	NoData			NoData	NoData
5	440875	403464							NoData	NoData			NoData	NoData
6	440923	403464							NoData	NoData			NoData	NoData
7	440971	403464							NoData	NoData			NoData	NoData
8	441019	403464							NoData	NoData			NoData	NoData
9	441067	403464							NoData	NoData			0.11	22.71
10	440827	403512							NoData	NoData			NoData	NoData
11	440875	403512							NoData	NoData			NoData	NoData
12	440923	403512							NoData	NoData			NoData	NoData
13	440971	403512							NoData	NoData			NoData	NoData
14	441019	403512							NoData	NoData			NoData	NoData
15	441067	403512							NoData	NoData			NoData	NoData
16	440827	403560							NoData	NoData			NoData	NoData

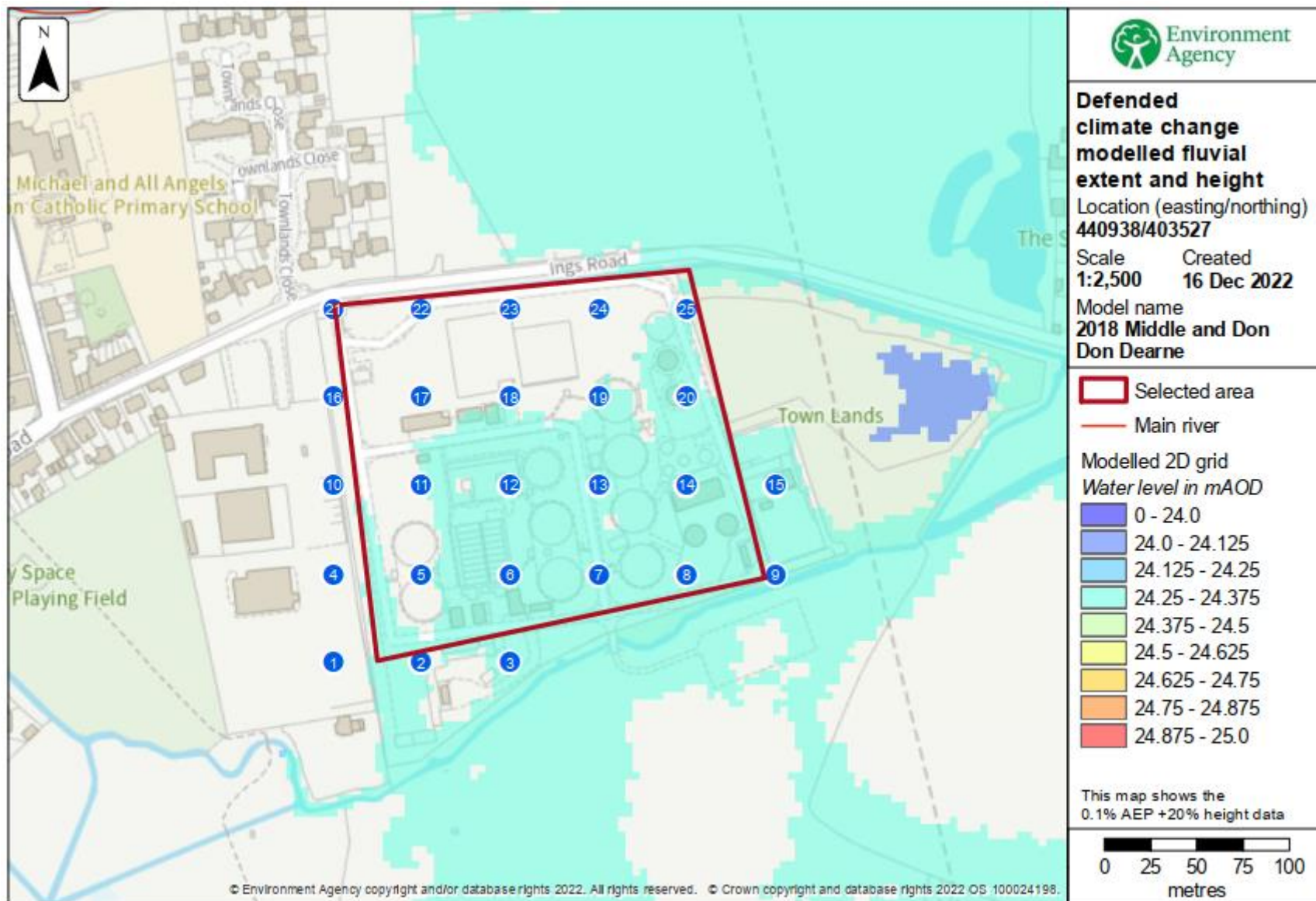
Label	Easting	Northing	5% AEP		2% AEP		1.33% AEP		1% AEP		0.5% AEP		0.1% AEP	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height	Depth	Height
17	440875	403560							NoData	NoData			NoData	NoData
18	440923	403560							NoData	NoData			NoData	NoData
19	440971	403560							NoData	NoData			NoData	NoData
20	441019	403560							NoData	NoData			NoData	NoData
21	440827	403608							NoData	NoData			NoData	NoData
22	440875	403608							NoData	NoData			NoData	NoData
23	440923	403608							NoData	NoData			NoData	NoData
24	440971	403608							NoData	NoData			NoData	NoData
25	441019	403608							NoData	NoData			NoData	NoData

Data in this table comes from the 2017 Low Valley ERR model.

Height values are shown in mAOD, and depth values are shown in metres.

Any blank cells show where a particular scenario has not been modelled for this location.

Cells which contain text 'NoData' for a scenario show that return period has been modelled but there is no flood risk for that return period for that location.



Sample point data

Defended climate change

Label	Easting	Northing	1% AEP (+20%)		1% AEP (+30%)		1% AEP (+50%)		0.1% AEP (+20%)	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height
1	440827	403416	NoData	NoData	NoData	NoData		NoData	NoData	NoData
2	440875	403416	NoData	NoData	NoData	NoData		23.94	0.19	24.34
3	440923	403416	NoData	NoData	NoData	NoData		23.94	0.45	24.34
4	440827	403464	NoData	NoData	NoData	NoData		NoData	NoData	NoData
5	440875	403464	NoData	NoData	NoData	NoData		NoData	NoData	NoData
6	440923	403464	NoData	NoData	0.00	23.80		NoData	0.50	24.34
7	440971	403464	0.29	23.73	0.38	23.80		23.94	0.91	24.34
8	441019	403464	0.40	23.73	0.48	23.80		23.94	1.01	24.34
9	441067	403464	0.95	23.73	1.03	23.80		23.94	1.57	24.34
10	440827	403512	NoData	NoData	NoData	NoData		NoData	NoData	NoData
11	440875	403512	NoData	NoData	NoData	NoData		NoData	NoData	NoData
12	440923	403512	NoData	NoData	NoData	NoData		NoData	0.23	24.34
13	440971	403512	NoData	NoData	NoData	NoData		NoData	0.30	24.34
14	441019	403512	0.10	23.73	0.18	23.80		23.94	0.71	24.34
15	441067	403512	0.13	23.73	0.21	23.80		23.94	0.74	24.34
16	440827	403560	NoData	NoData	NoData	NoData		NoData	NoData	NoData

Label	Easting	Northing	1% AEP (+20%)		1% AEP (+30%)		1% AEP (+50%)		0.1% AEP (+20%)	
			Depth	Height	Depth	Height	Depth	Height	Depth	Height
17	440875	403560	NoData	NoData	NoData	NoData		NoData	NoData	NoData
18	440923	403560	NoData	NoData	NoData	NoData		NoData	NoData	NoData
19	440971	403560	NoData	NoData	NoData	NoData		NoData	1.25	24.34
20	441019	403560	NoData	NoData	NoData	NoData		NoData	0.33	24.34
21	440827	403608	NoData	NoData	NoData	NoData		NoData	NoData	NoData
22	440875	403608	NoData	NoData	NoData	NoData		NoData	NoData	NoData
23	440923	403608	NoData	NoData	NoData	NoData		NoData	NoData	NoData
24	440971	403608	NoData	NoData	NoData	NoData		NoData	NoData	NoData
25	441019	403608	NoData	NoData	NoData	NoData		NoData	NoData	NoData

Data in this table comes from the 2018 Middle and Lower Don - Don Deame model.

Height values are shown in mAOD, and depth values are shown in metres.

Any blank cells show where a particular scenario has not been modelled for this location.

Cells which contain text 'NoData' for a scenario show that return period has been modelled but there is no flood risk for that return period for that location.

Appendix C. Historical Flood Map



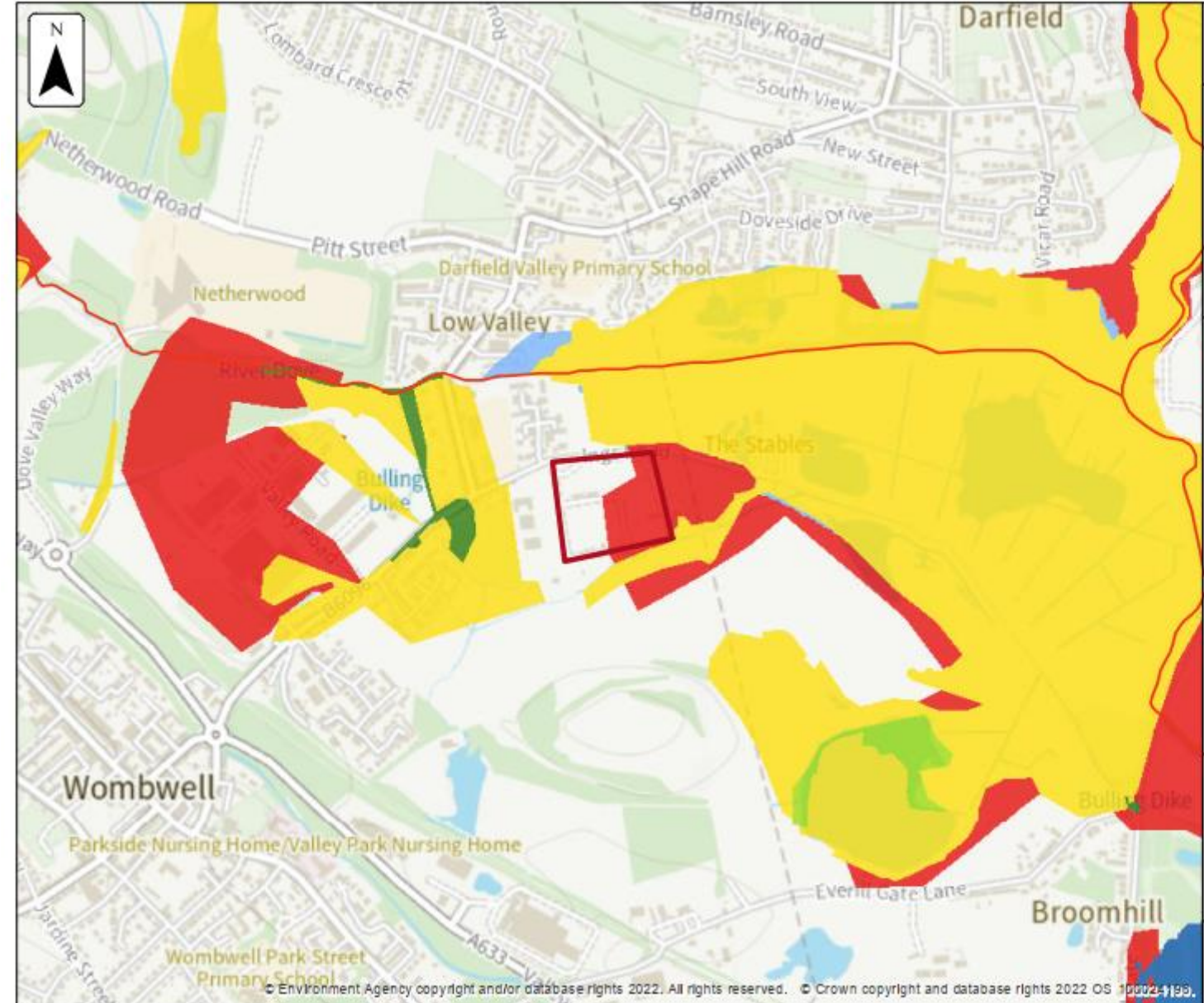
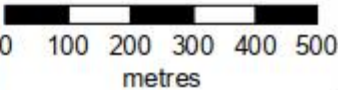
Historic flood map

Location (easting/northing)
440938/403527

Scale
1:10,000

Created
16 Dec 2022

- Selected area
- Main river
- Date of flood event
 - February, 2020
 - November, 2019
 - June, 2007
 - November, 2000
 - October, 2000
 - March, 1947



Historic flood event data

Start date	End date	Source of flood	Cause of flood	Affects location
8 February 2020	14 February 2020	main river	channel capacity exceeded (no raised defences)	No
7 November 2019	8 November 2019	main river	channel capacity exceeded (no raised defences)	No
25 June 2007	26 June 2007	main river	unknown	Yes
6 November 2000	4 December 2000	main river	unknown	No
1 October 2000	30 November 2000	main river	unknown	No
19 March 1947	22 March 1947	main river	channel capacity exceeded (no raised defences)	Yes

Appendix D. Dosing Kiosk Elevations



1. EXTENSION COLOUR OF THE HOOK TO BE BE RED-NC IN (DARK GREEN)
2. HOOK TO BE BROWNISH (BROWN) COLOUR, WITH VERTICAL TEXTURED (HORIZONTAL)

[illegible]WOM02- NOD- WWT- WWT- DR- C-00002

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