

COLLEGE FARM MASTERPLAN

BEDFORD, ENGLAND, UK

WIND SPEED ASSESSMENT REPORT

RWDI #2201247

March 9, 2022

SUBMITTED TO

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TABLE OF CONTENTS

1	INTRODUCTION	1
2	CLIMATOLOGICAL ASSESSMENT	1
2.1	Assessment of Wind Data	2
2.2	Assessment of Upwind Terrain Conditions	2
2.3	Assessment of Anemometer Siting Conditions	2
3	CONCLUSIONS	3
	REFERENCES	4

LIST OF FIGURES


- Figure 2-1: Location of Cardington Meteorological Station and Nearby Airport Meteorological Stations
Figure 2-2: Comparison of average wind speeds by wind direction based on Cranfield Airport
Figure 2-3: Comparison of average wind speeds by wind direction based on Luton Airport

APPENDIX

- Appendix A: Terrain Correction with ESDU
29533 9030 Aerial Plan A-A1
29533 9302 PP Land Use and Access Plan rev F-A2
29533 9302 PP Scale Plan Rev D-A2
29533 930 Aerial Plan-A1
31550 BL-M-06-PP Land Use and Access Plan Rev G-A3
31550 BL-M-08-PP Scale Plan Rev G-A3



VERSION HISTORY

RWDI Project #2201247		Wind Engineering Services
Report	Releases	Date
1. Report	Draft Report	October 29, 2021
2. Report	Final Report	November 8, 2021
3. Report	Updated for Single Report	March 9, 2022
Project Team		Technical Coordinator Technical Director Project Manager



1 INTRODUCTION

RWDI was retained by Gallagher Developments to undertake a desk-based wind engineering study regarding the impacts of the proposed College Farm development in Bedford, England, UK. The proposed development is located south of Bedford. To the south of the hangers and adjacent to the A600 there is a Met Office Research Unit, referred to as Cardington Meteorological Station, which includes several anemometers collecting data on wind speeds. The proposed College Farm housing development to the west of the Cardington anemometers could impact the wind speeds being measured by the anemometers. The housing development will increase ground roughness to some upwind directions to the anemometers, which could alter the oncoming wind profile.

Increases in upwind ground roughness typically result in decreases in mean wind speeds. In order to quantify the magnitude of these impacts, a desk-based analysis was undertaken to compute wind speeds that would be measured at the anemometers under the current conditions as well as with the housing developments in place. This report presents the findings of the study.

This study has been completed based upon the following information:

- The location and heights of the Met Office Cardington Meteorological Station anemometers;
- Photos and satellite imagery of the Cardington Meteorological Station location and surrounding area, used to characterize the upwind land use based on current conditions;
- Drawings and plans provided to RWDI documenting planned future development for:
 - College Farm (Shortstown)

This information has been used to characterize the wind conditions at the Cardington Meteorological Station and the impacts of the proposed College Farm development in order to determine a relationship between wind speeds in the current area and wind speeds after the proposed development. The factors presented in this study represent the worst case between the existing buildings surrounding the site and the currently planned future development. Should additional future developments within 500 m of the Cardington Meteorological Station anemometers³ location be added, RWDI should be contacted to determine if the site assessment conducted needs to be re-assessed.

2 CLIMATOLOGICAL ASSESSMENT

The desktop study consists of an assessment of wind data from two nearby airport meteorological stations, and an assessment on how the surrounding surface roughness may affect wind speeds in the area of the proposed development.



2.1 Assessment of Wind Data

The wind measurements used to characterize the conditions at Cardington Meteorological Station were based on data obtained from the Cranfield Airport and London Luton Airport meteorological stations located 14 km west and 26 km south of the development site, respectively. Data were obtained from National Centers for Environmental Information (NCEI), which is part of the National Oceanic and Atmospheric Administration of the United States. The data are provided to NCEI by the World Meteorological Organization (WMO). Cranfield Airport data were obtained for the period of 2000 to 2020. London Luton Airport data were obtained for the period of 1973 to 2020. These meteorological stations' data combined contain sufficiently long period of record to perform a comprehensive statistical analysis for the determination of the regional wind climate in the Bedford area. Figure 2-1 shows the location of these airports in relation to the Cardington Meteorological Station and the proposed development.

A data quality review of the high wind speeds in the record was conducted to ensure that all high wind speeds included in the records were true wind events. Any erroneous data discovered were removed from the dataset to not skew the subsequent analyses.

2.2 Assessment of Upwind Terrain Conditions

Upwind terrain conditions were assessed at the two airport meteorological stations and at the Cardington Meteorological Station anemometers. The terrain assessment, as described in Appendix A, was completed to allow for changes in the mean and gust velocity profiles caused by changes in ground roughness to be determined. This is particularly useful to translate wind speeds between locations that experience the same winds, but where upwind conditions at the locations vary.

Figure 2-1 shows the land use surrounding the Cardington Meteorological Station anemometers. It includes the areas that will be built up with the proposed development, based on information provided to RWDI. It was assumed that green space in the development will be grasses and shrubs. This information was provided to RWDI by Gallagher Developments. RWDI should be notified to revisit any assumptions and the influence on any findings derived in this report if the future development (College Farm) deviates from the plans sent in October and November 2021.

Figure 2-2 shows the predicted average wind speeds, by direction, at the Cardington Meteorological Station anemometers based on the Cranfield Airport and Figure 2-3 shows the predicted average wind speed, by direction, at the Cardington Meteorological Station anemometers based on the London Luton Airport. For both stations, the changes in average wind speed for most wind directions are negligible, with the largest difference in average wind speed being 1 km/h at the three anemometer heights (10 m, 25 m and 50 m). Further, when the average wind speed is calculated for all directions the differences are negligible (less than 0.1 km/h at all heights).

2.3 Assessment of Anemometer Siting Conditions

Figure 2-1 shows the anemometers at the Cardington Meteorological Station in relation to the proposed development, along with a 150 m buffer from the College Farm site. The anemometer is outside of this 150 m buffer. The nearest buildings in the proposed development will be approximately 600 m from the anemometers. The highest buildings in the development will be up to 15 m tall. The World Meteorological



Organization (WMO, 2014) recommends anemometers are sited a distance of at least 10 times the height of any nearby obstruction. Therefore, the anemometers at Cardington Meteorological Station will remain in compliance with industry standards with respect to their site location, relative to the proposed development.

3 CONCLUSIONS

A desk-based analysis has been conducted to determine the probable impacts of the proposed College Farm development on the measured wind speeds at Cardington Meteorological Station. The analysis indicated that for most wind directions the proposed development will not have an impact on the wind speeds measured by the Cardington Meteorological Station, and that changes to the overall average wind speed will be negligible. The analysis also indicated the anemometers at Cardington Meteorological Station will remain in compliance with industry standards with respect to their site location, relative to the proposed development.

The data and results provided in Figures 2-1, 2-2, and 2-3 are based on the current land use surrounding the Cardington Meteorological Station anemometer, as well as after the proposed College Farm development is constructed, as detailed in Section 1 of this report. This information was provided to RWDI by Gallagher Developments. RWDI should be notified to revisit any assumptions and the influence on any findings derived in this report if the future development (College Farm) deviates from the plans sent in October 2021. RWDI should also be contacted if additional future developments within 500 m of the Cardington Meteorological Station anemometers' location be added, beyond those already considered in this study.



REFERENCES

Deaves, D.M. and Harris, R.I. (1978) A Mathematical Model of the Structure of Strong Winds, Construction Industry Research and Information Association (U.K.), Report #76.

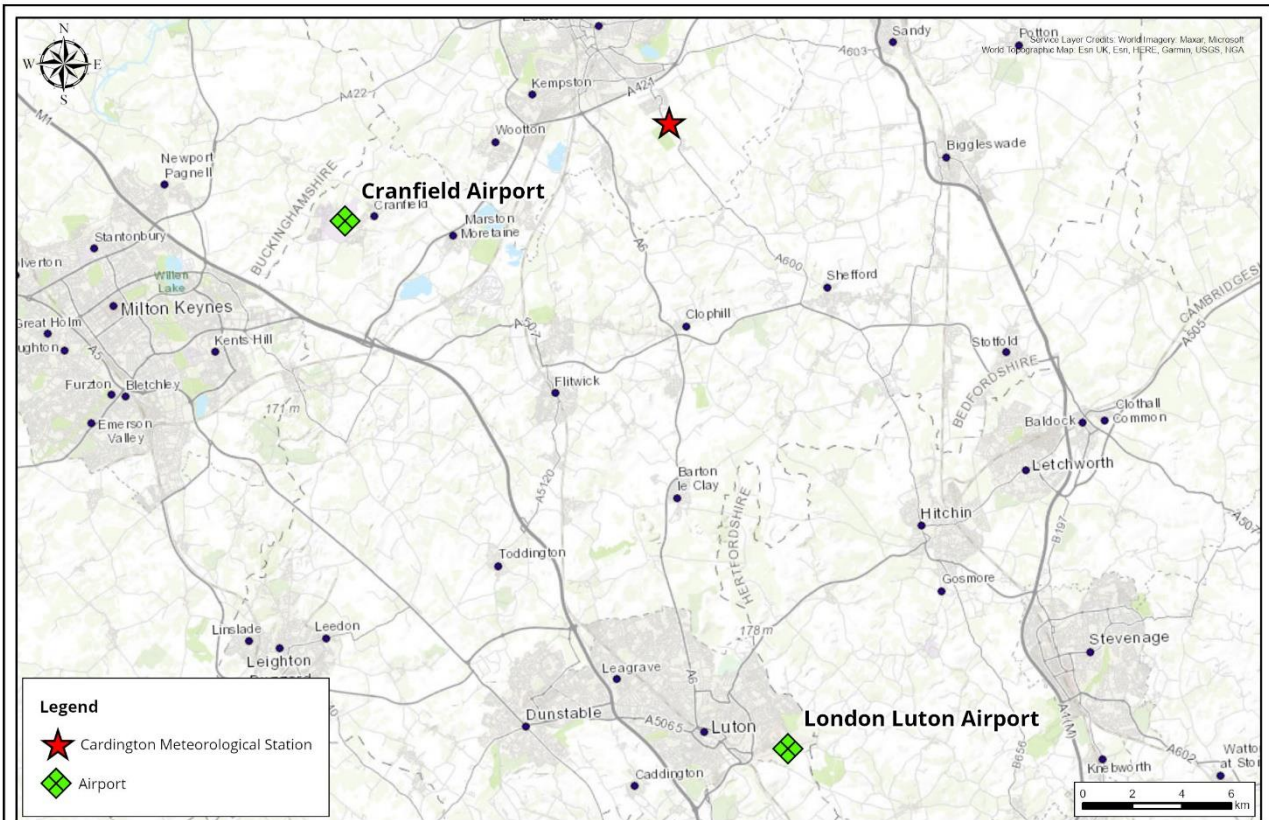
ESDU (1982) Strong Winds in the Atmospheric Boundary Layer. Part 1: Mean Hourly Speeds, Item 82026, Issued September 1982 with Amendments A and B April 1993. Engineering Sciences Data Unit, ESDU International, 27 Corsham Street, London N16UA.

ESDU (1983) Strong Winds in the Atmospheric Boundary Layer. Part 2: Discrete Gust Speeds, Item 83045, Issued November 1983 with Amendments to 1993. Engineering Sciences Data Unit, ESDU International, 27 Corsham Street, London N16UA.

WMO (2014) Guide to Meteorological Observing and Information Distribution Systems for Aviation Weather Services. WMO, 7 bis, avenue de la Paix, P.O. Box 2300, CH-1211 Geneva 2, Switzerland.

FIGURES

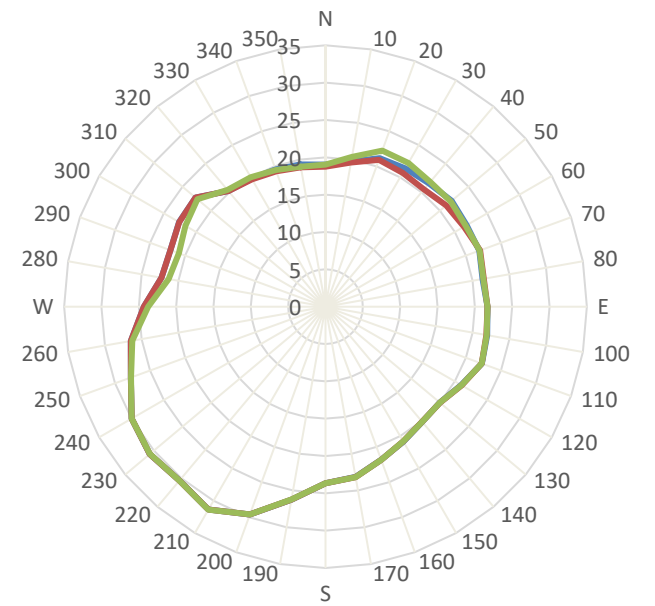
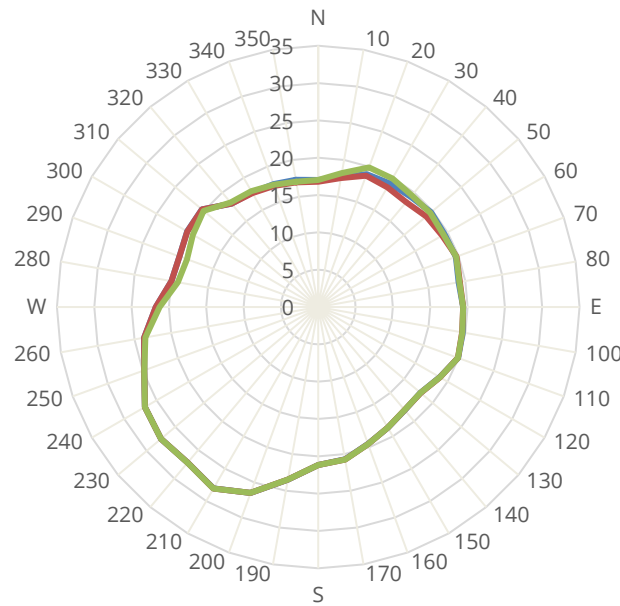
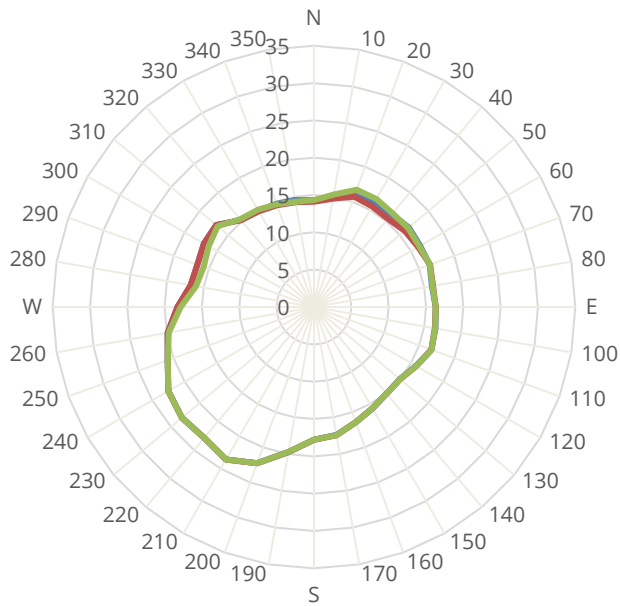




Location of Cardington Meteorological Station and Nearby Airport Meteorological Stations

Figure: 2-1





- Average Wind Speed - Current
- Average Wind Speed - Shorts Park development
- Average Wind Speed - College Farm development

- Current Average Wind Speed
- Average Wind Speed - Shorts Park development
- Average Wind Speed - College Farm development

- Current Average Wind Speed
- Average Wind Speed - Shorts Park development
- Average Wind Speed - College Farm development

10 m

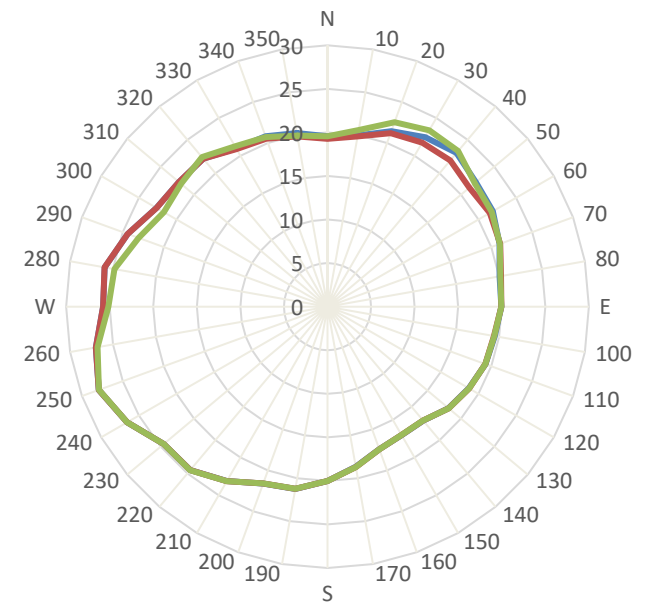
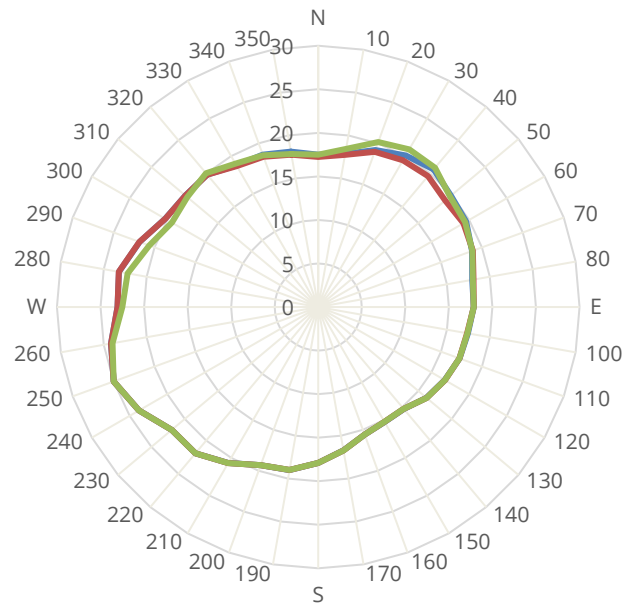
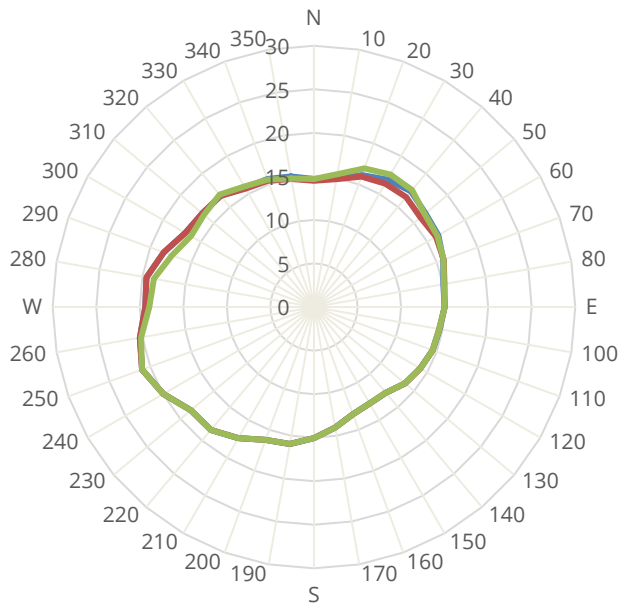
25 m

50 m

Comparison of average wind speeds by wind direction based on Cranfield Airport

Figure No. 2-2





- Average Wind Speed - Current
- Average Wind Speed - Shorts Park development
- Average Wind Speed - College Farm development

- Current Average Wind Speed
- Average Wind Speed - Shorts Park development
- Average Wind Speed - College Farm development

- Current Average Wind Speed
- Average Wind Speed - Shorts Park development
- Average Wind Speed - College Farm development

10 m

25 m

50 m

Comparison of average wind speeds by wind direction based on Luton Airport

Figure No. 2-3



APPENDIX A



APPENDIX A: TERRAIN CORRECTION WITH ESDU

Special attention is given to the analysis of the hourly records to account for the effects of the terrain surrounding an anemometer. Typically, anemometers are installed in an open terrain exposure that is used as a reference condition by building codes. However, this is rarely the case in real world applications. This means the true exposure of the anemometer is not that of the standard open terrain conditions. It is important to take this impact into account so as to avoid underestimating or overestimating design wind speeds.

Prior to conducting any analysis using the surface observations, the effect of upwind terrain roughness and land cover characteristics on the wind speeds at the anemometer station is assessed for each wind direction, and used to adjust wind speeds to a standard open terrain profile.

ESDU^{1,2} describes a method based on the work of Deaves and Harris³ for evaluating changes in the mean velocity profile following a change in ground roughness. This is particularly useful when analyzing meteorological records from an anemometer surrounded by varying terrain roughness for different wind directions.

This method is used to determine anemometer exposure. Maps, photographs and satellite imagery of the location are used to assess the ground roughness changes for each wind direction. The wind speeds for each wind direction were then adjusted based on the exposure of the anemometer to produce wind speeds that are equivalent to standard open terrain.

¹ ESDU (1982) *Strong Winds in the Atmospheric Boundary Layer. Part 1: Mean Hourly Speeds*, Item 82026, Issued September 1982 with Amendments A and B April 1993. Engineering Sciences Data Unit, ESDU International, 27 Corsham Street, London N16UA.

² ESDU (1983) *Strong Winds in the Atmospheric Boundary Layer. Part 2: Discrete Gust Speeds*, Item 83045, Issued November 1983 with Amendments to 1993. Engineering Sciences Data Unit, ESDU International, 27 Corsham Street, London N16UA.

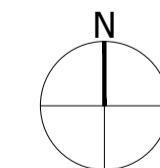
³ Deaves, D.M. and Harris, R.I. (1978) *A Mathematical Model of the Structure of Strong Winds*, Construction Industry Research and Information Association (U.K.), Report #76.



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Revision _____ Date _____ Dm _____ Ckd _____

— Site boundary

Project
**College Farm,
Shortstown**
Drawing Title
Aerial Plan



Date	03.11.2021	Scale	1:5,000 @ A1	Drawn by	DR	Check by	BW
Project No	29533	Drawing No	9030	Revision	A		

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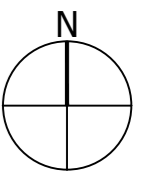


- Site Boundary
- ↘ Vehicular Access Point
- ↘ Pedestrian and Cycle Access
- - - Spine Road within a Tolerance of +-10m
- Residential Area
- Green Infrastructure
- Education and Residential
- Local Centre and Residential (Local Centre to include Retail, Leisure, Residential and Community Uses up to 01.00Ha)
- Indicative Location for Proposed Foul Pumping Station
- - - Flexible Boundary of Green Infrastructure within a tolerance of ±5m

Project
**College Farm,
 Shortstown**

Drawing Title
**Parameter Plans
 Land Use and Access Plan**

Date 09.09.2021	Scale 1:5000 @A2	Drawn by DR	Check by BW
Project No 29533	Drawing No 9302	Revision	F



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- Site Boundary
- Up to 13m high
Up to 3 Storeys
- Up to 10m high
Up to 2 Storeys
- Primary School
Up to 15m high (2-3 Storeys)
- Local Centre
Up to 14m for 3 Storeys where flats are located above retail
- 30.0 0.5m Contours

Notes:

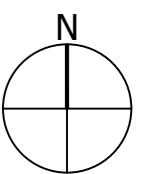
- In residential areas incidental elements such as chimneys may exceed the ridge by up to 1.5m.
- Some re-modelling of the existing ground levels will be necessary to achieve appropriate development platforms. Finished ground levels are not known at this stage and these could vary up to +/- 2 metres from the AOD heights shown

Contours denote existing ground levels AOD.

Project
**College Farm,
 Shortstown**

Drawing Title
**Parameter Plans
 Scale Plan**

Date 20.07.2021	Scale 1:5000 @A2	Drawn by DR	Check by BW
Project No 29533	Drawing No 9302	Revision D	



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— Site Boundary



Project
Land South of Cardington Hangars

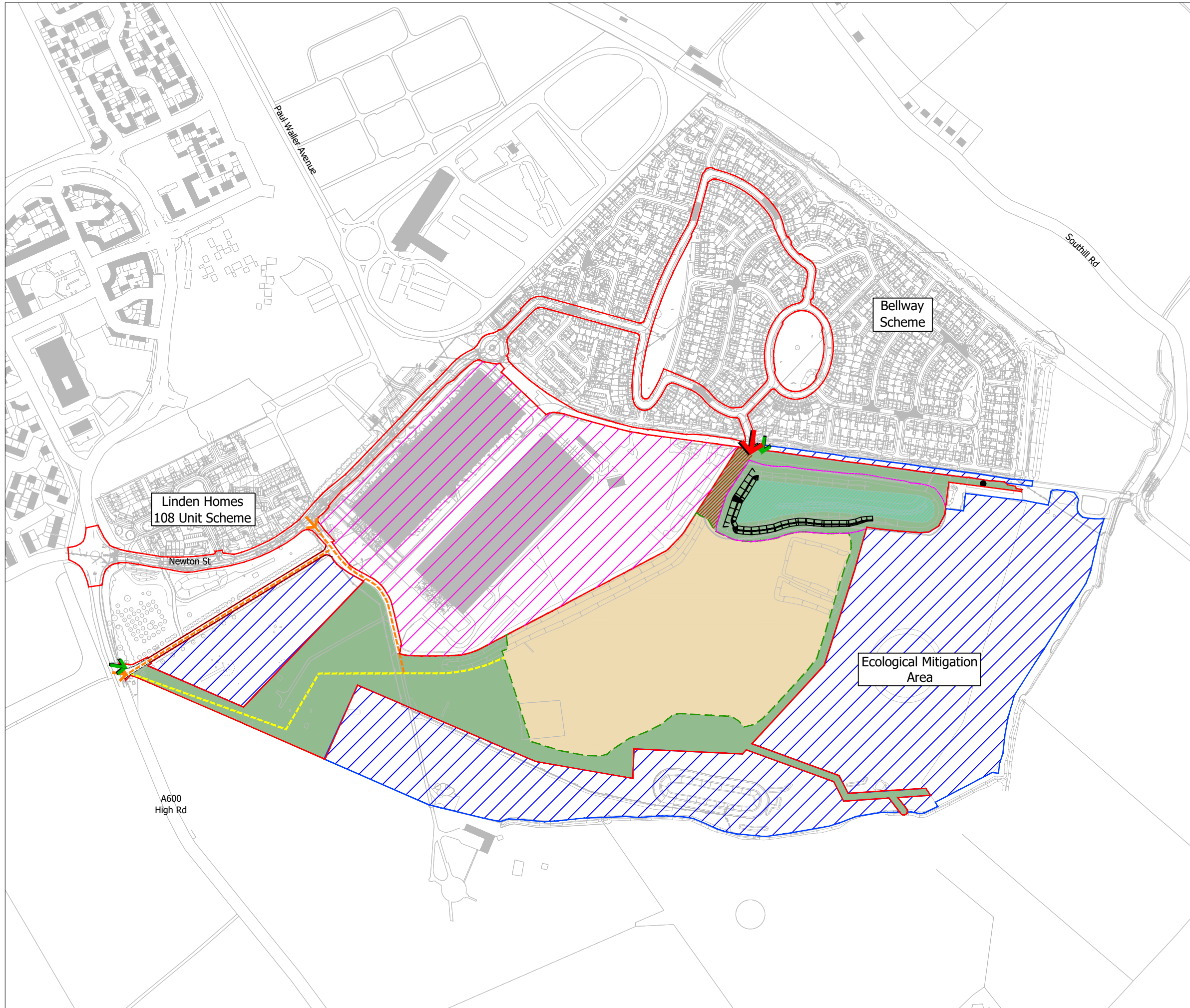
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Site Boundary Plan

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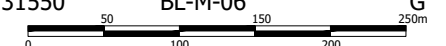


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- | Revision | Date | Drn | Ckd |
|----------|------|-----|-----|
| | | | |
- Site Boundary
 - ▨ Other Areas Under Gallagher Ownership
 - ➔ Vehicular Access Point
 - ▨ Main Access Route
 - ➔ Pedestrian and Cycle Access
 - ➔ Emergency Access
 - Residential Area
 - Green Infrastructure
 - - - Flexible Boundary of Green Infrastructure within a tolerance of ±5m
 - ▨ Area Outside Application Site
 - ▨ Existing Balancing Pond
 - - - Existing Access Road to the Sheds
 - Indicative Location for Proposed Foul Pumping Station
 - - - Indicative Pedestrian / Cyclist Routes
 - - - Emergency Routes
 - ▭ Existing Topographical Information
 - ▭ Revised Balancing Pond Design
 - ▭ 9m No Development Offset from Balancing Pond Top of Bank

Project
Land South of Cardington Hangars

Drawing Title
Parameter Plan
Land Use and Access Plan

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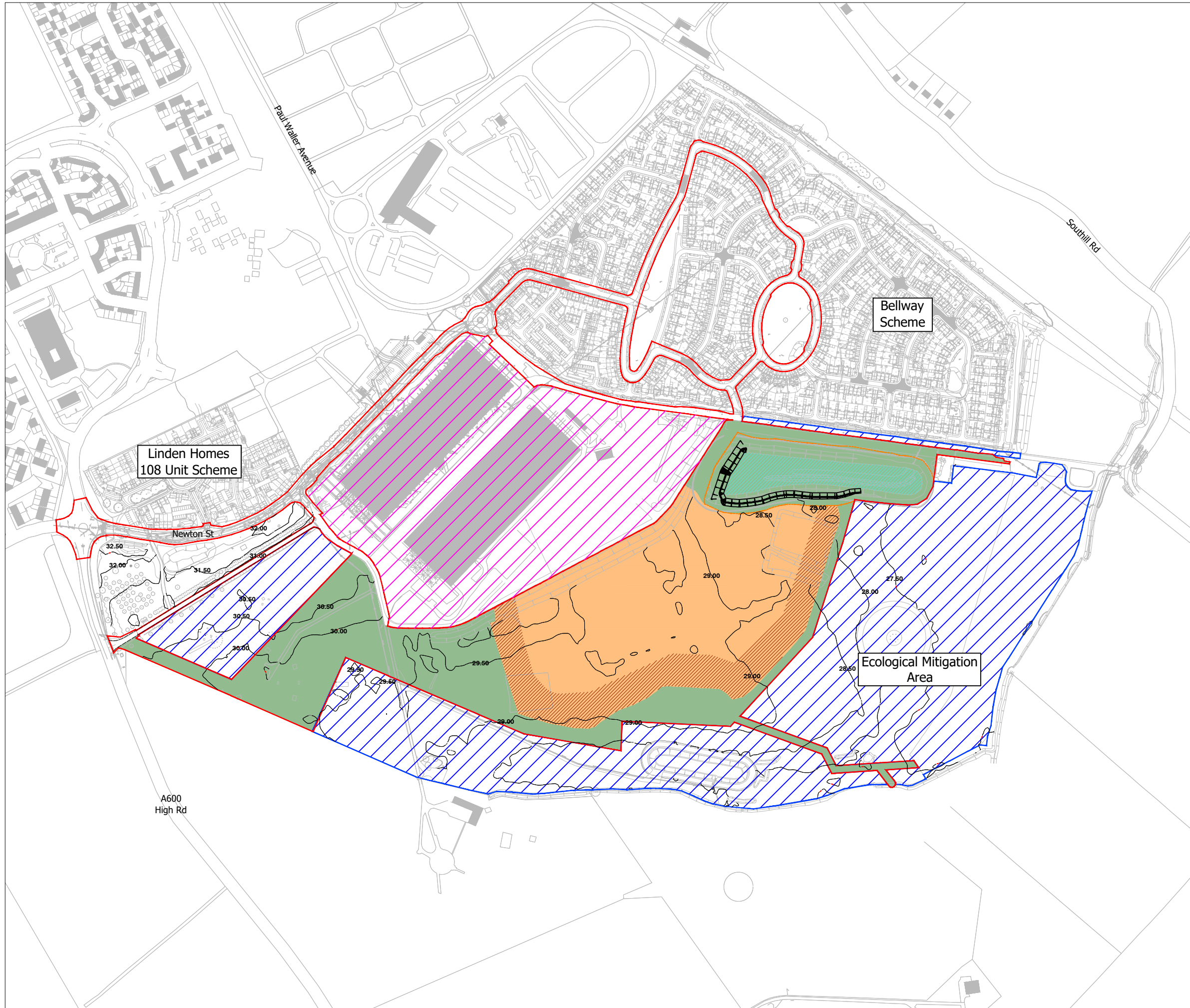


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Revision	Date	Drn	Ckd

- Site Boundary
- ▨ Other Areas Under Gallagher Ownership
- Up to 13m high
Up to 3 Storeys
- Up to 10m high
Up to 2 Storeys
- 0.5m Contours
- ▨ Area Outside Application Site
- Existing Balancing Pond
- Existing Access Road to the Sheds
- Existing Topographical Information
- Revised Balancing Pond Design
- 9m No Development Offset from Balancing Pond Top of Bank

Notes:

- In residential areas incidental elements such as chimneys may exceed the ridge by up to 1.5m.
- Some re-modelling of the existing ground levels will be necessary to achieve appropriate development platforms. Finished ground levels are not known at this stage and these could vary up to +/- 2 metres from the AOD heights shown

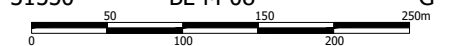
Contours denote existing ground levels AOD.



Project
Land South of Cardington Hangars

Drawing Title
**Parameter Plans
Scale Plan**

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Project No	Drawing No	Revision	
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