A46 Newark Bypass

TR010065/7.41

7.41 Floodplain Compensation Areas Technical Note

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 6

November 2024

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

A46 Newark Bypass

Development Consent Order 202[x]

7.41 FLOODPLAIN COMPENSATION AREAS TECHNICAL NOTE

Regulation Number:	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010065
Application Document Reference	TR010065/7.41
Author:	A46 Newark Bypass Project Team, National Highways

Version	Date	Status of Version
Rev 1	November 2024	Deadline 3 Submission

Contents

Figures

Tables

1 Introduction

1.1.1 The A46 Newark Bypass Scheme entails the development of a stretch of the A46 that spans between Farndon Junction and Winthorpe Junction. The Scheme aims to upgrade an existing single carriageway road in Newark-on-Trent to a dual carriageway.

1.1.2 The improvement Scheme requires the construction of a new carriageway that will run alongside the existing carriageway. These associated works will require new junctions and features such as utilities, drainage, public rights of way and accesses, which will include significant environmental mitigation work.

1.1.3 The project is currently undergoing Development Consent Order Examination. As a part of this, the Environment Agency, through a Relevant Representation, has requested additional information on the Floodplain Compensation Areas (FCAs).

1.1.4 The document provides additional information on the following points in the Environment Agency's Relevant Representation (EAFR-004):

- Details of the exact volumes of floodplain lost due to the development.
- Details of how the volume lost is mitigated in the flood risk mitigation design.

1.1.5 This Technical Note is intended to be read in conjunction with Appendix 13.2 (Flood Risk Assessment) of the Environmental Statement [APP-177] (hereafter referenced as the Scheme FRA) which provides justification for the location of the FCAs, hydraulic modelling to demonstrate effectiveness of the FCAs and descriptions of the infrastructure required to facilitate them.

2 FCA assessment

2.1 Assessment of floodplain loss

2.1.1 The FCA calculations have been carried out in accordance with CIRIA guidance document C624[1]. Following selection of the preferred route corridor and as part of the Scheme design process, the requirement for floodplain compensation was reduced where possible, for example by implementing steeper embankment slopes that reduced the Scheme's encroachment on the floodplain.

2.1.2 The floodplain volume loss (in 0.2m bands) detailed in the rest of this report is calculated from the Scheme design following completion of the preliminary Scheme design process. The design volume was calculated using a 3D CAD model of the Scheme. This model combined the highways model with conservative preliminary 3D representations of other elements not captured in that model. This created a 3D model for use in flood risk mitigation design. The additional elements captured outside of the initial 3D CAD model of the highway consist of raised drainage elements, additional earthworks and permanent access tracks.

2.1.3 Due to variation in peak fluvial flood levels along the length of the Scheme, the Scheme is split into three areas (see Figure 1) for the purposes of floodplain compensation design, with volumetric analysis undertaken for each section using the different design peak fluvial flood levels. These three areas are defined by the Railway Nottingham to Lincoln Line, the East Coast Main Line and A1 embankments, which cross the floodplain and result in the backing up of flood water. The peak fluvial flood levels were taken from early Scheme assessment and were set as 12.95mAOD, 12.20mAOD and 11.20mAOD for the green, red and purple shaded areas, respectively. These levels are still considered appropriate for demonstrating varying peak flood levels along the length of the Scheme.

2.1.4 For each 0.2m increment level between 8.6mAOD to 13mAOD, the volume lost in the floodplain (as taken by the Scheme design) was calculated from the 3D CAD model. This could also be described as the floodplain storage capacity lost in the floodplain. The cumulative volume loss for all aspects is presented in Figure *2*.

2.1.5 Of particular interest is the volume of floodplain lost between 8.6-10.2mAOD due to this being below the typical water level of the River Trent, and therefore challenging to mitigate due to the need to drain any FCA into the River Trent. Analysis of the existing ground indicates that these lower elevations are valid, as the existing ground is drained

[1] CIRIA, C624 - Development and flood risk, London 2004

by Internal Drainage Board (IDB) governed dykes that outfall into the River Trent several kilometres downstream.

2.1.6 In addition to the below volumes in Figure *2*, temporary works volumes add an increase at each level band. These increases are shown in **Figure 7**.

Figure 1 - Road section split (maximum flood levels shown). Source: Open Street Maps

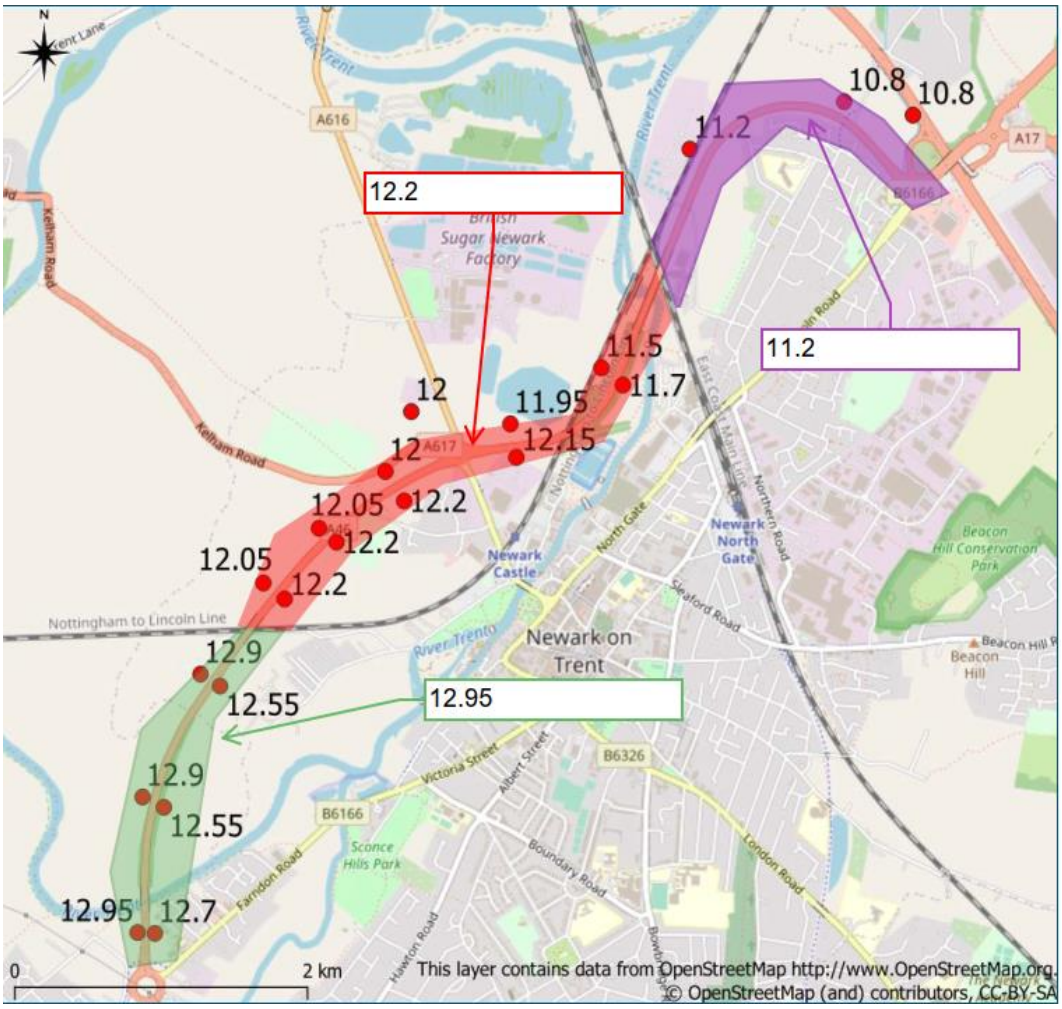
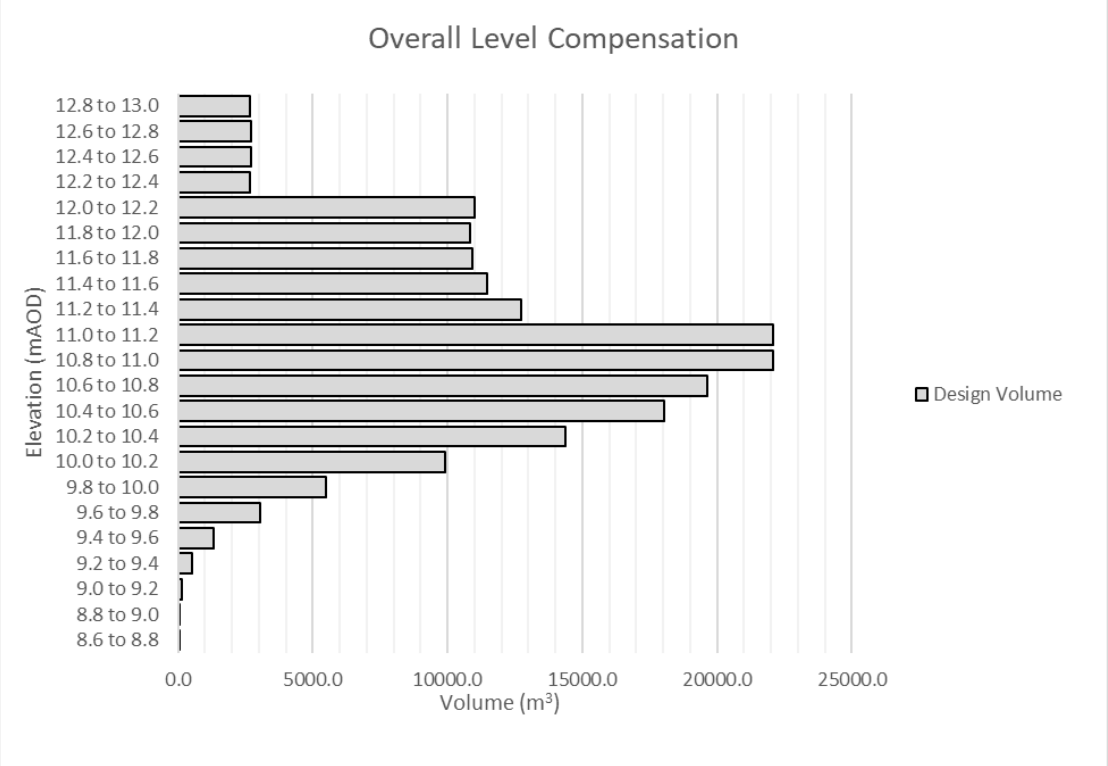


Figure 2 - Volume of floodplain loss



2.2 FCA Sites proposed in Development Consent Order

2.2.1 The rest of this Technical Note looks at the FCAs taken forward to DCO Examination and how they provide flood risk mitigation.

2.2.2 Figure 7 sets out the potential elevation ranges available at the three sites taken forwards. All but one (Kelham & Averham) of the FCAs are located within the existing floodplain, due to their proximity to the Scheme. Close proximity is considered best practice for FCA design, as the floodplain lost and floodplain compensation can be hydraulically linked in a consistent way with the source of fluvial flooding. This also provides the additional carbon saving of providing winnable material for construction of the Scheme embankments adjacent to the Scheme itself, reducing construction traffic and the associated carbon cost.

2.2.3 Between 8.6-9.6mAOD, the floodplain compensation requirement (total inc. temporary case 5500m^3, permanent case 2200m^3) is expected to be met by a combination of aspects of the Scheme design, outlined as follows:

- Landscape grading and the drainage cut-off ditches needed for the proposed access tracks in the Farndon area, which will largely replace the existing drainage cut-off ditches of the Newark bypass. This can only be confirmed at Detailed Design.
- Indirect compensation at Farndon East FCA, demonstrated in Figure 7 in light yellow. Floodplain compensation will only be available at these

elevations when groundwater levels allow, in a similar way to the lowest elevations of the floodplain in the baseline scenario which are subject to flooding from groundwater emergence.

Table 1 - Tabulated Existing Ground Elevation Data (mAOD)*

Site	NGR	Max Ground Elevation	Min Ground Elevation	Average Ground Elevation
Farndon West FCA	SK 77885 53388	11.27	9.39	11.22
Farndon East FCA	SK 78373 53270	11.32	9.91	10.75
Kelham and Averham FCA	SK 76350 55280	15.56	10.18	12.82

* The tabulated max levels shown in Table 1 are absolute maximums. Based on the negligible volumes available close to the max levels, the rest of the document refers to level bands where it is considered reasonable for floodplain compensation to be provided at the referenced site.

Farndon sites

2.2.4 Levels at both sites vary between approximately 10.0 and 11.6mAOD, with the Farndon West site providing greater volumes at the upper end of this range. By maintaining the existing bank of the River Trent, the Farndon sites are capable of providing floodplain compensation below the mean water level of the River Trent. The indicative areas of the FCAs are shown in Figure *3*.

2.2.5 GIS polygons of the two Farndon FCA sites to serve as floodplain compensation were assessed. The volumetric capacity of these sites in 0.2m increments is detailed in Table 2 at the end of this technical note. Whilst the Farndon sites can cater for a large portion of the floodplain compensation required, the volume necessary between 11.5-13.0mAOD would need to be provided elsewhere.

Farndon West FCA

2.2.6 For Farndon West FCA, the minimum elevation of the northernmost portion near the tie-in to the Old Trent Dyke is 10.5mAOD which is the existing ground level; the excavation levels for other areas range between 10.5-11.6mAOD. There will be an average change in elevation for FCA purposes of approximately 0.5m comparing with existing ground levels. The mechanism for flooding of the site is by overtopping of the River Trent bank adjacent to the FCA, which is unchanged from the existing flood mechanism.

2.2.7 The connection to the Old Trent Dyke for flood water conveyance following a flood will be enabled through flooding through a channel to

the left bank of the watercourse, which will also enable fish passage as discussed in the Farndon FCA Fish Escape Design Technical Note (Appendix G of APP-185). This approach was chosen to ensure that the proposed area can make maximum use of the land and mimic existing flood flow paths, whilst also not generating a fluvial bypass of the existing River Trent channel.

2.2.8 Currently, a 1:1000 gradient is proposed from south to north through the site, however detailed design of the wetland and floodplain grazing marsh that sit within the footprint of the FCA will likely result in a more effective conveyance mechanism.

Farndon East FCA

2.2.9 Farndon East FCA is to provide indirect compensation to floodplain lost between 8.6-9.6mAOD, when low groundwater levels make this appropriate. Direct compensation is provided at the site between 9.6-11.0mAOD. The mechanism for flooding of the site is by overtopping of the River Trent bank adjacent to the FCA, which is unchanged from the existing flood mechanism.

2.2.10 A connection to the Old Trent Dyke to enable flood water conveyance following a flood will be enabled through a shallow passage to the left bank of the watercourse, which will also enable fish passage as discussed in the Farndon FCA Fish Escape Design Technical Note (Appendix G of APP-185). This approach was chosen to ensure that the proposed area can make maximum use of the land and mimic existing flood flow paths, whilst also not generating a new flood flow path from the River Trent through breaking the high left bank of the river.

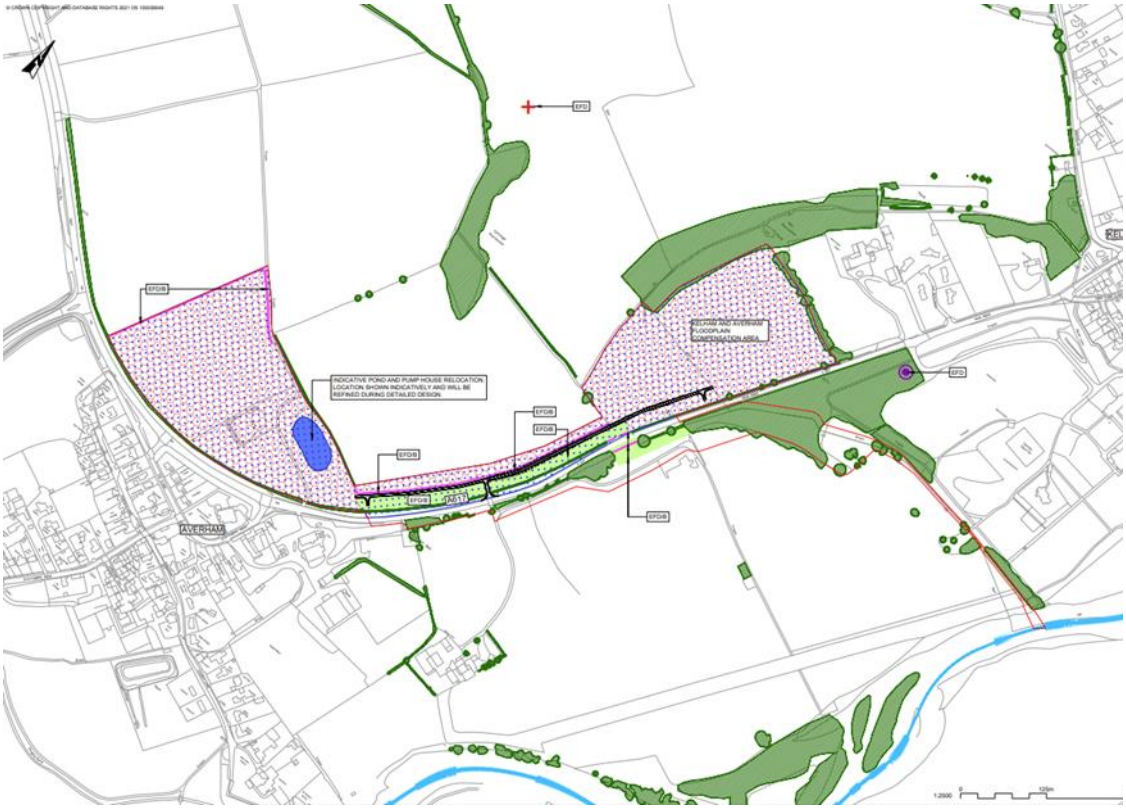
2.2.11 Due to the dual use of the site as a borrow pit, this FCA site will be a permanent groundwater fed lake, that will have a maximum crest level of 9.6mAOD.

Figure 3 - Farndon West and Farndon East FCA's. Source: Environmental Masterplan [AS-026]

Kelham and Averham FCA site

2.2.12 This site provides level-for-level floodplain compensation at the higher elevations required, in an area outside of the existing floodplain. The A617 road is the edge of the existing floodplain and the flooding mechanism proposed for the Kelham & Averham FCA is for the field ditch running along the south side the A617 to be connected to the FCA site via a series of culverts beneath the road.

Figure 4 - Kelham & Averham FCA. Source: Environmental Masterplan [AS-026]



2.2.13 Figure 7 and Table 2 at the end of this technical note demonstrate that the proposed FCA can meet the requirements of the upper elevation volume-for-volume and level-for-level compensation.

2.2.14 The site is intended to achieve floodplain compensation for volume lost in level bands between 11.4-13.0mAOD, predominately serving the highlighted green and red sections of the embankment shown in Figure 1. As flood levels do not reach above 12.4mAOD at the site for events up to the design event, elevation bands between 12.4-13.0mAOD are to be compensated indirectly at elevations between 11.6-12.4mAOD.

3 Hydraulic modelling

3.1 Overall context

3.1.1 The Scheme is not able to provide direct floodplain compensation for all elevations at all areas of the Scheme (see Figure 1). This is due to two main factors. Firstly, the floodplain is split into three areas (as shown in Figure 1) which have limited hydraulic connectivity between them due to flood water backing up behind the Railway Nottingham to Lincoln Line, the East Coast Main Line and A1 embankments. Secondly, there is a lack of suitable land in each section area to achieve flood volume mitigation at all elevations.

3.1.2 Hydraulic modelling of the Scheme was undertaken that included the FCAs to demonstrate their effectiveness. This hydraulic modelling is described in detail in the Hydraulic Modelling Technical report (Appendix A of the Scheme FRA [APP-177]). The design of the FCAs was incorporated into the hydraulic model to assess the connectivity of the FCAs with the floodplain, as well as to assess the impact of the FCAs in mitigating the peak water level and volume increase due to the Scheme. The outcomes of this assessment are discussed in the Scheme FRA, demonstrating that the FCAs have suitable connectivity to the floodplain.

3.1.3 Further to the Hydraulic Modelling Technical report, an additional Technical Note has been issued on Hydraulic Modelling [7.40] alongside this Note, that provides further detail on modelling tolerances and other sensitivity tests.

3.2 FCA sensitivity test

3.2.1 Prior to DCO examination (but post-DCO submission), the Environment Agency requested[2] that a targeted FCA sensitivity test be undertaken to establish if increasing the size of the FCAs resulted in substantial benefit to receptors. This could potentially address Environment Agency comments regarding the impacts to receptors in general, which are addressed in the accompanying Hydraulic Modelling Technical Note. Farndon West FCA was chosen for the sensitivity test as Farndon East FCA fills the suitable land it is constrained by, and Kelham & Averham FCA is intended to mitigate elevation bands that are higher than the elevations of many of the receptors in the floodplain.

3.2.2 Figure 5 and Figure 6 show the results of a sensitivity test that specifically looks at increasing the size of Farndon West FCA by 20%,

[2] Meeting held between the Applicant and Environment Agency 05/09/2024

to establish whether an appreciable benefit to flood risk could be achieved with a reasonably sized increase to the FCA volumes reported in Table 2. The addition to Farndon West FCA was implemented in the hydraulic model with the same approach as the rest of the FCA, extending to the north of the site outlined in the Scheme FRA. The figures show the difference between the Scheme FRA model outputs and the sensitivity model with increased FCA size. It should be noted that no decreases in flood depth were reported greater than 5mm in this modelling sensitivity test.

3.2.3 In Figure 5 for the 50% AEP event, areas of reduction are largely shown in agricultural land, which in both the sensitivity test and Scheme FRA modelling results are flooded to large depths, in the range of 1.5 to 2m. Therefore, a reduction of maximum 5mm is not considered to be an appreciable benefit, when considering the vulnerability of the receptors. It is acknowledged that a single low vulnerability receptor would experience a 5mm reduction in flood depth if the FCA is increased in size. However, this benefit is not considered proportionate to the increase in works required to achieve this when the receptor would still be flooded to a large depth in this case, as in the baseline scenario. Note that outside the area of floodplain shown, impacts are within the expected range for the modelling tolerance.

3.2.4 In Figure 6, areas where benefit is shown in the 1% AEP plus climate change event are already substantially benefitted in the Scheme FRA suite of results. Therefore, increasing the size of the FCA is not considered to have a appreciable benefit to the applicable agricultural receptors, as the decrease in depths is only expected to be an additional 0.002m at the receptors. Note that outside the area of floodplain shown, impacts are within the expected range for the modelling tolerance.

3.2.5 The sensitivity test therefore demonstrates that increasing the size of Farndon West FCA would not assist in materially reducing flood risk to receptors in the floodplain.

Figure 5 - 50% AEP sensitivity test depth difference map

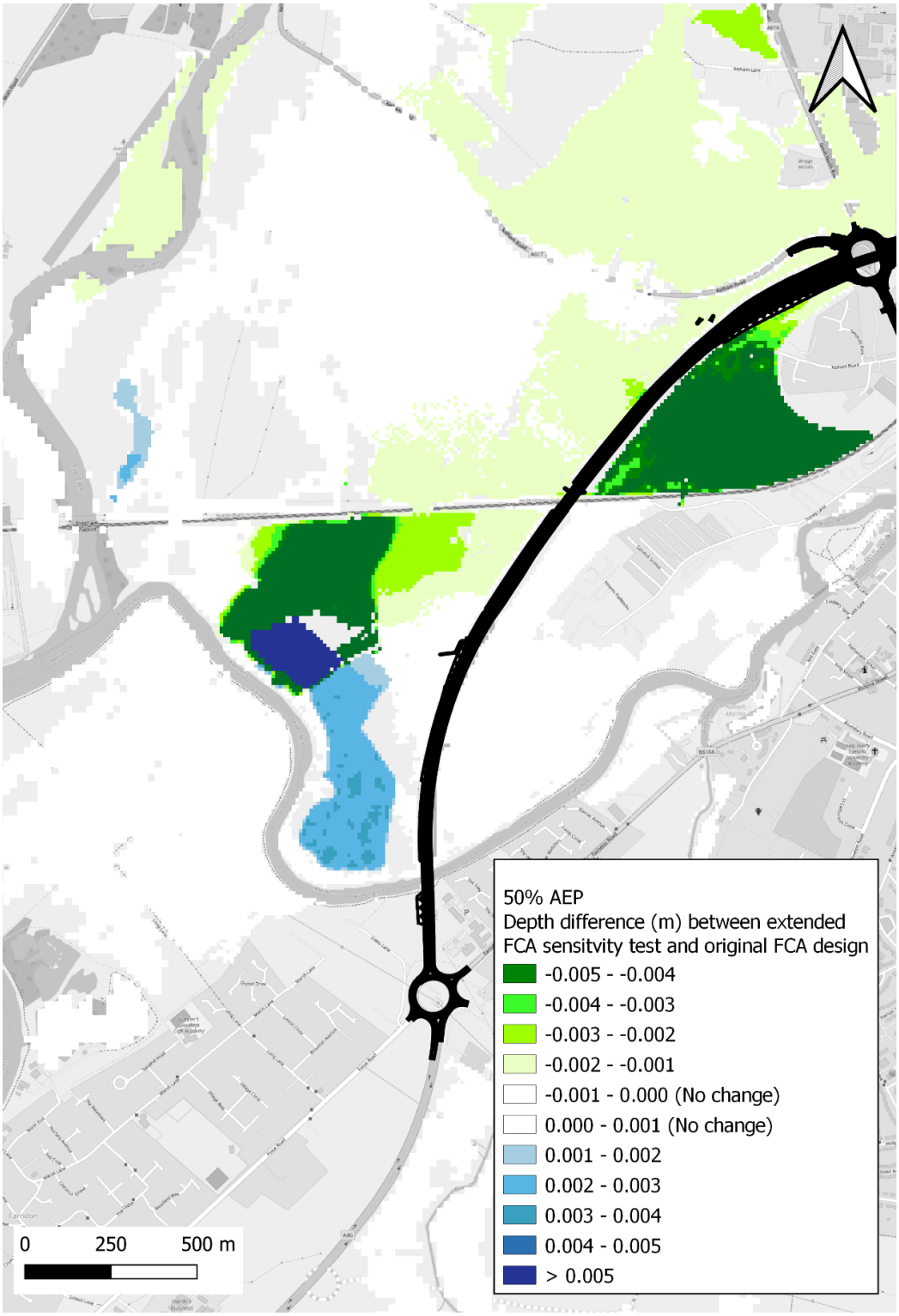
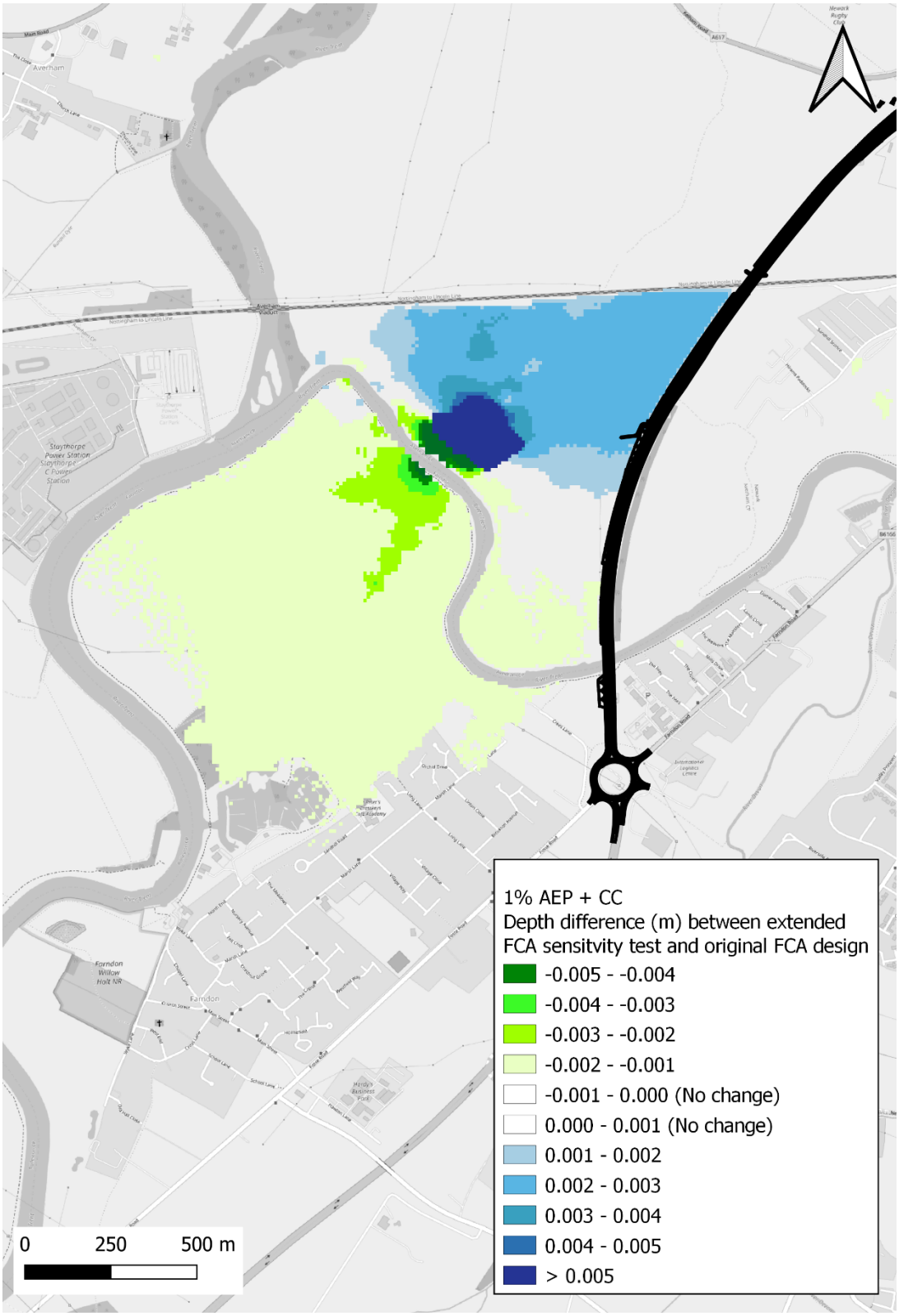


Figure 6 - 1% AEP+CC sensitivity test depth difference map



4 Conclusion

4.1.1 Figure 7 below details the floodplain volume lost and the associated compensatory excavation volumes available at the Farndon FCA sites (shown in Figure 3) and Kelham & Averham FCA (shown in Figure 4) site at 0.2m increments. The addition of temporary works volumes as shown does not exceed FCA capacity where direct compensation can be provided. Floodplain compensation at lower elevations (8.6-9.6m AOD) is to be achieved through the replacement access track cutoff ditches, landscaping and the groundwater fed lake in Farndon East FCA as volumes are relatively minor.

4.1.2 This Technical Note demonstrates the viability of the Farndon East, Farndon West and Kelham & Averham FCAs for floodplain compensation in a multi-site approach, to provide the required floodplain compensation for the Scheme, in support of the FRA. The sensitivity test demonstrates that increasing the size of Farndon West FCA would not assist in appreciably reducing flood risk to receptors in the floodplain.

Figure 7. Graphical representation of Farndon and Kelham & Averham sites storage potential. Light yellow indicates additional Farndon East FCA volume

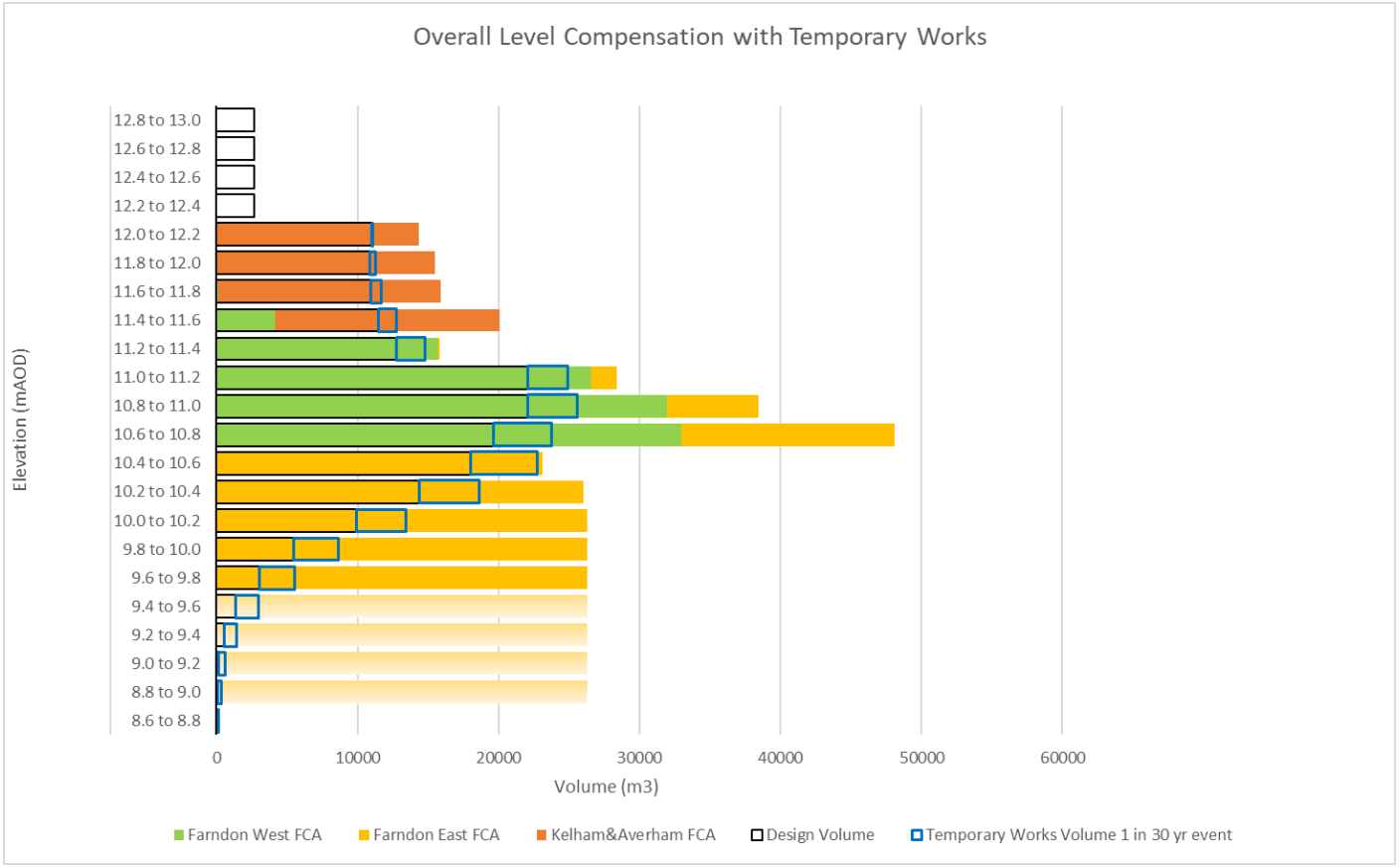


Table 2 - Floodplain Compensation Potential at FCA sites

Level (at top of layer)	Stage 3 Floodplain Loss	Farndon West FCA	Farndon East FCA	Kelham & Averham FCA
	Loss	**Gain**	**Gain**	**Gain**
mAOD	m^3	m^3	m^3	m^3
8.4-8.6	0			
8.6-8.8	59.3			
8.8-9.0	67.1	0*	**	
9.0-9.2	162.8	0*	**	
9.2-9.4	510.9	0*	**	
9.4-9.6	1338.9	0*	**	
9.6-9.8	3032.8	0*	26265	
9.8-10.0	5478.2	0*	26265	
10.0-10.2	9922.4	0*	26265	
10.2-10.4	14388.8	0*	26026	
10.4-10.6	18045.6	0*	23103	
10.6-10.8	19625.8	32955	15143	
10.8-11.0	22060.1	31933	6533	
11.0-11.2	22081.9	26593	1812	
11.2-11.4	12738.0	15718	131	
11.4-11.6	11483.9	4175	0	15,877
11.6-11.8	10931.2	93	0	15,785
11.8-12.0	10848.2	0	0	15,506
12.0-12.2	11011.0	0	0	14,351
12.2-12.4	2663.3	0	0	0
12.4-12.6	2694.2	0	0	0
12.6-12.8	2692.9	0	0	0
12.8-13.0	2659.9	0	0	0
Totals	**184,497**	**111,467**	**151,544**	**61,519**

Legend

Level band lower than the drain down watercourse invert level	
Above flood level at site location, levels compensated indirectly – see section 2.2	
FCA design levels	

*Levels not calculated due to geomorphological risks with implementation

**Compensation provided within deep lake, which may be inundated with groundwater due to seasonal variation