Wombwell Ings & Old Moor Nature Reserve Flood Risk Assessment

Final

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Contract

This report describes work commissioned by Jayne Wood, on behalf of the RSPB, by a letter dated 2/08/18. Alex Jones, Howard Keeble, Josh Rutherford and Jack Pordham of JBA Consulting carried out this work.

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Purpose

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1 Introduction

1.1 Terms of reference

JBA Consulting were appointed by the RSPB in August 2018 to prepare a Flood Risk Assessment (FRA) to support a wetland improvement scheme at Wombwell Ings, and the Old Moor Nature Reserve Darfield, South Yorkshire. This FRA provides information on the flood risk at both sites and follows Government guidance with regards to development and flood risk (National Planning Policy Framework and accompanying Planning Practice Guidance).

1.2 Requirements

It is a requirement for development applications to consider the potential risk of flooding to a proposed development over its expected lifetime and any possible impacts on flood risk elsewhere, in terms of its effects on flood flows and run-off.

This FRA follows guidance given on development and flood risk in the National Planning Policy Framework and accompanying Planning Practice Guidance.

1.3 Site Location

Wombwell Ings and the Old Moor Nature Reserve lies in an Environment Agency managed control washland cell in the floodplain between the River Dove to the north, Bulling Dyke to the south, and the River Dearne to the east. The Wombwell Ings site is surrounded by a control washland bund, and the site is occupied by two shallow ponds and grassland. The Old Moor Nature Reserve is a managed flood relief basin.

Flood risk relating to the Wombwell Ings site is addressed in Sections 2 and 3 of this report.

Section 4 includes consideration of flood risk to the Old Moor Nature Reserve following landscaping of ponds and other water features.

2 Wombwell Ings Site Description

2.1 Site Features

Figure 2-1 presents a map of the main hydrological features of the site:

- Two shallow lakes occupy the site currently (see Figure 2-2 and Figure 2-3).
- A bund forming the controlled washlands cell rings the site.
  - A spill in the north-west allows water into the cell (see Figure 2-4).
- There are two outfalls from the cell;
  - The main outfall is a flapped culvert on the eastern end of the main drain that crosses the site (see Figure 2-5).
  - A high level outfall, which only operates when the site is flooded and the penstocks on it are opened (see Figure 2-6).
- A dropboard weir just upstream of the main outfall controls water levels in the main lake. It is set at 20.45mAOD (see Figure 2-5).

Figure 2-1: Wombwell Ings Features

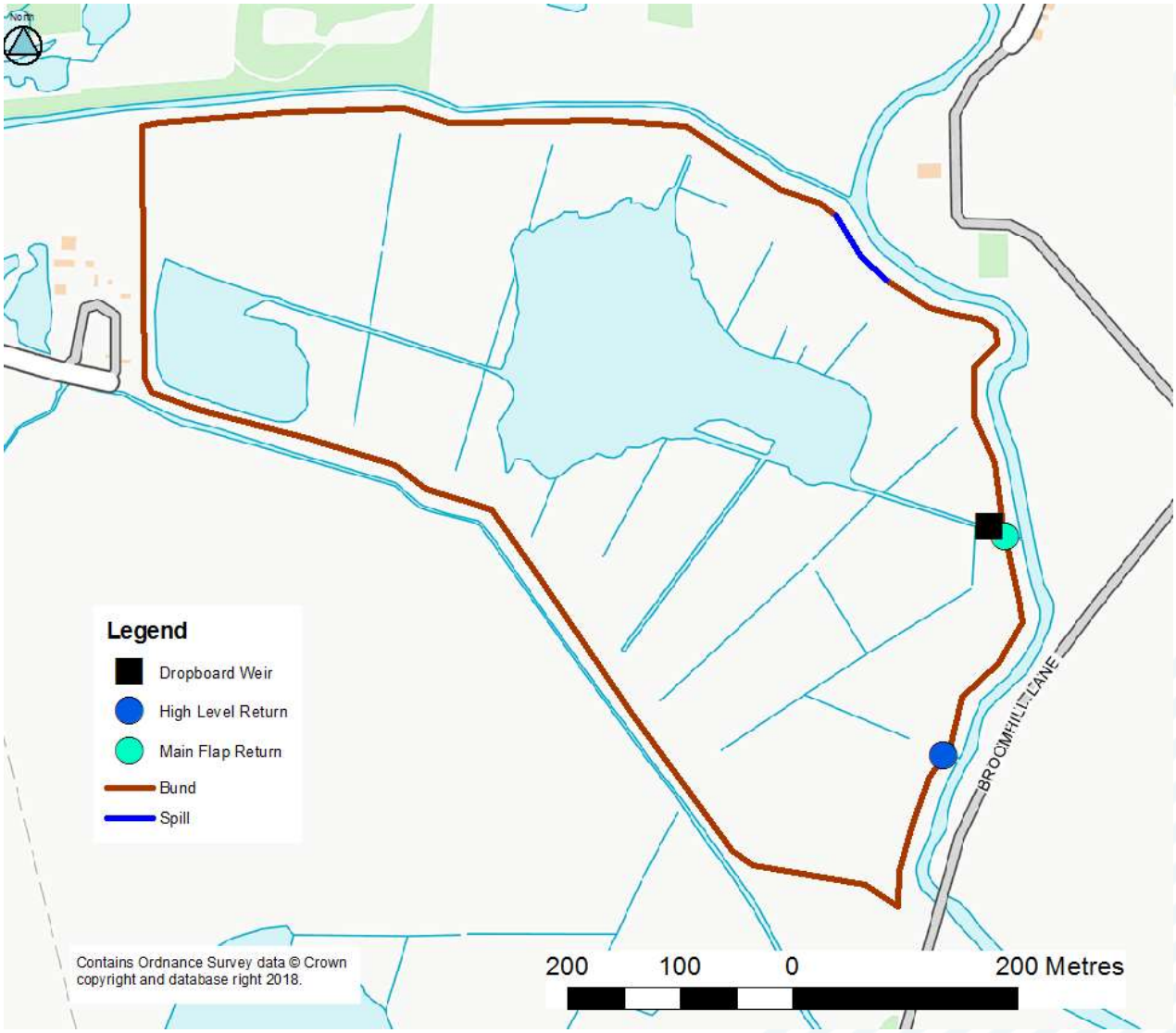


Figure 2-2: Wombwell Ings Main Waterbody from the East

Figure 2-3: South-West Waterbody looking East

Figure 2-4: Spill in Washland Bund

Figure 2-5: Dropboard and Main Outfall

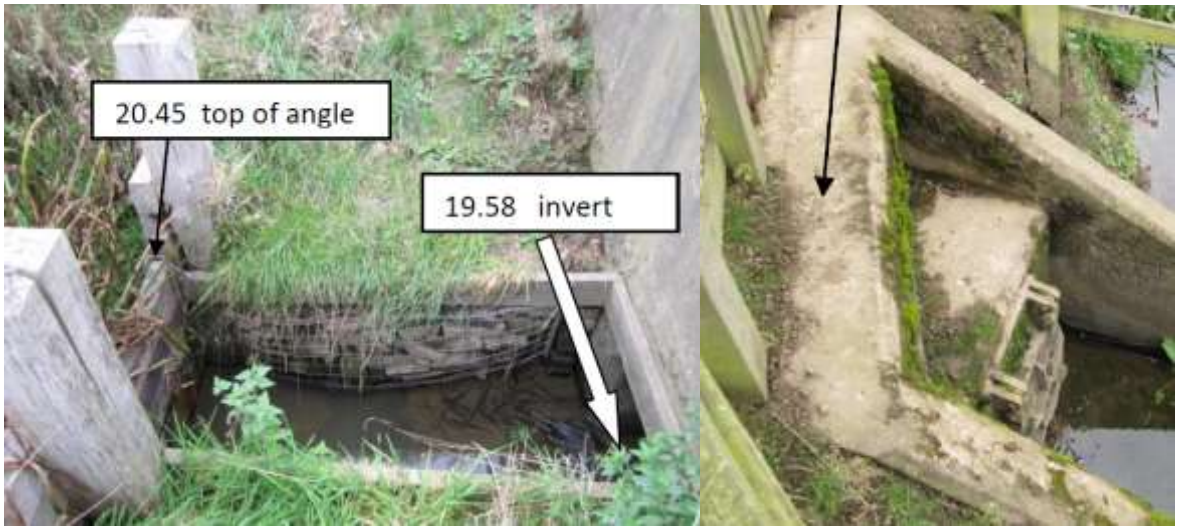


Figure 2-6: High Level Return

2.2 Proposed Development

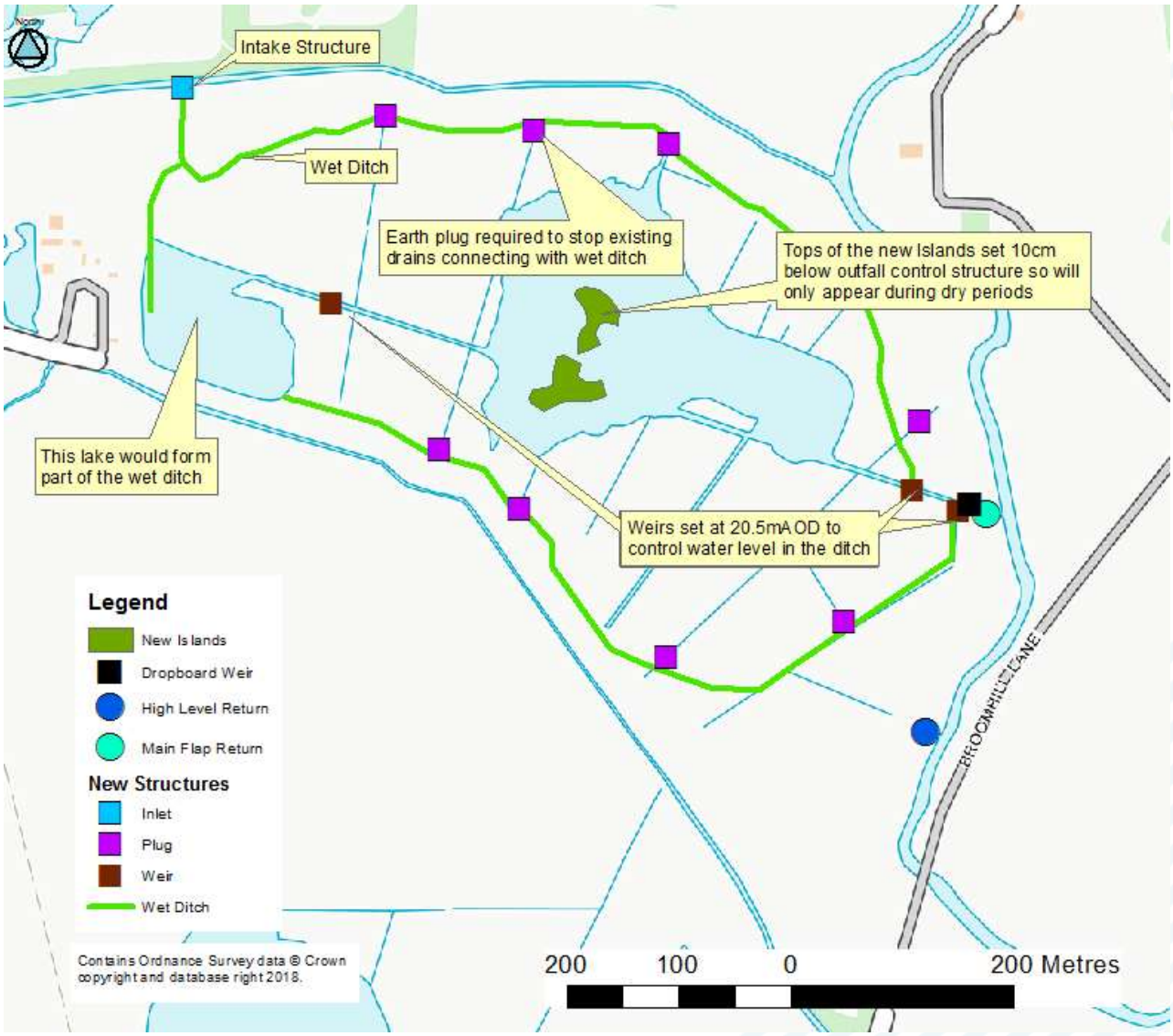
Figure 2-7 presents an overview of the wetland improvement design. The main feature is a wet ditch encircling the site. The aim of this ditch is to limit predation and disturbance to the bird species that may utilise Wombwell Ings. The ditch design has the following features:

- On average it is circa 5m wide and 1.5m deep, with 0.4m of water in the bottom.
- The water level is controlled at a single water level (20.5mAOD) and spills into the central ditch at three locations (marked as weirs on the map).
- The ditch will be topped up by an intake structure from the River Dove. This consists of;
  - a culvert intake from the river under the washland bund to a syphon structure,
  - The syphon will only allow water into the wet ditch when water levels drop in the wet ditch.
    - This means that it would automatically close in high water level conditions.
- The wet ditch will be isolated from the existing drains on site by a series of earth plugs in the ditches.

The material excavated from the ditch will be used in two ways:

- 2090m^3 will be placed in the centre pond to create a series of ephemeral islands.
  - The tops of these islands will be set 10cm below the weir on the outfall drain
    - This means they will only appear when water levels in the lake drop during dry periods.
- 1808m^3 will exported to the reservoir at Old Moor and placed to form reed bed margins
    - The impact from this is discussed in the Old Moor FRA.

Figure 2-7: Wet Ditch Design



3 Flood Risk Assessment

3.1 Planning context

All forms of flooding and their impact on the natural and built environment are material planning considerations. The National Planning Policy Framework (NPPF) and subsequent Planning Practice Guidance (published in March 2014) stress the importance of assessing, appraising and managing flood risk at all stages of the planning process. The NPPF aims to avoid inappropriate development in areas at risk from flooding but where development is necessary, making it safe without increasing flood risk elsewhere.

The NPPF outlines that only 'water-compatible uses' and 'essential infrastructure' should be permitted within Flood Zone 3. All the wetland improvement works are proposed to occur in Flood Zone 3. As the site will be used for nature conservation and biodiversity, then the proposed restoration works can be deemed to be a 'Water-Compatible Development' under the NPPF Planning Practice Guidance 6th March 2013[1]. Under this guidance, water-compatible uses can be permitted in this zone as long as they[2]:

- remain operational and safe for users in times of flood,
- result in no net loss of flood storage,
- not impede water flows; and
- not increase flood risk elsewhere.

3.2 Site Baseline

3.2.1 Fluvial Flood Risk

The site is in Flood Zone 3. The site is an identified flood storage area, and the bund surrounding the site is an Environment Agency flood defence structure.

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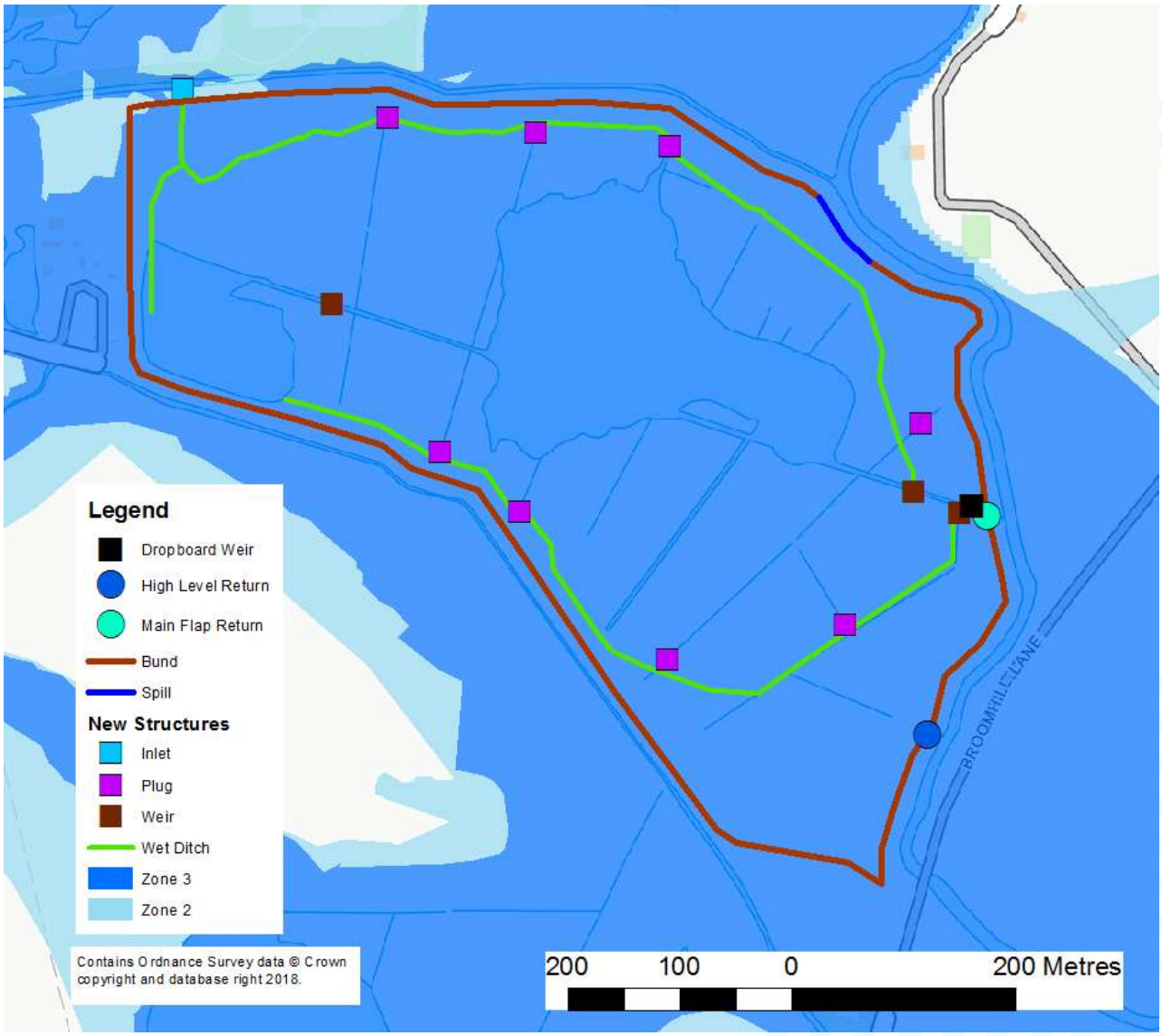
1 see http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/flood-zone-and-flood-risk-tables/table-2-flood-risk-vulnerability-classification/ (accessed October 3rd 2018)

2 see http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/flood-zone-and-flood-risk-tables/table-3-flood-risk-vulnerability-and-flood-zone-compatibility/

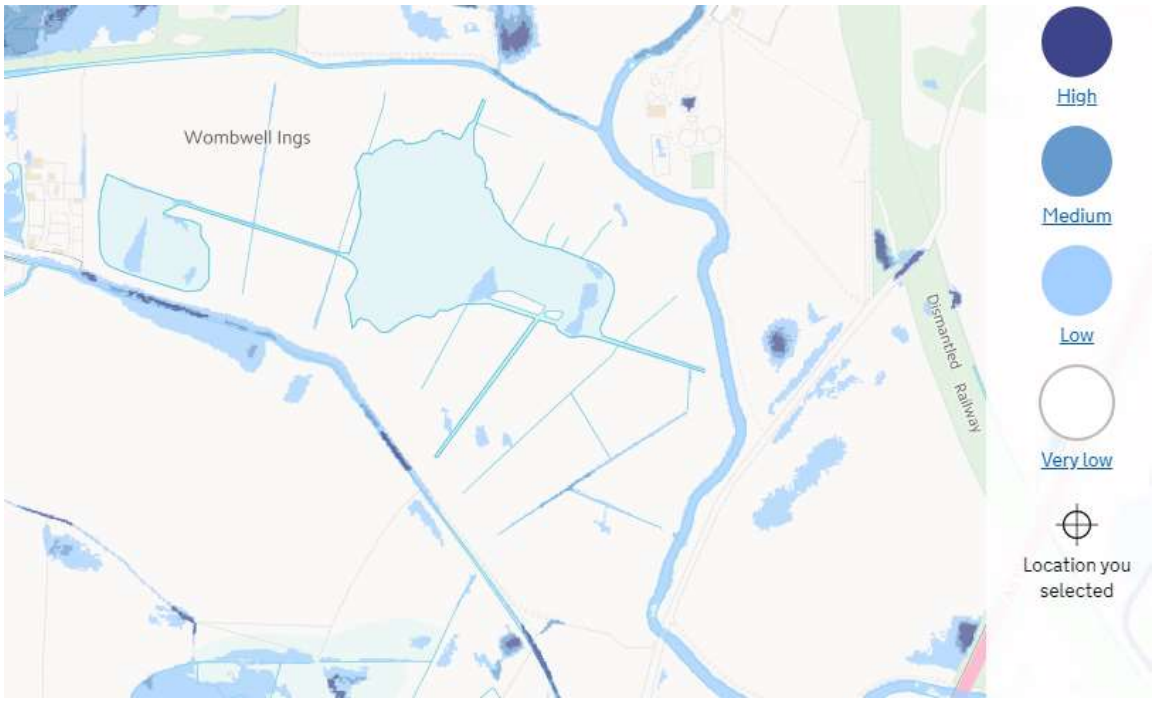
Figure 3-8: Fluvial Flood Risk



3.2.2 Surface Water Flood Risk

Surface water flooding arises when rain falling on saturated ground flows overland, following natural runoff pathways through the local topography. Surface water flood risk to the site has been assessed using the Environment Agency's national scale Risk of Flooding from Surface Water mapping. The map below indicates that limited areas are susceptible to surface water flooding (see Figure 3-9). This may be because the surrounding bunds and rivers limit the surface run-off catchment of the area.

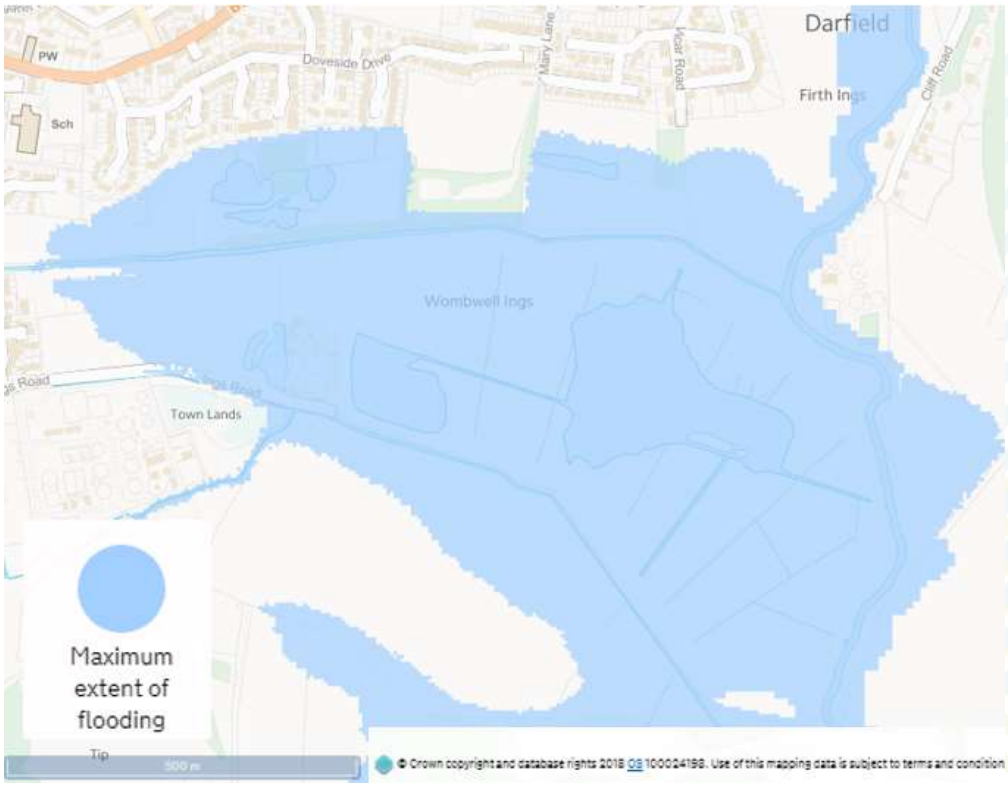
Figure 3-9: Surface Water Flood Risk



3.2.3 Reservoirs

The area is at risk from flooding from reservoirs (**Error! Reference source not found.**), i.e. in the event of the reservoir dam/embankment being breached.

Figure 3-10: Risk of Flooding from Reservoirs



3.3 Assessment of changes in flood risk as a result of proposed development

The following section aims to review the key features of the proposed development design against the tests outlined in the NPPF for water-compatible uses in Flood Zone 3, Table 3-1 as outlined in section 3.

Table 3-1 Assessment of changes in flood risk for key development features

NPPF test criteria	Intake Structure	Wet Ditch system (including ditch, weirs and earth plugs)	Sediment disposal
1) Remain operational and safe for users in times of flood	In flood flows the structure will automatically shut without the need for any manual inputs	The system would require no adjustments during flood events	N/A.
2) Result in no net loss of floodplain storage	The structure will be below ground level.	The wet ditch will contain some water. However, that level is beneath the current ground level. The scheme should result in a slight increase in floodplain storage as a result of the ditch excavation.	The material arising from the wet ditch will be placed beneath the current managed water level on the central pond at Wombwell and the reservoir at Old Moor
3) Do not impede water flows	By automatically shutting off when the wet ditch is full, the functioning of the washland cell (and therefore high flows) are not changed either in the river channels or the floodplain	The wet ditch is hydraulically isolated within the washland cell.	The material arising from the wet ditch will be placed beneath the current managed water level on the central pond at Wombwell and the reservoir at Old Moor
4) Do not increase flood risk elsewhere	By automatically shutting off when the wet ditch is full, the functioning of the washland cell during flood events is not changed.	Through the slight increase in floodplain storage, flood risk downstream will be slightly reduced.	The material arising from the wet ditch will be placed beneath the current managed water level on the central pond at Wombwell and the reservoir at Old Moor

3.4 Environmental Permits and Licences

The design will require a series of environmental permits and an abstraction licence from the Environment Agency before it can be implemented.

4 Old Moor Nature Reserve

4.1 Introduction to flood risk

To understand flood risk at the Old Moor site JBA have reviewed the available EA modelling. The site is located east of Wombwell Ings.

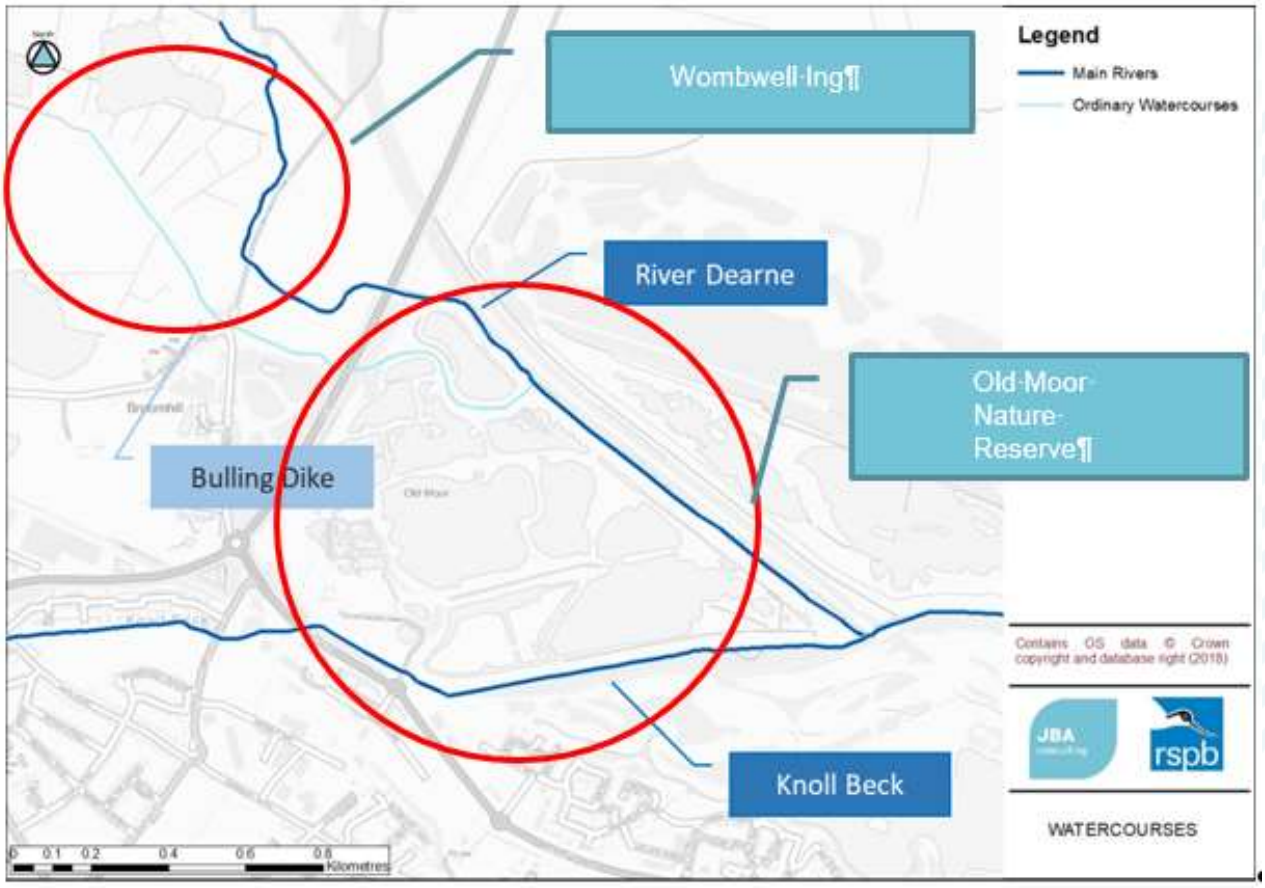
The primary focus of the FRA for the Old Moor Nature Reserve (Figure 4-1) is to determine the implications on water levels, if any, between the existing baseline layout of the nature reserve and water levels following modification to the reserve's features, ponds and habitats.

The reserve currently acts as a flood attenuation basin. It should be noted that the frequency and mechanism of flooding from the rivers remains unaffected by the proposed works. Flood embankment levels are not altered as part of the proposed landscaping works and all overflow levels and outlets remain unchanged.

Landscaping works primarily involve reprofiling the various ponds within the reserve to improve habitat potential and interconnectivity.

The area primarily floods by overtopping from Bulling Dyke before discharging back to the River Dearne.

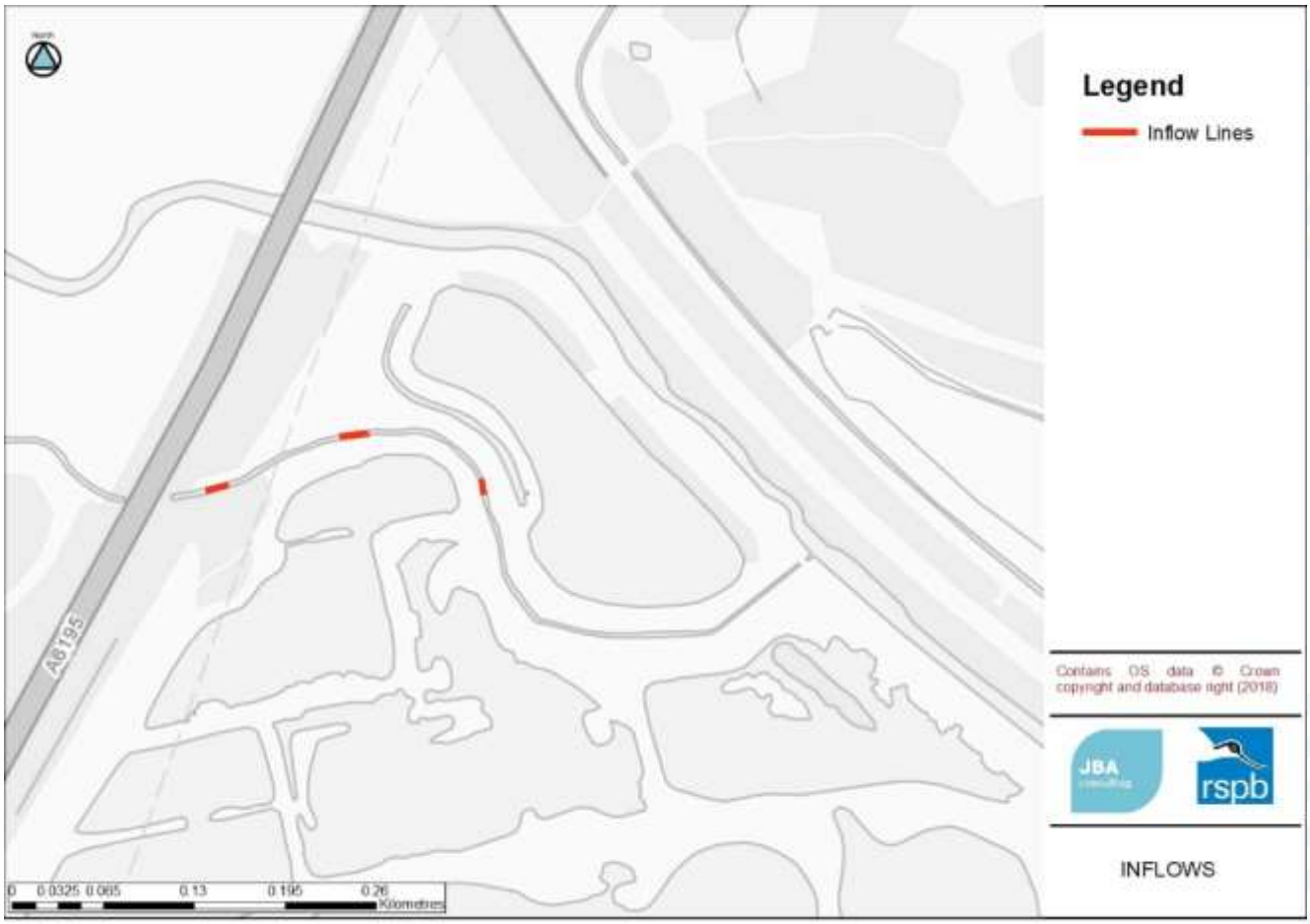
Figure 4-11: Location Plan and watercourse



4.2 Onset of flooding

The onset and mechanism of flooding remains the same as no changes to the perimeter flood embankments or controlling structures are envisaged. Inflow locations from the ISIS river model are in accordance with Figure 4-2.

Figure 4-12: ISIS model inflow locations



4.3 Proposed landscaping and habitat creation works

The RSPB reserve is located in Flood Zone 3. Landscaping proposals have been developed to enhance habitat potential, improve interconnectivity between ponds and to improve visitor experience at the reserve. Landscaping proposals comprise limited changes to the layout of the internal ponds and dividing land.

These measures are considered to be 'water compatible' due to the nature and use of the site. The proposed landscaping works are in accordance with Figure 4-3. Areas of cut and fill are more clearly defined on schematic Figure 4-4.

Figure 4-13: Proposed habitat and landscaping works

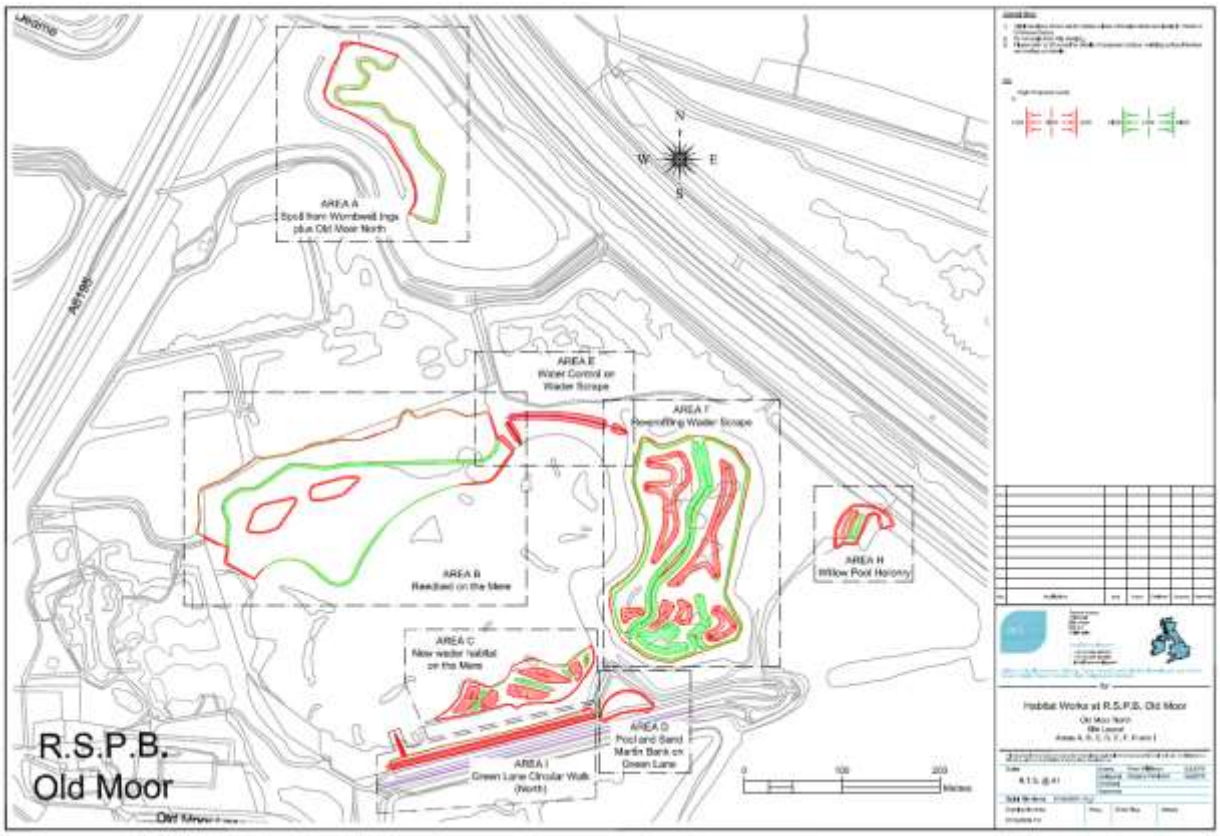
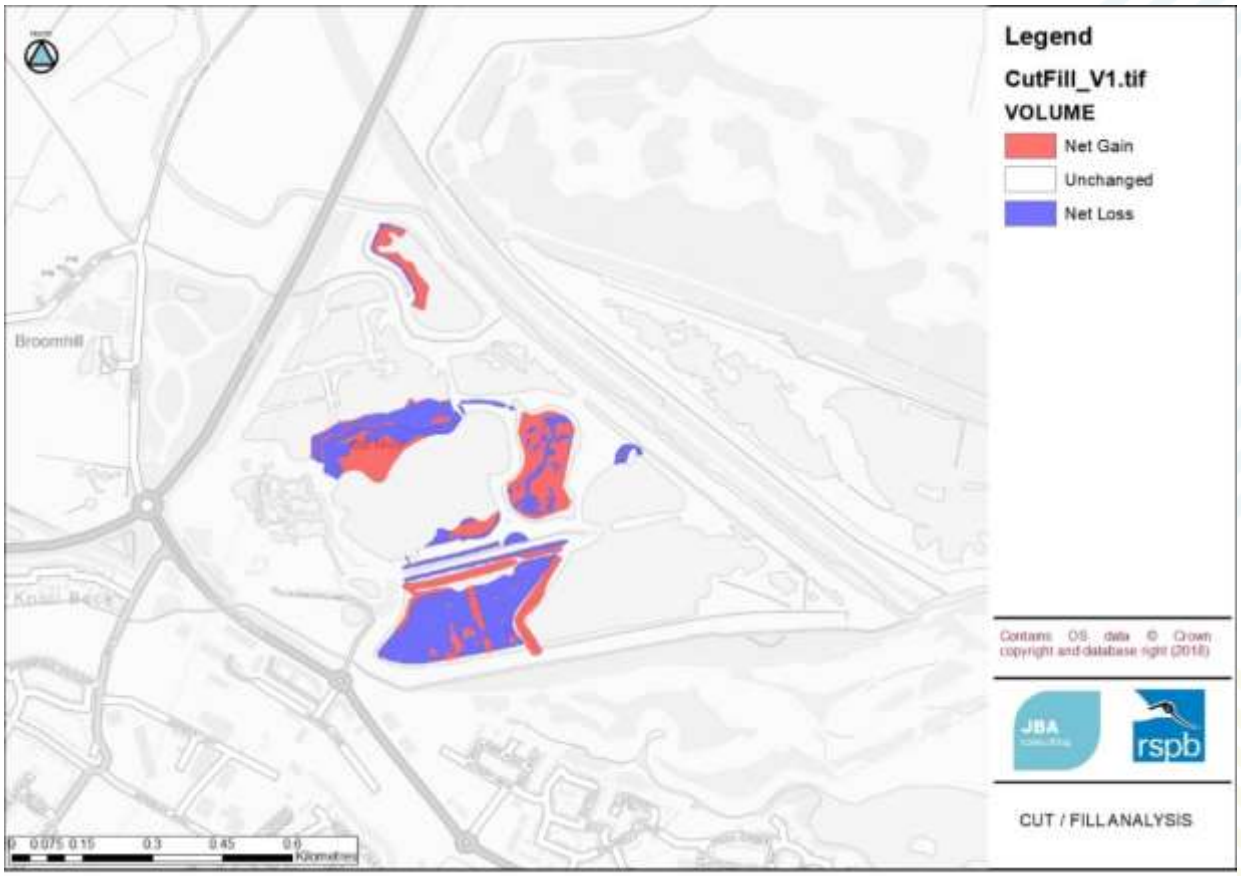


Figure 4-14: Proposed habitat and landscaping works - areas of cut and fill



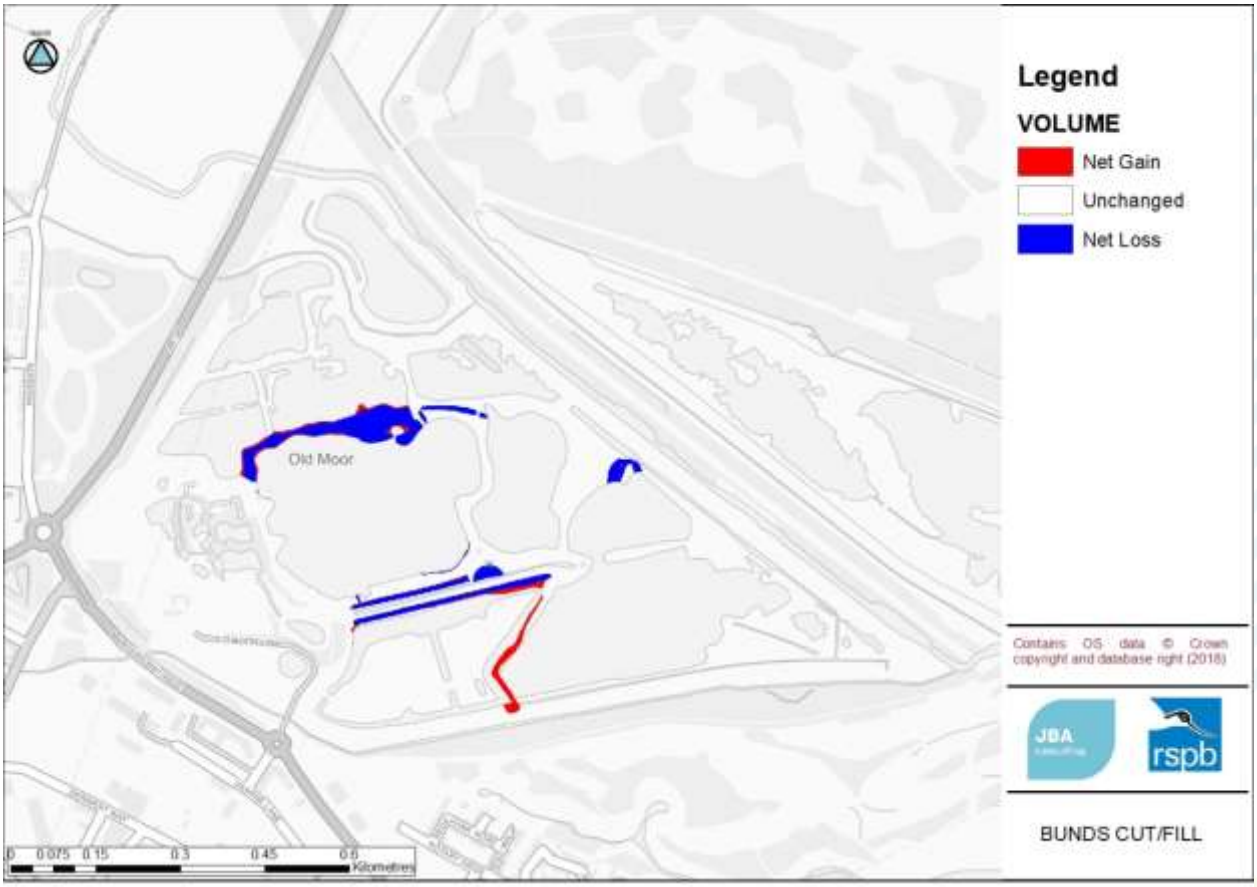
The volume of cut and fill within the reserve is balanced (providing a slight betterment in terms of available flood storage within the reserve). Flood levels are more sensitive to the resulting landscaping and improvements in connectivity between the various ponds and basins across the reserve. These measures enable design flood events to flow more freely between flood basins. Ultimately, landscaping proposals result in a design 1% AEP flood level that is actually lower than the baseline, based on flood levels within the south east basin.

The primary difference in landscaping will be removal, or lowering, of inter-dividing bunds that form the discrete edging to water features and ponds. Flood water will tend to flow more easily between the various water features during design flood events.

Whilst 1800m3 will be imported from Wombwell Ing. The majority of this will be used to reprofile bed levels beneath existing water levels. Approximately 600m3 will be used to form reed bed margins. Adaptation and lowering of existing bunds, with associated reuse of material beneath water level within the existing features. Figure 4-4A indicates the Net Loss of material (above water levels) with the reserve. This represents areas of increased flood storage of 2400m3.

The variation in imported volume is also considered negligible when compared to the operation water levels across the reservoir. Water levels within each basin vary depending on how they are controlled by the RSPB with operational water levels varying by between 0.5m and 1m.

Figure 4-4A: Proposed habitat and landscaping works (Net Cut and Fill above water level)



4.4 Available river modelling

JBA Consulting have supplied with the River Dove hydraulic model dating from 2008/9.

The model comprises representation of the River Dove (3,800m of modelled watercourse), Bulling Dike (3,500m of modelled course) and includes the lower reaches of the River Dearne.

The River Dove flows between the towns of Wombwell and Darfield before merging with the River Dearne. The Dearne continues to flow in a southerly direction adjacent to the Wombwell Ings washland and Old Moor Nature Reserve which is located on the right bank.

Bulling Dike generally flows parallel to the Dove until it enters the nature reserve (Figure 4-1). It then flows through the washland before discharging into the River Dearne.

Available modelling is a one dimensional ISIS model with cross-sections surveyed in early 2009. This includes interpolated sections from previous HEC-RAS modelling. No new survey or model update has been undertaken as part of this appraisal.

Flood risk in this instance is based on a comparison of pre and post landscaping scenarios.

There is only limited two dimensional representation of the nature reserve in the form of 10 separate flood storage areas alongside the watercourses. These have been modelled using reservoir units with areas and elevation derived from LiDAR (dating from 2009). The Old Moor Nature Reserve is modelled as 2 reservoirs. These represent a volume of storage only rather than based on any detailed ground profile or representation of the ponds.

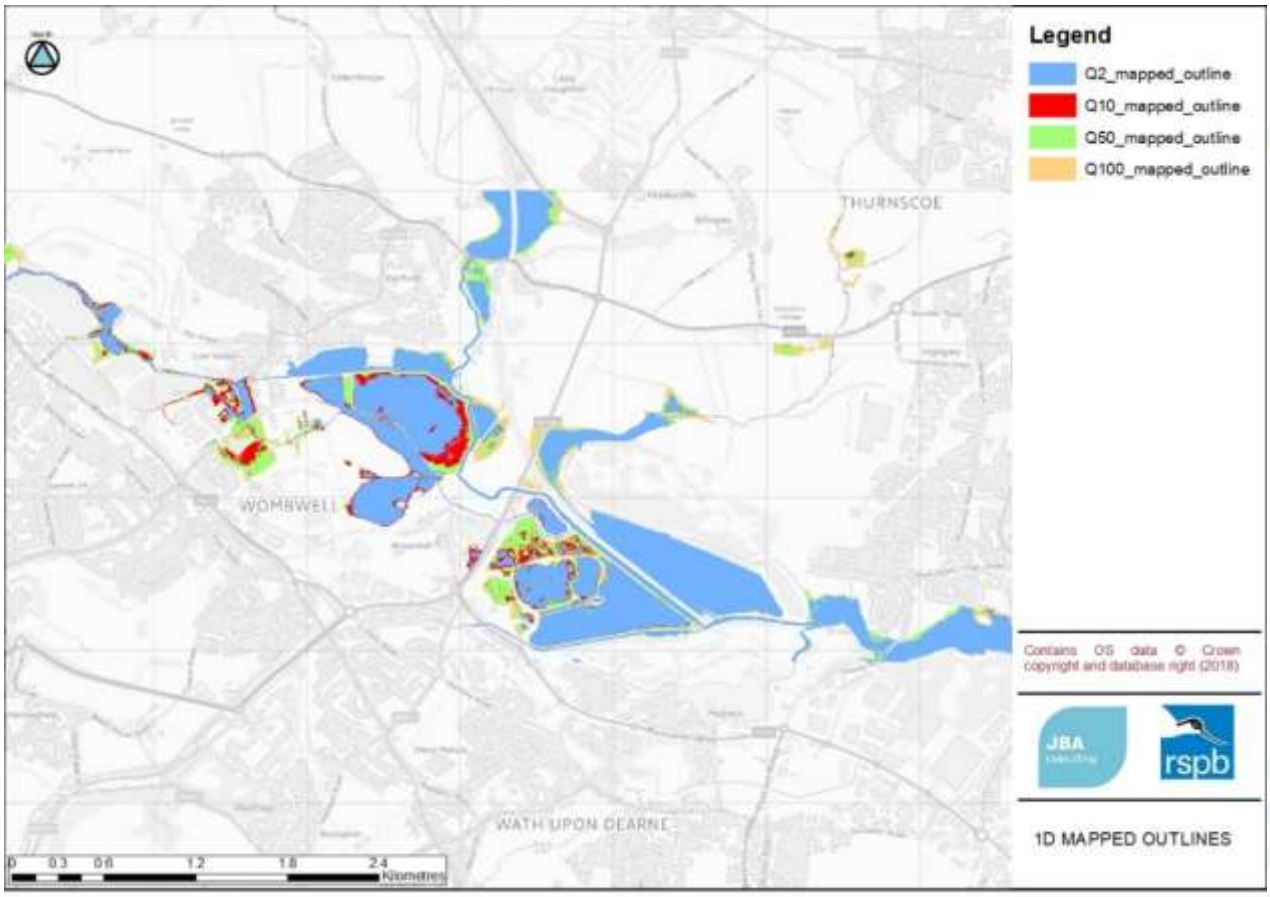
LiDAR has also been used to derive the floodplain in place of more detailed floodplain cross section survey which was deemed too expensive for the original modelling study.

Hydrological inflows into this model consist of 7 ReFH units, of which 4 have been laterally divided to multiple rivers sections and 2 flow-time boundaries. The downstream extent of the model has been modelled with a head-time boundary using a 1% AEP event dating from November 2000.

4.5 Flood Outlines

The available one dimensional model has been used to develop flood outlines across the Old Moor Nature Reserve for a range of flood events. Flood extents are based on extrapolation of river levels rather than based on any fully integrated modelling of floodplain flows. Flood outlines are therefore generated based a continuous water surface from interpolated levels across the LIDAR, ground surface was then subtracted from the water surface to produce a grid of water depth.

Figure 4-15: Flood outlines based on 1D modelled flood levels



4.6 Flood interactions and JFlow flood mapping

In order to develop a clearer understanding of flow interactions, a new JFlow model has been developed with the aim of reducing uncertainty. Again, inflow hydrographs remain unchanged. This improved mapping is based on more accurately defined profiles. LiDAR mapping was used to provide a greater level of detail than previously modelled.

JFlow modelling has been used as this is a habitat creation scheme with no built development. The available ISIS model is of limited use only as one dimensional modelling the flood outlines, for pre and post landscaping, effectively remain unchanged.

4.6.1 JFlow Modelling

JFlow flood maps have been developed for both the existing baseline and proposed landscaped scenarios.

The results from the JFlow modelling are presented as a series of flood maps for the following scenarios:

- 1% AEP event (Baseline scenario Figure 4-6)
- 1% AEP event (Post landscaping Figure 4-7)

4.6.2 JFlow Surface Water Mapping 1% AEP scenarios.

The following mapping is based on depths of flooding above normal water level and assumes free discharge. Assessment of flood risk is, therefore, based on a comparative study rather than detailed ISIS modelling.

The nature reserve acts as a significant flood alleviation basin during the 1% AEP event with overtopping during a range of lesser events too.

Comparison of Figures 4-6 and 4-7 indicates that excavation within the southernmost pond reduces flood depths slightly by 0.08m within the adjacent pond to the south east. This southern eastern pond corresponds to the outfall locations back into the River Dearne. The depth of flood storage with the southernmost pond is increased by approximately 1m owing to substantial excavation in this area down to water level.

The depth of flooding in the northern basins general reduces by 0.4m during the design event. With design levels in the central ponds tending to remain at the same design level.

The corresponding water level for each basin (corresponding to both the baseline and landscaped scenarios) are provided as Figures 4-6 and 4-7.

Modelling constraints mean that a qualitative review only can be undertake.

- Design inflow into the reserve has not increased as a result of the landscaping proposals.
- The frequency of inundation remains the same as flood embankment levels remain unchanged.
- The available volume of flood storage within the nature reserve remains the same (2400m3 of potential new flood storage) as the net cut and fill is balanced.
- Despite improved connectivity between ponds, variations in design water level/depths for both the baseline and landscaped scenarios are fairly limited.
- The nominally shallower depth of water (following landscaping) at the outfalls within the south eastern pond represents a slight reduction in peak discharge through flapped outfalls back into the Dearne. The driving head with the nature reservoir is reduced by 0.08m.

Figure 4-16: Comparative mapping baseline 1% AEP event flood extent (Note depths above normal water levels)

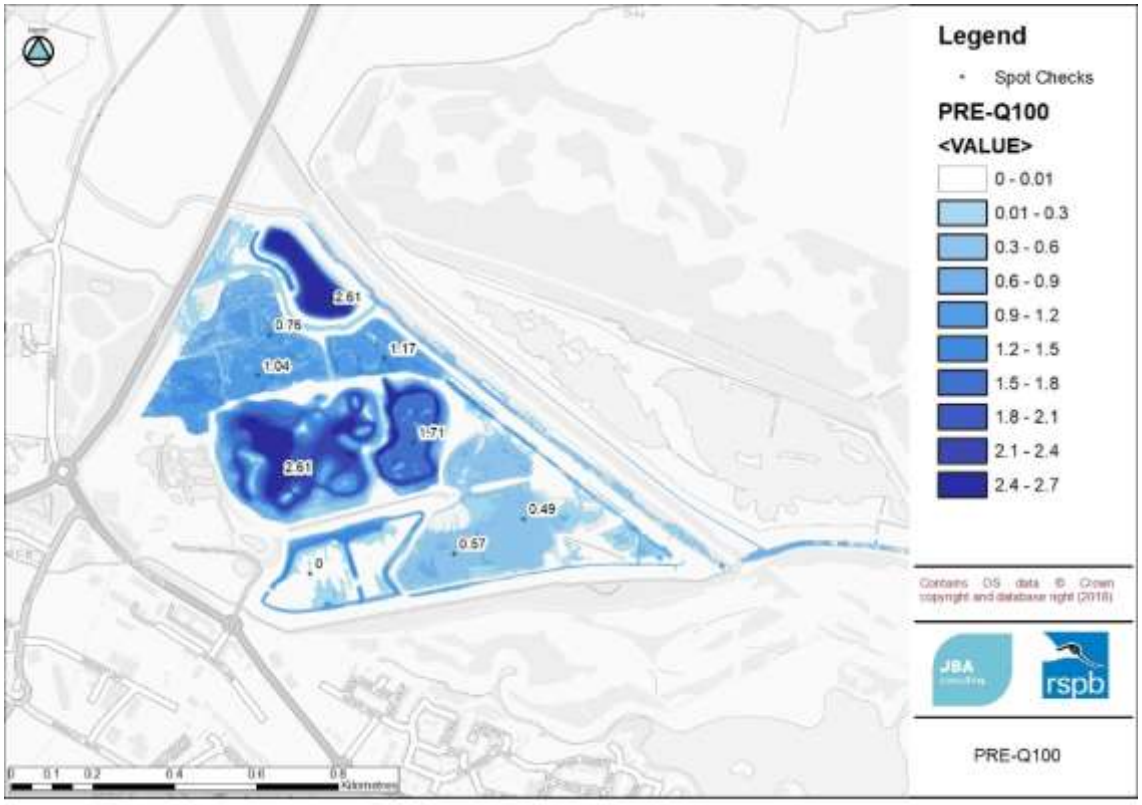
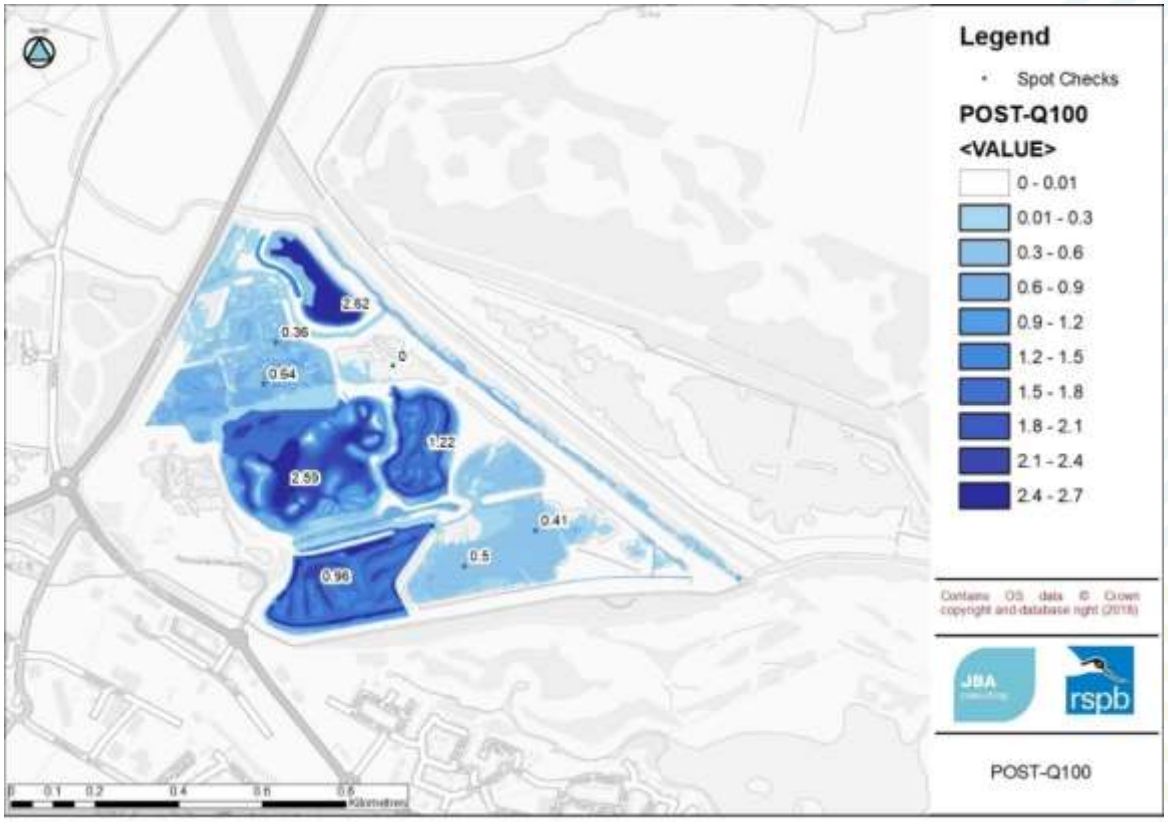


Figure 4-17: Comparative mapping for landscaped 1% AEP event flood extent (Note depths above normal water levels)



5 Conclusions and Discussion

5.1 Wombwell Ings

The site is within Flood Zone 3 but the wetland improvement scheme is defined as a water-compatible use under the NPPF. The scheme was required under NPPF to meet the following tests:

- remain operational and safe for users in times of flood,
- result in no net loss of flood storage,
- not impede water flows; and
- not increase flood risk elsewhere

And not affect the functioning of the control washland. This was achieved through the following features of the design:

- The structures require no active management during high flow events ensuring that site personnel remain safe.
- The intake structure will automatically close when the wet ditch is full, so it will not allow flood waters into the site ensuring the functioning of the control washlands will not be affected
- Excavating the wet ditch will increase floodplain storage
- The disposal method for excavated material will not decrease floodplain storage
- The design will not affect the functioning of the controlled washlands, therefore the design cannot increase flood risk elsewhere.

5.2 Old Moor Nature Reserve

The reserve currently acts as a flood attenuation basin. It should be noted that the frequency and mechanism of flooding from the rivers remains unaffected by the proposed works. Flood embankment levels are not altered as part of the landscaping works and all overflow levels remain unchanged.

Landscaping works primarily involve reprofiling the various ponds within the reserve to improve habitat potential and interconnectivity.

The available one dimensional model has been used to develop flood outlines across the Old Moor Nature Reserve for a range of flood events. Flood extents are based on extrapolation of river levels rather than based on any fully integrated modelling of floodplain flows.

In order to develop a clearer understanding of flow interactions, a new JFlow model has been developed with the aim of reducing uncertainty. Again, inflow hydrographs and outflows remain unchanged. This improved mapping is based on more accurately defined profiles. LiDAR mapping was used to provide a greater level of detail than previously modelled.

Comparative JFlow flood maps have been developed for both the existing baseline and proposed landscaped scenarios. The results from the JFlow modelling are presented as a series of flood maps.

The site is within Flood Zone 3 but the wetland improvement scheme is defined as a water-compatible use under the NPPF.

The nature reserve acts as a significant flood alleviation basin during the 1% AEP event. The corresponding water level for each basin (corresponding to both the baseline and landscaped scenarios) are provided as Figures 4-6 and 4-7.

Modelling constraints mean that a qualitative review only can be undertaken.

- Design inflow into the reserve has not increased as a result of the landscaping proposals. Proposals will not impede the flow of flood water.
- The frequency of inundation remains the same as flood embankment levels and outfall configurations remain unchanged.

- The primary difference in landscaping will be removal, or lowering, of inter-dividing bunds that form the discrete edging to water features and ponds. Flood water will tend to flow more easily between the various water features during design flood events.
- Whilst 1800m3 will be imported from Wombwell Ing. The majority of this will be used to reprofile bed levels beneath existing water levels. Approximately 600m3 will be used to form reed bed margins. Adaptation and lowering of existing bunds, with associated reuse of material beneath water level within the existing features. Figure 4-4A indicates the Net Loss of material (above water levels) with the reserve. This represents areas of increased flood storage of 2400m3.
- Despite improved connectivity between ponds, variations in design water level/depths for both the baseline and landscaped scenarios are fairly limited.
- The nominally shallower depth of water (following landscaping) at the outfalls within the south eastern pond represents a slight reduction in peak discharge through flapped outfalls back into the Dearne. The driving head with the nature reservoir is reduced by 0.08m. On this basis there is no increase in flood risk elsewhere.
- Landscaping measures will not alter the operational function of the flood storage basin and does not pose an increase risk to visitors (the site will be closed during significant flood events.
- It is envisaged that water levels within ponds will be drawn down in sequence during 'construction' in order to enable excavation and landscaping to be completed as far as reasonably practical in the dry.

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