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KILMARTIN PLOWMAN & PARTNERS LIMITED

LAND AT COOPER BRIDGE, HUDDERSFIELD

FLOOD RISK ASSESSMENT - FINAL

AUGUST 2023

your earth our world



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KILMARTIN PLOWMAN & PARTNERS LIMITED

LAND AT COOPER BRIDGE, HUDDERSFIELD

FLOOD RISK ASSESSMENT

AUGUST 2023

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| DRAWINGS | TITLE | SCALE |
|-----------------|--------------------------|--------------|
| LD10590-001 | Interpolated Flood Zones | 1:2000 (A3) |
| LD10590-002 | SW Management Strategy | 1:1000 (A2) |

1 INTRODUCTION

1.1 Instructions

1.1.1 This report is prepared in accordance with the terms of engagement by Wardell Armstrong, dated 19th May 2023, The Flood Risk Assessment will be carried out in line with the requirements for an outline planning application.

1.2 Background Information

National Planning Policy Framework

1.2.1 The National Planning Policy Framework and associated National Planning Practice Guidance explain how flood risk should be taken into consideration during the planning and development process. NPPF specifies a sequential test and an exception test to guide local planning authorities on the suitability of proposed development sites. It categorises flood risk by flood zone and defines the types of development appropriate to each flood zone according to vulnerability. The flood zones are defined as:

- Zone 1: Areas with a Low Probability of flooding (annual probability less than 0.1% or 1 in 1000 years).
- Zone 2: Areas with a Medium Probability of flooding (annual probability between 0.1% (1 in 1000 years) and 1.0% (1 in 100 years) for rivers, 0.1 – 0.5% (1 in 1000 to 1 in 200 years) for coastal areas).
- Zone 3a: Areas with a High Probability of flooding (annual probability greater than 1.0% (1 in 100 years) for rivers, 0.5% (1 in 200 years) for coastal areas).
- Zone 3b: The Functional Floodplain (probability as Zone 3a).

Environment Agency Flood Maps

1.2.2 The Environment Agency (EA) predicts the likelihood of flooding via a national series of indicative flood maps, available to the public by request and via the EA website. The Flood Map for Planning shows the Flood Zones, described above, coloured in different shades of blue. The Risk of Flooding from Surface Water map shows potential overland flow routes resulting from rainstorm events.

Calder Valley Strategic Flood Risk Assessment

- 1.2.3 As part of their Local Development Framework (LDF) documentation, local planning authorities are required to produce a Strategic Flood Risk Assessment (SFRA). The Calder Valley Strategic Flood Risk Assessment (SFRA) identifies and analyses current and future broad scale flooding issues across the Calder Valley. The SFRA was published in November 2008 and is a collaboration of Kirklees Council, Calderdale Council and City of Wakefield Metropolitan District Council and was updated July 2016.

Kirklees Council Preliminary Flood Risk Assessment

- 1.2.4 A Preliminary Flood Risk Assessment (PFRA) is a high-level screening exercise to identify areas where there is significant flood risk from ordinary watercourses, surface water run-off and groundwater, but not from main rivers or sewers. PFRAs have been produced by Lead Local Flood Authorities (LLFAs) to fulfil statutory requirements in the Flood Risk Regulations 2009. The Kirklees Council PFRA and Surface Water Management Plan were published in 2011. The preliminary flood risk assessment (PFRA) and flood risk areas (FRAs) for Kirklees Council were reviewed during 2017, using all relevant current flood risk data and information.

1.3 Data Sources

- 1.3.1 Product 4 data for the site and its surroundings have been obtained from the EA – attached at Appendix I. These include flood maps, flood records, defence asset details and flood model level and depth data.

2 SITE INFORMATION

2.1 Existing Site

2.1.1 The site is located at Cooper Bridge, about 6 km north-east of Huddersfield town centre, as shown below **Figure 1**

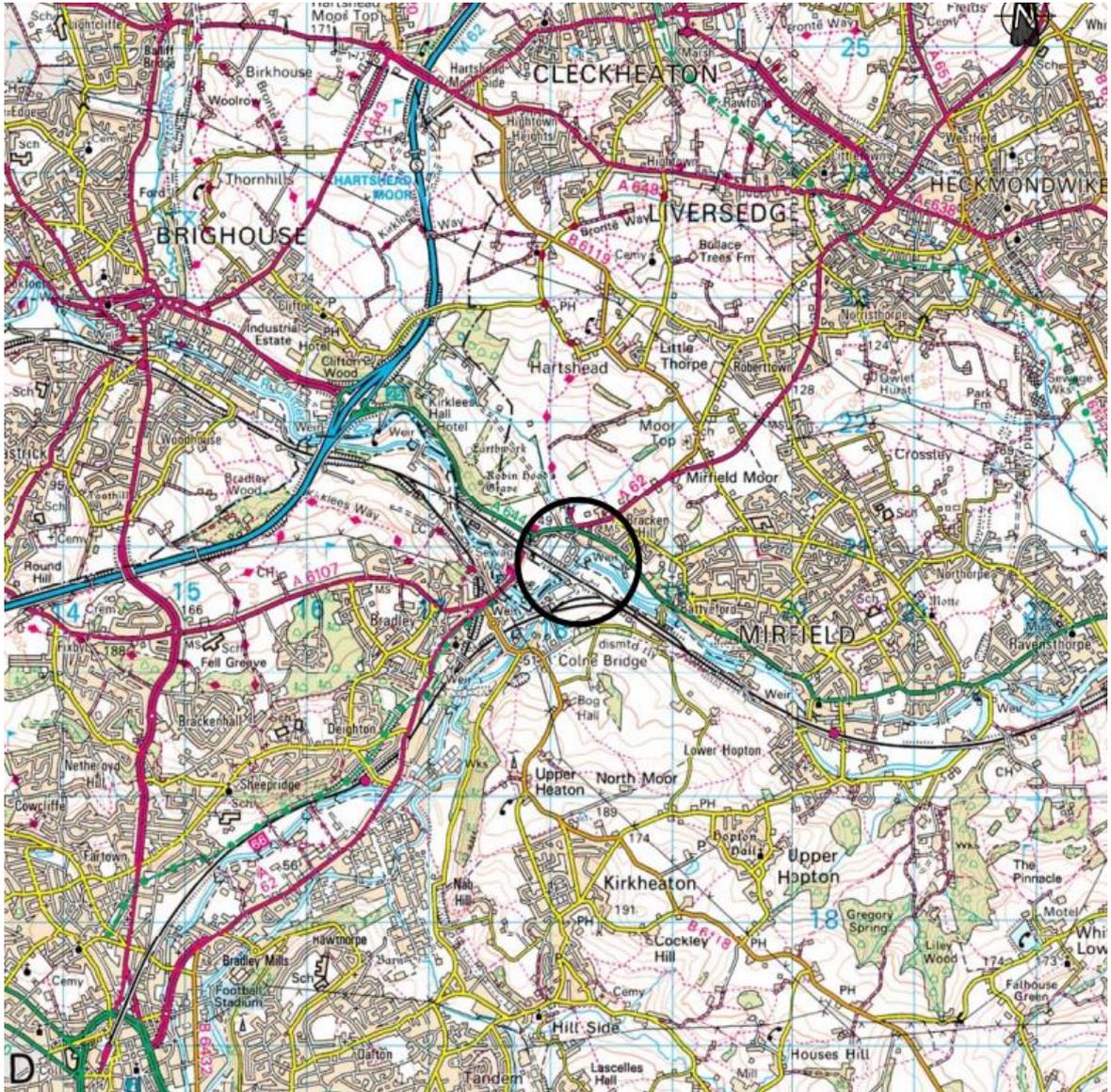


Figure 1

2.1.2 The site comprises a disused part of a Waste Water Treatment Works (WWTW) and is bounded by the Calder Valley main railway line to the south, Cooper Bridge Road and Leeds Road to west and north and the Nun Brook and the River Calder to the east.

2.1.3 The site area is about 6.2 ha, comprising about 4.7 ha of raised filter beds and 1.5 ha at original ground level. Access is gained via the original WWTW access road from Huddersfield Road.

2.2 Watercourses and Local Drainage

2.2.1 The nearby surface watercourses are:

- The River Calder, a main river, which flows from west to east along the south-eastern boundary of the southern part of the site.
- The Nun Brook, an ordinary watercourse, which flows beneath Leeds Road and along the north-eastern site boundary to join the River Calder.

2.3 Sewerage

2.3.1 The Yorkshire Water Services Pre-planning Sewerage Enquiries have indicated that there are no operational public sewers on the site.

2.3.2 There is a 600mm diameter public surface water sewer which flows from east to west along Leeds Road and outfalls to the Nun Brook at the north-eastern boundary of the southern part of the site.

2.3.3 There is a 300 mm diameter public combined sewer in Huddersfield Road, about 200 metres to the east of the site.

2.3.4 There are two rising mains with diameters of 200mm and 250mm in Cooper Bridge Road feeding the operational WWTW to the west from the land downstream to the east.

2.4 Geology

2.4.1 The site is located on superficial deposits of Alluvium comprising clay, silt, sand and gravel in the valleys of the River Calder and the Nun Brook, overlying Pennine Lower Coal Measures Formation comprising undifferentiated mudstone, siltstone and sandstones.

2.5 Development Proposals

2.5.1 The site is proposed to be developed for industrial use`.

2.5.2 Following demolition of the old WWTW filter beds, the level of the top of the beds will be restored by filling so as to ensure that the flood risk to the proposed development will be acceptable. Ground levels in relation to flooding and correlation between flood zones 2 and 3 are key to the way the site can be developed.

2.5.3 Surface water runoff will be attenuated to Greenfield rates using SuDS techniques prior to discharge to the Nun Brook.

3 FLOODING INFORMATION

3.1 Flood History

- 3.1.1 The EA has no record of flooding on the site.
- 3.1.2 Neither the Calder Valley SFRA nor the Kirklees Council PFRA and Surface Water Management Plan contain any reference to flooding at Cooper Bridge.

3.2 Potential for Fluvial Flooding

- 3.2.1 The EA Flood Map for Planning – see Appendix I – shows the site to be located in Flood Zone 3 which has a high probability of flooding and the chance of flooding each year is 1.0% (1 in 100) or greater.
- 3.2.2 Owing to being raised on concrete walls, the filter beds are shown to be located in Flood Zone 2 which has a moderate probability of flooding and the chance of flooding each year is between 1.0% (1 in 100) and 0.1% (1 in 1,000).
- 3.2.3 For some unexplained reason, the EA Flood Map for Planning shows irregular areas of Flood Zone 3 within the extent of the filter beds. This is inconsistent with the regular orthogonal geometry of the filter beds and has consequently been disregarded.
- 3.2.4 There are no specific references to the site in the Calder Valley SFRA.

3.3 Flooding from Surface Water Run-off

- 3.3.1 The site mainly comprised of WWTW filter beds and other tanks, buildings, roads and hardstanding which are understood to drain to the River Calder. There are some small areas with grass cover amounting to less than 1 ha.
- 3.3.2 The EA map Risk of Flooding from Surface Water – see Appendix I – shows surface water flood risk in the areas between the filter beds and the River Calder and the Nun Brook. As with the Flood map For Planning, there are also irregular areas of flood risk shown within the extent of the filter beds which has been similarly disregarded.

3.4 Groundwater Flooding

- 3.4.1 Owing to the Coal Measures geology, the flood risk from groundwater at the site is not considered to be an issue.

4 FLOOD RISK ASSESSMENT

4.1 Fluvial Flooding

Flood Map for Planning

- 4.1.1 The irregularity with the flood mapping prompted closer inspection and the procurement of a topographical survey of the site.
- 4.1.2 Combining the river flood levels provided by the EA Product 4 data, the EA flood mapping and the level information from the topographical survey has allowed the production of a more detailed assessment of the flood zoning around the site.
- 4.1.3 The site appears to flood from two directions. The south east of the site, bound by the River Calder and the flood levels for this section have been provided by the EA. The 100 yr. flood level (extent of Flood Zone 3) for the river Calder is given as varying between 48.33m by the railway embankment and 47.99m at the confluence of the Calder and Nunn Brook. The corresponding 1000 yr. flood levels (extent of Flood Zone 2) are 49.83m and 49.34m respectively.
- 4.1.4 The western corner of the site appears to flood from overland flow passing under the rail bridge on Copper Bridge Road. The 100 yr. flood levels for the River Calder adjacent to Cooper Bridge Road vary from 50.09m near the WWTW to 49.12m at the A62. The corresponding 1000 yr. levels are 51.27m and 50.64m respectively. This flood water flows from west to east across the site towards the River Calder.
- 4.1.5 Ground levels around the site vary from 46.9m to 51.5m. the tanks are enclosed by a concrete perimeter wall which tops out at 51.6m and 51.3m. the top of the filter media within the tanks is at 50.25m.
- 4.1.6 The development building finished floor level has been previously agreed with the Environmental Agency to be set at a minimum of 49.50 AOD.
- 4.1.7 Any development must provide flood routing from west to east across the site. This is most likely to be along the southern boundary.
- 4.1.8 Compensation volumes are likely to be required for any part of the development that is currently identified as being in Flood 3 and is removed from the flood plain.

5 DRAINAGE STRATEGY

5.1 Surface Water Drainage Strategy

5.1.1 Surface water runoff from the development will be controlled on site to ensure that there is no increase in the risk of flooding to areas downstream of the site and to the development itself.

5.1.2 The Building Regulations (2010) Part H stipulates a hierarchy for the disposal of surface water which should be followed as part of any surface water drainage design. This hierarchy is as follows:

1. an adequate soakaway or some other adequate infiltration system; or where that is not practicable,
2. a watercourse: or, where that is not practicable,
3. a sewer.

5.1.3 In accordance with this hierarchy, it is proposed that SuDS features are designed to promote infiltration to the underlying bedrock. Detailed permeability testing will be carried out at the design stage in accordance with BRE365 in order to assess the permeability of the underlying ground to determine the feasibility of infiltration drainage. It is assumed however, that due to the presence of the 'loamy and clayey' topsoil, that it will not be feasible to use infiltration as the primary method for the disposal of surface water runoff.

5.1.4 The proposed surface water management plan is shown on Drawing No. LD10590-002- 'Indicative Surface Water Management Plan'. Surface water runoff from the proposed development will discharge to the Nun Brook running through the site, via a conventional piped drainage network.

Greenfield Discharge Rates

5.1.5 It is proposed to restrict discharge from the site to the greenfield QBAR rate for all storm events up to and including the 1 in 100 years storm event (plus a 45% climate change allowance). Any flows in excess of the greenfield runoff rate will be attenuated in geocellular storage tanks designed up to and including the 1 in 100 years (+45%) storm event.

5.1.6 There will be approximately 8ha of developable area within the site consisting of rooftops, access roads, areas of hardstanding, and small areas of undeveloped land.

5.1.7 The existing greenfield runoff rates for the 8ha proposed developable area have been calculated following the IH124 methodology. The greenfield calculations are contained in Appendix 1 and are summarised in Table 4 below.

| Table 4. Greenfield Runoff Rates | | |
|----------------------------------|--|-----------------------|
| Return Period | Greenfield Runoff Rate (l/s per hectare) | Greenfield Ruoff rate |
| QBAR | 5.4 | 43.18 |
| 1 in 1 year | 4.64 | 37.13 |
| 1 in 30 years | 9.45 | 75.56 |
| 1 in 100 years | 11.23 | 89.81 |

Surface Water Attenuation Estimates

5.1.8 Preliminary estimates of the volume of attenuation required have been made using the Storage Estimate module in the Causeway ‘Flow’ software package. The attenuation calculations are based on there being no infiltration to the ground as a ‘worst case’ scenario. The infiltration rate for the site can, however, be confirmed at the detailed design stage by in-situ soakaway testing in accordance with BRE Digest 365.

5.1.9 Based on the proposed layout of the development, there will be two outfalls into the Nun Brook, with a small area to the northeast, and the remaining site area to the southwest, as shown in Drawing LD10590-002-P0 ‘Surface Water Management Plan’. This is also an accordance with guidance in the SuDS Manual which states that surface water runoff should be managed close to the source where flow rates and pollutant loadings are low, rather than conveying this to a single larger attenuation feature downstream.

5.1.10 Each attenuation feature will have its own associated flow control device with a restricted discharge rate based on the contributing impermeable area. A final flow control device will be installed at the outfall to restrict discharge to the cumulative final discharge rate of 43.18 l/s. and summarised in Table 1 below.

| Table 1. Preliminary Attenuation Estimates | | | | |
|---|---|-----------------------------|--|---|
| Catchment | Contributing Impermeable Area (ha) | Discharge Rate (l/s) | 1 in 30 years (+40%) Climate Change (m³) | 1 in 100 years (+45%) Climate Change (m³) |
| North of the Nun Brook | 0.225 | 2 | 108.5 | 158 |
| South of the Nun Brook | 4.724 | 41.18 | 2,295 | 3,335.5 |
| Total | 4.949 | 43.18 | 2,403.5 | 3,493.5 |

Sustainable Drainage Systems

5.1.11 Due to the high-density development and minimal areas of flat landscaping, it is proposed to provide the majority of surface water attenuation within geocellular tanks.

5.1.12 Attenuation for the warehouse rooftop will be provided by a geocellular storage tank to the northwest of the warehouse to the HGV parking spaces. A flow control device will restrict surface water from the rooftop to the greenfield runoff rate and discharge into the piped drainage network. Surface water runoff from the hardstanding adjacent to the warehouse to the northwest and northeast will be provided by a second geocellular storage tank to the northeast of the warehouse. A second flow control device will restrict the additional surface water runoff from the hardstanding areas to the greenfield runoff rate, and discharge into the piped drainage network. The carpark to the southwest of the Nun Brook will be attenuated via a permeable parking structure, which will discharge at 2 l/s into the piped drainage network. The carpark to the north of the Nun Brook will discharge into a piped drainage network to the northeast of the Nun Brook at 2 l/s.

Surface Water Quality

5.1.13 Following Simple Index Approach outlined in the CIRIA SuDS Manual, appropriate SuDS measures will be implemented within the site to ensure that water quality standards are met.

5.1.14 The Simple Index Approach identifies Pollution Hazard Indices for Total Suspended Solids, Metals and Hydrocarbons, for different types of land use. Within the site, the access roads, and areas heavily trafficked by cars and HGVs will have a High pollution

hazard level. Areas of parking specifically for cars and small vehicles will have a Medium pollution hazard level and the industrial building roofs will have a Low pollution hazard level.

5.1.15 To ensure that water quality standards are met, the Pollution Mitigation Indices need to be greater than or equal to the Pollution Hazard Indices. The Pollution Hazard Indices and the Pollution Mitigation Indices for the proposed development are presented in Table 2 below.

5.1.16 It is proposed that initial treatment is provided within each area by bypass oil separators, vortex grit separators or other appropriate manufactured proprietary devices.

5.1.17 The results show that the proposed manufactured proprietary devices will provide sufficient treatment for the anticipated pollutant loadings for an industrial development, and therefore, no additional treatment is required.

| Table 2. CIRIA Simple Index Approach Assessment | | | |
|---|---|-------------------|---------------------|
| | TSS | Metals | Hydrocarbons |
| Pollution Hazard Indices – Industrial Roof Runoff (Low) | 0.3 | 0.2 | 0.05 |
| Pollution Hazard Indices – Delivery Areas/Non-Residential Parking (Medium) | 0.7 | 0.6 | 0.7 |
| Pollution Hazard Indices – HGV routes (High) | 0.8 | 0.8 | 0.9 |
| Pollution Mitigation Indices – Proprietary Treatment Systems (eg oil interceptors, vortex grit separators) | These shall demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area. | | |
| Sufficient or Additional Treatment Required | Sufficient | Sufficient | Sufficient |

5.1.18 Additional SuDS features which may be appropriate within the proposed development, are included in Table 3 below. The final Surface Water Drainage Strategy will be fully designed post-planning and following appropriate BRE365 testing.

| Table 3. Sustainable Drainage System (SuDS) Options and Suitability | | | |
|--|----------------------|--|---|
| Type | Device | Description | Suitability |
| Source Control | Green roof | Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation. | Green roofs may be suitable for industrial buildings. |
| | Infiltration devices | Infiltration devices temporarily store runoff from a development and allow it to percolate into the ground. | Detailed permeability testing will be carried out at the design stage in accordance with BRE365 in order to assess the permeability of the underlying ground to determine the feasibility of infiltration drainage |
| | Pervious surfaces | Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water or sewers. | Permeable paving would be suitable for parking areas within this site. This would allow surface water to be filtered through the paving as a means of treatment. The base of the permeable paving could be unlined to promote any infiltration or lined to collect runoff and discharge to attenuation areas, based on the results of the infiltration testing in line with BRE365. |
| | Bioretention systems | Shallow landscaped depressions (eg tree pits, rain gardens) generally used for intercepting, managing and treating runoff from frequent rainfall events. | Suitable for use in open space. Runoff would be filtered through soils and vegetation and collected in an underdrain system to infiltrate to ground or discharge to attenuation areas. |
| | Rainwater harvesting | Rainwater harvesting reduces the amount of runoff from a site by re-using the water for non-potable uses. | Rainwater harvesting may potentially be suitable for use within the development, however, would not provide attenuation within a storm event as harvesting systems are likely to be full during periods of high rainfall. |
| Passive treatment/ end of pipe treatment | Infiltration basins | Infiltration basins are depressions in the surface that are designed to store runoff and infiltrate the water to the ground. They may also be landscaped to provide aesthetic and amenity value. | Detailed permeability testing will be carried out at the design stage in accordance with BRE365 in order to assess the permeability of the underlying ground to determine the feasibility of infiltration drainage |
| | Detention basins | Detention basins are depressions which are designed to store runoff prior to discharge to a watercourse or sewer. They may also be landscaped to provide aesthetic and amenity value. | Detention basins are considered to be suitable within areas of open space at the site. Areas of open space are, however, minimal |

| Table 3. Sustainable Drainage System (SuDS) Options and Suitability | | | |
|--|-------------------------|--|---|
| Type | Device | Description | Suitability |
| | Underground attenuation | Underground attenuation can be used where other forms of SuDS are not appropriate for the site. Underground attenuation stores water for volumes above the allowable discharge rate and releases the water at the restricted discharge rate. | Underground attenuation would be suitable for use on the site. Unlined underground attenuation would allow some infiltration to ground. |

5.2 Foul Sewerage

- 5.2.1 At the detailed design stage, application will be made to Yorkshire Water to discharge foul sewage from the proposed development to the 300 mm diameter public combined sewer recorded in Huddersfield Road, at a point approximately 200 metres from the site as suggested by Yorkshire Water in their Pre-Planning Sewerage Enquiry Return. Depending upon the invert level of this sewer, it may be necessary to pump sewage from the development at a maximum rate of 4 litres per second.
- 5.2.2 All relevant authorities will be kept fully informed regarding the detailed design of the foul sewerage system. It is normal practice for detailed foul sewerage design to be subject to the approval of the local planning authority subsequent to the grant of planning permission and this will be sought from Kirklees Council at the appropriate time.

5.3 Allowance for Climate Change

- 5.3.1 Climate change has been taken into account by utilising the floodwater levels with climate change allowance from the hydraulic modelling and by providing 30% climate change betterment to the surface water drainage system.

5.4 Residual Risk and Safety

- 5.4.1 Depending on the nature and level of the development, residual flood risk and safety will need to be considered.
- 5.4.2 The site will be safely accessible to emergency vehicles and personnel, even at times of deepest potential flood, the scenario of occupants needing to wade out through floodwater will be designed out.

5.4.3 A Flood Management Plan may be required if the development remains within Flood Zones 2 or 3. Should a flood event be predicted, occupants will evacuate in good time and before any local flooding occurs to the nearest area of continuous Flood Zone 1 without the need to cross main rivers where flood risk may be higher.

5.5 Sequential Test

5.5.1 The proposed development is for commercial use which is classified as 'less vulnerable' in the NPPF. Less vulnerable land uses located in Flood Zones 2 and 3 are deemed appropriate subject to satisfying the NPPF Sequential Test. The sequential test is designed to promote development in Flood Zone 1 wherever possible.

5.5.2 A full sequential test will be required to for the scheme to satisfy planning requirements.

5.6 Exception Test

5.6.1 The NPPF Exception Test is not required for 'less vulnerable' development within Flood Zones 2 and 3a.

6 CONCLUSIONS

- 6.1.1 The site is situated in Flood Zones 2 & 3. The perimeter wall of the tank provided an island which is effectively Flood Zone 1.
- 6.1.2 The bridge over Nun Brook may need to be widened to accommodate traffic, The impermeable area created by this will be offset by the proposed permeable areas in terms of storage.
- 6.1.3 Environment Agency have accepted that building development within filter bed area (high area) at a level of 49.500 would be acceptable.
- 6.1.4 Although infiltration will be investigated, it is expected to not be feasible and surface water will need to be discharged to watercourse.
- 6.1.5 Surface water run-off will be attenuated on site by appropriate SuDS related surface drainage techniques such as permeable paving,
- 6.1.6 There is no evidence of any significant risk of groundwater flooding.
- 6.1.7 Foul sewage will be discharged to the nearby public sewer system.
- 6.1.8 As regards safety and evacuation. Emergency vehicle and personnel access will be required at all times and a Flood Management Plan will likely be required.
- 6.1.9 The Exception Test is not required for 'less vulnerable'/commercial development in Flood Zones 2 and 3a.
- 6.1.10 With careful planning and appropriate consideration of the flood zones and site levels, the site will be suitable for development for commercial use.

APPENDICES

Asset Defence Information

RFI: 3151

| Asset ID | Asset Subtype | Asset Subtype | Asset Maintainer | Description | Design Standard of protection (yrs) | Actual Downstream Crest Level | Actual Upstream Crest Level | Actual condition Rating |
|----------|---------------|---------------|------------------|---------------------------------------|-------------------------------------|-------------------------------|-----------------------------|-------------------------|
| 28122 | Defence | High ground | Private | HIGH GROUND AT SEWAGE TREATMENT WORKS | 30 | | | 3 |
| 76414 | Defence | High ground | Private | HIGH GROUND | 30 | | | 3 |
| 52470 | Defence | High ground | Private | WALLS | 30 | | | 3 |
| 28010 | Defence | High ground | Private | WALLS AND NATURAL BANK | 30 | 44.9 | 47.22 | 3 |
| 28126 | Defence | High ground | Private | HIGH GROUND | 30 | | | 3 |
| 52471 | Defence | High ground | Private | FLOODBANK | 30 | 47.62 | 50.19 | 3 |
| 28012 | Defence | High ground | Private | MASONRY WALL TO SEWAGE WORKS | 30 | | | 3 |
| 28122 | Defence | High ground | Private | HIGH GROUND AT SEWAGE TREATMENT WORKS | 30 | | | 3 |
| 76414 | Defence | High ground | Private | HIGH GROUND | 30 | | | 3 |



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Scale: 1:7,000

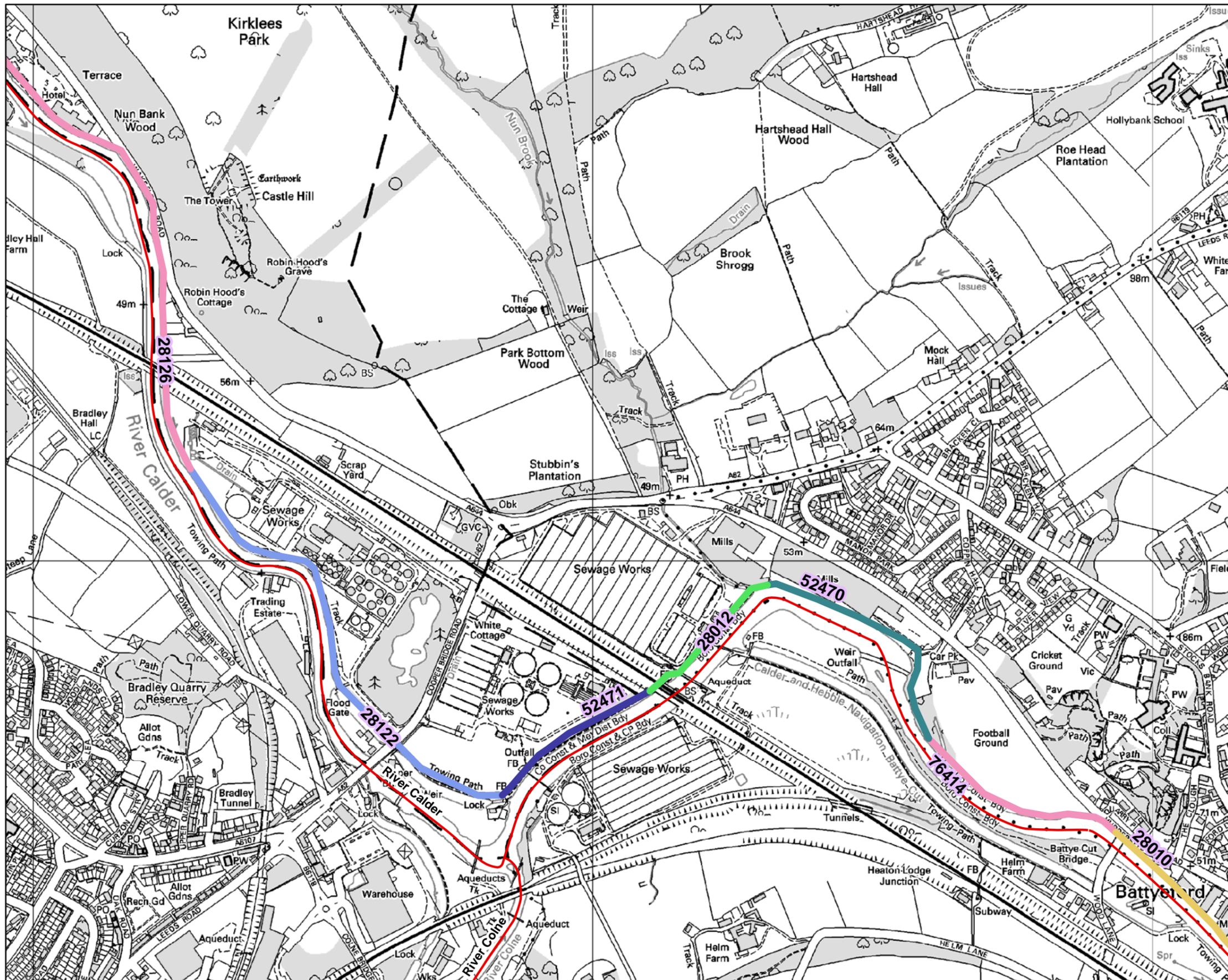


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LEGEND

- | Defences | Description |
|----------|---------------------------------------|
| | FLOOBBANK |
| | HIGH GROUND |
| | HIGH GROUND AT SEWAGE TREATMENT WORKS |
| | MASONRY WALL TO SEWAGE WORKS |
| | WALLS |
| | WALLS AND NATURAL BANK |
| | Main River |



Defended 100yr Depth Grids Cooper Bridge Road, Mirfield

RFI: 35983



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Scale: 1:7,000

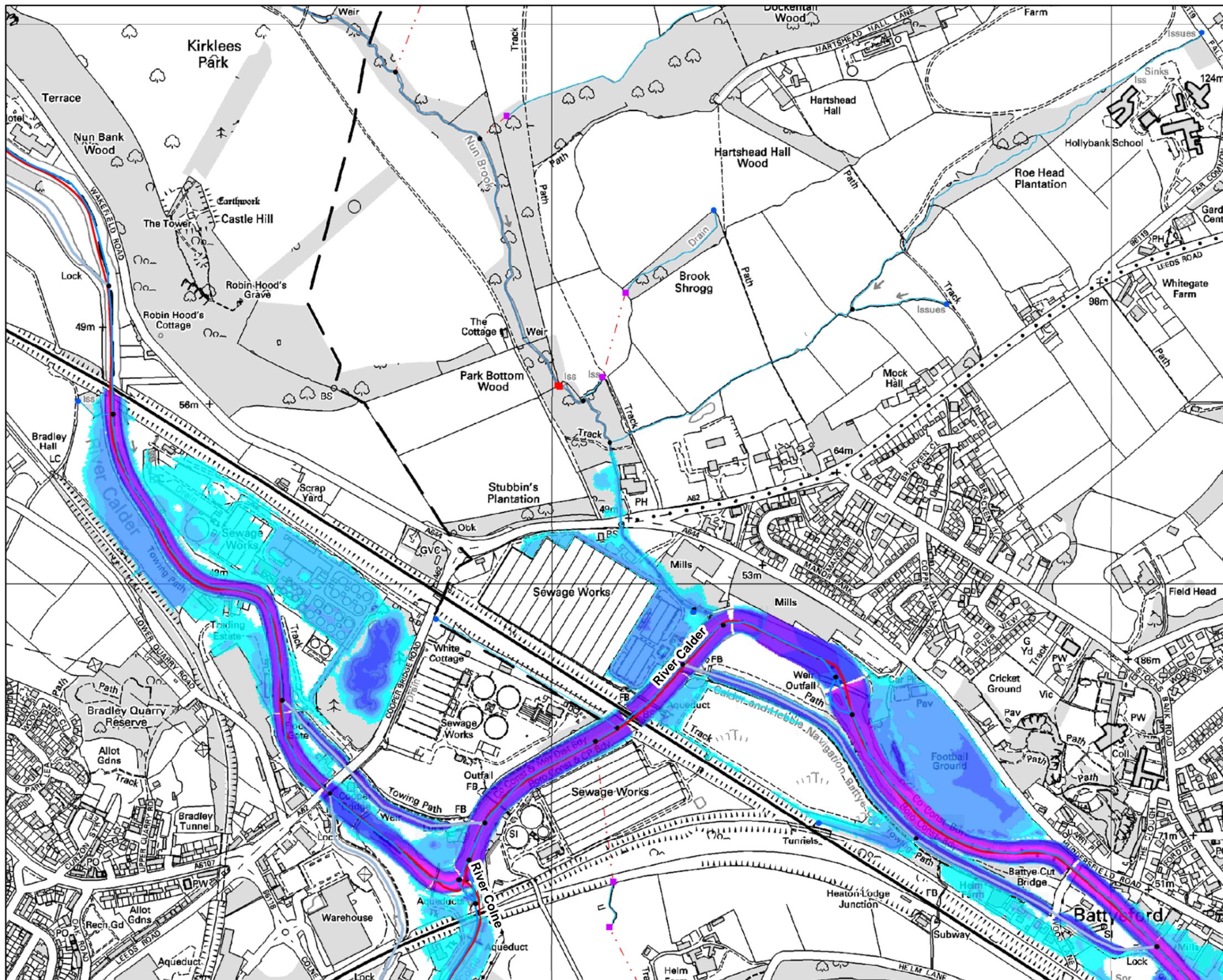


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LEGEND

- Main River
- 0 - 0.56
- 0.57 - 1.18
- 1.19 - 1.86
- 1.87 - 2.57
- 2.58 - 3.38
- 3.39 - 4.18
- 4.19 - 4.92
- 4.93 - 5.6
- 5.61 - 6.32
- 6.33 - 7.9



Defended 1000yr Depth Grids Cooper Bridge Road, Mirfield

RFI: 35983



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Scale: 1:7,000

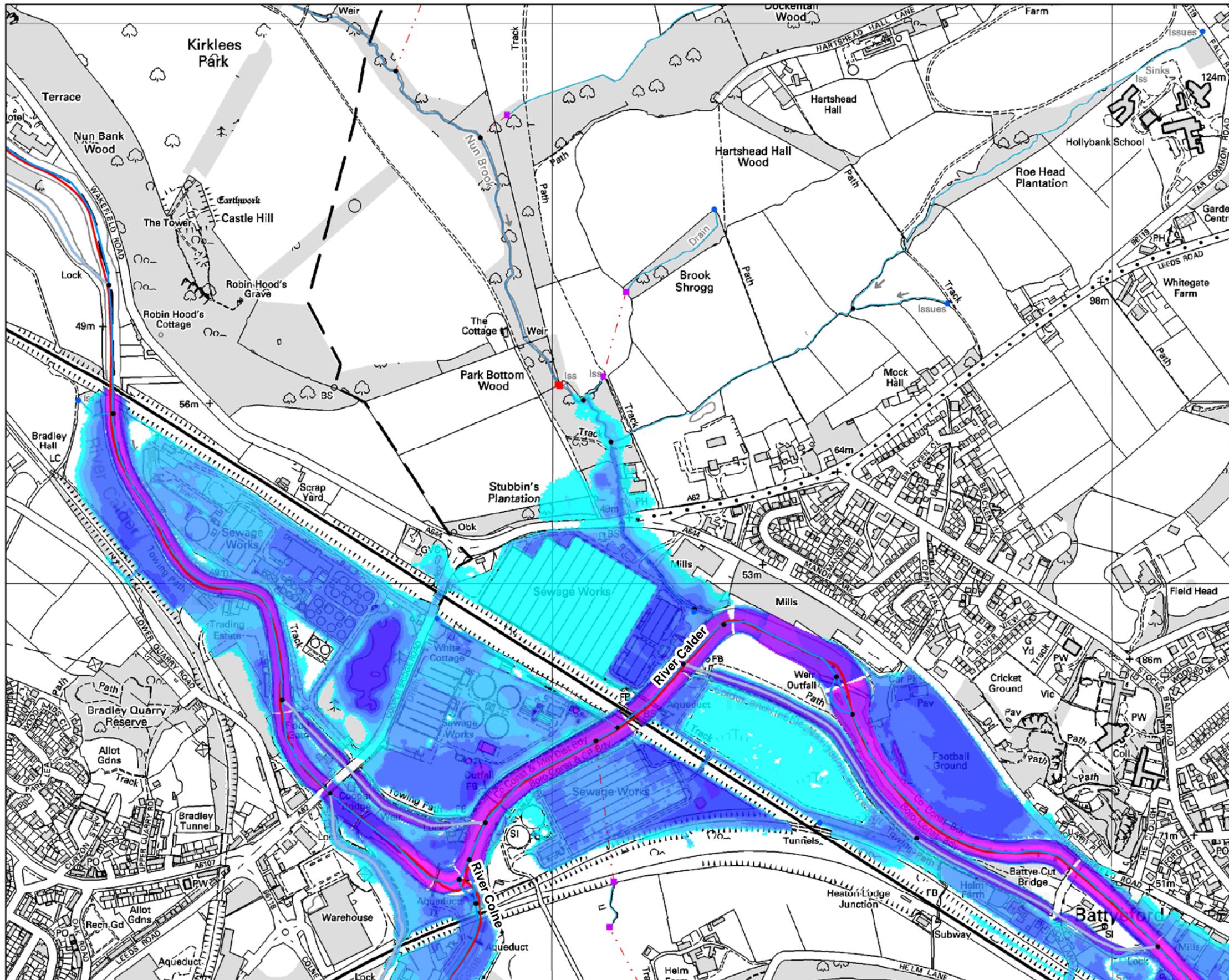


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LEGEND

- Main River
- 0 - 0.7
- 0.71 - 1.4
- 1.41 - 2.1
- 2.11 - 2.8
- 2.81 - 3.61
- 3.62 - 4.57
- 4.58 - 5.57
- 5.58 - 6.45
- 6.46 - 7.27
- 7.28 - 9.4



Defended 100yr Climate Change Depth Grids Cooper Bridge Road, Mirfield

RFI: 35983



www.environment-agency.gov.uk

Scale: 1:7,000

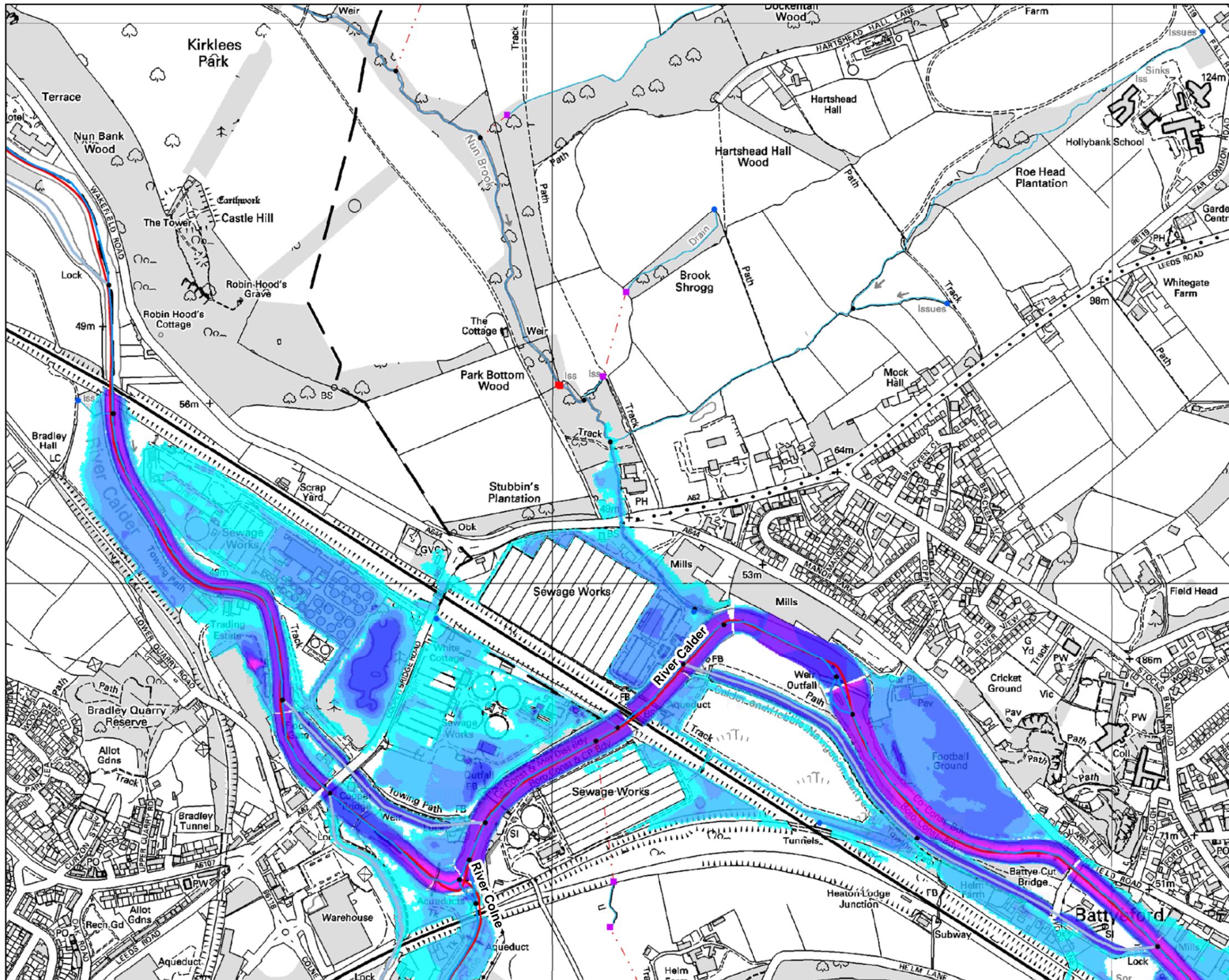


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LEGEND

- Main River
- 0 - 0.65
- 0.66 - 1.34
- 1.35 - 2.07
- 2.08 - 2.86
- 2.87 - 3.78
- 3.79 - 4.7
- 4.71 - 5.48
- 5.49 - 6.17
- 6.18 - 6.87
- 6.88 - 11.38



Undefended 100yr Depth Grids Cooper Bridge Road, Mirfield

RFI: 35983



www.environment-agency.gov.uk

Scale: 1:7,000

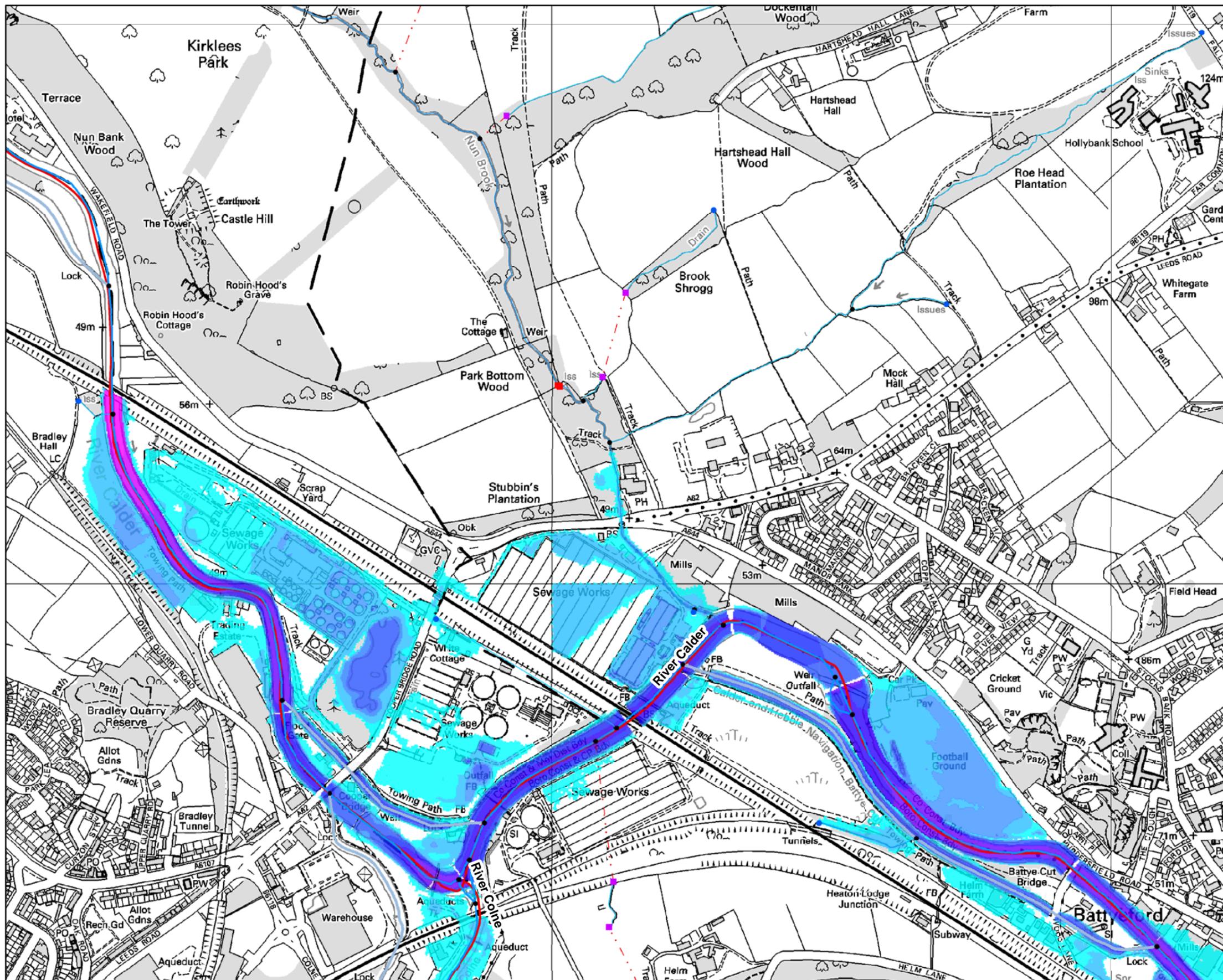


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LEGEND

- Main River
- 0 - 0.74
- 0.75 - 1.55
- 1.56 - 2.5
- 2.51 - 3.61
- 3.62 - 4.71
- 4.72 - 5.67
- 5.68 - 7.8
- 7.81 - 11.12
- 11.13 - 14.72
- 14.73 - 18.77



Undefended 1000yr Depth Grids Cooper Bridge Road, Mirfield

RFI: 35983



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Scale: 1:7,000

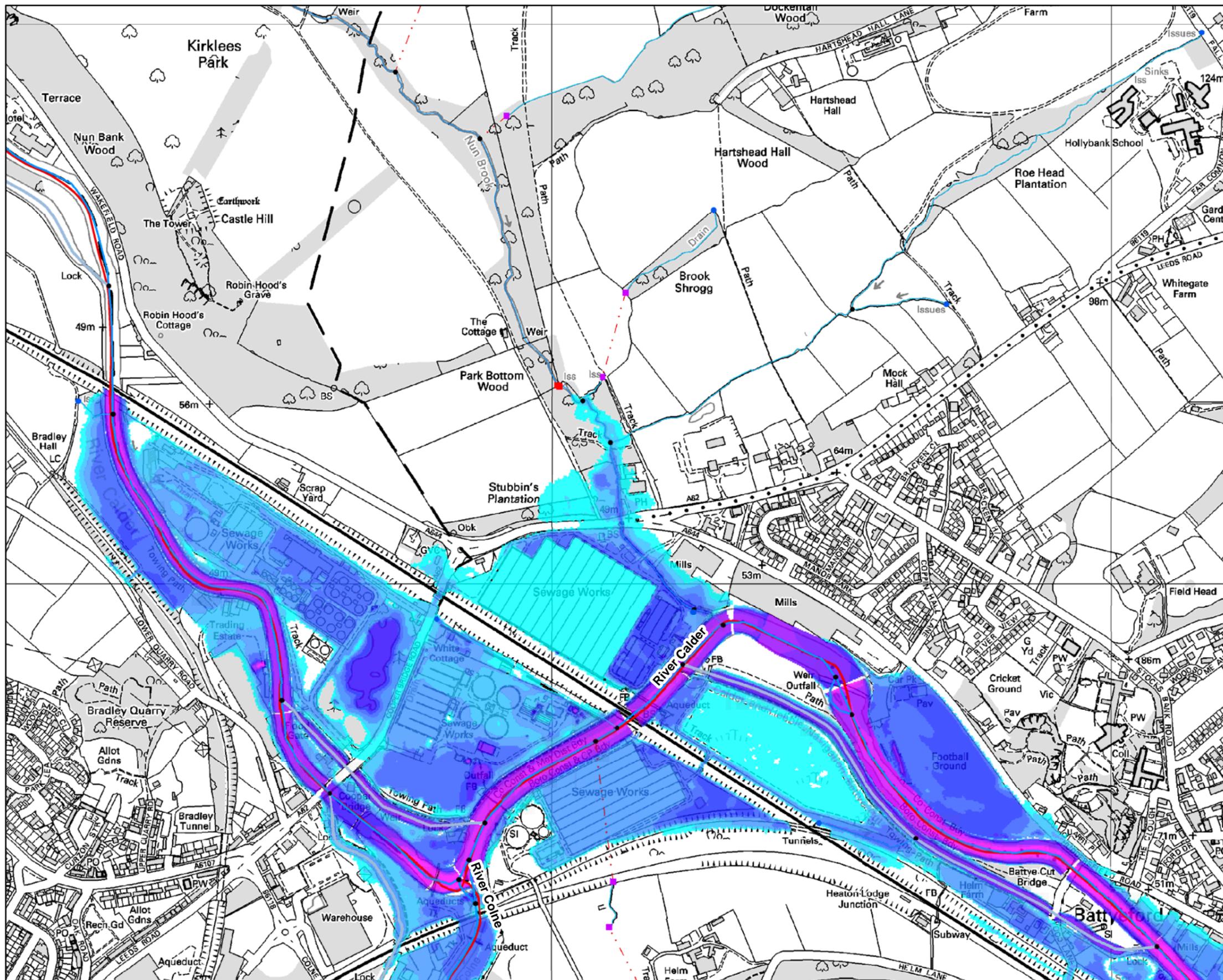


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LEGEND

- Main River
- 0 - 0.7
- 0.71 - 1.41
- 1.42 - 2.11
- 2.12 - 2.82
- 2.83 - 3.6
- 3.61 - 4.58
- 4.59 - 5.6
- 5.61 - 6.46
- 6.47 - 7.28
- 7.29 - 9.43



Node Point Information
RFI: 3151
Defended

Calder Model Defended Scenario Model Results (Stage - mAOD, Flow - m³/s)

| Node Point | Return Period | | | | | | | | | | | |
|------------------------|---------------|----------|-----------|----------|-----------|----------|-----------|----------|-----------|----------|-----------|----------|
| | 2 | | 5 | | 10 | | 25 | | 30 | | 50 | |
| | Max Level | Max Flow | Max Level | Max Flow | Max Level | Max Flow | Max Level | Max Flow | Max Level | Max Flow | Max Level | Max Flow |
| EA1231293_CALD11_0013u | 46.96 | 230.39 | 47.41 | 315.05 | 47.51 | 333.64 | 48 | 419.26 | 48.09 | 433.26 | 48.27 | 463.67 |
| EA1231293_CALD10_2301 | 46.65 | 231.57 | 46.97 | 316.04 | 47.03 | 334.19 | 47.45 | 420.29 | 47.53 | 433.66 | 47.7 | 463.96 |
| EA1231293_CALD10_1809 | 45.55 | 231.4 | 46.19 | 309.96 | 46.32 | 323.61 | 46.98 | 349.45 | 47.09 | 351.69 | 47.31 | 354.64 |
| EA1231293_CALD11_0013d | 46.93 | 230.44 | 47.35 | 315.1 | 47.44 | 333.7 | 47.91 | 419.33 | 47.99 | 433.33 | 48.16 | 463.75 |
| EA1231293_CALD10_2490d | 46.82 | 230.43 | 47.2 | 315.02 | 47.28 | 333.57 | 47.73 | 416.21 | 47.82 | 426.96 | 48.02 | 446.04 |
| EA1231293_CALD10_2365d | 46.71 | 231.57 | 47.06 | 316.05 | 47.13 | 334.19 | 47.56 | 420.22 | 47.64 | 433.88 | 47.81 | 464.65 |
| EA1231293_CALD10_2121d | 45.84 | 231.58 | 46.52 | 316.05 | 46.65 | 334.2 | 47.22 | 420.26 | 47.31 | 433.5 | 47.5 | 463.1 |
| EA1231293_CALD10_1760i | 45.52 | 231.38 | 46.17 | 307.75 | 46.3 | 320.91 | 46.95 | 354.8 | 47.06 | 357.92 | 47.28 | 361.31 |
| EA1231293_CALD10_1708i | 45.5 | 231.31 | 46.14 | 309.5 | 46.27 | 323.78 | 46.88 | 378.19 | 46.99 | 382.98 | 47.21 | 388.57 |
| EA1231293_CALD10_1656i | 45.47 | 231.31 | 46.1 | 315.39 | 46.22 | 333.08 | 46.77 | 423.46 | 46.84 | 431.69 | 47.05 | 455.08 |

| Node Point | Return Period | | | | | | | | | |
|------------------------|---------------|----------|-----------|----------|-----------|----------|-----------|----------|-----------|----------|
| | 75 | | 100 | | 101 | | 200 | | 1000 | |
| | Max Level | Max Flow | Max Level | Max Flow | Max Level | Max Flow | Max Level | Max Flow | Max Level | Max Flow |
| EA1231293_CALD11_0013u | 48.4 | 486.91 | 48.46 | 488.08 | 48.93 | 582.18 | 48.72 | 542.15 | 50.11 | 802.81 |
| EA1231293_CALD10_2301 | 47.82 | 487.99 | 47.89 | 488.85 | 48.28 | 577.16 | 48.09 | 547.31 | 49.23 | 792.26 |
| EA1231293_CALD10_1809 | 47.48 | 357.46 | 47.31 | 469.36 | 48.06 | 385.95 | 47.81 | 377.41 | 48.57 | 762.87 |
| EA1231293_CALD11_0013d | 48.29 | 486.99 | 48.35 | 488.24 | 48.8 | 582.37 | 48.6 | 542.25 | 49.83 | 802.95 |
| EA1231293_CALD10_2490d | 48.18 | 458.55 | 48.18 | 477.31 | 48.5 | 603.33 | 48.38 | 550.27 | 49.65 | 740.49 |
| EA1231293_CALD10_2365d | 47.93 | 488.95 | 47.99 | 488.87 | 48.39 | 577.71 | 48.2 | 548.51 | 49.34 | 789.87 |
| EA1231293_CALD10_2121d | 47.65 | 484.44 | 47.73 | 488.07 | 48.19 | 562.85 | 47.96 | 536.43 | 49.21 | 779.99 |
| EA1231293_CALD10_1760i | 47.45 | 366.14 | 47.28 | 473.43 | 48.04 | 395.71 | 47.78 | 387.01 | 48.62 | 738.95 |
| EA1231293_CALD10_1708i | 47.39 | 393.63 | 47.24 | 478.53 | 47.99 | 422.14 | 47.73 | 413.58 | 48.6 | 741.56 |
| EA1231293_CALD10_1656i | 47.21 | 469.93 | 47.2 | 486.66 | 47.83 | 511.65 | 47.55 | 501.6 | 48.57 | 752.41 |

Calder Model Undefended Scenario Model Results (Stage - mAOD, Flow - m³/s)

| Return Period | | | | |
|------------------------|-----------|----------|-----------|----------|
| | 100 | | 1000 | |
| Node Point | Max Level | Max Flow | Max Level | Max Flow |
| EA1231293_CALD11_0013u | 48.3 | 478.71 | 50.11 | 811.13 |
| EA1231293_CALD10_2301 | 47.68 | 481.52 | 49.24 | 795.25 |
| EA1231293_CALD10_1809 | 47.25 | 372.66 | 48.58 | 763.65 |
| EA1231293_CALD11_0013d | 48.19 | 478.88 | 49.83 | 811.28 |
| EA1231293_CALD10_2490d | 48.04 | 460.12 | 49.65 | 744.16 |
| EA1231293_CALD10_2365d | 47.81 | 481.37 | 49.35 | 794.01 |
| EA1231293_CALD10_2121d | 47.47 | 479.67 | 49.21 | 783.3 |
| EA1231293_CALD10_1760i | 47.21 | 380.1 | 48.63 | 739.79 |
| EA1231293_CALD10_1708i | 47.13 | 407.7 | 48.61 | 742.73 |
| EA1231293_CALD10_1656i | 46.95 | 475.22 | 48.57 | 751.58 |



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Scale: 1:4,500

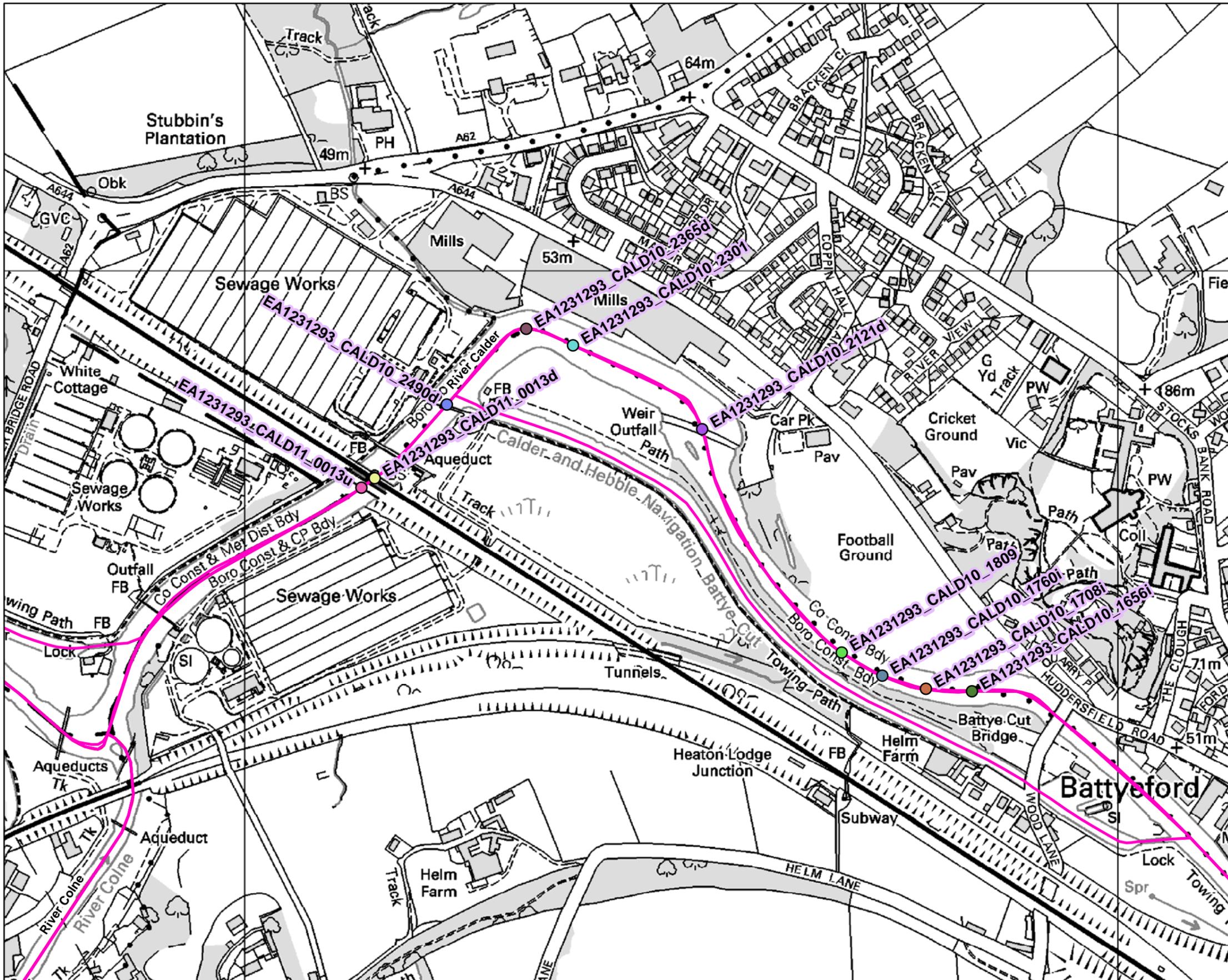


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LEGEND

| NODE POINT ID | |
|---------------|------------------------|
| | EA1231293_CALD10_2301 |
| | EA1231293_CALD10_1656i |
| | EA1231293_CALD10_1708i |
| | EA1231293_CALD10_1760i |
| | EA1231293_CALD10_1809 |
| | EA1231293_CALD10_2121d |
| | EA1231293_CALD10_2365d |
| | EA1231293_CALD10_2490d |
| | EA1231293_CALD11_0013d |
| | EA1231293_CALD11_0013u |
| | Main River |



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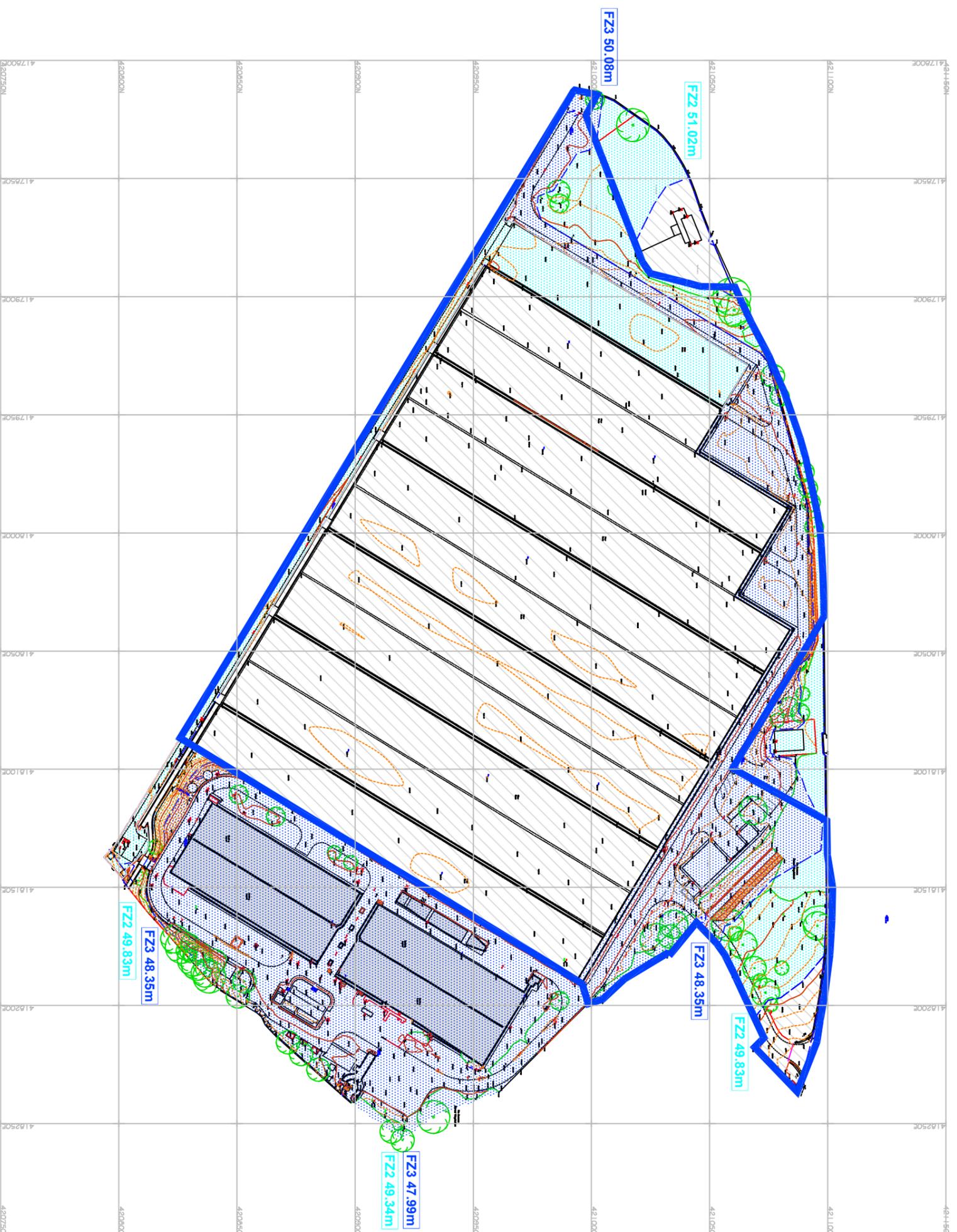
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| FLOOD ZONE 2 | |
| FLOOD ZONE 1 | |

| REVISION | DETAILS | DATE | DRN | CHK'D | APP'D |
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| | | | | | |

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LAND AT COOPER BRIDGE,
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DP - W/16 TITLE
INTERPOLATED
FLOOD ZONES

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| DRAWN BY | | CHECKED BY | |
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