REPORT

Boston Alternative Energy Facility

Outline Surface and Foul Water Drainage Strategy (Clean)

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Boston Alternative Energy Facility

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1 Introduction

1.1.1 Royal HaskoningDHV has been commissioned by Alternative Use Boston Projects Ltd. Boston Alternative Energy Facility to prepare an Outline Surface and Foul Water Drainage Strategy for the proposed Boston Alternative Energy Facility (the Facility) to be located at the Riverside Industrial Estate, Boston. Schedule 2 Part 1 (9) of the draft Development Consent Order (DCO) for the Facility states:

8.*(1) No part of the authorised development may commence until for that part a surface and foul water drainage strategy has been submitted to and approved by the relevant planning authority, following consultation with the Environment Agency, lead local flood authority and relevant internal drainage board on matters related to their function.*

(2) The plan submitted for approval sub-paragraph (1) must be substantially in accordance with the outline surface and foul water drainage plan.

(3) The surface and foul water drainage strategy must be implemented as approved under sub-paragraph (1) and maintained throughout the operation of the authorised development unless otherwise agreed with the relevant planning authority.

1.1.2 This report aims to provide assurance that a plausible surface water attenuation strategy can feasibly be delivered. The proposals set out in this document set out the strategy in principle. The exact position, location and scale of the drainage elements is to be agreed at detailed design stage.

1.1.3 Outline operational pollution control measures are set out along with information regarding both foul and industrial (trade) discharges originating from the operational Facility and how they will be disposed of.

1.2 Site Location

1.2.1 The Development Consent Order (DCO) Application Site for the Boston Alternative Energy Facility (hereafter referenced to as 'the Application Site') is located approximately 2 km to the south east of Boston town centre. The Application Site (NGR TF33950 42241) covers 26.8 hectares (ha) and is neighboured to the west by the Riverside Industrial Estate and to the east by The Haven, a tidal waterway of the River Witham between The Wash and the town of Boston. The A16 public highway is located approximately 1.3 km to the west.

1.2.2 The Application site is split in to two components:

- The Principal Application Area – comprising of an area of 25.3 ha; and

- The Habitat Mitigation Area – comprising of 1.5 ha, located approximately 170 m to the south east of the Principal Application Area, encompassing an area of saltmarsh and small creeks at the margins of The Haven. This area will remain in a semi-natural condition and not be subject to any changes which would affect drainage and this area is therefore not included within this report, with drainage remaining linked to the tidal state of The Haven and not altered in any significant way.

1.2.3 The proposed indicative operational area[1] covers 14.85 ha, of which 10.266 ha are impermeable surfaces. Refer to **Figure 1-1** for extents of the site.

1.2.4 The Application Site is accessed by road via the Riverside Industrial Estate's existing road network from Nursery Road. Access to the site from the west to Marsh Lane is gained from Bittern Way.

1.2.5 The Boston Biomass UK No.3 Ltd plant (hereafter referenced to as 'Biomass Power Station') is located on the eastern boundary of the Application Site. A waste management facility (previously operated by Mick George but having ceased operation at the time of submission) which processed construction and demolition waste is located to the east of Nursery Road and is bounded by the Application Site on all sides (but not included within the proposed Application Site itself).

1.2.6 A Household Waste Recycling Centre (HWRC) (built in 2018) is located to the west of the Application Site, south of the junction with Nursery Road/Callen Road. Public access to the HWRC is from Bittern Way.

1.2.7 A Waste Transfer Station (WTS) operated by Lincolnshire County Council (LCC) is located to the south of the Application Site, off Slippery Gowt Lane. The WTS receives all of the residual household waste from Boston Borough Council and South Holland District Council areas, and some residual household waste from East Lindsey Council area.

[1] *Landside area of permanent works proposed under the DCO Application.*

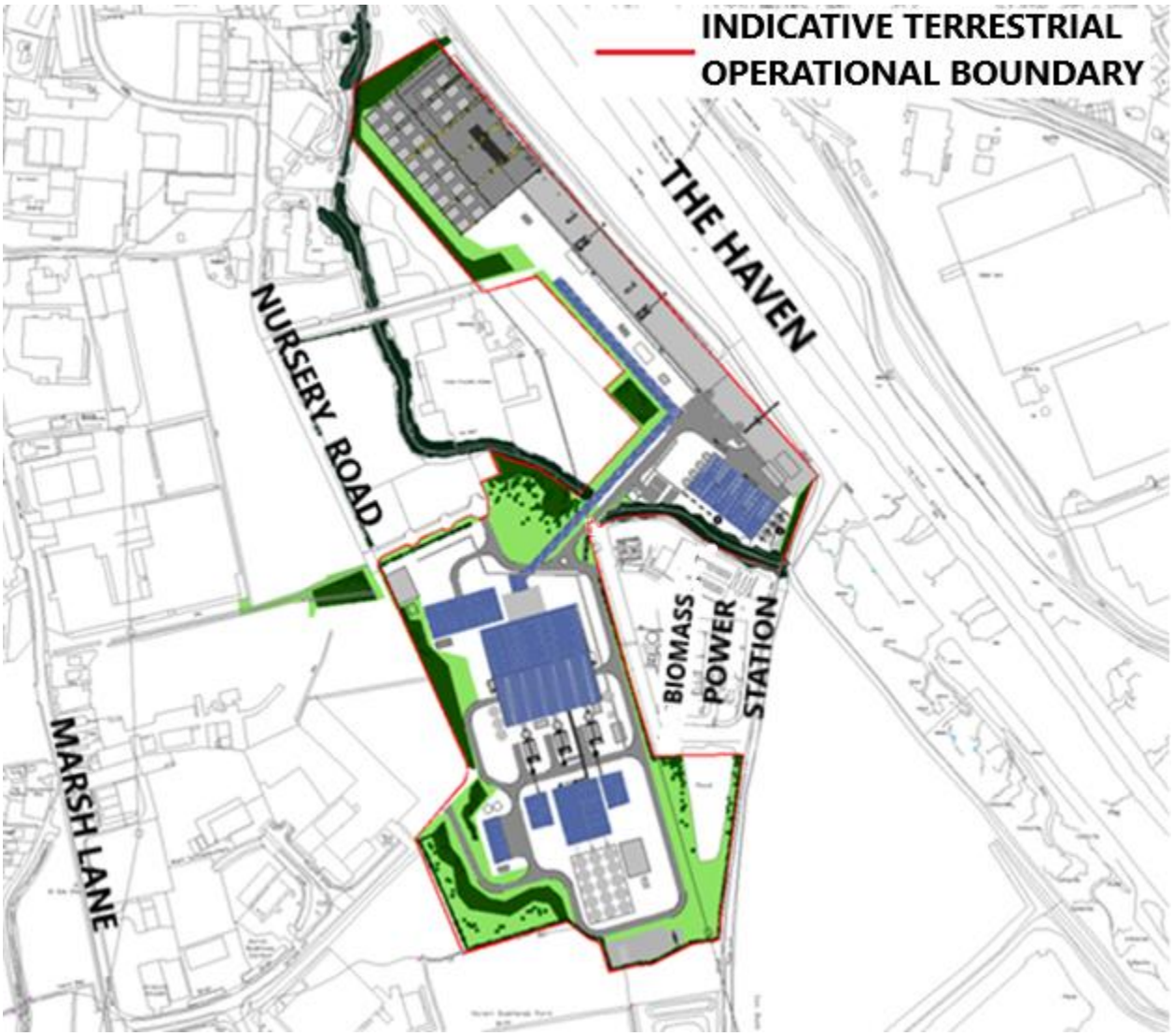


Figure 1-1 Proposed Indicative Terrestrial Operational Area

1.3 Overview of the Development

1.3.1 The proposed Facility would deliver approximately 80 megawatts electric (MWe)of renewable energy to the National Grid using Refuse Derived Fuel (RDF) as a feed stock into a thermal treatment facility generating power via steam turbine generators. This technology provides significant environmental benefits compared to landfilling residual waste and contributes to Government sustainable energy targets to achieve a net zero reduction in carbon emissions by 2050.

1.3.2 The Facility would comprise the following main elements:

- a wharf and associated infrastructure (including re-baling facility, workshop, transformer pen and welfare facilities);

- a RDF bale contingency storage area, including sealed drainage, with automated crane system for transferring bales;
- conveyor system running in parallel to the wharf between the RDF storage area and the RDF bale shredding plant. Part of the conveyor system is open and part of which is under cover (including thermal cameras);
- bale shredding plant;
- RDF bunker building;
- thermal treatment plant comprising three nominal 34 MWe combustion lines (circa 120 megawatts thermal (MWth)) and associated ductwork and piping, transformer pens, diesel generators, three stacks, ash silos and ash transfer network; and air pollution control residues (APCr) silo and transfer network;
- turbine plant comprising three steam turbine generators, make-up water facility and associated piping and ductwork;
- air-cooled condenser structure, transformer pen and associated piping and ductwork;
- Lightweight Aggregate (LWA) manufacturing plant comprising four kiln lines, two filter banks with stacks, storage silos for incoming ash, APCr, and binder material (clay and silt), a dedicated berthing point at the wharf, silt storage and drainage facility, clay storage and drainage facility, LWA workshop, interceptor tank, LWA control room, aggregate storage facility and plant for loading aggregate / offloading clay or silt;
- electrical export infrastructure;
- two carbon dioxide (CO2) recovery plants and associated infrastructure, including chiller units;
- associated site infrastructure, including site roads, pedestrian routes, car parking, site workshop and storage, security gate, control room with visitor centre and site weighbridge; and
- habitat mitigation works for Redshank and other bird species comprising of improvements to the existing habitat through the creation of small features such as pools/scrapes and introduction of small boulders (Habitat Mitigation Works) within the Habitat Mitigation Area (see para 1.2.2).

1.3.3 The Facility would be designed to operate for an expected period of at least 25 years, after which ongoing operation will be reviewed and if it is not appropriate to continue operation the plant will be decommissioned. The wharf structure would replace a section of the current primary flood defence bank (without impacting on the integrity of the bank) and would form a permanent structure that is not anticipated to be decommissioned.

1.4 Site Description

1.4.1 The Application Site comprises both undeveloped and previously developed land enclosed by a network of drainage ditches and forms part of a wider emerging industrial/commercial area.

1.4.2 The eastern site margins of the Application Site are defined in part by a primary flood defence bank along The Haven. Large and small industrial business units are located to the north, west and south of the site. A 132 kilovolt (kV) overhead powerline on pylons traverses the site from north to south and bisects the Application Site.

1.4.3 The part of the Application Site which will accommodate the wharf is approximately 750 m downstream from the existing Port of Boston (measured from the entrance to the impounded basin, the Wet Dock, to the approximate centre of the site).

1.4.4 There are no existing buildings within any part of the Application Site that will require demolition.

2 Existing Drainage and Watercourses

2.1.1 The Haven is a tidal main river. It is contained within flood banks (in good condition and currently being upgraded by the Environment Agency as part of their Haven Banks project) which are located within the Application Site along its eastern area at approximately 6.3 m Above Ordnance Datum (AOD).

2.1.2 A water main runs across the Application Site from Bittern Way to the north-eastern corner of the Principal Application Site where it then crosses The Haven. This piece of infrastructure will be avoided by the proposed wharf infrastructure. Where the water main would cross the Application Site it will be diverted, and this is subject to a separate application to Anglian Water on behalf of the landowner. The route of the diversion will be determined in accordance with advice provided by Anglian Water. The diversion will be completed before construction of the Facility.

2.1.3 The Application Site lies within the administrative area of the Black Sluice Internal Drainage Board (IDB), specifically within the Wyberton Marsh catchment. The IDB is responsible for enforcing restrictions to prevent flooding within its district[2]. For the IDB's asset map refer to **Figure 2-1**.

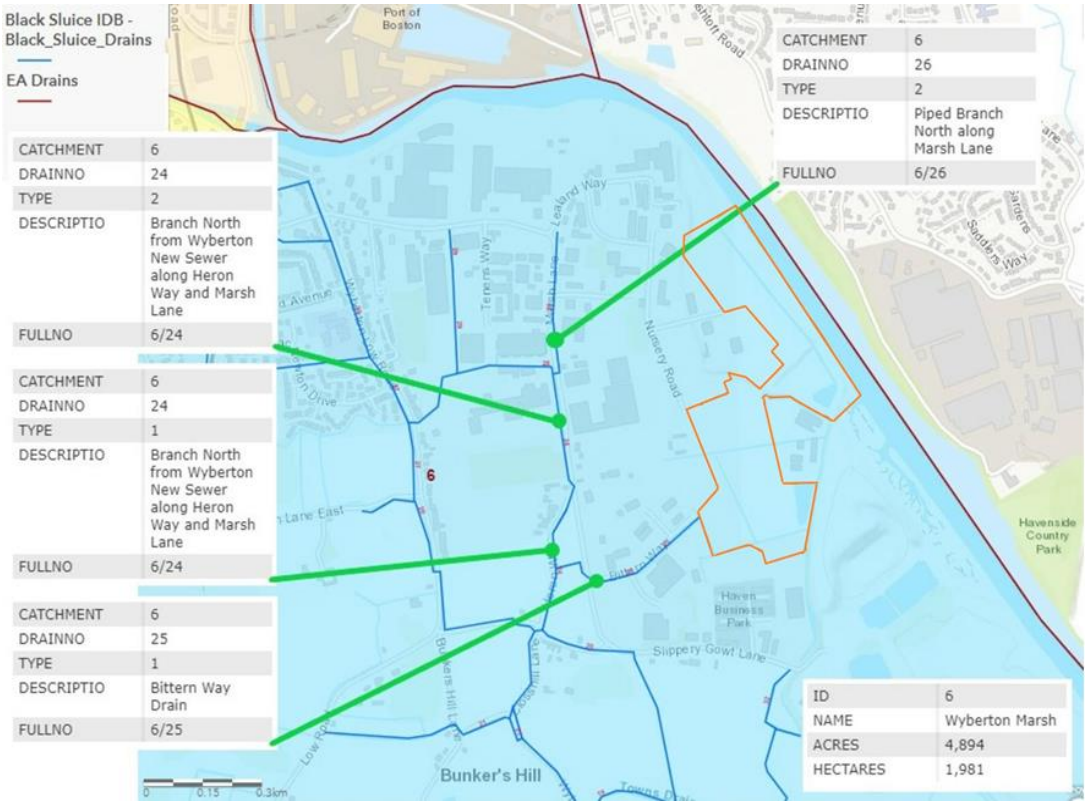


Figure 2-1 - Black Sluice IDB Drain Map

3 Previous Development

3.1 Flood Risk Assessment

3.1.1 R.M. Associates prepared a PPS25 Flood Risk Assessment (FRA) as part of the, now existing, Biomass Power Station located within the Riverside Industrial Estate.

3.1.2 Whilst the FRA defines the flooding characteristics and prevention measures required for the site, it also notes the agreement secured with the Black Sluice IDB regarding the disposal of surface water for the 25 ha site. The agreement is for 1.4 l/s/ha, which results in a 35 l/s discharge rate for the 25 hectares.

3.1.3 The FRA is dated 4th December 2009 and can be found in **Appendix A**.

[2] *Map of District | Black Sluice Internal Drainage Board (blacksluiceidb.gov.uk)*

3.2 Surface Water Management Plan

3.2.1 L.D.A. Ltd Consulting Engineers and Transportation Planners prepared a Surface Water Management Plan (SWMP) as part of the continued development of land within Riverside Industrial Estate.

3.2.2 The SWMP defines the drainage requirements specific to the Riverside Industrial Estate, which include the Biomass Power Station. It also outlines the basic principles of the water management options available for the long-term future proofing of the Riverside Industrial Estate.

3.2.3 It must be noted that the SWMP calculations assumed a 51% catchment rate for the development of the 25 ha site.

3.2.4 The SWMP is dated 28th February 2013 and can be found in **Appendix A**.

4 Proposed Drainage Strategy

4.1 General Strategy Concept

4.1.1 The drainage strategy proposed within this report considers the water management principles proposed by the SWMP described in section 3.2. This will result in the retention of the existing pond and utilising the same discharge principles, including location. No discharge is proposed into The Haven.

4.1.2 The strategy proposes altering the existing drainage ditches impacted by the proposed layout to accommodate the proposals.

4.1.3 Furthermore, this drainage strategy considers the surface water discharge rate, of 1.4 l/s/ha, imposed by the Black Sluice IDB as stated in the FRA described in section 3.1.

4.1.4 The discharge rate of 35 l/s as calculated by the SWMP for 25 ha of the Riverside Industrial Estate development is used in the calculations included in this report.

4.1.5 The existing catchment areas and the catchment introduced by the proposed development are as noted in **Table 4-1**.

4.1.6 The proposals increase the ratio of catchment per developed area to 67%. Hence, the updated calculations for the wider development are based on this rate. Refer to **Figure 4-1**.

Table 4-1 Catchment Areas and Attenuation Volume Required

Catchment	Total Area (ha)	Catchment Area (ha)	Attenuation Volume (m^3)	Comments
Biomass Power Station (Existing)	**1.880**	**0.933**	**4,633.0**	Volume provided by existing pond, which can feasibly be retained.
Boston Alternative Energy (Proposed)	**14.850**	**10.266** (69%)	**- -**	As the proposed site will be part of the wider development, standalone calculations were not produced.
TOTAL	**16.73**	**11.199** (67%)	**7,787.0**	Refer to calculations in **Appendix B**
TOTAL (25ha)	**25.00**	**16.750** (67%)	**13,082.0**	Updated attenuation volume requirements to equal the 67% impermeable surface. Refer to calculations in **Appendix B**

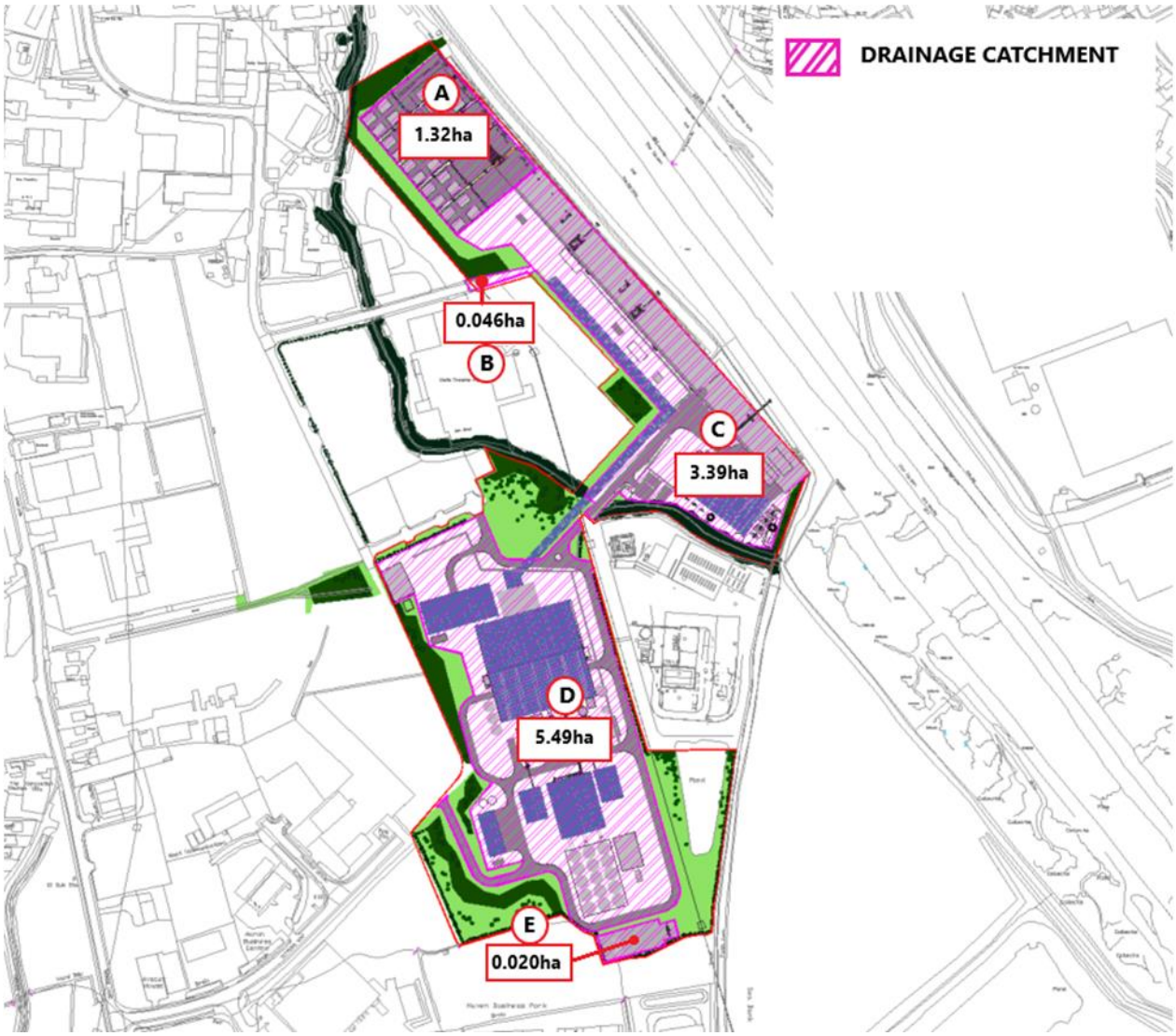


Figure 4-1 Proposed Drainage Catchment Plan

4.1.7 The calculations summarised in **Table 4-1**, demonstrate that the existing attenuation pond would not suffice to accommodate the additional flows from the proposed development. These volumes are estimations based on the total catchments and do not consider the extent and topography of the site.

4.1.8 The scale and general arrangement of the proposed layout will require additional attenuation and conveyance features to manage and connect the north of the site with the existing drainage at the south. The balancing of water volumes between these attenuation features will dictate the total volumes required for the development.

4.2 Drainage Strategy

4.2.1 A sub-catchment cascading network was developed, as shown on drawing PB6934-RHD-XX-ZZ-DR-D-0501 (see **Appendix D**), to ascertain the scale of the attenuation and conveyance SuDS required across the development to manage the surface water runoff. These calculations consider the proposed development and the existing Biomass Power Station, the total development of the 25.3 ha Principal Application Site is not considered in these. For the cascading calculations summary per sub-catchment refer to **Appendix C.**

4.2.2 The calculations were carried out to establish the critical storm for the 1 in 100 Year Return Period plus 40% Climate Change allowance in line with current guidance[3].

4.2.3 The climate change allowance was increased to 40% from the 30% allowed in the previous assessments to account for the current local and national guidance[4]. The upper end has been applied due to risk of flood to the site and neighbouring sites as well as the proposed site use.

4.2.4 The proposed drainage strategy for the development considers the construction of a network of ditches and culverts under paved areas to connect them.

4.2.5 To collect the runoff from surfaces across the site buried piped networks will be required. These are shown indicatively on drawing PB6934-RHD-XX-ZZ-DR-D-0501, however, its volume has not been considered in the calculations. The calculations for the strategy are based on preliminary calculation using the Source Control tool within MicroDrainage. This is a commonly used method for this early stage of design. The model calculates the runoff within a specific catchment and conveys it through the attenuation structure to estimate its suitability. The multiple catchments are then collated as a cascading system which accounts for the discharge from a catchment into the next. This method does not account for detailed networks of pipes and the volumes within the same.

4.2.6 Other SuDS solutions may also be considered to collect runoff across the site, these include but are not limited to, permeable pavements and swales.

4.2.7 For the drainage strategy layout refer to drawing PB6934-RHD-XX-ZZ-DR-D-0501 included in **Appendix D**.

[3] *As set out at* Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk)
[4] *See* Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk)
Development Roads and Sustainable Drainage Design Approach (lincolnshire.gov.uk)

4.3 Proposed Catchment Strategy

4.3.1 The concept for the drainage strategy is summarised in **Table 4-2** as shown on drawing PB6934-RHD-XX-ZZ-DR-D-0501, in which the total impermeable area per catchment and the proposed SuDS features proposed are described.

Table 4-2 Proposed Strategy Summary Per Sub-Catchment

Catchment Reference	Catchment Area (ha)	Surface Area of SuDS (ha)	Total Impermeable Area (ha)	SuDS Feature	Flow Control	Comments
A+B	1.366	0.139	**1.505**	Ditch	Orifice Plate	Cascades into Catchment C SuDS
C	3.390	0.238	**3.628**	Ditch	Orifice Plate	Cascades into Catchment D North SuDS
D (North)	2.745	0.242	**2.987**	Ditch & Pond	Orifice Plate	Cascades into Catchment D South+E+ Existing
D(South) + E + Biomass Pw St	3.698	1.320	**5.018**	Ditch & Pond	Hydro Brake	Discharge to IDB Ditch at 35 l/s

4.3.2 The results of the cascading model between the sub-catchments demonstrates that the strategy proposed is feasible. For the cascading calculations summary per sub-catchment refer to **Appendix C.**

Table 4-3 Catchment Requirements Details

Catchment Reference	SuDS Feature	SuDS Description	Flow Rate	Volume Required
A+B	Ditch	199m Long, 1:2 Banks, 1.5m Deep, 1m Wide Base	12 l/s	844 m^3
C	Ditch	360m Long, 1:2 Banks, 1.5m Deep, 0.6m Wide Base	199.2 l/s	1,092 m^3
D (North)	Ditch Pond	121m Long, 1:2 Banks, 1.5m Deep, 0.6m Wide Base 646 m^2 Base, 1052 m^2 Surface	216.5 l/s	1,791 m^3
D(South) + E + Biomass Pw St	Ditch Pond	261m Long, 1:2 Banks, 1.5m Deep, 1m Wide Base As Existing	35 l/s	9,021 m^3

4.4 Crossing the Roman Bank

4.4.1 The Roman Bank is a secondary flood defence feature which bisects the Principal Application Site and consists of a raised earth bank c. 2m high, above the adjacent ground level, as shown on the plan: The Roman Bank Within the Order Limits (document reference 4.12, REP9-008). The crest level along the Roman Bank is subject to variation in its relative elevation along its length. There is a Public Right of Way (PRoW) located along its length and further details of this are provided in the Public Rights of Way – Outline Design Guide and Stopping Up Plan (document reference 9.41(1), REP8-007).

4.4.2 The proposals for the Facility include an elevated conveyor and service road which would bisect the Roman Bank at a relative low point, with the provision of a footbridge to ensure continued connectivity of the PRoW along the bank.

4.4.3 Following discussion with the Environment Agency and the Black Sluice Internal Drainage Board it has been determined that where the surface water drainage will cross the Roman Bank it will take the form of an appropriately sized pipe with controls for isolating flows (e.g. penstock or similar). Operating Procedures will be drawn up for the penstock which will be triggered by a Flood Alert[5] for tidal events along The Haven.

4.4.4 An indicative figure for this arrangement is provided in **Figure 4-2**. The final design will be presented as part of the final Drainage and Foul Water Strategy and will be agreed with both parties named above.

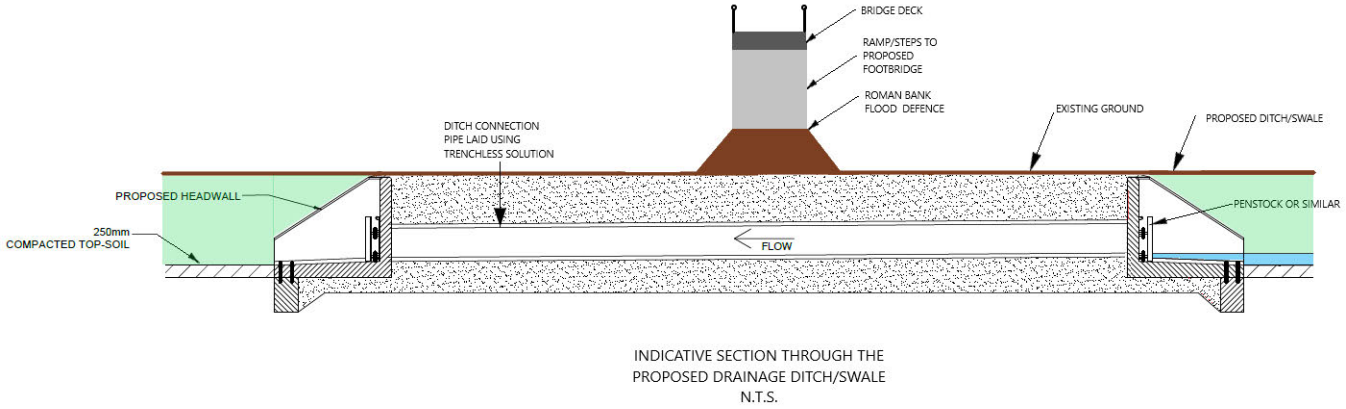


Figure 4-2 Indicative Surface Water Drainage Crossing the Roman Bank

4.4.5 In addition to ensuring that the design of the SuDS crossing the Roman Bank is agreed, with the Environment Agency, the Applicant also notes that the following works which may affect the Roman Bank will be discussed and agreed with the Environment Agency in accordance with their Protective Provisions:

- Clearing of vegetation to improve the accessibility of the public footpath along the line of the secondary defence;
- Construction of a footbridge along the line of the secondary flood defence;
- Installation of a conveyor line crossing the secondary flood defence;
- Construction of an access road crossing the secondary flood defence; and
- Construction of a drainage channel beneath the secondary flood defence.

[5] A Flood Alert is issued by the Environment Agency when flooding is possible, between two days and two hours before an event is expected.

4.5 Pollution Control

4.5.1 The site drainage system will include a suite of embedded measures designed to manage the risk of pollution from the operational quay, general surface runoff, runoff from parking areas and fire water. These are described in the subsequent sections.

Pollution control measures for the operational wharf

4.5.2 As set out in **Section 1.3**, sealed RDF bales would be unloaded from the vessel into a contingency storage area with a sealed drainage system, or onto a covered conveyor system and into the bale shredding plant. All bales would be inspected in situ on the vessel prior being unloaded, and any damaged bales would not be accepted in to the Facility. This non-acceptance will be managed through contractual conditions with the vessel operators/owners and Operating Procedures to be followed. Further information on management of RDF bales arriving by vessel can be found in ES Chapter 23 Waste (document reference 6.2.23, APP-061). The RDF bale contingency storage area located near the wharf will contain a sealed drainage that will convey flows through via oil interceptors under the wharf deck, with individual recovery pumps to a water system for nodule formation within individual pelletising lines for water re-use. There is therefore very limited potential for material from the RDF bales to enter surface water receptors as they are unloaded from the vessel and transferred onto the conveyor or storage area.

4.5.3 However, there remains a small risk that the sealed bales could split as they are being unloaded. In order to manage this risk, the surface of the wharf will be graded to ensure that any potentially contaminated drainage flows away from The Haven and into the sealed drainage system as set out in this report. Additionally, any RDF that escapes from bales that split whilst being removed by crane from the vessel will be captured by underslung sheeting designed to slope either back in to the vessel or to the wharf (depending on tidal state). Any RDF on the wharf will be subject to an operational procedure to immediately clear the area.

Pollution control measures for surface runoff

4.5.4 Surface runoff resulting from the site would be generally produced from runoff from roofs, roads and pavements. The risk of contamination associated with this runoff is therefore expected to be sufficiently low to allow treatment to take place as flows are conveyed through the cascading SuDS, including a network of open drainage ditches (as described in **Section 4.2** and shown in **Appendix D**).

4.5.5 The drainage ditches will be designed to ensure that flow velocities are sufficiently low and therefore retention time sufficiently high to facilitate the effective removal of fine sediment and contaminants through physical processes such as sedimentation and chemical processes such as adsorption[6]. They will therefore have a low gradient and high surface roughness to ensure that sediment and contaminants are retained (e.g. with vegetation growth for bioretention).

Pollution control measures for parking areas

4.5.6 Oil separators compliant with BS EN 858-1:2002 and BS EN 858-2:2003 will be installed to intercept drainage from areas of hardstanding used for car parking, in order to remove hydrocarbons from surface runoff and associated sediment prior to discharge into the site drainage system. Given that the eventual discharge point of the site drainage system is to an IDB drain (cf. **Section 4.3**), Class 1 bypass separators will be installed. These devices, which will contain a silt separation chamber and coalescing devices to separate oil droplets from water, will achieve a discharge concentration of less than 5 mg/l oil and fully treat flows generated by rainfall rates of up to 6.5 mm/hour[7]. Bypass separators provide sufficient levels of protection to car parking areas due to the relatively low risk of major spillages occurring.

4.5.7 An additional level of protection will be provided in any areas used for fuel or chemical storage (including the fuel oil store located on the lower wharf), in addition to bunded storage tanks with 110% capacity of the stored liquids. These will consist of Class 1 full retention separators, which will achieve a discharge concentration of less than 5 mg/l oil and fully treat flows generated by rainfall rates of up to 65 mm/hour[8]. Full retention separators provide sufficient levels of protection to areas with a greater risk of larger or more frequent spillages occurring.

Pollution control measures for fire water

4.5.8 During an emergency situation, fire water will be managed through the use of penstocks[9], with additional retention made through use of the natural retaining walls of the Roman Bank (at +6.2 m AOD) to the West and the flood defence on the Haven (+7.2 m AOD) (incorporating the new wharf) then ends to the North and South are tied into the original sea defences. Vehicular access from the unnamed road is via an elevated down ramp to the +3.2 m lower wharf. This provides some considerable volume to fill via fire mains and the norm for fighting fires in a waste stack is to extinguish normally within 11 hours.

[6] *CIRIA SuDS Manual C753*
[7] *Environment Agency, SEPA and Environment and Heritage Service (2006) PPG3: Use and design of oil separators in surface water drainage systems. Available online: http://www.oilstorageregs.co.uk/downloads/PPG3.pdf*

4.5.9 This attenuation will be used to isolate the piped networks in the event of a fire and prevent contaminated fire water entering the surface drainage network. The penstocks will be situated at agreed locations on the drainage system and will be automatically operated with manual back up as a second line of safety. These will be overseen by a dedicated operative with delegated responsibility under the Emergency Response Plan for the operational site.

4.6 Foul and Industrial Water Disposal

4.6.1 The foul water to be discharged during the operational phase includes black and grey waste water originating from toilets, showers / bathrooms / welfare facilities and the on-site canteen.

4.6.2 In the early stages of construction (before connection to the local sewer system) foul water discharges from toilets / showers will be collected and tankered off-site by an authorised contractor for legal disposal (e.g. disposed of at a waste water treatment works under licence). Once the sewer system is available locally there is the option to apply for a temporary connection from the construction village.

4.6.3 Two industrial sources of waste water have been identified which will be disposed of to the local sewer system under a Water Industry Act (1991) consent:

- Water used for the amine scrubbers in the CO_2 plants[10]; and
- Water used for food grade CO_2 testing in the on-site laboratory.

[8] *Environment Agency, SEPA and Environment and Heritage Service (2006) PPG3: Use and design of oil separators in surface water drainage systems. Available online: http://www.oilstorageregs.co.uk/downloads/PPG3.pdf*
[9] *Environment Agency, SEPA and Environment and Heritage Service (2006) PPG18: Managing fire water and major spillages. Available online: https://www.netregs.org.uk/media/1674/ppg-18.pdf*
[10] *Discharges from the amine scrubbers will only be discharged in the order of twice per year – dependant on operational circumstances.*

4.6.4 No on-site waste water treatment works will be provided either during construction or operation and therefore no discharges of waste (or industrial) effluents will be made to the local surface drainage system, groundwaters or The Haven.

4.6.5 Discussions have commenced with Anglian Water and rates/volumes and testing of pollutants will all be in line with any requirements of this statutory sewerage undertaker. The new site foul drainage will be designed in accordance with the required British Standards in force at the time.

5 Conclusions

5.1.1 The proposed indicative operational area covers 14.85 ha, of which 10.266 ha are impermeable surfaces.

5.1.2 The Haven is a tidal main river, it is contained within flood banks which are located within the Application Site along its eastern area currently at approximately 6.3 m Above Ordnance Datum.

5.1.3 The Application Site lies within the administrative area of the Black Sluice Internal Drainage Board, specifically within the Wyberton Marsh catchment.

5.1.4 Previous drainage assessments established a surface water discharge agreement of 1.4 l/s/ha, which results in a 35 l/s discharge rate for the 25 ha development, and which is considered in this Outline Drainage Strategy.

5.1.5 The proposals consider the water management principles proposed by the previous drainage assessment.

5.1.6 The proposals increase the ratio of catchment per developed area to 67%.

5.1.7 The calculations were carried out to establish the critical storm for the 1 in 100 Year Return Period plus 40% Climate Change allowance.

5.1.8 This strategy proposes a network of cascading SuDS features that collect and convey surface water to the outfall location. The strategy also proposes that these features connect with the existing SuDS pond which is to be retained.

5.1.9 The development requires 12,748 m^3 of attenuation volume to manage the surface water generated by the impermeable surfaces.

5.1.10 Outline pollution prevention measures are identified covering the Principal Application site in general and car parks and fire water specifically.

5.1.11 The outline principles to collect and dispose of both foul (black and grey) water and industrial (trade) discharges originating on-site is also provided. No discharges to the wider receiving environment will take place from such waste water streams with disposal off-site either via tanker (construction phase only) to a licenced waste water treatment site or discharged under licence to sewer.

Appendix

Appendix A – Previous Assessments

PPS25 Flood Risk Assessment
Surface Water Management Plan

Royal HaskoningDHV

PPS25 FLOOD RISK ASSESSMENT

FOR THE ERECTION OF A GASIFICATION PLANT
RIVERSIDE INDUSTRIAL SITE
BOSTON

R.M.ASSOCIATES
10 Main Street
Thorpe on the Hill
Lincoln
LN6 9BG
Tel 01522 681728
Mobile 07967 304737
e-mail; ray-morgan@talktalk.net
Version 4 December 2009

FLOOD RISK ASSESSMENT
FOR THE ERECTION OF A GASIFICATION PLANT
AT RIVERSIDE INDUSTRIAL ESTATE BOSTON

INTRODUCTION

The Government has placed increasing priority on the need to take full account of the risks associated with flooding at all stages of the planning and development process. This seeks to reduce the future damage to property and the risk to life from incidents of flooding. Their expectations relating to flooding are contained in PPS 25 Development and Flood Risk, which identify how the issue of flooding is dealt with in the drafting of planning policy and the consideration of planning applications by avoiding inappropriate development in areas at risk from flooding and to direct development away from areas at highest risk by applying a risk-based approach to development with the sequential test in Table 1 of paragraph 30 PPS25. This should also take into account the vulnerability of proposed uses to flood risk.

The Environment Agency's flood maps show areas that are at risk, from fluvial and tidal flooding. These maps show the limits of the flood plain of the area which could be affected by flood events, over topping or breaching of flood defences. They are based on the approximate extent of floods with a 1% annual probability of exceedance (1 in 100 year flood) for rivers and 0.5% annual probability of exceedance (1 in 200 years flood) for coastal areas under present expectations or the highest known flood. However they do not take into account of the presence of defences or the likelihood that flood return intervals will be reduced by climate change.

This Flood Risk Assessment has been prepared solely in support of the planning application and considers the risk of flooding from fluvial and tidal sources in accordance with PPS 25. It also considers the risks of localised flooding due to inadequate Foul and Surface Water Sewers, Failure of Reservoirs, Water Main pipe bursts, Sewer Blockages, Pump Failures or High Ground Water Table etc.

This document has been prepared solely as a flood risk assessment on behalf of the client. RM Associates accepts no responsibility or liability for any use of this document other than by the client for the purposes for which it was originally commissioned and prepared. If any unauthorised Third Party comes into procession of this report, they rely on it at their own risk and RM Associates owe them no duty of care or skill.

APPLICATION SITE

The proposed development lies within the Riverside Industrial Estate Boston, which is the principal industrial area for the town. The area for the proposed site development is allocated within the Local Development Plan ED1 Development on Allocated Employment Sites. The Plan identifies the area as an existing Industry/Commercial Area and future expansion of 44.8Ha. In the interests of The Borough of Boston on going economic prosperity it is important that these areas are allowed to be used for employment purposes. **Map 1**

The nation Grid reference is TF 340421and the site area amounts to 1.876 hectare, the site lies behind the second tidal defence to the Boston Haven which is a tidal river. The primary defence crest level is 6.50m ODN and the secondary defence crest level is 5.31m ODN

The Site would be classed as Major Development applying the Town & Country Planning (Consultation) (England) Direction 2009 as the site is to be developed is more than 1 hectare

The proposed development site is shown to be within Flood Zone 3a 'high probability' as detailed on the Environment Agency's Flood Zone Maps, and as defined in Table D1 of Planning Policy Statement 25 (PPS25).and within Tidal Category 2 of the Boston Strategic Flood Risk Assessment

Applying the Flood Risk Vulnerability Classification in Table D2 of PPS25, the proposed development is classified as Essential Infrastructure with Table D1 of PPS25 stating that such uses are appropriate in this zone if the Exceptions Test is passed and it should be designed and constructed to remain operational and safe for users in times of flood.

Table D.2: Flood Risk Vulnerability Classification

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable	• Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent.[19]
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste.[20] • Sites used for holiday or short-let caravans and camping, **subject to a specific warning and evacuation plan**.
Less Vulnerable	• Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in 'more vulnerable'; and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment plants. • Sewage treatment plants (if adequate pollution control measures are in place).

The proposal is to erect a conventional 'gasification' plant capable of producing 12 megawatt of electricity. The proposed development on the disused agricultural land is for the installation of Energy from Waste System. This system employs Gasification as the focal part of the plant for Syngas production. **Plan 1**

The Plant overall size, throughput and expected out put of 12Mw maximum is engineered on the availability to source the wastes locally.

The average ground site level is 2.90mODN, which will be raised by 500mm for the hardcore storage areas the ground floor level for the proposed buildings will be 3.50mODN and all offices and control equipment will be located at First floor level above the 1 in 200 year tide level, the lowest plant base will also be above the predicated tide level of 6.60m ODN. **Plan 2 & 3**

The site area amounts to 1.876 hectare. **Plan 4**
The development consists of the following: - Concrete Hard standings 6640.17 s.m.
Total roof areas 4665.83 s.m.
Permeable Hard standings 4896.57 s.m.
Landscaping 2971.00 sm

Slippery Gowt landfill site is located alongside the eastern boundary and this has raised land levels to above 10mODN.

DRAINAGE AUTHORITIES

Environment Agency

The Environment Agency has permissive powers for reducing the risk of flooding from designated main rivers and from the sea.

The following potential sources of flooding affecting the development site have been identified as:

- the tidal Haven
- The Wyberton Marsh pumped catchment

The Haven is a tidal river and the flood defences along the southern bank consist of earth embankments with a crest level of 6.50mODN and represents a 1 in 200 year protection with a tide level of 5.93mODN. (Northern Area Tidal Modal Analysis June 2006) and in 75 years time with predicted global warming would be 6.60mODN.

The Environment Agency's flood zone maps, show that the application site as being at risk from flooding from the Boston Haven, adjacent to the site. **Map 2**

These maps show that the area lies within the natural floodplain of the river and would naturally be affected by flooding if the river rose above its banks. However the area is protected by the presence of flood defences.

The flood banks, which are earth embankments, maintained by the Environment Agency and are in a good state of repair.

From the Boston SFRA the Marsh Lane FRZ extends over an area of 30 Hectares.

1D Breach Analysis to the Haven Flood Banks

If a breach or overtopping occurred to the flood banks alongside the Boston Haven would initially fill the low area immediately behind the defences.

From the Northern Area Tidal Modal Analysis Peak tide levels Present Day (2008) at Hobhole Gauge 0.5% (1 in 200) = 5.93mODN

From these tide levels the site would not be affected by overtopping (2009) as the tidal defence crest level is 6.50mODN downstream of Black Sluice.

In considering a breach the following approach is proposed:-

a) Use "Tide 200" spread sheet with above tide levels to obtain level in Flood Cell (A) 30 km^2. Avg. ground level 2.50mODN. Note: - Breach for Tidal River 50m Time to close 72 hrs. Defence level 6.50mODN. Ground level at breach 3.30mODN, 1 in 200 year tide level 5.93mODN.

b) Use this level (a) to give the maximum head at the breach into flood cell. This level will occur for a short period due to tide cycle Max 4 hrs. Assume half of this maximum head to calculate velocity at the site in the EA Hazard/Breach Spreadsheet.

c) Repeat for Climate Change Rise in sea level 667mm (6.60m ODN)

d) Taking the precautionary approach the Hazard Rating following a breach which in Flood Risk Assessment (FD 2320) Guidance for New Development Phase 2 R& D Technical Report these are classified as low <0.75, moderate 0.75-1.25, significant 1.25-2.50 and extreme >2.50 based upon an empirical measure of velocity and depth.

HR = d x (v + 0.5) +DF

HR = (flood) hazard rating d = depth of flooding (m)

V = velocity of flood waters (m/sec) DF = debris hazard = 0.5. (1.0 depth above 250mm)

For the degree of Flood Hazard to be classified as low HR has to be <0.75.

The site lies 30m behind the primary defences

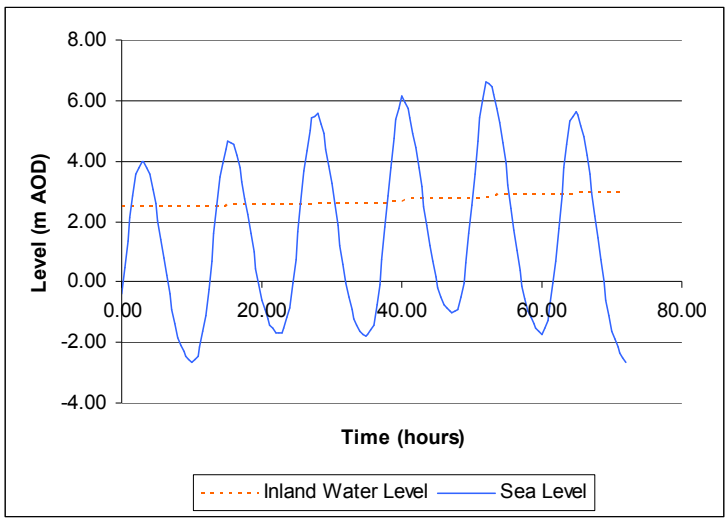
Flood Cell	Size	Breach Base Level (into cell)	Average ground level in cell
A	30 km^2	3.30mODN	2.50mODN

Results tabulated below

	0.5% 2009	0.5% 2084
Tide Level	5.93mODN	6.60mODN
Ground level at breach	3.30mODN	3.30mODN
Avg. Ground level in cell A	2.50mODN	2.50mODN
Level in Cell A From Tide 200	2.81mODN	2.98mODN
Existing Ground level at the site	2.90mODN	2.90mODN
Floor level of building	3.50mODN	3.50mODN
average depth at breach	5.93- 2..64/2 1.65m	6.68- 2.78/2 1.95m
Depth at site	2.81-2.90=0.00m	2.98 – 2.90 = 0.08m
Velocity at 30m from source EA Hazard Spread Sheet	1.13m/sec	1.68m/sec
Hazard Rating	0.50 Low Hazard	0.67 Low Hazard

Year 2084

RESULTS	
Peak Net Volume of Inflows (m3)	14352489.0
Peak Level (m AOD)	2.98



This is the peak depth which occurs over 4 hrs maximum. Use average head to find velocity.

VELOCITY		Site Name	Alternative Energy Boston			Date	Oct-09			
		Defence Type	Tidal River - Earth Bank							
		Ground Level at breach	3.3	mODN	Flood Level	6.6	mODN	Head at Breach	1.65	m
		Breach Width	50	m						
		Increments from breach	5	m						
	Debris Factor	Shallow	0.5		Deep	1	(note: shallow <0.26m)			

DEPTH AT BREACH	DISTANCE FROM BREACH										
	0	5	10	15	20	25	30	35	40	45	50
1.35	1.99	1.86	1.77	1.69	1.63	1.57	1.52	1.48	1.44	1.40	1.37
1.40	2.02	1.90	1.80	1.72	1.66	1.60	1.55	1.51	1.47	1.43	1.40
1.45	2.06	1.93	1.83	1.75	1.69	1.63	1.58	1.53	1.49	1.46	1.42
1.50	2.09	1.96	1.86	1.78	1.71	1.66	1.60	1.56	1.52	1.48	1.45
1.55	2.13	2.00	1.90	1.81	1.74	1.68	1.63	1.58	1.54	1.50	1.47
1.60	2.16	2.03	1.93	1.84	1.77	1.71	1.66	1.61	1.57	1.53	1.49
1.65	2.20	2.06	1.96	1.87	1.80	1.74	1.68	1.63	1.59	1.55	1.52
1.70	2.23	2.09	1.99	1.90	1.83	1.76	1.71	1.66	1.62	1.58	1.54
1.75	2.26	2.12	2.01	1.93	1.85	1.79	1.73	1.68	1.64	1.60	1.56
1.80	2.29	2.15	2.04	1.95	1.88	1.81	1.76	1.71	1.66	1.62	1.58

From calculations the HR, at 30m from the breach to the primary defences, at the site of the existing building in year 2009 is 0.50 Low Hazard rating area after climate change year (2084) is 0.67 Low Hazard, for the lifetime of the buildings (75years).

With the primary defences having a crest level of 6.50mODN these defences will not be subject to over topping for the present day. If the defences are not raised or other flood defences provided to protect Boston the site could be flooded from over topping of the defences at a depth of 160mm.

Boston Borough Strategic Flood Risk Assessment

In order to inform the process of risk assessment and site selection the Borough Council commissioned Consultants to prepare a Strategic Flood Risk Assessment. It was found that a significant proportion of the Borough was at little or no risk when the defences were taken into account. The majority of land in the Borough is at low to medium risk and only a small proportion at high risk

The findings reflect the considerable protection afforded to the area by coastal and tidal flood defences and by the extensive well organised system of fluvial drainage.

The Borough Council has designated fifteen separate Flood Risk Zones within and around the town of Boston. The application site lies within Marsh Lane FRZ 10 and is shown to be in category 2 Low- Medium Risk. **Map 3**

The study has identified that, for the Wyberton Marsh pumped catchment 1 in 100 year flood event, the maximum water level would be 1.45mODN, which is well below bank level.

The primary flood risk to the area is potential tidal flooding from a breach of the right hand bank of Boston Haven between Black Sluice and Slippery Gowt landfill site. The Riverside Industrial Estate is bounded by the Haven and a breach in the primary defence in this area would rapidly result in flooding of the estate. The SFRA stated that the secondary flood defence line of the old sea bank is too close to afford the FRZ more than a limited and temporary alleviation from a breach to the primary defence. A breach further downstream of Slippery Gowt could also cause flooding but with a much lower risk as the overland path would be more than 2km and the secondary flood bank is at a greater distance from the primary embankment and thus forms an effective impediment to tidal flooding.

With the height of the defences being well above the 1 in 200 year tide level it is doubtful that overtopping the defences will occur, the main threat is from a beach occurring at high tide. The risk of over topping will increase during the lifetime of the development unless the defences are raised to cater for global warming

Black Sluice Internal Drainage Board

The site lies within the administrative area of the Black Sluice Internal Drainage Board who has powers under the Land Drainage Act to carry out measures to alleviate flooding in districts with special drainage needs other than Main River. The Internal Drainage Board was consulted regarding flooding history from their system and has stated that they have no record of the site being flooded from their system and are not aware of any flooding from the Haven having affected the site in recent years.

The nearest IDB watercourse to the application site is located to the north of the site and flows in an easterly direction to the Wyberton Marsh Pumping Station. The pumps discharge into the Haven and are designed to cope with all heads.

A scheme for the disposal of surface water has been agreed with the IDB. E-mails 20th November 2009 and 1st December 2009. **Appendix A**

SEQUENTIAL APPROACH

The proposed use for residential development for the site falls within “Essential Infrastructure” uses of land in Table D.3 Flood Risk Vulnerability Classification and Table D1 shows that developments of this nature are appropriate in this zone subject to passing the Exception Test. All development is permitted in Zone 1. Development in Zones 2 and 3 is restricted based on Table D3 of PPS 25 replicated below.

Table D.3[22]: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception Test required	✔	✔
	Zone 3a	Exception Test required	✔	✗	Exception Test required	✔
	Zone 3b 'Functional Floodplain'	Exception Test required	✔	✗	✗	✗

FLOODING FROM OTHER SOURCES

Flooding is a natural process and can happen at any time from sources other than watercourses and the sea.

- Flooding from land can occur from intense rainfall, often over short duration of time that is unable to soak into the ground or enter the drainage system. With the surrounding built up environment and the land falling to the east to the IDB watercourse there is little risk of flooding and this is likely to be of short duration and cause some local ponding of shallow depth

- The area is not known to suffer from any groundwater problems.

- Flooding from sewers can occur from over loading from heavy rainfall caused by blockages or having inadequate capacity. With the surrounding built up environment and the land falling to the east to the IDB watercourse there is little risk of flooding and this is likely to be of short duration and cause some local ponding of shallow depth

- Non natural or artificial sources of flooding such as reservoirs, lakes or canals where water is stored above natural ground

level could cause flooding if the structure fails or is over topped. There are no other known facilities close by which would affect the site.

CLIMATE CHANGE

Global warming is now recognised that it is likely to affect the frequency and severity of extreme events as both tidal and fluvial flooding.

The annual sea rise due to climate change is given in Annex B, PPS25 and the recommended contingency allowances are stated in Table B1. This for the year 2084 (the life span of industrial buildings) will give a general rise for the Humber Area of 679mm.

2006-2025 = 4mm 19 x 4 = 76mm

2025-2055 =8.5mm 30 x 8.5= 255mm

2055-2084 = 12.mm 29 x 12 = 348mm

The effect of global warming on fluvial flood peaks is given in Table B2. It is expected that the overall effect up to 2025 will result in an increase of rainfall of 5%, 2025-2055 10%, 2055-2085 20% with Peak River flows increasing by 10%,

From information from the Environment Agency the existing defences adjacent to the application site are adequate to deal with tidal events upto 2084

ACCESS AND EGRESS

This is provided along through the existing Marsh Lane Industrial site. Due to the existing land levels it will not be possible
to provide dry access/egress to and from the site hover the flood levels along this route would not prevent emergency access/egress during a flood event.

INFRASTRUCTUE

The buildings will be connected into the foul sewerage system which serves the industrial estate on the northern boundary, surface water from impervious areas will be also discharged into this dyke having first been through a petrol/oil interceptor.

Discussions have been held with the Black Sluice IDB regarding the disposal of surface water not only from this site but from the 25 Hectares owned by the land owner of which 10 Ha has already been developed and arrangements have for surface water has been ad hoc. A scheme has been proposed and submitted to the IDB for necessary improvements to the network to accommodate the additional flow from the 25 hectares. The calculated volume of storage required discharging at the Greenfield rate of 1.4 litres/sec/hectare into the adjacent watercourses, is 9350 cubic metres. The IDB have had this proposal modelled by their Consultants .The IDB have confirmed that the additional storage provided within the system can be accepted without raising levels elsewhere and there is no need for the attenuation weir. **Appendix A**

On site drainage pipes will be laid from the impermeable areas with direct connections into the dyke drainage system and following the Consultants model they have confirmed that the watercourse 1 in 100 year level including climate changes (30%) is 2.44mAOD in the IBD drain and 2.56mAOD in the site drains. With the proposed site level being 3.5mODN, therefore with a freeboard of 1.0m there will be no flooding or surcharging on the site and also there will be no impacts to any third parties from the onsite drainage network, or with the wider IDB watercourse improvements.

As there is a positive drainage system capable of receiving flows the development there is no likely impact on neighbouring property also there will not be above ground flooding which would become a hazard to buildings or site access routes.

CONCLUSION

- Following the assessment of the Flood Risk from the Haven the category of the site would be in Flood Zone 3, (High Probability) The site is protected to at least 1 in 200 year tidal flood event from the Haven. The Banks are in good condition and the risk of a breech in the banks being minimal. However it is understood that flood defences do not completely remove the chance of flooding and can be overtopped or fail in extreme weather conditions.

- Applying the Flood Risk Vulnerability Classification in Table D2 of PPS25, the proposed development is classified as Essential Infrastructure, with Table D1 of PPS25 stating that such uses are appropriate in this zone if the site passes the Exception Test.

- The Haven is tidal and therefore the flood risk is only at its greatest when under high tide conditions. Metrological forecasts together with known variations of the predicted spring tides will allow sufficient warning time when these events will occur to safely evacuate the site.

- The lowland drainage system is well maintained by the Internal Drainage Board and they have stated that the site has no record of flooding from the Board's system. The Board's pumping station at Wyberton Marsh Pumping Station can operate under all tide levels. Run-off from the site will be controlled to an acceptable rate as per the proposals agreed with the Black Sluice IDB (Appendix A)

- The attenuation proposals to deal with the run-off from this site and the remaining land within the ownership of the land owner has been modelled within the Black Sluice IDB model and will provide a satisfactory solution without causing any above land flooding to the site and to neighbouring lands.

- Any impact of damage to the property can be foreseen and mitigated against by relatively simple design and construction techniques.

    - Floor levels for the development are to be set as high as practicable above ground level taking into account the need for disable access, use of the building and visual amenity issues.

    - The plant is to be raised above the predicted high tide following global warming i.e. 6.65m ODN so as to remain operational at all times.

    - Register the site with the Environment Agency to receive early flood warning information.

    - The Operator of the site shall provide all operatives a flood evacuation plan detailing what to do in the event of a flood.

    - The proposal falls into Essential Infrastructure, the proposed plant and sensitive control areas are to be located above the high tide level, following climate change, i.e.6.60mODN

APPENDIX

Photo 1 Proposed Development Site and Secondary Flood Banks

Photo 2 Haven Flood Banks

Map 1 Extract from Boston Local Plan Map

Map 2 Extract from Environment Agency Flood Map

Map 3 Extract from Boston SFRA Flood Map

Plan 1 Typical Schematic Plan

Plan 2 Site Location Plan

Plan 3 Site Layout Plan

Plan 4 Site Surface Areas

Plan 5 OS Levels Marsh Lane FRZ

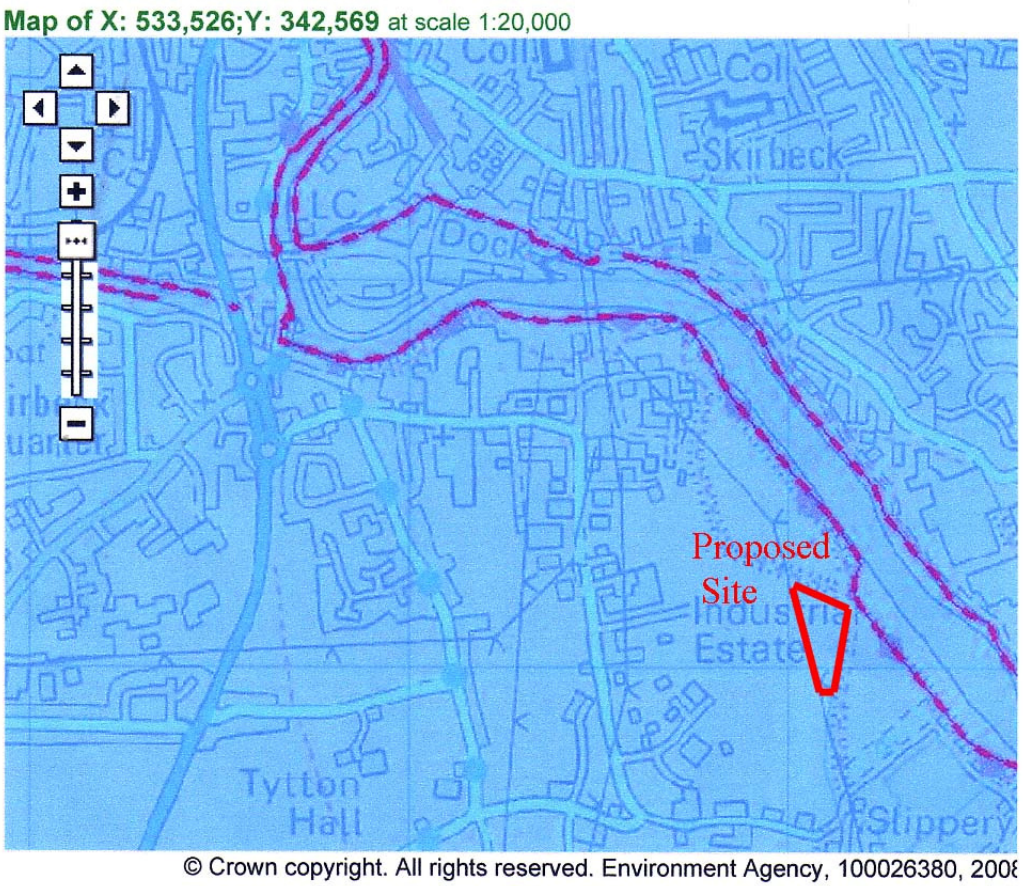
Appendix A Proposed Surface Water Drainage Scheme.

Flood Evacuation Plan

Figure 1 Proposed site and Secondary Flood Defence

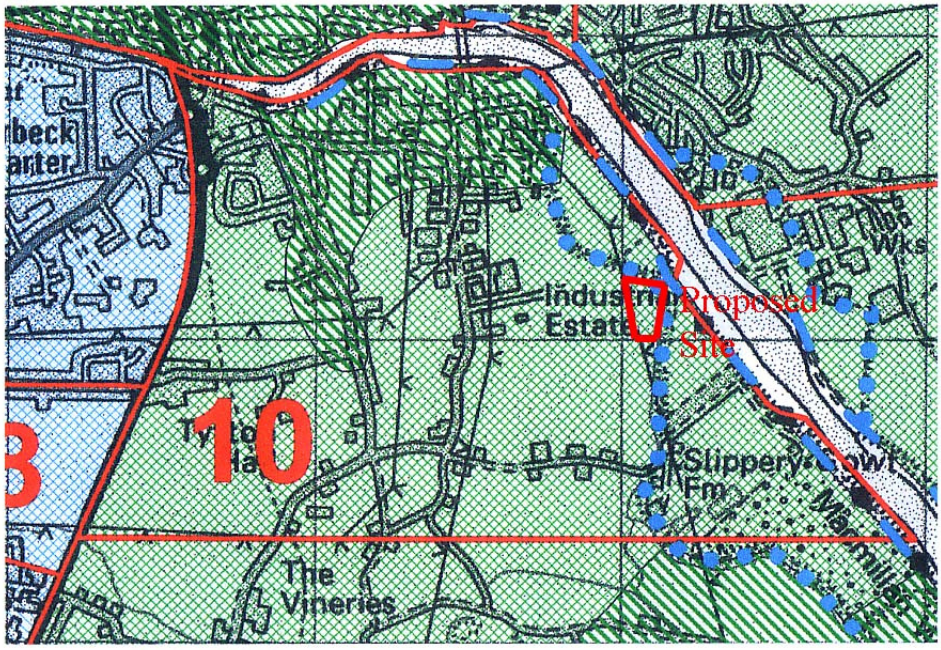
Figure 2 Haven Flood Banks

EXTRACT FROM ENVIRONMENT AGENCY FLOOD MAP



MAP 1

EXTRACT FROM BOSTON SFRA FLOOD MAPS



Tidal Flood Risk

Category 1 - Little or No Risk (<0.1%)

Category 2 - Low to Medium Risk (0.5% to 0.1%)

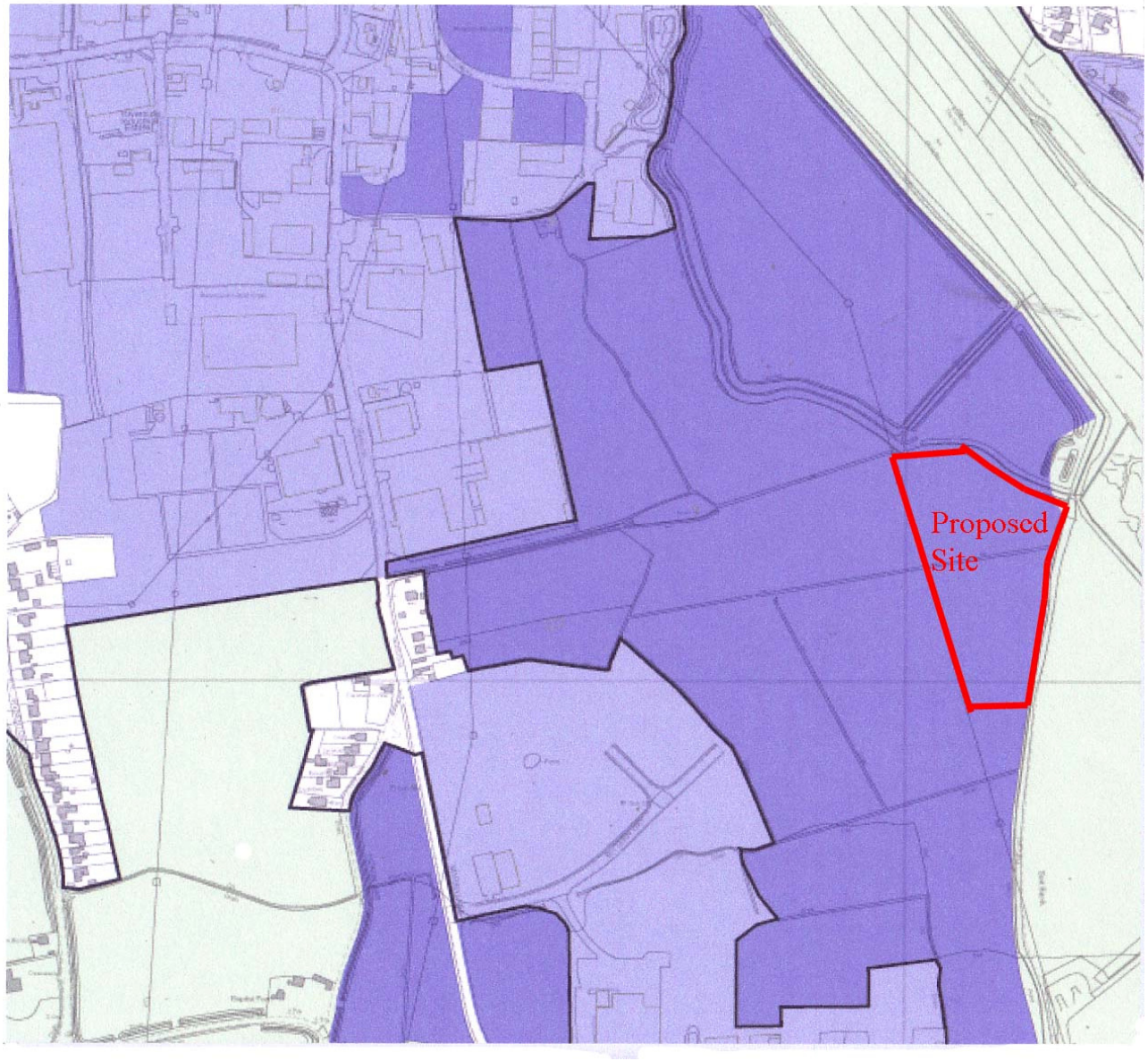
Category 3 - High Risk (>0.5%)

Primary Tidal Defences

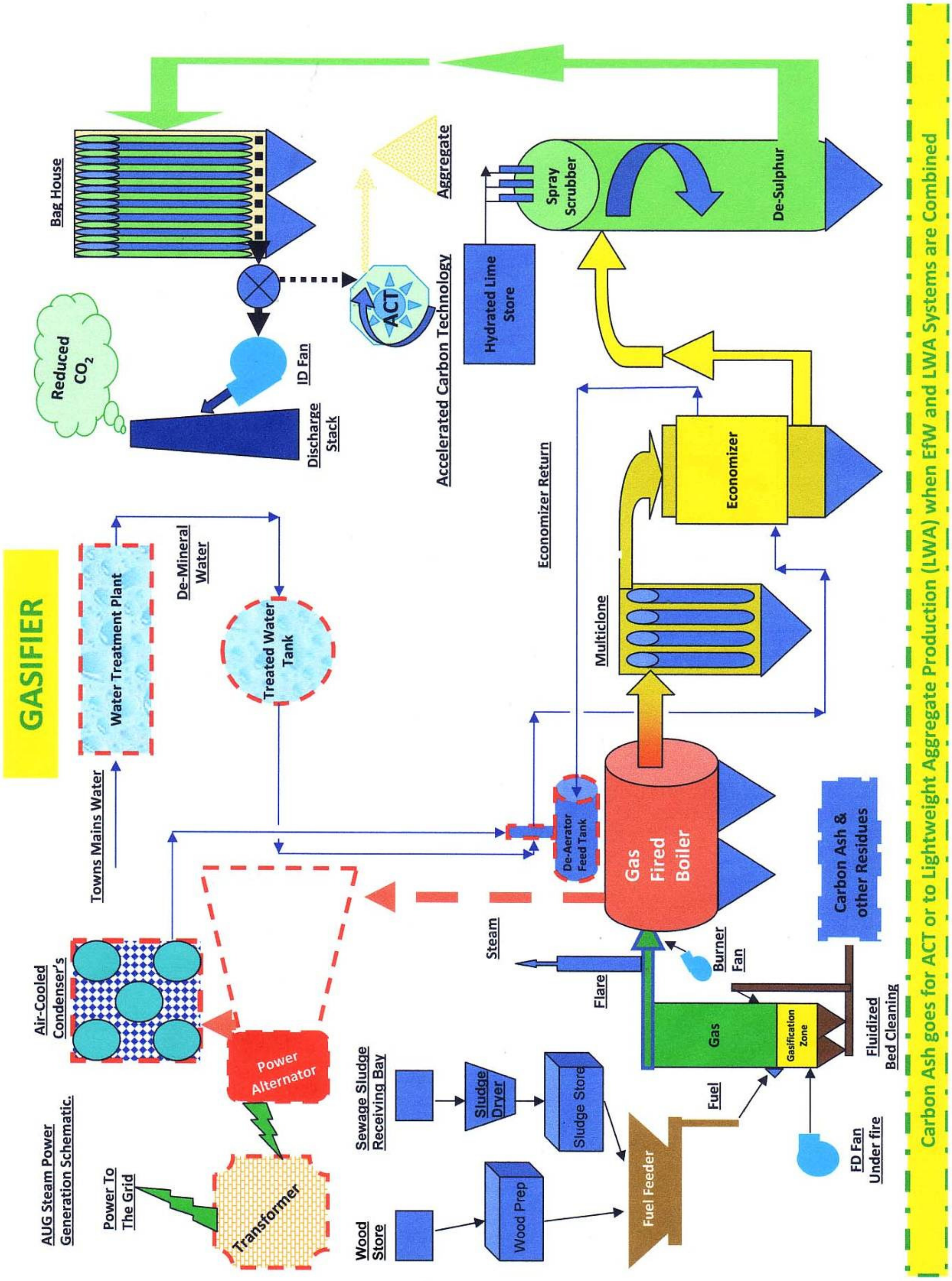
Secondary Tidal Defences

MAP 2

EXTRACT FROM BOSTON LOCAL PLAN

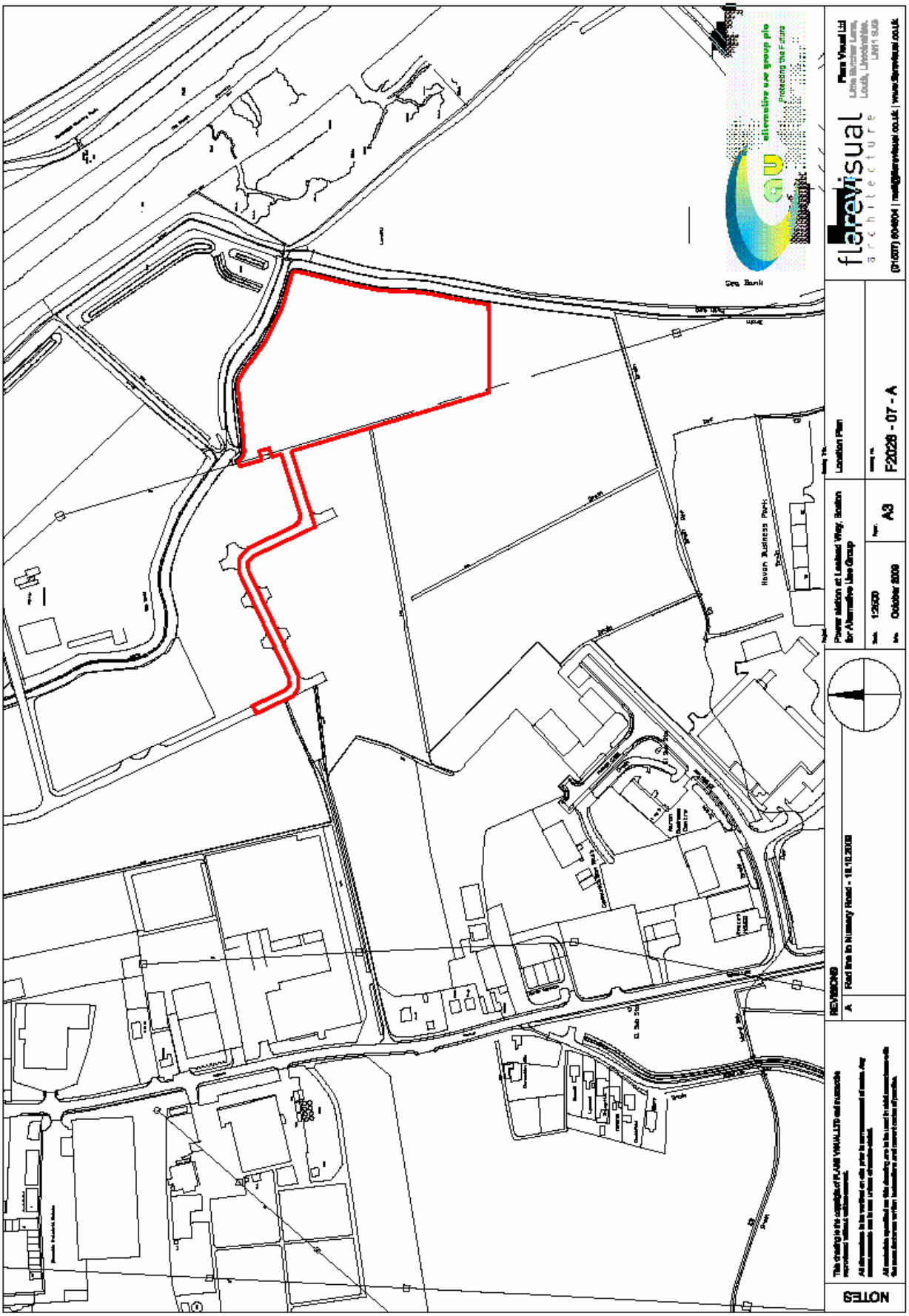


MAP 3

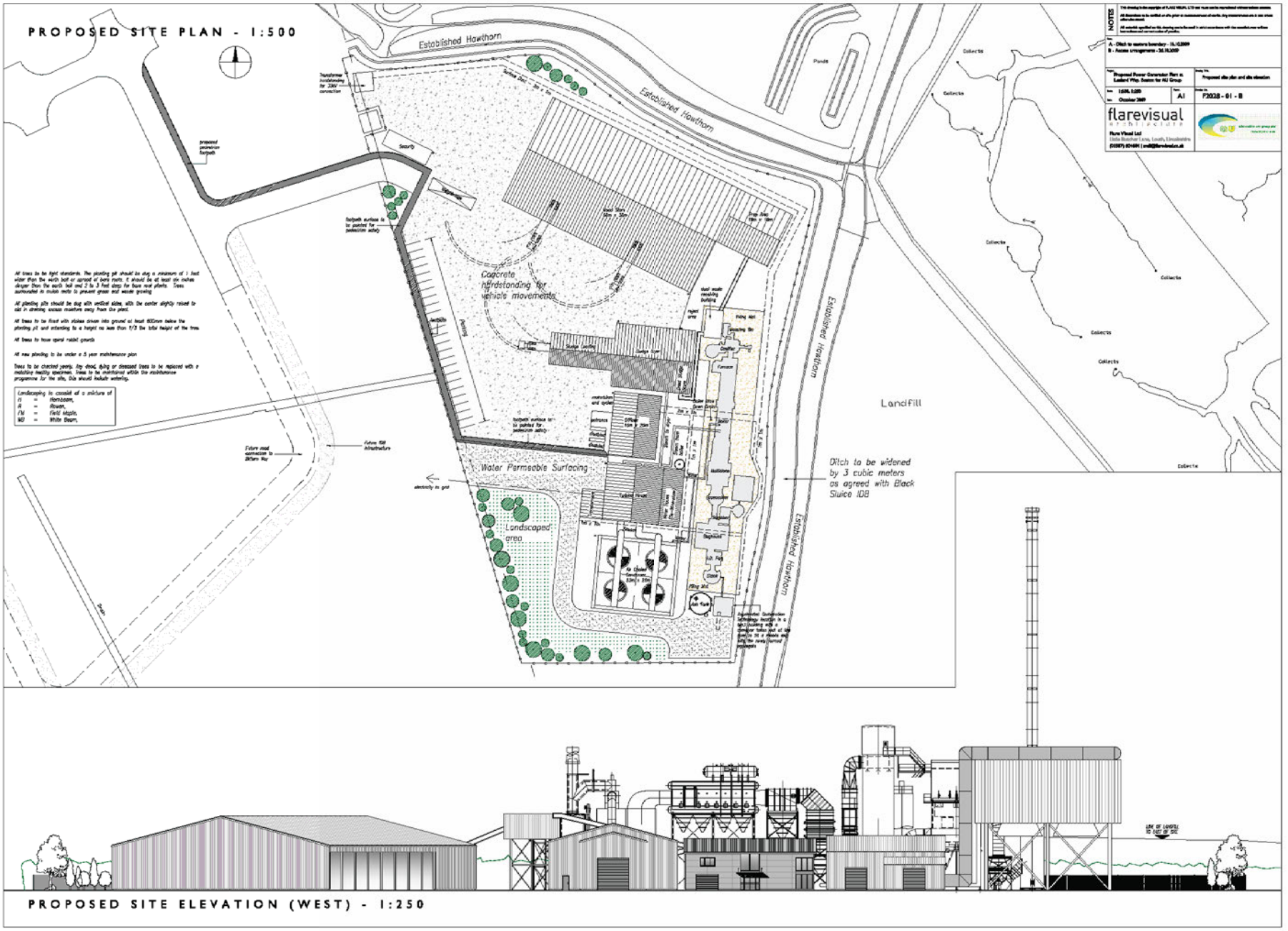


GASIFIER
AUG Steam Power Generation Schematic.
Power To The Grid
Transformer
Power Alternator
Air-Cooled Condenser's
Towns Mains Water
Water Treatment Plant
De-Mineral Water
Treated Water Tank
Reduced CO_2
Discharge Stack
ID Fan
Bag House
ACT
Accelerated Carbon Technology
Aggregate
Hydrated Lime Store
Spray Scrubber
De-Sulphur
Economizer Return
Economizer
Multiclone
De-Aerator Feed Tank
Gas Fired Boiler
Steam
Flare
Burner Fan
Carbon Ash & other Residues
Gas
Gasification Zone
Fluidized Bed Cleaning
FD Fan Under fire
Fuel
Fuel Feeder
Wood Store
Wood Prep
Sewage Sludge Receiving Bay
Sludge Dryer
Sludge Store
Carbon Ash goes for ACT or to Lightweight Aggregate Production (LWA) when EfW and LWA Systems are Combined

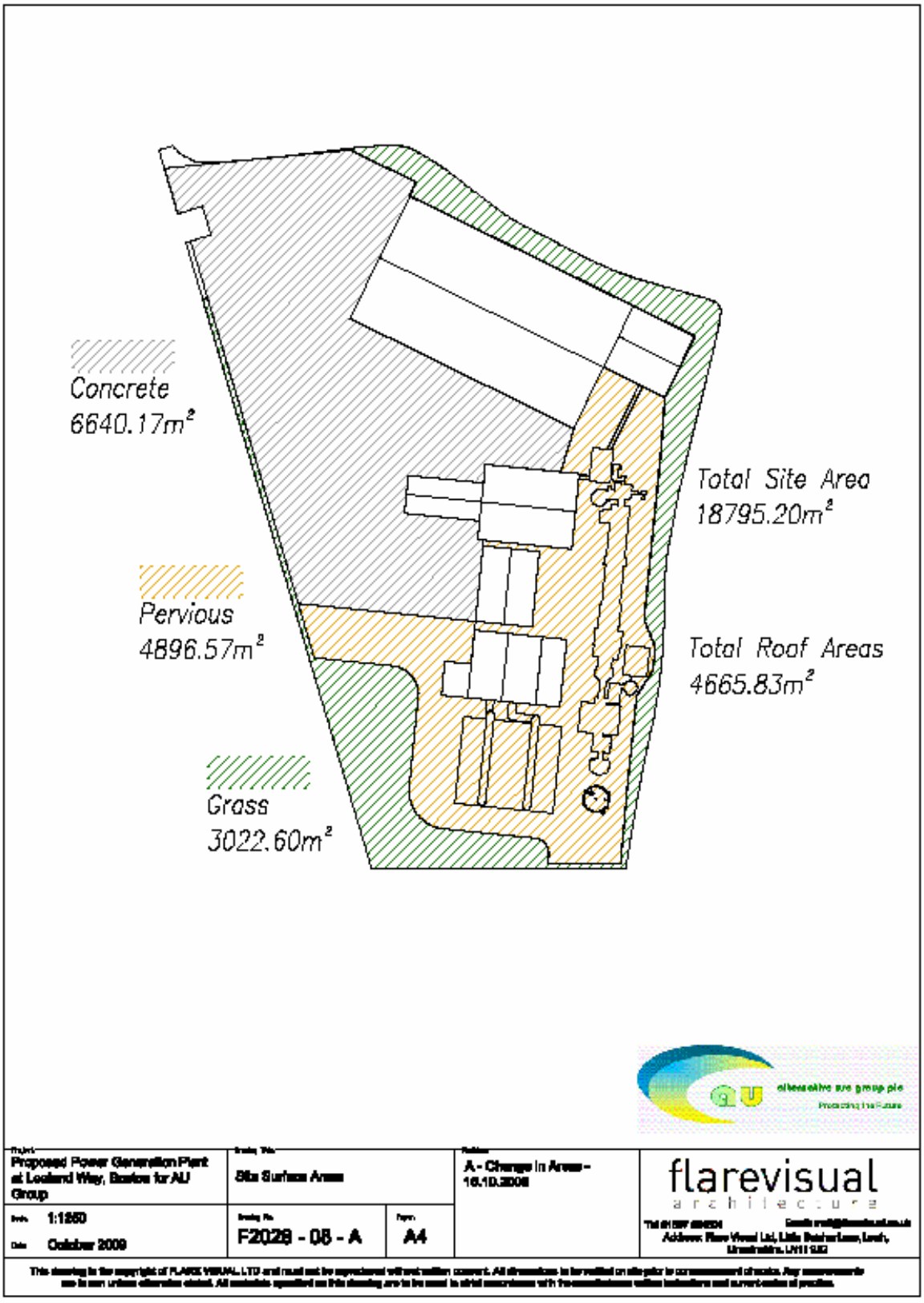
PLAN 1


flarevisual
architecture
Location Plan
F20228 - 07 - A
A3
1:2500
October 2009
Power station at Lealand Way, Boston for Alternative Use Group
Red line to Nursery Road - 15.10.2009
NOTES

PLAN 2

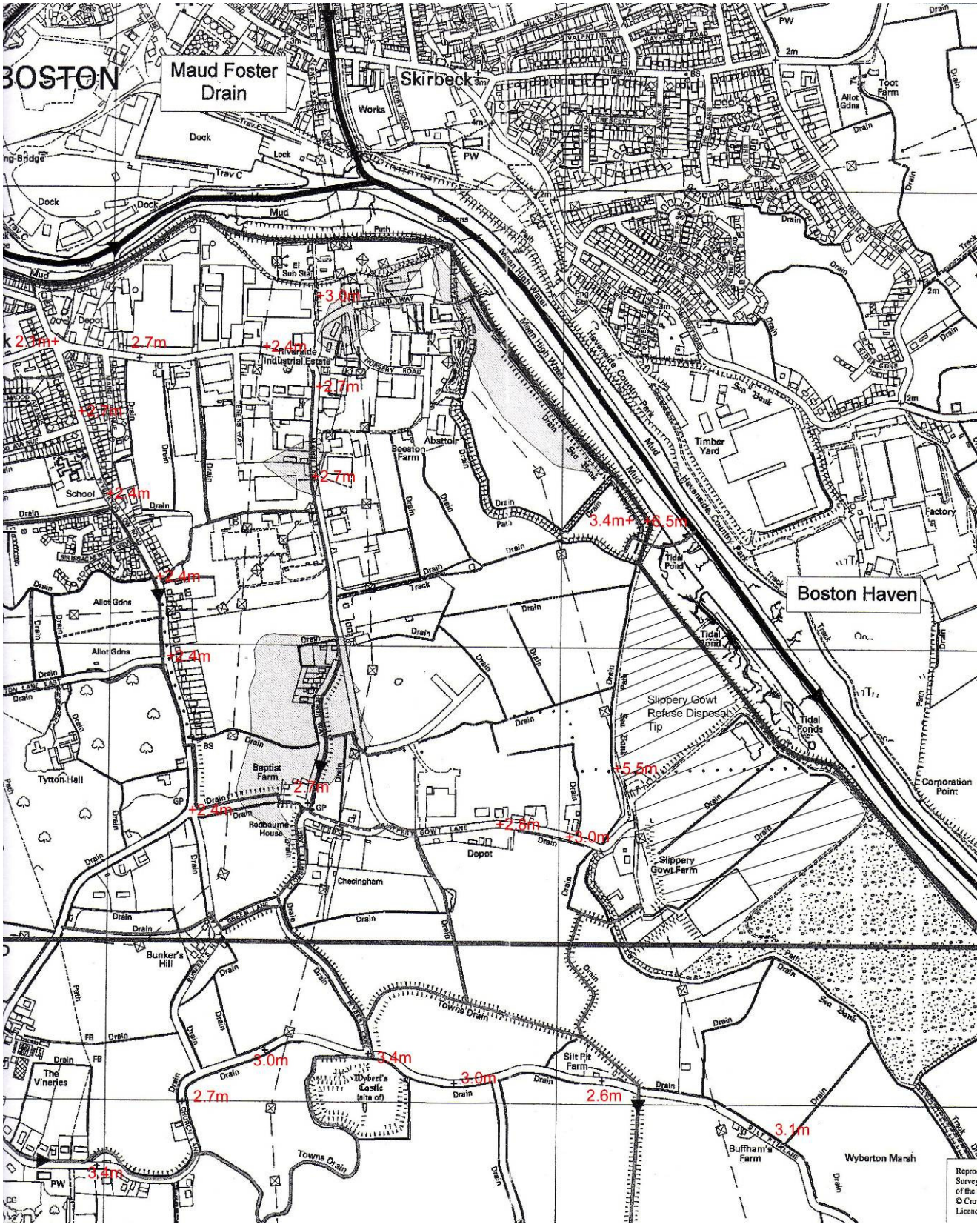

PROPOSED SITE PLAN - 1:500
Established Hawthorn
Established Hawthorn
Established Hawthorn
Concrete hardstanding for vehicle movements
Water Permeable Surfacing
Landscaped area
Ditch to be widened by 3 cubic meters as agreed with Black Sluice IDB
Landfill
Future road connection to Bittern Way
Future ESB infrastructure
electricity to grid
Security
proposed pedestrian footpath
Transformer Arrangement for ESBN connection
Footpath surface to be painted for pedestrian safety
Footpath surface to be painted for pedestrian safety
Parking
Drain
All trees to be light standards. The planting pit should be dug a minimum of 1 foot wider than the earth ball or spread of bare roots. It should be at least six inches deeper than the earth ball and 2 to 3 feet deep for bare root plants. Trees surrounded in mulch mats to prevent grass and weeds growing
All planting pits should be dug with vertical sides, with the centre slightly raised to aid in draining excess moisture away from the plant.
All trees to be fixed with stakes driven into ground at least 600mm below the planting pit and extending to a height no less than 1/3 the total height of the tree.
All trees to have spiral rabbit guards
All new planting to be under a 5 year maintenance plan
Trees to be checked yearly. Any dead, dying or diseased trees to be replaced with a matching healthy specimen. Trees to be maintained within the maintenance programme for the site, this should include watering.
Landscaping is consist of a mixture of
H = Hornbeam,
B = Rowan,
FM = Field Maple,
WB = White Beam,
NOTES
A - Ditch to eastern boundary - 16/12/2009
B - Access arrangements - 26/10/2009
Proposed Power Generation Plant at Ludford Whip, Saxilby for AU Group
Proposed site plan and site elevation
1:500, 1:250
A1
October 2009
P2028 - 01 - B
flarevisual
architecture
Flare Visual Ltd
Units Bluecher Farm, Louth, Lincolnshire
(01507) 601491 | mail@flarevisual.co.uk
LINE OF LEVEL TO EAST OF SITE
PROPOSED SITE ELEVATION (WEST) - 1:250

PLAN 3


Concrete
6640.17m²
Pervious
4896.57m²
Grass
3022.60m²
Total Site Area
18795.20m²
Total Roof Areas
4665.83m²
Proposed Power Generation Plant at Lealand Way, Boston for AU Group
Site Surface Areas
A - Change in Area - 16.10.2009
1:1250
October 2009
F2029 - 05 - A
A4
flarevisual
architecture

PLAN 4

OS Levels Marsh Lane FRZ



PLAN 5

SEQUENTIAL TEST

Paragraph E5 Annex E PPS 25 states that the SFRA should provide the basis from which to apply the Sequential Test and the Exception Test in the development allocation and development control process.

Boston Borough Council has produced a Flood Risk Matrix to ascertain whether or not the application complies with PPS25 and for the applicant to undertake a self assessment.

From **Sheet 1** of the matrix as the site lies within Flood Risk Category 3 High Risk a FRA is required and that Sequential and Exceptional Tests are also required.

Sheet 2 Sequential Tests answers to the Questions

1. *Is the site specifically allocated (following sequential testing) for the use proposed in the Interim plan?*

Site shown allocated for Industrial development within the Local Plan

2. *Is the site in a location where the use is allowed (having regard to the SFRA) as a windfall development under the interim plan?*

No

3. *Are there any Interim Plan allocated sites that are available in a lower risk flood category area?*

No

4. *Do the Interim Plan or background documents identify reasonably available alternative allocations in the same flood zone but subject to a lower probability of flooding from all sources (as identified in the SFRA)?*

No

Sequential Test is passed.

Sequential Test is passed

Sheet 3 Exceptions Test

1 Is it a housing development within a defined town centre

No

1. *Is the site Brownfield?*

No

2. *Would significant community benefit or sustainability benefit arise that could not be realised in an alternative location at lesser flood risk or which would outweigh the flood risk?*

The site is located within an area allocated for employment use up to 27 jobs will be created by this development. This is an "A" test as per D9 in PPS25

The proposal will generate 12Mw maximum of electricity from sources of locally obtained waste.

3. *If the proposal includes a "more vulnerable use" is this excluded from the ground floor or put to a suitable level?* No

The proposal falls into Essential Infrastructure, the proposed plant and sensitive control areas are to be located above the high tide level following global warming i.e.6.60mODN

4 *Is the development a translocation of an existing use/development which in its existing location is at a greater flood risk compared to the proposed site?*

No

6 There are no other allocated employment sites identified in the Local Plan which could accommodate the proposed development

Exceptions Test passed

Appendix A

PROPOSED SURFACE WATER DRAINAGE SCHEME
RIVERSIDE INDUSTRIAL ESTATE, BOSTON.

An area of land comprising of approximately 25 Ha of land is included in the Borough of Boston Local Plan. Approximately 10 Ha has been developed or has an extant planning approval. **Plan 1** The Surface water disposal which is to local watercourses is very ad hoc with some areas attenuated by various on site means. The Black Sluice Internal Drainage Board has been concerned about the present and future developments for the surface water disposal.

Meetings have been held between the Internal Drainage Board and the Landowner to discuss what arrangements can be made to satisfactorily resolve the drainage problem.

The preliminary design has been prepared in accordance with the guidelines of the Black Sluice Internal Drainage Board and is based on limiting the outflow into the Board's system to 1.4litres/sec, the accepted Greenfield rate of run-off from the site.

The design will also comply with the Environment Agency requirements for surface water disposal to regulate the flow of surface water into the local water courses or drains.

This will be achieved by on-site attenuation within the existing private onsite drainage watercourses and the proposed new watercourse and pond and is designed to deal with surface water run-off up to the critical 1 in 100 year event plus an allowance of 30% for climate change.

The new watercourse will be cut alongside the extension of Bittern Way to the New Power Station Site Road length 250m coloured red. The watercourses shown in Blue on the plan will be widened and the new pond to provide the shortfall in capacity. **Plan 2**

<u>Drainage Calculations</u>

Total Area of Site = 25 Ha

Impervious areas – A broad assumption has been agreed that the impervious factor for the calculations is taken to be 51%

The Environment Agency requires the surface water attenuation facilities to be designed to cope with a 1 in100 year event plus an allowance of 30% for climate change, as stated in Table B2 PPS25.
The Black Sluice IDB has stated that the Greenfield rate of run-off for the area has been determined to be 1.4 litres/sec/Ha. This gives an allowable discharge of 35 litres/sec

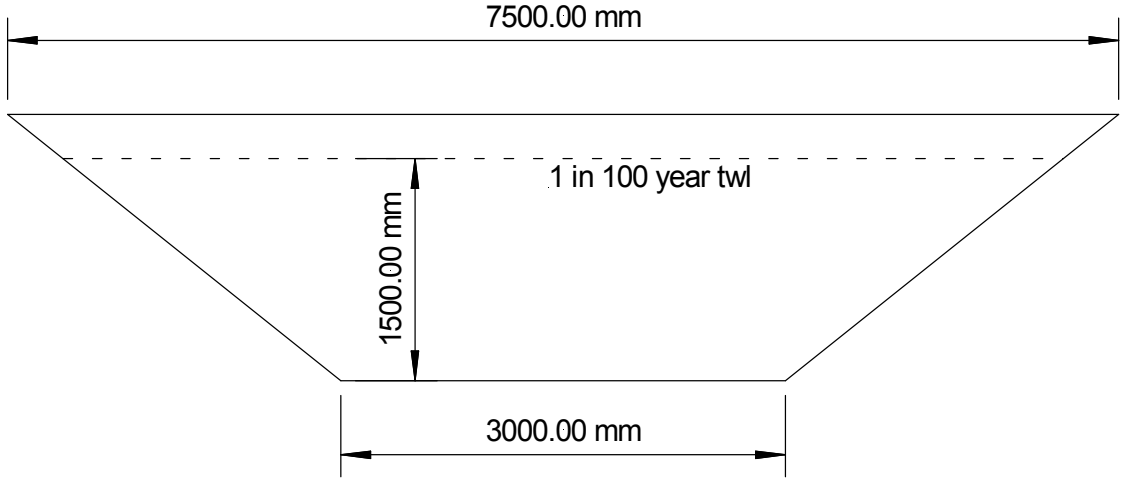
From **Table 1** the calculated volume of storage required, to discharge at the rate of 35 litres/sec into the adjacent watercourses, is 9350 cubic metres.

It is proposed that this storage capacity is provided by:-

- Anew dyke cut from Bitton Way
- The existing boundary watercourse widened on the owners side,
- Provision of new attenuation pond

Storage Capacity Required

A new dyke is to cut to the same profile as the existing dyke alongside Bittern Way,
7.5m top width.3.0m bottom 1.5m deep with 1 to 1.5 side slopes. This gives a volume of storage per metre run of 7.875m^3

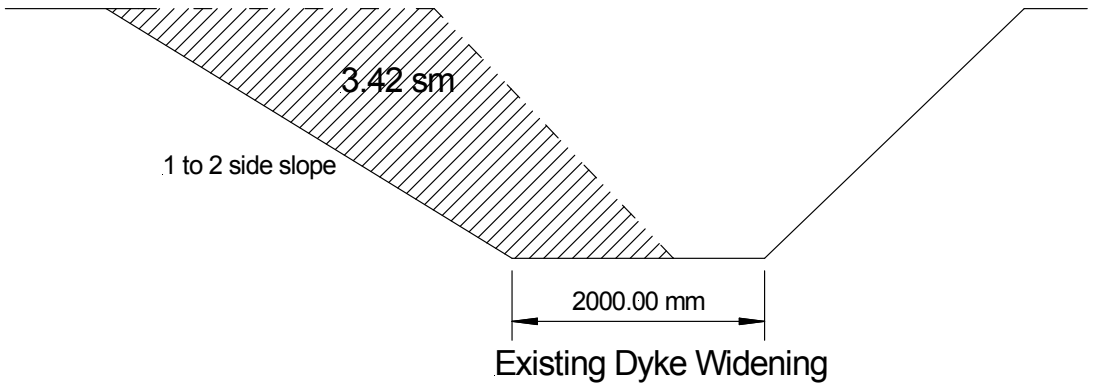


New Cut Watercourse

Total volume of storage within new dyke system = 250m x 7.875 = 1968.75 cub metres.

Length of existing watercourse to be widened =590 lin. Metres

Total volume of storage within the widened dyke system = 590m x 3.42 = 2017.80 cub metres.



Existing Dyke Widening

Shortfall in capacity = 9350 – 1968.75 – 2017.80 = 5463.45 m^3

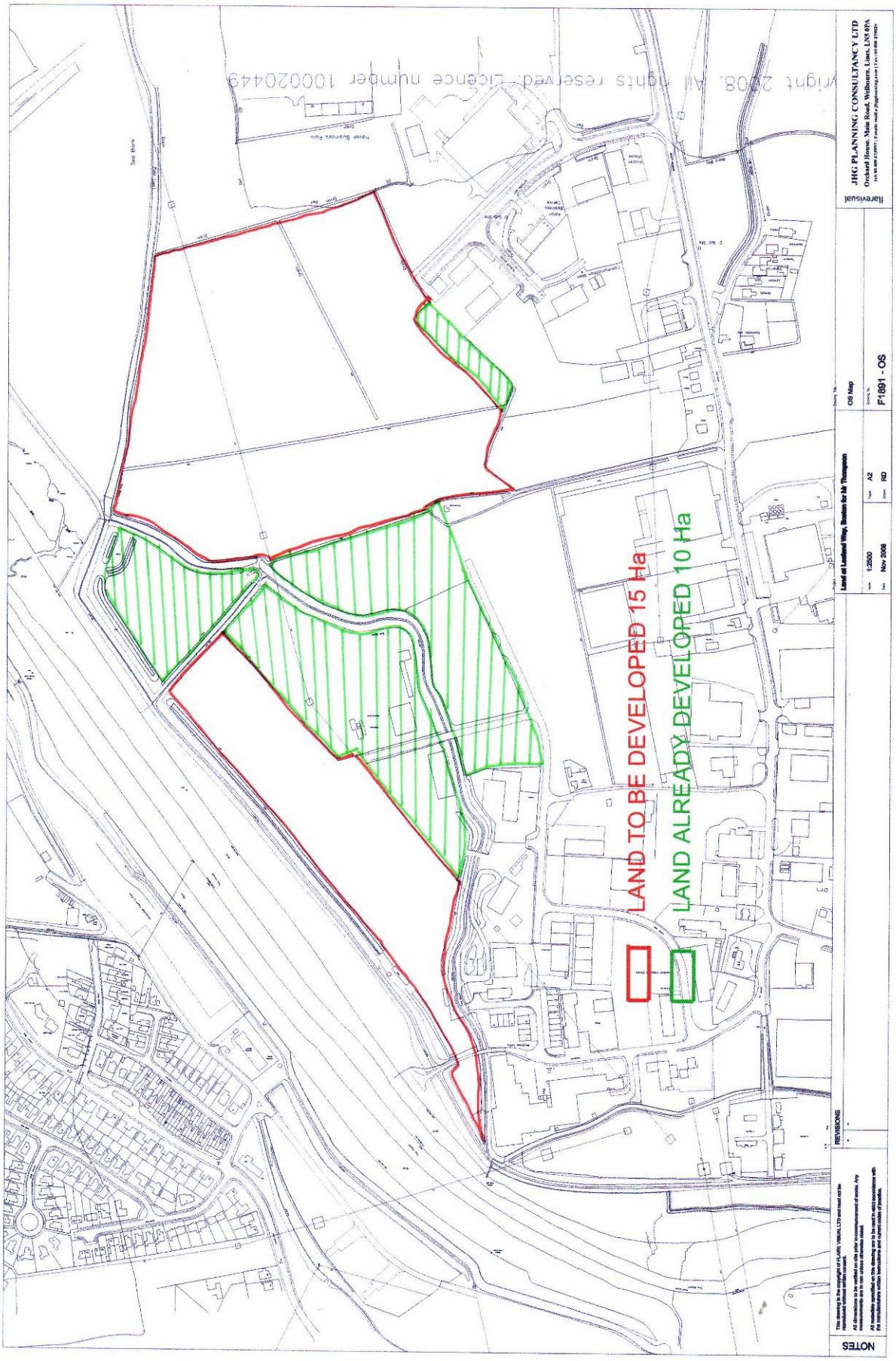
Pond size 91m x 40m x 1.5m deep

The proposed attenuation volume has been included in the Black Sluice IDB catchment model, and the consultants have confirmed the following.

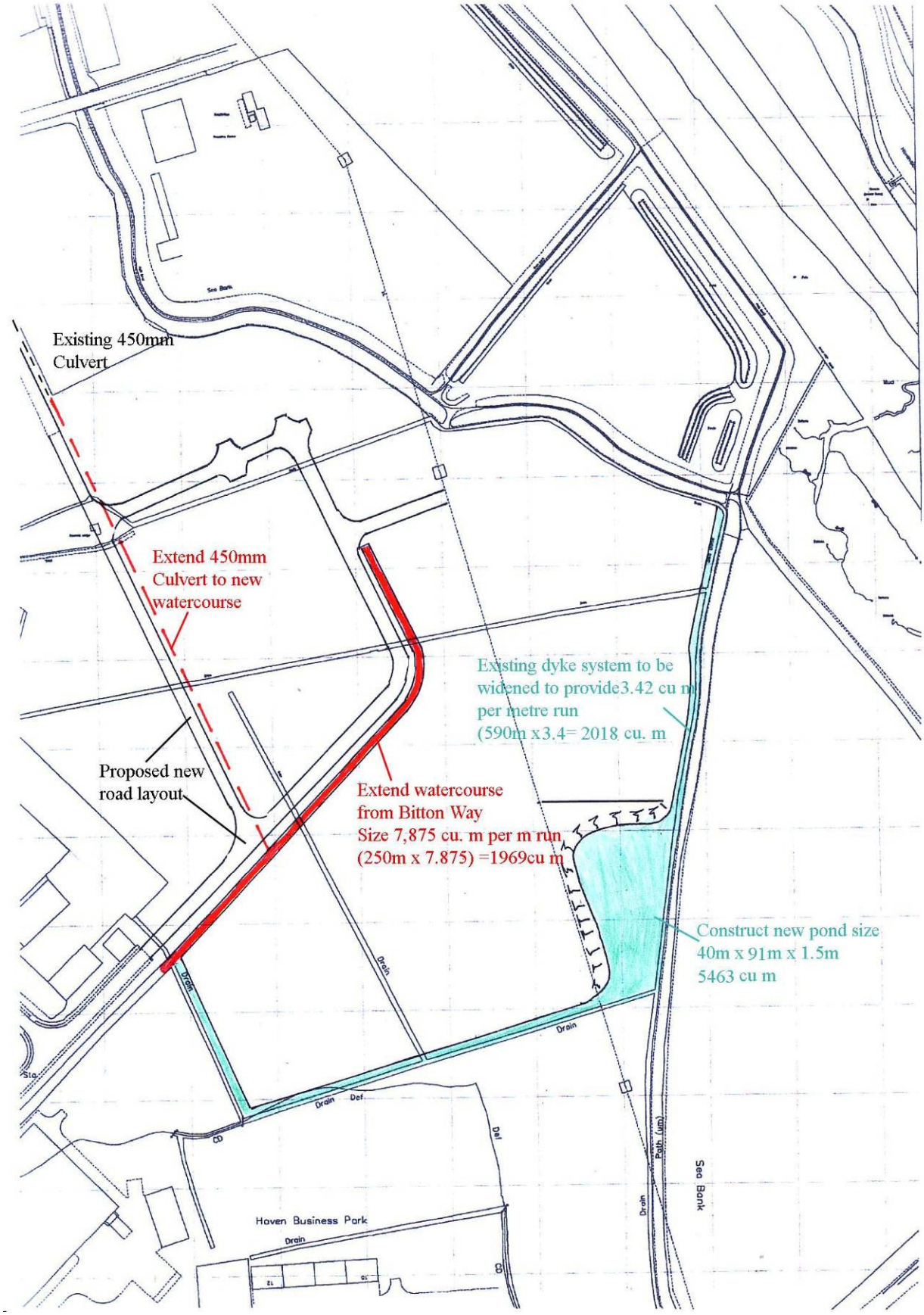
Results of modelling of extension of Wyberton Marsh Area:

Summary
If the proposed development takes place as specified the drains in the development site will have enough capacity to store the runoff from the 100-year event and the maximum level will be 1.80mAOD in the IBD drain and 2.39mAOD in the site drains. This will not exceed the crest level of the control structure and any flow leaving the development will be controlled by the dimensions of orifice structure. **Model results have shown that for the 100-year event the outflow into the IDB drain will be approximately 30l/s**.

The drains will also have enough capacity to store the runoff from the 100-year plus climate change (+30%) event and the maximum level will be 2.44mAOD in the IBD drain and 2.56mAOD in the site drains. **In the 100-year climate change event the outflow into the IBD drain will be approximately 35l/s.**


LAND TO BE DEVELOPED 15 Ha
LAND ALREADY DEVELOPED 10 Ha
JHG PLANNING CONSULTANCY LTD
Orchard House, Main Road, Wellhours, Lincs. LN5 0PA
Land at Lockfield Way, Boston for Mr Thompson
OS Map
F1691 - OS
1:2500
Nov 2008
A2
RD
REVISIONS
NOTES

PLAN 1


Existing 450mm
Culvert
Extend 450mm
Culvert to new
watercourse
Existing dyke system to be
widened to provide3.42 cu m
per metre run
(590m x3.4= 2018 cu. m
Proposed new
road layout
Extend watercourse
from Bitton Way
Size 7,875 cu. m per m run
(250m x 7.875) =1969cu m
Construct new pond size
40m x 91m x 1.5m
5463 cu m
Drain
Drain
Drain
Drain
Def
Def
CD
Haven Business Park
Drain
CD
Path (um)
Drain
Sea Bank

PLAN 2

PROPOSED RIVERSIDE INDUSTRIAL ESTATE BOSTON

Volume of Storage

TABLE 1 UsingThe Modified Rational Method

Volume of Storage Required for a 1 in 100 Year Storm

Catchment Area 25 Ha (51% impervious) greenfield rate of run-off 1.4 litres/sec/ha

r = 0.40

Duration min	M5-60min 20	Z1	M5-D mm	Z2	M100-D	Intensity mm/hr	Areal Factor	Areal Inten mm/hr	Area ha	Imp Factor	Q1 l/sec	Q2 l/sec	Volume cub m	Q1 + 30% l/sec	Q2 l/sec	Vol + CC cub m
15	20	0.64	12.80	1.98	25.34	101.38	0.94	95.29	25	0.51	3377.68	35.00	3008.41	4390.98	35.00	3920.38
30	20	0.81	16.20	1.97	31.91	63.83	0.95	60.64	25	0.51	2149.26	35.00	3805.68	2794.04	35.00	4966.28
60	20	1	20.00	1.93	38.60	38.60	0.96	37.06	25	0.51	1313.45	35.00	4602.42	1707.48	35.00	6020.95
120	20	1.21	24.20	1.89	45.74	22.87	0.97	22.18	25	0.51	786.27	35.00	5409.17	1022.16	35.00	7107.52
180	20	1.35	27.00	1.87	50.49	16.83	0.97	16.33	25	0.51	578.64	35.00	5871.35	752.24	35.00	7746.15
240	20	1.4	28.00	1.86	52.08	13.02	0.97	12.63	25	0.51	447.65	35.00	5942.15	581.94	35.00	7875.99
300	20	1.55	31.00	1.84	57.04	11.41	0.98	11.18	25	0.51	396.27	35.00	6502.85	515.15	35.00	8642.70
360	20	1.62	32.40	1.83	59.29	9.88	0.98	9.68	25	0.51	343.26	35.00	6658.46	446.24	35.00	8882.80
480	20	1.76	35.20	1.81	63.71	7.96	0.98	7.80	25	0.51	276.64	35.00	6959.18	359.63	35.00	9349.34
600	20	1.75	35.00	1.81	63.35	6.34	0.98	6.21	25	0.51	220.05	35.00	6661.91	286.07	35.00	9038.49

Maximum voume of storage = 9350 cub. metres at a storm duration of 8 hours

TABLE 1

Email from Black Sluice IDB

Ray Morgan

From: Ian Watts [redacted]
Sent: 01 December 2009 11:40
To: Ray Morgan
Subject: RE: Proposed Power Station Development at Marsh Lane

Ray

Provided the surface water drainage scheme is carried out to provide the level of attenuation required, then the Board will request that any outstanding details of the scheme be dealt with by the conditioning of any planning consent issued. This will be done in agreement with the local Planning Authority to address the Boards concerns regarding the development site (points 2, 3, 4 and 5 of our original response).

Additionally any Byelaw easement along the length of watercourse to be adopted should be agreed with the Board before any development commences. This is to ensure that the Board are satisfied that future access can be gained effectively along the relevant section and are able to issue the relevant consents, if required.

If you have any queries regarding this matter, then please do not hesitate to contact me.

Best Regards, Ian.

Ian Watts

Technical Engineer

Black Sluice Internal Drainage Board

[redacted]

From: Ray Morgan [redacted]
Sent: 29 Novembe
To: Ian Watts
Subject: RE: Proposed Power Station Development at Marsh Lane

Good evening Ian
Thank you for your e-mail regarding the attenuation proposals. Will the Board accept that points 2, 3 & 5 can be covered with planning conditions should planning consent be given? If so I will arrange for the planning consultant to forward for your approval conditions for the Board to request when the application is being considered.
Regards
Ray

01/12/2009

From: Stuart Hemmings
Sent: 20 November 2009 15:46
To [redacted]
Cc: Ian Watts
Subject: Proposed Power Station Develpment at Marsh Lane

I have the following comments to make on the scheme that you have submitted for the surface water drainage of the area owned by Alan Thompson east of Marsh Lane:-

1. The Board accept that the overall scheme in principal will provide a satisfactory level of attenuation for the area concerned.

2. The proposed 450mm diameter pipe does not seem to be adequate to convey the drainage from the area to the north into the proposed open drain alongside Bittern Way

3. I look forward to receiving in due course a detailed plan showing proposed levels of new watercourses and culverts with detailed designs as required for the Board's approval.

4. I shall recommend to the Board that the section along Bittern Way should in future be maintained by the Board. As a Board's drain it will be subject to the Board's Byelaws, of particular note is Byelaw 10, the 9.0 metre rule. I would recommend a 6.0 metre wide strip should be created on the south east side of the new watercourse as a dedicated maintenance strip.

5. The future maintenance responsibility for other new watercourses, culverts and storage lagoons to be created should be established.

Regards

Stuart

[redacted]

01/12/2009

FLOOD EVACUATION PLAN
GASIFICATION PLANT RIVERSIDE INDUSTRIAL ESTATE BOSTON

The site is located within an area behind two flood defences at Riverside Industrial Estate Boston and is used as a gasification plant producing electricity the area of the site is approximately 1.8 Hectares.

The area is identified on the Environment Agency's Flood Maps as being at risk from flooding in extreme weather from a breach to the flood defences to the tidal River Haven. The risk has been assessed as being minimal due to the width height and construction of the tidal defence and is classified as being greater than 1in 200 years.

As visitors or employees to the site you will be using a site, which is classified as being vulnerable in flood conditions and you will be required to register upon arrival and on leaving the site and to familiarise themselves with the plan.

Access to and from the site is along Nursery Road, Marsh Lane to the A16 as shown on the evacuation plan.

In the remote chance of a flooding happening on the site the following plan and action will be implemented.

A flood Marshal *Name*.....has been appointed who will be responsible to notify the occupants that flood warnings have been issued and to implement the evacuation of the site if necessary. A loud hailer will be kept in the office to assist in the evacuation notification.

The Environment Agency Automated Flood warning System will be subscribed to.
They will notify the owners of the site when the risk of flooding can be expected.

Upon receipt of a warning the Environment Agency website will be monitored regularly for new warnings.

The Plan will have three trigger points:

1. **FLOOD WATCH:-**Alert all site users of increased flood threat and ensure they are aware of possible evacuation if the situation deteriorates. All buildings will be visited as well to by the Flood Marshals explain the likelihood of the site flooding and that they should be prepared to move off.

Means; - Flooding of low lying and & roads is expected

What to do
- Monitor local news and weather forecasts
- Be aware of water levels near you
- Be prepared to act on your Flood Plan
- Check on safety of pets & livestock
- Charge your mobile phone

2. 2 **FLOOD WARNING:-** Alert all site users of the further increased flood threat and ensure that they are ready to move off site if the next warning is received. Contact all those who are booked on site but not there, explain the situation and request that they do not return to the site unless further instructed by the owner or agent. The state of the Rivers will be checked, also the local weather forecast to ascertain whether the situation will deteriorate or improve. In the case of the situation deteriorating visitors will be asked to leave the site.

Means Flooding of homes and businesses is expected ACT NOW

What to do
- Move cars, pets, food, valuables & important documents to safety
- Get flood protection in place
- Turn off gas, electricity and water if safe to do
- Be prepared to evacuate
- Protect yourself, your family and help others
- Act on the flood plan
-

3. **SEVERE FLOOD WARNING:-**Evacuate the site to the A16 by turning Right at the public highway at the site entrance, priority given to the vulnerable (elderly or disabled) with assistance if necessary from 4 wheel vehicle. Those away from the site will be contacted to stay away. Each visitor is recorded within the sites booking in procedures; therefore the owners are in a position to be able to make contact and accounted for.

Means:- Act now Severe flooding is expected and extreme danger to life & property

What to do
- Collect things you need for evacuation

- Turn of gas, electricity and water if safe to do
- Stay in a high place with a means of escape
- Avoid electricity sources
- Avoid walking or driving through flood water
- In danger call 999 immediately
- Listen to emergency services
- Act on the flood plan

4. **All Clear:-**Nobody will be allowed back on site until the Environment Agency has issued the all clear notice for the area.

Means:- No further flooding is expected
Water levels will go down

What to do
- Keep listening to weather reports
- Only return to evacuated buildings when told to do so
- Beware of sharp objects and pollution in flood waters
- Ask for advice before cleaning up

A notice with the evacuation procedure and trigger points will be displayed in all the cabins and all personnel will be requested to make themselves aware of the contents together with the evacuation route plan.

The evacuation plan will be subject to an annual revue.

The **Floodline** telephone number is 0845 988 1188 for up to date flood information.


multimap
A16
London Road
Linley Drive
Linley Drive
Linley Drive
Saint Thomas Drive
B1397
A16
A16
A16
Marsh Lane
Marsh Lane
Wyberton Low Road
Marsh Avenue
Bayswood Avenue
Tenens Way
Marsh Lane
Marsh Lane
Lealand Way
Nursery Road
Nursery Road
Fishtoft Road
SITE

. L.D.A. Ltd.
. 2 Central Mews
. Dinnington
. Sheffield.
. S25 2QN.
. Tel/Fax No: 01909 561075
. Mob No: 07831 557306
. Email –mail@longdendesign.co.uk

RIVERSIDE INDUSTRIAL ESTATE, BOSTON, LINCOLNSHIRE.

SURFACE WATER MANAGEMENT PLAN.

Prepared for: Alternative Use Group Plc.
Units 1 – 4 Dounsells,
Mores Lane,
Brentwood,
Essex. CM14 5RZ.

Prepared by: - **M Longden** Date: - **26th February 2013** Report No: - **ML/JHG/01A**

SURFACE WATER MANAGEMENT PLAN.

Report To: Alternative Use Group Plc.
Units 1 – 4 Dounsells,
Mores Lane,
Brentwood,
Essex. CM14 5RZ.

Report Title: Surface Water Management Plan.
Riverside Industrial Estate,
Boston,
Lincolnshire.

Revision Date: 28th February 2013. - Final

Originated By: M Longden ..... Date:...28th February 2013

CONTENTS

1 GENERAL

1.1 The following report considers the further risk of internal flooding and the implications of storm water run–off associated with the continued development of land within Riverside Industrial Estate, Boston Lincoln.

1.2 Riverside Industrial Estate extends to 44.8 hectares and is a principal area for industrial development in the town and allocated accordingly in the Local Development Framework Strategy.

1.3 Approximately 25 hectares of the industrial estate are owned by Alchemy Farms Ltd and approximately 10 hectares has already been developed or has extant planning approval for industrial land-uses.

1.4 As part of the on-going development of the land owned by Alchemy Farms Ltd an application for the construction of a Gasification Power Station comprising gasification plant, turbine house, air cooled condenser, waste timber storage and preparation building, sewage sludge, drying and storage building, combined two storey offices, control room and workshop building, weighbridge and site security building, site security fence, surfaced vehicle manoeuvring and parking area and construction of access at land off Marsh Lane, Riverside Industrial Estate, Boston was granted a conditional planning permission on the 7th September 2010 – App Ref: B09/0477 (LCC Ref: B/0477/09).

1.5 Included within the Conditions regulating the planning approval were specific measures for "Site Drainage & Pollution Prevention". In this regard condition 12 states '*No development shall take place until a scheme for the provision of both on-site and off-site surface water drainage has been submitted to and approved in writing by the Waste Planning Authority, in consultation with the Internal Drainage Board and the Environment Agency. The scheme shall reflect the details and proposals as set out in Appendix A of the Flood Risk Assessment (as defined by Condition 2) and shall also include details if the measures to be taken to enhance the new and enlarged drainage ditches and the water storage systems so as to provide optimal habitat for use by water voles. The approved scheme shall thereafter be implemented and carried out in accordance with the approved details before the construction of the facility hereby permitted commences and shall thereafter be maintained for the duration that the development hereby permitted subsists*'

1.6 A Discharge of Conditions Application was submitted to the LPA by JHG Planning Consultants to address all the pre-commencement conditions; in particular to this report those concerning "Site Drainage and Pollution prevention" as described above.

1.7 Included in the supporting information for the discharge of conditions application, with particular reference to site drainage and pollution prevention, were the following documents:

(i) Dwg N°: LDA/836/LDS/01A – STORM WATER STORAGE – SHEET 1 of 2.

(ii) Dwg N°: LDA/836/LDS/02A – STORM WATER STORAGE – SHEET 2 of 2.

(iii) Addendum to Flood Risk Assessment (Ref: LDA/ADDENDUM/14_06_2012)

1.8 The above documents reflected the principles of the Flood Risk Assessment – Version 4 - December 2009 – Appendix A- which took into consideration the following criteria:

(i) *Total Site Area = 25 hectares.*

(ii) Impervious Area – 51% of total site area.

(iii) Maximum discharge rate = 35 litres/sec into IDB system.

(iv) A volume of 9,350 cubic metres of attenuation was required for a 1 in 100 year plus climate change at 30%.

(v) Water channel to be developed with a maximum water depth of 1.5 metres.

(vi) The I.D.B had modelled and agreed that both the volume and depth of water to be attenuated at Riverside Industrial Estate was acceptable and in keeping with the off-site land drainage system locally.

1.9 As a consequence of the application for the discharge of planning conditions, particularly affecting site drainage and pollution, the LPA re-consulted with both the Black Sluice Internal Drainage Board and the Environment Agency.

1.10 In January 2013 the Environment Agency informed the L.P.A that they were unable to support the discharge of the drainage conditions for the following reason:

(i) Although the addendum to the Flood Risk Assessment sets out the right principles for surface water treatment on the site, no detailed calculations or network details have been submitted in support of achieving these principles.

(ii) That the minimum level of detail necessary for the E.A to support the discharge of Condition would be a production of information in accordance with the E.A Surface Water Guidance Sheet 3: Discharge of Surface Water Condition.

1.11 In compliance with the guidance referred to above, the following sections of this report undertake to provide the production of information, data and hydraulic model results for the land drainage implication of both the Gasification Application Site and the Riverside Industrial Estate. The aim being to establish the basis of a Surface Water Management Plan for Riverside Industrial Estate.

2 SURFACE WATER MANAGEMENT PLAN.(S.W.M.P.)

2.1 The following sections of this report consider the measures necessary to establish a Surface Water Management Plan (SWMP) for Alchemy Farms Ltd, Riverside Industrial Estate, Boston, Lincolnshire.

2.2 This SWMP will establish the long-term action plan to manage the impact of surface water on the industrial estate; inform future capital investors, establish drainage maintenance programmes and inform all future stakeholders in land-use planning, emergency planning and the planning of future developments.

2.3 The SWMP guidance is structured into four key phases:

(i) Preparation.
(ii) Risk Assessment.
(iii) Options.
(iv) Implementation and Review.

3 PREPARATION OF S.W.M.P. – Stakeholders.

3.1 The Riverside Industrial Estate is a low lying area of land that is potentially susceptible to flooding from the following sources:

(i) The tidal Haven.

(ii) The Wyberton Marsh pumped catchment.

(iii) Continuing development of Riverside Industrial Estate.

3.2 The Haven is a tidal main river and the flood defences along the south bank that protect the industrial estate consist of earth embankments with a crest level of 6.5 m ODN and provide a 1 in 200 year level of protection against a tide level of 5.93 m ODN. The flood defences are maintained by the Environment Agency in this case.

3.3 The site lies within the administrative area of the Black Sluice Internal Drainage Board who has power under the Land Drainage Act to carry out measures to alleviate flooding in districts with special drainage needs other than main rivers.

3.4 The Riverside Industrial Estate is the principal industrial area within the Borough of Boston Lincs. It is an area that is proposed to extending to 44.8 Hectares within the Local Development Framework and represents an important element of the economic prosperity of the town. Lincolnshire County Council and Boston Borough Council are local government authorities responsible for the future planning, regeneration and permissible land-uses on the industrial estate.

3.5 The Riverside Industrial Estate (44.8 Ha) is owned in-part by Alchemy Farms Ltd (25 Ha) and the current application site (1.876 Ha) is for a Gasification Power Station promoted by Alternative Use Group Plc.

3.6 All the stakeholders referred to above have been directly involved with the development of the Riverside Industrial Estate and will continue to be involved with all future developments especially in respect to “Site Drainage and Pollution Prevention”.

4 RISK ASSESSMENT.

4.1 The assessment of the volume of attenuation storage is based on the 1 in 100 year storm event plus an allowance of 30% for climate change and an allowable discharge rate 35 litres/second.

4.2 The complete suite of assessments for the above criteria is given in APPENDIX 1 but summarised below are the essential results:

(i)	Assessments of overall long-term storage for 1 in 100 year storm event	= 6,996.1sq.m
(ii)	Critical storm event and duration	= 1,440 mins
(iii)	Critical storm rainfall rate	= 3.45 mm/hr
(iv)	Assessment of overall long-term storage for 1 in 100 year + additional 30% for climate change	= 9,642 sq.m
(v)	Assessment of overall long-term storage for 1 in 200 year storm event	= 10,870.9sq.m

4.3 The engineers of Black Sluice Internal Drainage Board have advised that the control structure for the improved drainage channel and attenuation pond will be the Wyberton Marsh Pumping Station.

4.4 In this regard the engineers of Black Sluice I.D.B have undertaken various hydraulic assessments and simulations to incorporate the Riverside Industrial Estate in the overall Wyberton Marsh catchment area.

4.5 The Board have determined that the volume and the associated depth of water anticipated within the Riverside Industrial Estate area is compatible with the Boards drains in the locality. The Boards drains in the vicinity of the industrial estate also attenuate storm water run-off from Wyberton Marsh catchment area during a severe storm event.

5.0 OPTIONS.

5.1 The options available for the long-term future proofing of Riverside Industrial Estate with regard to sustainable drainage systems (SUDS) to safeguard site drainage and pollution are as follows:

(i) RIVERSIDE INDUSTRIAL ESTATE – EXTERNAL AREAS

- Constructed Wetlands.
- Balancing Ponds – Detention Basin – Retention Ponds.
- Filter Strips and Swales to estate roads.
- Additional water channels to extend the I.D.B network.

(ii) INDIVIDUAL DEVELOPMENT SITE – INTERNAL AREAS

- Water Harvesting.
- Green Roofs.
- Landscaping.
- Soakaways, infiltration trenches, swales and basins.
- Permeable surfaces and filter drains.

5.2 The options for Riverside Industrial Estate have been considered in detail in Section 4: Risk Assessment but the options applicable to individual development sites need to be managed, planned and executed to accord with the specified criteria.

5.3 In this regard the detailed consideration of the application site provides the following results in respect to "Site Drainage and Pollution". The following areas are applicable to the proposed power station plant at Lealand Way, Boston for the Alternative Use Group: (Refer the FIG 5.1 below)

(i) Total impermeable areas = 9,326.68m^2.

(ii) Total permeable area = 9,468.52m^2. (including landscape)

(iii) Total site area = 18,795.20m^2.

5.4 From the above figures the following percentage changes are:

(i) % Impermeable areas (including roofs and paving) = 49.63%

(ii) % Permeable areas (incl landscaping) = 50.37%

100.00%

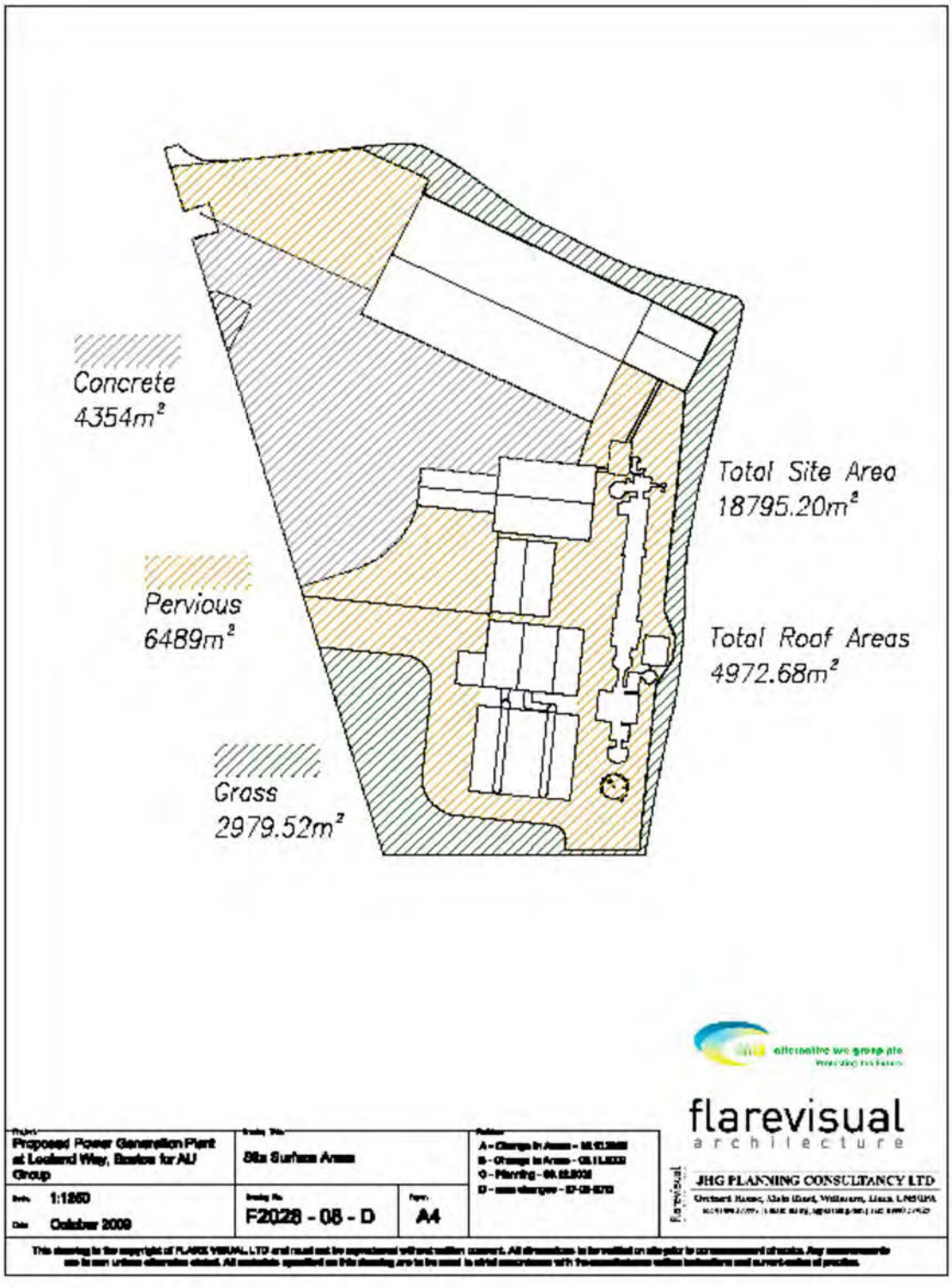


Fig 5.1 – Proposed Application Site Surfacing Details.

5.5 From the above figures it can be seen that the impermeable conversion rate of 49.63 % for the Gasification Site is in accordance with the original FRA reference Version 4: December 2009 which states – "Appendix A, Drainage Calculations, Impervious areas – A broad assumption has been agreed that the impervious factor for calculations is taken to be 51%.

5.6 The development of the Gasification Site incorporates perimeter landscaping and pervious paved areas to reduce the operational impermeable area necessary for the complex to function. Unfortunately the prevailing ground conditions will prohibit infiltration into the underlying sub-strata to any significant effect. (Refer to Fig 5.2 below.)

Plate 1 – General view across the site, looking southeast

Plate 3 – Trench 1 section, looking southwest

Plate 2 – Trench 1 after cleaning, looking northwest

Plate 4 – Trench 2 after cleaning, looking north

Plate 5 – Trench 2 section, looking east

Fig 5.2 – Prevailing Ground Conditions.

5.7 The pervious areas of the application site will therefore incorporate land drainage to relieve any accumulated storm water within the sub-base layers by discharging to nearby open ditches.

5.8 The future flood proofing of Riverside Industrial Estate will necessitate the continued monitoring, review and implementation of the SWMP as the impermeable conversion rates for future developments are considered.

5.9 In this regard the current assessment of storm water attenuation requirements for Riverside Industrial Estate, with regard to any variation of the impermeable conversion rates have been considered as follows:-

(i) Impermeable Conversion Rate of **65%** = 12,921 m^3 of storage.

(ii) Impermeable Conversion Rate of **75%** = 15,403 m^3 of storage.

(iii) Impermeable Conversion Rate of **85%** = 17,996 m^3 of storage.

(Complete Micro Drainage data results are attached – Appendix 2).

6.0 IMPLEMENTATION AND REVIEW

6.1 This section considers the measures necessary for implementing and more importantly delivering the SWMP detailed in the preceding sections.

6.2 The options that have been specified for the Riverside Industrial Estate in general and the individual development sites in particular have to be continually monitored and assessed to ensure that the outcomes and benefits of the SWMP are being complied with and where practicable exceeded wherever possible.

6.3 The implementation and review of the surface water management plan therefore needs to follow the following strategy:

- Retain compliance with the principles and objectives set out in the SWMP study.
- Establish capital and revenue budgets and actions for the construction and maintenance of each element of the SWMP critical actions.
- Maintain contemporary advice and information for all approving authorities and other stake holders in future re-development applications.
- Provide advice, guidance and supplementary data to all approving authorities and other stakeholders on review results and remedial measures necessary to maintain the principle objectives of the SWMP.

6.4 It is recommended that the partnership established between the various stakeholders involved with the re-development of Riverside Industrial Estate continue to work together to agree implementation of the proposed actions which are identified in the preparation of future action plans. In this regard there may be circumstances which might trigger a review and/or an update of the action plan such as:

- Occurrence of a flooding incident.
- Additional data or modelling becoming available which may alter the understanding of risk within the catchment/rivers/industrial estate.
- Outcome of investment decisions by stakeholders/partners affecting the land drainage or flood defences in the catchment/rivers/industrial area.
- Additional development or other changes in the catchment and/or industrial estate which effects surface water flood risk.

6.5 It is recommended that the impermeable conversion rate for all future developments are monitored and assessed against the base rate of 51% or 12.75 hectares of the Riverside Industrial Estate.

6.6 At the point of exceedance of the impermeable base rate the additional sections of open ditch and the required extension to the attenuation basin will be constructed in accordance with the requirements of the approving authorities so that the discharge rate of 35 litres per second is retained into the Black Sluice Internal Drainage Board maintained system of land drainage ditches.

APPENDIX 1.

Baseline Assessments of On-Site Storage.
1 in 100 years and 1 in 100 years + 30% CC.

SCP		Page 1
Lawrence Buildings 2 Mount Street Manchester M2 5WQ		Micro Drainage
Date 25/02/2013 10:58 File 1 in 100year st...	Designed by Gary Ben... Checked by	
Micro Drainage	Source Control 2013.1	

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.333	0.333	26.9	0.0	26.9	2333.0	O K
30 min Summer	0.437	0.437	26.9	0.0	26.9	3057.4	O K
60 min Summer	0.543	0.543	26.9	0.0	26.9	3803.9	O K
120 min Summer	0.649	0.649	28.1	0.0	28.1	4544.2	O K
180 min Summer	0.707	0.707	29.3	0.0	29.3	4950.1	O K
240 min Summer	0.745	0.745	30.1	0.0	30.1	5211.9	O K
360 min Summer	0.794	0.794	31.1	0.0	31.1	5557.0	O K
480 min Summer	0.826	0.826	31.7	0.0	31.7	5780.0	O K
600 min Summer	0.847	0.847	32.1	0.0	32.1	5928.1	O K
720 min Summer	0.861	0.861	32.4	0.0	32.4	6027.0	O K
960 min Summer	0.876	0.876	32.6	0.0	32.6	6129.8	O K
1440 min Summer	0.876	0.876	32.6	0.0	32.6	6129.7	O K
2160 min Summer	0.863	0.863	32.4	0.0	32.4	6041.8	O K
2880 min Summer	0.846	0.846	32.1	0.0	32.1	5921.6	O K
4320 min Summer	0.803	0.803	31.3	0.0	31.3	5624.4	O K
5760 min Summer	0.757	0.757	30.4	0.0	30.4	5300.9	O K
7200 min Summer	0.712	0.712	29.4	0.0	29.4	4980.9	O K
8640 min Summer	0.668	0.668	28.5	0.0	28.5	4673.3	O K
10080 min Summer	0.626	0.626	27.7	0.0	27.7	4383.7	O K
15 min Winter	0.374	0.374	26.9	0.0	26.9	2615.1	O K
30 min Winter	0.490	0.490	26.9	0.0	26.9	3428.5	O K
60 min Winter	0.609	0.609	27.3	0.0	27.3	4265.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	98.681	0.0	1569.9	0.0	31
30 min Summer	64.789	0.0	1988.8	0.0	45
60 min Summer	40.510	0.0	3263.2	0.0	74
120 min Summer	24.461	0.0	3849.8	0.0	134
180 min Summer	17.964	0.0	4132.9	0.0	192
240 min Summer	14.342	0.0	4287.8	0.0	252
360 min Summer	10.418	0.0	4432.0	0.0	370
480 min Summer	8.302	0.0	4471.4	0.0	488
600 min Summer	6.956	0.0	4467.0	0.0	608
720 min Summer	6.017	0.0	4446.0	0.0	726
960 min Summer	4.784	0.0	4404.0	0.0	964
1440 min Summer	3.456	0.0	4301.3	0.0	1346
2160 min Summer	2.493	0.0	7817.3	0.0	1684
2880 min Summer	1.975	0.0	7974.1	0.0	2060
4320 min Summer	1.421	0.0	7492.3	0.0	2896
5760 min Summer	1.124	0.0	10088.8	0.0	3696
7200 min Summer	0.936	0.0	10467.7	0.0	4544
8640 min Summer	0.806	0.0	10756.6	0.0	5360
10080 min Summer	0.710	0.0	10937.9	0.0	6152
15 min Winter	98.681	0.0	1754.7	0.0	30
30 min Winter	64.789	0.0	2116.7	0.0	45
60 min Winter	40.510	0.0	3620.7	0.0	74

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File 1 in 100year st...	Checked by	
Micro Drainage	Source Control 2013.1	

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	0.728	0.728	29.8	0.0	29.8	5097.8	O K
180 min Winter	0.794	0.794	31.1	0.0	31.1	5556.9	O K
240 min Winter	0.836	0.836	31.9	0.0	31.9	5854.2	O K
360 min Winter	0.893	0.893	33.0	0.0	33.0	6250.5	O K
480 min Winter	0.930	0.930	33.6	0.0	33.6	6510.6	Flood Risk
600 min Winter	0.955	0.955	34.1	0.0	34.1	6687.0	Flood Risk
720 min Winter	0.973	0.973	34.4	0.0	34.4	6808.7	Flood Risk
960 min Winter	0.993	0.993	34.8	0.0	34.8	6947.9	Flood Risk
1440 min Winter	0.999	0.999	34.9	0.0	34.9	6996.1	Flood Risk
2160 min Winter	0.977	0.977	34.5	0.0	34.5	6837.6	Flood Risk
2880 min Winter	0.953	0.953	34.1	0.0	34.1	6674.4	Flood Risk
4320 min Winter	0.892	0.892	32.9	0.0	32.9	6244.5	O K
5760 min Winter	0.825	0.825	31.7	0.0	31.7	5773.0	O K
7200 min Winter	0.759	0.759	30.4	0.0	30.4	5310.0	O K
8640 min Winter	0.696	0.696	29.1	0.0	29.1	4868.9	O K
10080 min Winter	0.636	0.636	27.9	0.0	27.9	4452.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
120 min Winter	24.461	0.0	4202.3	0.0	132
180 min Winter	17.964	0.0	4444.1	0.0	190
240 min Winter	14.342	0.0	4553.2	0.0	248
360 min Winter	10.418	0.0	4634.2	0.0	364
480 min Winter	8.302	0.0	4655.9	0.0	480
600 min Winter	6.956	0.0	4670.7	0.0	596
720 min Winter	6.017	0.0	4684.9	0.0	712
960 min Winter	4.784	0.0	4694.2	0.0	938
1440 min Winter	3.456	0.0	4616.3	0.0	1378
2160 min Winter	2.493	0.0	8596.0	0.0	1760
2880 min Winter	1.975	0.0	8615.9	0.0	2200
4320 min Winter	1.421	0.0	8004.2	0.0	3120
5760 min Winter	1.124	0.0	11305.2	0.0	4032
7200 min Winter	0.936	0.0	11724.0	0.0	4904
8640 min Winter	0.806	0.0	12032.3	0.0	5720
10080 min Winter	0.710	0.0	12221.2	0.0	6560

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Lawrence Buildings 2 Mount Street Manchester M2 5WQ		Micro Drainage
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Micro Drainage	Source Control 2013.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 12.750

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	3.180	4	8	3.190	8	12	3.180	12	16	3.200

On-Site Storage Data For 1 in 100 yrs Storm Return Period.

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Lawrence Buildings 2 Mount Street Manchester M2 5WQ		
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Micro Drainage	Source Control 2013.1	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.472	0.472	20.9	0.0	20.9	3043.8	O K
30 min Summer	0.619	0.619	22.4	0.0	22.4	3990.0	O K
60 min Summer	0.770	0.770	25.0	0.0	25.0	4968.2	O K
120 min Summer	0.922	0.922	27.4	0.0	27.4	5948.4	O K
180 min Summer	1.007	1.007	28.6	0.0	28.6	6496.1	O K
240 min Summer	1.063	1.063	29.4	0.0	29.4	6856.3	O K
360 min Summer	1.139	1.139	30.4	0.0	30.4	7347.6	O K
480 min Summer	1.191	1.191	31.1	0.0	31.1	7681.2	O K
600 min Summer	1.228	1.228	31.6	0.0	31.6	7917.7	Flood Risk
720 min Summer	1.254	1.254	31.9	0.0	31.9	8090.6	Flood Risk
960 min Summer	1.289	1.289	32.4	0.0	32.4	8312.6	Flood Risk
1440 min Summer	1.314	1.314	32.7	0.0	32.7	8474.0	Flood Risk
2160 min Summer	1.303	1.303	32.5	0.0	32.5	8406.5	Flood Risk
2880 min Summer	1.286	1.286	32.3	0.0	32.3	8295.9	Flood Risk
4320 min Summer	1.243	1.243	31.8	0.0	31.8	8019.1	Flood Risk
5760 min Summer	1.194	1.194	31.1	0.0	31.1	7702.0	O K
7200 min Summer	1.143	1.143	30.5	0.0	30.5	7374.0	O K
8640 min Summer	1.094	1.094	29.8	0.0	29.8	7053.3	O K
10080 min Summer	1.046	1.046	29.1	0.0	29.1	6744.7	O K
15 min Winter	0.529	0.529	20.9	0.0	20.9	3410.8	O K
30 min Winter	0.693	0.693	23.7	0.0	23.7	4471.8	O K
60 min Winter	0.863	0.863	26.5	0.0	26.5	5569.2	O K
120 min Winter	1.034	1.034	29.0	0.0	29.0	6671.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	128.285	0.0	1702.3	0.0	31
30 min Summer	84.226	0.0	1747.1	0.0	46
60 min Summer	52.662	0.0	3629.3	0.0	76
120 min Summer	31.800	0.0	3850.3	0.0	134
180 min Summer	23.353	0.0	4010.9	0.0	194
240 min Summer	18.644	0.0	4129.0	0.0	254
360 min Summer	13.543	0.0	4286.9	0.0	372
480 min Summer	10.792	0.0	4384.5	0.0	490
600 min Summer	9.043	0.0	4443.8	0.0	610
720 min Summer	7.823	0.0	4477.9	0.0	728
960 min Summer	6.219	0.0	4495.9	0.0	966
1440 min Summer	4.493	0.0	4412.0	0.0	1442
2160 min Summer	3.241	0.0	8335.0	0.0	1924
2880 min Summer	2.568	0.0	8279.3	0.0	2280
4320 min Summer	1.847	0.0	7844.7	0.0	3036
5760 min Summer	1.461	0.0	13015.6	0.0	3872
7200 min Summer	1.217	0.0	13369.0	0.0	4688
8640 min Summer	1.048	0.0	13370.8	0.0	5536
10080 min Summer	0.923	0.0	12825.1	0.0	6352
15 min Winter	128.285	0.0	1726.2	0.0	31
30 min Winter	84.226	0.0	1820.0	0.0	45
60 min Winter	52.662	0.0	3775.1	0.0	74
120 min Winter	31.800	0.0	4076.1	0.0	132

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Micro Drainage	Source Control 2013.1	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	1.130	1.130	30.3	0.0	30.3	7290.1	O K
240 min Winter	1.194	1.194	31.1	0.0	31.1	7699.2	O K
360 min Winter	1.281	1.281	32.3	0.0	32.3	8261.0	Flood Risk
480 min Winter	1.341	1.341	33.0	0.0	33.0	8646.7	Flood Risk
600 min Winter	1.384	1.384	33.5	0.0	33.5	8923.7	Flood Risk
720 min Winter	1.415	1.415	33.9	0.0	33.9	9129.7	Flood Risk
960 min Winter	1.458	1.458	34.4	0.0	34.4	9404.1	Flood Risk
1440 min Winter	1.495	1.495	34.8	0.0	34.8	9641.9	Flood Risk
2160 min Winter	1.493	1.493	34.8	0.0	34.8	9629.3	Flood Risk
2880 min Winter	1.463	1.463	34.5	0.0	34.5	9436.5	Flood Risk
4320 min Winter	1.408	1.408	33.8	0.0	33.8	9081.0	Flood Risk
5760 min Winter	1.339	1.339	33.0	0.0	33.0	8639.6	Flood Risk
7200 min Winter	1.267	1.267	32.1	0.0	32.1	8175.2	Flood Risk
8640 min Winter	1.197	1.197	31.2	0.0	31.2	7717.7	O K
10080 min Winter	1.128	1.128	30.3	0.0	30.3	7277.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
180 min Winter	23.353	0.0	4283.8	0.0	190
240 min Winter	18.644	0.0	4417.6	0.0	248
360 min Winter	13.543	0.0	4587.7	0.0	366
480 min Winter	10.792	0.0	4690.4	0.0	482
600 min Winter	9.043	0.0	4752.1	0.0	598
720 min Winter	7.823	0.0	4786.9	0.0	716
960 min Winter	6.219	0.0	4803.6	0.0	946
1440 min Winter	4.493	0.0	4710.5	0.0	1400
2160 min Winter	3.241	0.0	8977.0	0.0	2052
2880 min Winter	2.568	0.0	8912.5	0.0	2392
4320 min Winter	1.847	0.0	8431.8	0.0	3252
5760 min Winter	1.461	0.0	14501.9	0.0	4168
7200 min Winter	1.217	0.0	14764.1	0.0	5056
8640 min Winter	1.048	0.0	14477.6	0.0	5968
10080 min Winter	0.923	0.0	13887.7	0.0	6856

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Micro Drainage	Source Control 2013.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 12.750

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	3.180	4	8	3.190	8	12	3.180	12	16	3.200

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Micro Drainage	Source Control 2013.1	

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	6450.0	1.400	6450.0	2.800	0.0	4.200	0.0
0.200	6450.0	1.600	6450.0	3.000	0.0	4.400	0.0
0.400	6450.0	1.800	0.0	3.200	0.0	4.600	0.0
0.600	6450.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	6450.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	6450.0	2.400	0.0	3.800	0.0		
1.200	6450.0	2.600	0.0	4.000	0.0		

Hydro-Brake® Outflow Control

Design Head (m) 1.500 Hydro-Brake® Type Md1 Invert Level (m) 0.000
Design Flow (l/s) 35.0 Diameter (mm) 160

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.3	1.200	31.2	3.000	49.4	7.000	75.4
0.200	16.8	1.400	33.7	3.500	53.3	7.500	78.0
0.300	20.9	1.600	36.0	4.000	57.0	8.000	80.6
0.400	19.5	1.800	38.2	4.500	60.5	8.500	83.1
0.500	20.3	2.000	40.3	5.000	63.7	9.000	85.5
0.600	22.1	2.200	42.3	5.500	66.8	9.500	87.8
0.800	25.5	2.400	44.2	6.000	69.8		
1.000	28.5	2.600	46.0	6.500	72.7		

Complex Overflow Control

Depth/Flow Relationship

Invert Level (m) 0.000

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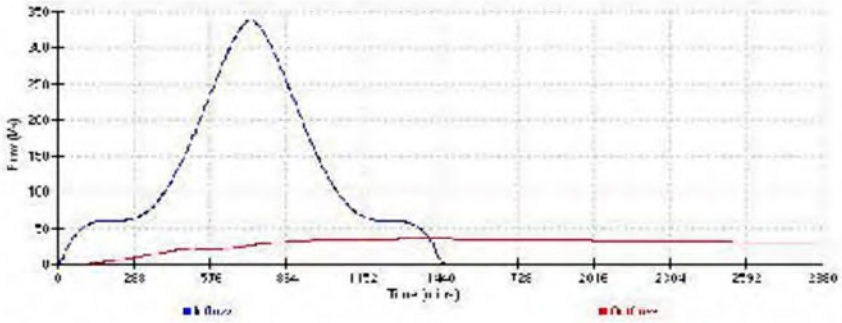
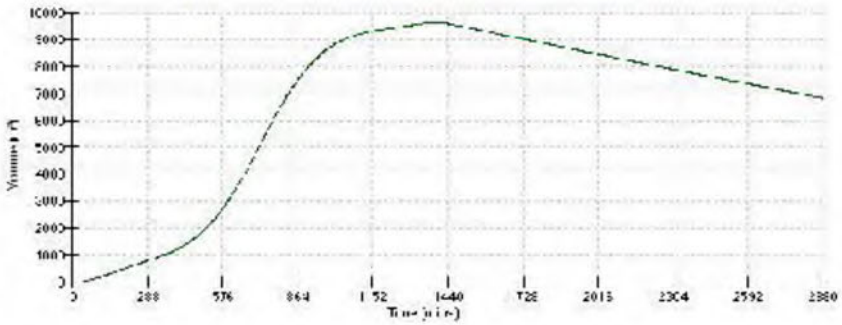
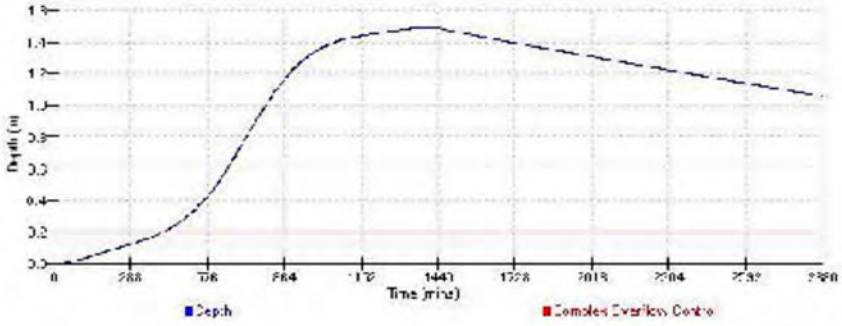
Micro Drainage	Source Control 2013.1	

Event: 1440 min Winter







On-Site Storage Data For 1 in 100 yrs + 30% CC.

APPENDIX 2.

Future Assessments of On-Site Storage.
For 1 in 100 year + 30% CC with
Impermeable Site Areas of 65%, 75% and 85%.

SCP		Page 1
Lawrence Buildings 2 Mount Street Manchester M2 5WQ		Micro Drainage
Date 28/02/2013 16:26 File 1 in 100year + 3...	Designed by ian withe... Checked by	
Micro Drainage	Source Control 2013.1	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.450	0.450	31.8	0.0	31.8	3877.3	O K
30 min Summer	0.590	0.590	31.8	0.0	31.8	5085.8	O K
60 min Summer	0.736	0.736	31.8	0.0	31.8	6342.0	O K
120 min Summer	0.883	0.883	31.8	0.0	31.8	7610.4	O K
180 min Summer	0.966	0.966	31.7	0.0	31.7	8328.1	O K
240 min Summer	1.022	1.022	31.8	0.0	31.8	8806.6	O K
360 min Summer	1.099	1.099	31.8	0.0	31.8	9471.1	O K
480 min Summer	1.153	1.153	31.8	0.0	31.8	9935.7	O K
600 min Summer	1.192	1.192	31.8	0.0	31.8	10276.1	O K
720 min Summer	1.222	1.222	31.8	0.0	31.8	10535.8	Flood Risk
960 min Summer	1.264	1.264	32.0	0.0	32.0	10896.5	Flood Risk
1440 min Summer	1.306	1.306	32.5	0.0	32.5	11254.0	Flood Risk
2160 min Summer	1.315	1.315	32.6	0.0	32.6	11339.4	Flood Risk
2880 min Summer	1.299	1.299	32.4	0.0	32.4	11200.5	Flood Risk
4320 min Summer	1.262	1.262	32.0	0.0	32.0	10880.5	Flood Risk
5760 min Summer	1.220	1.220	31.8	0.0	31.8	10520.7	Flood Risk
7200 min Summer	1.176	1.176	31.8	0.0	31.8	10138.3	O K
8640 min Summer	1.131	1.131	31.8	0.0	31.8	9745.4	O K
10080 min Summer	1.085	1.085	31.8	0.0	31.8	9357.0	O K
15 min Winter	0.504	0.504	31.8	0.0	31.8	4345.5	O K
30 min Winter	0.662	0.662	31.8	0.0	31.8	5702.2	O K
60 min Winter	0.825	0.825	31.8	0.0	31.8	7110.3	O K
120 min Winter	0.990	0.990	31.7	0.0	31.7	8532.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	128.285	0.0	2240.8	0.0	31
30 min Summer	84.226	0.0	2560.0	0.0	46
60 min Summer	52.662	0.0	4671.3	0.0	76
120 min Summer	31.800	0.0	4770.9	0.0	134
180 min Summer	23.353	0.0	4629.7	0.0	194
240 min Summer	18.644	0.0	4567.5	0.0	254
360 min Summer	13.543	0.0	4552.4	0.0	372
480 min Summer	10.792	0.0	4573.9	0.0	492
600 min Summer	9.043	0.0	4594.4	0.0	610
720 min Summer	7.823	0.0	4606.3	0.0	730
960 min Summer	6.219	0.0	4602.7	0.0	968
1440 min Summer	4.493	0.0	4509.9	0.0	1446
2160 min Summer	3.241	0.0	9015.8	0.0	2160
2880 min Summer	2.568	0.0	8821.6	0.0	2576
4320 min Summer	1.847	0.0	8300.5	0.0	3296
5760 min Summer	1.461	0.0	16018.3	0.0	4088
7200 min Summer	1.217	0.0	16195.6	0.0	4904
8640 min Summer	1.048	0.0	15689.7	0.0	5712
10080 min Summer	0.923	0.0	14654.5	0.0	6560
15 min Winter	128.285	0.0	2442.4	0.0	31
30 min Winter	84.226	0.0	2484.9	0.0	45
60 min Winter	52.662	0.0	4836.3	0.0	74
120 min Winter	31.800	0.0	4662.3	0.0	132

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Lawrence Buildings 2 Mount Street Manchester M2 5WQ		
Date 28/02/2013 16:26 File 1 in 100year + 3...	Designed by ian withe... Checked by	
Micro Drainage	Source Control 2013.1	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	1.084	1.084	31.8	0.0	31.8	9340.1	O K
240 min Winter	1.146	1.146	31.8	0.0	31.8	9880.3	O K
360 min Winter	1.234	1.234	31.8	0.0	31.8	10634.0	Flood Risk
480 min Winter	1.295	1.295	32.4	0.0	32.4	11164.5	Flood Risk
600 min Winter	1.341	1.341	32.9	0.0	32.9	11556.7	Flood Risk
720 min Winter	1.376	1.376	33.4	0.0	33.4	11858.5	Flood Risk
960 min Winter	1.425	1.425	33.9	0.0	33.9	12285.8	Flood Risk
1440 min Winter	1.478	1.478	34.6	0.0	34.6	12737.4	Flood Risk
2160 min Winter	1.499	1.499	34.8	0.0	34.8	12920.7	Flood Risk
2880 min Winter	1.487	1.487	34.7	0.0	34.7	12822.0	Flood Risk
4320 min Winter	1.433	1.433	34.0	0.0	34.0	12354.8	Flood Risk
5760 min Winter	1.379	1.379	33.4	0.0	33.4	11887.8	Flood Risk
7200 min Winter	1.318	1.318	32.6	0.0	32.6	11360.6	Flood Risk
8640 min Winter	1.254	1.254	31.9	0.0	31.9	10809.0	Flood Risk
10080 min Winter	1.189	1.189	31.8	0.0	31.8	10252.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
180 min Winter	23.353	0.0	4629.3	0.0	192
240 min Winter	18.644	0.0	4662.7	0.0	250
360 min Winter	13.543	0.0	4749.0	0.0	366
480 min Winter	10.792	0.0	4818.2	0.0	484
600 min Winter	9.043	0.0	4863.9	0.0	602
720 min Winter	7.823	0.0	4890.6	0.0	718
960 min Winter	6.219	0.0	4901.4	0.0	952
1440 min Winter	4.493	0.0	4813.6	0.0	1412
2160 min Winter	3.241	0.0	9540.7	0.0	2084
2880 min Winter	2.568	0.0	9413.5	0.0	2740
4320 min Winter	1.847	0.0	8906.9	0.0	3460
5760 min Winter	1.461	0.0	17619.8	0.0	4376
7200 min Winter	1.217	0.0	17346.6	0.0	5272
8640 min Winter	1.048	0.0	16443.0	0.0	6224
10080 min Winter	0.923	0.0	15622.4	0.0	7072

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Lawrence Buildings 2 Mount Street Manchester M2 5WQ		Micro Drainage
Date 28/02/2013 16:34 File 1 in 100year + 3...	Designed by ian withe... Checked by	
Micro Drainage	Source Control 2013.1	

Rainfall Details

Rainfall Model	PSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 16.250

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	4.062	4	8	4.062	8	12	4.062	12	16	4.064

On-Site Storage Data For 1 in 100 yrs + 30% CC at 65% Imp Area.

SCP		Page 1
Lawrence Buildings 2 Mount Street Manchester M2 5WQ		Micro Drainage
Date 28/02/2013 16:28 File 1 in 100year + 3...	Designed by ian withe... Checked by	
Micro Drainage	Source Control 2013.1	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.436	0.436	31.8	0.0	31.8	4478.9	O K
30 min Summer	0.572	0.572	31.8	0.0	31.8	5875.3	O K
60 min Summer	0.713	0.713	31.8	0.0	31.8	7329.7	O K
120 min Summer	0.856	0.856	31.8	0.0	31.8	8803.8	O K
180 min Summer	0.938	0.938	31.8	0.0	31.8	9643.9	O K
240 min Summer	0.993	0.993	31.8	0.0	31.8	10208.5	O K
360 min Summer	1.070	1.070	31.8	0.0	31.8	11000.4	O K
480 min Summer	1.125	1.125	31.8	0.0	31.8	11562.2	O K
600 min Summer	1.166	1.166	31.8	0.0	31.8	11981.4	O K
720 min Summer	1.197	1.197	31.8	0.0	31.8	12307.1	O K
960 min Summer	1.243	1.243	31.8	0.0	31.8	12776.2	Flood Risk
1440 min Summer	1.293	1.293	32.3	0.0	32.3	13293.6	Flood Risk
2160 min Summer	1.318	1.318	32.6	0.0	32.6	13544.0	Flood Risk
2880 min Summer	1.311	1.311	32.6	0.0	32.6	13481.6	Flood Risk
4320 min Summer	1.281	1.281	32.2	0.0	32.2	13166.8	Flood Risk
5760 min Summer	1.247	1.247	31.8	0.0	31.8	12817.6	Flood Risk
7200 min Summer	1.211	1.211	31.8	0.0	31.8	12445.2	Flood Risk
8640 min Summer	1.173	1.173	31.8	0.0	31.8	12056.2	O K
10080 min Summer	1.134	1.134	31.8	0.0	31.8	11659.0	O K
15 min Winter	0.488	0.488	31.8	0.0	31.8	5019.1	O K
30 min Winter	0.641	0.641	31.8	0.0	31.8	6586.5	O K
60 min Winter	0.799	0.799	31.8	0.0	31.8	8216.4	O K
120 min Winter	0.960	0.960	31.8	0.0	31.8	9869.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	128.285	0.0	2326.7	0.0	31
30 min Summer	84.226	0.0	2588.3	0.0	46
60 min Summer	52.662	0.0	4865.8	0.0	76
120 min Summer	31.800	0.0	4705.5	0.0	134
180 min Summer	23.353	0.0	4561.3	0.0	194
240 min Summer	18.644	0.0	4525.4	0.0	254
360 min Summer	13.543	0.0	4538.6	0.0	374
480 min Summer	10.792	0.0	4570.7	0.0	492
600 min Summer	9.043	0.0	4594.9	0.0	612
720 min Summer	7.823	0.0	4607.7	0.0	730
960 min Summer	6.219	0.0	4602.7	0.0	970
1440 min Summer	4.493	0.0	4504.6	0.0	1446
2160 min Summer	3.241	0.0	9080.9	0.0	2164
2880 min Summer	2.568	0.0	8921.8	0.0	2860
4320 min Summer	1.847	0.0	8396.7	0.0	3504
5760 min Summer	1.461	0.0	17352.8	0.0	4264
7200 min Summer	1.217	0.0	16684.9	0.0	5048
8640 min Summer	1.048	0.0	15748.2	0.0	5880
10080 min Summer	0.923	0.0	14941.6	0.0	6672
15 min Winter	128.285	0.0	2516.5	0.0	31
30 min Winter	84.226	0.0	2484.7	0.0	45
60 min Winter	52.662	0.0	4858.3	0.0	74
120 min Winter	31.800	0.0	4597.6	0.0	134

SCP		Page 2
Lawrence Buildings 2 Mount Street Manchester M2 5WQ		Micro Drainage
Date 28/02/2013 16:28 File 1 in 100year + 3...	Designed by ian withe... Checked by	
Micro Drainage	Source Control 2013.1	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	1.052	1.052	31.8	0.0	31.8	10813.9	O K
240 min Winter	1.114	1.114	31.8	0.0	31.8	11449.9	O K
360 min Winter	1.201	1.201	31.8	0.0	31.8	12345.9	Flood Risk
480 min Winter	1.263	1.263	32.0	0.0	32.0	12984.6	Flood Risk
600 min Winter	1.310	1.310	32.5	0.0	32.5	13464.6	Flood Risk
720 min Winter	1.346	1.346	33.0	0.0	33.0	13840.0	Flood Risk
960 min Winter	1.400	1.400	33.6	0.0	33.6	14387.9	Flood Risk
1440 min Winter	1.461	1.461	34.4	0.0	34.4	15016.0	Flood Risk
2160 min Winter	1.496	1.496	34.8	0.0	34.8	15379.4	Flood Risk
2880 min Winter	1.498	1.498	34.8	0.0	34.8	15403.0	Flood Risk
4320 min Winter	1.459	1.459	34.3	0.0	34.3	14996.7	Flood Risk
5760 min Winter	1.414	1.414	33.8	0.0	33.8	14537.1	Flood Risk
7200 min Winter	1.366	1.366	33.2	0.0	33.2	14042.2	Flood Risk
8640 min Winter	1.314	1.314	32.6	0.0	32.6	13504.7	Flood Risk
10080 min Winter	1.260	1.260	31.9	0.0	31.9	12949.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
180 min Winter	23.353	0.0	4603.6	0.0	192
240 min Winter	18.644	0.0	4653.8	0.0	250
360 min Winter	13.543	0.0	4751.5	0.0	368
480 min Winter	10.792	0.0	4822.9	0.0	484
600 min Winter	9.043	0.0	4868.1	0.0	602
720 min Winter	7.823	0.0	4893.2	0.0	720
960 min Winter	6.219	0.0	4900.4	0.0	954
1440 min Winter	4.493	0.0	4806.0	0.0	1418
2160 min Winter	3.241	0.0	9662.4	0.0	2100
2880 min Winter	2.568	0.0	9531.9	0.0	2768
4320 min Winter	1.847	0.0	8999.4	0.0	3980
5760 min Winter	1.461	0.0	18204.5	0.0	4496
7200 min Winter	1.217	0.0	17421.9	0.0	5408
8640 min Winter	1.048	0.0	16763.5	0.0	6320
10080 min Winter	0.923	0.0	16090.2	0.0	7264

SCP		Page 1
Lawrence Buildings 2 Mount Street Manchester M2 5WQ		Micro Drainage
Date 28/02/2013 16:35 File 1 in 100year + 3...	Designed by ian withe... Checked by	
Micro Drainage	Source Control 2013.1	

Rainfall Details

Rainfall Model	PSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 18.750

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	4.687	4	8	4.687	8	12	4.687	12	16	4.689

On-Site Storage Data For 1 in 100 yrs + 30% CC at 75% Imp Area.

SCP		Page 1
Lawrence Buildings 2 Mount Street Manchester M2 5WQ		Micro Drainage
Date 28/02/2013 16:31	Designed by ian withe...	
File 1 in 100year + 3...	Checked by	
Micro Drainage	Source Control 2013.1	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.423	0.423	31.8	0.0	31.8	5080.7	O K
30 min Summer	0.555	0.555	31.8	0.0	31.8	6664.9	O K
60 min Summer	0.693	0.693	31.8	0.0	31.8	8317.3	O K
120 min Summer	0.833	0.833	31.7	0.0	31.7	9997.2	O K
180 min Summer	0.913	0.913	31.8	0.0	31.8	10959.4	O K
240 min Summer	0.967	0.967	31.8	0.0	31.8	11609.8	O K
360 min Summer	1.044	1.044	31.8	0.0	31.8	12529.2	O K
480 min Summer	1.099	1.099	31.8	0.0	31.8	13187.9	O K
600 min Summer	1.140	1.140	31.8	0.0	31.8	13685.8	O K
720 min Summer	1.173	1.173	31.8	0.0	31.8	14077.8	O K
960 min Summer	1.221	1.221	31.8	0.0	31.8	14655.4	Flood Risk
1440 min Summer	1.278	1.278	32.2	0.0	32.2	15333.4	Flood Risk
2160 min Summer	1.313	1.313	32.6	0.0	32.6	15751.7	Flood Risk
2880 min Summer	1.317	1.317	32.6	0.0	32.6	15808.7	Flood Risk
4320 min Summer	1.293	1.293	32.3	0.0	32.3	15518.4	Flood Risk
5760 min Summer	1.265	1.265	32.0	0.0	32.0	15180.6	Flood Risk
7200 min Summer	1.235	1.235	31.8	0.0	31.8	14816.1	Flood Risk
8640 min Summer	1.203	1.203	31.8	0.0	31.8	14434.1	Flood Risk
10080 min Summer	1.170	1.170	31.8	0.0	31.8	14041.2	O K
15 min Winter	0.474	0.474	31.8	0.0	31.8	5692.8	O K
30 min Winter	0.623	0.623	31.8	0.0	31.8	7470.8	O K
60 min Winter	0.777	0.777	31.8	0.0	31.8	9322.4	O K
120 min Winter	0.934	0.934	31.8	0.0	31.8	11206.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	128.285	0.0	2383.4	0.0	31
30 min Summer	84.226	0.0	2606.2	0.0	46
60 min Summer	52.662	0.0	4960.6	0.0	76
120 min Summer	31.800	0.0	4648.4	0.0	136
180 min Summer	23.353	0.0	4522.2	0.0	194
240 min Summer	18.644	0.0	4501.4	0.0	254
360 min Summer	13.543	0.0	4527.1	0.0	374
480 min Summer	10.792	0.0	4562.7	0.0	492
600 min Summer	9.043	0.0	4587.4	0.0	612
720 min Summer	7.823	0.0	4599.6	0.0	732
960 min Summer	6.219	0.0	4592.4	0.0	970
1440 min Summer	4.493	0.0	4489.7	0.0	1448
2160 min Summer	3.241	0.0	9140.5	0.0	2164
2880 min Summer	2.568	0.0	8986.0	0.0	2880
4320 min Summer	1.847	0.0	8448.6	0.0	3724
5760 min Summer	1.461	0.0	17486.8	0.0	4448
7200 min Summer	1.217	0.0	16669.1	0.0	5200
8640 min Summer	1.048	0.0	15971.6	0.0	6048
10080 min Summer	0.923	0.0	15265.6	0.0	6864
15 min Winter	128.285	0.0	2563.5	0.0	31
30 min Winter	84.226	0.0	2488.6	0.0	45
60 min Winter	52.662	0.0	4829.5	0.0	74
120 min Winter	31.800	0.0	4561.2	0.0	134

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Lawrence Buildings 2 Mount Street Manchester M2 5WQ		
Date 28/02/2013 16:31 File 1 in 100year + 3...	Designed by ian withe... Checked by	
Micro Drainage	Source Control 2013.1	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	1.024	1.024	31.8	0.0	31.8	12287.3	O K
240 min Winter	1.085	1.085	31.8	0.0	31.8	13018.9	O K
360 min Winter	1.171	1.171	31.8	0.0	31.8	14057.1	O K
480 min Winter	1.234	1.234	31.8	0.0	31.8	14804.3	Flood Risk
600 min Winter	1.281	1.281	32.2	0.0	32.2	15371.6	Flood Risk
720 min Winter	1.318	1.318	32.7	0.0	32.7	15820.9	Flood Risk
960 min Winter	1.374	1.374	33.3	0.0	33.3	16489.3	Flood Risk
1440 min Winter	1.441	1.441	34.1	0.0	34.1	17295.5	Flood Risk
2160 min Winter	1.487	1.487	34.7	0.0	34.7	17842.9	Flood Risk
2880 min Winter	1.500	1.500	34.8	0.0	34.8	17995.8	Flood Risk
4320 min Winter	1.479	1.479	34.6	0.0	34.6	17749.1	Flood Risk
5760 min Winter	1.437	1.437	34.1	0.0	34.1	17240.8	Flood Risk
7200 min Winter	1.399	1.399	33.6	0.0	33.6	16783.1	Flood Risk
8640 min Winter	1.356	1.356	33.1	0.0	33.1	16270.4	Flood Risk
10080 min Winter	1.311	1.311	32.6	0.0	32.6	15726.8	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
180 min Winter	23.353	0.0	4587.5	0.0	192
240 min Winter	18.644	0.0	4644.7	0.0	250
360 min Winter	13.543	0.0	4745.9	0.0	368
480 min Winter	10.792	0.0	4816.8	0.0	486
600 min Winter	9.043	0.0	4860.5	0.0	604
720 min Winter	7.823	0.0	4884.0	0.0	720
960 min Winter	6.219	0.0	4888.0	0.0	956
1440 min Winter	4.493	0.0	4788.8	0.0	1422
2160 min Winter	3.241	0.0	9740.3	0.0	2108
2880 min Winter	2.568	0.0	9599.8	0.0	2780
4320 min Winter	1.847	0.0	9046.4	0.0	4068
5760 min Winter	1.461	0.0	18214.0	0.0	4664
7200 min Winter	1.217	0.0	17693.0	0.0	5552
8640 min Winter	1.048	0.0	17127.9	0.0	6488
10080 min Winter	0.923	0.0	16459.0	0.0	7368

SCP		Page 1
Lawrence Buildings 2 Mount Street Manchester M2 5WQ		Micro Drainage
Date 28/02/2013 16:32 File 1 in 100year + 3...	Designed by ian withe... Checked by	
Micro Drainage	Source Control 2013.1	

Rainfall Details

Rainfall Model	PSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 21.250

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	5.312	4	8	5.312	8	12	5.312	12	16	5.314

On-Site Storage Data For 1 in 100 yrs + 30% CC at 85% Imp Area.

POWER STATION SITE.

OVERHEAD CONDUCTORS.

PROPOSED ESTATE ROAD.

PROPOSED ESTATE ROAD.

PROPOSED DITCH.

Invert level = 1.5m AOD.

Crest level = 3.0m AOD.

Redundant ditch to be infilled.

Crest level = 2.75m AOD.

Water level = 2.5m AOD.

BASE LEVEL TO POND. AT 1.0m AOD.

Embankments at 1 in 2.

1 in 1.98

1 in 2.028

1 in 2.056

PROPOSED DETENTION BASIN.

DITCH TO BE IMPROVED.

Fence

Footway

Kerb

WL1.128

WL1.429

CH 0m

CH 20m

CH 40m

CH 60m

CH 80m

CH 100m

CH 120m

CH 140m

CH 160m

CH 180m

CH 200m

CH 220m

CH 240m

CH 260m

CH 280m

CH 300m

CH 320m

CH 340m

CH 360m

CH 380m

CH 400m

CH 420m

CH 440m

CH 460m

CH 480m

CH 500m

7.283

7.300

3.000

2.000

2.490

4.091

13.241

10.376

4.000

4.000

5.000

Proposed High Water Level = 2.5m AOD.

Additional ditch volume - 3.569sqm CSA.

Berm at 2.75m AOD Crest Level.

Existing Ground Level.

Ditch Invert 1.0m AOD.

TYPICAL DITCH SECTION - CH. 40 m

Existing Ground Level.

Berm at 2.75m AOD Crest Level.

Additional ditch volume - 3.976sqm CSA.

Proposed High Water Level = 2.5m AOD.

Embankment only to be re-graded with the agreement of the I.D.B.

Ditch Invert 1.0m AOD.

TYPICAL DITCH SECTION - CH. 320 m

Existing Ground Level.

Berm at 2.75m AOD Crest Level.

Additional pond volume - 7,490 cu.m.

Proposed High Water Level = 2.5m AOD.

Embankment only to be re-graded with the agreement of the I.D.B.

TYPICAL POND SECTION - CH. 420 m

RIVERSIDE INDUSTRIAL ESTATE.

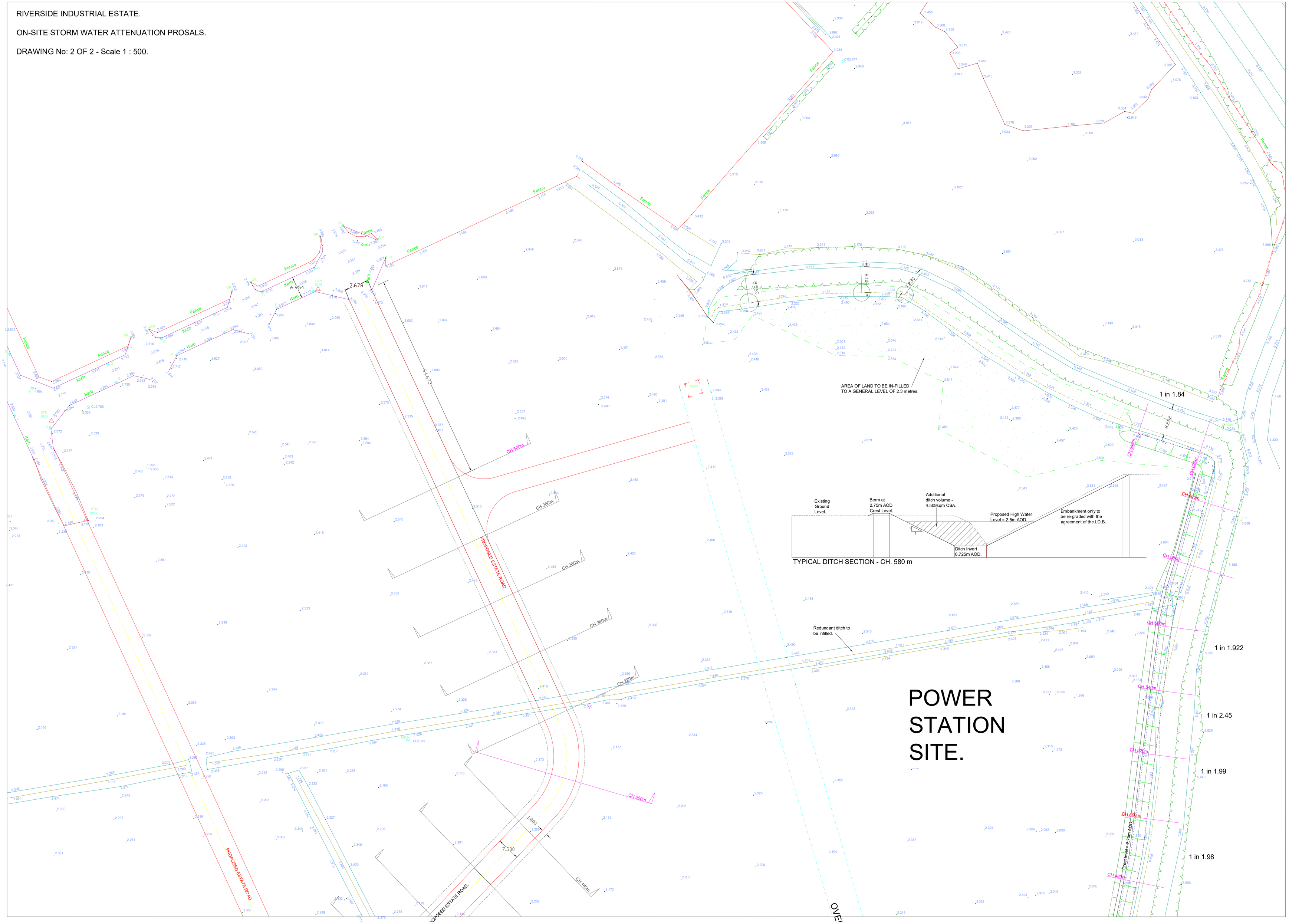
ON-SITE STORM WATER ATTENUATION PROSALS.

DRAWING No: 1 - Scale 1 : 500.

RIVERSIDE INDUSTRIAL ESTATE.

ON-SITE STORM WATER ATTENUATION PROSALS.

DRAWING No: 2 OF 2 - Scale 1 : 500.



Appendix

Appendix B – Total Catchment Based Calculations

PB6934-RHD-SW-ZZ-MD-D-0500_Proposed+Biomass No.3
PB6934-RHD-SW-ZZ-MD-D-0501_Full Development

Royal HaskoningDHV

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	1.749	0.749	35.0	0.0	35.0	2618.3	O K
30 min Summer	1.902	0.902	35.0	0.0	35.0	3437.4	O K
60 min Summer	2.042	1.042	35.0	0.0	35.0	4285.7	O K
120 min Summer	2.167	1.167	35.0	0.0	35.0	5132.1	O K
180 min Summer	2.231	1.231	35.0	0.0	35.0	5600.4	O K
240 min Summer	2.272	1.272	35.0	0.0	35.0	5905.2	Flood Risk
360 min Summer	2.318	1.318	35.0	0.0	35.0	6265.5	Flood Risk
480 min Summer	2.346	1.346	35.0	0.0	35.0	6489.4	Flood Risk
600 min Summer	2.363	1.363	35.0	0.0	35.0	6631.7	Flood Risk
720 min Summer	2.374	1.374	35.0	0.0	35.0	6718.8	Flood Risk
960 min Summer	2.382	1.382	35.0	0.0	35.0	6787.5	Flood Risk
1440 min Summer	2.371	1.371	35.0	0.0	35.0	6690.9	Flood Risk
2160 min Summer	2.334	1.334	35.0	0.0	35.0	6394.4	Flood Risk
2880 min Summer	2.299	1.299	35.0	0.0	35.0	6113.1	Flood Risk
4320 min Summer	2.231	1.231	35.0	0.0	35.0	5598.2	O K
5760 min Summer	2.165	1.165	35.0	0.0	35.0	5115.6	O K
7200 min Summer	2.097	1.097	35.0	0.0	35.0	4650.4	O K
8640 min Summer	2.022	1.022	35.0	0.0	35.0	4164.0	O K
10080 min Summer	1.941	0.941	35.0	0.0	35.0	3666.6	O K
15 min Winter	1.811	0.811	35.0	0.0	35.0	2937.7	O K
30 min Winter	1.973	0.973	35.0	0.0	35.0	3857.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	126.830	0.0	2461.7	0.0	30
30 min Summer	83.383	0.0	2912.5	0.0	45
60 min Summer	52.299	0.0	4294.8	0.0	74
120 min Summer	31.753	0.0	5132.5	0.0	134
180 min Summer	23.426	0.0	5489.1	0.0	194
240 min Summer	18.779	0.0	5524.6	0.0	252
360 min Summer	13.642	0.0	5459.6	0.0	370
480 min Summer	10.873	0.0	5404.8	0.0	490
600 min Summer	9.115	0.0	5360.8	0.0	608
720 min Summer	7.889	0.0	5323.1	0.0	726
960 min Summer	6.276	0.0	5258.2	0.0	964
1440 min Summer	4.539	0.0	5154.3	0.0	1440
2160 min Summer	3.278	0.0	9776.7	0.0	1784
2880 min Summer	2.600	0.0	10169.1	0.0	2160
4320 min Summer	1.872	0.0	9463.9	0.0	2952
5760 min Summer	1.482	0.0	11927.2	0.0	3800
7200 min Summer	1.235	0.0	12425.6	0.0	4616
8640 min Summer	1.064	0.0	12841.7	0.0	5448
10080 min Summer	0.938	0.0	13185.0	0.0	6160
15 min Winter	126.830	0.0	2702.6	0.0	30
30 min Winter	83.383	0.0	2888.5	0.0	45

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	2.121	1.121	35.0	0.0	35.0	4812.4	O K
120 min Winter	2.254	1.254	35.0	0.0	35.0	5769.3	Flood Risk
180 min Winter	2.323	1.323	35.0	0.0	35.0	6305.5	Flood Risk
240 min Winter	2.367	1.367	35.0	0.0	35.0	6658.3	Flood Risk
360 min Winter	2.418	1.418	35.0	0.0	35.0	7085.4	Flood Risk
480 min Winter	2.450	1.450	35.0	0.0	35.0	7359.5	Flood Risk
600 min Winter	2.471	1.471	35.0	0.0	35.0	7542.3	Flood Risk
720 min Winter	2.484	1.484	35.0	0.0	35.0	7663.2	Flood Risk
960 min Winter	2.498	1.498	35.0	0.0	35.0	7786.4	Flood Risk
1440 min Winter	2.496	1.496	35.0	0.0	35.0	7770.2	Flood Risk
2160 min Winter	2.461	1.461	35.0	0.0	35.0	7455.0	Flood Risk
2880 min Winter	2.418	1.418	35.0	0.0	35.0	7087.1	Flood Risk
4320 min Winter	2.334	1.334	35.0	0.0	35.0	6392.1	Flood Risk
5760 min Winter	2.244	1.244	35.0	0.0	35.0	5692.6	O K
7200 min Winter	2.148	1.148	35.0	0.0	35.0	5000.9	O K
8640 min Winter	2.041	1.041	35.0	0.0	35.0	4285.0	O K
10080 min Winter	1.912	0.912	35.0	0.0	35.0	3495.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
60 min Winter	52.299	0.0	4781.3	0.0	74
120 min Winter	31.753	0.0	5527.1	0.0	132
180 min Winter	23.426	0.0	5533.7	0.0	190
240 min Winter	18.779	0.0	5494.4	0.0	248
360 min Winter	13.642	0.0	5444.9	0.0	364
480 min Winter	10.873	0.0	5415.1	0.0	482
600 min Winter	9.115	0.0	5395.7	0.0	598
720 min Winter	7.889	0.0	5383.2	0.0	714
960 min Winter	6.276	0.0	5375.0	0.0	944
1440 min Winter	4.539	0.0	5356.1	0.0	1392
2160 min Winter	3.278	0.0	10728.6	0.0	2016
2880 min Winter	2.600	0.0	10538.0	0.0	2280
4320 min Winter	1.872	0.0	9789.2	0.0	3204
5760 min Winter	1.482	0.0	13358.3	0.0	4104
7200 min Winter	1.235	0.0	13915.6	0.0	4984
8640 min Winter	1.064	0.0	14380.9	0.0	5888
10080 min Winter	0.938	0.0	14775.8	0.0	6568

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.500	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 11.199

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	2.800	4	8	2.800	8	12	2.800	12	16	2.799

Model Details

Storage is Online Cover Level (m) 2.550

Tank or Pond Structure

Invert Level (m) 1.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2180.0	1.500	9000.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0247-3500-1500-3500
Design Head (m)	1.500
Design Flow (l/s)	35.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	247
Invert Level (m)	1.000
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	35.0
Flush-Flo™	0.472	35.0
Kick-Flo®	1.032	29.3
Mean Flow over Head Range	-	29.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.0	1.200	31.4	3.000	48.9	7.000	73.7
0.200	25.2	1.400	33.9	3.500	52.6	7.500	76.2
0.300	33.8	1.600	36.1	4.000	56.2	8.000	78.6
0.400	34.8	1.800	38.2	4.500	59.4	8.500	81.0
0.500	35.0	2.000	40.2	5.000	62.6	9.000	83.3
0.600	34.7	2.200	42.1	5.500	65.5	9.500	85.5
0.800	33.5	2.400	43.9	6.000	68.4		
1.000	30.3	2.600	45.6	6.500	71.1		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 8.000 Invert Level (m) 2.500

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	1.567	0.567	35.0	0.0	35.0	3941.8	O K
30 min Summer	1.717	0.717	35.0	0.0	35.0	5175.9	O K
60 min Summer	1.863	0.863	35.0	0.0	35.0	6466.6	O K
120 min Summer	2.004	1.004	35.0	0.0	35.0	7791.0	O K
180 min Summer	2.083	1.083	35.0	0.0	35.0	8557.0	O K
240 min Summer	2.134	1.134	35.0	0.0	35.0	9075.4	O K
360 min Summer	2.198	1.198	35.0	0.0	35.0	9737.2	O K
480 min Summer	2.241	1.241	35.0	0.0	35.0	10193.0	O K
600 min Summer	2.272	1.272	35.0	0.0	35.0	10525.3	Flood Risk
720 min Summer	2.295	1.295	35.0	0.0	35.0	10774.0	Flood Risk
960 min Summer	2.326	1.326	35.0	0.0	35.0	11107.4	Flood Risk
1440 min Summer	2.352	1.352	35.0	0.0	35.0	11400.6	Flood Risk
2160 min Summer	2.350	1.350	35.0	0.0	35.0	11381.9	Flood Risk
2880 min Summer	2.328	1.328	35.0	0.0	35.0	11129.0	Flood Risk
4320 min Summer	2.280	1.280	35.0	0.0	35.0	10604.3	Flood Risk
5760 min Summer	2.231	1.231	35.0	0.0	35.0	10084.6	O K
7200 min Summer	2.183	1.183	35.0	0.0	35.0	9576.4	O K
8640 min Summer	2.134	1.134	35.0	0.0	35.0	9077.1	O K
10080 min Summer	2.085	1.085	35.0	0.0	35.0	8580.7	O K
15 min Winter	1.626	0.626	35.0	0.0	35.0	4418.8	O K
30 min Winter	1.789	0.789	35.0	0.0	35.0	5804.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	126.830	0.0	2838.5	0.0	31
30 min Summer	83.383	0.0	2965.1	0.0	45
60 min Summer	52.299	0.0	5608.1	0.0	76
120 min Summer	31.753	0.0	5731.5	0.0	134
180 min Summer	23.426	0.0	5558.0	0.0	194
240 min Summer	18.779	0.0	5442.7	0.0	254
360 min Summer	13.642	0.0	5304.9	0.0	372
480 min Summer	10.873	0.0	5217.7	0.0	492
600 min Summer	9.115	0.0	5156.8	0.0	610
720 min Summer	7.889	0.0	5112.5	0.0	730
960 min Summer	6.276	0.0	5058.0	0.0	968
1440 min Summer	4.539	0.0	5008.5	0.0	1446
2160 min Summer	3.278	0.0	10341.9	0.0	2160
2880 min Summer	2.600	0.0	10010.4	0.0	2632
4320 min Summer	1.872	0.0	9363.4	0.0	3336
5760 min Summer	1.482	0.0	17536.8	0.0	4104
7200 min Summer	1.235	0.0	18086.8	0.0	4912
8640 min Summer	1.064	0.0	18197.4	0.0	5792
10080 min Summer	0.938	0.0	17497.4	0.0	6568
15 min Winter	126.830	0.0	2955.5	0.0	31
30 min Winter	83.383	0.0	2949.4	0.0	45

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	1.948	0.948	35.0	0.0	35.0	7255.0	O K
120 min Winter	2.102	1.102	35.0	0.0	35.0	8747.8	O K
180 min Winter	2.186	1.186	35.0	0.0	35.0	9609.9	O K
240 min Winter	2.242	1.242	35.0	0.0	35.0	10197.3	O K
360 min Winter	2.312	1.312	35.0	0.0	35.0	10954.6	Flood Risk
480 min Winter	2.360	1.360	35.0	0.0	35.0	11482.7	Flood Risk
600 min Winter	2.394	1.394	35.0	0.0	35.0	11873.0	Flood Risk
720 min Winter	2.420	1.420	35.0	0.0	35.0	12169.5	Flood Risk
960 min Winter	2.456	1.456	35.0	0.0	35.0	12580.2	Flood Risk
1440 min Winter	2.491	1.491	35.0	0.0	35.0	12984.6	Flood Risk
2160 min Winter	2.499	1.499	35.0	0.0	35.0	13081.7	Flood Risk
2880 min Winter	2.483	1.483	35.0	0.0	35.0	12889.7	Flood Risk
4320 min Winter	2.423	1.423	35.0	0.0	35.0	12194.8	Flood Risk
5760 min Winter	2.365	1.365	35.0	0.0	35.0	11541.4	Flood Risk
7200 min Winter	2.302	1.302	35.0	0.0	35.0	10850.0	Flood Risk
8640 min Winter	2.237	1.237	35.0	0.0	35.0	10146.1	O K
10080 min Winter	2.169	1.169	35.0	0.0	35.0	9439.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
60 min Winter	52.299	0.0	5815.3	0.0	74
120 min Winter	31.753	0.0	5570.6	0.0	132
180 min Winter	23.426	0.0	5424.2	0.0	192
240 min Winter	18.779	0.0	5346.4	0.0	250
360 min Winter	13.642	0.0	5269.7	0.0	366
480 min Winter	10.873	0.0	5240.2	0.0	484
600 min Winter	9.115	0.0	5239.0	0.0	602
720 min Winter	7.889	0.0	5257.9	0.0	718
960 min Winter	6.276	0.0	5287.5	0.0	952
1440 min Winter	4.539	0.0	5248.4	0.0	1414
2160 min Winter	3.278	0.0	10504.1	0.0	2092
2880 min Winter	2.600	0.0	10284.0	0.0	2744
4320 min Winter	1.872	0.0	9886.7	0.0	3508
5760 min Winter	1.482	0.0	19478.0	0.0	4392
7200 min Winter	1.235	0.0	19741.9	0.0	5336
8640 min Winter	1.064	0.0	18998.5	0.0	6232
10080 min Winter	0.938	0.0	18053.9	0.0	7168

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.500	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 16.750

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	4.188	4	8	4.188	8	12	4.188	12	16	4.186

Model Details

Storage is Online Cover Level (m) 2.550

Tank or Pond Structure

Invert Level (m) 1.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	6000.0	1.500	11780.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0247-3500-1500-3500
Design Head (m)	1.500
Design Flow (l/s)	35.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	247
Invert Level (m)	1.000
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	35.0
Flush-Flo™	0.472	35.0
Kick-Flo®	1.032	29.3
Mean Flow over Head Range	-	29.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.0	1.200	31.4	3.000	48.9	7.000	73.7
0.200	25.2	1.400	33.9	3.500	52.6	7.500	76.2
0.300	33.8	1.600	36.1	4.000	56.2	8.000	78.6
0.400	34.8	1.800	38.2	4.500	59.4	8.500	81.0
0.500	35.0	2.000	40.2	5.000	62.6	9.000	83.3
0.600	34.7	2.200	42.1	5.500	65.5	9.500	85.5
0.800	33.5	2.400	43.9	6.000	68.4		
1.000	30.3	2.600	45.6	6.500	71.1		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 8.000 Invert Level (m) 2.500

Appendix

Appendix C – Sub-Catchment Cascading Calculations

PB6934-RHD-SW-ZZ-MD-D-0550_Catchment AB
PB6934-RHD-SW-ZZ-MD-D-0551_Catchment C
PB6934-RHD-SW-ZZ-MD-D-0552_Catchment D.North
PB6934-RHD-SW-ZZ-MD-D-0553_Catchment D.South+E+EX

Royal HaskoningDHV

Cascade Summary of Results for PB6934-RHD-SW-ZZ-MD-D-0550_Catchment AB.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	PB6934-RHD-SW-ZZ-MD-D-0551_Catchment C.SRCX	PB6934-RHD-SW-ZZ-MD-D-0551_Catchment C.SRCX

Half Drain Time : 649 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	2.661	0.911	0.0	9.6	0.0	9.6	348.5	O K
30 min Summer	2.790	1.040	0.0	10.3	0.0	10.3	453.9	O K
60 min Summer	2.904	1.154	0.0	10.8	0.0	10.8	558.3	O K
120 min Summer	2.999	1.249	0.0	11.3	0.0	11.3	653.3	O K
180 min Summer	3.042	1.292	0.0	11.5	0.0	11.5	697.8	Flood Risk
240 min Summer	3.063	1.313	0.0	11.6	0.0	11.6	720.4	Flood Risk
360 min Summer	3.074	1.324	0.0	11.6	0.0	11.6	732.9	Flood Risk
480 min Summer	3.070	1.320	0.0	11.6	0.0	11.6	728.3	Flood Risk
600 min Summer	3.062	1.312	0.0	11.6	0.0	11.6	719.7	Flood Risk
720 min Summer	3.053	1.303	0.0	11.5	0.0	11.5	710.0	Flood Risk
960 min Summer	3.033	1.283	0.0	11.4	0.0	11.4	688.6	Flood Risk
1440 min Summer	2.989	1.239	0.0	11.2	0.0	11.2	642.9	O K
2160 min Summer	2.924	1.174	0.0	10.9	0.0	10.9	577.9	O K
2880 min Summer	2.864	1.114	0.0	10.6	0.0	10.6	520.5	O K
4320 min Summer	2.754	1.004	0.0	10.1	0.0	10.1	423.4	O K
5760 min Summer	2.656	0.906	0.0	9.5	0.0	9.5	345.2	O K
7200 min Summer	2.570	0.820	0.0	9.1	0.0	9.1	282.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	126.830	0.0	357.9	0.0	22
30 min Summer	83.383	0.0	470.6	0.0	37
60 min Summer	52.299	0.0	590.3	0.0	66
120 min Summer	31.753	0.0	716.8	0.0	126
180 min Summer	23.426	0.0	793.3	0.0	184
240 min Summer	18.779	0.0	847.9	0.0	244
360 min Summer	13.642	0.0	923.9	0.0	362
480 min Summer	10.873	0.0	981.8	0.0	464
600 min Summer	9.115	0.0	1028.9	0.0	514
720 min Summer	7.889	0.0	1068.5	0.0	574
960 min Summer	6.276	0.0	1133.4	0.0	700
1440 min Summer	4.539	0.0	1229.8	0.0	972
2160 min Summer	3.278	0.0	1332.1	0.0	1384
2880 min Summer	2.600	0.0	1408.5	0.0	1788
4320 min Summer	1.872	0.0	1521.5	0.0	2556
5760 min Summer	1.482	0.0	1605.6	0.0	3336
7200 min Summer	1.235	0.0	1673.2	0.0	4040

Cascade Summary of Results for PB6934-RHD-SW-ZZ-MD-D-0550_Catchment AB.SRCX

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
8640 min Summer	2.494	0.744	0.0	8.6	0.0	8.6	232.2	O K
10080 min Summer	2.427	0.677	0.0	8.2	0.0	8.2	191.2	O K
15 min Winter	2.715	0.965	0.0	9.9	0.0	9.9	391.3	O K
30 min Winter	2.853	1.103	0.0	10.6	0.0	10.6	510.1	O K
60 min Winter	2.975	1.225	0.0	11.2	0.0	11.2	628.8	O K
120 min Winter	3.079	1.329	0.0	11.6	0.0	11.6	738.8	Flood Risk
180 min Winter	3.127	1.377	0.0	11.8	0.0	11.8	792.3	Flood Risk
240 min Winter	3.152	1.402	0.0	12.0	0.0	12.0	821.1	Flood Risk
360 min Winter	3.170	1.420	0.0	12.0	0.0	12.0	842.1	Flood Risk
480 min Winter	3.172	1.422	0.0	12.0	0.0	12.0	844.0	Flood Risk
600 min Winter	3.165	1.415	0.0	12.0	0.0	12.0	835.5	Flood Risk
720 min Winter	3.152	1.402	0.0	12.0	0.0	12.0	821.0	Flood Risk
960 min Winter	3.130	1.380	0.0	11.9	0.0	11.9	794.9	Flood Risk
1440 min Winter	3.076	1.326	0.0	11.6	0.0	11.6	734.7	Flood Risk
2160 min Winter	2.987	1.237	0.0	11.2	0.0	11.2	640.9	O K
2880 min Winter	2.902	1.152	0.0	10.8	0.0	10.8	556.3	O K
4320 min Winter	2.747	0.997	0.0	10.0	0.0	10.0	417.1	O K
5760 min Winter	2.610	0.860	0.0	9.3	0.0	9.3	310.9	O K
7200 min Winter	2.493	0.743	0.0	8.6	0.0	8.6	231.0	O K
8640 min Winter	2.392	0.642	0.0	8.0	0.0	8.0	171.6	O K
10080 min Winter	2.307	0.557	0.0	7.4	0.0	7.4	127.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
8640 min Summer	1.064	0.0	1729.8	0.0	4760
10080 min Summer	0.938	0.0	1778.8	0.0	5456
15 min Winter	126.830	0.0	400.8	0.0	22
30 min Winter	83.383	0.0	527.1	0.0	37
60 min Winter	52.299	0.0	661.2	0.0	66
120 min Winter	31.753	0.0	802.8	0.0	124
180 min Winter	23.426	0.0	888.4	0.0	180
240 min Winter	18.779	0.0	949.6	0.0	238
360 min Winter	13.642	0.0	1034.8	0.0	352
480 min Winter	10.873	0.0	1099.6	0.0	462
600 min Winter	9.115	0.0	1152.4	0.0	568
720 min Winter	7.889	0.0	1196.8	0.0	662
960 min Winter	6.276	0.0	1269.4	0.0	746
1440 min Winter	4.539	0.0	1377.3	0.0	1054
2160 min Winter	3.278	0.0	1491.9	0.0	1496
2880 min Winter	2.600	0.0	1577.5	0.0	1932
4320 min Winter	1.872	0.0	1704.1	0.0	2728
5760 min Winter	1.482	0.0	1798.3	0.0	3464
7200 min Winter	1.235	0.0	1873.9	0.0	4184
8640 min Winter	1.064	0.0	1937.4	0.0	4928
10080 min Winter	0.938	0.0	1992.2	0.0	5552

Cascade Rainfall Details for PB6934-RHD-SW-ZZ-MD-D-0550_Catchment AB.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.500	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.505

Time From: (mins)	To:	Area (ha)	Time From: (mins)	To:	Area (ha)
0	4	0.753	4	8	0.752

Cascade Model Details for PB6934-RHD-SW-ZZ-MD-D-0550_Catchment AB.SRCX

Storage is Online Cover Level (m) 3.300

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	199.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	2.0
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	1.00	Cap Volume Depth (m)	1.500
Invert Level (m)	1.750	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

Orifice Outflow Control

Diameter (m) 0.070 Discharge Coefficient 0.600 Invert Level (m) 1.750

Weir Overflow Control

Discharge Coef 0.544 Width (m) 7.000 Invert Level (m) 3.250

Cascade Summary of Results for PB6934-RHD-SW-ZZ-MD-D-0551_Catchment C.SRCX

Upstream Structures

Outflow To

PB6934-RHD-SW-ZZ-MD-D-0550_Catchment AB.SRCX PB6934-RHD-SW-ZZ-MD-D-0552_Catchment D.North.SRCX PB6934-RHD-SW-ZZ-MD-D-0552_Catchment D.South.SRCX

Half Drain Time : 53 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	2.433	1.183	0.0	178.9	0.0	178.9	697.2	O K
30 min Summer	2.547	1.297	0.0	188.4	0.0	188.4	865.5	Flood Risk
60 min Summer	2.596	1.346	0.0	192.4	0.0	192.4	943.6	Flood Risk
120 min Summer	2.583	1.333	0.0	191.4	0.0	191.4	923.2	Flood Risk
180 min Summer	2.545	1.295	0.0	188.2	0.0	188.2	862.2	Flood Risk
240 min Summer	2.502	1.252	0.0	184.7	0.0	184.7	796.1	Flood Risk
360 min Summer	2.413	1.163	0.0	177.1	0.0	177.1	668.6	O K
480 min Summer	2.331	1.081	0.0	169.9	0.0	169.9	561.7	O K
600 min Summer	2.257	1.007	0.0	163.0	0.0	163.0	472.6	O K
720 min Summer	2.190	0.940	0.0	156.5	0.0	156.5	398.6	O K
960 min Summer	2.074	0.824	0.0	144.6	0.0	144.6	286.1	O K
1440 min Summer	1.900	0.650	0.0	124.7	0.0	124.7	154.9	O K
2160 min Summer	1.734	0.484	0.0	102.2	0.0	102.2	73.0	O K
2880 min Summer	1.648	0.398	0.0	86.1	0.0	86.1	44.8	O K
4320 min Summer	1.576	0.326	0.0	64.5	0.0	64.5	27.6	O K
5760 min Summer	1.537	0.287	0.0	52.7	0.0	52.7	20.2	O K
7200 min Summer	1.511	0.261	0.0	45.1	0.0	45.1	16.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	126.830	0.0	1220.7	0.0	22
30 min Summer	83.383	0.0	1605.0	0.0	34
60 min Summer	52.299	0.0	2013.4	0.0	54
120 min Summer	31.753	0.0	2444.8	0.0	88
180 min Summer	23.426	0.0	2705.5	0.0	122
240 min Summer	18.779	0.0	2891.8	0.0	156
360 min Summer	13.642	0.0	3151.1	0.0	222
480 min Summer	10.873	0.0	3348.6	0.0	286
600 min Summer	9.115	0.0	3509.2	0.0	348
720 min Summer	7.889	0.0	3644.4	0.0	408
960 min Summer	6.276	0.0	3865.6	0.0	526
1440 min Summer	4.539	0.0	4194.2	0.0	758
2160 min Summer	3.278	0.0	4543.3	0.0	1108
2880 min Summer	2.600	0.0	4803.7	0.0	1468
4320 min Summer	1.872	0.0	5189.3	0.0	2200
5760 min Summer	1.482	0.0	5476.2	0.0	2936
7200 min Summer	1.235	0.0	5706.5	0.0	3672

Cascade Summary of Results for PB6934-RHD-SW-ZZ-MD-D-0551_Catchment C.SRCX

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
8640 min Summer	1.492	0.242	0.0	39.7	0.0	39.7	13.5	O K
10080 min Summer	1.477	0.227	0.0	35.6	0.0	35.6	11.6	O K
15 min Winter	2.500	1.250	0.0	184.5	0.0	184.5	793.2	O K
30 min Winter	2.624	1.374	0.0	194.6	0.0	194.6	990.4	Flood Risk
60 min Winter	2.683	1.433	0.0	199.2	0.0	199.2	1092.1	Flood Risk
120 min Winter	2.663	1.413	0.0	197.7	0.0	197.7	1056.1	Flood Risk
180 min Winter	2.608	1.358	0.0	193.3	0.0	193.3	963.1	Flood Risk
240 min Winter	2.544	1.294	0.0	188.2	0.0	188.2	861.6	Flood Risk
360 min Winter	2.416	1.166	0.0	177.4	0.0	177.4	673.2	O K
480 min Winter	2.300	1.050	0.0	167.0	0.0	167.0	522.9	O K
600 min Winter	2.196	0.946	0.0	157.1	0.0	157.1	405.0	O K
720 min Winter	2.104	0.854	0.0	147.8	0.0	147.8	313.4	O K
960 min Winter	1.953	0.703	0.0	131.1	0.0	131.1	189.6	O K
1440 min Winter	1.751	0.501	0.0	104.7	0.0	104.7	79.4	O K
2160 min Winter	1.627	0.377	0.0	79.9	0.0	79.9	39.3	O K
2880 min Winter	1.579	0.329	0.0	65.3	0.0	65.3	28.1	O K
4320 min Winter	1.525	0.275	0.0	49.2	0.0	49.2	18.2	O K
5760 min Winter	1.494	0.244	0.0	40.4	0.0	40.4	13.8	O K
7200 min Winter	1.472	0.222	0.0	34.6	0.0	34.6	11.0	O K
8640 min Winter	1.452	0.202	0.0	30.4	0.0	30.4	8.9	O K
10080 min Winter	1.437	0.187	0.0	27.2	0.0	27.2	7.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
8640 min Summer	1.064	0.0	5899.8	0.0	4384
10080 min Summer	0.938	0.0	6066.8	0.0	5136
15 min Winter	126.830	0.0	1367.1	0.0	23
30 min Winter	83.383	0.0	1797.6	0.0	34
60 min Winter	52.299	0.0	2255.0	0.0	58
120 min Winter	31.753	0.0	2738.2	0.0	94
180 min Winter	23.426	0.0	3030.2	0.0	132
240 min Winter	18.779	0.0	3238.8	0.0	168
360 min Winter	13.642	0.0	3529.2	0.0	236
480 min Winter	10.873	0.0	3750.5	0.0	300
600 min Winter	9.115	0.0	3930.3	0.0	362
720 min Winter	7.889	0.0	4081.8	0.0	422
960 min Winter	6.276	0.0	4329.5	0.0	536
1440 min Winter	4.539	0.0	4697.5	0.0	760
2160 min Winter	3.278	0.0	5088.5	0.0	1104
2880 min Winter	2.600	0.0	5380.2	0.0	1468
4320 min Winter	1.872	0.0	5812.0	0.0	2204
5760 min Winter	1.482	0.0	6133.4	0.0	2936
7200 min Winter	1.235	0.0	6391.3	0.0	3672
8640 min Winter	1.064	0.0	6607.8	0.0	4408
10080 min Winter	0.938	0.0	6794.8	0.0	5096

Cascade Rainfall Details for PB6934-RHD-SW-ZZ-MD-D-0551_Catchment C.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.500	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 3.628

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	1.209	4	8	1.209	8	12	1.210

Cascade Model Details for PB6934-RHD-SW-ZZ-MD-D-0551_Catchment C.SRCX

Storage is Online Cover Level (m) 2.800

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	360.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	2.0
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	1.00	Cap Volume Depth (m)	1.500
Invert Level (m)	1.250	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.6		

Orifice Outflow Control

Diameter (m) 0.290 Discharge Coefficient 0.600 Invert Level (m) 1.250

Weir Overflow Control

Discharge Coef 0.544 Width (m) 6.600 Invert Level (m) 2.750

Cascade Summary of Results for PB6934-RHD-SW-ZZ-MD-D-0552_Catchment D.North.SRCX

Upstream Structures | **Outflow To**

PB6934-RHD-SW-ZZ-MD-D-0551_Catchment C.SRCX PB6934-RHD-SW-ZZ-MD-D-0553_Catchment D.South+Existing.SRCX
PB6934-RHD-SW-ZZ-MD-D-0550_Catchment AB.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	1.866	0.816	153.3	0.0	153.3	793.2	O K
30 min Summer	2.040	0.990	172.2	0.0	172.2	1021.3	O K
60 min Summer	2.215	1.165	189.2	0.0	189.2	1274.7	O K
120 min Summer	2.365	1.315	202.8	0.0	202.8	1512.0	Flood Risk
180 min Summer	2.410	1.360	206.6	0.0	206.6	1586.2	Flood Risk
240 min Summer	2.408	1.358	206.5	0.0	206.5	1583.3	Flood Risk
360 min Summer	2.381	1.331	204.1	0.0	204.1	1537.7	Flood Risk
480 min Summer	2.348	1.298	201.3	0.0	201.3	1484.5	Flood Risk
600 min Summer	2.312	1.262	198.1	0.0	198.1	1425.8	Flood Risk
720 min Summer	2.273	1.223	194.6	0.0	194.6	1363.7	O K
960 min Summer	2.189	1.139	186.8	0.0	186.8	1235.6	O K
1440 min Summer	2.023	0.973	170.4	0.0	170.4	997.9	O K
2160 min Summer	1.820	0.770	148.0	0.0	148.0	736.5	O K
2880 min Summer	1.675	0.625	129.4	0.0	129.4	567.4	O K
4320 min Summer	1.509	0.459	104.5	0.0	104.5	392.6	O K
5760 min Summer	1.441	0.391	87.3	0.0	87.3	326.5	O K
7200 min Summer	1.401	0.351	74.5	0.0	74.5	288.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	126.830	0.0	1918.8	0.0	59
30 min Summer	83.383	0.0	2522.9	0.0	64
60 min Summer	52.299	0.0	3179.9	0.0	70
120 min Summer	31.753	0.0	3861.7	0.0	126
180 min Summer	23.426	0.0	4273.6	0.0	182
240 min Summer	18.779	0.0	4567.9	0.0	222
360 min Summer	13.642	0.0	4977.4	0.0	276
480 min Summer	10.873	0.0	5289.1	0.0	338
600 min Summer	9.115	0.0	5542.3	0.0	400
720 min Summer	7.889	0.0	5755.4	0.0	464
960 min Summer	6.276	0.0	6103.5	0.0	588
1440 min Summer	4.539	0.0	6616.6	0.0	826
2160 min Summer	3.278	0.0	7184.7	0.0	1172
2880 min Summer	2.600	0.0	7596.0	0.0	1520
4320 min Summer	1.872	0.0	8202.9	0.0	2216
5760 min Summer	1.482	0.0	8662.6	0.0	2936
7200 min Summer	1.235	0.0	9026.4	0.0	3672

Cascade Summary of Results for PB6934-RHD-SW-ZZ-MD-D-0552_Catchment D.North.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	1.372	0.322	65.2	0.0	65.2	261.5	O K
10080 min Summer	1.350	0.300	58.3	0.0	58.3	241.4	O K
15 min Winter	1.931	0.881	160.6	0.0	160.6	875.1	O K
30 min Winter	2.116	1.066	179.8	0.0	179.8	1128.5	O K
60 min Winter	2.302	1.252	197.2	0.0	197.2	1409.6	Flood Risk
120 min Winter	2.466	1.416	211.4	0.0	211.4	1681.5	Flood Risk
180 min Winter	2.522	1.472	216.0	0.0	216.0	1780.7	Flood Risk
240 min Winter	2.528	1.478	216.5	0.0	216.5	1791.3	Flood Risk
360 min Winter	2.489	1.439	213.3	0.0	213.3	1721.7	Flood Risk
480 min Winter	2.439	1.389	209.1	0.0	209.1	1636.1	Flood Risk
600 min Winter	2.378	1.328	203.9	0.0	203.9	1532.8	Flood Risk
720 min Winter	2.310	1.260	197.9	0.0	197.9	1422.4	Flood Risk
960 min Winter	2.169	1.119	184.9	0.0	184.9	1206.1	O K
1440 min Winter	1.919	0.869	159.3	0.0	159.3	859.8	O K
2160 min Winter	1.669	0.619	128.6	0.0	128.6	560.9	O K
2880 min Winter	1.529	0.479	107.7	0.0	107.7	412.2	O K
4320 min Winter	1.423	0.373	81.6	0.0	81.6	309.4	O K
5760 min Winter	1.375	0.325	66.2	0.0	66.2	264.1	O K
7200 min Winter	1.343	0.293	56.1	0.0	56.1	235.5	O K
8640 min Winter	1.319	0.269	49.0	0.0	49.0	214.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
8640 min Summer	1.064	0.0	9330.7	0.0	4408
10080 min Summer	0.938	0.0	9591.2	0.0	5136
15 min Winter	126.830	0.0	2149.3	0.0	60
30 min Winter	83.383	0.0	2824.4	0.0	64
60 min Winter	52.299	0.0	3561.8	0.0	68
120 min Winter	31.753	0.0	4325.3	0.0	124
180 min Winter	23.426	0.0	4786.6	0.0	180
240 min Winter	18.779	0.0	5116.1	0.0	232
360 min Winter	13.642	0.0	5574.6	0.0	288
480 min Winter	10.873	0.0	5923.5	0.0	356
600 min Winter	9.115	0.0	6206.8	0.0	422
720 min Winter	7.889	0.0	6445.3	0.0	488
960 min Winter	6.276	0.0	6834.4	0.0	610
1440 min Winter	4.539	0.0	7403.0	0.0	842
2160 min Winter	3.278	0.0	8046.9	0.0	1188
2880 min Winter	2.600	0.0	8507.5	0.0	1528
4320 min Winter	1.872	0.0	9187.9	0.0	2216
5760 min Winter	1.482	0.0	9702.1	0.0	2944
7200 min Winter	1.235	0.0	10109.7	0.0	3672
8640 min Winter	1.064	0.0	10450.8	0.0	4408

Cascade Summary of Results for PB6934-RHD-SW-ZZ-MD-D-0552_Catchment D.North.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	1.302	0.252	43.7	0.0	43.7	199.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
10080 min Winter	0.938	0.0	10743.4	0.0	5144

Cascade Rainfall Details for PB6934-RHD-SW-ZZ-MD-D-0552_Catchment D.North.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.500	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 2.987

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	1.494	4	8	1.493

Cascade Model Details for PB6934-RHD-SW-ZZ-MD-D-0552_Catchment D.North.SRCX

Storage is Online Cover Level (m) 2.600

Tank or Pond Structure

Invert Level (m) 1.050

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	719.0	1.550	1848.0

Orifice Outflow Control

Diameter (m) 0.300 Discharge Coefficient 0.600 Invert Level (m) 1.050

Weir Overflow Control

Discharge Coef 0.544 Width (m) 6.600 Invert Level (m) 2.550

Cascade Summary of Results for PB6934-RHD-SW-ZZ-MD-D-0553_Catchment D.South +Existing.SRCX

Upstream Structures	Outflow To	Overflow To
PB6934-RHD-SW-ZZ-MD-D-0552_Catchment D.North.SRCX PB6934-RHD-SW-ZZ-MD-D-0551_Catchment C.SRCX PB6934-RHD-SW-ZZ-MD-D-0550_Catchment AB.SRCX	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	1.546	0.496	35.0	0.0	35.0	2270.8	O K
30 min Summer	1.677	0.627	35.0	0.0	35.0	3084.9	O K
60 min Summer	1.803	0.753	35.0	0.0	35.0	3966.4	O K
120 min Summer	1.925	0.875	35.0	0.0	35.0	4907.8	O K
180 min Summer	1.993	0.943	35.0	0.0	35.0	5477.1	O K
240 min Summer	2.039	0.989	35.0	0.0	35.0	5881.1	O K
360 min Summer	2.099	1.049	35.0	0.0	35.0	6429.0	O K
480 min Summer	2.140	1.090	35.0	0.0	35.0	6817.0	O K
600 min Summer	2.170	1.120	35.0	0.0	35.0	7111.1	O K
720 min Summer	2.193	1.143	35.0	0.0	35.0	7336.6	O K
960 min Summer	2.221	1.171	35.0	0.0	35.0	7617.9	O K
1440 min Summer	2.243	1.193	35.0	0.0	35.0	7846.9	O K
2160 min Summer	2.240	1.190	35.0	0.0	35.0	7817.7	O K
2880 min Summer	2.217	1.167	35.0	0.0	35.0	7578.7	O K
4320 min Summer	2.167	1.117	35.0	0.0	35.0	7080.8	O K
5760 min Summer	2.118	1.068	35.0	0.0	35.0	6606.1	O K
7200 min Summer	2.064	1.014	35.0	0.0	35.0	6108.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	126.830	0.0	2639.7	0.0	226
30 min Summer	83.383	0.0	2962.2	0.0	277
60 min Summer	52.299	0.0	4879.5	0.0	332
120 min Summer	31.753	0.0	5647.6	0.0	398
180 min Summer	23.426	0.0	5693.8	0.0	448
240 min Summer	18.779	0.0	5586.8	0.0	492
360 min Summer	13.642	0.0	5375.7	0.0	568
480 min Summer	10.873	0.0	5239.6	0.0	638
600 min Summer	9.115	0.0	5145.6	0.0	712
720 min Summer	7.889	0.0	5073.4	0.0	792
960 min Summer	6.276	0.0	4965.4	0.0	996
1440 min Summer	4.539	0.0	4824.1	0.0	1452
2160 min Summer	3.278	0.0	10346.2	0.0	2164
2880 min Summer	2.600	0.0	9985.0	0.0	2720
4320 min Summer	1.872	0.0	9181.2	0.0	3412
5760 min Summer	1.482	0.0	13950.7	0.0	4160
7200 min Summer	1.235	0.0	14523.7	0.0	4920

Cascade Summary of Results for PB6934-RHD-SW-ZZ-MD-D-0553_Catchment D.South +Existing.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	2.008	0.958	35.0	0.0	35.0	5609.6	O K
10080 min Summer	1.953	0.903	35.0	0.0	35.0	5143.7	O K
15 min Winter	1.598	0.548	35.0	0.0	35.0	2577.9	O K
30 min Winter	1.738	0.688	35.0	0.0	35.0	3496.8	O K
60 min Winter	1.872	0.822	35.0	0.0	35.0	4489.2	O K
120 min Winter	2.001	0.951	35.0	0.0	35.0	5551.8	O K
180 min Winter	2.074	1.024	35.0	0.0	35.0	6199.9	O K
240 min Winter	2.123	1.073	35.0	0.0	35.0	6652.7	O K
360 min Winter	2.184	1.134	35.0	0.0	35.0	7254.2	O K
480 min Winter	2.228	1.178	35.0	0.0	35.0	7689.8	O K
600 min Winter	2.260	1.210	35.0	0.0	35.0	8026.2	O K
720 min Winter	2.285	1.235	35.0	0.0	35.0	8291.0	O K
960 min Winter	2.318	1.268	35.0	0.0	35.0	8649.7	Flood Risk
1440 min Winter	2.347	1.297	35.0	0.0	35.0	8965.2	Flood Risk
2160 min Winter	2.352	1.302	35.0	0.0	35.0	9020.8	Flood Risk
2880 min Winter	2.335	1.285	35.0	0.0	35.0	8833.9	Flood Risk
4320 min Winter	2.275	1.225	35.0	0.0	35.0	8183.5	O K
5760 min Winter	2.215	1.165	35.0	0.0	35.0	7565.4	O K
7200 min Winter	2.149	1.099	35.0	0.0	35.0	6904.0	O K
8640 min Winter	2.070	1.020	35.0	0.0	35.0	6162.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
8640 min Summer	1.064	0.0	14993.0	0.0	5656
10080 min Summer	0.938	0.0	15368.4	0.0	6408
15 min Winter	126.830	0.0	2848.5	0.0	243
30 min Winter	83.383	0.0	2962.5	0.0	298
60 min Winter	52.299	0.0	5374.9	0.0	358
120 min Winter	31.753	0.0	5723.6	0.0	428
180 min Winter	23.426	0.0	5540.5	0.0	482
240 min Winter	18.779	0.0	5389.6	0.0	522
360 min Winter	13.642	0.0	5237.5	0.0	592
480 min Winter	10.873	0.0	5156.1	0.0	660
600 min Winter	9.115	0.0	5105.5	0.0	730
720 min Winter	7.889	0.0	5073.0	0.0	806
960 min Winter	6.276	0.0	5040.2	0.0	988
1440 min Winter	4.539	0.0	5004.2	0.0	1438
2160 min Winter	3.278	0.0	10387.3	0.0	2124
2880 min Winter	2.600	0.0	10085.8	0.0	2772
4320 min Winter	1.872	0.0	9474.1	0.0	3584
5760 min Winter	1.482	0.0	15617.0	0.0	4432
7200 min Winter	1.235	0.0	16247.9	0.0	5328
8640 min Winter	1.064	0.0	16759.8	0.0	6184

Cascade Summary of Results for PB6934-RHD-SW-ZZ-MD-D-0553_Catchment D.South +Existing.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
10080 min Winter	1.981	0.931	35.0	0.0	35.0	5376.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
10080 min Winter	0.938	0.0	17163.9	0.0	6920

Cascade Rainfall Details for PB6934-RHD-SW-ZZ-MD-D-0553_Catchment D.South +Existing.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.500	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 5.018

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	1.673	4	8	1.673	8	12	1.672

Cascade Model Details for PB6934-RHD-SW-ZZ-MD-D-0553_Catchment D.South +Existing.SRCX

Storage is Online Cover Level (m) 2.600

Tank or Pond Structure

Invert Level (m) 1.050

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	3408.0	1.550	13204.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0247-3500-1500-3500
Design Head (m)	1.500
Design Flow (l/s)	35.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	247
Invert Level (m)	1.050
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	35.0
Flush-Flo™	0.472	35.0
Kick-Flo®	1.032	29.3
Mean Flow over Head Range	-	29.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.0	1.200	31.4	3.000	48.9	7.000	73.7
0.200	25.2	1.400	33.9	3.500	52.6	7.500	76.2
0.300	33.8	1.600	36.1	4.000	56.2	8.000	78.6
0.400	34.8	1.800	38.2	4.500	59.4	8.500	81.0
0.500	35.0	2.000	40.2	5.000	62.6	9.000	83.3
0.600	34.7	2.200	42.1	5.500	65.5	9.500	85.5
0.800	33.5	2.400	43.9	6.000	68.4		
1.000	30.3	2.600	45.6	6.500	71.1		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 5.000 Invert Level (m) 2.550

Appendix

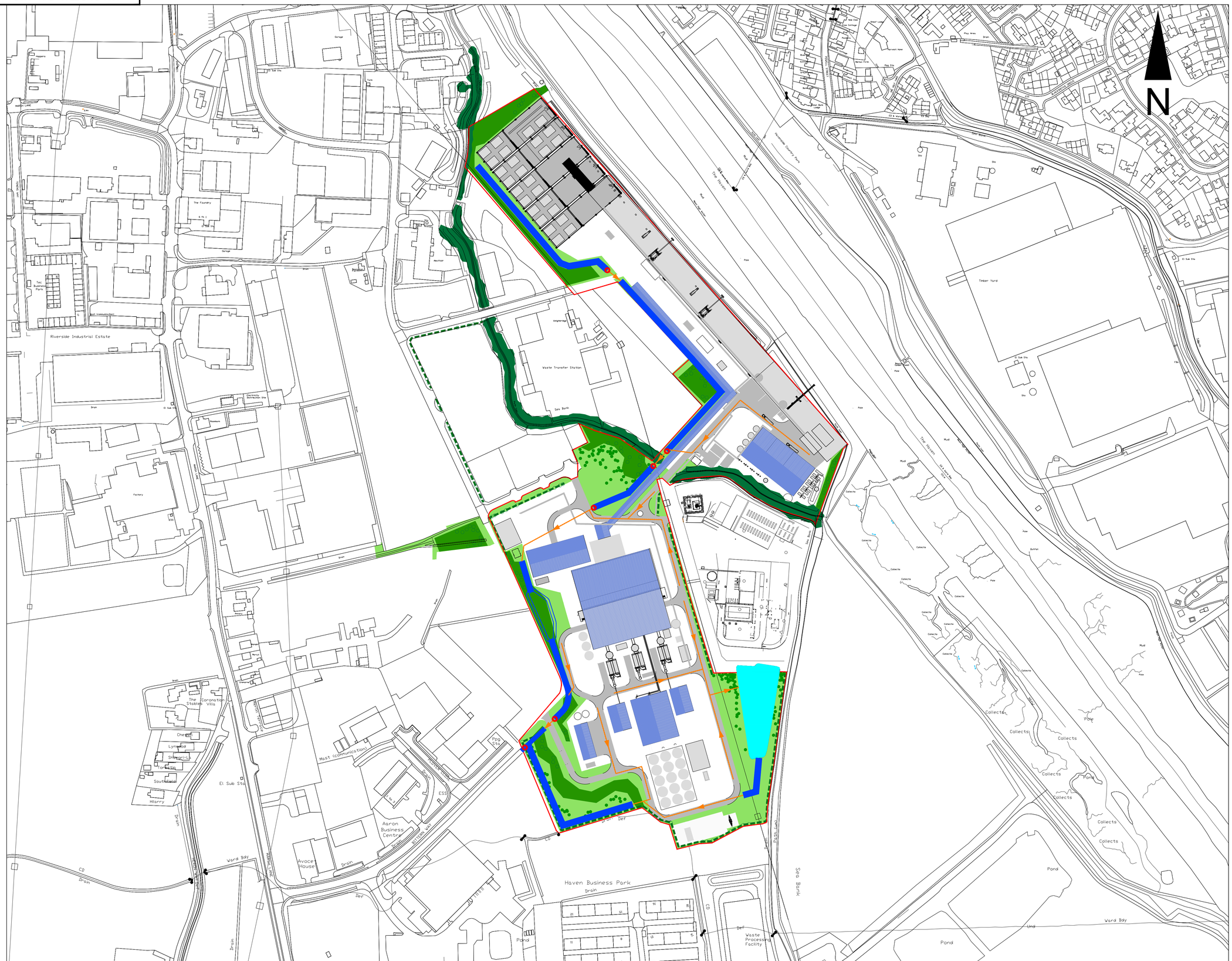
Appendix D – Drainage Strategy Layout

PB6934-RHD-XX-ZZ-DR-D-0501

Royal HaskoningDHV

DRG No.
PB6934-RHD-XX-ZZ-DR-D-0501

DO NOT SCALE



NOTES

KEY:

- CULVERT / PIPE
- CONVEYANCE DITCH
- ATTENUATION POND
- FLOW CONTROL
- EXISTING POND

REV	DATE	DESCRIPTION	BY	CHK	APP

REVISIONS

CLIENT

ALTERNATIVE USE
BOSTON PROJECTS LTD

PROJECT

BOSTON
ALTERNATIVE ENERGY FACILITY
ENVIRONMENTAL STATEMENT

TITLE

PROPOSED DRAINAGE
STRATEGY LAYOUT

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DRAWN	CHECKED	APPROVED
PPV	DJ	PS
DATE	SCALE AT A1	REF.
13/08/2021	1:2000	REF

DRAWING No.	SUITABILITY	REVISION
PB6934-RHD-XX-ZZ-DR-D-0501	S2	P02