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EAST FULWOOD FARM, INCHINNAN
FLOOD RISK ASSESSMENT REPORT
FOR
LYNDSEY MARTIN

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SITE SUMMARY INFORMATION

Name of Site:	East Fulwood Farm, Inchinnan
Ordnance Survey Grid Reference:	NS 45515 67875
Site Address:	East Fulwood Farm, Houston Road, Inchinnan, PA4 9LX
Local Authority:	Renfrewshire Council
Land Use (Existing):	Vacant Hardstanding
On site buildings:	No
Proposed Site Use:	Holiday Dwelling
Area (m^2);	425m^2
Local Development Plan (LDP);	LDP 2 2021- ENV1 Greenbelt
Type of Investigation:	Level 3 Flood Risk Assessment

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1 INTRODUCTION

1.1 BACKGROUND

The development of a holiday dwelling on the grounds of East Fulwood Farm, Inchinnan is currently under consideration by the Client, Lyndsey Martin.

The Lin Burn flows in close proximity to the northwest boundary and joins the River Gryffe some 430m south-southeast of site. As part of the development process Terrenus Land & Water Ltd was commissioned by Messrs Mabbett & Associates Ltd, on behalf of the Client, to carry out a Level 3 flood risk assessment of the site.

1.2 OBJECTIVES OF INVESTIGATION

The principal aim of the investigation is to define the functional floodplain in the local area and to assess the risk of flooding to the proposed development.

1.3 SCOPE OF STUDY

The following tasks were undertaken during the course of this investigation:

- Site walkover inspection;
- Acquisition of site topographic spot height data;
- Collation of data;
- Assessment of data;
- Joint probability analysis;
- 2D Hydraulic Modelling using HEC-RAS modelling software; and
- Production of an Interpretative Report.

1.4 PROPOSED SITE END-USE

It is understood that the proposed development of the site will involve the construction of a holiday cabin. The site location and extent is shown on Figure 1, which is included in the Appendix.

It is noted that the proposed development increases the SEPA Land Use Vulnerability Classification[1] as per table 1 in the guidance document, holiday dwellings are classified as Most Vulnerable and thus the 1 in 1000-year storm event constitutes the design storm event.

1.5 LIMITATIONS OF REPORT

Terrenus Land & Water Ltd has prepared this report for the sole use of the Client, in accordance with generally accepted consulting practice and for the intended purpose as stated in the related contract agreement. No other warranty, expressed or implied, is made as to the professional advice included in this report. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from Terrenus Land & Water Ltd; a charge may be levied against such approval.

To the best of our knowledge, information contained in this report is accurate at the date of issue. There may be conditions pertaining at the site not disclosed by the study, which might have a bearing on the recommendations provided if such conditions were known. We have, however, used our professional judgement in attempting to limit this during the assessment.

It is important therefore that these implications be clearly recognised when the findings of this study are being interpreted. In addition, this should be borne in mind if this report is used without further confirmatory investigation after a significant delay.

[1] https://www.sepa.org.uk/media/143416/land-use-vulnerability-guidance.pdf

2 SITE DETAILS

2.1 DATA SOURCES

The following data sources were consulted during the course of the Flood Risk Assessment:

- Client-supplied data including site location;
- 0.5m Phase 5 DTM LiDAR data set, obtained from the Scottish Remote Sensing Portal;
- Site walkover inspection and additional topographic surveying;
- Flood Estimation Handbook – Web Service (FEH13);
- Publicly available online historic maps; and
- Available additional information.

2.2 SITE LOCATION & DESCRIPTION

The site is located within a rural area of Renfrewshire, near Inchinnan, situated 1km west of Inchinnan Business Park, and is centred on National Grid Reference NS 45515 67875. As shown on Figure 1, which is contained within the Appendix.

The site covers and area of around 425m^2 and has an approximately rectangular shaped boundary, which lies between the southern bank of the Lin Burn and the existing farm steading of East Fulwood Farm. The boundary is marked by palisade fencing on the northwest and southwest edges and the wall of the farm steading building to the southeast. The northwest boundary is open to the site access road.

An understanding for the local topography was provided by project commissioned topographic spot height survey undertaken by Terrenus Land & Water Ltd during the site walkover inspection on the 7 March 2022. The location of the spot heights acquired by Terrenus are shown on Figures 2A & 2B, contained within the Appendix.

The site is generally flat-lying with a very slight slope southeast to northwest, from a high of 6.0m OD to 5.77m OD. The Lin Burn channel bed lies at around 2.9mOD.

2.2.1 Ground Truthing

The LiDAR dataset was 'truthed' against the spot height survey data at key locations within the site and surrounding area. Table A, below, provides a sample of the spot height survey points against the LiDAR data. The average deviation between the LiDAR and survey data is 17mm, with the greatest differential being 30mm which is reasonable in this instance. The locations of the survey points chosen for comparison are shown on Figure 3. The LiDAR data was found to be a reasonable and accurate representation of the local topography.

Survey Point	Surveyed Levels	LiDAR Data Levels	Deviation
1	6.13	6.12	+0.01
2	6.0	6.01	-0.01
3	6.48	6.48	0
4	6.58	6.61	-0.03
5	5.46	5.49	-0.03
6	4.99	5.01	-0.02
Average Deviation		0.017	
Maximum Deviation		0.03	

Table A: Ground Truthing

The survey comparison found that LiDAR levels within the Lin Burn channel were typically around 600mm higher than actual surveyed levels. This effect is due to the water and vegetation within the channel providing a surface within the LiDAR dataset.

2.3 SITE HISTORY

The site and East Fulwood Farm as a whole is shown on the First Edition Ordnance Survey maps dated 1863. The site and adjacent farm steading are shown to be relatively unchanged since the earliest record. The farm steading is noted to have been changed, likely the historic structure was demolished and replaced with the steading that is now present. The warehouse of the landscaping company to the southeast of site is absent and due to its modern construction, was likely erected in the 2010's.

Little change is recorded in the wider area, with the exception of the relatively recent M8 to the west and the expansion of the industrial estate and Inchinnan to the east.

2.4 SITE NEIGHBOURS

Immediately adjacent to the southeastern site boundary is the farm steading of East Fulwood Farm, with the courtyard beyond. Further southeast is the parking area and warehouse of a local landscaping firm.

Immediately south of the site is the garden of East Fulwood Farm, with small paddocks beyond.

The Lin Burn flows north to south along the northwest and western site boundary, with agricultural fields beyond.

Immediately north of the site is the road bridge over the Lin Burn which connects to the fields north of the site.

2.5 HYDROLOGY AND DRAINAGE

The Lin Burn is the closest watercourse to the site. This watercourse is fed by the fields north of site and has a catchment of 5.03km^2. The burn is culverted at numerous locations along its course and generally lies within a steep-banked trapezoidal channel. Approximately 440m south-southeast of the site, the Lin Burn comes to confluence with the River Gryffe.

The River Gryffe, which is a tributary of the Black Cart Water and the River Clyde further downstream flows from west to east originating from Loch Thorn and the Gryffe Reservoirs 20km upstream of the site.

During the site walkover, the channel bed of the River Gryffe was noted to be generally flat with gravel and cobbles present. The banks of the watercourse are earthen and well-defined.

The Black Cart Water is fed by the hills of Clyde Muirshiel some 14km southwest of the site. It is additionally fed by runoff from the fields and by tributaries along its course towards the River Clyde.

2.5.1 SEPA Flood Map

The Scottish Environment Protection Agency (SEPA) has produced 'Flood Maps' for the local area. These maps are enhanced and show potential flooding from coastal, rivers (fluvial) and surface water (pluvial) sources. In addition, the maps provide a breakdown of flood likelihood in broad agreement with the Scottish Planning Policy Risk Framework.

A review of the maps indicate that the site is within the Medium to Low Likelihood of fluvial flood risk, with a High Likelihood of fluvial flooding immediately adjacent to the northwestern boundary.

There is no likelihood of surface water flood risk at site, according to the SEPA flood maps.

There is no likelihood of coastal flood risk at site, however, a high likelihood of coastal flood risk is present along the course of the Lin Burn in the immediate vicinity of site, and along the River Gryffe and the Black Cart Water in the wider vicinity. This indicates that there is coastal/tidal influence on the water levels at site.

There is no likelihood of flood risk from any source on the access road or Houston Road as it heads east.

SEPA makes the following statement about the Flood Map:

> *"The river flood map was developed using a nationally consistent approach to producing flood hazard information, such as depth of water and speed of flow arising from river flooding. It is based on a two-dimensional flood modelling method applied across Scotland to all catchments greater than 3km^2. The river flood map includes hydraulic structures and defences such as bridges, culverts and flood storage areas where appropriate information was available.*

and

> *The surface water flood map combines information on rainfall and sewer model outputs. It incorporates data from a national surface water study, a regional surface water study with increased resolution in selected areas and a Scottish Water sewer flooding assessment."*

The flood map should be treated with caution and SEPA makes the following general comment:

> *"The flood maps are designed to provide a community level assessment of flooding and its impacts. They model flooding at a national scale. As with any approach of this scale, there are limitations and assumptions made to enable modelling and a consistent approach to be applied across Scotland. Limitations arise from the data used to create the maps, the modelling techniques applied and the ability to incorporate datasets from local studies into a national approach."*

Additional background details of the SEPA flood map can be found on the SEPA website: http://www.sepa.org.uk/flooding/flood_maps.aspx

2.5.2 Scottish Water Assets

From a review of Scottish Water asset plans there are no known Scottish Water drainage assets in the vicinity of the site with the nearest assets being along Barnsford Road A726 1km east of site.

A trunk water supply main runs adjacent to the Lin Burn upstream of site and along the access road. A visible washout is located upstream of the bridge adjacent to the site's northern boundary.

An abandoned pipe is present along the northern edge of Houston Road south of site, evidence of which is visible upstream of the Houston Road bridge over the Lin Burn.

The Scottish Water assets plans are included in the Appendix.

2.6 GEOLOGICAL SETTING

The following summary of the solid and superficial geology of the site is based on a review of the British Geological Survey (BGS) Geology of Britain Viewer[2].

The underlying superficial deposits are recorded to comprise gravel, sand and silt of Devensian age raised tidal flat deposits.

The bedrock at site is recorded to comprise a mix of the Lower Limestone Formation and Limestone Coal Formation.

2.7 FLOOD DEFENCE WORKS

There are no known flood defence works within the vicinity of the site.

[2] http://mapapps.bgs.ac.uk/geologyofbritain/home.html

3 FLOOD RISK ASSESSMENT

3.1 GENERAL

Flooding occurs when the amount of water arriving on land exceeds the capacity of the land to discharge that water (by infiltration, overland flow, groundwater rise or a failed drainage system). It can occur on any level or near-level areas of land but the main concern in inland areas is with land adjacent to watercourses (fluvial flooding) and the possibility of overland flow (surface water flooding).

3.2 COASTAL FLOOD RISK

3.2.1 Coastal Flood Boundary Conditions for the UK (2018)

A review of the Coastal Flood Boundary Conditions for the UK: Update 2018 was undertaken, and the September 2020 dataset was utilised following download from data.gov.uk[3]. The data was downloaded and used under Open Government License V3.0.

The nearest node to the site lies on the River Gryffe, within the Clyde Estuary section of the dataset. The node is situated at the confluence of the Lin Burn and the River Gryffe, some 430m south of the site. The Coastal Design Sea Level – Coastal Flood Boundary (CDSL-CFB) Extreme Sea Level Estuary layer was examined and data for the node at Chainage 1806_51 was adopted. The dataset includes the extreme sea level values for still water sea levels and are based on 2017/18 topographic data for boundary outlines.

Confidence levels provide allowances for uncertainty. The 2.5% and 97.5% confidence levels associated with an extreme sea level estimate are the values such that, in the interval between these values, there is a 95% probability of observing the true extreme sea level. This interval is often referred to as the 95% confidence interval and is commonly used to quantify the uncertainty associated with parameter estimates of a statistical model. The 2.5% and 97.5% confidence levels are provided and referred to as 'C1_' and 'C2_' respectively.

Table B below summarises the dataset entry for the node at Chainage 1806_51:

Is study area within estuary areas?	Adopted Chainage point	*Allowance for Uncertainty - c1 (2.5%) Confidence Level (mO.D.)*		Coastal Design Sea Levels - Coastal Flood Boundary Extreme Sea Levels Estuary (mO.D.)		*Allowance for Uncertainty - c2 (97.5%) Confidence Level (mO.D.)*	
Yes	**1806_51**	c1_T1	3.68	T1	3.73	c2_T1	3.78
		c1_T2	3.85	T2	3.91	c2_T2	3.97
		c1_T5	4.06	T5	4.14	c2_T5	4.23
		c1_T10	4.18	T10	4.29	c2_T10	4.40
		c1_T20	4.30	T20	4.44	c2_T20	4.60
		c1_T25	4.34	T25	4.49	c2_T25	4.67
		c1_T50	4.44	T50	4.63	c2_T50	4.85
		c1_T75	4.49	T75	4.70	c2_T75	4.98
		c1_T100	4.50	T100	4.73	c2_T100	5.03
		c1_T150	4.52	T150	4.77	c2_T150	5.12
		c1_T200	4.54	T200	4.81	c2_T200	5.19
		c1_T250	4.54	T250	4.83	c2_T250	5.24
		c1_T300	4.56	T300	4.86	c2_T300	5.28
		c1_T500	4.58	T500	4.92	c2_T500	5.40
		c1_T1000	4.61	**T1000**	**5.01**	c2_T1000	5.59
		c1_T10000	4.68	T10000	5.03	c2_T10000	6.47

Application of Climate Change Allowance - (using Table 3 from SEPA Guidance for Clyde River Basin) (m)
0.85

T1000 plus Climate Change Allowance (mO.D.):
5.86

Table B: Extreme Sea Levels and Climate Change Allowance

3 https://data.gov.uk/dataset/73834283-7dc4-488a-9583-a94.8320072d9a9d/coastal-design-sea-levels-coastal-flood-boundary-extreme-sea-levels-20184

As can be seen from Table B, the T1000 Tide extreme sea level within the Clyde Estuary has been predicted at 5.01mOD. A review of the project commissioned spot height data indicates that the majority of the site is at or above 5.66m OD. This puts the site entirely outwith the 1 in 1000-year tidal event floodplain.

Application of the SEPA Climate Change Allowances for Flood Risk Assessment in Land Use Planning[4] guidance puts the site within the Clyde River Basin Region, with a corresponding sea level rise allowance of 0.85m, up to year 2100. It should be noted that SEPA recommend that an additional allowance of 0.15m per decade after the year 2100 be applied where the design life of a development is known to extend beyond that date. Assuming a design life up to year 2100 the peak extreme sea level estuary level for the site would be 5.86mOD. The inclusion of climate change to the 1 in 1000-year tidal level would impact the northwestern edge of the site, however, depths are less than or equal to 200mm.

3.2.2 Assessed Risk of Inundation from the Sea

The site is situated inland of the Firth of Clyde and is protected by the canalised Black Cart Water and heavily modified River Clyde.

The distance from the estuary mouth with the Firth of Clyde will limit tidal, wave and wind fetch from generating significant waves.

The northwestern edge of the site is considered to be at **Low to Medium Risk** of coastal flooding from an isolated extreme sea level coastal event.

The remainder of the site is at **Little or No Risk** of flooding from coastal sources.

Hydraulic modelling of the Tidal conditions at the site are discussed in full in Section 3.7 below.

3.3 JOINT PROBABILITY

The analysis was undertaken using the DEFRA / Environment Agency (EA) Flood and Coastal Defence R&D Programme Technical Reports FD2308/TR1, FD2308/TR2 and FD2308/TR3. These reports look at Joint Probability: Dependence Mapping and Best Practice, Use of Joint Probability Methods in Flood Management and Joint probability: Dependence between extreme sea surge, river flow and precipitation. Together these technical reports provide a robust methodology and approach to the assessment of Joint Probability and form the current guide to best practice for this assessment.

The first variable was established as the peak flow rate of the River Gryffe for a range of eleven (11) return periods: 1 in 1-year, 1 in 2-year, 1-in 5-year 1 in 10-year, 1 in 20-year, 1 in 50-year, 1 in 75-year, 1 in 100-year, 1 in 200-year, 1 in 500-year and 1 in 1000-year. The peak flow estimations for each return period were carried out using the Revitalised Flood Estimation Handbook, Version 2.3 (ReFH2.3), which calculates the peak flow estimation from the Flood Estimation Handbook Web Service (FEH13) Catchment Descriptors.

The second variable was established as the peak still extreme sea level for the same return periods. The data was taken from the Coastal Design Sea Level – Coastal Flood Boundary Dataset (April 19) and applied to the DEFRA/EA Skew Surge Joint Probability Method. The results of the assessment are shown in Table B in Section 3.2.1 above. As the tidal sequence is applied for the peak sea level assessment, the number of records / years for the joint probability assessment was set at 707.

The Correlation Factor (CF value) for the 1 in 1000-year event used the 1 in 500-year values from Table 3.6 of the DEFRA/EA R&D Technical Report FD2308/TR1 (pg38). This is the most severe storm event considered under the current guidance and extrapolation was not considered a feasible approach. Thus, the correlations will be approximate.

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4 https://sepaweb.maps.arcgis.com/apps/webappviewer/index.html?id=a01f82dbc66145f4a4b558d7b840f51a&extent=-2086266.4068%2C6926044.231%2C1044594.2717%2C9056497.0833%2C102100

The level of dependence for the relationship between river flow and surge was taken from Figure 2 in the DEFRA/EA R&D Technical Report FD2308/TR2 (pg22). The nearest river station to the site was taken as Station 84011 – Gryffe at Craigend (NGR NS414663). The River Gryffe at Craigend is noted to be Well Correlated in the level of dependence between river flow and surge. This level of dependence has been adopted for the simple desktop joint probability assessment. The CF value for the 1 in 1000-year event was calculated at CF = 182.

The results of the simple desk study joint probability analysis are shown in Table 1, included in the Appendix.

A review of Table 1 shows that the 1 in 1000-year peak flow estimation of the River Gryffe (317.21m^3/s) has a joint exceedance return period peak sea level of 0.69mOD, which is less than a peak tide of a 1 in 1-year tidal event. This means that a 1 in 1000-year fluvial storm event (Q1000) is not likely to occur during any tidal storm event. Conversely, a 1 in 1000-year tidal storm event (T1000) is likely to coincide with a 1 in 1-year fluvial event (Q1) of 50m^3/s.

Under less severe fluvial storm events such as the Q200 and Q500, the corresponding tidal event remains less than 1 in 1-year and vice versa.

3.4 SURFACE WATER

Topographic maps, LiDAR data and project commissioned spot height survey data were interrogated to determine general overland flow pathways for the site and the surrounding area. The general indicative overland flow pathways are shown on Figure 4, which is included in the Appendix.

Within the site, overland flow pathways stem from the access road and flow west across the site. The local landform will prevent ponding within the site.

Overland flow from the adjacent fields will be prevented from entering site by the raised road and the Lin Burn.

It is therefore considered that the site is at **Little or No Risk** of surface water flooding.

It is understood that any proposed development will comply with Renfrewshire Council requirements for Sustainable Drainage Systems (SuDS), if applicable.

3.5 LOCAL DRAINAGE

No drainage infrastructure currently serves the site. Standard roof drainage was noted to be in place along the southeast boundary, servicing the farm steading. No road drainage at site or along the access road was evidenced during the site walkover inspection.

In the event of the adjacent roof drainage becoming blocked, some nuisance water may wash onto site. The gentle slope of the landform and the lack of ponding-supporting topography will mean that any such water will wash across the site as shallow overland flow and fall into the Lin Burn before being carried away from site.

Standard field drainage is expected to be in place in the neighbouring fields. This drainage will discharge into the Lin Burn and not directly impact the site. Any upwelling from damaged field drains will be prevented from entering site by the raised road deck and the presence of the Lin Burn.

A failure in road drainage along Houston Road leading to upwelling at the gullies may result in shallow overland flow onto the southernmost extent of the farm access road. This flow will wash across the access road due to the lack of kerbing and infiltrate into the soils of the fields.

Due to the site's sloping topography towards the watercourse and the lack of significant drainage infrastructure within the site or surrounding area, the site is assessed to be at **Little or No Risk** of flooding from a failure in drainage systems.

3.6 GROUNDWATER RISE

Given the presence of historic Made Ground and the underlying superficial deposits of alluvium, there is potential for perched groundwater beneath the site.

The groundwater in close proximity to the Lin Burn is likely to be in hydraulic continuity with the watercourses, but the extent will be extremely limited due to the narrow profile of the burn.

Site commissioned survey spot height data records the bed of the Lin Burn to be at around 3.0mOD, with the lowest site level around 5.66mOD. This gives at least 2.66m between the site level and the bed of the burn.

Local superficial groundwater will be impacted by the Lin Burn, however the site is considered to be at **Little or No Risk** of isolated Groundwater rise. Groundwater may be present at shallow depth and encountered during any further excavation.

3.7 FLUVIAL FLOOD RISK

3.7.1 General

Fluvial flood risk in the vicinity of the site arises primarily from the interaction of the Lin Burn and the River Gryffe.

The hydrological analysis uses modified Flood Estimation Handbook Web Service data (FEH13) together with the Hydrologic Engineering Centre's River Analysis System (HEC-RAS), developed by the U.S. Army Corps of Engineers (USACE). HEC-RAS Version 6.1. HEC-RAS provides appropriate 2D hydraulic flood modelling capabilities for the determination of flood routing, overland flow conveyance and flood storage.

Whilst the current HEC-RAS model (6.1) does allow for infiltration, no infiltration losses were applied to this model.

3.7.2 Model Domain

The two-dimensional (2D) flow area for the model covers an area of 3.72km^2. The model domain was established to be inclusive of all floodplain and potential overland flow pathways that could impact the site and site neighbours from the three watercourses. The extent of the model domain is shown on Figure A.

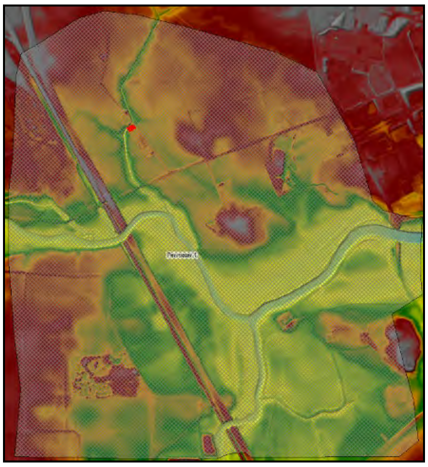

Figure A – Model domain

3.7.3 Digital Terrain Development

A digital terrain was developed in HEC-RAS using the following terrain data:

- Scottish Remote Sensing Portal 0.5m Phase 5 LiDAR DTM data set (NS46 NW & NE tiles);
- TLW GS08 Leica Geosystem Survey Staff and Net Rover Spot Heights – March 2022.

The existing terrain is a composite terrain surface generated from the RAS Mapper functionality within HEC-RAS 6.1. The LiDAR forms the basis of the topographic data and the channel profiles were refined by supplementing the LiDAR data with the project commissioned spot height survey data. This allowed for a more accurate representation of the channels. Figure B shows an extract of the final existing terrain used for the hydraulic modelling.

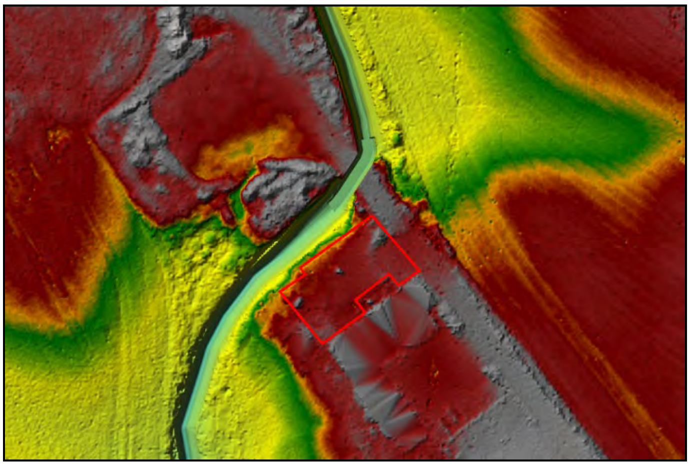

Figure B – Existing Terrain Model

3.7.4 Contributing Catchments

Catchment descriptors for the three watercourses were obtained from the Flood Estimation Handbook Web Service (FEH13).

Catchments for the River Gryffe and Black Cart Water could not be generated in the vicinity of site owing to them being considered tidal catchments at this location under the FEH methodology. Thus, in order to capture suitable fluvial catchments for these watercourses, the closest upstream catchments were extracted and extended to encompass their catchment area up to the vicinity of the site. Due to the areal alterations being greater than 10% of each catchment's area, alterations to other catchment descriptors was necessary. The revised catchment descriptors for the Gryffe and Black Cart are included in the Appendix.

The River Gryffe originates from Loch Thorn and the Gryffe Reservoirs some 20km upstream of the site. The revised River Gryffe catchment is 144.54km^2 in extent.

The Black Cart Water is initially fed from the hills and moors of Clyde Muirshiel Regional Park as the runoff flows into the Lochwinnoch lochs. The Black Cart is additionally fed by runoff from the fields and burns along its course towards its confluence with the River Clyde. The revised Black Cart Water catchment is 139.97km^2 in extent.

From review of topographic data, the representation of the Lin Burn catchment was considered accurate and its catchment descriptors were applied without any change. The Lin Burn catchment is 5.04km^2 in extent.

The revised catchment extents are shown on Figure 5, which is included in the Appendix.

3.7.5 Inflow Boundary Condition

Gauging station data for the Craigend Gauge was reviewed for the River Gryffe. The National River Flow Archive[5] indicates the gauge to lie some 4.4km west of the site at NGR NS 41476 66362. A review of the gauging station records a maximum observed flow of 142.03m^3/s since its earliest records in 1963.

There is also a SEPA gauging station on the Black Cart Water at Milliken Park (NGR NS 41122, 62025), upstream of the site. This station records a maximum observed flow of 110m^3/s since its earliest records in 1963.

[5] https://nrfa.ceh.ac.uk/

In each instance, the gauging stations are located significantly upstream of site and the highest recorded flows of each are lower than the estimations calculated using the methodologies described below.

Catchment descriptors from the Flood Estimation Handbook web service (FEH13) were used to calculate the peak flow estimation for the contributing catchments and are included in the Appendix.

The peak flow estimation was calculated using the following methodologies:

- FEH Statistical;
- Revitalised Flood Hydrograph, Version 2.3 (ReFH2.3); and
- FEH Rainfall Runoff.

The results of the flow estimations found that the FEH Rainfall Runoff was the most conservative of the methodologies.

Table 2, in the Appendix provides a summary of the design storm event peak flow estimations under various methodologies. Table 3 provides a suite of peak flow estimations under a variety of storm events using the FEH Rainfall Runoff methodology.

The inflow boundary conditions were applied as hydrographs with energy gradients calculated from the terrain.

3.7.6 Climate Change Allowance

A review of the SEPA Climate Change Allowances for Flood Risk Assessment in Land Use Planning web map[6] shows that the site lies within the Clyde River Basin Region and in the West Rainfall Uplift Region.

As per the SEPA guidance, the applicable Climate Change Allowance (CCA) for the Lin Burn is an increase of 55% on Peak Rainfall Intensity due to the catchment size being less than 30km^2.

As per the SEPA guidance, the applicable Climate Change Allowance (CCA) for the River Gryffe and Black Cart Water is an increase of 44% on Peak River Flow due to the catchment sizes being greater than 50km^2.

Table B, below, lists the corresponding peak flow estimates for the watercourse.

	1 in 1000-year flow	1 in 1000-year plus Climate Change Allowance (CCA)
Lin Burn	14.55	24.78
River Gryffe	317.21	456.78
Black Cart Water	374.55	539.35

Table B – Peak inflow rates

The 1 in 1000-year and 1 in 1000-year plus climate change allowance inflow hydrographs are shown on Figures 6 to 8, which are contained within the Appendix.

3.7.7 Downstream Model Boundary

The downstream model boundary condition is set to a time/stage relationship representing a typical tidal sequence within the Clyde Estuary. The was included in the model as a stage hydrograph to represent the influence of the tide on this point of the watercourses.

[6]https://sepaweb.maps.arcgis.com/apps/webappviewer/index.html?id=a01f82dbc66145f4a4b558d7b840f51a&extent=-2086266.4068%2C6926044.231%2C1044594.2717%2C9056497.0833%2C102100

The MIKE21 Tidal Prediction mode, by DHI, was used to generate a typical 3-day tidal sequence as close to the site as possible. The tidal sequence was then modified to provide coincident peaks between the fluvial discharge from the River Gryffe and peak tide. This is a conservative estimation, as the likelihood of coincident peaks is low.

The tidal sequence was then adapted to match the peak water levels from the Coastal Flood Boundary Dataset, with a baseline fluvial scenario peak water level of 3.73m OD, which equates to a 1 in 1-year tidal storm event.

Finally, the tidal sequences were adjusted using the Simplified Harmonic Method for the storm surge profile at the nearest Admiralty Port, Rothesay Dock, Clydebank.

Additional tidal sequence levels corresponding to the 1 in 1-year plus Climate Change Allowance and the 1 in 1000-year extreme sea level with and without Climate Change Allowance, were also assessed.

The downstream boundary was applied at the downstream extent of the modelled domain across the River Gryffe. The modelling software calculates separate water surface elevations per cell face along the boundary condition line.

The downstream boundary condition was applied as a stage hydrograph and these stage hydrographs are shown on Figure 9, included in the Appendix.

3.7.8 Roughness Coefficient

A global Manning's n roughness coefficient value of 0.03n was applied to the whole domain. This value was derived from the mid-range for short-grassed pasture, which makes up the majority of the model domain. Where notable land use changes occur a separate Manning's n map layer was added to the model to reflect changes in land use. The Manning's n map layer overwrites the global Manning's n value and applied a new value corresponding to the terrain as can be seen below on Figure C.

Figure C – Existing Manning's n Layer Extract

The Manning's roughness coefficients n values assigned to the polygons are summarised below in Table C:

Colour	Land Use Classification	Manning's n Value
Cyan	Channel	0.03
Green	Woodland/brush	0.07
Magenta	Road	0.013
Red	Building	0.1

Table C – Existing Manning's n values for hydraulic modelling

All Manning's n values are based on a review of aerial imagery, the site walkover inspection and are aligned to those described in Manning's n for Channels (Chow, 1959).

Manning's n values of 0.07n were applied to areas of more dense vegetation and brush coverings, or areas with mature stands of trees with branches outwith the flood zone. Road surfaces were attributed a roughness value of 0.013n for asphalt. The channel was set with a roughness value of 0.03n for clean, straight channels.

Where the existing buildings are present within the floodplain, a Manning's n roughness value of 0.1n was applied to the footprint of the building. This simulates the slowing of flow through vents, doors and other openings into the building. No terrain modifications were made to represent buildings within the model.

3.7.9 Structures

There are two structures present within the model domain, these being the bridge immediately upstream of the site and the Houston Road bridge downstream.

Each of these structures has been included in the model as a 1D (one-dimensional) feature, with a break line assigned perpendicular to flow to represent the overtopping weir. Each structure is set to a weir representing the overtopping level of the road, and an associated culvert barrel. The details of each structure are described below.

The upstream bridge has a 1.7m wide, 1.9m tall arched culvert orifice, with a weir set at the road deck level.

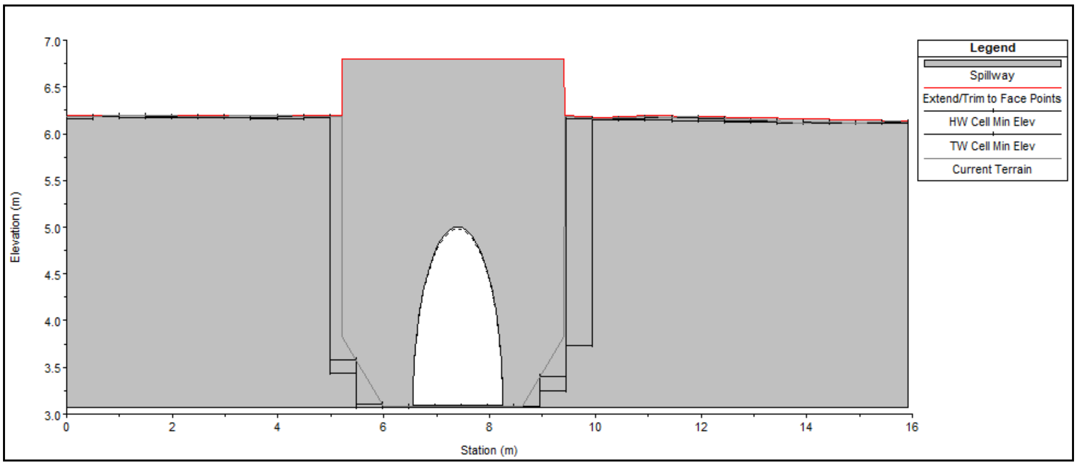

Figure D – 1D HEC-RAS Structure – Upstream Bridge

The downstream bridge has a 1.9m wide, 1.9m tall arched culvert orifice, with a weir set at the road deck level.

Figure E – 1D HEC-RAS Structure – Downstream Bridge

3.7.10 Computational Mesh

A 5m-by-5m computational mesh was assigned to the whole model domain. The profiles of the Lin Burn, River Gryffe and Black Cart Water were aligned through the use of central break lines and lateral bank break lines. The break lines served to orientate the grid cells perpendicular to flow and to refine the mesh resolution along the channels.

Each channel is represented by a minimum of eight cells at any cross-sectional location, however this is not necessary for accurate representation of the channels, due to HEC-RAS recognising sub-grid topography/bathymetry and creating more than 1 result per cell.

Figure F below shows an extract of the geometry file including the computational grid around the site.

Figure F – Extract of 2D Geometry with Computational Mesh

3.7.11 Computational Time Step

A fixed 0.5 second time step was applied as the computational time step. The results of the modelled outputs were reviewed for Courant Number violations and velocity spikes which could indicate instability. No instabilities were found within the modelled outputs and the model time step was assessed to be appropriate. The model simulation was set to run for 24 hours of the predicted peak flow estimation hydrographs. The simulation time allows for all the peaks, both fluvial and tidal, to pass and for receding water levels to be observed throughout the domain.

Comparison with a finer timestep of 0.2 seconds found that water levels and other key outputs remained consistent, indicating that the adopted timestep of 0.5 seconds is considered suitable.

3.7.12 Mass Balance Errors

HEC-RAS tracks the cumulative mass balance error throughout the simulation window. Mass balance errors and water surface elevation convergence errors were checked to ensure model stability and that imbalances remained below reasonable thresholds, confirming compliance with Courant Number criteria.

The maximum recorded Mass balance error is 0.0145% for the percentage error, well within tolerances. Computational Reports recording Mass Balance Errors for the modelled scenarios are contained within the Appendix.

3.7.13 Equation Set and Default Parameters

Unsteady plan files were run using the Shallow Water Equations with Eulerian-Lagrangian approach to solving for advection, the SWE-ELM (original/faster) equation set. The SWE-ELM (original/faster) equation set was chosen for the model in order to account for inertial terms resulting from the multidirectional flow paths inherent in the modelled area.

All other parameters were set to default values.

3.7.14 Projection

All geospatial input and output data are projected using the OSGB 1936 British National Grid.

3.7.15 Sensitivity Analysis

To assess the model sensitivity to various parameters, a series of sensitivity analyses was undertaken with respect to the flow, roughness coefficient and downstream boundary conditions.

Analysis of the watercourse was undertaken with a variety of flow rates (1 in 200-year, 1 in 500-year, 1 in 1000-year and 1 in 1000-year plus Climate Change Allowance events). Profile lines were drawn at the locations shown on Figure G and maximum water surface elevations recorded and shown on Table D.

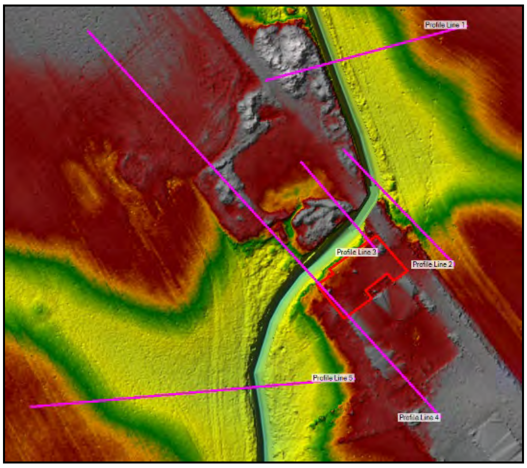

Figure F – Extract of 2D Geometry with Computational Mesh

Profile Line	Water Levels at site during fluvial storm events (m OD)				
	Q200	Q200+CCA	Q500	Q1000	Q1000+CCA
1	6.03	6.34	6.18	6.28	6.43
2	6.03	6.33	6.18	6.28	6.43
3	5.06	6.15	5.87	6.05	6.24
4	4.97	6.18	6.05	6.12	6.30
5	4.92	5.46	5.08	5.32	5.84

Table D – Flow Sensitivity Analysis

The variations in peak water level are in line with expectations. The 1 in 200-year flow is largely contained within the channel banks however, under more severe storm conditions, out of bank flows occur from higher water levels, leading to overland flow and inundation at site. The model is, therefore, not considered to be unduly sensitive to changes in peak flow. Figures 10 through 14 provide the extent of inundation during the considered storm events.

Analysis of the watercourse was undertaken with a +/-20% variation on the Manning's n values. The variation in maximum water surface elevation on the baseline scenario from the sensitivity analysis is up to 50mm at site. Such variation has negligible impact on the inundation extents at site. The model is, therefore, not considered to be unduly sensitive to changes in Manning's n value.

Further analysis of the watercourse was undertaken with variations on the downstream boundary condition. Analysis of the tidal impact was undertaken with a variety of tidal storm events (1 in 200-year with and without Climate Change Allowance, 1 in 500-year, 1 in 1000-year and 1 in 1000-year with and without Climate Change Allowance). Profile lines were drawn at the locations shown on Figure G and maximum water surface elevations recorded and shown on Table E:

Profile Line	Water Levels at site during fluvial storm events (m OD)				
	Q200	Q200+CCA	Q500	Q1000	Q1000+CCA
1	4.90	5.72	5.0	5.08	5.89
2	4.90	5.72	5.0	5.08	5.89
3	4.90	5.74	5.0	5.08	5.93
4	4.90	5.74	5.0	5.08	5.93
5	4.90	5.74	5.0	5.08	5.93

Table E – Tide Sensitivity Analysis

The variations in peak water level are in line with expectations. The tidal storm events are largely contained within the channel banks in the vicinity of site however, under the 1 in 1000-year plus Climate Change Allowance event, out of bank flows occur from higher water levels, leading to inundation at site. The model is, therefore, not considered to be unduly sensitive to changes in peak flow. The results of the tidal analysis in Section 3.2 are corroborated by hydraulic modelling.

Figures 15 and 16 provide the extent of inundation during the 1 in 1000-year tidal storm and the 1 in 1000-year tidal storm plus climate change scenario, respectively.

3.7.16 Velocity

Figure 17, contained within the Appendix records the maximum water velocities recorded throughout the model domain during the 1 in 1000-year fluvial storm event. As can be seen, maximum velocities throughout the domain are typically less than 1m/s. Highs of up to 5.26m/s are recorded in the vicinity of the large Barnsford Road and M8 structures, owing to the increase in velocity from passing through a constriction.

3.7.17 Froude Number

Figure 18, contained within the Appendix records the maximum Froude Number values throughout the model domain. Froude Numbers in excess of 1 are generally indicative of super-critical flow and have erosive potential, Froude Numbers of 1, or less, are generally indicative of sub-critical flow and have low erosive potential.

As can be seen from Figure 18, throughout the model the Froude Numbers are generally less than 1, indicating sub-critical flow and low erosive potential, as well as indicating a stable model. Froude Numbers in excess of 1 typically occur along the banks of the Black Cart water downstream of its confluence with the River Gryffe which may lead to erosion of the banks which is supported by observations made during the site walkover.

3.7.18 Courant Number

The maximum Courant Number values for the model were taken at time 6 hours and 30 minutes into the modelled run time; this is equivalent to the maximum inundation at the site. Courant Numbers are generally at or below 0.4 throughout the site and the immediate surrounding area. Courant Numbers less than 1 indicate stable model performance and sufficient timestep refinement to avoid any Courant Number violations in the hydraulic calculations. Courant numbers at or near 1 are associated with main channel flows, structures and areas of refined computational mesh grid sizes, such as within the channel of the Lin Burn.

A review of the Courant numbers confirms that the model is within acceptable tolerances, with all Courant values less than 3.0 as outlined in the HEC-RAS technical manual. This confirms that the timestep chosen is appropriate.

The maximum Courant Number values are shown on Figure 19, in the Appendix.

3.7.19 Model Results under Existing Conditions

As with all fluvial flood models, uncertainties remain that affect the relationship between flow rate and water level. The analysis must, therefore, be regarded as approximate whilst using the best available data at the time of reporting.

The 1 in 200-Year fluvial storm event constitutes the functional floodplain and should be avoided, whilst the 1 in 1000-year fluvial storm event constitutes the design storm event and influences design criteria.

The bridge immediately upstream of site constrains the peak flow in the channel and causes backing up of water, resulting in overtopping of the road and overland flow onto site through the site entrance. Flow entering site will wash across before falling back into the Lin Burn.

The peak water level during the 1 in 200-year fluvial event is recorded to be 6.03m OD at the site entrance, falling to 5.93m OD near the southern site corner.

The peak water level during the 1 in 1000-year fluvial event is recorded to be 6.27m OD at the site entrance, falling to 5.96m OD along the southwest boundary.

Elements of the site are at **Medium to High Risk** of fluvial flooding and lie within the functional floodplain, however, the expected depths are at or less than 70mm. The majority of the site is at **Low to Medium Risk** of fluvial flooding with depths up to 150mm within the site and up to 290mm at the site entrance.

Figures 10 and 13 show the fluvial inundation at site during the 1 in 200-year and 1 in 1000-year events, respectively.

3.7.20 Blockage Analysis

Under existing conditions, there are no sources that could significantly block the orifices of the two bridges. Thus, 15% and 30% blockages were considered reasonable for the sensitivity analysis if somewhat conservative. This was applied by reducing the span of the culverts, thus imposing a constriction to flow throughout the full hydrograph.

The blockage scenarios were considered for the both the 1 in 200-year and 1 in 1000-year fluvial storm events.

Under the 15% minor blockage scenario, the 1 in 200-year water levels at site rise by 20mm. Under the 30% major blockage scenario, the 1 in 200-year water levels rise by 170mm. The extent of inundation is not significantly increased under the minor blockage scenario. However, under the major blockage scenario, the vast majority of the site is inundated due to the overland flow path from the field to the northeast of site. Figures 20 and 21 provide the extent of inundation during the 1 in 200-year fluvial storm during the minor and major blockage scenarios, respectively.

Under the 15% minor blockage scenario, the 1 in 1000-year water levels at site rise by 50mm. Under the 30% major blockage scenario, the 1 in 1000-year water levels rise marginally by 90mm. The extent of inundation is not significantly increased under either of the scenarios.

4 DISCUSSION AND RECOMMENDATIONS

4.1 GENERAL

For new developments the acceptable risk of flooding should take into account various factors including risk to human health and the direct and indirect financial losses relating to flooding.

Under existing conditions, the risks from flooding at the site are defined as follows:

- The majority of the site is at **Little or No Risk** of flooding from an isolated extreme coastal flooding event. The northwest edge, adjacent to the Lin Burn, is at **Low to Medium Risk**.
- The site is at **Little or No Risk** of surface water flooding.
- The site is at **Little or No Risk** of flooding as a result of a failure in the local drainage network.
- The site is at **Little or No Risk** of isolated groundwater rise.
- The site entrance and along the southeast boundary are considered to be at **Medium to High Risk** of fluvial flooding. The majority of the site is at **Low to Medium Risk** of fluvial flooding from the Lin Burn.

While dry pedestrian and vehicular access and egress is compromised by functional floodplain, the anticipated depths will not be sufficient to prevent access to the site. Furthermore, this inundation on the access is limited to only the vicinity of site, with the remainder of the access road being free from flooding throughout all considered storm events.

4.2 DEVELOPMENT AND POSSIBLE FLOOD RESILIENCE MEASURES

The proposed redevelopment has been applied for under the land use classification 5, Most Vulnerable. To comply with this application, the following flood mitigation and flood resilience measures will be required to ensure there is minimal impact upon the flood storage, conveyance and risk to the proposed re-development and site neighbours.

The following design measures are required:

- No land raising within the functional floodplain within the site;
- A Final Ground Floor Level of 6.57mOD is recommended (providing a 300mm freeboard on the 1 in 200-year plus climate change event peak water level and a 350mm freeboard on the 1 in 1000-year event for the development).
- Use of Flood Resilient construction methods and materials for new building(s);
- Locating electrical equipment outwith estimated peak water surface elevations at a minimum of 6.87m OD, allowing for 600mm freeboard;
- Mandatory registration with SEPA Floodline for flooding alerts;
- Installation of bespoke flood monitoring alarm system to initiate site flood evacuation plan.

4.3 PHYSICAL WORKS ASSOCIATED WITH THE EXISTING WATERCOURSE

In relation to flood risk, the Water Environment (Controlled Activities) (Scotland) Regulations 2005 (CAR) may be affected by the development of the site. No earthworks shall be carried out within the banks of the Lin Burn without prior consultation with SEPA and the application of the relevant licensing guidance in relation to CAR.

Any construction works will likely require sediment control for surface water runoff to ensure watercourses are not impacted by increased sediment load as a result of construction activities. A pollution prevention plan or surface water management plan for construction may also be required. Early consultation with SEPA is recommended in relation to any proposed construction works to ensure compliance.

4.4 EFFECTS ON SITE NEIGHBOURS

The specifics of the proposed development are not known at this time. Due to the presence of existing made ground and impermeable surfaces, the proposed development cannot increase the hardstanding at site and therefore will not increase runoff. Any new buildings may present an obstruction to overland flow routes and this should be accommodated into the design and drainage management so as not to force water onto the adjacent property to the southeast.

The provision of Sustainable Drainage Systems will have a neutral or better impact on runoff from the site, as runoff will be attenuated to greenfield runoff rates which will be equal to or better than the existing conditions.

With a careful and considered approach, the development can achieve an overall neutral impact on the site neighbours.

4.5 OVERALL FLOOD RISK ASSESSMENT CONCLUSION

The Scottish Planning Policy notes that new developments should be free from significant flood risk from any source and that such development should not:

- materially increase the probability of flooding elsewhere;
- add to the area of land which requires protection by flood prevention measures;
- affect the ability of the functional floodplain to attenuate the effects of flooding by storing flood water;
- interfere detrimentally with the flow of water in the floodplain; or
- compromise options for future river management.

It has been established that parts of the site lie within the functional floodplain. Given that the access road to the site allows pedestrian and vehicular access during the design storm event, development of areas outwith the functional floodplain can be considered to be in line with the broad principles of Scottish Planning Policy.

Mandatory registration with the SEPA Floodline will be required as will the installation of a flood monitoring / alarm system in conjunction with a site evacuation plan and operation and maintenance policy highlighting flood risk responsibilities and mitigation actions. Bedrooms should not be located on the ground floor of any proposed residence, whether permanent or holiday, and it is recommended that flood resilient materials be used for the construction.

-oo000oo-

Terrenus Land & Water Ltd wishes to thank the Client Lyndsey Martin and Messrs Mabbett & Associates Ltd for the opportunity to prepare this report and trust that it meets with your requirements. However, should you wish to discuss the contents of the report then please do not hesitate to contact the undersigned.

Signed for and on behalf of

Terrenus Land & Water Ltd

pp [redacted]

Douglas Aitken

Director

[redacted]

William Hume

Director

APPENDICES

FIGURES

Site Location

Renfrewshire County Boundary

Atlas

Site Boundary

Google Satellite Hybrid

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Hamilton International Park
G72 0BN
www.terrenus.co.uk

Client:
Lyndsey Martin

Project:
East Fulwood Farm,
Inchinnan

Drawing Title:
Site Location Plan

Drawn:	Checked:	Approved:
JS	DA	DA

Date:
29/03/2022

Figure:
1

Spot Heights

Site Boundary

Google Satellite Hybrid

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Client:
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Project:
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Drawing Title:
Spot Heights Survey

Drawn:	Checked:	Approved:
JS	DA	DA
Date: 17/03/22	Figure: 2A	

Site Boundary

Spot Heights

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Project:
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Drawing Title:
Spot Heights Survey

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JS	DA	DA

Date: 17/03/22

Figure: 2B

Site Boundary

Comparison Points

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Drawing Title:
Survey Comparison Points

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Site Boundary

Flow Accumulation

HIGH

LOW

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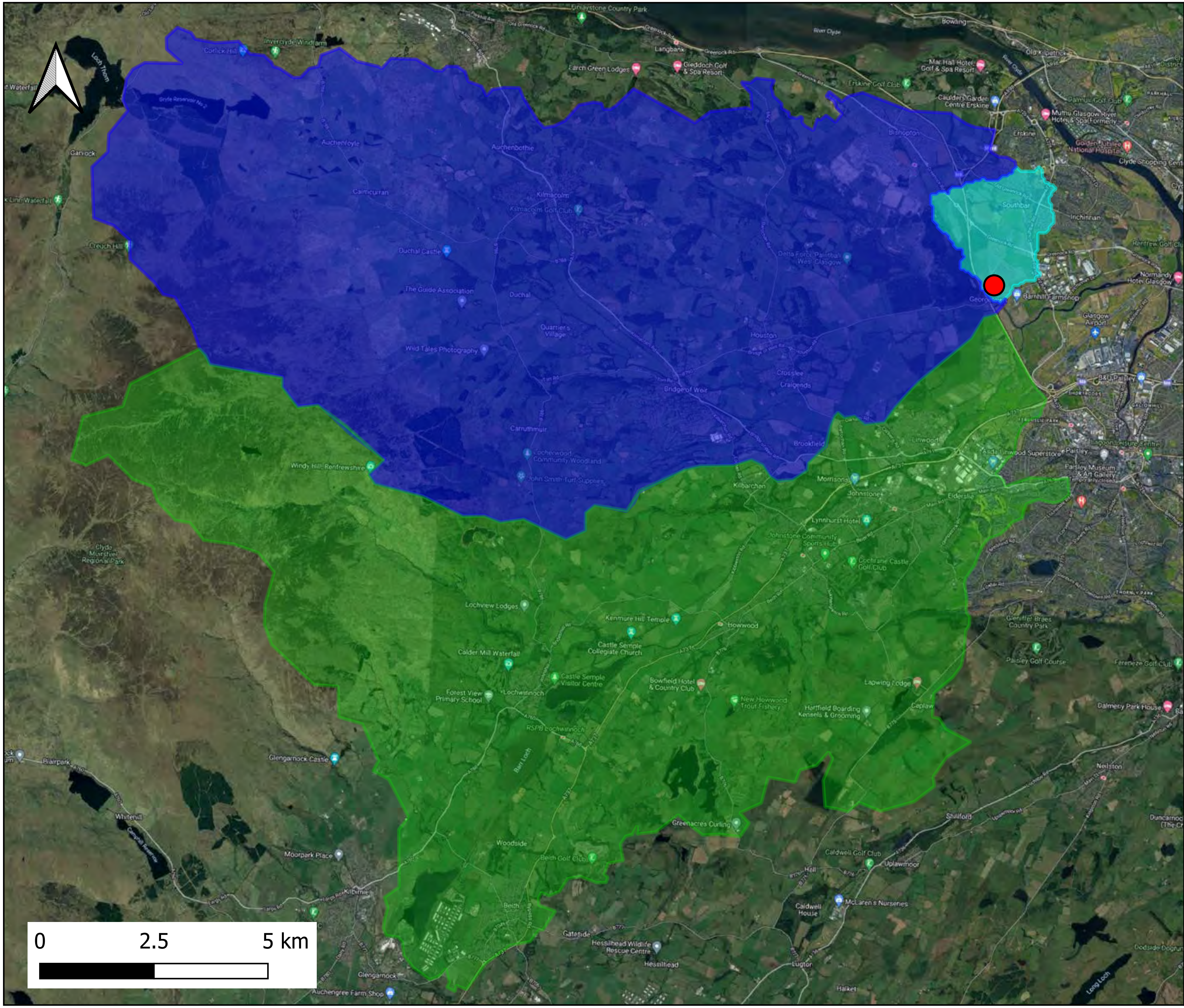
Drawing Title:
Flow Accumulation Pathways

Drawn:	Checked:	Approved:
JS	DA	DA

Date:
15/03/2022

Figure:
4



Site Location
Black Cart Catchment
Gryffe Catchment
Lin Burn Catchment

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Drawing Title:
Catchment Analysis

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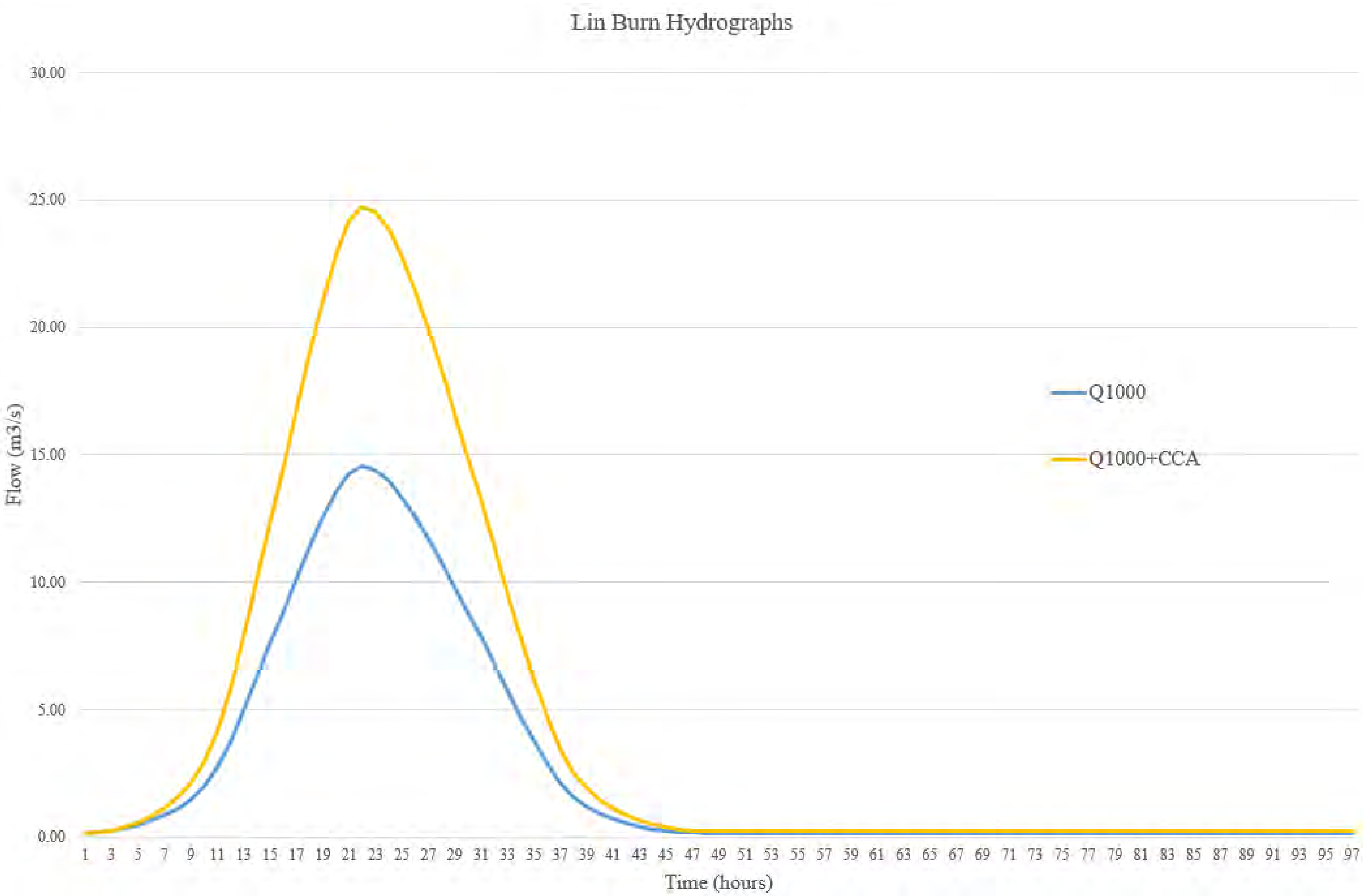
JS	DA	DA

Date:
15/03/2022

Figure:
5



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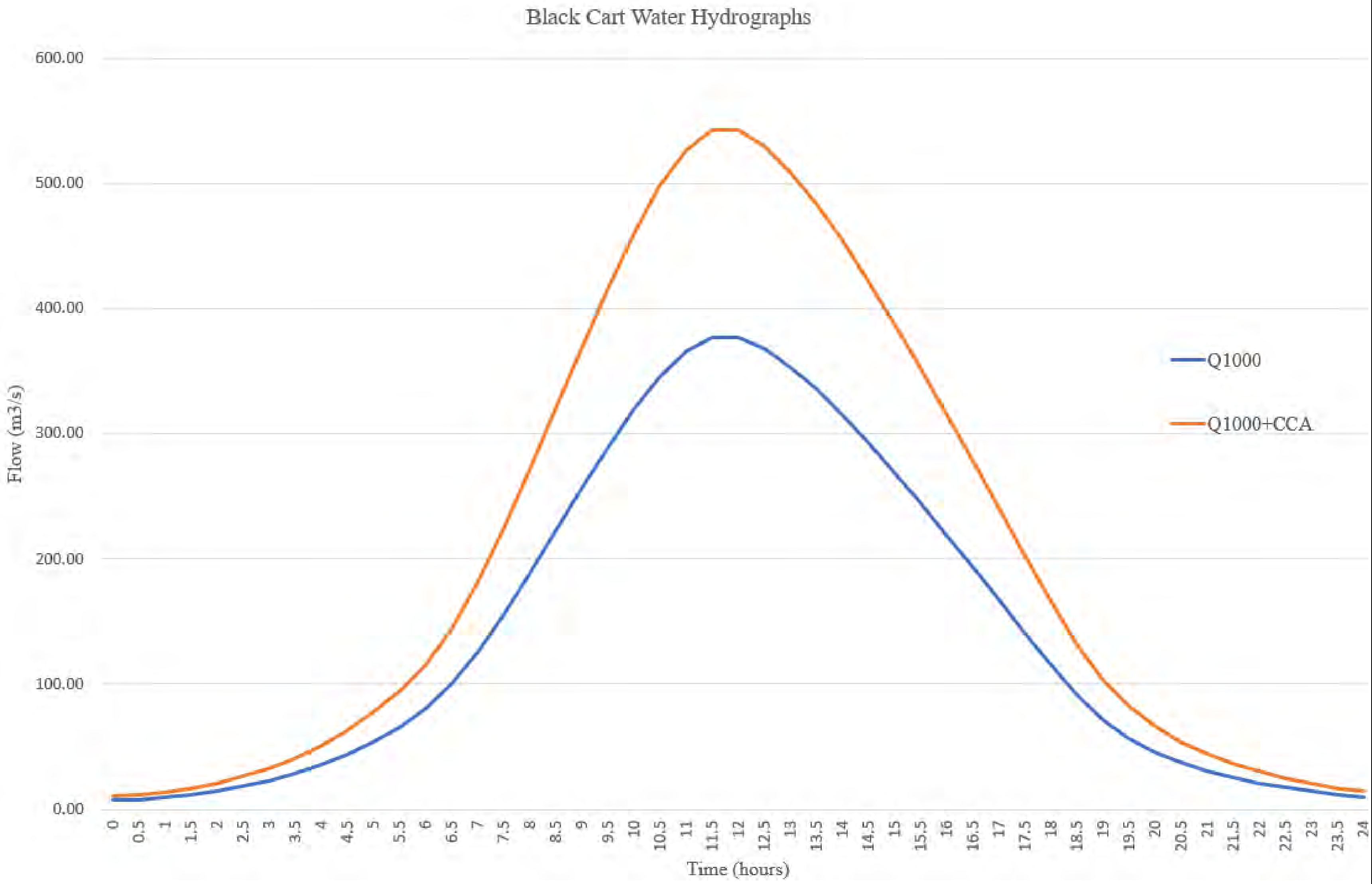
Drawing Title:
Lin Burn Hydrographs

Drawn: JS	Checked: DA	Approved: DA
Date: 29/03/2022	Figure: 6	



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Project:
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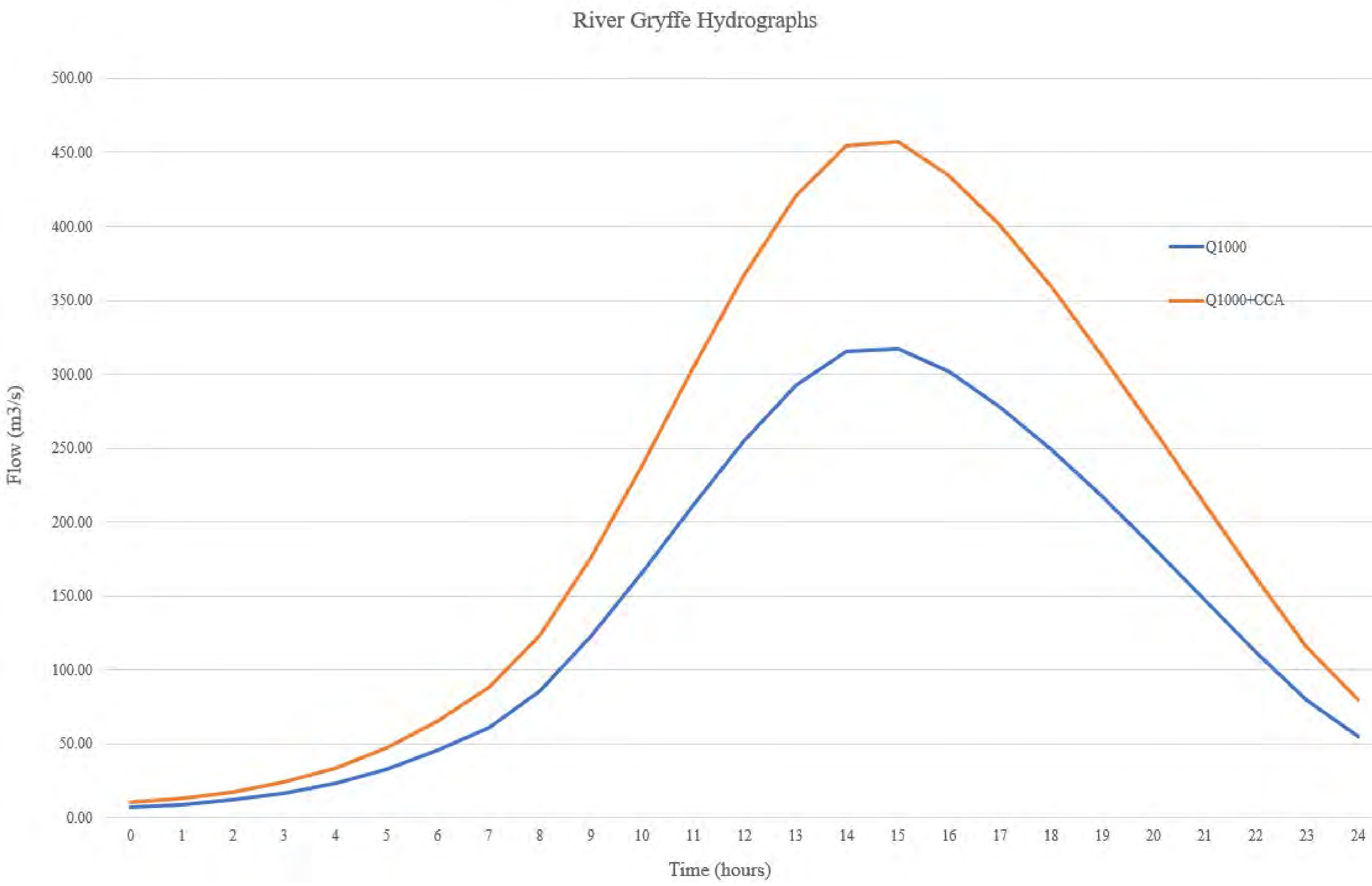
Drawing Title:
Black Cart Water Hydrographs

Drawn: JS	Checked: DA	Approved: DA
Date: 29/03/2022	Figure: 7	



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Project:
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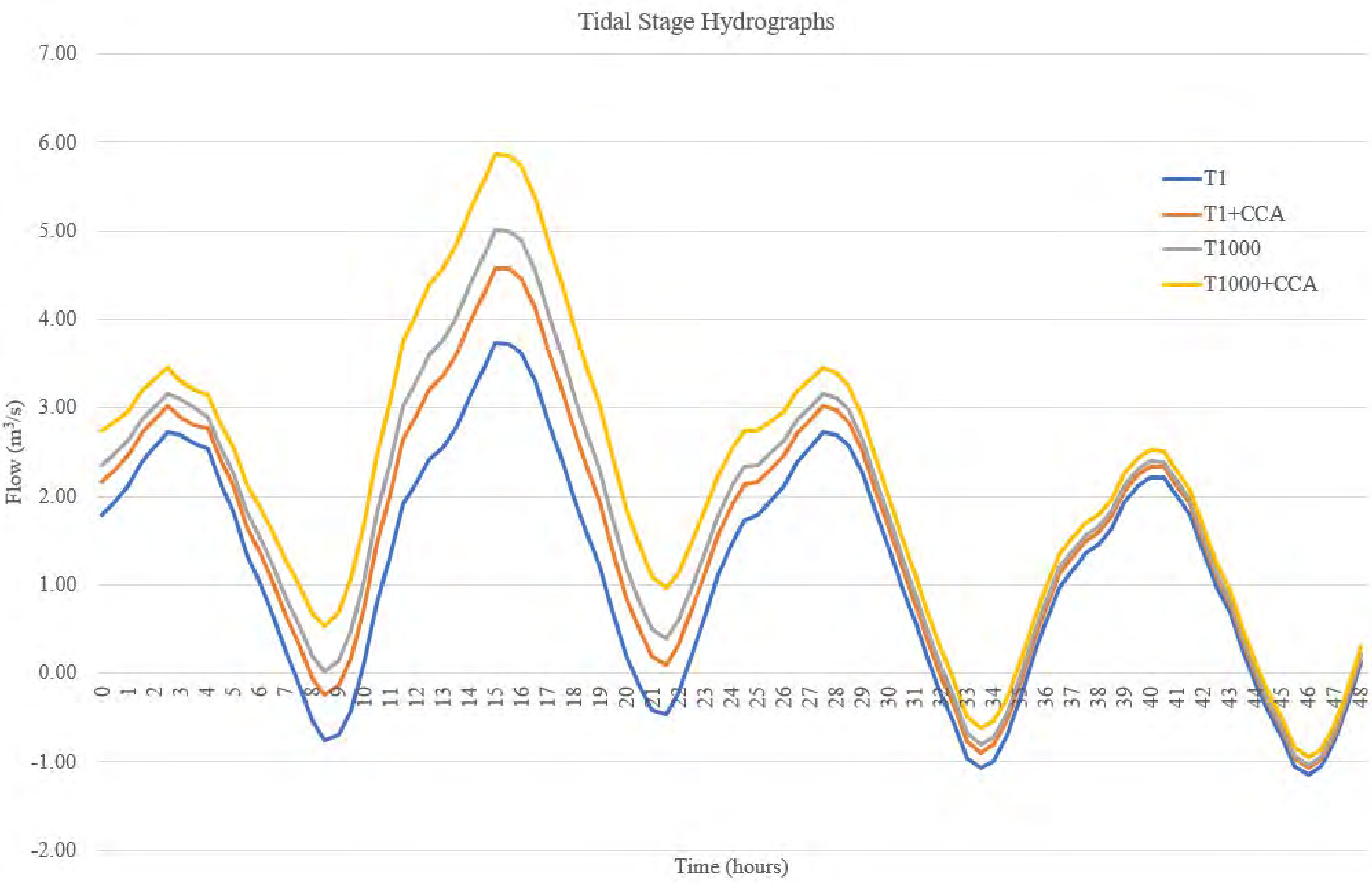
Drawing Title:
River Gryffe Hydrographs

Drawn: JS	Checked: DA	Approved: DA
Date: 29/03/2022	Figure: 8	



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Project:
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Drawing Title:
Tidal Stage Hydrographs

Drawn:	Checked:	Approved:
JS	DA	DA
Date: 29/03/2022	Figure: 9	

Site Boundary

Q200 Depth (Max)

3.0m

0.02m

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Drawing Title:
1 in 200-Year Fluvial Storm Event Inundation Extent - Site Specific

Drawn:	Checked:	Approved:
JS	DA	DA

Date: 29/03/2022

Figure: 10

Site Boundary

Q200 +CCA Depth (Max)

3.0m

0.02m

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Drawing Title:
1 in 200-Year plus Climate Change Allowance Fluvial Storm Event Inundation Extent - Site Specific

Drawn:	Checked:	Approved:
JS	DA	DA

Date:
29/03/2022

Figure:
11

Site Boundary

Q500 Depth (Max)

3.0m

0.02m

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Drawing Title:
1 in 500-Year Fluvial Storm Event Inundation Extent - Site Specific

Drawn:	Checked:	Approved:
JS	DA	DA

Date: 29/03/2022

Figure: 12

Site Boundary

Q1000 T1 Depth (Max)

3.0m

0.02m

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Project:
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Drawing Title:
1 in 1000-Year Fluvial Storm Event Inundation Extent - Site Specific

Drawn:	Checked:	Approved:
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Figure: 13

Site Boundary

Q1000 T1 +CCA Depth (Max)

3.0m

0.02m

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Client:
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Project:
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Drawing Title:
1 in 1000-Year plus Climate Change Allowance Fluvial Storm Event Inundation Extent - Site Specific

Drawn:	Checked:	Approved:
JS	DA	DA

Date:
29/03/2022

Figure:
14

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Client:
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Project:
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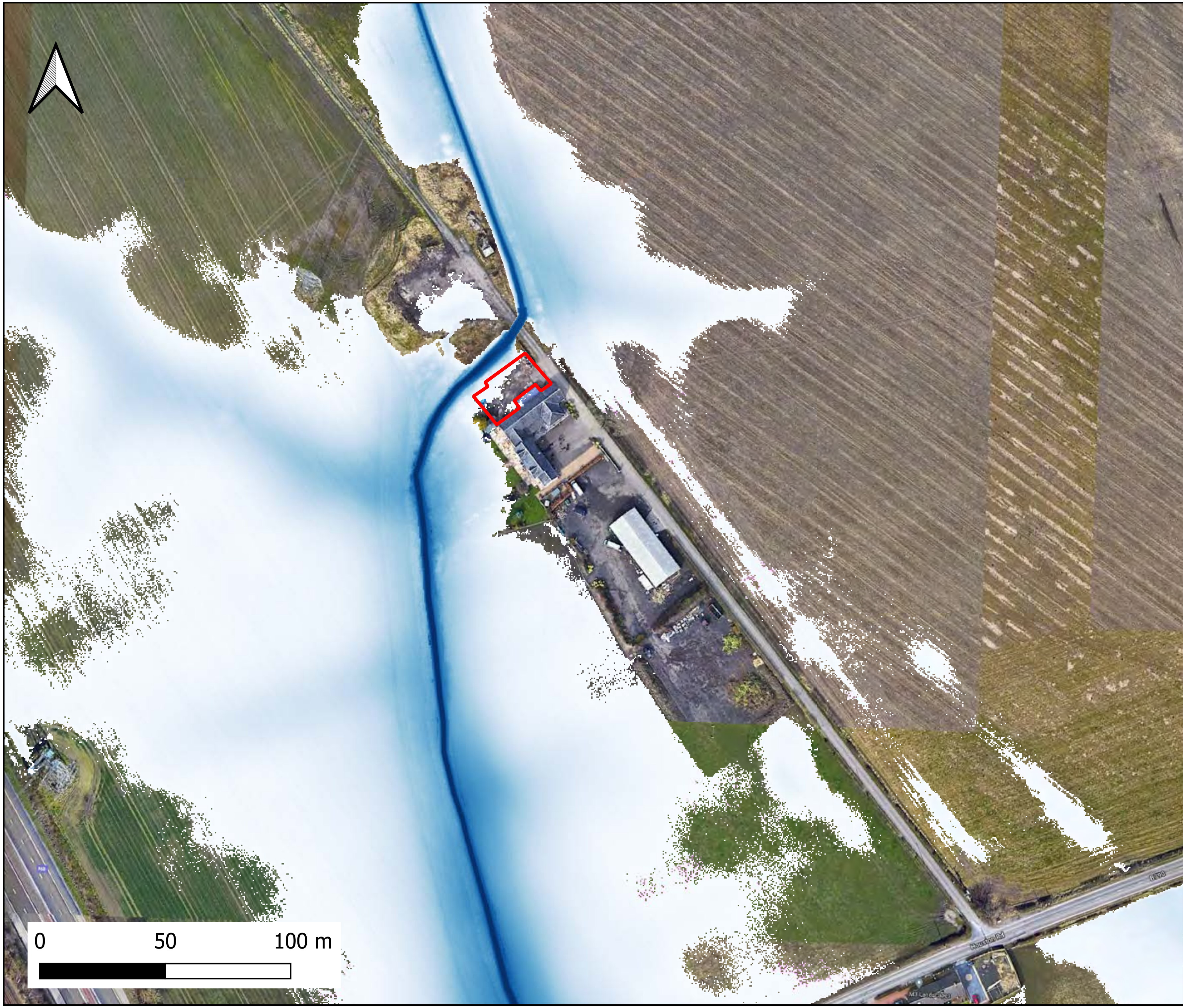
Drawing Title:
1 in 200-Year plus Climate Change Allowance Tidal Storm Event Inundation Extent - Site Specific

Drawn:	Checked:	Approved:
JS	DA	DA

Date: 29/03/2022

Figure: 15



Site Boundary

T1000 +CCA Depth (Max)

3.0m

0.02m

Google Satellite Hybrid

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Client:
Lyndsey Martin

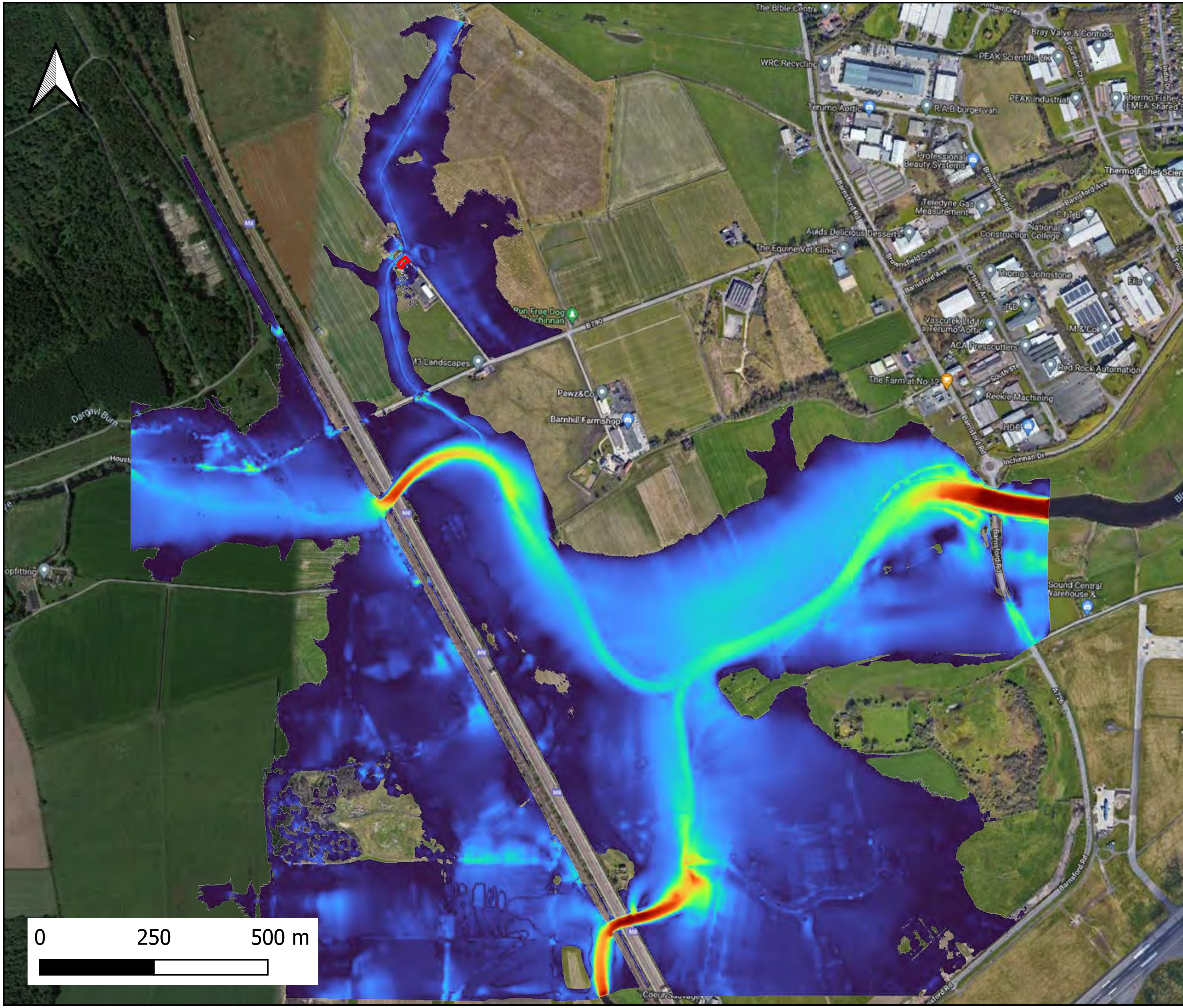
Project:
East Fulwood Farm, Inchinnan

Drawing Title:
1 in 1000-Year plus Climate Change Allowance Tidal Storm Event Inundation Extent - Site Specific

Drawn:	Checked:	Approved:
JS	DA	DA

Date: 29/03/2022

Figure: 16



Site Boundary

Q1000 T1 Velocity (Max)

5.0m/s

0.001m/s

Google Satellite Hybrid

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Client:
Lyndsey Martin

Project:
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Drawing Title:
1 in 1000-Year Fluvial Storm Event Maximum Water Velocity

Drawn:	Checked:	Approved:
JS	DA	DA

Date:
29/03/2022

Figure:
17

Site Boundary

Q1000 T1 Froude (Max)

1

0

Google Satellite Hybrid

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Project:
East Fulwood Farm, Inchinnan

Drawing Title:
1 in 1000-Year Fluvial Storm Event Froude Sensitivity Analysis

Drawn:	Checked:	Approved:
JS	DA	DA

Date:	Figure:
15/03/2022	18

Site Boundary

Courant V-L 18 30

1

0

Google Satellite Hybrid

Terrenus Land & Water Ltd
Hamilton International Park
G72 0BN
www.terrenus.co.uk

Client:
Lyndsey Martin

Project:
East Fulwood Farm, Inchinnan

Drawing Title:
1 in 1000-Year Fluvial Storm Event Courant Sensitivity Analysis

Drawn: JS	Checked: DA	Approved: DA
Date: 29/03/2022	Figure: 19	

Site Boundary

Q200 Minor Block Depth (Max)

3m

0.02m

Google Satellite Hybrid

terrenus land & water

Terrenus Land & Water Ltd
Hamilton International Park
G72 0BN
www.terrenus.co.uk

Client:
Lyndsey Martin

Project:
East Fulwood Farm, Inchinnan

Drawing Title:
1 in 200-Year Fluvial Storm Event Inundation Extent - Minor Blockage Analysis

Drawn:	Checked:	Approved:
JS	DA	DA

Date:
29/03/2022

Figure:
20

Site Boundary

Q200 Major Block Depth (Max)

3m

0.02m

Google Satellite Hybrid

Terrenus Land & Water Ltd
Hamilton International Park
G72 0BN
www.terrenus.co.uk

Client:
Lyndsey Martin

Project:
East Fulwood Farm, Inchinnan

Drawing Title:
1 in 200-Year Fluvial Storm Event Inundation Extent - Major Blockage Analysis

Drawn:	Checked:	Approved:
JS	DA	DA

Date:
29/03/2022

Figure:
21