

OEC Consulting Engineers Ltd Flexspace, Monckton Road, Wakefield, WF2 7AS



QUALITY MANAGEMENT

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Prepared By	W Walker	W Walker	W Walker	W Walker
Date	14 th February 2020	9 th March 2020	12 th August 2020	9 th November
Signature				
Reviewed By	A Bottomley	A Bottomley	A Bottomley	R Binnersley
Date	14 th February 2020	9 th March 2020	12 th August 2020	9 th November
Signature				

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1.0 INTRODUCTION

- BDW Yorkshire West is proposing to develop a parcel of land located off Westminster Drive, Clayton with new residential dwellings. As part of the viability of the site and to supplement a planning application, it was decided that a Flood Risk Assessment Report should be undertaken.
- 1.2 It is within the general development strategy of the country for development in areas where there is a risk of flooding to be assessed to avoid unnecessary increase in the requirement for flood defence. Under the National Planning Policy Framework (NPPF) and the Planning Practice Guidance (PPG), consultation is required with the Environment Agency, Water Authority, Land Drainage Authority and Internal Drainage Board and a Flood Risk Assessment Report should be prepared considering the development proposals and make recommendations for any flood mitigation measures.
- 1.3 OEC has been appointed to carry out an assessment of the site, implement appropriate consultations and prepare a Flood Risk Assessment Report, in accordance with NPPF, to satisfy the requirements of the Planning Authority.
- 1.4 The consultations and walkover survey have been undertaken in January and February 2020, with the report updated in August and November 2020 to suit the current planning layout.
- 1.5 This report is based on the interpretation and assessment of data provided by third parties. Whilst every effort has been taken to ensure this information is accurate and up-to-date, OEC cannot guarantee the accuracy of third-party data and the findings of this report may change if the data is amended or updated after the date of consultation.



2.0 EXISTING SITE

General

- 2.1 The site is a square shaped piece of land equating to an area of approximately 1.72ha. The site is located on the north eastern outskirts of Clayton and is situated at Ordnance Survey Grid Reference SE 112 316.
- 2.2 A site location plan is presented in Appendix A.

Current Use

2.3 The site is greenfield, consisting of open grassland for the grazing of animals.

Boundaries

2.4 The site is bounded by series of dry stone walls to all boundaries, with open fields to the north, west and south west. A residential development is currently under construction to the east, with an existing residential development following the full extent of the south eastern boundary. A narrow public footpath is located between the existing residential dwellings and dry stone wall. Westminster Drive abuts the site along the south eastern boundary.

Topography and Vegetation

- 2.5 The site has a prominent fall in a northerly direction, with levels in the southern corner being at a high point of approximately 266.27m A.O.D, dropping to approximately 256.73m A.O.D. in the northern corner.
- 2.6 Vegetation on the site is minimal and is maintained grassland.
- 2.7 A topographical survey is presented in Appendix B.



Existing Drainage

- 2.8 There is no obvious positive drainage system on the site, although land drainage may be present. Surface water run-off would clearly discharge in a northerly direction.
- 2.9 The nearest watercourse to the site is Hole Bottom Beck, that is located approximately 285m in a north westerly direction, from the site boundary at its nearest location. The watercourse flows in a northerly direction before ultimately discharging into Clayton Beck.
- 2.10 No rivers are recorded within the vicinity of the site.

Geology and Hydrogeology

- 2.11 The Geological Survey Maps of Great Britain available on the BGS website indicates that the site is underlain by the Elland Flags - Sandstone Formation.
- 2.12 The Environment Agency website designates the bedrock under the site as a Secondary A Aquifer. This is a permeable strata capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers.
- 2.13 The Environment Agency website shows that the site does not lie within a Groundwater Source Protection Zone.



3.0 ENVIRONMENT AGENCY CONSULTATION

- 3.1 A consultation was requested from the Environment Agency (EA), however, at the time of writing the report a response was still to be received.
- 3.2 The Environment Agency Flood Map, which shows area of land that could flood from rivers or the sea and are shaded blue are provided is presented in Appendix C. These areas do not take into account defences as water can overtop or can fail in extreme conditions. The EA flood zone classifications are defined as:-
 - 3.2.1 Flood Zone 1 'Low Probability' is assessed as having a less than 1 in 1,000 annual probability of river or sea flooding in any year (less than 0.1%).
 - 3.2.2 Flood Zone 2 'Medium Probability' is assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding in any year (1% 0.1%) and between a 1 in 200 and 1 in 1,000 annual probability of flooding from the sea (0.5% 0.1%).
 - 3.2.3 Flood Zone 3 'High Probability' is assessed as having a 1 in 100 or greater annual probability of river flooding in any year (greater than 1%) and a 1 in 200 chance or greater annual probability of flooding from the sea (less than 0.5%).
- 3.3 The EA flood map for planning shows that the site is located within Flood Zone 1 and the site, therefore, has a low risk of fluvial flooding.
- 3.4 The flood map for surface water, which shows areas where surface water only would be expected to flow or pond in England & Wales, is also presented in Appendix C. All land in England and Wales will be within 'one' of a possible 'four' categories. The four categories shown on the map are:-
 - 3.4.1 High This area has a chance of flooding greater than 1 in 30 in any given year (annual probability of flooding 3.3%).



- 3.4.2 Medium This area has a chance of flooding between 1 in 100 (1%) and 1 in 30 (3.3%) in any given year.
- 3.4.3 Low This area has a chance of flooding between 1 in 1000 (0.1%) and 1 in 100 (1%) in any given year.
- 3.4.4 Very low This area has a chance of flooding of less than 1 in 1000 (0.1%) in any given year.
- 3.5 The proposed development is shown to be within a very low risk area for surface water flooding.



4.0 WATER AUTHORITY CONSULTATION

- 4.1 A consultation was requested from Yorkshire Water (YW), who are the Water Authority for this area, and a copy of their response, reference T706059, dated 27th January 2020, is presented in Appendix D for reference purposes.
- 4.2 As of October 2011 and the private to public sewer transfer, there are many unchartered Yorkshire Water assets currently not shown on their records.
- 4.3 Development of the site should take place with separate systems for foul and surface water drainage. The separate systems should extend to the points of discharge to be agreed.
- 4.4 A whole phase foul water discharge has been agreed into the 225mm combined sewer in Delph Drive, therefore, foul water will need to discharge into phase one.
- In respect of surface water, a whole phase surface water discharge has been set at 5l/s into the 225mm combined public sewer in Delph Drive, therefore, surface water will need to discharge into phase 1.



5.0 LEAD LOCAL FLOOD AUTHORITY CONSULTATION

- 5.1 A consultation was requested from Bradford Metropolitan District Council (BMDC) who are the Lead Local Flood Authority (LLFA) for this area, however, at the time of writing the report a response was still to be received. The following comments are anticipated.
- 5.2 The use of infiltration techniques should be investigated to dispose of surface water from the proposed development.
- 5.3 As the site is Greenfield, surface water runoff shall be restricted to the existing greenfield runoff rate for the site, calculated in accordance with IH124, based on the developed area of the site.
- 5.4 On site surface water attenuation shall be incorporated into the design to accommodate all storms up to and including the 1 in 100 year plus 30% climate change storm event within the site, without causing flooding to property or third-party land. No flooding of the site should take place for a 1 in 30 year storm event.



6.0 INTERNAL DRAINAGE BOARD CONSULTATION

6.1 The proposed development site is not located within an Internal Drainage Board catchment.



7.0 MATERIAL CONSIDERATION IN RESPECT OF NPPF AND PPG

Flood Classification

- 7.1 The Environment Agency Flood Map has identified that the site falls within land assessed as having less than a 1 in 1,000 annual probability of river or sea flooding in any year (less than 0.1%). In accordance with Table 1 of the PPG, the site falls within Flood Zone 1 "low probability".
- 7.2 Therefore, all uses of the land are appropriate within this zone, but an assessment of the effect of surface water run-off will need to be incorporated in any Flood Risk Assessment.

End Use

- 7.3 The development proposal is for the construction of residential development on the site, and a planning layout is presented in Appendix E.
- 7.4 When applying Table 2 of the PPG, the flood risk vulnerability classification shows that the proposed end use will fall into a "more vulnerable" classification.

Sequential & Exception Test

- 7.5 As set out in the NPPF, the aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding (Zone 1).
- 7.6 When the development site is evaluated in accordance with Table 3 of the PPG, the development shows that the Sequential Test is satisfied.
- 7.7 As the Sequential Test is satisfied it is not a requirement for an exception test to be provided.



Flood Sources

7.8 The risk of flooding to the site from all current and future potential sources of flooding has been assessed as follows:-

7.9 Flooding from Rivers (Fluvial)

There are no rivers recoded within the vicinity of the site, therefore, flooding from this source is considered low risk. This is evident from the Environment Agency Flood Maps.

7.10 Flooding from Local Watercourses (Fluvial)

Hole Bottom Beck is located approximately 285m in a north westerly direction, from the site boundary at its nearest location. However, due to the topography of the site being substantially elevated above the watercourse, flooding from this source is considered low risk.

7.11 Flooding from the Sea (Tidal/Coastal)

The site is not located near enough to the sea to cause a problem of flooding from this source.

7.12 Flooding from Land (Surface Water)

The Environment Agency surface water flood map shows the site to have a very low risk of surface water flooding, with no flood routes affecting the proposed development. However, although flooding from this source is considered low risk, there is a possibility that overland runoff from land to the south could enter the site, therefore, this will need to be considered as part of the proposed development.

7.13 Flooding from Groundwater

The Geological Survey Maps of Great Britain available on the BGS website indicates that the site is underlain by the Elland Flags - Sandstone Formation. Whilst sandstone is considered to be permeable, therefore allowing groundwater to potentially rise, the steep topography of the site and surrounding area would suggest that that the ground water level would remain below the ground level. Therefore,



whilst flooding from this source is considered to be low risk it should still be considered.

7.14 Flooding from Sewer

Existing public sewers are recorded within the vicinity of the site and there will also be a new drainage system introduced for the proposed development. It is possible that any blockage of these sewers will result in flooding from the lowest cover level of manholes or gullies and this will need to be considered as part of any proposed development. Flooding from this source is considered to be low-medium risk.

7.15 Flooding from Reservoirs, Canals or Artificial Sources

The Environment Agency produce maps which show the expected inundation area should a reservoir fail and release its capacity. It should be noted, however, that reservoir flooding is extremely unlikely to happen and there has been no loss of life in the UK from reservoir flooding since 1925. The proposed development site is shown to be outside of the maximum extent of reservoir flooding.

- 7.16 There are no canals or other artificial sources within the vicinity of the proposed development site that would pose a risk of flooding on site, therefore, the risk from this source is deemed to be negligible.
- 7.17 Table 1.0 below, summarises the findings of the detailed assessment and explanations of the flood risk issues on the site.



Table 1.0 – Degree of risk from each source of flooding

FLOOD SOURCE	RISK	
River (Fluvial)	Low	
Watercourse (Fluvial)	Low	
Sea (Tidal/Coastal)	Negligible	
Land (Surface Water)	Low	
Groundwater	Low	
Sewer	Low/Medium	
Other - Reservoir	Negligible	
Other - Canals	Negligible	

Climate Change

- 7.18 The NPPF and PPG has indicated that the Global sea level will continue to rise, depending on greenhouse gas emissions, and the sensitivity of the climate system and there will be an increase in rainfall across the country.
- 7.19 United Kingdom climate change guidance was revised in February 2016 for peak river flows and peak rainfall intensities. With regards to peak river flows, a regionalised approach has now been adopted to climate change impacts based upon the river basin district of the proposed development site, the flood risk vulnerability of the proposed development and the present-day Flood Zone classification.
- 7.20 The proposed development site is situated within the River Humber river basin district, which, based on an "upper end" climate change scenario, could see peak river flows increase by 50% by 2115. As the site is situated entirely within Flood Zone 1, an increase of 50% in river flows is deemed unlikely to affect the proposed development site.



- 7.21 In accordance with the revised climate change data, the published figures show that, for an expected life of greater than 50 years for any new development, the anticipated increase in rainfall could be up to 40%, subject to the location within the country and the drainage system should be designed in accordance with this requirement. However, the Bradford Metropolitan District Council flood risk requirements for managing on/off-site flood risk from fluvial flooding is to assess the development using a 30% allowance for climate change for the 1 in 100 year event.
- 7.22 Due to the topography of the land and surrounding area, overland run-off from adjoining land is unlikely to be an issue. Therefore, any run-off from outside the site will be insignificant and, on this basis, only rainfall falling within the site boundaries will need to be considered in respect of climate change.

Flood Mitigation

- 7.23 As the site falls within Flood Zone 1, flood mitigation measures are only required in the event of a catastrophic storm or blockage of the proposed drainage system. The following precautionary flood mitigation measures are, therefore, recommended:-
 - 7.23.1 The finished flood levels (FFL) to the properties shall be raised above external levels by a minimum of 150mm, wherever possible.
 - 7.23.2 Properties shall be designed without any basements and ground floors shall comprise solid concrete slabs or beam and block with screed construction.
 - 7.23.3 Incoming electricity supplies shall be raised above ground floor level and ground floor electric sockets shall be served by loops from upper level.
 - 7.23.4 In the unlikely event of flooding of the site, it would be appropriate to design external levels with falls to non-critical areas, such as landscape, where the water can pond without causing flooding to buildings.



7.23.5 If any water issues are found on the site or boundary levels result in flow of water into the site, these shall be accommodated by introducing "cut-off" drains to direct the flow around the development.

Emergency Egress During Times of Flood

- 7.24 It is a requirement under the PPG that occupants should be able to egress any building during times of flood, without being trapped by flood conditions.
- 7.25 As the site falls within Flood Zone 1, no special mitigation measures are required for emergency egress during times of flood.



8.0 EXISTING AND PROPOSED DRAINAGE

Sustainable Drainage

8.1 In order to comply with the requirements of NPPF, it will be necessary to consider aspects of Sustainable Drainage techniques for the new development. The Geological Survey Maps of Great Britain available on the BGS website indicates that the site is underlain by the Elland Flags - Sandstone Formation. An intrusive ground investigation has been carried out by Groundtech Consulting, report reference with 19262/1219, dated January 2020, with three number percolation tests being undertaken. The results of the testing indicated mixed results, with rates between 4.73x10⁻⁴ and 9.25x10⁻⁶ respectively, therefore, whilst soakaways may be suitable on part of the site, the report also indicates ground water strikes at 1.2m, 1.8m and 2.0m below ground level. Therefore, considering the variable infiltration rates, in conjunction with the high ground water table, it is concluded that the site is unsuitable for the disposal of surface water using infiltration techniques, and a positive drainage system to watercourse or sewer will be required for surface water drainage.

Drainage

8.2 It is a requirement to ensure that surface water run-off from any proposed development has negligible consequence on downstream areas either in sewer capacity or discharge to watercourse.

Existing Surface Water Run-Off

8.3 The site is greenfield and, therefore, in accordance with current guidelines and Regulations, indicative surface water calculations have been undertaken using the IH124 method of calculating greenfield run-off rates. The calculations are presented in Appendix F.



- 8.4 It is unusual to use the IH124 method for calculating greenfield runoff rates with an area less than 50ha. The Interim Code of Practice recommends that the IH124 method is applied with 50ha and the resulting discharge is linearly interpolated for the required.
- 8.5 For the proposed developed area of approximately 1.50ha, the existing greenfield run-off rates have been linearly interpolated with the results presented in Table 2.0 below.

Table 2.0 – Existing greenfield runoff rates

Storm Event	Discharge Rate
1 year	3.88 l/s
QBAR	4.50 l/s
30 year	7.92 l/s
100 year	9.37 l/s

8.6 Based on the above the proposed discharge rate for the site will be restricted to no greater than 4.5l/s.

Proposed Surface Water Drainage

- 8.7 Consideration of the proposed drainage should firstly be given to infiltration techniques (to ground). However, as the use of infiltration techniques has been discounted it will be necessary to provide a positive drainage system to watercourse or sewer.
- 8.8 The nearest watercourse to the site, Hole Bottom Beck, is located approximately 285m in a north westerly direction. Due to the distance from the site and topography of the intervening land any such connection is considered difficult. However, due to issues with connecting into the adjacent development, currently under construction, a connection to watercourse is considered the most viable outfall location at the time of writing the report.



- 8.9 It is anticipated that the proposed layout will have an impermeable area of approximately 0.98ha for semi-detached and detached properties. Indicative calculations have been carried out using the WinDES Source Control Computer Program. The proposed surface water sewer system should be designed to accommodate the 1 in 1 year storm without surcharging, the 1 in 30 year storm event without flooding and a 1 in 100 year storm plus climate change event should be retained within the site in an area that does cause flooding to properties or third parties.
- 8.10 Restricting the discharge rate to no greater than 4.5l/s, on site storage of 402.5m³ will need to be provided for a 1 in 30 year storm. This can be achieved by several methods, including oversized pipes, underground tanks and balancing ponds. The drainage system will also need to accommodate the 1 in 100 year plus 30% climate change event without causing flooding or property or third-party land. In the event that levels dictate that the 1 in 100 year plus climate change flood water will flow off site, an additional or larger storage facility will be required. Therefore, on site storage would increase to 727.9m³. The indicative surface water calculations are presented in Appendix G. However, detailed calculations and proposals will need to be prepared and submitted to the Planning Authority for approval prior to construction.

Proposed Foul Water Drainage

8.11 Foul water domestic waste should discharge into the adjacent development, currently under construction, to accommodate a whole phase discharge into the 225mm combined sewer in Delph Drive.



9.0 CONCLUSION

- 9.1 The site falls within Flood Zone 1 and the Sequential Test is satisfied. However, in order to accommodate the possibilities of flood from a catastrophic storm or blockage of the proposed drainage system, the following precautionary flood mitigation measures are recommended:-
 - 9.1.1 The finished flood levels (FFL) to the properties shall be raised above external levels by a minimum of 150mm, wherever possible.
 - 9.1.2 Properties shall be designed without any basements and ground floors shall comprise solid concrete slabs or beam and block with screed construction.
 - 9.1.3 Incoming electricity supplies shall be raised above ground floor level and ground floor electric sockets shall be served by loops from upper level.
 - 9.1.4 In the unlikely event of flooding of the site, it would be appropriate to design external levels with falls to non-critical areas, such as landscape, where the water can pond without causing flooding to buildings.
 - 9.1.5 If any water issues are found on the site or boundary levels result in flow of water into the site, these shall be accommodated by introducing "cut-off" drains to direct the flow around the development.
- 9.2 A 30% increase in rainfall shall be incorporated into any new positive drainage system to satisfy the requirements of climate change.
- 9.3 Sustainable Drainage Systems of infiltration techniques have been considered as unsuitable for the disposal of surface water using infiltration techniques, and a positive drainage system to watercourse will be required for surface water drainage.



- 9.4 The proposed surface water drainage system shall be restricted to the agreed discharge rate with appropriate attenuation for a 1 in 100 year storm plus climate change event incorporated into the design, prior to discharge to sewer. The detailed design and calculations shall be submitted to the Planning Authority for approval prior to construction on the development site.
- 9.5 Foul water domestic waste should discharge into the adjacent development, currently under construction, to accommodate a whole phase discharge into the 225mm combined sewer in Delph Drive.
- 9.6 No special mitigation measures are required for emergency egress during times of flood.
- 9.7 Subject to compliance with the above, the proposed development can satisfy the requirements of the National Planning Policy Framework and the Planning Practice Guidance in relation to flood risk.



APPENDIX A: SITE LOCATION PLAN



BDW YORKSHIRE WEST

CLAYTON, BRADFORD

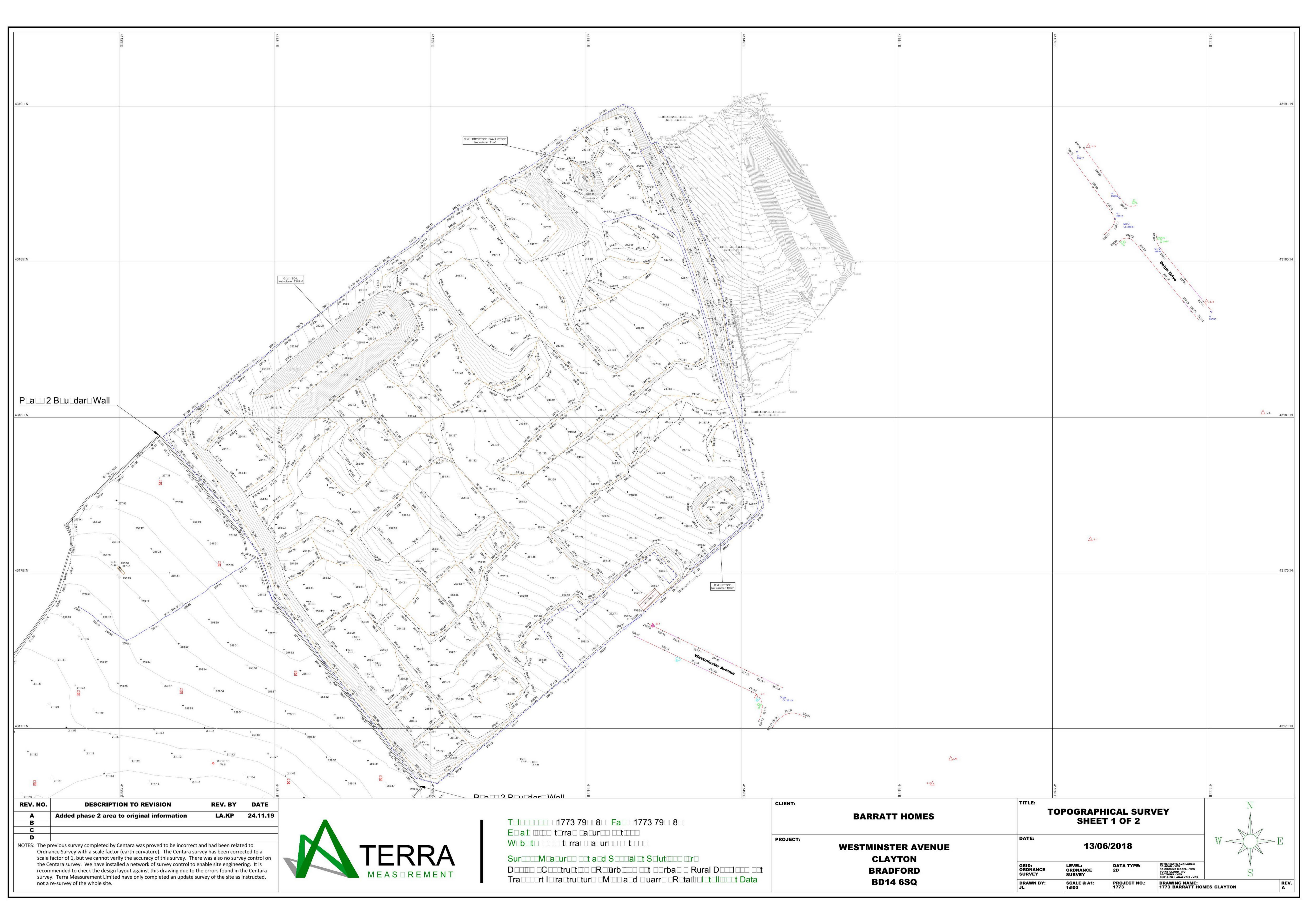
106.012.01

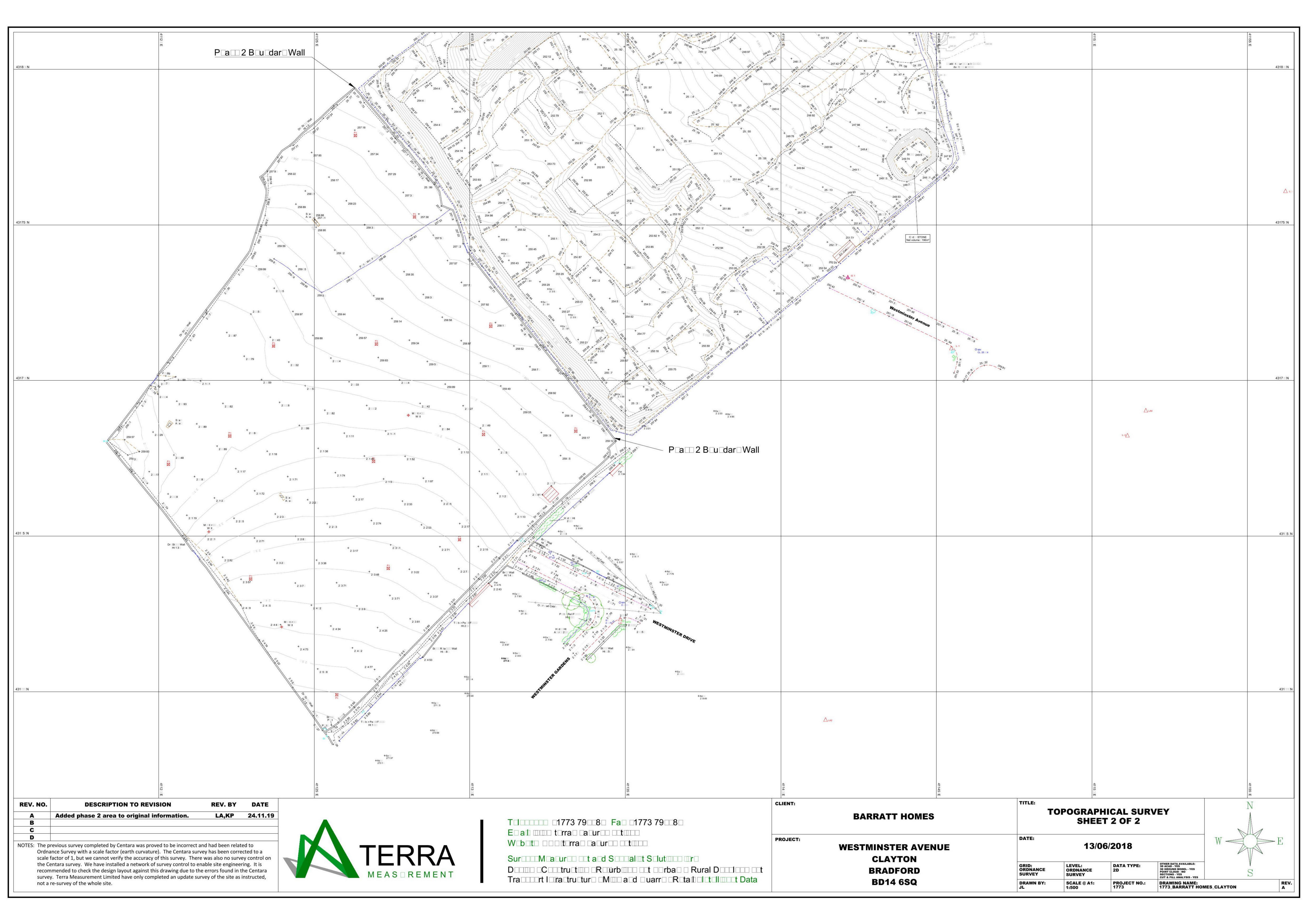


GRID RELATED TO GPS. GRID REREFENCE SE 112 316



APPENDIX B: TOPOGRAPHICAL SURVEY







APPENDIX C: ENVIRONMENT AGENCY CONSULTATION



Flood map for planning

Your reference Location (easting/northing) Created

106.012 411267/431688 14 Feb 2020 14:20

Your selected location is in flood zone 1, an area with a low probability of flooding.

This means:

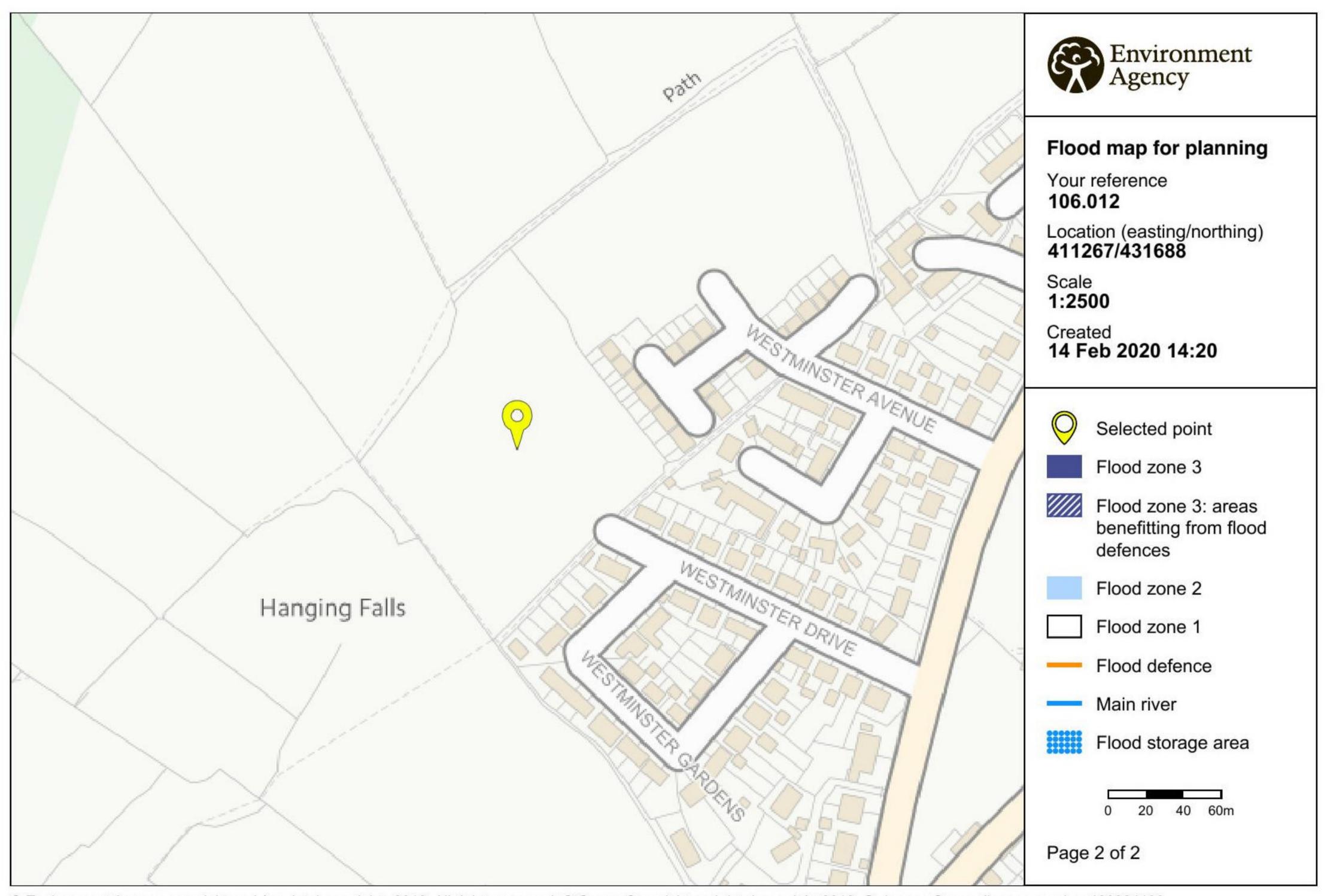
- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1
 hectare or affected by other sources of flooding or in an area with critical drainage
 problems

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

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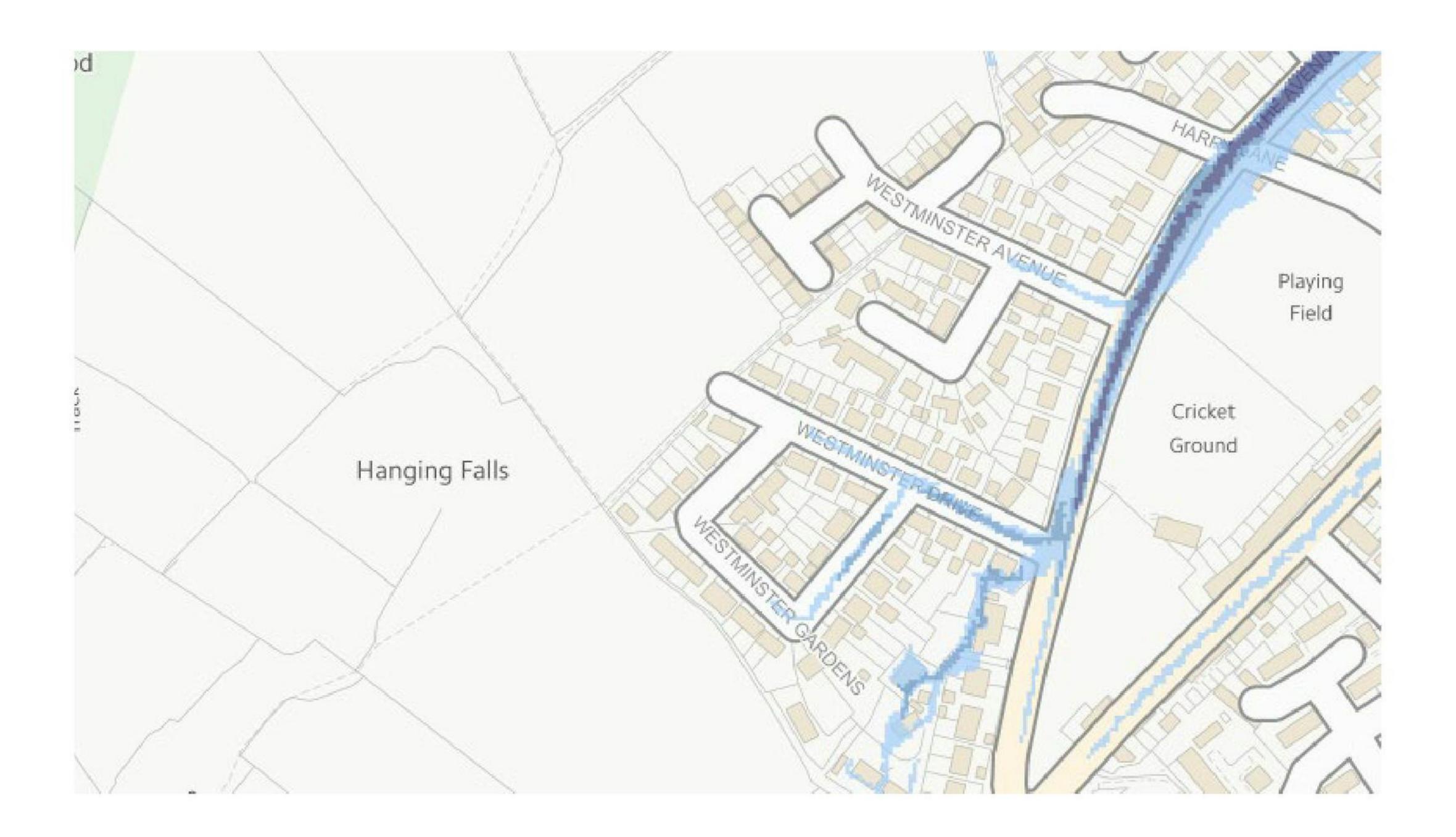
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BDW YORKSHIRE WEST

WESTMISNTER DRIVE, CLAYTON

ENVIRONMENT AGENCY SURFACE WATER FLOOD MAP





APPENDIX D: WATER AUTHORITY CONSULTATION



Mr A Khan Walker Ingram Associates Office G4 Monckton Road Wakefield WF2 7AS Yorkshire Water Services
Developer Services
Sewerage Technical Team
PO BOX 52
Bradford
BD3 7AY

Tel: 0345 120 8482 Fax: (01274) 372 834

Your Ref: WIA005 Our Ref: W000670

Email: technical.sewerage@yorkshirewater.co.uk

For telephone enquiries ring: Chris Roberts on 0345 120 8482

27th January 2020

Dear Mr Khan,

Holts Lane, Clayton, Bradford, BD14 6SL - Pre-Planning Sewerage-Enquiry-Residential T706059

Thank you for your recent enquiry. Our charge of £164.00 (plus VAT) will be added to your account with us, reference WIA005. You will receive an invoice for your account in due course.

Please find enclosed a complimentary extract from the Statutory Sewer Map which indicates the recorded position of the public sewers. Please note that as of October 2011 and the private to public sewer transfer, there are many uncharted Yorkshire Water assets currently not shown on our records. The following comments reflect our view, with regard to the public sewer network only, based on a 'desk top' study of the site and are valid for a maximum period of twelve months.

Development of the site should take place with separate systems for foul and surface water drainage. The separate systems should extend to the points of discharge to be agreed.

Foul Water

A whole phase foul water discharge has been agreed into the 225 mm combined public sewer in Delph Drive so foul water will need to discharge into phase one.

Surface Water

A whole phase surface water discharge has been set at 5 l/s into the 225 mm combined public sewer in Delph Drive so surface water will need to discharge into phase one.

Other Observations

Any new connection to an existing public sewer will require the prior approval of Yorkshire Water. You may apply on line or obtain an application form from our website (www.yorkshirewater.com) or by telephoning 0345 120 84 82.

Prospectively adoptable sewers and pumping stations must be designed and constructed in accordance with the WRc publication "Sewers for Adoption - a design and construction guide for developers" 6th Edition as supplemented by Yorkshire Water's requirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991.







YorkshireWater

An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site. Please contact our Developer Services Team (telephone 0345 120 84 82) for further information.

All the above comments are based upon the information and records available at the present time and is subject to formal planning approval agreement. The information contained in this letter together with that shown on any extract from the Statutory Sewer Map that may be enclosed is believed to be correct and is supplied in good faith. Please note that capacity in the public sewer network is not reserved for specific future development. It is used up on a 'first come, first served' basis. You should visit the site and establish the line and level of any public sewers affecting your proposals before the commencement of any design work.

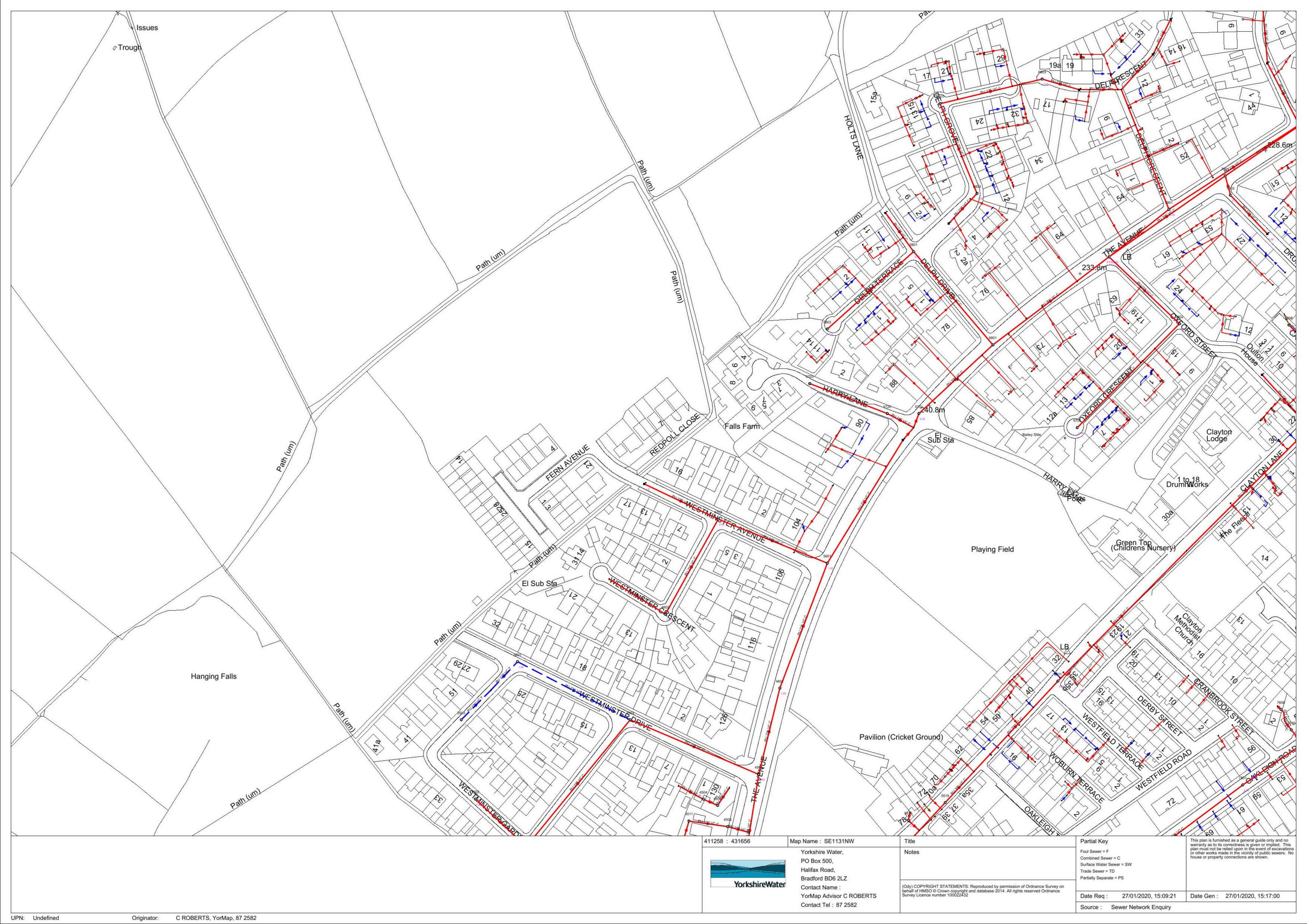
Yours sincerely



Chris Roberts Development Services Technician









APPENDIX E: PLANNING LAYOUT





APPENDIX F: INDICATIVE GREENFIELD RUNOFF RATE CALCULATIONS

Walker Ingram Associates		Page 1
Office G4, Flexspace		
Monckton Road		
Wakefield, WF2 7AS		Micro
Date 12/02/2020 15:31	Designed by Wayne Walker	Drainage
File	Checked by	Dialilade
Innovyze	Source Control 2019.1	

IH 124 Mean Annual Flood

Input

Return Period (years) 1 Soil 0.300

Area (ha) 50.000 Urban 0.000

SAAR (mm) 1073 Region Number Region 3

Results 1/s

QBAR Rural 150.2 QBAR Urban 150.2

Q1 year 129.2

Q1 year 129.2 Q2 years 141.7 Q5 years 187.7 Q10 years 217.8 Q20 years 246.7 Q25 years 256.2 Q30 years 264.0 Q50 years 284.5 Q100 years 312.4 Q200 years 354.5 Q250 years 368.0

Q1000 years 456.6



APPENDIX G: INDICATIVE SURFACE WATER DRAINAGE CALCULATIONS

Walker Ingram Associates				
Office G4, Flexspace	Westminster Drive, Clayton			
Monckton Road	BDW Yorkshire West			
Wakefield, WF2 7AS	100yr + 30%	Micro		
Date 12/08/2020 13:03	T	Drainage		
File 106.012 - 30yr - V2.SRCX	Checked by	Dialilage		
Innovyze	Source Control 2019.1			

Summary of Results for 30 year Return Period

Storm Event		Max Level (m)	Max Depth (m)	Max Control (1/s)	Max Volume (m³)	Status	
15	min	Summer	100.553	0.553	2.6	115.1	О К
30	min	Summer	100.750	0.750	2.6	156.0	0 K
60	min	Summer	100.969	0.969	2.6	201.5	O K
120	min	Summer	101.201	1.201	2.7	249.8	O K
180	min	Summer	101.333	1.333	2.9	277.3	O K
240	min	Summer	101.419	1.419	3.0	295.1	O K
360	min	Summer	101.530	1.530	3.1	318.3	O K
480	min	Summer	101.595	1.595	3.1	331.8	O K
600	min	Summer	101.633	1.633	3.2	339.6	0 K
720	min	Summer	101.653	1.653	3.2	343.8	O K
960	min	Summer	101.665	1.665	3.2	346.2	O K
1440	min	Summer	101.660	1.660	3.2	345.3	0 K
2160	min	Summer	101.622	1.622	3.1	337.4	0 K
2880	min	Summer	101.573	1.573	3.1	327.2	O K
4320	min	Summer	101.465	1.465	3.0	304.7	O K
5760	min	Summer	101.357	1.357	2.9	282.3	O K
7200	min	Summer	101.254	1.254	2.8	260.8	0 K
8640	min	Summer	101.155	1.155	2.7	240.2	O K
0800	min	Summer	101.060	1.060	2.6	220.6	O K
15	min	Winter	100.621	0.621	2.6	129.1	0 K
30	min	Winter	100.842	0.842	2.6	175.1	O K

Storm		Rain	${\tt Flooded}$	Discharge	Time-Peak	
	Even	t	(mm/hr)	Volume	Volume	(mins)
				(m³)	(m³)	
15	min	Summer	63.733	0.0	115.3	19
30	min	Summer	43.450	0.0	156.6	34
60	min	Summer	28.447	0.0	208.2	64
120	min	Summer	18.083	0.0	264.6	124
180	min	Summer	13.703	0.0	300.7	182
240	min	Summer	11.188	0.0	327.1	2 42
360	min	Summer	8.400	0.0	367.9	3 62
480	min	Summer	6.846	0.0	398.7	482
600	min	Summer	5.837	0.0	422.6	600
720	min	Summer	5.122	0.0	438.9	720
960	min	Summer	4.164	0.0	444.8	856
1440	min	Summer	3.105	0.0	438.8	1110
2160	min	Summer	2.311	0.0	610.7	1512
2880	min	Summer	1.872	0.0	659.4	1932
4320	min	Summer	1.389	0.0	730.9	2764
5760	min	Summer	1.125	0.0	793.7	3576
7200	min	Summer	0.955	0.0	842.4	4400
8640	min	Summer	0.836	0.0	884.4	5192
10080	min	Summer	0.747	0.0	921.3	60 48
		Winter		0.0	129.1	19
			43.450	0.0	174.6	33
			_	_		_ _

Walker Ingram Associates	Page 2	
Office G4, Flexspace	Westminster Drive, Clayton	
Monckton Road	BDW Yorkshire West	
Wakefield, WF2 7AS	100yr + 30%	Micro
Date 12/08/2020 13:03	Designed by W.Walker	Drainage
File 106.012 - 30yr - V2.SRCX	Checked by	Dialilade
Innovyze	Source Control 2019.1	

Summary of Results for 30 year Return Period

	Stor Even		Max Level (m)	Max Depth (m)	Max Control (1/s)	Max Volume (m³)	Status
60	min	Winter	101.088	1.088	2.6	226.4	○ K
120	min	Winter	101.353	1.353	2.9	281.4	0 K
180	min	Winter	101.506	1.506	3.0	313.2	0 K
240	min	Winter	101.606	1.606	3.1	334.0	0 K
360	min	Winter	101.740	1.740	3.2	361.9	0 K
480	min	Winter	101.823	1.823	3.3	379.2	0 K
600	min	Winter	101.875	1.875	3.4	390.0	0 K
720	min	Winter	101.908	1.908	3.4	396.8	0 K
960	min	Winter	101.935	1.935	3.4	402.5	O K
1440	min	Winter	101.923	1.923	3.4	400.0	0 K
2160	min	Winter	101.871	1.871	3.4	389.2	0 K
2880	min	Winter	101.793	1.793	3.3	373.0	0 K
4320	min	Winter	101.620	1.620	3.1	336.9	0 K
5760	min	Winter	101.450	1.450	3.0	301.7	0 K
7200	min	Winter	101.290	1.290	2.8	268.4	0 K
8640	min	Winter	101.140	1.140	2.7	237.2	0 K
10080	min	Winter	100.998	0.998	2.6	207.5	○ K

Storm		Rain	Flooded	Discharge	Time-Peak	
	Even	t	(mm/hr)	Volume	Volume	(mins)
				(m³)	(m³)	
60		' .	00 447		000 0	60
60	min	Winter	28.447	0.0	233.2	62
120	min	Winter	18.083	0.0	296.3	122
180	min	Winter	13.703	0.0	336.5	180
240	min	Winter	11.188	0.0	366.0	238
360	min	Winter	8.400	0.0	410.7	354
480	min	Winter	6.846	0.0	441.8	470
600	min	Winter	5.837	0.0	455.8	584
720	min	Winter	5.122	0.0	459.4	694
960	min	Winter	4.164	0.0	461.2	912
1440	min	Winter	3.105	0.0	464.7	1154
2160	min	Winter	2.311	0.0	684.0	1620
2880	min	Winter	1.872	0.0	738.3	2076
4320	min	Winter	1.389	0.0	807.7	2984
5760	min	Winter	1.125	0.0	889.0	3864
7200	min	Winter	0.955	0.0	943.5	4688
8640	min	Winter	0.836	0.0	990.6	5536
10080	min	Winter	0.747	0.0	1032.1	6448

Walker Ingram Associates				
Office G4, Flexspace	Westminster Drive, Clayton			
Monckton Road	BDW Yorkshire West			
Wakefield, WF2 7AS	100yr + 30%	Micro		
Date 12/08/2020 13:03	Designed by W.Walker	Drainage		
File 106.012 - 30yr - V2.SRCX	Checked by	Dialilade		
Innovyze	Source Control 2019.1			

Rainfall Details

Rainfall Model FSR Winter Storms Yes 30 Cv (Summer) 0.750 Return Period (years) Cv (Winter) 0.840 Region England and Wales M5-60 (mm) 18.500 Shortest Storm (mins) 15 Ratio R 0.303 Longest Storm (mins) 10080 Climate Change % Summer Storms Yes +0

<u>Time Area Diagram</u>

Total Area (ha) 0.980

Time (mins) Area From: To: (ha)

0 4 0.980

Walker Ingram Associates				
Office G4, Flexspace	Westminster Drive, Clayton			
Monckton Road	BDW Yorkshire West			
Wakefield, WF2 7AS	100yr + 30%	Micro		
Date 12/08/2020 13:03	Designed by W.Walker	Drainage		
File 106.012 - 30yr - V2.SRCX	Checked by	Diali lage		
Innovyze	Source Control 2019.1			

Model Details

Storage is Online Cover Level (m) 105.000

Tank or Pond Structure

Invert Level (m) 100.000

Depth (m)	Area (m²)						
0.000	208.0	0.700	208.0	1.400	208.0	2.100	208.0
0.100	208.0	0.800	208.0	1.500	208.0	2.200	208.0
0.200	208.0	0.900	208.0	1.600	208.0	2.300	208.0
0.300	208.0	1.000	208.0	1.700	208.0	2.400	208.0
0.400	208.0	1.100	208.0	1.800	208.0	2.500	208.0
0.500	208.0	1.200	208.0	1.900	208.0		
0.600	208.0	1.300	208.0	2.000	208.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0076-4500-3500-4500 Design Head (m) 3.500 Design Flow (1/s) 4.5 Flush-Flo™ Calculated Objective Minimise upstream storage Application Surface Sump Available Yes Diameter (mm) 76 100.000 Invert Level (m) Minimum Outlet Pipe Diameter (mm) 100 Suggested Manhole Diameter (mm) 1200

Control Points Head (m) Flow (1/s) Design Point (Calculated) 3.500 4.5 Flush-Flow 0.330 2.6 Kick-Flow 0.680 2.1 Mean Flow over Head Range - 3.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m) E	?low (1/s)	Depth (m)	Flow (1/s)	Depth (m)	Flow (1/s)	Depth (m)	Flow (1/s)
0.100	2.1	1.200	2.7	3.000	4.2	7.000	6.2
0.200	2.5	1.400	2.9	3.500	4.5	7.500	6.4
0.300	2.6	1.600	3.1	4.000	4.8	8.000	6.6
0.400	2.6	1.800	3.3	4.500	5.1	8.500	6.8
0.500	2.5	2.000	3.5	5.000	5.3	9.000	7.0
0.600	2.4	2.200	3.6	5.500	5.6	9.500	7.2
0.800	2.3	2.400	3.8	6.000	5.8		
1.000	2.5	2.600	3.9	6.500	6.0		

Walker Ingram Associates				
Office G4, Flexspace	Westminster Drive, Clayton			
Monckton Road	BDW Yorkshire West			
Wakefield, WF2 7AS	100yr + 30%	Micro		
Date 12/08/2020 13:01	Designed by W.Walker	Drainage		
File 106.012 - 100yr + 30%	Checked by	Dialilage		
Innovyze	Source Control 2019.1			

Summary of Results for 100 year Return Period (+30%)

Storm Event		Max Level (m)	Max Depth (m)	Max Control (1/s)	Max Volume (m³)	Status	
15	min	Summer	100.934	0.934	2.6	194.2	○ K
30	min	Summer	101.280	1.280	2.8	266.3	0 K
60	min	Summer	101.672	1.672	3.2	347.7	0 K
120	min	Summer	102.089	2.089	3.5	434.6	0 K
180	min	Summer	102.326	2.326	3.7	483.9	○ K
240	min	Summer	102.478	2.478	3.8	515.4	0 K
360	min	Summer	102.685	2.685	4.0	558.6	0 K
480	min	Summer	102.817	2.817	4.1	585.9	0 K
600	min	Summer	102.903	2.903	4.1	603.8	O K
720	min	Summer	102.959	2.959	4.2	615.4	0 K
960	min	Summer	103.012	3.012	4.2	626.6	○ K
1440	min	Summer	103.017	3.017	4.2	627.6	○ K
2160	min	Summer	102.968	2.968	4.2	617.4	○ K
2880	min	Summer	102.892	2.892	4.1	601.5	○ K
4320	min	Summer	102.724	2.724	4.0	566.6	○ K
5760	min	Summer	102.572	2.572	3.9	534.9	○ K
7200	min	Summer	102.428	2.428	3.8	505.1	○ K
8640	min	Summer	102.293	2.293	3.7	476.9	O K
.0080	min	Summer	102.164	2.164	3.6	450.1	○ K
15	min	Winter	101.047	1.047	2.6	217.7	○ K
30	min	Winter	101.436	1.436	3.0	298.6	○ K

Storm Event		Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
15	min	Summer	106.855	0.0	190.1	19
30	min	Summer	73.642	0.0	213.9	34
60	min	Summer	48.563	0.0	354.9	64
120	min	Summer	30.907	0.0	448.0	124
180	min	Summer	23.333	0.0	485.2	184
240	min	Summer	18.946	0.0	497.6	2 42
360	min	Summer	14.121	0.0	515.7	3 62
480	min	Summer	11.447	0.0	532.8	482
600	min	Summer	9.716	0.0	548.6	602
720	min	Summer	8.493	0.0	560.1	722
960	min	Summer	6.860	0.0	574.6	960
1440	min	Summer	5.065	0.0	583.3	1226
2160	min	Summer	3.730	0.0	983.3	1600
2880	min	Summer	2.996	0.0	1025.3	2016
4320	min	Summer	2.196	0.0	993.1	2852
5760	min	Summer	1.763	0.0	1243.8	3688
7200	min	Summer	1.488	0.0	1311.7	4472
8640	min	Summer	1.295	0.0	1370.0	5280
10080	min	Summer	1.152	0.0	1421.1	6056
15	min	Winter	106.855	0.0	206.5	19
30	min	Winter	73.642	0.0	217.0	33

Walker Ingram Associates		Page 2
Office G4, Flexspace	Westminster Drive, Clayton	
Monckton Road	BDW Yorkshire West	
Wakefield, WF2 7AS	100yr + 30%	Micro
Date 12/08/2020 13:01	Designed by W.Walker	Drainage
File 106.012 - 100yr + 30%	Checked by	Dialilage
Innovyze	Source Control 2019.1	

Summary of Results for 100 year Return Period (+30%)

Storm Event		Max Level (m)	Max Depth (m)	Max Control (1/s)	Max Volume (m³)	Status		
60	min	Winter	101.876	1.876	3.4	390.3	0 K	
120	min	Winter	102.350	2.350	3.7	488.9	○ K	
180	min	Winter	102.622	2.622	3.9	545.3	0 K	
240	min	Winter	102.797	2.797	4.0	581.7	O K	
360	min	Winter	103.040	3.040	4.2	632.4	○ K	
480	min	Winter	103.199	3.199	4.3	665.5	0 K	
600	min	Winter	103.308	3.308	4.4	688.0	0 K	
720	min	Winter	103.383	3.383	4.4	703.7	0 K	
960	min	Winter	103.469	3.469	4.5	721.6	0 K	
1440	min	Winter	103.499	3.499	4.5	727.9	ОК	
2160	min	Winter	103.436	3.436	4.5	714.6	0 K	
2880	min	Winter	103.338	3.338	4.4	694.4	0 K	
4320	min	Winter	103.089	3.089	4.2	642.4	0 K	
5760	min	Winter	102.853	2.853	4.1	593.4	0 K	
7200	min	Winter	102.634	2.634	3.9	547.8	0 K	
8640	min	Winter	102.429	2.429	3.8	505.3	0 K	
.0080	min	Winter	102.240	2.240	3.7	466.0	○ К	

Storm		Rain	Flooded	Discharge	Time-Peak	
	Even	t	(mm/hr)	Volume	Volume	(mins)
				(m³)	(m³)	
			40 5 50			
60		Winter	48.563	0.0	396.8	64
120	min	Winter	30.907	0.0	484.9	122
180	min	Winter	23.333	0.0	506.2	180
240	min	Winter	18.946	0.0	520.8	240
360	min	Winter	14.121	0.0	549.0	356
480	min	Winter	11.447	0.0	571.8	472
600	min	Winter	9.716	0.0	587.7	588
720	min	Winter	8.493	0.0	599.1	702
960	min	Winter	6.860	0.0	613.0	924
1440	min	Winter	5.065	0.0	619.5	1354
2160	min	Winter	3.730	0.0	1087.0	1688
2880	min	Winter	2.996	0.0	1088.8	2160
4320	min	Winter	2.196	0.0	1072.4	3068
5760	min	Winter	1.763	0.0	1393.1	3976
7200	min	Winter	1.488	0.0	1469.1	4832
8640	min	Winter	1.295	0.0	1534.3	5704
10080	min	Winter	1.152	0.0	1590.9	6464

Walker Ingram Associates		Page 3
Office G4, Flexspace	Westminster Drive, Clayton	
Monckton Road	BDW Yorkshire West	
Wakefield, WF2 7AS	100yr + 30%	Micro
Date 12/08/2020 13:01	III) a conservation of the following the conservation of the conse	Drainage
File 106.012 - 100yr + 30%	Checked by	Drairiage
Innovyze	Source Control 2019.1	

Rainfall Details

Rainfall Model FSR Winter Storms Yes Return Period (years) 100 Cv (Summer) 0.750 Region England and Wales Cv (Winter) 0.840 M5-60 (mm) 18.500 Shortest Storm (mins) 15 Ratio R 0.303 Longest Storm (mins) 10080 Climate Change % Summer Storms Yes +30

Time Area Diagram

Total Area (ha) 0.980

Time (mins) Area From: To: (ha)

0 4 0.980

Walker Ingram Associates					
Office G4, Flexspace	Westminster Drive, Clayton				
Monckton Road	BDW Yorkshire West				
Wakefield, WF2 7AS	100yr + 30%	Micro			
Date 12/08/2020 13:01	Designed by W.Walker	Drainage			
File 106.012 - 100yr + 30%	Checked by	Drail laye			
Innovyze	Source Control 2019.1				

Model Details

Storage is Online Cover Level (m) 105.000

Tank or Pond Structure

Invert Level (m) 100.000

Depth (m)	Area (m²)						
0.000	208.0	0.700	208.0	1.400	208.0	2.100	208.0
0.100	208.0	0.800	208.0	1.500	208.0	2.200	208.0
0.200	208.0	0.900	208.0	1.600	208.0	2.300	208.0
0.300	208.0	1.000	208.0	1.700	208.0	2.400	208.0
0.400	208.0	1.100	208.0	1.800	208.0	2.500	208.0
0.500	208.0	1.200	208.0	1.900	208.0		
0.600	208.0	1.300	208.0	2.000	208.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0076-4500-3500-4500 Design Head (m) 3.500 Design Flow (1/s) 4.5 Flush-Flo™ Calculated Objective Minimise upstream storage Application Surface Sump Available Yes Diameter (mm) 76 100.000 Invert Level (m) Minimum Outlet Pipe Diameter (mm) 100 Suggested Manhole Diameter (mm) 1200

Control Points Head (m) Flow (1/s) Design Point (Calculated) 3.500 4.5 Flush-Flow 0.330 2.6 Kick-Flow 0.680 2.1 Mean Flow over Head Range - 3.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m) Flow	(1/s)	Depth (m) Flow	(1/s)	Depth (m) Flow	(1/s)	Depth (m)	Flow (1/s)
0.100	2.1	1.200	2.7	3.000	4.2	7.000	6.2
0.200	2.5	1.400	2.9	3.500	4.5	7.500	6.4
0.300	2.6	1.600	3.1	4.000	4.8	8.000	6.6
0.400	2.6	1.800	3.3	4.500	5.1	8.500	6.8
0.500	2.5	2.000	3.5	5.000	5.3	9.000	7.0
0.600	2.4	2.200	3.6	5.500	5.6	9.500	7.2
0.800	2.3	2.400	3.8	6.000	5.8		
1.000	2.5	2.600	3.9	6.500	6.0		