

Park Farm Donington Development

Flood Risk and Drainage Impact Assessment



October 2016

Amec Foster Wheeler Environment
& Infrastructure UK Limited



Report for

Christopher Sparrow
Duchy of Lancaster
1 Lancaster
Strand
London
WC2E 7ED

Main contributors

Patricia Sanz Lazaro

Issued by



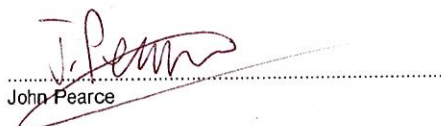
Mona Martin

Technically Approved by



Nick Jarritt

Approved by



John Pearce

Amec Foster Wheeler

12th Floor
25 Canad Square
Canary Wharf
London E14 5LQ
United Kingdom
Tel D +44 (0)20 3215 1420

Doc Ref. 38780

Q:\Projects\38780 Park Farm, Donnington - OPA\1
Client\Reports

Copyright and non-disclosure notice

The contents and layout of this report are subject to copyright owned by Amec Foster Wheeler (© Amec Foster Wheeler Environment & Infrastructure UK Limited 2015). save to the extent that copyright has been legally assigned by us to another party or is used by Amec Foster Wheeler under licence. To the extent that we own the copyright in this report, it may not be copied or used without our prior written agreement for any purpose other than the purpose indicated in this report. The methodology (if any) contained in this report is provided to you in confidence and must not be disclosed or copied to third parties without the prior written agreement of Amec Foster Wheeler. Disclosure of that information may constitute an actionable breach of confidence or may otherwise prejudice our commercial interests. Any third party who obtains access to this report by any means will, in any event, be subject to the Third Party Disclaimer set out below.

Third-party disclaimer

Any disclosure of this report to a third party is subject to this disclaimer. The report was prepared by Amec Foster Wheeler at the instruction of, and for use by, our client named on the front of the report. It does not in any way constitute advice to any third party who is able to access it by any means. Amec Foster Wheeler excludes to the fullest extent lawfully permitted all liability whatsoever for any loss or damage howsoever arising from reliance on the contents of this report. We do not however exclude our liability (if any) for personal injury or death resulting from our negligence, for fraud or any other matter in relation to which we cannot legally exclude liability.

Management systems

This document has been produced by Amec Foster Wheeler Environment & Infrastructure UK Limited in full compliance with the management systems, which have been certified to ISO 9001, ISO 14001 and OHSAS 18001 by LRQA.

Document revisions

No.	Details	Date
-----	---------	------

Executive summary

Purpose of this report

The purpose of this report is to assess the level of flood risk at the proposed site, to confirm whether the proposed development is acceptable under NPPF- National Planning Policy Framework and to detail measures required to ensure that the potential development will be safe and will not increase flood risk elsewhere or within the site.

Amec Foster Wheeler Environment & Infrastructure UK Ltd was commissioned by the Duchy of Lancaster to carry out a Flood Risk Assessment (FRA) and Drainage Strategy (DS) for a proposed employment development which consists of two units with hardstanding and car parks at Park Farm, Donington, Lincolnshire (National Grid Reference TF 2016935716), hereafter referred to as 'the Development'.

Development and site context

The proposed units, associated hardstanding and parking areas are situated on an area of land shown on the Environmental Agency(EA) online flood maps as being situated in a zone of Low risk from Tidal flooding, Low risk from River flooding and Medium risk from Surface Water flooding.

Flood level information and guidance provided by South Holland District Council/ Black Sluice IDB and Environmental Agency (EA) has been used to determine a suitable design level for the development. Measures to ensure flood flows are not impeded have been included in the site design.

Key report findings and recommendations

Based on the Flood Risk assessment findings, the following key recommendations are made:

- ▶ Proposed development are located in areas at low risk from tidal, fluvial and medium risk from surface water. The sources of information consulted indicate that overall development will be affected by surface water flooding.
- ▶ In order to attenuate part of the runoff rate to be discharged into the existing ditch located within the vicinity of the development at discharge rate required by Black Sluice IDB, using pipes.
- ▶ The remaining runoff will be stored in the permeable pavings and swales as suggested in section 4. 5.
- ▶ During the temporary works of the construction phase the development, siltbusters will be put in place to avoid contamination of the groundwater during dewatering.
- ▶ Enhanced soils to be used to improve the previous pavement system against pollution. Previous pavements can provide amenity in the form of both the usefulness and the visual aspects.



Contents

1.	Introduction	6
1. 1	Background and site context	6
	Purpose of the report	6
	Structure of this report	6
1. 2	Sources of data and information	6
2.	Planning context, site description and development proposal	7
2. 1	Planning context	7
2. 2	Site description	7
	Sites affected	7
	Topography	7
	Hydrology and drainage	8
	Geology, hydrogeology and soils	8
2. 3	Development proposals (Description of the development)	8
3.	Flood risk appraisal	10
3. 1	Historic flooding	10
3. 2	Tidal flooding	11
3. 3	Fluvial flooding	11
3. 4	Surface water flooding	11
3. 5	Sewer flooding	11
3. 6	Flooding from canals, reservoirs and other artificial sources	12
4.	Drainage impact assessment - Surface water management strategy	13
4. 1	Development of drainage strategy	13
	Planning policy	13
4. 2	The SUDS strategy	13
	Requirements of the drainage system	13
	The SUDS hierarchy	13
4. 3	The proposed SUDS solution	14
4. 4	Discharge location	15
4. 5	Greenfield runoff rate and attenuation volumes	15
5.	Summary	17
5. 1	Flood risks and mitigation	17
5. 2	Key recommendations	17
6.	Conclusions	18

Table 3. 1	Summary of Potential Flood Risk Sources posed to the proposed development	10
Table 4. 1.	Greenfield runoff rates obtained with Microdrainage	15
Table 4. 2.	Attenuation volumes required for different storm events and Climate Change Allowances obtained	
Microdrainage	15	
Table 4. 3.	Suds systems proposed for the site attenuation	16



Figure 4. 1 SUDS Hierarchy

14

Appendix A	Development plans
Appendix B	Walkover information
Appendix C	Communications with EA and South Holland District Council
Appendix D	Microdrainage calculations

1. Introduction

1.1 Background and site context

Amec Foster Wheeler Environment & Infrastructure UK Ltd was commissioned by the Duchy of Lanchaster to carry out a Flood Risk Assessment (FRA) and Drainage Strategy (DS) for a proposed employment development with associated hardstanding and parking areas at Park Farm, Donington, Lincolnshire (National Grid Reference TF 2016935716), hereafter referred to as 'the Development'.

Purpose of the report

The purpose of this report is to assess the level of flood risk at the proposed Development, to confirm whether it is acceptable under NPPF- National Planning Policy Framework and SUDS Manual Ciria C753, and to detail measures required to ensure that the proposed development will be safe and will not increase flood risk elsewhere.

Structure of this report

The report is structured as follows:

- ▶ Section 2 – Site Description: Existing conditions and development proposals;
- ▶ Section 3 – Flood Risk Assessment: this details the various sources of flood risk to the Site;
- ▶ Section 4 – Surface water management and drainage; and
- ▶ Section 5 – Flood Risk Management, Mitigation Recommendations and Conclusions.

The figures along with supporting documents are presented at the end of the report in the form of appendices. In total there are five appendices, as follows:

- ▶ Appendix A presents the Development Plans;
- ▶ Appendix B contains walkover information.
- ▶ Appendix C contains Communications with EA and South Holland District Council
- ▶ Appendix D contains Microdrainage Calculations

1.2 Sources of data and information

- ▶ NPPF- National Planning Policy Framework
- ▶ EA flood maps accessed online (<http://apps.environment-agency.gov.uk/wiyby/37837.aspx>);
- ▶ The British Geological Survey BGS online 'Geology of Britain' mapping (<http://mapapps.bgs.ac.uk/geologyofbritain/home.html>);
- ▶ Strategic Flood Risk Assessment report , prepared in January 2010 by South Holland District Council;
- ▶ OS maps Ordnance Survey accessed online (<https://www.ordnancesurvey.co.uk/osmaps/>);

2. Planning context, site description and development proposal

2.1 Planning context

Flood risk and drainage in England and Wales is regulated by NPPF- National Planning Policy Framework and SUDS manual C753, Strategic Flood Risk Assessment (SFRA 2010) and the Lead Local Authority of the location where the development is proposed.

Section 100 of National Planning Policy Framework-NPPF- establishes that:

“ Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk. Local Plans should apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change.”

Section 101 of National Planning Policy Framework-NPPF- establishes that: *“The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding. The Strategic Flood Risk Assessment will provide the basis for applying this test. A sequential approach should be used in areas known to be at risk from any form of flooding.”*

2.2 Site description

Sites affected

The proposed development is located at Park Farm, Donington, Lincolnshire (PE11 4UJ) at NGR TF20133 35516. The A52 runs along eastern boundary of the site, up to the roundabout located at the point where road crosses A152. Appendix A contains a plan describing proposed development.

The existing site extends to 2 hectares and is located to the west of Donington village, separated from the village by the A52. The site forms part of Park Farm and is currently a greenfield site in agricultural use.

The site is bounded by trees and hedgerow. The A52 runs adjacent to the eastern boundary of the site and runs along the northern edge of the village. The roundabout on the A52, which is situated to the south of the site, provides access onto Station Street and facilities within the village. The farm buildings and access road lie adjacent to the south and west of the site, and agricultural fields lie to the west and north.

The larger settlements of Boston and Spalding are approximately 17.1 km north-east and 16.8 km south-east of the site respectively, and contain a wide range of services and facilities.

The topography of the site is flat. Although the site is within Flood Zone 1, land to the north and west is Flood Zones 2 and 3, according to the Environment Agency flood map. A drainage ditch runs east to west through the site.

Topography

Topographical survey indicateds that the site is quite flat. Elevation at northern boundary is approximately 3.31m AOD while on southern boundary is 3.90m AOD. However site elevation is lower in the middle adjacent to the existing ditch (3.09 m AOD) allows the runoff to drain gradually into this ditch from both sides.

Hydrology and drainage

The proposed development is surrounded on the west by South Forty Foot Drain and on South by river Glen which discharges to the Wash and is located in Black Sluice IDB catchment area.

The river Glen discharges to the river Welland via tidal gates at Surfleet Reservoir. The South Forty Foot Drain, on the western boundary of the District is manmade embanked water course receiving drainage runoff from adjacent low-lying land.

Information on the existing drainage features and watercourses affected by the proposed development was gathered during the site visit undertaken on 23 August 2016 by Amec Foster Wheeler personnel. Photos of the issues encountered have been included in Appendix B. The elements are briefly described below:

- ▶ A surface water drainage ditch running in a East-West direction crossing under the A52 road using a 300 mm concrete highway culvert. This ditch enters the site on eastern boundary at approximate NGR TF 20183 35551 running through the site towards west boundary and exits the site at approximate NGR TF 20085 35562. Turning towards North the ditch continues alongside the western boundary till it turns again at approximate NGR TF 20072 35640 towards west under the private road using 600 mm farm access culvert. It continues west till discharges to Hammond Beck and finally to South Forty Foot Drain.
- ▶ Two Surface water drainage ditches were identified at the Western side of the A52 road and alongside the eastern boundary of the site which are used for road drainage and no discharge is allowed to them . One runs from North to South and drains into the main ditch which is going through the site at approximate NGR TF 20182 35551 after crossing the access road using a 600 mm diameter field access culvert. Second ditch runs south to north and drains in the same ditch at approximate NGR TF 20182 35551.
- ▶ Two Surface water drainage ditches were identified at the eastern side of the A52 road. One runs from north to south and drains into the main ditch which going through the site at approximate NGR TF 20203 35545 after crossing the access road using a 600 mm diameter field access culvert. Second one runs south to north and drains in the same ditch at approximate NGR TF 20203 35545.
- ▶ Continuous water was not flowing along the ditches at the time of the site visit. Overgrown vegetation is present along the drainage feature.
- ▶ A storage pond is located at approximate NGR TF 20269 35619 and it is assumed that this pond is used as a storage for the development located at eastern side of the A52 at approximate NGR TF 20263 35532. At the day of the visit there was no access to the pond so the condition and purpose of the pond is unknown.

Geology, hydrogeology and soils

The British Geological Survey BGS online 'Geology of Britain' mapping indicates that the Development is underlain by the Oxford Clay Formation – Mudstone. Sedimentary Bedrock formed approximately 156 to 165 million years ago in the Jurassic Period. Local environment previously dominated by shallow seas. These rocks were formed in shallow seas with mainly siliciclastic sediments (comprising of fragments or clasts of silicate minerals) deposited as mud, silt, sand and gravel.

Groundwater Systems and Water Quality Commissioned Report CR/06/060N prepared by British Geological Survey and the Environment Agency has identified that the area is located over a Lincolnshire Limestone which is a hard, fractured carbonate aquifer.

2.3 Development proposals (Description of the development)

The application is submitted in outline with all matters reserved, although it is envisaged that two units for employment/commercial use will be constructed on site. The exact uses will be subject to end user requirements and are not known at present. The illustrative layout indicates that two warehouses which will also include ancillary office space within each of the units, approximate 53 parking spaces for staff and 7 for

delivery vehicles, as well as appropriate landscaping and the provision of Sustainable Urban Drainage Systems (SUDS) to mitigate any against potential flooding risk.

The proposed development areas as shown on the illustrative masterplan include the following:	Area (ha)
Warehouse Unit 1	0.131
Warehouse Unit 2	0.235
Roads	0.14
Hardstanding Areas	0.37
Parking Areas	0.041
Total Impermeable Area	0.917
Total Site Area	2

3. Flood risk appraisal

Flood risk appraisal for the proposed development has been based on available and suitable information, and consultation with EA, IDB and Lincolnshire Council.

EA flood maps accessed online and SFRA produced by South Holland District Council indicate that the site is at low risk from river and sea flooding, and that the main risk in the area will be generated from surface water during a flood event. The proposed development therefore will potentially be affected by surface water flooding.

Table 3. 1 summarises the sources of flood risk posed to the proposed development.

Table 3. 2 Summary of Potential Flood Risk Sources posed to the proposed development

Source of Flooding	Risk Posed	Notes
Fluvial	Low	The proposed development is surrounded by the South Forty Foot Drain on the west and on the south by river Glen which discharges to the Wash. Proposed development would only be at low risk of flooding from the rivers , assuming no flood defence exist or at the event of river level rise due to climat change. South Holland district council SFRA suggests that the existing flood defences are in good condition so only the river level rise must be take into account over the lifetime of the development.
Tidal	Low	The proposed development is surrounded by the South Forty Foot Drain on the west and on the south by river Glen which discharges to the Wash. Proposed development would only be at low risk of flooding from the sea , assuming no flood defence exist or at the event of sea level rise due to climat change. South Holland district council SFRA suggests that the existing flood defences are in good condition so only the river level rise must be take into account over the lifetime of the development.
Groundwater	Low	The underlying geology has low permeability and as such it is unlikely that the site would be subject to groundwater flooding although the ground water level is relatively high.
Surface water runoff and drainage	Medium	The surface water runoff generated within the site will be discharged to the tributary of the existing ditch at the permitted discharge rate as the capacity of infiltration of the ground is very limited due to the geology of the area. The development would be at medium risk form surface water flooding and therefore a suitable method of discharge and attenuation should be considered to avoid flooding in any flood event.
Sewer	N/A	Given the location, risks are considered limited.
Artificial	N/A	There are no artificial water sources within proximity of the site.

3.1 Historic flooding

Flooding history data is available in the South Holland Distrcit Council Flood Study report which includes a map summarising water levels within the South Holland District. However there was no report on any flooding in the proposed development.

The major incidents around the proposed development would be as follows:

- ▶ March 1999- breach of the right bank of South Forty Drain just north of Black Hole Drove pumping station(approximately about 10. 9 km away form the proposed development). Flooded area extended 400m from the drain. The fluvial flood event gave peak water levels in the drain about 0. 3m lower than bank full.

- ▶ Surfleet Reservoir, immediately upstream of Surfleet outfall on the river Glen (approximately about 10.9 km away from the proposed development) – Several flood incidents in March 1980. This area is functional flood plain for the river.

At this stage no record of historic water levels is available.

3.2 Tidal flooding

As mentioned in Section 3 of this report, there are several sources of data to assess the tidal flood levels in South Holland District. The sources of information that have been consulted indicate that most of the proposed development is at low risk from tidal flooding.

Environment Agency, South Holland District Council, Lincolnshire Council and Black Sluice IDB have been consulted as Lead Local Authority and statutory consultee involved in the planning process of the proposed development. The SFRA Flood Study report prepared by South Holland District Council in 2010 is the most reliable and up to date flood study in the area. Correspondence with the EA and South Holland District Council in this respect is included in Appendix D.

Flood maps included in the SFRA report indicate that the whole development will be affected by low Risk from tidal flooding.

No information on the tidal levels or flooding velocities is available for the potential areas affected in the flood maps.

3.3 Fluvial flooding

South Holland District Council's SFRA indicates that the fluvial effects of the South Forty Foot Drain and river Glen are low due to good flood defences. Therefore the developed area is at low risk from fluvial flooding.

No information on the fluvial levels or flooding velocities is available for the potential areas affected in the flood maps.

3.4 Surface water flooding

Surface water and the drainage system are controlled by drainage boards in Lincolnshire. Donington area is controlled by Black Sluice IDB as indicated in SFRA report produced by South Holland District Council in 2010. As indicated in section 2.2 drainage and hydrology, there is an existing ditch which runs through the site where the discharge rate is limited to 1.4 lit/sec/ha for green field runoff rate. In addition, there are also two ditches that run alongside the eastern boundary of the site which relate to the A52 to which no discharge is allowed.

Due to the data provided in SFRA, IDB considers that most of their drains may reach bank-full conditions in urban areas but there is no risk of flooding to the properties. In the proposed site, however as it is an agricultural area there would be shallow flooding. The report also indicates that further detailed technical analysis of the internal drainage systems is required to have a better understanding of the current situation of the surface water drainage system.

EA flood maps indicate that the proposed site might be affected by Medium-high Risk from surface water flooding.

Geological mapping indicates that the ground beneath the site has limited permeability as it is mainly covered by Oxford clay. EA flood maps indicate that the area might not be affected by groundwater flooding. The SFRA report does not mention groundwater as a source of flooding in the area.

3.5 Sewer flooding

Due to SFRA report there is not significant floodings from the sewers in this area.

3.6 Flooding from canals, reservoirs and other artificial sources

The SFRA reports that the nearest reservoir near the proposed development is Surfleet reservoir which has a good flood defence. The flood embankments of these reservoirs are the same as the flood defences of the river Glen and have already been assessed for risk of over topping and breach. Therefore the risk from this flood source is low.

4. Drainage impact assessment - Surface water management strategy

4.1 Development of drainage strategy

Planning policy

This section discusses the outline strategy for managing run-off from the Development in a sustainable manner, in accordance with the England and Wales Planning Policy , Flooding and Sustainable Urban Drainage Systems (SUDS manual) and Black Sluice IDB.

4.2 The SUDS strategy

Requirements of the drainage system

The drainage strategy for managing surface water needs to be based on the Management Train as outlined in 'The SuDS Manual' (Ciria C753) released in November 2015. This ensures that surface water is managed at source and as the water is conveyed through the Site, each sequential technique is designed to reduce the intensity of flow and to enhance the quality of flow by removing pollutants. The most suitable techniques for use across the Site can be ascertained by undertaking a SuDS Assessment. A high level assessment has been made by considering the SuDS hierarchy and choosing suitable techniques in line with the main objectives of Quantity (Flood Reduction), Quality (Pollution Reduction) and Amenity/Biodiversity (Landscape and Wildlife Benefit).

The SUDS hierarchy

The SuDS Hierarchy is illustrated in Figure 4.1. This table rates each type of technique in terms of its overall sustainability.

Figure 4.1 SUDS Hierarchy

Most Sustainable	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
	Living roofs	✓	✓	✓
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration devices - soakaways - infiltration trenches and basins	✓	✓	✓
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviers	✓	✓	
	Tanked systems - over-sized pipes/tanks - storms cells	✓		
Least Sustainable				

Source: SUDS: A Practical Guide, Environment Agency Development Control Thames Region, 2006.

Techniques such as permeable surfaces offer source control by managing flow intensity entering the system, although they do not promote any wildlife benefit. Tanked systems are typically located underground and as such they offer no landscape, wildlife or pollution control benefit and this option could be quite costly due to high level of ground water level. Therefore, these systems are only to be used once all other sustainable techniques have been assessed and considered unsuitable.

SuDS techniques that promote infiltration of surface water are preferred over those which promote attenuation before discharge to a watercourse. As identified in Section 2. 2, the development is underlain by Silt and Clay Superficial Deposits. Overall, the geology at the Site is not particularly permeable; therefore, SuDS techniques which primarily utilise infiltration are not suitable at this Site.

As infiltration rates across the Site are considered poor, on-Site attenuation should be the primary means of surface water management. However, if the results of any future infiltration testing indicate that infiltration could be utilised as part of the drainage system, then the total attenuation volume will be reduced. As the Site is not located in a groundwater Source Protection Zone (SPZ), there would be no reason from a groundwater pollution perspective as to why the run-off generated on - Site could not be infiltrated into the ground, providing a risk assessment has been carried out to ascertain the potential levels of pollution.

4.3 The proposed SUDS solution

As dicribed in section 2.3 impermeable surface generated by 2 units of industrial warehouses, Parking areas and roads is 0.917 ha. Considering the nature of the construction and the proximity of the existing ditch in the middle of the site , also discharge rate limitations required by Black Sluice IDB-1.4 lit/sec/ha greenfield run off rate- additional surface to attenuate the runoff generated by the proposed developments should be incorporated. Using figure 4.1 different options including ponds, swales,permeable pavings and attunation tanks, have been considered for the attunation storage required considering the most

suitable and preferable option for the development. However due to site poor infiltration, high level of ground water level, existing ditch 9m by-law requirement and discharge rate limitations, two main options are considered to be suitable for the attenuation storage required for this development.

As part of this study site divided in two parts :

- ▶ Area located north side of the existing ditch
- ▶ Area located south part of the existing ditch

suggested methods considered for each area is described in section 4.5 of this report.

4.4 Discharge location

It has been assumed that infiltration will not be possible, due to the anticipated low permeability of the underlying alluvium. Surface water will be discharged at controlled rates to a nearby watercourse (existing ditch) via pipes connected to swales. The details of the new pipes or ditch and details of flow control will need to be determined at the detailed design stage.

4.5 Greenfield runoff rate and attenuation volumes

Two proposed units as part of the development which have the potential to increase surface water runoff. The increase of impermeable area will be of 0.917 ha as per the proposed dimensions of the units and proposed scheme shown on the illustrative masterplan. Microdrainage calculations have been undertaken to identify the greenfield runoff rate and the potential attenuation volumes for different storm events.

The Standard Average Annual Rainfall (SAAR) is 600mm at the location where the substation is proposed and the Standard Percentage Runoff (SPR) is 0.3. Greenfield runoff values for different storm events are included in Appendix E.

Table 4.1. Greenfield runoff rates obtained with Microdrainage

Return Period (Years)	Q(l/s)
Q1	1.9
Qbar	2.2
Q100	7.7
Q200	9.1

Using Microdrainage it has been calculated the potential attenuation volumes required for a range of storm events and climate change allowances. The calculations have been based on the limited discharge rate equal to the Qbar with a value of 2.2 l/s. SUDS manual indicates that the minimum discharge rate for storage volume calculation can not be less than 5 lit/sec therefore we consider limited discharge rate equal to the Qbar with a value of 5 l/s.

Table 4.2. Attenuation volumes required for different storm events and Climate Change Allowances obtained Microdrainage

Return Period (Years)	Climate Change Allowance (%)	Attenuation Volume (m³)
100	20	607
100	40	737

Return Period (Years)	Climate Change Allowance (%)	Attenuation Volume (m ³)
200	20	719
200	40	871

A range of attenuation volumes have been calculated having regard to the instructions included in the SUDS manual

“The calculated post development peak runoff flow rates for the range of 100 year return period storm events. The attenuation required to limit the 100 year return period post development storm runoffs to the required limiting pre development runoff flow rates.”

“Check drainage network calculation for range of 200 year return period storm events to assess the level and location of potential back up flooding within the drainage network and ensure that any back up flooding does not encroach within 600 mm of any adjacent property ground floor level ”

The first suds system which was considered is 2 no. swales one located at the northern elevation of the existing ditch and the second one located on the southern side of the existing ditch. In addition to the swales, permeable pavings are required under the proposed staff car parks in the northern and southern areas. The type considered for permeable pavings are Type C with no infiltration to the ground. Please see below the area required for each of the suds systems to comply with the storage required.

Table 4. 3. Suds systems proposed for the site attenuation

Attenuation system	Length (m)	Width (m)	Depth (m)	Area (m ²)
North Swale	74	9.4	0.8	696
South Swale	65	7.4	0.8	481
Northern area staff permeable car park	43	12	1.5	516
Southern area staff permeable car park	27	15	1.5	405

5. Summary

5.1 Flood risks and mitigation

Flood risk has been considered from all sources, low risk identified from tidal, fluvial and medium risk from surface water flooding.

The new development will produce an increase of the greenfield runoff rate in the area, Due to Black Sluice IDB requirements the discharge should be limited to 1.4 lit/sec/ha at greenfield runoff rate. In order to minimise the discharge rate to the limit required by IDB, attenuation storage is required. Therefore swales and permeable pavements are proposed on the two halves of the site. The flow will be discharge at the limited discharge rate from the proposed swales and permeable pavings to the existing ditch using pipes. The size and location of the pipes will be finalised at the detail design stage

Following mitigation measures to protect the development from flooding should be used in case no flood defence exist or the river/sea level rises due to climate change.

- ▶ Raising the FFL to the units above the flood level
- ▶ Sealing entire site with flood gates or removable flood planks

Runoff from impermeable areas of the development will be directed to adjacent permeable paving areas and swales using the appropriate gradient and slope on the surface. These flows will be allowed to infiltrate gradually if ground conditions permit. If infiltration is not viable at the development, runoff will be stored within the void space between the gravel material or within the swales (depending on the final site design), and released at a controlled rate to an adjacent watercourse.

5.2 Key recommendations

- ▶ Flood warning signs and evacuation procedures should be displayed in the vicinity of the development. Operating procedures should be developed and communicated to staff detailing how maintenance activities will be scheduled, and the procedures in the event of flooding;
- ▶ The runoff should be managed by storage within the swales and impermeable pavings. Water quality measures such as bunding and spill kits will be incorporated in the warehouses design and operation; and
- ▶ Construction – a flood warning and evacuation plan should be developed to ensure the safety of staff, and manage the risks during this phase;
- ▶ Measures such as siltbusters will be put in place for the temporary abstraction of groundwater by means of pumping.
- ▶ Limit the discharge to 1.4 lit/sec/ha as required by Black Sluice IDB and use the swales and permeable paving as the attenuated storage during any flood event.

6. Conclusions

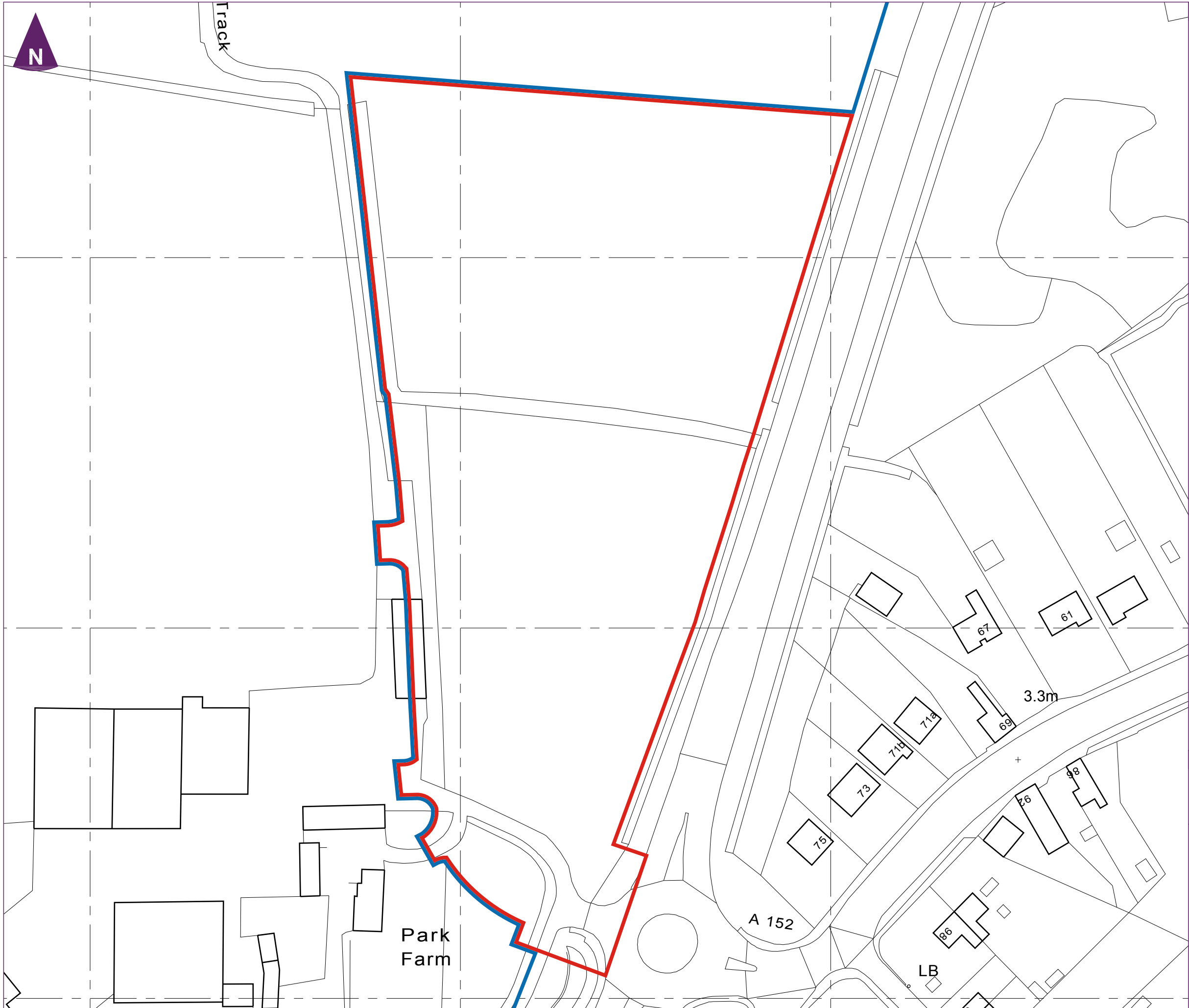
Based on the Flood Risk assessment and Drainage strategy findings, consultation with Environmental Agency and Black Sluice IDB, as the proposed development located in flood risk zone 1 and the major flood risk associated to the site is surface water the following recommendations are presented.

- ▶ Proposed development are located in areas at low risk from tidal, fluvial and medium risk from surface water. The sources of information consulted indicate that overall development will be affected by surface water flooding.
- ▶ In order to attenuate part of the runoff rate to be discharged into the existing ditch located within the vicinity of the development at discharge rate required by Black Sluice IDB, using pipes.
- ▶ The remaining runoff will be stored in the permeable pavings and swales as suggested in section 4.5.
- ▶ During the temporary works of the construction phase the development, siltsbusters will be put in place to avoid contamination of the groundwater during dewatering.
- ▶ Enhanced soils to be used to improve the previous pavement system against pollution. Previous pavements can provide amenity in the form of both the usefulness and the visual aspects.



Appendix A

Development plans



Key

- Planning application boundary (2.0 Hectares)
- Land owned by applicant

0 m 50 m

Scale 1:1000 @ A3

Client

 DUCHY of LANCASTER

38780 Park Farm,
Donington



P001
Site Plan As Existing

DRAFT

Oct 2016 38780-LEA-PDD-P001 Site Plan As Existing.dwg AsheS



Key

- Planning application boundary (2.0 Hectares)
- Land owned by applicant
- Existing landscaping, retained and enhanced where practicable
- Proposed illustrative landscaping

0 m 50 m

Scale 1:1000 @ A3

Client

 DUCHY of LANCASTER

38780 Park Farm,
Donington



P002
Illustrative Masterplan

DRAFT

Oct 2016 38780-LEA-PDD-P002 Illustrative Masterplan.dwg AsheS



Appendix B

Walkover information

Below are presented the surface water observations identified during the walkover undertaken the 23 August 2016. A brief description of the findings encountered is incorporated for each of the observations.



Figure 1- surface water drainage ditch running in a East-West direction crossing under the A52 road using a 300 mm concrete highway culvert



Figure 2- Turning towards North the ditch continues alongside the western boundary till it turns again at approximate NGR TF 20072 35640 towards west under the private road using 600 mm farm access culvert



Figure 3-Two Surface water drainage ditches were identified at the Western side of the A52 road



Figure 4- Two Surface water drainage ditches were identified at the eastern side of the A52 road



Appendix C

Communications with EA and South Holland District Council

Martin, Mona

From: Andrew Scott <Andrew.Scott@blacksluiceidb.gov.uk>
Sent: 26 August 2016 15:40
To: Martin, Mona
Cc: Ian Warsap; Paul Nicholson
Subject: RE: Park farm house - Donnington Lincolnshire
Attachments: FX1357.pdf; EA Living on the Edge booklet.pdf

Our Ref: IW/AS/FX1357/D05

Proposed industrial development - land adjacent to Park Farm, Donnington

Thank you for your email below.

Having discussed the matter with our Chief Executive and Operations Manager, I have the following comments in answer to your queries (please refer to the plan attached):

1. As per our website, the Board has a Byelaw (No.10) which prohibits any structures, including planting, within 9 metres of a Board-maintained watercourse. In this instance, the "ditch" crossing the site marked dark blue is a Board-maintained watercourse. The Board will not allow anything which would form an obstruction to its workforce or machinery within this 9m distance without prior written consent from the Board. Whilst the Board appreciates that this will present some restrictions on the available space for any prospective developer, the Board must ensure that its assets under the Land Drainage Act 1991 are adequately protected at all times.
2. The greenfield rate of **1.4 ltrs/sec/Ha** is the agricultural run-off rate for the site. As per current planning guidelines, the use of sustainable drainage schemes is a presumption, and therefore you will be expected to achieve a restricted discharge from the development at the greenfield rate. Should this be impracticable, then the Board will levy a discharge fee based on the final discharge rate achievable above the greenfield rate and the total impermeable area to be constructed. The Board's current rate for a full un-attenuated discharge of 100 ltrs/sec/Ha is £7.50 +VAT per square metre of impermeable area. The Board will charge a proportional fee if the final rate of discharge is between 1.4 & 100 ltrs/sec/Ha (i.e. if the discharge rate is 5 ltrs/sec/Ha, then the fee would be approximately £0.38p +VAT per square metre). All drainage schemes will be considered for approval by the local planning authority – the Board cannot approve any schemes.
3. As per point 1 above, the Board would not allow the siting of any ditch/swale/pond within the 9m byelaw distance.

Additional information:

The Board does not own any land within which its maintained watercourses lie. Ownership and maintenance responsibility lies with the adjacent landowner where ownership is different either side, or with a single landowner where both sides come under the same ownership. This applies for ANY watercourse, and not just Board-maintained, and also includes any structures within the watercourse, such as access culverts or bridges. I have attached a copy of the Environment Agency's Living on the Edge booklet which provides further guidance on rights and responsibilities.

You will note from the plan attached that there are watercourses within the land ownership of the site not maintained by the Board running parallel to the A52 highway. As these watercourses drain into the Board-maintained watercourse, you may wish to utilise these either as additional storage (i.e. enlarge and convert into balancing ponds?) or position any proposed lagoons at the northern or southern boundaries of the site and discharge into these watercourses.

I have also indicated pipe diameters of the existing culverts within or bounding the site. The Board would expect any new culvert pipe placed within the Board watercourse to at least match the existing pipe diameters, but would recommend an additional 30% increase in diameter to account for climate change.

If you have any further queries, please let me know.

Kind regards.

Andy Scott
Planning & Byelaw Officer
For the Chief Executive
Black Sluice Internal Drainage Board
Tel: 01205 821440
Website: www.blacksluiceidb.gov.uk

From: Martin, Mona [<mailto:Mona.Martin@amecfw.com>]
Sent: 24 August 2016 10:27
To: TempUser <MAILBOX@blacksluiceidb.gov.uk>
Subject: Park farm house - Donnington Lincolnshire

Dear Sir/Madam,

AMEC was appointed by our client to carryout initial flood risk assessment and drainage strategy report as part planning application for a new development in site located in Park farm House Donnington Lincolnshire (PE11 4UJ). Please see attached for site boundary.

The new development will include a construction of 2 units of industrial warehouse , hardstanding and car parks.

This area is located in flood risk zone 1 and there is a ditch crossing through the site from east to west located in the middle of the site boundary.

As part of our assessment we would like to clarify some constrains and understand your requirements to be able to proceed with the application.

It is envisaged that infiltration will not be an appropriate option in this site due to ground condition, therefore, potential attenuation storage options such as swales and ponds are being looked at.

Requirements:

- 1) I would like to confirm the 9m byelaw as stated by IDB website.
- 2) I would like to confirm whether the Greenfield runoff rate for this site is 1.4lit/sec
- 3) Also I would like to check whether we could construct any ditch or swale /pond within 9m of the existing ditch.

Please do not hesitate to contact me if you have any requirement.

Kind regards

Mona Martin

Civil Engineer Consultant, Environment & Infrastructure UK Limited, Amec Foster Wheeler
4th floor, 60 London Wall, London, EC2M 5TQ
M +44 (0)7583109536
mona.martin@amecfw.com amecfw.com



This message is the property of Amec Foster Wheeler plc and/or its subsidiaries and/or affiliates and is intended only for the named recipient(s). Its contents (including any attachments) may be confidential, legally privileged or otherwise protected from disclosure by law. Unauthorised use, copying, distribution or disclosure of any of it may be unlawful and is strictly prohibited. We assume no responsibility to persons other than the intended named recipient(s) and do not accept liability for any errors or omissions which are a result of email transmission. If you have received this message in error, please notify us immediately by reply email to the sender and confirm that the original message and any attachments and copies have been destroyed and deleted from your system. This disclaimer applies to any and all messages originating from us and set out above. If you do not wish to receive future unsolicited commercial electronic messages from us, **please forward this email to: unsubscribe@amecfw.com and include “Unsubscribe” in the subject line.** If applicable, you will continue to receive invoices, project communications and similar factual, non-commercial electronic communications.

Please click <http://amecfw.com/email-disclaimer> for notices and company information in relation to emails originating in the UK, Italy or France.

Martin, Mona

From: Lincs & Northants, Customer Enquiries <LNenquiries@environment-agency.gov.uk>
Sent: 20 September 2016 14:21
To: Martin, Mona
Subject: RE: 160830/DP05 - Park Farm House - Donnington Lincolnshire CCN/2016/22198
Attachments: CCN-2016_22198_FM.PDF; FRA_Advisary_Text_July_12 (2).pdf; Product 3 Standard Letter - 22198.docx

Dear Mona,

Enquiry regarding Park Farm House - Donnington Lincolnshire

Thank you for your enquiry which was received on 24 August 2016.

We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

I enclose the Product 3 information as requested. This data will be shared under the Open Government Licence, to read this and find out about permitted use, please click [here](#) .

Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent.

We would welcome any comments or suggestions that you might have on how we can improve our service. We would be really grateful if you could spare a few moments and click on the link below to fill in our online survey – we use every piece of feedback we receive:

<http://www.smartsurvey.co.uk/s/EnvironmentAgencyCustomerSurvey/?a=LN>

Kind Regards

Rebecca Baker

Customers & Engagement Officer

Environment Agency – Lincolnshire & Northamptonshire Area

✉ Waterside House, Waterside North, Lincoln, LN2 5HA

☎ 02084 745373

☎ 45373 (internal)

✉ Rebecca.baker@environment-agency.gov.uk

💻 www.gov.uk/environment-agency



From: Enquiries, Unit
Sent: 30 August 2016 14:39
To: Mona.Martin@amecfw.com
Subject: 160830/DP05 - Park Farm House - Donnington Lincolnshire CCN/2016/22198

Dear Mona

I have passed your enquiry to our customer team for the relevant area and they will be in touch with you shortly.

The Freedom of Information Act and Environmental Information Regulations state that a public authority must respond to requests for information within 20 working days, but we aim to respond to all enquiries as quickly as we can.

You can find more information about our service commitment by clicking on the link below:

<https://www.gov.uk/government/publications/environment-agency-customer-service-commitment>

Should you wish to contact the customer team directly, please use the contact details below. Please quote your Enquiry Reference 160830/DP05 in any correspondence with us regarding this matter.

Customers and Engagement
Environment Planning & Engagement
Environment Agency
Lincolnshire and Northamptonshire Area
Waterside House
Waterside North
LINCOLN
LN2 5HA

Tel: 03708 506506

Regards

David Powell

Customer Service Advisor
National Customer Contact Centre - Part of National Operations Services

Tel: 03708 506 506
Web Site: www.gov.uk/environment-agency

Click an icon to keep in touch with us:-



So how did we do...?

Our National Customer Contact Centre relies on customer feedback, so we really value your thoughts on how we are doing. We will always make changes where we can to improve our service. This will only take three minutes to complete:

<http://www.smartsurvey.co.uk/s/NCCCcustomer/>

From: Martin, Mona [<mailto:Mona.Martin@amecfw.com>]
Sent: 24 August 2016 11:32
To: Enquiries, Unit <enquiries@environment-agency.gov.uk>
Subject: Park Farm House - Donnington Lincolnshire

Dear Sir/Madam,

AMEC was appointed by our client to carry out initial flood risk assessment and drainage strategy report as part of planning application for a new development in site located in Park farm House Donnington Lincolnshire (PE11 4UJ). Please see attached for site boundary.

The new development will include a construction of 2 units of industrial warehouse, hardstanding and car parks.

This area is located in flood risk zone 1 and there is a ditch crossing through the site from east to west located in the middle of the site boundary.

As part of our assessment we would like to clarify some constraints and understand your requirements to be able to proceed with the application.

It is envisaged that infiltration will not be an appropriate option in this site due to ground condition, therefore, potential attenuation storage options such as swales and ponds are being looked at.

Requirements:

- 1) As it is necessary to provide FRA given that the site is mainly located in flood zone 1 and the presence of an existing ditch crossing the site and high level of ground water I would like to know whether there is any information on the groundwater flooding,
- 2) I would also like to confirm the 9m byelaw from all the surrounding ditches as stated by IDB.
- 3) As part of the development there is a necessity to have a culvert ditch as marked up on the attached drawings, is there any additional consideration for its construction and what kind of modelling which is required for the culvert-ditch.
- 4) Options are being investigated where the discharge into the ditches is being considered. Could you please confirm the limit discharge rate which should be considered. As part of our design 1.4 lit/sec/ha discharge limit was considered as stated by Black Sluice IDB. However the minimum discharge limit as stated by circa is 5 lit/sec which is used in our design.
- 5) Given latest climate change allowances in climate change, could you please confirm that the allowances we need to consider. For the basis of our design both the central and upper end allowances for 60 years lifetime of the project were assessed based on <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances> and the following allowances were assumed:

Upper end : 40%

Central : 20%

Could you please confirm whether these assumptions are acceptable.

Please do not hesitate to contact me if you have any requirement.

Kind regards

Mona Martin

Civil Engineer Consultant, Environment & Infrastructure UK Limited, Amec Foster Wheeler
4th floor, 60 London Wall, London, EC2M 5TQ
M +44 (0)7583109536
mona.martin@amecfw.com amecfw.com



This message is the property of Amec Foster Wheeler plc and/or its subsidiaries and/or affiliates and is intended only for the named recipient(s). Its contents (including any attachments) may be confidential, legally privileged or otherwise protected from disclosure by law. Unauthorised use, copying, distribution or disclosure of any of it may be unlawful and is strictly prohibited. We assume no responsibility to persons other than the intended named recipient(s) and do not accept liability for any errors or omissions which are a result of email transmission. If you have received this message in error, please notify us immediately by reply email to the sender and confirm that the original message and any attachments and copies have been destroyed and deleted from your system. This disclaimer applies to any and all messages originating from us and set out above. If you do not wish to receive future unsolicited commercial electronic messages from us, **please forward this email to: unsubscribe@amecfw.com and include "Unsubscribe" in the subject line.** If applicable, you will continue to receive invoices, project communications and similar factual, non-commercial electronic communications.

Please click <http://amecfw.com/email-disclaimer> for notices and company information in relation to emails originating in the UK, Italy or France.

This message has been scanned and no issues discovered.

Click [here](#) to report this email as spam

Information in this message may be confidential and may be legally privileged. If you have received this message by mistake, please notify the sender immediately, delete it and do not copy it to anyone else.

We have checked this email and its attachments for viruses. But you should still check any attachment before opening it.

We may have to make this message and any reply to it public if asked to under the Freedom of Information Act, Data Protection Act or for litigation. Email messages and attachments sent to or from any Environment Agency address may also be accessed by someone other than the sender or recipient, for business purposes.

Click [here](#) to report this email as spam

Martin, Mona

From: Norman, Phil <pnorman@sholland.gov.uk>
Sent: 06 September 2016 09:39
To: Martin, Mona
Subject: FW: Park Farm House- Donnington Lincolnshire
Attachments: Mimecast Attachment Protection Instructions; DOC220816-22082016164113.pdf

Dear Mona,

Thank you for your enquiry. I believe that you have also been in dialogue with the County Council as Lead Local Flood Authority for surface water and Black Sluice IDB, regarding this issue. In the main we would defer to their expertise for the majority of your query. However, I have contacted them separately to obtain their opinion on your questions. I include the two responses I have received as follows:

County Council - "The watercourse running between the A52 and the enquiry site was almost certainly constructed as part of the Donington by-pass as it doesn't feature on the Ordnance Survey maps that pre-date the construction of the by-pass. It will be a highway drain, taking surface water run-off from the A52 alone, and we would not wish to see surface water from third party land discharging into it. "

Black Sluice IDB - "Mr Mona's email to me asked whether they could put balancing ponds within the 9m byelaw distance of our watercourse across the site. We said no, and suggested siting any ponds/lagoons at the northern or southern boundaries with a restricted discharge of 1.4ltrs/sec/Ha into one or both of the A52 watercourses. We also "suggested" that these watercourses could possibly be considered as "storage" if they couldn't find room for lagoons within the site. If they take this option, then I would ask them to make an allowance for highway run-off within their calculations."

I am unable to offer any further advice in this respect given that this is the County and IDB's area of expertise. Essentially on any forthcoming planning application we would consult them directly and would defer to their advice. Clearly, they will need to be satisfied for a positive outcome on any planning application.

In respect of planning policy, we would rely on the National Planning Policy Framework (2012) and the accompanying Planning Practice Guidance (PPG). In terms of local evidence we are currently in the process of revising our SFRA. For the most up-to-date position on this I would suggest speaking to Gary Alexander who manages the local plans team (01775 764467 / galexander@sholland.gov.uk).

Kind regards
Phil

Phil Norman BSc (Hons), MSc, MSc, MRTPI | Principal Planning Officer | **South Holland District Council**
DDI: 01775 764669
www.sholland.gov.uk

From: Martin, Mona [<mailto:Mona.Martin@amecfw.com>]
Sent: 30 August 2016 16:15
To: _planningadvice
Subject: FW: Park Farm House- Donnington Lincolnshire

Mimecast Attachment Protection has created safe copies of your attachments.

This message originated from outside your organization

Dear Sir/Madam,

Following to my email below I would like to confirm additional information with regarding to ditches going alongside of A52 on eastern side of the site boundary .

I have received an email from Black Sluice IDB with regard to discharge limits and ownership of the ditch within the site boundary however they mentioned that they don't own the ditches going along A52 and we have to consider them as additional flow ,therefore my question will be as follows:

Do you have any discharge limit from this ditches to the main one within the site boundary and how much it would be ?

Also does the council/highway agency own this ditch ?

And should we comply with 9m bye law as stated by IDB for this ditch as well as the one within the site boundary?

I am looking forward to hear from you ASAP if at all possible. Please do not hesitate to contact me if you have any enquiries.

Regards

Mona Martin

Civil Engineer Consultant, Environment & Infrastructure UK Limited, Amec Foster Wheeler
12th floor, 25 Canada Square, Canary Wharf, London, E14 5LQ, United Kingdom
Tel: 02032151678
mona.martin@amecfw.com amecfw.com

From: Martin, Mona
Sent: 24 August 2016 12:08
To: 'info@sholland.gov.uk' <info@sholland.gov.uk>
Subject: Park Farm House- Donnington Lincolnshire

Dear Sir/Madam,

AMEC was appointed by our client to carryout initial flood risk assessment and drainage strategy report as part planning application for a new development in site located in Park farm House Donnington Lincolnshire (PE11 4UJ) .Please see attached for site boundary.

The new development will include a construction of 2 units of industrial warehouse, hardstanding and car parks.

This area is located in flood risk zone 1 and there is a ditch crossing through the site from east to west located in the middle of the site boundary.

As part of our assessment we would like to clarify some constrains and understand your requirements to be able to proceed with the application.

It is envisaged that infiltration will not be an appropriate option in this site due to ground condition, therefore, potential attenuation storage options such as swales and ponds are being looked at.

Requirements:

- 1) I would also like to confirm the 9m byelaw as stated by IDB.
- 2) As part of the development there is a necessity to have a culvert ditch as marked up on the attached drawings, is there any additional consideration for its construction and what kind of modelling which is required for the culvert-ditch.

- 3) In addition to PPS 15 and SFRA 2010 is there any other policies that council wishes to be considered.
- 4) Options are being investigated where the discharge into the ditches is being considered. Could you please confirm the limit discharge rate which should be considered. As part of our design 1.4 lit/sec/ha discharge limit was considered as stated by Black Sluice IDB. However the minimum discharge limit as stated by circa is 5 lit/sec which is used in our design.

Please do not hesitate to contact me if you have any requirement.

Kind regards

Mona Martin

Civil Engineer Consultant, Environment & Infrastructure UK Limited, Amec Foster Wheeler
4th floor, 60 London Wall, London, EC2M 5TQ
M +44 (0)7583109536
mona.martin@amecfw.com amecfw.com



This message is the property of Amec Foster Wheeler plc and/or its subsidiaries and/or affiliates and is intended only for the named recipient(s). Its contents (including any attachments) may be confidential, legally privileged or otherwise protected from disclosure by law. Unauthorised use, copying, distribution or disclosure of any of it may be unlawful and is strictly prohibited. We assume no responsibility to persons other than the intended named recipient(s) and do not accept liability for any errors or omissions which are a result of email transmission. If you have received this message in error, please notify us immediately by reply email to the sender and confirm that the original message and any attachments and copies have been destroyed and deleted from your system. This disclaimer applies to any and all messages originating from us and set out above. If you do not wish to receive future unsolicited commercial electronic messages from us, **please forward this email to: unsubscribe@amecfw.com and include "Unsubscribe" in the subject line.** If applicable, you will continue to receive invoices, project communications and similar factual, non-commercial electronic communications.

Please click <http://amecfw.com/email-disclaimer> for notices and company information in relation to emails originating in the UK, Italy or France.



Appendix D

Microdrainage calculations

AMEC Foster Wheeler Group Ltd								Page 1
Booths Park Chelford Road Knutsford Cheshire WA16 8QZ								
Date 11/10/2016 14:26				Designed by mona.martin				
File Storage control.srcx				Checked by				
XP Solutions				Source Control 2014.1.1				
<u>Summary of Results for 100 year Return Period (+20%)</u> Half Drain Time : 3 minutes.								
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (1/s)	Max Control (1/s)	Max Overflow (1/s)	Max Σ Outflow (1/s)	Max Volume (m³)	Status
15 min Summer	3.357	0.307	0.0	108.8	0.0	108.8	25.7	O K
30 min Summer	3.365	0.315	0.0	115.4	0.0	115.4	27.4	O K
60 min Summer	3.353	0.303	0.0	105.0	0.0	105.0	24.9	O K
120 min Summer	3.320	0.270	0.0	80.2	0.0	80.2	18.8	O K
180 min Summer	3.290	0.240	0.0	65.6	0.0	65.6	14.2	O K
240 min Summer	3.269	0.219	0.0	55.5	0.0	55.5	11.4	O K
360 min Summer	3.242	0.192	0.0	42.4	0.0	42.4	8.3	O K
480 min Summer	3.222	0.172	0.0	34.4	0.0	34.4	6.5	O K
600 min Summer	3.208	0.158	0.0	29.4	0.0	29.4	5.3	O K
720 min Summer	3.197	0.147	0.0	25.6	0.0	25.6	4.5	O K
960 min Summer	3.182	0.132	0.0	20.6	0.0	20.6	3.5	O K
1440 min Summer	3.161	0.111	0.0	14.9	0.0	14.9	2.4	O K
2160 min Summer	3.145	0.095	0.0	10.8	0.0	10.8	1.7	O K
2880 min Summer	3.133	0.083	0.0	8.5	0.0	8.5	1.3	O K
4320 min Summer	3.117	0.067	0.0	6.1	0.0	6.1	0.8	O K
5760 min Summer	3.108	0.058	0.0	4.9	0.0	4.9	0.6	O K
7200 min Summer	3.103	0.053	0.0	4.1	0.0	4.1	0.5	O K
8640 min Summer	3.099	0.049	0.0	3.5	0.0	3.5	0.4	O K
10080 min Summer	3.097	0.047	0.0	3.1	0.0	3.1	0.4	O K
15 min Winter	3.372	0.322	0.0	120.8	0.0	120.8	28.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)			
15 min Summer	111.940	0.0	96.1	0.0	17			
30 min Summer	73.565	0.0	126.3	0.0	25			
60 min Summer	46.096	0.0	158.3	0.0	40			
120 min Summer	27.939	0.0	191.9	0.0	70			
180 min Summer	20.582	0.0	212.1	0.0	100			
240 min Summer	16.478	0.0	226.4	0.0	130			
360 min Summer	11.961	0.0	246.5	0.0	190			
480 min Summer	9.535	0.0	262.0	0.0	250			
600 min Summer	7.993	0.0	274.5	0.0	308			
720 min Summer	6.916	0.0	285.1	0.0	368			
960 min Summer	5.501	0.0	302.3	0.0	488			
1440 min Summer	3.977	0.0	327.9	0.0	734			
2160 min Summer	2.871	0.0	355.1	0.0	1076			
2880 min Summer	2.276	0.0	375.3	0.0	1464			
4320 min Summer	1.639	0.0	405.3	0.0	2152			
5760 min Summer	1.296	0.0	427.5	0.0	2864			
7200 min Summer	1.081	0.0	445.4	0.0	3568			
8640 min Summer	0.931	0.0	460.4	0.0	4360			
10080 min Summer	0.820	0.0	473.4	0.0	5016			
15 min Winter	111.940	0.0	107.7	0.0	17			
©1982-2014 XP Solutions								

AMEC Foster Wheeler Group Ltd								Page 2
Booths Park Chelford Road Knutsford Cheshire WA16 8QZ								
Date 11/10/2016 14:26 File Storage control.srcx		Designed by mona.martin Checked by						
XP Solutions			Source Control 2014.1.1					
<u>Summary of Results for 100 year Return Period (+20%)</u>								
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	3.375	0.325	0.0	123.3	0.0	123.3	29.5	O K
60 min Winter	3.349	0.299	0.0	102.1	0.0	102.1	24.1	O K
120 min Winter	3.298	0.248	0.0	69.8	0.0	69.8	15.4	O K
180 min Winter	3.265	0.215	0.0	53.8	0.0	53.8	10.9	O K
240 min Winter	3.244	0.194	0.0	43.6	0.0	43.6	8.6	O K
360 min Winter	3.215	0.165	0.0	32.0	0.0	32.0	5.9	O K
480 min Winter	3.197	0.147	0.0	25.6	0.0	25.6	4.5	O K
600 min Winter	3.185	0.135	0.0	21.6	0.0	21.6	3.7	O K
720 min Winter	3.177	0.127	0.0	18.7	0.0	18.7	3.2	O K
960 min Winter	3.161	0.111	0.0	14.9	0.0	14.9	2.4	O K
1440 min Winter	3.145	0.095	0.0	10.8	0.0	10.8	1.7	O K
2160 min Winter	3.128	0.078	0.0	7.8	0.0	7.8	1.1	O K
2880 min Winter	3.117	0.067	0.0	6.2	0.0	6.2	0.8	O K
4320 min Winter	3.106	0.056	0.0	4.5	0.0	4.5	0.5	O K
5760 min Winter	3.100	0.050	0.0	3.6	0.0	3.6	0.4	O K
7200 min Winter	3.096	0.046	0.0	3.0	0.0	3.0	0.4	O K
8640 min Winter	3.093	0.043	0.0	2.5	0.0	2.5	0.3	O K
10080 min Winter	3.091	0.041	0.0	2.2	0.0	2.2	0.3	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)			
30 min Winter	73.565	0.0	141.5	0.0	24			
60 min Winter	46.096	0.0	177.3	0.0	40			
120 min Winter	27.939	0.0	215.0	0.0	70			
180 min Winter	20.582	0.0	237.5	0.0	100			
240 min Winter	16.478	0.0	253.6	0.0	130			
360 min Winter	11.961	0.0	276.1	0.0	190			
480 min Winter	9.535	0.0	293.5	0.0	250			
600 min Winter	7.993	0.0	307.5	0.0	310			
720 min Winter	6.916	0.0	319.3	0.0	370			
960 min Winter	5.501	0.0	338.6	0.0	494			
1440 min Winter	3.977	0.0	367.2	0.0	740			
2160 min Winter	2.871	0.0	397.6	0.0	1100			
2880 min Winter	2.276	0.0	420.3	0.0	1444			
4320 min Winter	1.639	0.0	453.9	0.0	2172			
5760 min Winter	1.296	0.0	478.8	0.0	2872			
7200 min Winter	1.081	0.0	498.9	0.0	3568			
8640 min Winter	0.931	0.0	515.7	0.0	4360			
10080 min Winter	0.820	0.0	530.2	0.0	5128			
©1982-2014 XP Solutions								

AMEC Foster Wheeler Group Ltd

Booths Park
Chelford Road
Knutsford Cheshire WA16 8QZ

Date 11/10/2016 14:25
File Storage control.srcx

XP Solutions

Page 1



Designed by mona.martin
Checked by

Source Control 2014.1.1

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 3 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	3.378	0.328	0.0	126.2	0.0	126.2	30.3	O K
30 min Summer	3.388	0.338	0.0	134.1	0.0	134.1	32.4	O K
60 min Summer	3.374	0.324	0.0	122.9	0.0	122.9	29.3	O K
120 min Summer	3.341	0.291	0.0	95.1	0.0	95.1	22.6	O K
180 min Summer	3.311	0.261	0.0	76.1	0.0	76.1	17.3	O K
240 min Summer	3.287	0.237	0.0	64.4	0.0	64.4	13.7	O K
360 min Summer	3.256	0.206	0.0	49.2	0.0	49.2	9.9	O K
480 min Summer	3.237	0.187	0.0	40.2	0.0	40.2	7.9	O K
600 min Summer	3.221	0.171	0.0	34.1	0.0	34.1	6.4	O K
720 min Summer	3.209	0.159	0.0	29.7	0.0	29.7	5.4	O K
960 min Summer	3.192	0.142	0.0	24.0	0.0	24.0	4.2	O K
1440 min Summer	3.171	0.121	0.0	17.3	0.0	17.3	2.9	O K
2160 min Summer	3.152	0.102	0.0	12.6	0.0	12.6	2.0	O K
2880 min Summer	3.142	0.092	0.0	10.0	0.0	10.0	1.6	O K
4320 min Summer	3.124	0.074	0.0	7.2	0.0	7.2	1.0	O K
5760 min Summer	3.114	0.064	0.0	5.7	0.0	5.7	0.7	O K
7200 min Summer	3.108	0.058	0.0	4.8	0.0	4.8	0.6	O K
8640 min Summer	3.103	0.053	0.0	4.1	0.0	4.1	0.5	O K
10080 min Summer	3.100	0.050	0.0	3.7	0.0	3.7	0.4	O K
15 min Winter	3.395	0.345	0.0	140.3	0.0	140.3	34.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	130.597	0.0	112.2	0.0	17
30 min Summer	85.825	0.0	147.4	0.0	25
60 min Summer	53.779	0.0	184.7	0.0	40
120 min Summer	32.595	0.0	223.9	0.0	70
180 min Summer	24.012	0.0	247.4	0.0	100
240 min Summer	19.224	0.0	264.1	0.0	130
360 min Summer	13.954	0.0	287.6	0.0	190
480 min Summer	11.125	0.0	305.7	0.0	250
600 min Summer	9.325	0.0	320.3	0.0	310
720 min Summer	8.069	0.0	332.6	0.0	370
960 min Summer	6.417	0.0	352.7	0.0	490
1440 min Summer	4.640	0.0	382.5	0.0	734
2160 min Summer	3.350	0.0	414.2	0.0	1088
2880 min Summer	2.656	0.0	437.9	0.0	1432
4320 min Summer	1.912	0.0	472.8	0.0	2168
5760 min Summer	1.513	0.0	498.8	0.0	2896
7200 min Summer	1.261	0.0	519.7	0.0	3552
8640 min Summer	1.086	0.0	537.2	0.0	4344
10080 min Summer	0.957	0.0	552.3	0.0	5120
15 min Winter	130.597	0.0	125.6	0.0	17

©1982-2014 XP Solutions

AMEC Foster Wheeler Group Ltd								Page 2	
Booths Park Chelford Road Knutsford Cheshire WA16 8QZ									
Date 11/10/2016 14:25 File Storage control.srcx			Designed by mona.martin Checked by						
XP Solutions			Source Control 2014.1.1						
<u>Summary of Results for 100 year Return Period (+40%)</u>									
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max E (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	3.398	0.348	0.0	142.8	0.0		142.8	34.9	O K
60 min Winter	3.370	0.320	0.0	119.1	0.0		119.1	28.3	O K
120 min Winter	3.321	0.271	0.0	80.9	0.0		80.9	19.0	O K
180 min Winter	3.283	0.233	0.0	62.5	0.0		62.5	13.2	O K
240 min Winter	3.259	0.209	0.0	50.8	0.0		50.8	10.2	O K
360 min Winter	3.231	0.181	0.0	37.3	0.0		37.3	7.2	O K
480 min Winter	3.209	0.159	0.0	29.9	0.0		29.9	5.4	O K
600 min Winter	3.195	0.145	0.0	25.1	0.0		25.1	4.4	O K
720 min Winter	3.186	0.136	0.0	21.8	0.0		21.8	3.8	O K
960 min Winter	3.171	0.121	0.0	17.3	0.0		17.3	2.9	O K
1440 min Winter	3.152	0.102	0.0	12.6	0.0		12.6	2.0	O K
2160 min Winter	3.136	0.086	0.0	9.1	0.0		9.1	1.4	O K
2880 min Winter	3.124	0.074	0.0	7.2	0.0		7.2	1.0	O K
4320 min Winter	3.111	0.061	0.0	5.2	0.0		5.2	0.6	O K
5760 min Winter	3.103	0.053	0.0	4.1	0.0		4.1	0.5	O K
7200 min Winter	3.099	0.049	0.0	3.4	0.0		3.4	0.4	O K
8640 min Winter	3.096	0.046	0.0	3.0	0.0		3.0	0.4	O K
10080 min Winter	3.093	0.043	0.0	2.6	0.0		2.6	0.3	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)				
30 min Winter	85.825	0.0	165.1	0.0	25				
60 min Winter	53.779	0.0	206.9	0.0	40				
120 min Winter	32.595	0.0	250.8	0.0	70				
180 min Winter	24.012	0.0	277.1	0.0	100				
240 min Winter	19.224	0.0	295.8	0.0	130				
360 min Winter	13.954	0.0	322.1	0.0	190				
480 min Winter	11.125	0.0	342.4	0.0	250				
600 min Winter	9.325	0.0	358.7	0.0	310				
720 min Winter	8.069	0.0	372.5	0.0	368				
960 min Winter	6.417	0.0	395.0	0.0	488				
1440 min Winter	4.640	0.0	428.4	0.0	728				
2160 min Winter	3.350	0.0	463.9	0.0	1088				
2880 min Winter	2.656	0.0	490.4	0.0	1452				
4320 min Winter	1.912	0.0	529.5	0.0	2180				
5760 min Winter	1.513	0.0	558.6	0.0	2936				
7200 min Winter	1.261	0.0	582.0	0.0	3648				
8640 min Winter	1.086	0.0	601.6	0.0	4424				
10080 min Winter	0.957	0.0	618.5	0.0	5088				
©1982-2014 XP Solutions									

AMEC Foster Wheeler Group Ltd							Page 1
Booths Park Chelford Road Knutsford Cheshire WA16 8QZ							
Date 11/10/2016 14:33			Designed by mona.martin				
File Storage control.srcx			Checked by				
XP Solutions			Source Control 2014.1.1				
<u>Summary of Results for 100 year Return Period (+40%)</u> Half Drain Time : 38 minutes.							
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	3.058	0.708	0.0	0.2	0.2	109.5	O K
30 min Summer	3.197	0.847	0.0	25.8	25.8	131.2	O K
60 min Summer	3.251	0.901	0.0	47.0	47.0	139.5	O K
120 min Summer	3.272	0.922	0.0	56.9	56.9	142.7	O K
180 min Summer	3.267	0.917	0.0	54.7	54.7	142.0	O K
240 min Summer	3.259	0.909	0.0	50.8	50.8	140.7	O K
360 min Summer	3.243	0.893	0.0	43.1	43.1	138.2	O K
480 min Summer	3.229	0.879	0.0	36.8	36.8	136.1	O K
600 min Summer	3.217	0.867	0.0	32.5	32.5	134.1	O K
720 min Summer	3.206	0.856	0.0	28.9	28.9	132.5	O K
960 min Summer	3.191	0.841	0.0	23.5	23.5	130.1	O K
1440 min Summer	3.170	0.820	0.0	17.1	17.1	127.0	O K
2160 min Summer	3.152	0.802	0.0	12.5	12.5	124.1	O K
2880 min Summer	3.141	0.791	0.0	9.9	9.9	122.5	O K
4320 min Summer	3.123	0.773	0.0	7.1	7.1	119.7	O K
5760 min Summer	3.114	0.764	0.0	5.7	5.7	118.2	O K
7200 min Summer	3.107	0.757	0.0	4.7	4.7	117.2	O K
8640 min Summer	3.103	0.753	0.0	4.0	4.0	116.5	O K
10080 min Summer	3.100	0.750	0.0	3.6	3.6	116.0	O K
15 min Winter	3.130	0.780	0.0	8.1	8.1	120.7	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)			
15 min Summer	130.597	0.0	1.1	27			
30 min Summer	85.825	0.0	36.3	33			
60 min Summer	53.779	0.0	73.6	46			
120 min Summer	32.595	0.0	112.8	76			
180 min Summer	24.012	0.0	136.2	108			
240 min Summer	19.224	0.0	152.9	136			
360 min Summer	13.954	0.0	176.2	196			
480 min Summer	11.125	0.0	194.2	256			
600 min Summer	9.325	0.0	208.6	314			
720 min Summer	8.069	0.0	220.8	374			
960 min Summer	6.417	0.0	240.6	492			
1440 min Summer	4.640	0.0	270.0	736			
2160 min Summer	3.350	0.0	300.9	1100			
2880 min Summer	2.656	0.0	323.7	1468			
4320 min Summer	1.912	0.0	357.1	2204			
5760 min Summer	1.513	0.0	381.6	2912			
7200 min Summer	1.261	0.0	400.9	3664			
8640 min Summer	1.086	0.0	416.8	4400			
10080 min Summer	0.957	0.0	430.4	5080			
15 min Winter	130.597	0.0	14.6	25			
©1982-2014 XP Solutions							

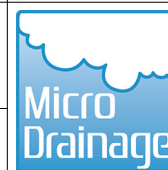
AMEC Foster Wheeler Group Ltd							Page 1																																																																																																																																																																																																																																																																																	
Booths Park Chelford Road Knutsford Cheshire WA16 8QZ																																																																																																																																																																																																																																																																																								
Date 11/10/2016 14:32 File Storage control.srcx			Designed by mona.martin Checked by																																																																																																																																																																																																																																																																																					
XP Solutions			Source Control 2014.1.1																																																																																																																																																																																																																																																																																					
<u>Summary of Results for 100 year Return Period (+20%)</u> Half Drain Time : 54 minutes. <table><thead><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Control (l/s)</th><th>Max Σ Outflow (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr></thead><tbody><tr><td>15 min Summer</td><td>2.954</td><td>0.604</td><td>0.0</td><td>0.0</td><td>0.0</td><td>93.5</td><td>O K</td></tr><tr><td>30 min Summer</td><td>3.126</td><td>0.776</td><td>0.0</td><td>7.6</td><td>7.6</td><td>120.1</td><td>O K</td></tr><tr><td>60 min Summer</td><td>3.193</td><td>0.843</td><td>0.0</td><td>24.2</td><td>24.2</td><td>130.5</td><td>O K</td></tr><tr><td>120 min Summer</td><td>3.224</td><td>0.874</td><td>0.0</td><td>35.1</td><td>35.1</td><td>135.3</td><td>O K</td></tr><tr><td>180 min Summer</td><td>3.229</td><td>0.879</td><td>0.0</td><td>36.7</td><td>36.7</td><td>136.0</td><td>O K</td></tr><tr><td>240 min Summer</td><td>3.225</td><td>0.875</td><td>0.0</td><td>35.4</td><td>35.4</td><td>135.5</td><td>O K</td></tr><tr><td>360 min Summer</td><td>3.214</td><td>0.864</td><td>0.0</td><td>31.6</td><td>31.6</td><td>133.8</td><td>O K</td></tr><tr><td>480 min Summer</td><td>3.205</td><td>0.855</td><td>0.0</td><td>28.5</td><td>28.5</td><td>132.4</td><td>O K</td></tr><tr><td>600 min Summer</td><td>3.197</td><td>0.847</td><td>0.0</td><td>25.8</td><td>25.8</td><td>131.1</td><td>O K</td></tr><tr><td>720 min Summer</td><td>3.190</td><td>0.840</td><td>0.0</td><td>23.3</td><td>23.3</td><td>130.1</td><td>O K</td></tr><tr><td>960 min Summer</td><td>3.179</td><td>0.829</td><td>0.0</td><td>19.5</td><td>19.5</td><td>128.4</td><td>O K</td></tr><tr><td>1440 min Summer</td><td>3.160</td><td>0.810</td><td>0.0</td><td>14.6</td><td>14.6</td><td>125.4</td><td>O K</td></tr><tr><td>2160 min Summer</td><td>3.145</td><td>0.795</td><td>0.0</td><td>10.8</td><td>10.8</td><td>123.0</td><td>O K</td></tr><tr><td>2880 min Summer</td><td>3.132</td><td>0.782</td><td>0.0</td><td>8.5</td><td>8.5</td><td>121.1</td><td>O K</td></tr><tr><td>4320 min Summer</td><td>3.117</td><td>0.767</td><td>0.0</td><td>6.1</td><td>6.1</td><td>118.7</td><td>O K</td></tr><tr><td>5760 min Summer</td><td>3.108</td><td>0.758</td><td>0.0</td><td>4.9</td><td>4.9</td><td>117.3</td><td>O K</td></tr><tr><td>7200 min Summer</td><td>3.103</td><td>0.753</td><td>0.0</td><td>4.0</td><td>4.0</td><td>116.5</td><td>O K</td></tr><tr><td>8640 min Summer</td><td>3.099</td><td>0.749</td><td>0.0</td><td>3.5</td><td>3.5</td><td>116.0</td><td>O K</td></tr><tr><td>10080 min Summer</td><td>3.096</td><td>0.746</td><td>0.0</td><td>3.1</td><td>3.1</td><td>115.5</td><td>O K</td></tr><tr><td>15 min Winter</td><td>3.029</td><td>0.679</td><td>0.0</td><td>0.0</td><td>0.0</td><td>105.1</td><td>O K</td></tr></tbody></table> <table><thead><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Discharge Volume (m³)</th><th>Time-Peak (mins)</th></tr></thead><tbody><tr><td>15 min Summer</td><td>111.940</td><td>0.0</td><td>0.0</td><td>27</td></tr><tr><td>30 min Summer</td><td>73.565</td><td>0.0</td><td>15.3</td><td>38</td></tr><tr><td>60 min Summer</td><td>46.096</td><td>0.0</td><td>47.3</td><td>52</td></tr><tr><td>120 min Summer</td><td>27.939</td><td>0.0</td><td>80.8</td><td>80</td></tr><tr><td>180 min Summer</td><td>20.582</td><td>0.0</td><td>100.9</td><td>112</td></tr><tr><td>240 min Summer</td><td>16.478</td><td>0.0</td><td>115.1</td><td>142</td></tr><tr><td>360 min Summer</td><td>11.961</td><td>0.0</td><td>135.1</td><td>202</td></tr><tr><td>480 min Summer</td><td>9.535</td><td>0.0</td><td>150.5</td><td>260</td></tr><tr><td>600 min Summer</td><td>7.993</td><td>0.0</td><td>162.9</td><td>320</td></tr><tr><td>720 min Summer</td><td>6.916</td><td>0.0</td><td>173.3</td><td>378</td></tr><tr><td>960 min Summer</td><td>5.501</td><td>0.0</td><td>190.3</td><td>496</td></tr><tr><td>1440 min Summer</td><td>3.977</td><td>0.0</td><td>215.3</td><td>736</td></tr><tr><td>2160 min Summer</td><td>2.871</td><td>0.0</td><td>241.7</td><td>1100</td></tr><tr><td>2880 min Summer</td><td>2.276</td><td>0.0</td><td>261.2</td><td>1468</td></tr><tr><td>4320 min Summer</td><td>1.639</td><td>0.0</td><td>289.6</td><td>2192</td></tr><tr><td>5760 min Summer</td><td>1.296</td><td>0.0</td><td>310.3</td><td>2936</td></tr><tr><td>7200 min Summer</td><td>1.081</td><td>0.0</td><td>326.7</td><td>3640</td></tr><tr><td>8640 min Summer</td><td>0.931</td><td>0.0</td><td>340.1</td><td>4400</td></tr><tr><td>10080 min Summer</td><td>0.820</td><td>0.0</td><td>351.5</td><td>5088</td></tr><tr><td>15 min Winter</td><td>111.940</td><td>0.0</td><td>0.0</td><td>27</td></tr></tbody></table>								Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status	15 min Summer	2.954	0.604	0.0	0.0	0.0	93.5	O K	30 min Summer	3.126	0.776	0.0	7.6	7.6	120.1	O K	60 min Summer	3.193	0.843	0.0	24.2	24.2	130.5	O K	120 min Summer	3.224	0.874	0.0	35.1	35.1	135.3	O K	180 min Summer	3.229	0.879	0.0	36.7	36.7	136.0	O K	240 min Summer	3.225	0.875	0.0	35.4	35.4	135.5	O K	360 min Summer	3.214	0.864	0.0	31.6	31.6	133.8	O K	480 min Summer	3.205	0.855	0.0	28.5	28.5	132.4	O K	600 min Summer	3.197	0.847	0.0	25.8	25.8	131.1	O K	720 min Summer	3.190	0.840	0.0	23.3	23.3	130.1	O K	960 min Summer	3.179	0.829	0.0	19.5	19.5	128.4	O K	1440 min Summer	3.160	0.810	0.0	14.6	14.6	125.4	O K	2160 min Summer	3.145	0.795	0.0	10.8	10.8	123.0	O K	2880 min Summer	3.132	0.782	0.0	8.5	8.5	121.1	O K	4320 min Summer	3.117	0.767	0.0	6.1	6.1	118.7	O K	5760 min Summer	3.108	0.758	0.0	4.9	4.9	117.3	O K	7200 min Summer	3.103	0.753	0.0	4.0	4.0	116.5	O K	8640 min Summer	3.099	0.749	0.0	3.5	3.5	116.0	O K	10080 min Summer	3.096	0.746	0.0	3.1	3.1	115.5	O K	15 min Winter	3.029	0.679	0.0	0.0	0.0	105.1	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	15 min Summer	111.940	0.0	0.0	27	30 min Summer	73.565	0.0	15.3	38	60 min Summer	46.096	0.0	47.3	52	120 min Summer	27.939	0.0	80.8	80	180 min Summer	20.582	0.0	100.9	112	240 min Summer	16.478	0.0	115.1	142	360 min Summer	11.961	0.0	135.1	202	480 min Summer	9.535	0.0	150.5	260	600 min Summer	7.993	0.0	162.9	320	720 min Summer	6.916	0.0	173.3	378	960 min Summer	5.501	0.0	190.3	496	1440 min Summer	3.977	0.0	215.3	736	2160 min Summer	2.871	0.0	241.7	1100	2880 min Summer	2.276	0.0	261.2	1468	4320 min Summer	1.639	0.0	289.6	2192	5760 min Summer	1.296	0.0	310.3	2936	7200 min Summer	1.081	0.0	326.7	3640	8640 min Summer	0.931	0.0	340.1	4400	10080 min Summer	0.820	0.0	351.5	5088	15 min Winter	111.940	0.0	0.0	27
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status																																																																																																																																																																																																																																																																																	
15 min Summer	2.954	0.604	0.0	0.0	0.0	93.5	O K																																																																																																																																																																																																																																																																																	
30 min Summer	3.126	0.776	0.0	7.6	7.6	120.1	O K																																																																																																																																																																																																																																																																																	
60 min Summer	3.193	0.843	0.0	24.2	24.2	130.5	O K																																																																																																																																																																																																																																																																																	
120 min Summer	3.224	0.874	0.0	35.1	35.1	135.3	O K																																																																																																																																																																																																																																																																																	
180 min Summer	3.229	0.879	0.0	36.7	36.7	136.0	O K																																																																																																																																																																																																																																																																																	
240 min Summer	3.225	0.875	0.0	35.4	35.4	135.5	O K																																																																																																																																																																																																																																																																																	
360 min Summer	3.214	0.864	0.0	31.6	31.6	133.8	O K																																																																																																																																																																																																																																																																																	
480 min Summer	3.205	0.855	0.0	28.5	28.5	132.4	O K																																																																																																																																																																																																																																																																																	
600 min Summer	3.197	0.847	0.0	25.8	25.8	131.1	O K																																																																																																																																																																																																																																																																																	
720 min Summer	3.190	0.840	0.0	23.3	23.3	130.1	O K																																																																																																																																																																																																																																																																																	
960 min Summer	3.179	0.829	0.0	19.5	19.5	128.4	O K																																																																																																																																																																																																																																																																																	
1440 min Summer	3.160	0.810	0.0	14.6	14.6	125.4	O K																																																																																																																																																																																																																																																																																	
2160 min Summer	3.145	0.795	0.0	10.8	10.8	123.0	O K																																																																																																																																																																																																																																																																																	
2880 min Summer	3.132	0.782	0.0	8.5	8.5	121.1	O K																																																																																																																																																																																																																																																																																	
4320 min Summer	3.117	0.767	0.0	6.1	6.1	118.7	O K																																																																																																																																																																																																																																																																																	
5760 min Summer	3.108	0.758	0.0	4.9	4.9	117.3	O K																																																																																																																																																																																																																																																																																	
7200 min Summer	3.103	0.753	0.0	4.0	4.0	116.5	O K																																																																																																																																																																																																																																																																																	
8640 min Summer	3.099	0.749	0.0	3.5	3.5	116.0	O K																																																																																																																																																																																																																																																																																	
10080 min Summer	3.096	0.746	0.0	3.1	3.1	115.5	O K																																																																																																																																																																																																																																																																																	
15 min Winter	3.029	0.679	0.0	0.0	0.0	105.1	O K																																																																																																																																																																																																																																																																																	
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)																																																																																																																																																																																																																																																																																				
15 min Summer	111.940	0.0	0.0	27																																																																																																																																																																																																																																																																																				
30 min Summer	73.565	0.0	15.3	38																																																																																																																																																																																																																																																																																				
60 min Summer	46.096	0.0	47.3	52																																																																																																																																																																																																																																																																																				
120 min Summer	27.939	0.0	80.8	80																																																																																																																																																																																																																																																																																				
180 min Summer	20.582	0.0	100.9	112																																																																																																																																																																																																																																																																																				
240 min Summer	16.478	0.0	115.1	142																																																																																																																																																																																																																																																																																				
360 min Summer	11.961	0.0	135.1	202																																																																																																																																																																																																																																																																																				
480 min Summer	9.535	0.0	150.5	260																																																																																																																																																																																																																																																																																				
600 min Summer	7.993	0.0	162.9	320																																																																																																																																																																																																																																																																																				
720 min Summer	6.916	0.0	173.3	378																																																																																																																																																																																																																																																																																				
960 min Summer	5.501	0.0	190.3	496																																																																																																																																																																																																																																																																																				
1440 min Summer	3.977	0.0	215.3	736																																																																																																																																																																																																																																																																																				
2160 min Summer	2.871	0.0	241.7	1100																																																																																																																																																																																																																																																																																				
2880 min Summer	2.276	0.0	261.2	1468																																																																																																																																																																																																																																																																																				
4320 min Summer	1.639	0.0	289.6	2192																																																																																																																																																																																																																																																																																				
5760 min Summer	1.296	0.0	310.3	2936																																																																																																																																																																																																																																																																																				
7200 min Summer	1.081	0.0	326.7	3640																																																																																																																																																																																																																																																																																				
8640 min Summer	0.931	0.0	340.1	4400																																																																																																																																																																																																																																																																																				
10080 min Summer	0.820	0.0	351.5	5088																																																																																																																																																																																																																																																																																				
15 min Winter	111.940	0.0	0.0	27																																																																																																																																																																																																																																																																																				
©1982-2014 XP Solutions																																																																																																																																																																																																																																																																																								

AMEC Foster Wheeler Group Ltd								Page 1
Booths Park Chelford Road Knutsford Cheshire WA16 8QZ								
Date 11/10/2016 14:27 File Storage control.srcx				Designed by mona.martin Checked by				
XP Solutions				Source Control 2014.1.1				
<u>Summary of Results for 200 year Return Period (+20%)</u> Half Drain Time : 3 minutes.								
Storm Event	Max Level	Max Depth	Max Infiltration	Max Control	Max Overflow	Max Σ Outflow	Max Volume	Status
	(m)	(m)	(l/s)	(l/s)	(l/s)	(l/s)	(m³)	
15 min Summer	3.378	0.328	0.0	125.8	0.0	125.8	30.1	O K
30 min Summer	3.388	0.338	0.0	134.1	0.0	134.1	32.4	O K
60 min Summer	3.374	0.324	0.0	122.9	0.0	122.9	29.4	O K
120 min Summer	3.341	0.291	0.0	95.5	0.0	95.5	22.6	O K
180 min Summer	3.311	0.261	0.0	76.1	0.0	76.1	17.4	O K
240 min Summer	3.287	0.237	0.0	64.4	0.0	64.4	13.8	O K
360 min Summer	3.256	0.206	0.0	49.2	0.0	49.2	9.8	O K
480 min Summer	3.237	0.187	0.0	39.9	0.0	39.9	7.9	O K
600 min Summer	3.221	0.171	0.0	33.9	0.0	33.9	6.4	O K
720 min Summer	3.208	0.158	0.0	29.6	0.0	29.6	5.3	O K
960 min Summer	3.191	0.141	0.0	23.7	0.0	23.7	4.1	O K
1440 min Summer	3.170	0.120	0.0	17.1	0.0	17.1	2.9	O K
2160 min Summer	3.151	0.101	0.0	12.4	0.0	12.4	1.9	O K
2880 min Summer	3.141	0.091	0.0	9.8	0.0	9.8	1.5	O K
4320 min Summer	3.122	0.072	0.0	7.0	0.0	7.0	0.9	O K
5760 min Summer	3.113	0.063	0.0	5.5	0.0	5.5	0.7	O K
7200 min Summer	3.107	0.057	0.0	4.6	0.0	4.6	0.5	O K
8640 min Summer	3.102	0.052	0.0	4.0	0.0	4.0	0.5	O K
10080 min Summer	3.099	0.049	0.0	3.5	0.0	3.5	0.4	O K
15 min Winter	3.394	0.344	0.0	139.5	0.0	139.5	33.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)			
15 min Summer	129.924	0.0	111.6	0.0	17			
30 min Summer	85.820	0.0	147.4	0.0	25			
60 min Summer	53.940	0.0	185.3	0.0	40			
120 min Summer	32.710	0.0	224.7	0.0	70			
180 min Summer	24.068	0.0	248.0	0.0	100			
240 min Summer	19.235	0.0	264.3	0.0	130			
360 min Summer	13.912	0.0	286.7	0.0	190			
480 min Summer	11.067	0.0	304.1	0.0	250			
600 min Summer	9.260	0.0	318.1	0.0	308			
720 min Summer	8.000	0.0	329.8	0.0	368			
960 min Summer	6.347	0.0	348.8	0.0	490			
1440 min Summer	4.572	0.0	376.9	0.0	734			
2160 min Summer	3.287	0.0	406.5	0.0	1084			
2880 min Summer	2.598	0.0	428.4	0.0	1468			
4320 min Summer	1.862	0.0	460.4	0.0	2200			
5760 min Summer	1.468	0.0	484.1	0.0	2872			
7200 min Summer	1.220	0.0	502.9	0.0	3600			
8640 min Summer	1.048	0.0	518.6	0.0	4392			
10080 min Summer	0.922	0.0	532.1	0.0	4992			
15 min Winter	129.924	0.0	125.0	0.0	17			
©1982-2014 XP Solutions								

Booths Park
Chelford Road
Knutsford Cheshire WA16 8QZ

```
Date 11/10/2016 14:27
File Storage control.srcx
```

Designed by mona.martin
Checked by



XP Solutions

Source Control 2014.1.1

Summary of Results for 200 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	3.398	0.348	0.0	142.8	0.0	142.8	34.9	O K
60 min Winter	3.370	0.320	0.0	119.5	0.0	119.5	28.5	O K
120 min Winter	3.322	0.272	0.0	81.2	0.0	81.2	19.1	O K
180 min Winter	3.283	0.233	0.0	62.5	0.0	62.5	13.3	O K
240 min Winter	3.259	0.209	0.0	50.8	0.0	50.8	10.2	O K
360 min Winter	3.230	0.180	0.0	37.2	0.0	37.2	7.2	O K
480 min Winter	3.209	0.159	0.0	29.7	0.0	29.7	5.4	O K
600 min Winter	3.195	0.145	0.0	25.1	0.0	25.1	4.4	O K
720 min Winter	3.185	0.135	0.0	21.6	0.0	21.6	3.7	O K
960 min Winter	3.171	0.121	0.0	17.2	0.0	17.2	2.9	O K
1440 min Winter	3.151	0.101	0.0	12.4	0.0	12.4	2.0	O K
2160 min Winter	3.135	0.085	0.0	8.9	0.0	8.9	1.3	O K
2880 min Winter	3.123	0.073	0.0	7.0	0.0	7.0	0.9	O K
4320 min Winter	3.110	0.060	0.0	5.1	0.0	5.1	0.6	O K
5760 min Winter	3.103	0.053	0.0	4.0	0.0	4.0	0.5	O K
7200 min Winter	3.098	0.048	0.0	3.4	0.0	3.4	0.4	O K
8640 min Winter	3.095	0.045	0.0	2.9	0.0	2.9	0.3	O K
10080 min Winter	3.093	0.043	0.0	2.5	0.0	2.5	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Overflow Volume (m ³)	Time-Peak (mins)
30 min Winter	85.820	0.0	165.1	0.0	25
60 min Winter	53.940	0.0	207.5	0.0	40
120 min Winter	32.710	0.0	251.7	0.0	70
180 min Winter	24.068	0.0	277.8	0.0	100
240 min Winter	19.235	0.0	296.0	0.0	130
360 min Winter	13.912	0.0	321.1	0.0	190
480 min Winter	11.067	0.0	340.6	0.0	250
600 min Winter	9.260	0.0	356.2	0.0	308
720 min Winter	8.000	0.0	369.3	0.0	372
960 min Winter	6.347	0.0	390.7	0.0	490
1440 min Winter	4.572	0.0	422.2	0.0	732
2160 min Winter	3.287	0.0	455.3	0.0	1092
2880 min Winter	2.598	0.0	479.7	0.0	1436
4320 min Winter	1.862	0.0	515.7	0.0	2132
5760 min Winter	1.468	0.0	542.1	0.0	2904
7200 min Winter	1.220	0.0	563.2	0.0	3568
8640 min Winter	1.048	0.0	580.8	0.0	4360
10080 min Winter	0.922	0.0	595.9	0.0	4944

AMEC Foster Wheeler Group Ltd								Page 1
Booths Park Chelford Road Knutsford Cheshire WA16 8QZ								
Date 11/10/2016 14:28 File Storage control.srcx				Designed by mona.martin Checked by				
XP Solutions				Source Control 2014.1.1				
<u>Summary of Results for 200 year Return Period (+40%)</u> Half Drain Time : 3 minutes.								
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	3.402	0.352	0.0	145.7	0.0	145.7	35.7	O K
30 min Summer	3.414	0.364	0.0	153.3	0.0	153.3	38.7	O K
60 min Summer	3.398	0.348	0.0	142.8	0.0	142.8	34.8	O K
120 min Summer	3.361	0.311	0.0	111.7	0.0	111.7	26.5	O K
180 min Summer	3.334	0.284	0.0	89.2	0.0	89.2	21.2	O K
240 min Summer	3.308	0.258	0.0	74.6	0.0	74.6	16.9	O K
360 min Summer	3.272	0.222	0.0	57.2	0.0	57.2	11.8	O K
480 min Summer	3.251	0.201	0.0	46.7	0.0	46.7	9.3	O K
600 min Summer	3.236	0.186	0.0	39.5	0.0	39.5	7.8	O K
720 min Summer	3.222	0.172	0.0	34.4	0.0	34.4	6.5	O K
960 min Summer	3.203	0.153	0.0	27.7	0.0	27.7	4.9	O K
1440 min Summer	3.181	0.131	0.0	20.1	0.0	20.1	3.4	O K
2160 min Summer	3.159	0.109	0.0	14.4	0.0	14.4	2.3	O K
2880 min Summer	3.147	0.097	0.0	11.4	0.0	11.4	1.8	O K
4320 min Summer	3.130	0.080	0.0	8.2	0.0	8.2	1.2	O K
5760 min Summer	3.119	0.069	0.0	6.4	0.0	6.4	0.8	O K
7200 min Summer	3.112	0.062	0.0	5.4	0.0	5.4	0.7	O K
8640 min Summer	3.107	0.057	0.0	4.6	0.0	4.6	0.6	O K
10080 min Summer	3.103	0.053	0.0	4.1	0.0	4.1	0.5	O K
15 min Winter	3.422	0.372	0.0	158.3	0.0	158.3	40.6	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)			
15 min Summer	151.578	0.0	130.2	0.0	18			
30 min Summer	100.123	0.0	172.0	0.0	25			
60 min Summer	62.930	0.0	216.2	0.0	40			
120 min Summer	38.162	0.0	262.2	0.0	70			
180 min Summer	28.079	0.0	289.4	0.0	100			
240 min Summer	22.441	0.0	308.3	0.0	130			
360 min Summer	16.231	0.0	334.5	0.0	190			
480 min Summer	12.911	0.0	354.8	0.0	250			
600 min Summer	10.803	0.0	371.1	0.0	310			
720 min Summer	9.334	0.0	384.7	0.0	370			
960 min Summer	7.405	0.0	407.0	0.0	490			
1440 min Summer	5.334	0.0	439.7	0.0	734			
2160 min Summer	3.835	0.0	474.2	0.0	1096			
2880 min Summer	3.031	0.0	499.7	0.0	1432			
4320 min Summer	2.172	0.0	537.2	0.0	2172			
5760 min Summer	1.713	0.0	564.7	0.0	2912			
7200 min Summer	1.423	0.0	586.7	0.0	3560			
8640 min Summer	1.223	0.0	605.0	0.0	4360			
10080 min Summer	1.076	0.0	620.8	0.0	5000			
15 min Winter	151.578	0.0	145.8	0.0	17			
©1982-2014 XP Solutions								

AMEC Foster Wheeler Group Ltd								Page 2
Booths Park Chelford Road Knutsford Cheshire WA16 8QZ								
Date 11/10/2016 14:28 File Storage control.srcx								
XP Solutions			Designed by mona.martin Checked by					
Source Control 2014.1.1								
Summary of Results for 200 year Return Period (+40%)								
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	3.428	0.378	0.0	162.1	0.0	162.1	42.3	O K
60 min Winter	3.393	0.343	0.0	138.6	0.0	138.6	33.7	O K
120 min Winter	3.342	0.292	0.0	95.9	0.0	95.9	22.8	O K
180 min Winter	3.304	0.254	0.0	72.7	0.0	72.7	16.3	O K
240 min Winter	3.277	0.227	0.0	59.3	0.0	59.3	12.3	O K
360 min Winter	3.244	0.194	0.0	43.3	0.0	43.3	8.6	O K
480 min Winter	3.223	0.173	0.0	34.6	0.0	34.6	6.6	O K
600 min Winter	3.207	0.157	0.0	29.0	0.0	29.0	5.2	O K
720 min Winter	3.196	0.146	0.0	25.2	0.0	25.2	4.4	O K
960 min Winter	3.181	0.131	0.0	20.1	0.0	20.1	3.4	O K
1440 min Winter	3.160	0.110	0.0	14.5	0.0	14.5	2.3	O K
2160 min Winter	3.143	0.093	0.0	10.4	0.0	10.4	1.6	O K
2880 min Winter	3.131	0.081	0.0	8.2	0.0	8.2	1.2	O K
4320 min Winter	3.115	0.065	0.0	5.9	0.0	5.9	0.7	O K
5760 min Winter	3.107	0.057	0.0	4.7	0.0	4.7	0.6	O K
7200 min Winter	3.102	0.052	0.0	3.9	0.0	3.9	0.5	O K
8640 min Winter	3.098	0.048	0.0	3.4	0.0	3.4	0.4	O K
10080 min Winter	3.096	0.046	0.0	3.0	0.0	3.0	0.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)			
30 min Winter	100.123	0.0	192.6	0.0	25			
60 min Winter	62.930	0.0	242.1	0.0	40			
120 min Winter	38.162	0.0	293.6	0.0	70			
180 min Winter	28.079	0.0	324.1	0.0	100			
240 min Winter	22.441	0.0	345.3	0.0	130			
360 min Winter	16.231	0.0	374.7	0.0	190			
480 min Winter	12.911	0.0	397.4	0.0	250			
600 min Winter	10.803	0.0	415.6	0.0	310			
720 min Winter	9.334	0.0	430.9	0.0	372			
960 min Winter	7.405	0.0	455.8	0.0	490			
1440 min Winter	5.334	0.0	492.5	0.0	728			
2160 min Winter	3.835	0.0	531.1	0.0	1072			
2880 min Winter	3.031	0.0	559.7	0.0	1464			
4320 min Winter	2.172	0.0	601.6	0.0	2180			
5760 min Winter	1.713	0.0	632.5	0.0	2872			
7200 min Winter	1.423	0.0	657.1	0.0	3656			
8640 min Winter	1.223	0.0	677.6	0.0	4320			
10080 min Winter	1.076	0.0	695.3	0.0	5048			
©1982-2014 XP Solutions								

AMEC Foster Wheeler Group Ltd		Page 1
Booths Park Chelford Road Knutsford Cheshire WA16 8QZ		
Date 11/10/2016 13:10 File	Designed by mona.martin Checked by	
XP Solutions Source Control 2014.1.1		

IH 124 Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	2.000	Urban	0.000
SAAR (mm)	596	Region Number	Region 5

Results l/s

QBAR Rural	4.3
QBAR Urban	4.3
Q100 years	15.3
Q1 year	3.7
Q2 years	3.8
Q5 years	5.6
Q10 years	7.1
Q20 years	9.0
Q25 years	9.7
Q30 years	10.3
Q50 years	12.2
Q100 years	15.3
Q200 years	18.0
Q250 years	18.9
Q1000 years	24.8

Warning: It is unusual to use the IH124 method with an area < 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 area. The ICP SUDS tab will do this automatically.

©1982-2014 XP Solutions

