



Development site

Pond

Swale

New Hedgerow

Irrigation pipes

Irrigation pipes

Shallow wet area

Reed bed

Reed bed

Shrubs

Shallow wet area

Shrubs

Shrubs

Re-profiled  
Reed bed

Shrubs

Shallow wet area

Reed bed

Shrubs

Route of  
existing river

Route of  
existing river

Route of  
existing river

Hedgerow

Reed bed

ZONE DEDICATED TO CONSERVATION 1:500

PRELIMINARY

Rev	Date	Revision Description
Revision Schedule		
Catalyst Bicester Wendlebury Road, Bicester		
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CONSERVATION ZONE		
BAILEY JOHNSON HAYES Consulting Engineers		
ST ALBANS: Suite 4, Phoenix House, 63 Campbell Rd, ST ALBANS, Herts AL1 1PL MANCHESTER: Grange House, John Dalton Street, MANCHESTER, M2 6FW		
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# **APPENDIX G**

## **BAILEY JOHNSON HAYES FLOOD COMPENSATION SCHEME**

# CATALYST BICESTER

WENDLEBURY ROAD, BICESTER

## Flood Compensation Scheme

Issue 1  
30<sup>th</sup> July 2019

**B A I L E Y**

**J O H N S O N**

**H A Y E S**

**CONSULTING ENGINEERS**

SUITE 4  
PHOENIX HOUSE  
63 CAMPFIELD ROAD  
ST ALBANS  
AL1 5FL

---

Tel: 01727 841172




Fax: 01727 841085

Email: james.griffiths@bjh.co.uk

Email: wb@bjh.co.uk

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## CONTENTS PAGE

<b>DOCUMENT ISSUE RECORD</b>	<b>2</b>
<b>CONTENTS PAGE</b>	<b>2</b>
<b>1.0 INTRODUCTION</b>	<b>3</b>
Sources of Data	3
Flood Compensation Policy and Guidance	3
<b>2.0 METHODOLOGY</b>	<b>5</b>
Flood Compensation “Level for Level” Slices	5
Calculating Existing Floodplain Storage Volume	6
Calculating New Floodplain Storage Volume	6
<b>3.0 FLOOD COMPENSATION SCHEME ONE</b>	<b>7</b>
Design Philosophy	7
Floodplain Storage Volumes	7
Advantages and Disadvantages of the scheme	8
Maintenance	8
<b>4.0 CONCLUSIONS AND RECOMMENDATIONS</b>	<b>9</b>

### APPENDICES

Appendix G.1 – Existing Site Flood Storage Capacity 2D/3D – Calculations and Drawings  
Appendix G.2 – Proposed Flood Compensation Scheme – Calculations and Drawings



## 1.0 INTRODUCTION

- 1.1 The following calculations are prepared to justify the principles for design of flood compensation schemes for the above development, in line with guidance in CIRIA C624 Development and Flood Risk. The flood compensation scheme (FCS) has been produced on behalf of Albion Land Limited in respect achieving mitigation of flood risk outlined in the Flood Risk Assessment (FRA) for Catalyst Bicester. Note that it is highly beneficial to read the FRA prior to review of the FCS report.

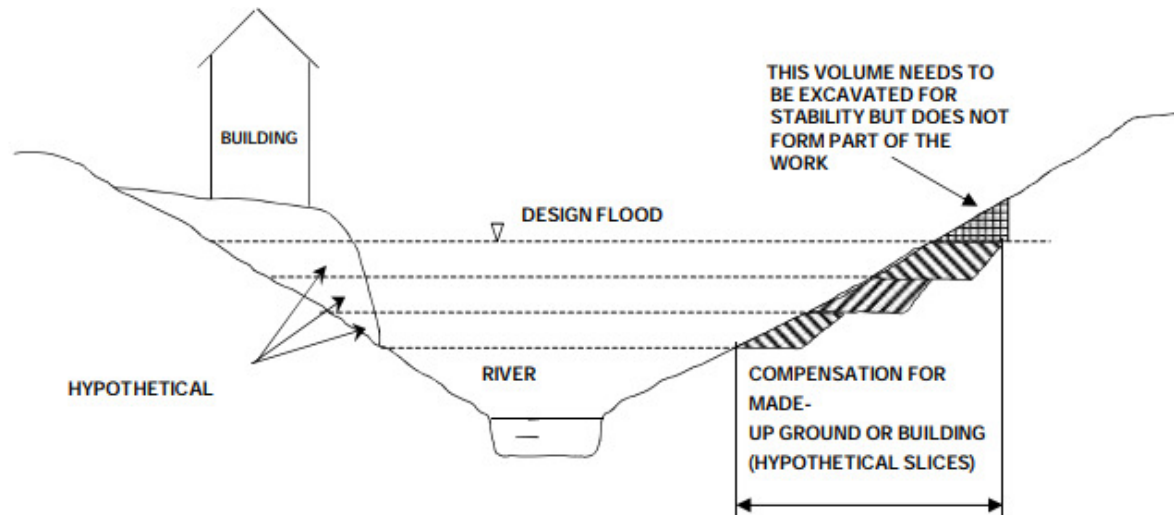
### Sources of Data

- 1.2 The report is based on the following information:
- (i) Proposed Masterplan – Cornish Architects - 18022-SK-025
  - (ii) 2D/3D Topographical Survey Data
  - (iii) Environment Agency Product 4 Flood information
  - (iv) Cherwell Level 1 & 2 Strategic Flood Risk Assessments
  - (v) CIRIA C625, Appendix A3.3.10 Compensatory flood storage

### Flood Compensation Policy and Guidance

- 1.3 The Level 1 SFRA outlines from a national planning perspective the following:
- “All new development within Flood Zone 3 must not result in a net loss of flood storage capacity. Where possible, opportunities should be sought to achieve an increase in the provision of floodplain storage.”*
- 1.4 Where ground levels are elevated to raise the development out of the floodplain, compensatory floodplain storage within areas that currently lie outside the floodplain must be provided to ensure that the total volume of the floodplain storage is not reduced.
- 1.5 Compensatory storage must become effective at the same point in a flood event as the lost storage would have done (McPherson, 2002). It should therefore provide the same volume, and be at the same level relative to the flood level, as the lost storage. This is referred to in this report as “level for level” compensation.
- 1.5 Compensatory storage may also be provided by indirect replacement of flood storage described as, replacement of lost storage at a different level to that at which it is lost, although flow into the compensatory storage area is controlled with the objective of filling the storage at the same rate during a flood event as would occur in normal conditions. Level for level is normally the recommended approach to take but indirect compensation should not be discounted. Both schemes will be assessed on their effect, advantages and disadvantages.

- 1.5 As depicted in Figure 1.1, floodplain compensation must be provided on a level for level, volume for volume basis on land which does not already flood and is within the site boundary. Where land is not within the site boundary, it should be in the immediate vicinity, in the applicant's ownership and linked to the site



**Figure 1.1 - Example of Floodplain Compensation Storage (Environment Agency, 2009)**

- 1.6 Floodplain compensation must be considered in the context of the 1% annual probability (1 in 100 year) flood level including an allowance for climate change of 35%. When designing a scheme flood water must be able to flow in and out and must not pond. An FRA must demonstrate that there is no loss of flood storage capacity and include details of an appropriate maintenance regime to ensure mitigation continues to function for the life of the development.
- 1.7 The use of under-floor voids with adequate openings beneath the raised finished levels can be considered for development in Flood Zone 2 and 3 according to Cherwell Level 1 SFRA. The use of under-floor voids will typically require a legal agreement or planning condition and maintenance plan for them to remain open for the lifetime of the development and agreement.
- 1.8 Ideally, void openings should be a minimum of 1m long and open from existing ground levels to at least the 1% annual probability (1 in 100 year) plus 35% flood level. By setting finished levels with sufficient cover above the design flood level, there is usually enough space provision for voids below. There should be a minimum of 1m of open void length per 5m length of wall.
- 1.9 Where car parks are specified as areas for the temporary storage of surface water and fluvial floodwaters, flood depths should not exceed 300mm given that vehicles may be moved by water of greater depths. Where greater depths are expected, car parks should be designed to prevent vehicles from floating out of the car park. Signs should be in place to notify drivers of the susceptibility of flooding and flood warning should provide sufficient time for vehicles to be moved.

## 2.0 METHODOLOGY

2.1 The following steps should be followed in order to carry out FCS:

1. Obtain the design flood level (1% AEP + 35%)
2. Identify level for level flood compensation slices
3. Calculate existing floodplain volumes storage at critical slices
4. Assess proposed development for volume lost at critical slices
5. Provide compensation scheme with betterment of lost volume.
6. Review scheme with the Environment Agency for approval.

### Flood Compensation “Level for Level” Slices

2.2 The starting point from the Environment Agency’s requirements is that floodplain compensation must be provided on a level for level basis up to the 1 in 100 year +35% Climate Change (1% +35% CC) flooding event. The FRA identified that this would be around 64.15m AOD.

2.3 As a result the modelled EA flood levels, based on a minimum of five slices at 200mm intervals the following slices have been outlined to define the loss of storage in the floodplain. If required by the Environment Agency slices may be reduced to 100mm but for conceptual design 200mm is acceptable. The defined slices are detailed in table 2.1.

**Table 2.1 – Proposed Flood Compensation Layers**

Slice Number	Top Level (m AOD)	Bottom Level (m AOD)
Slice 1	64.15	63.95
Slice 2	63.95	63.75
Slice 3	63.75	63.55
Slice 4	63.55	63.35
Slice 5	63.35	63.15

2.3 Additional to previous advice it is not adequate compensation to:

- Excavating holes in the floodplain
- Create landlocked areas of lower ground, even if connected to the main floodplain by channels or culverts
- Provide low level volumes to replace high level volumes and vice-versa

## Calculating Existing Floodplain Storage Volume

- 2.4 In order to design the compensatory flood storage scheme it is first necessary to calculate the existing floodplain volumes. This has been done initially by BJH using the 2D topographical survey to contour the various slices using CAD. A simplified calculation of each slices volume has then been done in the first instance. The second calculation was done with the 3D topographical survey which was modelled in Autodesk Revit to carry out accurate cut and fill calculations and verify the volumes. Both sets of calculations and drawings can be found in **Appendix G.1**. A summary of the results is found in Table 2.2.

**Table 2.2 – Comparison of Existing Flood Volume Storage Estimates**

Slice Number	Hand Calc. Volumes	Revit Volumes
Slice 1 (64.15 - 63.95)	20,979 m <sup>3</sup>	21,151 m <sup>3</sup>
Slice 2 (63.95 - 63.75)	13,946 m <sup>3</sup>	12,635 m <sup>3</sup>
Slice 3 (63.75 - 63.55)	7,000 m <sup>3</sup>	6,475 m <sup>3</sup>
Slice 4 (63.55 - 63.35)	2,054 m <sup>3</sup>	1,205 m <sup>3</sup>
Slice 5 (63.35 - 63.15)	27 m <sup>3</sup>	322 m <sup>3</sup>
<b>Total Storage Volume</b>	<b>44,000 m<sup>3</sup></b>	<b>43,446 m<sup>3</sup></b>

- 2.5 Given that the assumptions made in the preliminary 2D analysis included ignoring small ditches and indentations in the land, the volumes calculated using 3D model in Revit are generally as would be expected from a more accurate analysis. Therefore for future volume analysis the figures in the right hand column of table 2.2 should be adopted. Throughout the volume calculation phases there will be a simple and a model based calculation to increase reliability of results.

## Calculating New Floodplain Storage Volume

- 2.6 The same approach will be taken as calculating the existing floodplain volume storage above. An initial scheme will be devised in 2D AutoCAD using hand calculations and engineering judgement. It will then be re-modelled in 3D Revit to verify the volume quantities which will provide reliability of results. In general all the following calculations, models and drawings will require final approval from the EA before adoption of the chosen scheme.



## 3.0 FLOOD COMPENSATION SCHEME

### Design Philosophy

- 3.1 In the scheme an approach has been taken to work on a level for level, direct approach for slices 2 to 5. The top slice between the upper flooding levels of 64.15 – 63.95m is compensated through providing floodplain storage at lower levels to reduce the area required for compensation. The overall goal of preventing loss of floodplain storage is still achieved but not in the most desired way. This option is being presented as viable due to the extremely shallow nature of the flooding and the multiple benefits outlined later in this chapter.

### Floodplain Storage Volumes

- 3.2 The proposals for this scheme can be found in **Appendix G.2**. In summary, the scheme was devised, hand calculations were undertaken first, followed by more detailed model on Revit using the existing 3D topography. Table 3.1 shows a summary of volumes calculated with implementation of scheme 1.

**Table 3.1 – Comparison of Existing vs New Volume Storage Estimates**

Slice Number	Existing Storage Vol. (Revit Volumes)	Storage Vol. Post Compensation Work
Slice 1 (64.15 - 63.95)	21,151 m <sup>3</sup>	21,470 m <sup>3</sup>
Slice 2 (63.95 - 63.75)	12,635 m <sup>3</sup>	14,099 m <sup>3</sup>
Slice 3 (63.75 - 63.55)	6,475 m <sup>3</sup>	7,023 m <sup>3</sup>
Slice 4 (63.55 - 63.35)	1,205 m <sup>3</sup>	1,831 m <sup>3</sup>
Slice 5 (63.35 - 63.15)	322 m <sup>3</sup>	760 m <sup>3</sup>
<b>Total Storage Volume</b>	<b>43,446 m<sup>3</sup></b>	<b>45,183 m<sup>3</sup></b>

- 3.3 The proposals include; land re-grading in the wetland wildlife area to optimise volume storage without digging holes in the floodplain. Different depths of smooth plateau grading will be created up to 500mm deep; slight level tweaks both increasing and reducing within the public landscaped green zone;
- 3.4 Construction of two banks at 63.95m high near units 10 and units 13 to allow only flood water to only overtop at the top slice. Levels lowered (highlighted in yellow) to provide indirect volume storage at 63.60. This means maximum water depth will be 0.55m which is considered of low risk generally. Flow controls will be installed so that water can drain into watercourse with non-return valves after flood events.

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## Advantages/Disadvantages of the Scheme

- 3.5 The proposals completely mitigate flooding to buildings, roads and car parks through land raising up to the 1 in 100 year event. Areas of flood compensation will add ecological value with the opportunity to add planting and landscaping to enhance the appearance of the development and provide habitats for local biodiversity. In flooding events tenants will be unaffected and flooding locally will be very shallow reducing risk of damage to plants and wildlife.
- 3.6 There are potential disadvantages/risks associated with risk from failure of flood compensation to contain waters. Either from flood devices becoming blocked leading to flood water entering the surface water system or flood water egress causing excessive flows onto adjacent land. Generally these can be mitigated through detailed design of compensation elements and regular maintenance as listed below.

## Maintenance

- 3.7 As the flood compensation areas will need to allow free flowing water, the following maintenance will be required. In open watercourses the works include clearing silt and gravel deposits which build up naturally in the channel and can restrict the flow of water. Debris such as fallen trees which can lead to blockages in watercourse channels is removed.
- 3.8 Annual maintenance will be required to check outlet flow control pipes are free of blockages. Flood compensation areas to be maintained as per normal landscape maintenance schedule to trim back grass and trim back any shrubs or bushes. As flood compensation areas are only expected to hold water in long term events normal planting would be expected and therefore no additional maintenance of special species is required.

## 4.0 CONCLUSIONS AND RECOMMENDATIONS

- 4.1 The Flood Compensation Schemes (FCS's) produced are compliant with the requirements from Oxfordshire County Council as the Local Lead Flood Authority. The FCSs have been produced on behalf of Albion Land Ltd in respect of a planning application for the proposed Catalyst Bicester development on Wendlebury Road, Bicester. This report is to be read in conjunction with the FRA.
- 4.2 This report demonstrates a clear viable option for providing flood compensation to the site. In the first instance this will require approval from the Environment Agency before implementation of either scheme. The advantages and disadvantages of the scheme have been outlined. As a starting point this scheme looks to present the first iteration/concept of the final flood compensation scheme. As detailed design develops the scheme may change slightly but the philosophy outlined will stay the same.
- 4.3 It is recommended that this report be presented to the EA to get feedback on the outline proposals before construction details, management schemes and maintenance schedules are provided in the detailed design stage. In the meantime further work is recommended to evolve the masterplan to the next stage and carry out more detailed drainage and external works design.

## **APPENDIX G.1**

# **Bailey Johnson Hayes**

## **Existing Site Flood Storage Capacity**

### **2D/3D Calculations and Drawings**