
Hollins Paper Mill Site Darwen Lancashire

Flood Risk Assessment

Client:

Gleeson Homes (North West) Ltd
Sandringham House
Little 66
Bury
BL9 8RN

Prepared by:

joc consultants ltd

Park Farm House
Leathley Lane
Leathley
Otley
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REVISION HISTORY

Revision	Date	Details
00	24 th November 2016	First issue
01	28 th July 2017	Updated site layout plan

SITE	Hollins Paper Mill site, Hollins Grove Street, Darwen, Lancashire
PURPOSE OF THIS REPORT	This site-specific flood risk assessment is required in connection with a planning application to Blackburn with Darwen Borough Council for residential development of the site.
PLANNING APPLICATION NUMBER	Not yet issued
ANNEXES TO THIS REPORT	
Annex A	Figures 1 to 5
Annex B	Topographical Survey Plan
Annex C	Extract from the ground investigation review letter dated 26 th August 2016 by Eastwood and Partners.
Annex D	Site Layout Plan
Annex E	Environment Agency fluvial flood map
Annex F	Surface water run-off volumes: Tables F1 to F8
Annex G	UK SUDS estimates of greenfield run-off rates
SITE LOCATION AND DESCRIPTION	See Figure 1 at Annex A.
National Grid Reference	368924E, 423720N

Gross Site Area	6.28ha
General description	The site is bounded by Lower Eccleshill Road and Hollins Grove Street along its eastern boundary. The land to the north and north-west is former industrial land and to the south-west there is woodland.
Ground surface	Approximately: 60% permeable surface. 40% impermeable surface comprising former vehicle parking areas, building footprints and roadways.
Topography	Ground levels generally fall towards the west from around 155.0m AOD at the eastern boundary with Lower Eccleshill Road to around 140.0m AOD at western boundary with existing buildings. (See topographical survey plan at Annex B).
Ground conditions	The site comprises made ground overlying boulder clay overlying mudstone and sandstone of the Lower Coal Measures. The sandstone occurs in the NW third of the site with the mudstone elsewhere. There is evidence of soil contamination linked to the previous industrial uses of the site. (See extract from the review of previous ground investigations in Annex C).
History	The site was in industrial use since the mid 19 th century but was cleared of its buildings by 2013.
Watercourses	The River Darwen flows northwards approximately 40m to the west of the western boundary. The river flows in open channel to the SW of the site before entering a culvert and re-emerging into open channel to the NW of the site. The River Darwen has Main River status and is therefore regulated by the Environment Agency. The right bank level upstream of the culvert is recorded on the topographical survey to be 130.29m AOD. An unnamed ordinary watercourse issues (possibly from a culvert) at the boundary with Hollins Grove Street and flows westward adjacent to the SW boundary of the site, towards the River Darwen before entering a sink hole.

Reservoirs and Canals	<p>There is a cluster of industrial reservoirs to the SW of the site, on the left bank of the River Darwen.</p> <p>There are no canals in the vicinity of the site.</p>
Existing site drainage	<p>Any former site drainage is unlikely to remain functional following demolition and clearance of the site.</p>
THE DEVELOPMENT	<p>A development of 151 dwellings is proposed as shown in the Site Layout Plan at Annex D.</p> <p>The impermeable area will be approximately 50% of the gross site area.</p>
VULNERABILITY CLASSIFICATION	<p>The development is classified as 'More Vulnerable', in accordance with Table 2 of the Technical Guidance to the National Planning Policy Framework (NPPF).</p>
FLOOD ZONE	<p>Flood zone 1.</p> <p>See Environment Agency flood map at Annex E.</p>
REQUIREMENT TO CONSULT THE ENVIRONMENT AGENCY	<p>Not required when the development is in flood zone 1.</p>
REQUIREMENT FOR THE SEQUENTIAL TEST	<p>Not required when the development is in flood zone 1.</p>
REQUIREMENT FOR THE EXCEPTION TEST	<p>In accordance with Table 3 of the NPPF Technical Guidance, there is no requirement for the Exception Test.</p>
HISTORY OF FLOODING	<p>No known incidents.</p>
FLUVIAL FLOODING	
Functional floodplain	<p>The site is not in the functional floodplain.</p>
Annual probability of fluvial flooding	<p>0.1% or less.</p>
Flood defences	<p>None</p>

Fluvial flood hazard None

Loss of floodplain storage None

Obstruction to overland flow routes None

Flood warning area The site is not in a flood warning area.

SURFACE WATER FLOODING

Risk of surface water flooding

The Environment Agency surface water flood map indicates a generally 'Very Low' risk except for a small isolated area where a 'High' risk is indicated adjacent to one of the former buildings in the western part of the site.

There is also a small isolated area adjacent to Hollins Grove Street where a 'Low' risk is indicated.

Flood depths in both areas are indicated to be less than 300mm.

No surface water flooding is indicated elsewhere on the site.

Critical Drainage Areas

The site is understood to be not in a critical drainage area.

GROUNDWATER FLOODING

Groundwater flooding occurs when the water table rises above the ground surface or enters basements. It is typically associated with highly permeable rock such as chalk and highly fissured limestone, but these conditions are not present at the site.

The risk of this type of flooding is assessed to be low (less than 0.1%).

SEWER FLOODING

Sewer flooding can occur when the capacity of the sewerage system is exceeded by exceptional rainfall. The capacity of the local sewers will, from time to time, be exceeded, but this is unlikely to occur more frequently than once in 30 years.

In the event that sewer capacity is exceeded, there will be overland flow in the highway, following the natural gradient. The entrance to the site is at a high point of 154.80m AOD in Hollins Grove Street, from which levels fall towards the SW and NE. It is therefore unlikely that surface water resulting from sewer flooding would enter the site.

The risk of this type of flooding affecting the site is assessed to be low.

FLOODING FROM RESERVOIRS AND CANALS

The Environment Agency flood map shows the site is not in an area affected by the uncontrolled release of water from a reservoir.

The site is not in an area at risk from the uncontrolled release of water from canals.

EFFECT OF THE DEVELOPMENT ON FLOOD RISK

Fluvial and tidal flood risk

No effect

Surface water flood risk

It is estimated that the development will increase surface water run-off volumes by approximately 11% overall, as shown in Tables F1 - F4 at Annex F and Figures 2 and 3. This is due to an increase in the impermeable of approximately 26%.

Groundwater flood risk

No effect

Sewer flooding risk

No effect

EFFECT OF CLIMATE CHANGE

Climate change must be considered over the expected lifetime of the development which, for residential development is defined to be 100 years in paragraph 026 of the Planning Practice Guidance. Climate change must therefore be considered up to 2117.

New guidance on the application of climate change allowances was issued in February 2016 and updated on 3rd February 2017. The guidance provides the anticipated changes to peak river flow and rainfall intensity for

different scenarios of carbon dioxide emissions over future epochs up to 2115.

The effects of climate change on peak river flow are not relevant to this FRA as the site is not at risk from fluvial flooding.

The new guidance requires the Central and Upper End allowances to be used when assessing the effects of increases to peak rainfall intensities. The allowances apply across the whole of England and in the period 2070 to 2115 are:

- Central allowance: 20%
- Upper end allowance: 40%

The detailed drainage design must therefore take into account the range of climate change effects on rainfall intensity.

The effect of the new climate change allowances on surface water run-off is shown in Figures 4 and 5.

FLOOD RISK MANAGEMENT

Fluvial flood risk

No recommendations

Surface water flood risk

The effect of the development on surface water flood risk can be mitigated by the inclusion of sustainable drainage principles in the detailed drainage design. Ground conditions suggest that the disposal of surface water to ground by infiltration is unlikely to be feasible, owing to the presence on contaminated made ground overlying low permeability soils.

Controlled discharge rate

The rate of discharge of surface water will be subject to agreement by the Lead Local Flood Authority if disposal is to the ordinary watercourse at the southern boundary of the site.

The UK SuDS model estimates greenfield run-off rates to be as follows:

Q-bar: 64.0 l/s

1 in 1 year: 55.7 l/s

1 in 30 years: 108.8 l/s

1 in 100 years: 133.2 l/s

(See Annex G)

Attenuation storage

Attenuation storage may be required, and the form that this will take will be a matter for the detailed design of the drainage system. Preliminary estimates of attenuation storage, based on the average of the central and upper end CCA and assuming a controlled discharge to the watercourse at greenfield rates are as follows:

- 1 in 30 years event: 858m³
- 1 in 100 years event: 1,423m³.

See Tables F5 to F8 (Annex F) and Figures 4 and 5.

Residual surface water flood risks

The detailed drainage design should ensure that exceedance flow routes are managed to minimise risks to people and property.

Groundwater flood risk

No recommendations.

Sewer flooding risk

No recommendations.

Reservoir flood risk

No recommendations.

CONCLUSIONS

1. The development classification is **More Vulnerable**.
2. The site is in flood zone 1 where the annual probability of fluvial flooding is less than 0.1%.
3. There is no requirement for the Environment Agency to be consulted on this development.
4. There is no requirement for the development to be subjected to the Sequential Test or the Exception Test.
5. There is no evidence of the site having been affected by flooding in the past.
6. The annual probability of surface water flooding within the site is indicated to be 'Very Low' except for a small isolated high risk area adjacent to a former building towards the west of the site.

There is also a 'Low' risk area adjacent to the boundary with Lower Eccleshill Road.

The risk of surface water flooding in these areas will be alleviated by the drainage system for the development.
7. The risk of groundwater flooding is assessed to be low.
8. The risk of sewer flooding is assessed to be low.
9. The site is not in an area at risk of flooding from reservoir failure.
10. The site is not in a flood warning area.
11. The development will create impermeable area amounting to approximately 50% of the gross area. This could increase rapid response run-off volume by approximately 11% but the effect of this can be mitigated by the implementation of sustainable drainage principles.

12. The disposal of surface water to ground by infiltration is unlikely to be feasible, owing to the presence on contaminated made ground overlying low permeability soils. A surface water discharge to the ordinary watercourse at the south-west corner of the site is likely to be the preferred option for surface water disposal.
13. Preliminary estimates of attenuation storage, based on greenfield run-off rates indicate 109m³ and 133m³ for the 1 in 30 and 1 in 100 years events respectively.
14. Subject to the implementation of the flood risk management measures recommended in this report, the development will not increase flood risk elsewhere.

RECOMMENDATIONS

1. A detailed drainage design should be prepared and submitted to Blackburn with Darwen Borough Council and United Utilities for approval, prior to construction of the development.
2. The flood risk management measures recommended in this report should be implemented in the design and construction of the development.

USE OF REPORT

This report is prepared specifically for Gleeson Homes (North West) Ltd for the purpose of the aforementioned planning application and the report may not be used for any other purpose and it may not be assigned to any third party without our written permission.

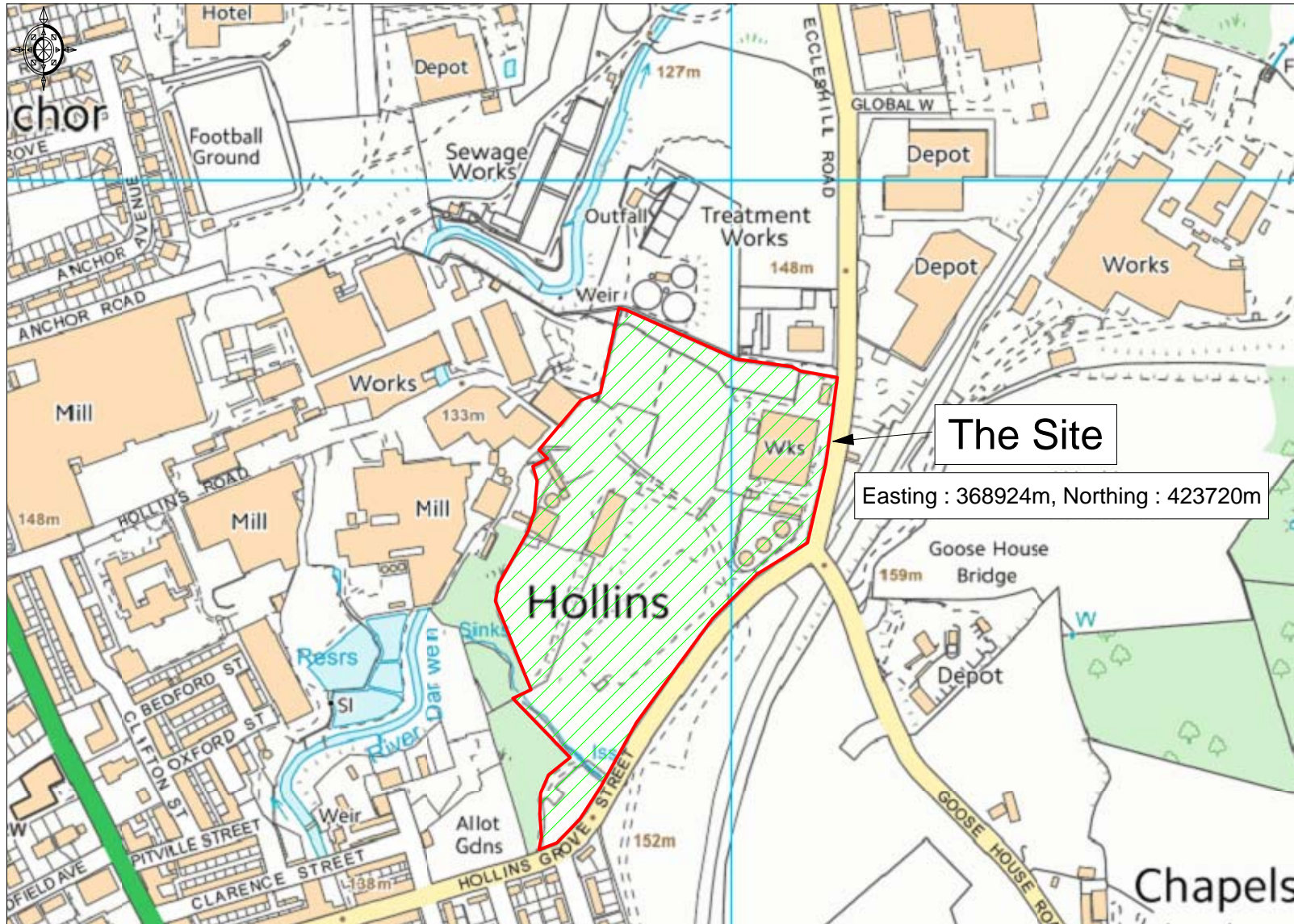
DISCLAIMER

This flood risk assessment is based on data available at the time of its preparation and JOC Consultants Ltd accepts no liability for the consequences of any changes to or re-assessment of this data in the future.

ANNEX A

Figures 1 to 5

Hollins Paper Mill, Darwen, Lancashire, BB3 0BE

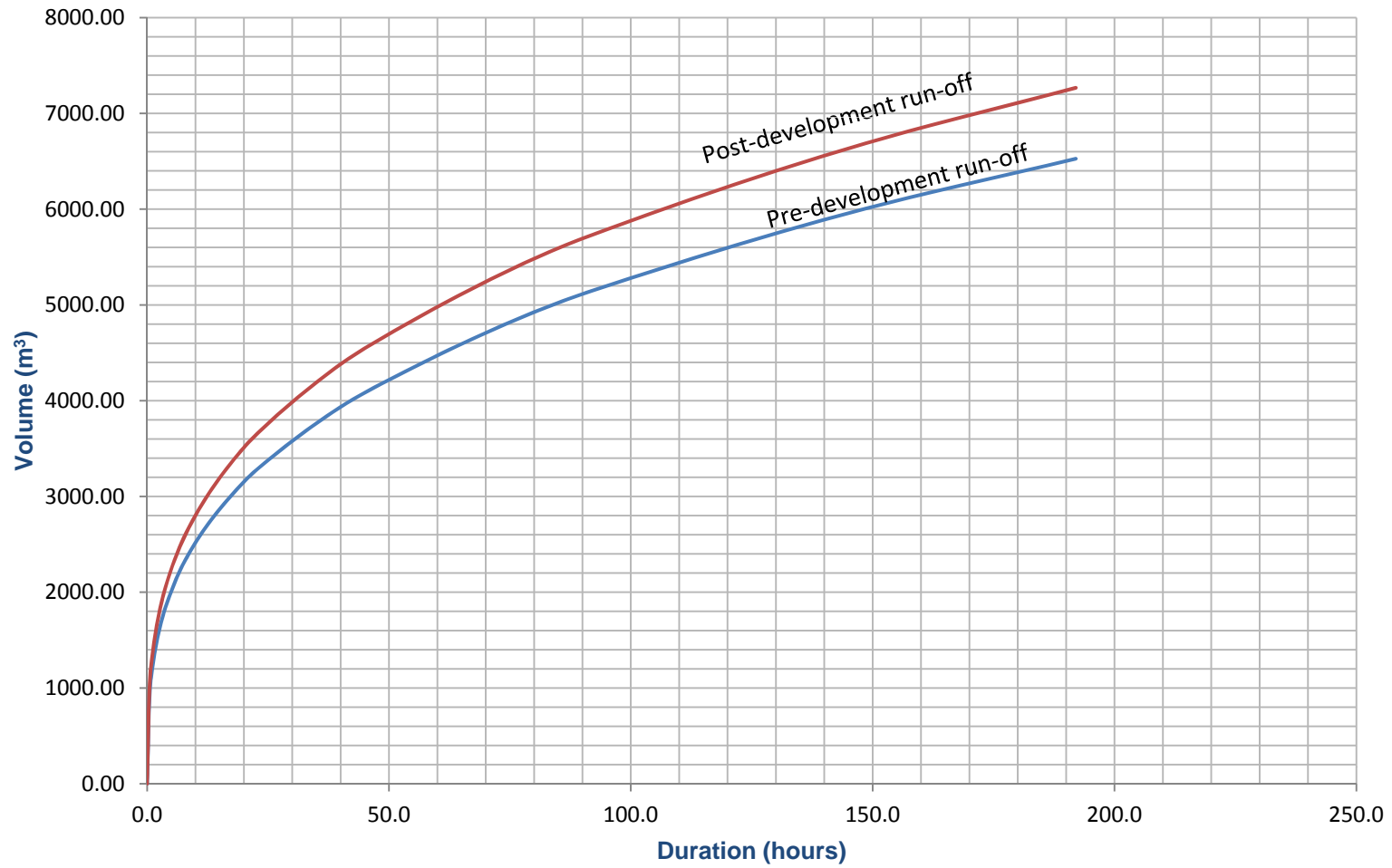


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Figure 1: Location Plan

**Figure 2: Effect of the development on rapid response surface water run-off
(3.3% A.E.P event)**



**Figure 3: Effect of the development on rapid response surface water run-off
(1% A.E.P. event)**

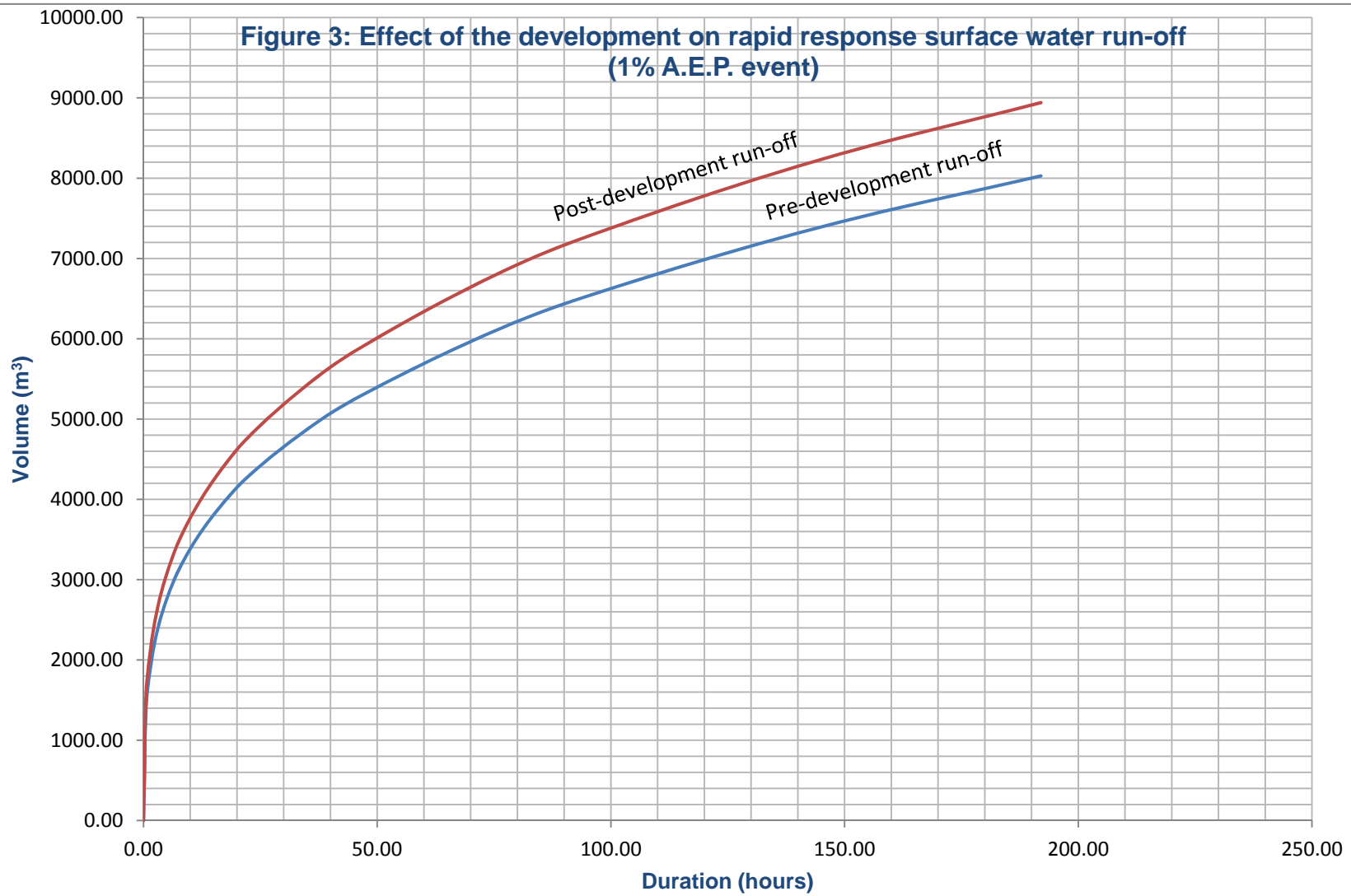


Figure 4: Surface water run-off from a 3.3% A.E.P. rainfall event including CCA (post-development)

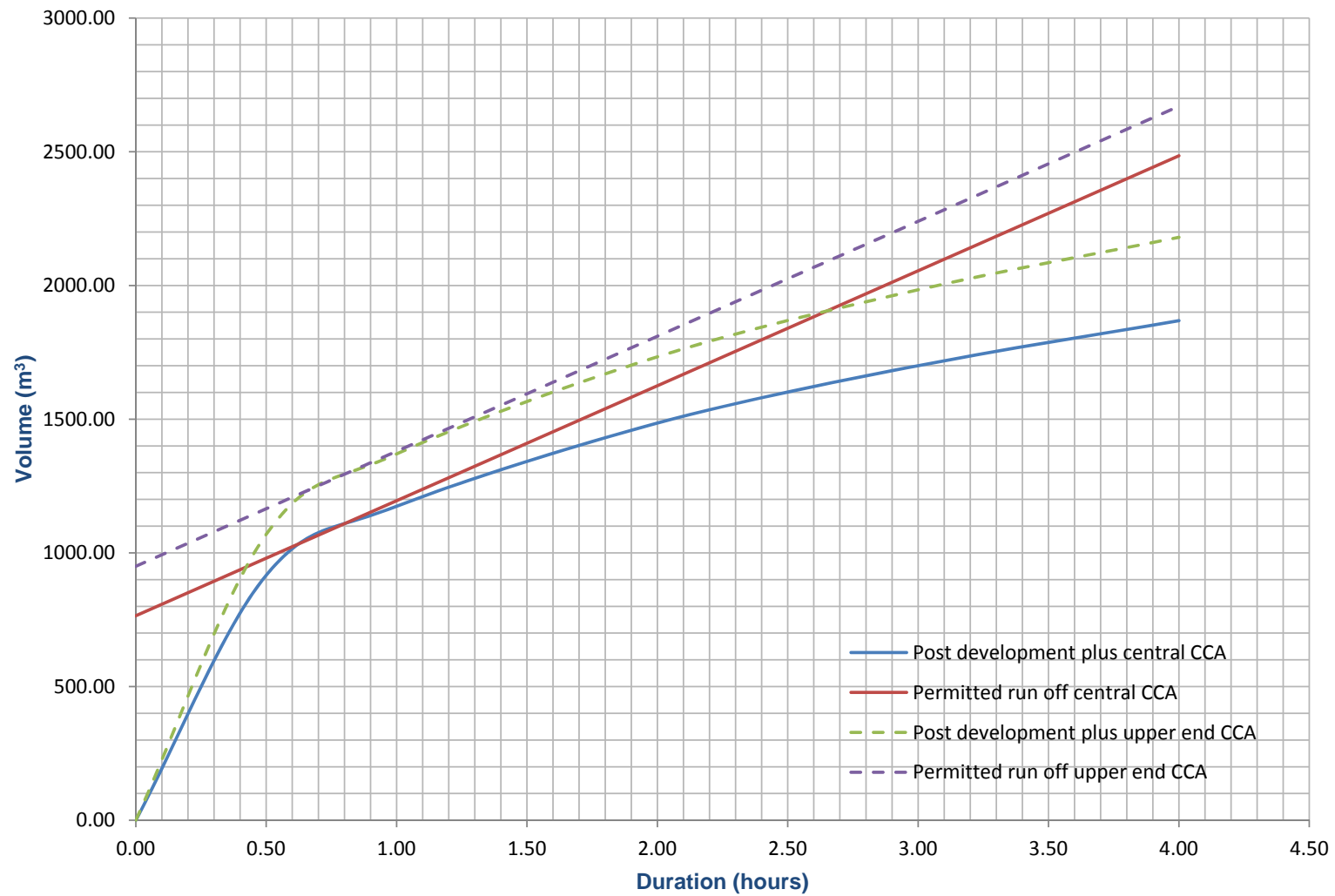
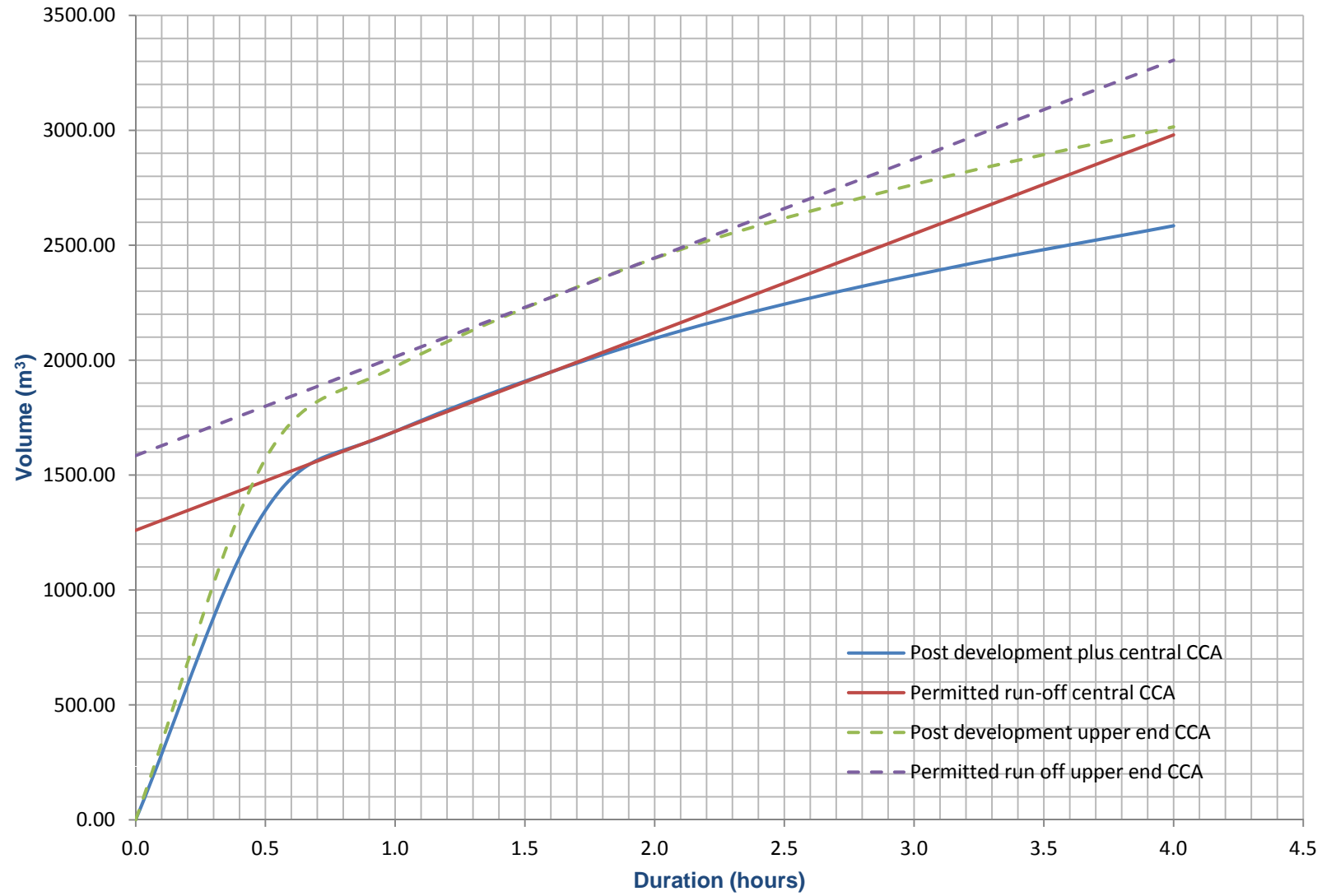
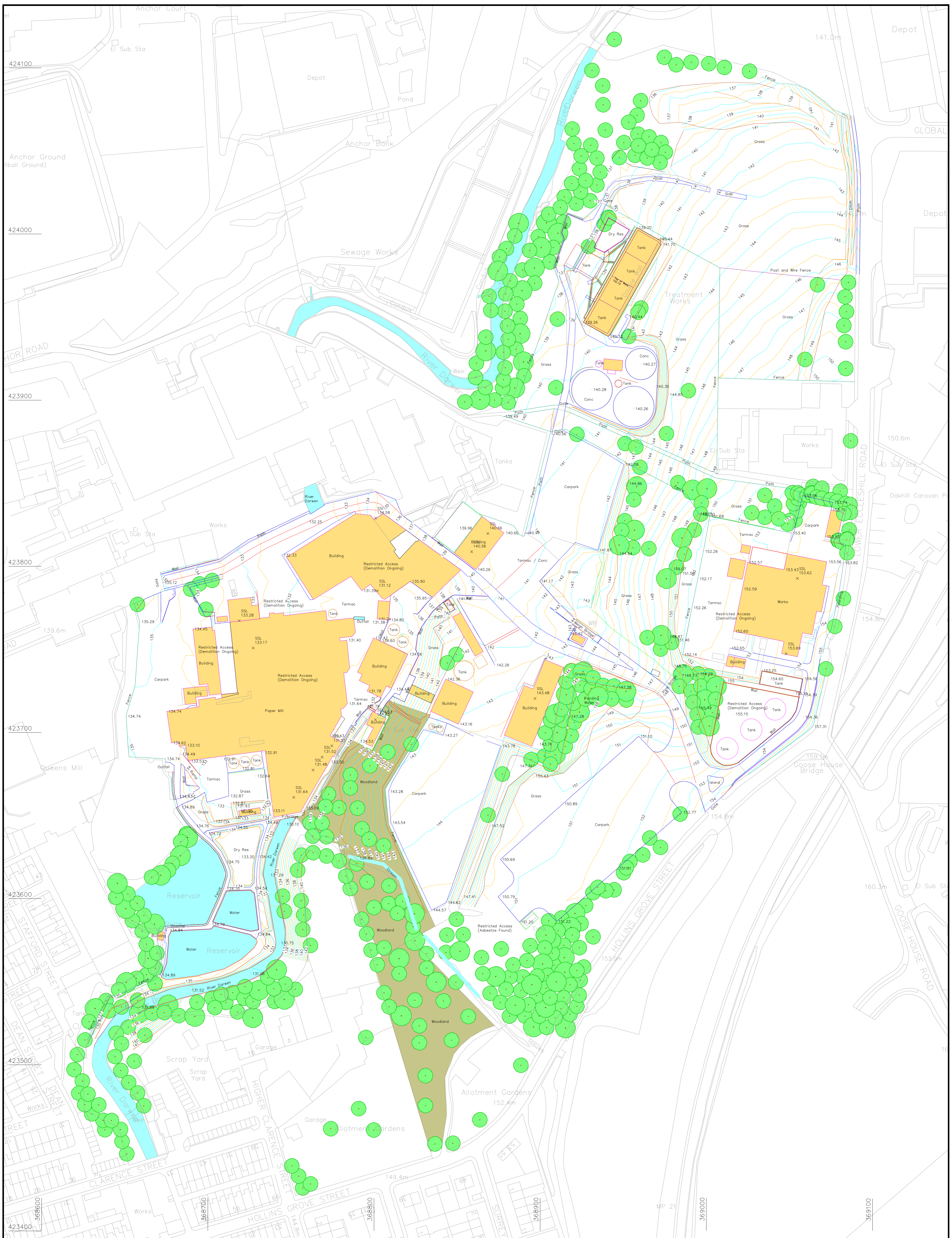


Figure 5: Surface water run-off from a 1% A.E.P. rainfall event including CCA (post-development)



ANNEX B

Topographical Survey Plan



NOTES:

1. SURVEY UNDERTAKEN FEB-MARCH 2013
2. COORDINATE SYSTEM : OSGB36 (02) National Grid
3. ACCESS TO BUILDINGS RESTRICTED - LEVELS TBC FOLLOWING DEMOLITION
4. 'SSL ????' INDICATES STRUCTURAL SLAB LEVEL (BUILDINGS)
5. CONTOURS INDICATED AT 0.5m Minor AND 1m Major

Scale	1:1000	Project	DARWEN PAPERMILL	
Drawn	SB	Title	SITE SURVEY - MARCH 2013	
Date	18/03/2013	Drawing Number	BES/B823/001	Revision
Paper Size	A1			0

111 Poynter Street
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Benchmark
 Engineering Services Limited
 Survey, Setting-Out, Measurement, CAD Drafting & Modelling

ANNEX C

Extract from the ground investigation review

Eastwood and Partners review letter dated 26th August 2016



1 report. It was concluded that severe widespread contamination was not present, but small localised hotspots were present in the former pulp tipping area and the power station.

Site Description

The site is located off Hollins Road and west of Hollins Grove Street and Lower Eccleshill Road. At the time of the March 2013 Ground Investigation, the site was predominantly surfaced with hard-standing. The 2013 report states that the works manufactured and recycled paper until September 2012. The premises on site were used for paper manufacturing and offices. A de-inking facility was located in the centre of the site, an effluent treatment plant in the north and central power station in the east of the wider site.

The River Darwen is culverted through the centre of the larger site area.

The site of interest to Gleeson Developments is estimated to be around 6.3 hectares and is centred on grid reference 368976, 423708.

A topographical survey covering the majority of the site has been reviewed. The former lorry park area lies at around 152.5 m AOD, falling to around 150 m AOD in the north west (around 1 in 40). Ground levels then drop steeply to around 144 m AOD (around 1 in 3). North of the site, the ground level around the former buildings and tanks was around 153 to 155 m AOD, dropping down to 145 m AOD further west at around 1 in 7 before reaching a 3 m high embankment in the centre of this part of the site. West of the embankment, ground levels are fairly level at around 141 m AOD. The proposed development plan appears to take these central embankments already into account.

History

In the early 19th Century, the Phase 1 report notes that the area was predominantly used for the textile industry, and the mill was once a bleach works before it closed in 1840. The buildings were then used to print wallpaper during the mid-1840s. The power station was added in the 1960s.

The early 19th Century maps show two large reservoirs constructed in the southern half of the site, with steep embankments along the northern and western edges indicating a drop in ground level towards the west and north. A well is also shown north of the reservoirs.

Within the wider area, a brick works and clay pit are present around 150 m north and north east of the site, with a railway line shown just off the eastern boundary. The mills in the west are also shown, as is the River Darwen. A small sandstone quarry is recorded to the north west of the site.



By the 1930s, the mills to the west had expanded significantly. Spoil is shown on site east of the reservoirs. The southern corner of the site appears to be gardens or allotments. Tanks are shown north of the reservoirs by the 1950s, and the spoil extends south along the eastern boundary. The 'electricity works' (power station) is shown by the 1960s in the east of the site, with a cooling tank, pipe line and three large circular tanks shown south of the works. The reservoirs appear to have been infilled between 1975 and 1989.

We understand the mill ceased manufacturing in 2012. Aerial photos indicate the site was cleared of buildings except for a tall chimney by 2013.

Geology

According to the British Geological Survey Online Viewer and geological map Sheet 76, superficial Boulder Clay covers the site.

The solid geology below comprises Lower Coal Measures (mudstone) strata, except for the north western third which is shown to be underlain by Lawrence Rock (sandstone).

Two faults are inferred to cross the centre of the site, trending north west to south east.

Hydrogeology and Hydrology

According to the Environment Agency, the site does not lie within a Groundwater Source Protection Zone.

The superficial deposits are classified by the Environment Agency as 'Secondary Undifferentiated', whilst the Coal Measures strata are shown as a Secondary A aquifer.

The closest surface water feature is a stream which runs through the southern quarter of the site. The River Darwen is also close by, and is culverted around 40 m west of the western boundary.

Coal Mining

Shallow coal seams are not shown to outcrop within the vicinity of the site. Shallow coal workings are therefore not expected below the site.

Potential Contamination Sources Identified in Phase 1 Report

The CPS area was predominantly occupied by a power and steam generation plant and housed three gas fired boilers, which until 1984 were powered by heavy fuel oil stored in three large tanks south of the power station. The northern tank once ruptured, spilling oil, although the Phase 1 report notes that the oil did not spill over the bund. The report also

ANNEX D

Site Layout Plan

Housetype	No. of Beds	Type	No. of Units	Percentage
201	2 Bedrooms	Semi-detached	30	19.87
202	2 Bedrooms	Semi-detached	18	11.92
212	2 Bedrooms	Semi-detached	6	3.97
301	3 Bedrooms	Semi-detached	14	9.27
311	3 Bedrooms	Semi-detached	7	4.64
309	3 Bedrooms	Semi-detached	10	6.62
313	3 Bedrooms	Semi-detached	5	3.31
304	3 Bedrooms	Detached	23	15.23
307	3 Bedrooms	Detached	15	9.93
310	3 Bedrooms	Detached	11	7.28
314	3 Bedrooms	Detached	4	2.65
401	4 Bedrooms	Detached	4	2.65
403	4 Bedrooms	Detached	4	2.65
Totals			151	100.00

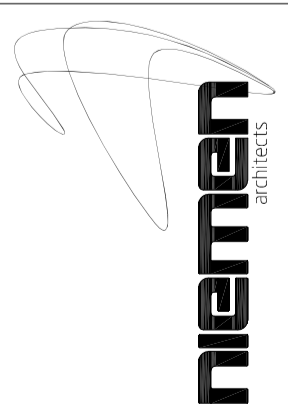


LEGEND

- 1.8M (H) TIMBER FENCE
- POST & WIRE FENCE
- 3M (H) ACOUSTIC FENCE
- DRIVE DETAIL
- PROPOSED TREES
- EXISTING TREES TO BE REMOVED/PRUNED
- EXISTING TREES TO BE RETAINED
- ⊠ DENOTES FUTURE GARAGE

revision	date	content	initials
H	24.07.17	LAYOUT UPDATED FOLLOWING CLIENTS COMMENTS. SCHEDULE OF ACCOMMODATION UPDATED.	LD
G	06.06.17	RED LINE EXTENDED TO INCLUDE ACOUSTIC FEATURE TO NORTH OF SITE.	RB
F	31.05.17	ACOUSTIC BUND & FENCE EXTENDED AND PUBLIC FOOTPATH RE-ROUTED.	JB
E	30.05.17	ACOUSTIC BUND & FENCE ADDED TO NORTH EAST BOUNDARY.	JB
D	26.05.17	STREET SCENE INDICATORS ADDED. PLOTS 13, 14, 31 & 32 HANDED.	JB
C	18.05.17	PLOTS 21, 22, 23, 24, 27, 28, 92, 93, 94, 108 & 109 AMENDED. SCHEDULE OF ACCOMMODATION UPDATED.	JB
B	12.05.17	SITE LAYOUT RE-DRAWN. SCHEDULE OF ACCOMMODATION UPDATED.	JB
A	14.12.16	VEHICLE TRACKING AND VISIBILITY SPLAYS ADDED.	JB

project PROPOSED RESIDENTIAL HOLLINS PAPER MILL HOLLINS GROVE STREET, DARWEN	
client GLEESON HOMES	
title PROPOSED SITE LAYOUT	
date 28.11.16	scale 1:1000 @A1
drawing number 2895-0-001	checked H



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SKETCH
 subject to structural review
 subject to accurate measured survey

ANNEX E

Environment Agency Flood Map



Enter a postcode or place name:

BB3 0BE



Other topics for this area...

Flood Map for Planning (Rivers and Sea)

Flood Map for Planning (Rivers and Sea)

Map legend

Click on the map to see what Flood Zone (National Planning Policy Guidance definitions) the proposed development is in.

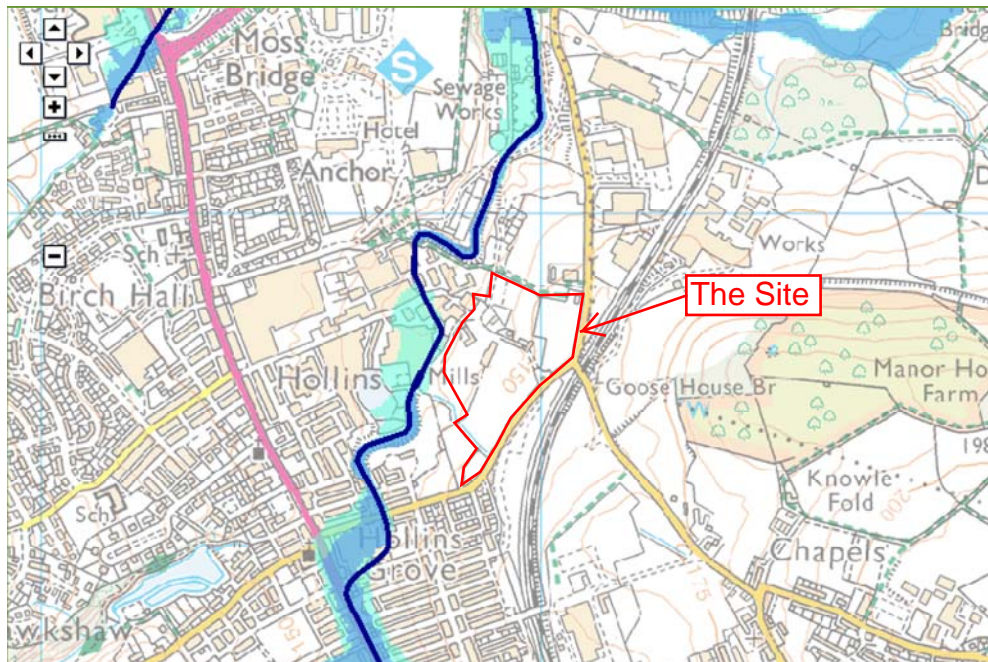
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<input type="checkbox"/>	Flood Zone 3
<input type="checkbox"/>	Flood Zone 2
<input type="checkbox"/>	Flood defences (Not all may be shown*)
<input type="checkbox"/>	Areas benefiting from flood defences (Not all may be shown*)
<input checked="" type="checkbox"/>	Main River
<input type="checkbox"/>	Other national environmental organisations
<input type="checkbox"/>	Natural Resources Wales Area of responsibility
<input type="checkbox"/>	Scottish Environment Protection Agency Area of responsibility

X: 368,928;Y: 423,750 at scale 1:10,000

[Other maps](#)

[Data search](#)

[Text only version](#)



Customers in Wales - From 1 April 2013 Natural Resources Wales (NRW) has taken over the responsibilities of the Environment Agency in Wales.
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Flood Map for Planning – Information Warnings

Swavesey, Cambridgeshire

We are aware of problems with the flood map for the Swavesey area. We are currently working to correct this information.

Lower Brailes, Warwickshire

We are aware of problems with the flood map for the Lower Brailes area. We are currently working to correct this information.

Please contact the Environment Agency on 03708 506 506 for accurate information.

More about flooding:

Understanding the Flood Map for Planning (Rivers and Sea)

A more detailed explanation to help you understand the flood map shown above.

Current flood warnings

We provide flood warnings online 24 hours a day. Find out the current flood warning status in your local area.

* **Legend Information:** Flood defences and the areas benefiting from them are gradually being added through updates. Please contact your local [environment agency office](#) for further details.

creating a better place

ANNEX F

Surface water run-off volumes: Tables F1 to F8

Table F1: Rapid response run-off from 3.3% A.E.P. rainfall event: existing condition

Duration hours	Rainfall at Site mm	Area (m ²)			Volume (m ³)		
		Impervious Area (ha)	Pervious Area (ha)	Total Area (ha)	Impervious Area	Pervious Area	Run-off Volume
		C _v 95.0%	SPR HOST 32.1%				
0.0	0.0	2.49	3.79	6.28	0.00	0.00	0.00
0.5	25.6	2.49	3.79	6.28	606.15	311.35	917.50
1.0	32.8	2.49	3.79	6.28	776.63	398.91	1175.54
2.0	41.5	2.49	3.79	6.28	982.63	504.72	1487.35
3.0	47.5	2.49	3.79	6.28	1124.70	577.69	1702.39
4.0	52.2	2.49	3.79	6.28	1235.98	634.86	1870.84
6.0	59.6	2.49	3.79	6.28	1411.20	724.85	2136.05
8.0	65.4	2.49	3.79	6.28	1548.53	795.39	2343.92
12.0	74.5	2.49	3.79	6.28	1764.00	906.07	2670.06
18.0	84.9	2.49	3.79	6.28	2010.25	1032.55	3042.80
24.0	93.1	2.49	3.79	6.28	2204.40	1132.28	3336.68
36.0	106.0	2.49	3.79	6.28	2509.85	1289.17	3799.02
48.0	116.2	2.49	3.79	6.28	2751.36	1413.22	4164.58
72.0	132.6	2.49	3.79	6.28	3139.68	1612.68	4752.36
96.0	145.5	2.49	3.79	6.28	3445.12	1769.57	5214.69
144.0	165.9	2.49	3.79	6.28	3928.15	2017.67	5945.82
192.0	182.1	2.49	3.79	6.28	4311.73	2214.70	6526.42

Table F2: Rapid response run-off from 1% A.E.P. rainfall event: existing condition							
Duration hours	Rainfall at Site mm	Area (m ²)			Volume (m ³)		
		Impervious Area (ha)	Pervious Area (ha)	Total Area (ha)	Impervious Area	Pervious Area	Run-off Volume
		Cv 95.0%	SPR HOST 32.1%				
0.00	0.0	2.49	3.79	6.28	0.00	0.00	0.00
0.50	37.6	2.49	3.79	6.28	890.29	457.29	1347.58
1.00	47.2	2.49	3.79	6.28	1117.59	574.05	1691.64
2.00	58.5	2.49	3.79	6.28	1385.15	711.48	2096.63
3.00	66.2	2.49	3.79	6.28	1567.47	805.12	2372.59
4.00	72.2	2.49	3.79	6.28	1709.54	878.10	2587.63
6.00	81.4	2.49	3.79	6.28	1927.37	989.99	2917.36
8.00	88.5	2.49	3.79	6.28	2095.49	1076.34	3171.82
12.00	99.6	2.49	3.79	6.28	2358.31	1211.33	3569.64
18.00	112.1	2.49	3.79	6.28	2654.28	1363.36	4017.64
24.00	121.9	2.49	3.79	6.28	2886.32	1482.55	4368.87
36.00	137.1	2.49	3.79	6.28	3246.23	1667.41	4913.63
48.00	148.9	2.49	3.79	6.28	3525.62	1810.92	5336.54
72.0	167.9	2.49	3.79	6.28	3975.50	2042.00	6017.50
96.0	182.8	2.49	3.79	6.28	4328.30	2223.21	6551.51
144.0	205.9	2.49	3.79	6.28	4875.26	2504.15	7379.41
192.0	224.0	2.49	3.79	6.28	5303.83	2724.28	8028.11

Table F3: Rapid response run-off from 3.3% A.E.P. rainfall event: post development condition

Duration hours	Rainfall at Site mm	Area (m ²)			Volume (m ³)			% increase in run-off volume
		Impervious Area (ha)	Pervious Area (ha)	Total Area (ha)	Impervious Area	Pervious Area	Run-off Volume	
		Cv 95.0%	SPR HOST 32.1%					
0.0	0.0	3.14	3.14	6.28	0.00	0.00	0.00	
0.5	25.6	3.14	3.14	6.28	763.65	258.11	1021.76	11%
1.0	32.8	3.14	3.14	6.28	978.42	330.71	1309.13	11%
2.0	41.5	3.14	3.14	6.28	1237.95	418.43	1656.37	11%
3.0	47.5	3.14	3.14	6.28	1416.93	478.92	1895.85	11%
4.0	52.2	3.14	3.14	6.28	1557.13	526.31	2083.43	11%
6.0	59.6	3.14	3.14	6.28	1777.87	600.92	2378.79	11%
8.0	65.4	3.14	3.14	6.28	1950.88	659.40	2610.28	11%
12.0	74.5	3.14	3.14	6.28	2222.34	751.15	2973.48	11%
18.0	84.9	3.14	3.14	6.28	2532.57	856.01	3388.57	11%
24.0	93.1	3.14	3.14	6.28	2777.17	938.68	3715.86	11%
36.0	106.0	3.14	3.14	6.28	3161.98	1068.75	4230.73	11%
48.0	116.2	3.14	3.14	6.28	3466.25	1171.59	4637.84	11%
72.0	132.6	3.14	3.14	6.28	3955.46	1336.94	5292.40	11%
96.0	145.5	3.14	3.14	6.28	4340.27	1467.01	5807.27	11%
144.0	165.9	3.14	3.14	6.28	4948.80	1672.69	6621.49	11%
192.0	182.1	3.14	3.14	6.28	5432.04	1836.03	7268.07	11%

Table F4: Rapid response run-off from 1% A.E.P. rainfall event: post development condition

Duration hours	Rainfall at Site mm	Area (m ²)			Volume (m ³)			% increase in run-off volume
		Impervious Area (ha)	Pervious Area (ha)	Total Area (ha)	Impervious Area	Pervious Area	Run-off Volume	
		C _v 95.0%	C _v 32.1%					
0.00	0.0	3.14	3.14	6.28	0.00	0.00	0.00	
0.50	37.6	3.14	3.14	6.28	1121.61	379.10	1500.71	11%
1.00	47.2	3.14	3.14	6.28	1407.98	475.90	1883.87	11%
2.00	58.5	3.14	3.14	6.28	1745.06	589.83	2334.88	11%
3.00	66.2	3.14	3.14	6.28	1974.75	667.46	2642.21	11%
4.00	72.2	3.14	3.14	6.28	2153.73	727.96	2881.69	11%
6.00	81.4	3.14	3.14	6.28	2428.16	820.72	3248.88	11%
8.00	88.5	3.14	3.14	6.28	2639.96	892.30	3532.26	11%
12.00	99.6	3.14	3.14	6.28	2971.07	1004.22	3975.29	11%
18.00	112.1	3.14	3.14	6.28	3343.94	1130.25	4474.20	11%
24.00	121.9	3.14	3.14	6.28	3636.28	1229.06	4865.34	11%
36.00	137.1	3.14	3.14	6.28	4089.69	1382.32	5472.01	11%
48.00	148.9	3.14	3.14	6.28	4441.69	1501.29	5942.98	11%
72.00	167.9	3.14	3.14	6.28	5008.46	1692.86	6701.32	11%
96.00	182.8	3.14	3.14	6.28	5452.92	1843.09	7296.01	11%
144.00	205.9	3.14	3.14	6.28	6142.00	2075.99	8217.99	11%
192.00	224.0	3.14	3.14	6.28	6681.92	2258.49	8940.41	11%

Table F5: Post-development rapid response run-off from impervious area (3.3% A.E.P. rainfall including central CCA)

Duration hours	Rainfall at Site mm	Area (m ²)			Volume (m ³)			Controlled run off m ³	Tangent m ³
		Impervious Area (ha)	Pervious Area (ha)	Total Area (ha)	Impervious Area	Pervious Area	Run-off Volume		
		C _v 95.0%	C _v 0.0%					Controlled rate (l/s) 119.5	
0.00	0.0	3.14	3.14	6.28	0.00	0.00	0.00	0.00	765.00
0.50	30.7	3.14	3.14	6.28	916.38	0.00	916.38	215.01	980.01
1.00	39.4	3.14	3.14	6.28	1174.11	0.00	1174.11	430.02	1195.02
2.00	49.8	3.14	3.14	6.28	1485.53	0.00	1485.53	860.04	1625.04
3.00	57.0	3.14	3.14	6.28	1700.31	0.00	1700.31	1290.06	2055.06
4.00	62.6	3.14	3.14	6.28	1868.55	0.00	1868.55	1720.08	2485.08
6.00	71.5	3.14	3.14	6.28	2133.44	0.00	2133.44	2580.12	3345.12
8.00	78.5	3.14	3.14	6.28	2341.06	0.00	2341.06	3440.16	4205.16
12.00	89.4	3.14	3.14	6.28	2666.80	0.00	2666.80	5160.24	5925.24
18.00	101.9	3.14	3.14	6.28	3039.08	0.00	3039.08	7740.36	8505.36
24.00	111.7	3.14	3.14	6.28	3332.61	0.00	3332.61	10320.48	11085.48
36.00	127.2	3.14	3.14	6.28	3794.38	0.00	3794.38	15480.72	16245.72
48.00	139.4	3.14	3.14	6.28	4159.50	0.00	4159.50	20640.96	21405.96
72.00	159.1	3.14	3.14	6.28	4746.55	0.00	4746.55	30961.44	31726.44
96.00	174.6	3.14	3.14	6.28	5208.32	0.00	5208.32	41281.92	42046.92
144.00	199.1	3.14	3.14	6.28	5938.56	0.00	5938.56	61922.88	62687.88
192.00	218.5	3.14	3.14	6.28	6518.45	0.00	6518.45	82563.84	83328.84
Total Storage Requirement (m ³)									765.00

Table F6: Post-development rapid response run-off from impervious area (3.3% A.E.P. rainfall including upper end CCA)

Duration hours	Rainfall at Site mm	Area (m ²)			Volume (m ³)			Controlled run off m ³	Tangent m ³
		Impervious Area (ha)	Pervious Area (ha)	Total Area (ha)	Impervious Area	Pervious Area	Run-off Volume		
		C _v 95.0%	C _v 0.0%					Controlled rate (l/s) 119.5	
0.0	0.0	3.14	3.14	6.28	0.00	0.00	0.00	0.00	950.00
0.5	35.8	3.14	3.14	6.28	1069.11	0.00	1069.11	215.01	1165.01
1.0	45.9	3.14	3.14	6.28	1369.79	0.00	1369.79	430.02	1380.02
2.0	58.1	3.14	3.14	6.28	1733.12	0.00	1733.12	860.04	1810.04
3.0	66.5	3.14	3.14	6.28	1983.70	0.00	1983.70	1290.06	2240.06
4.0	73.1	3.14	3.14	6.28	2179.98	0.00	2179.98	1720.08	2670.08
6.0	83.4	3.14	3.14	6.28	2489.02	0.00	2489.02	2580.12	3530.12
8.0	91.6	3.14	3.14	6.28	2731.23	0.00	2731.23	3440.16	4390.16
12.0	104.3	3.14	3.14	6.28	3111.27	0.00	3111.27	5160.24	6110.24
18.0	118.9	3.14	3.14	6.28	3545.59	0.00	3545.59	7740.36	8690.36
24.0	130.3	3.14	3.14	6.28	3888.04	0.00	3888.04	10320.48	11270.48
36.0	148.4	3.14	3.14	6.28	4426.77	0.00	4426.77	15480.72	16430.72
48.0	162.7	3.14	3.14	6.28	4852.74	0.00	4852.74	20640.96	21590.96
72.0	185.6	3.14	3.14	6.28	5537.64	0.00	5537.64	30961.44	31911.44
96.0	203.7	3.14	3.14	6.28	6076.37	0.00	6076.37	41281.92	42231.92
144.0	232.3	3.14	3.14	6.28	6928.32	0.00	6928.32	61922.88	62872.88
192.0	254.9	3.14	3.14	6.28	7604.86	0.00	7604.86	82563.84	83513.84
Total Storage Requirement (m ³)									950.00

Average: 857.50

Table F7: Post-development rapid response run-off from impervious area (1% A.E.P. rainfall including central CCA)

Duration hours	Rainfall at Site mm	Area (m ²)			Volume (m ³)			Controlled run off m ³	Tangent m ³
		Impervious Area (ha)	Pervious Area (ha)	Total Area (ha)	Impervious Area	Pervious Area	Run-off Volume		
		C _v 95.0%	C _v 0.0%					Controlled rate (l/s) 146.2	
0.0	0.0	3.14	3.14	6.28	0.00	0.00	0.00	0.00	1260.00
0.5	45.1	3.14	3.14	6.28	1345.93	0.00	1345.93	215.01	1475.01
1.0	56.6	3.14	3.14	6.28	1689.57	0.00	1689.57	430.02	1690.02
2.0	70.2	3.14	3.14	6.28	2094.07	0.00	2094.07	860.04	2120.04
3.0	79.4	3.14	3.14	6.28	2369.70	0.00	2369.70	1290.06	2550.06
4.0	86.6	3.14	3.14	6.28	2584.47	0.00	2584.47	1720.08	2980.08
6.0	97.7	3.14	3.14	6.28	2913.79	0.00	2913.79	2580.12	3840.12
8.0	106.2	3.14	3.14	6.28	3167.95	0.00	3167.95	3440.16	4700.16
12.0	119.5	3.14	3.14	6.28	3565.28	0.00	3565.28	5160.24	6420.24
18.0	134.5	3.14	3.14	6.28	4012.73	0.00	4012.73	7740.36	9000.36
24.0	146.3	3.14	3.14	6.28	4363.53	0.00	4363.53	10320.48	11580.48
36.0	164.5	3.14	3.14	6.28	4907.63	0.00	4907.63	15480.72	16740.72
48.0	178.7	3.14	3.14	6.28	5330.02	0.00	5330.02	20640.96	21900.96
72.0	201.5	3.14	3.14	6.28	6010.15	0.00	6010.15	30961.44	32221.44
96.0	219.4	3.14	3.14	6.28	6543.51	0.00	6543.51	41281.92	42541.92
144.0	247.1	3.14	3.14	6.28	7370.40	0.00	7370.40	61922.88	63182.88
192.0	268.8	3.14	3.14	6.28	8018.30	0.00	8018.30	82563.84	83823.84
Total Storage Requirement (m ³)									1260.00

Table F8: Post-development rapid response run-off from impervious area (1% A.E.P. rainfall including upper end CCA)

Duration hours	Rainfall at Site mm	Area (m ²)			Volume (m ³)			Controlled run off m ³	Tangent m ³
		Impervious Area (ha)	Pervious Area (ha)	Total Area (ha)	Impervious Area	Pervious Area	Run-off Volume		
		C _v 95.0%	C _v 0.0%					Controlled rate (l/s) 146.2	
0.0	0.0	3.14	3.14	6.28	0.00	0.00	0.00	0.00	1585.00
0.5	52.6	3.14	3.14	6.28	1570.25	0.00	1570.25	215.01	1800.01
1.0	66.1	3.14	3.14	6.28	1971.17	0.00	1971.17	430.02	2015.02
2.0	81.9	3.14	3.14	6.28	2443.08	0.00	2443.08	860.04	2445.04
3.0	92.7	3.14	3.14	6.28	2764.64	0.00	2764.64	1290.06	2875.06
4.0	101.1	3.14	3.14	6.28	3015.22	0.00	3015.22	1720.08	3305.08
6.0	114.0	3.14	3.14	6.28	3399.43	0.00	3399.43	2580.12	4165.12
8.0	123.9	3.14	3.14	6.28	3695.94	0.00	3695.94	3440.16	5025.16
12.0	139.4	3.14	3.14	6.28	4159.50	0.00	4159.50	5160.24	6745.24
18.0	156.9	3.14	3.14	6.28	4681.52	0.00	4681.52	7740.36	9325.36
24.0	170.7	3.14	3.14	6.28	5090.79	0.00	5090.79	10320.48	11905.48
36.0	191.9	3.14	3.14	6.28	5725.57	0.00	5725.57	15480.72	17065.72
48.0	208.5	3.14	3.14	6.28	6218.36	0.00	6218.36	20640.96	22225.96
72.0	235.1	3.14	3.14	6.28	7011.84	0.00	7011.84	30961.44	32546.44
96.0	255.9	3.14	3.14	6.28	7634.09	0.00	7634.09	41281.92	42866.92
144.0	288.3	0.00	0.00	0.00	0.00	0.00	0.00	61922.88	63507.88
192.0	313.6	0.00	0.00	0.00	0.00	0.00	0.00	82563.84	84148.84
Total Storage Requirement (m ³)									1585.00

Average: 1422.50

ANNEX G

UK SUDS estimates of greenfield run-off rates

Site name: Hollins Paper Mill
Site location: Darwen

Site coordinates
Latitude: 53.70886° N
Longitude: 2.47071° W

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the CIRIA SUDS Manual (2007). It is not to be used for detailed design of drainage systems. It is recommended that every drainage scheme uses hydraulic modelling software to finalise volume requirements and design details before drawings are produced.

Reference: gcw1xc2uu31j / 6.28
Date: 23 Nov 2016

Site characteristics

Total site area	6.28	ha
Significant public open space	0	ha
Area positively drained	6.28	ha

Methodology

Greenfield runoff method	IH124
Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type
SOIL type	4
HOST class	N/A
SPR	0.47

Hydrological characteristics

	Default	Edited	
SAAR	1326	1326	mm
M5-60 Rainfall Depth	20	20	mm
'r' Ratio M5-60/M5-2 day	0.3	0.3	
FEH/FSR conversion factor	0.84	0.84	
Hydrological region	10	10	
Growth curve factor: 1 year	0.87	0.87	
Growth curve factor: 10 year	1.38	1.38	
Growth curve factor: 30 year	1.7	1.7	
Growth curve factor: 100 year	2.08	2.08	

Greenfield runoff rates

	Default	Edited	
Qbar	64.02	64.02	l/s
1 in 1 year	55.70	55.70	l/s
1 in 30 years	108.84	108.84	l/s
1 in 100 years	133.16	133.16	l/s

Please note that a minimum flow of 5 l/s applies to any site

End of Report