

architecture - civil and structural engineering - cost consultancy - interior design - cdm co-ordinator - project management - facilities management



## PROPOSED DEVELOPMENT, HOUGHTON MAIN, GRIMETHORPE

STRATEGIC SITES LIMITED

**FLOOD RISK ASSESSMENT**

JUNE 2008

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## 1.0 Executive Summary

This Flood Risk Assessment (FRA) has been prepared in accordance with the guidance set out in the Government's Planning Policy Statement 25: Development and Flood Risk (PPS25) which was issued in December 2006.

The aim of the FRA is to demonstrate how flood risk to the development and downstream areas will be managed now and taking climate change into account.

This report summarises the methodology and results of the FRA in relation to a 3.76 hectare site on which it is proposed to implement industrial development falling within use classes B1, B2 and B8 (as the Town and Country Planning (Use Classes) Order 1987 as amended). It will accompany the planning application in respect of the proposed development.

The development area (DA) covers a site east of Barnsley within Barnsley Metropolitan Borough.

The site falls within the Environment Agency's (EA) Flood Zone 1, land assessed as having a less than 1 in 1000 (<0.1%) annual probability of river or sea flooding in any year. Consequently, this study focuses on management of surface water runoff, as recommended in the EA's FRA Guidance Note 1, and concludes that the DA can be drained in a manner that will ensure no increased risk of flooding to the development or its environs.

## 2.0 Introduction

Government policy with respect to development in flood risk areas is contained within PPS25 which replaces Planning Policy Guidance Note No.25 (PPG25).

This FRA assesses the flood risk in relation to proposals for industrial development at Houghton Main in Barnsley Metropolitan Borough.

Barnsley Metropolitan Borough Council (BMBC) as the Local Planning Authority (LPA) will make the final decision with regard to planning permission applications. In terms of the Town and Country Planning (General Development Procedure) Order 1995 as amended, the LPA must consult the EA on all applications for development on land exceeding 1 hectare which is located outside flood risk areas.

Wm. Saunders Partnership LLP has prepared this FRA as part of its commission with Strategic Sites Limited, a property development company.

### 3.0 Sources of Information

- Topographical survey (Appendix A);
- Barnsley Unitary Development Plan;
- Site walkover survey;
- Environment Agency correspondence and websites;
- Barnsley Metropolitan Borough Council website;
- Centre for Ecology and Hydrology publications;
- CIRIA publications.

## 4.0 Proposed Development

### 4.1 Site Location and Description

The development site is located approximately 5 miles east of Barnsley in South Yorkshire. It encompasses part of a reclaimed open-cast mine, the former Houghton Main Colliery. It is bounded by a line of trees and grassland in the southwest, a 300 metre long dismantled railway embankment to the north, Park Spring Road (A6195) and a roundabout to the east, and a private development – Green Park Energy – immediately to the south. The River Dearne runs some 60 to 80 metres away from the southwestern boundary, with flood defences and grassland in between.

The site location is shown below. Its National Grid Reference is 441700, 406400.

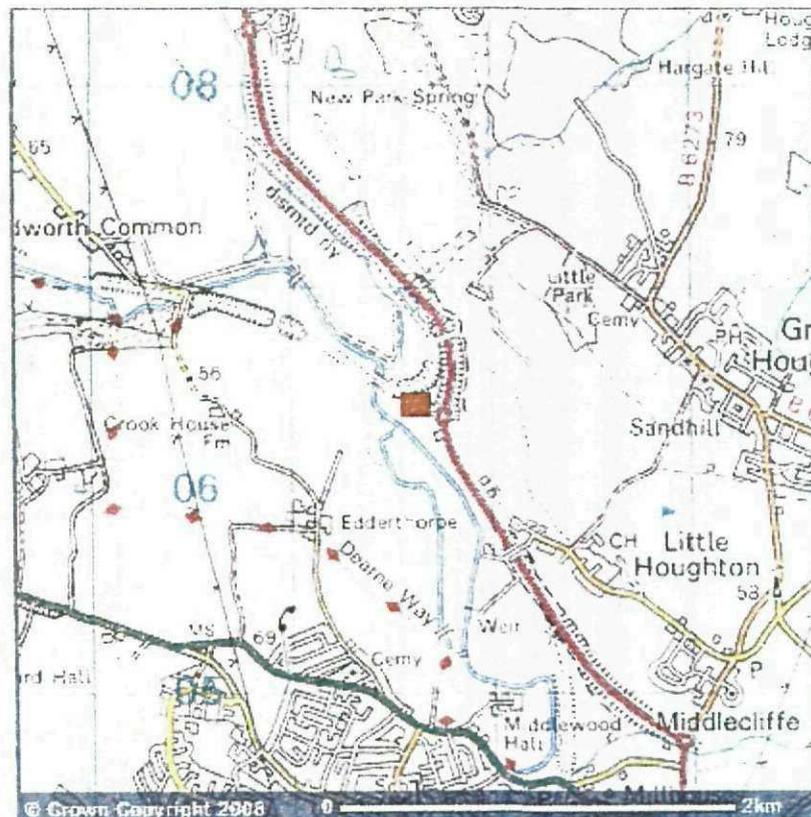


Figure 1 Location Map

The topography of the area is generally flat, the steepest part being the southwestern triangular portion which slopes outwards at gradients varying between 1 in 11 and 1 in 40 towards the River Dearne flood plain.

Existing levels vary between 34m AOD in the north and just over 30m AOD at the westernmost point. The former railway embankment along the northern boundary is over 20m at its widest, rising over 3m above adjacent ground at its highest point, which is 36.44m AOD.

The geology consists of artificial or made ground. After cessation of open cast mining operations, the site was restored to original levels using earthworks compaction methods, with the intention of making the land suitable for industrial use. Materials used in the backfilling and compaction works were classified as: cohesive soils; well graded and granular cohesive soils; and uniformly graded material.

All structures to do with mining operations have long been removed, and the site is generally covered with scrub and grass.

Access to the site is by way of the roundabout in the southeast.

#### 4.2 Development Proposals

It is proposed to construct units for industrial use with uses falling within classes B1, B2 and B8 as defined in the Town and Country Planning (Use Classes) Order 1987 as amended. The development will comprise 1.101 hectares of ground floor space, 1.782 hectares of car parking, accessways and footpaths, and just under 8800 square metres of landscaped areas.

The proposed layout for the development is shown in Appendix B.

## 5.0 Flood Risk

### 5.1 Introduction

According to Annex E of PPS25, any new development should not increase but rather reduce flood risk, and flood risk assessments should be proportionate to the risk and appropriate to the scale, nature and location of the development.

The EA has stipulated (letter dated 23/01/2008 in Appendix C) that surface water runoff generated by the proposed development and flowing into any watercourse would have to be limited to 5 litres per second per hectare for the impermeable area, with a balancing facility provided to contain a 1 in 30 year storm flow. The site would also need to retain a 1 in 100 year storm flow without causing flooding to property.

### 5.2 Existing Information

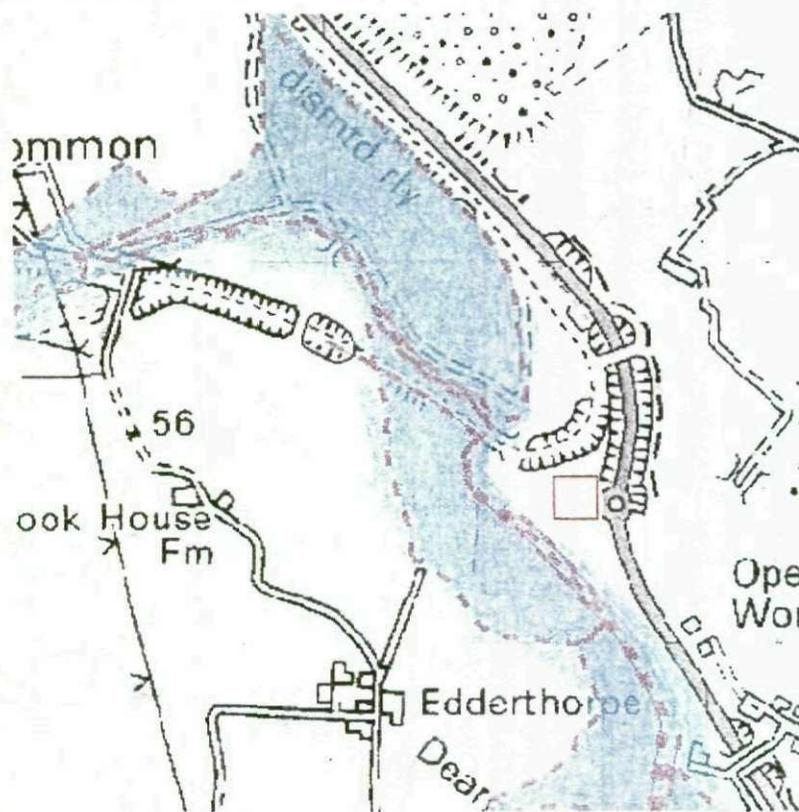


Figure 2 EA Flood Map

### Fluvial Flooding

The site is located approximately 80 metres northeast of the River Dearne. The EA's flood map (figure 2) shows that the DA is located in Flood Zone 1, which means the likelihood of river flooding is **low**, or less than 1 in 1000 annual probability – less than 0.1% in any year.

The flood map also shows a thin Flood Zone 2 strip next to the wider Flood Zone 3 area constituting the River Dearne's flood plain. Flood Zone 2 represents land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1% in any year) whilst similarly, Flood Zone 3 refers to a 1 in 100 or greater annual probability of river flooding.

It is noted that there is a flood defence on the river's eastern bank some 65 metres from the site's southwestern boundary. Further description of this has been considered unnecessary as the lowest point on the site at 31m AOD is 3 metres above the estimated water level for the 1 in 100 year return period (see ISIS Model summary sheets in Appendix D).

The site's location precludes tidal flooding.

### Surface Water and Groundwater Flooding

The site has undergone restoration from its former state as an open cast mine. It is grassed and there is no evidence of previous flooding. There are no apparent surface water drainage features, suggesting that rainwater finds its way naturally into the ground. Groundwater levels within the site appear to be concurrent with the regional water levels within shallow mine workings as monitored by the Coal Authority, with the highest level recorded on site being approximately 28.4m AOD.

## **5.3 Climate Change**

Because of increasing scientific evidence that human activity is altering the global climate, the Government established the UK Climate Impacts Programme (UKCIP) to assist local and regional organisations in assessing their vulnerability to climate change, and plan appropriate adaptation measures. It is projected that a future consequence of climate

change will be an increase in the frequency and intensity of both winter and summer storms.

The interim national procedure 'Preliminary Rainfall Runoff Management for Developments' (DEFRA/EA Report W5-074/A) stipulates: "Climate change will be taken into account in hydrological regions by increasing the rainfall depth by 10% for computing storage volumes. Due to the relationship between rainfall and runoff being non-linear, the use of 10% additional rainfall is considered to approximate to a 20% increase in runoff for larger events. No allowance for climate change should be applied to calculated greenfield peak rates of runoff from the site for any hydrological region."

Annex B to PPS25 recommends increasing peak rainfall intensity by 10% and 30% for the years 2025-2055 and 2085-2115 respectively, to allow for climate change.

PPS25 also states that for developments, an allowance should be made for the projected rise of sea level over the life of the development. According to the relevant table in the Guide, the recommended contingency allowances for net sea level rise for the East of England are: 4mm/year from 1990 to 2025; 8.5mm/year for 2025-2055; 12mm/year for 2055-2085; and 15mm per year between 2085 and 2115. This adds up to a net sea level rise of 1.028m over 100 years for this region within which South Yorkshire is located. Though the DA is some distance from the sea, it was considered necessary to look at net sea level rise as the nearby River Dearne will be affected by this.

#### 5.4 Summary

The Development Area is not at risk from river or tidal flooding. It will, however, be at risk from possible flooding arising out of the development itself due to the additional surface water runoff generated by the greatly increased impermeable area. The surface water disposal system devised for this development will have to address this flood risk, ensuring properties and people in the development and surrounding areas will not be put in danger at any time.

## 6.0 Drainage Strategy

### 6.1 Maximum Allowable Discharge

As previously stated, the EA has set the maximum allowable discharge rate for surface water arising from the developed site at 5 litres/second/hectare of impermeable areas.

This means with hard surfaces adding up to 2.8824 ha, an absolute maximum of 14.4 l/s would be allowed to flow into the nearby River Dearne.

### 6.2 Sustainable Urban Drainage Systems

PPS25 states that "surface water arising from a developed site should be managed in a sustainable manner to mimic surface water flows from the site prior to the development while reducing flood risk to the site itself and elsewhere, taking climate change into account." Sustainable urban drainage systems (SUDS) provide a means towards achieving that aim. The Building Regulations give priority to the use of infiltration drainage systems over watercourses and sewerage.

Soakaway tests conducted on site confirmed the feasibility of using infiltration devices as a means of removing runoff from the development. The mean infiltration rate was found to be 1.99E-05 m/s, or 71.64 mm/hour.

#### Infiltration Devices

Part of the accessways and parking areas may be surfaced with permeable blocks, permitting infiltration of runoff and its subsequent detention either in the subbase layer or in modular geocellular blocks underneath the pavement. Roof runoff would be directed into the same storage space. The detained runoff would be allowed to percolate into adjacent ground, in similar fashion to a soakaway.

In addition, a detention pond with a capacity of up to 1100 cubic metres will be constructed in the southwestern corner. This is considered more appropriate than an **infiltration basin** due to the site falling within Groundwater Vulnerability map sheet 12 which classifies the soil as predominantly high leaching (see EA letter of 23/01/2008 in Appendix C).

Impermeable surfacing may be used in lieu of pervious blocks for all or part of the hard areas with the water being collected by gullies before entering storage.

### 6.3 Drainage Design

The responsible water company, Yorkshire Water, have confirmed that no stormwater drainage apparatus is located in or near the DA ( e-mail dated 11/02/2008 in Appendix C).

It is proposed that an outfall pipe will be constructed from the detention pond mentioned above to the river, emerging at the westernmost point of the site.

Features of the proposed surface water drainage scheme include:

- A detention pond with a capacity of 1100 m<sup>3</sup> located downstream of the drainage system, with a hydrobrake flow control chamber set to 14.4 l/s and a 150mm diameter outfall;
- If space provides a further detention pond could be added to remove the need for the 300m<sup>3</sup> of additional storage;
- If a further detention pond cannot be provided on site, Geocellular block or subbase attenuation with a storage volume of 300 m<sup>3</sup>, under pervious or impervious surfacing (Type A system in CIRIA C697, reflecting total infiltration into the sub-soils after temporary storage in the sub-structure);

Note: A permeable geotextile specifically designed for hydrocarbon pollution treatment – such as Althon Ltd's SEL Sudstex Permafilter – will be laid between the storage medium and the soils beneath.

- Maximum filtration from the storage structure of 40 l/s;
- Peak discharges to the watercourse of 13.3 l/s and 14.0 l/s for the 30-year and 100-year return periods respectively.

### Flood Protection

The detention pond has been designed to accommodate a 1 in 100 year storm in line with recommended practice.

Type A infiltration systems within the car park areas will be designed with a safety factor of 10 (CIRIA C697) to afford long-term flood protection in terms of delaying eventual siltation of the structures.

Ground floor levels will be set not less than 150mm above adjacent ground levels. This will ensure the buildings will be protected from flooding throughout the development's design life.

Note: The Windes drainage design suite was used in all calculations (see Appendix D for printouts).

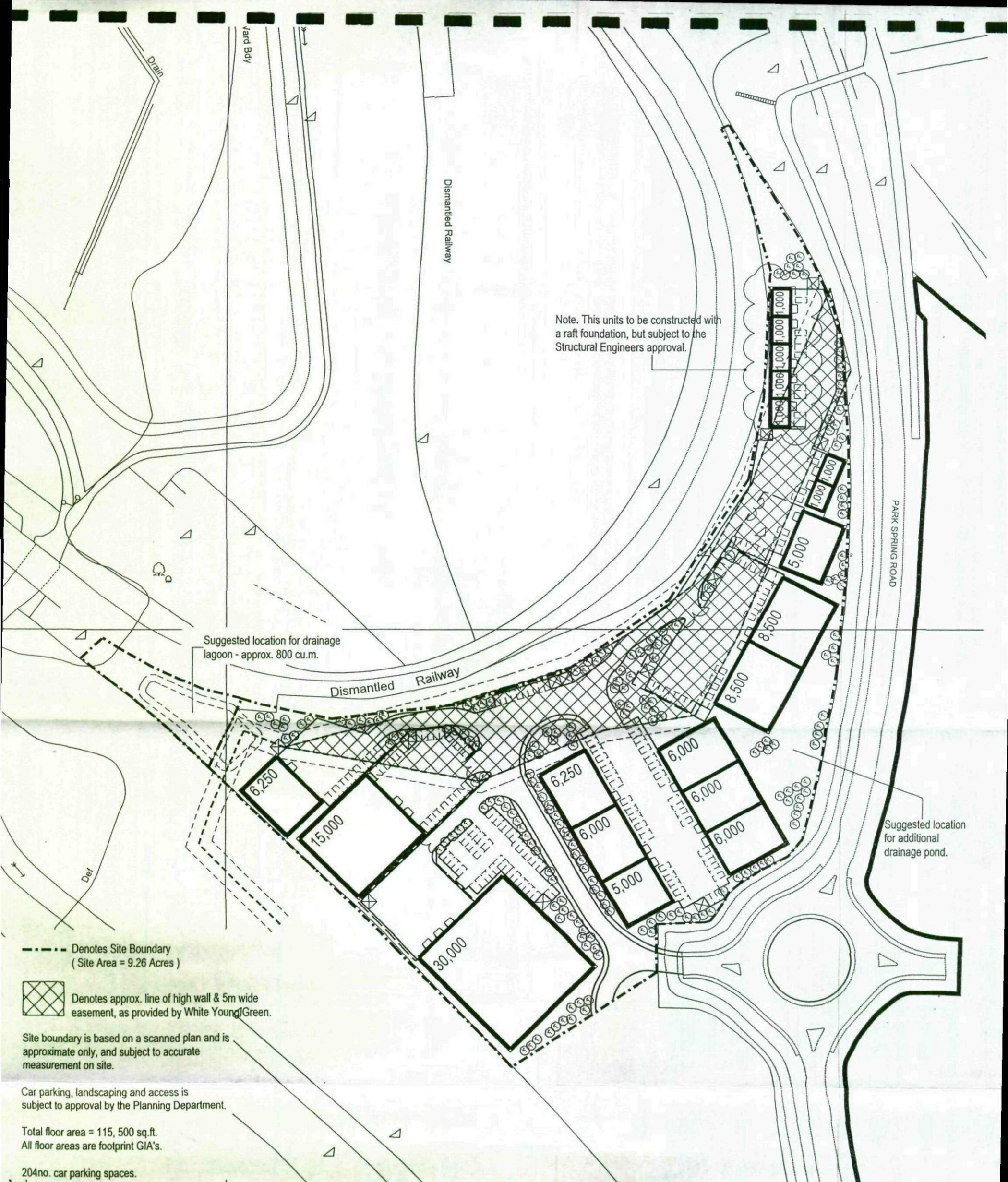
## 7.0 Conclusions

- The proposed development site is not at risk from fluvial nor tidal waters, *nor from any artificial water bodies.*
- The development will generate quantities of surface water runoff which will pose flood risk to the development itself and to its neighbours, unless appropriate design and management measures are taken.
- The maximum allowable discharge and water quality requirements of the EA will need *to be maintained through the life of the development.*
- This report has demonstrated that the DA can be drained in a manner that will ensure no increased risk of flooding to the development or its environs.

**APPENDIX A**

**APPENDIX B**

APPENDIX B  
CONTENTS



Note. This units to be constructed with a raft foundation, but subject to the Structural Engineers approval.

Suggested location for drainage lagoon - approx. 800 cu.m.

Suggested location for additional drainage pond.

--- Denotes Site Boundary  
(Site Area = 9.26 Acres)

Denotes approx. line of high wall & 5m wide easement, as provided by White Young & Green.

Site boundary is based on a scanned plan and is approximate only, and subject to accurate measurement on site.

Car parking, landscaping and access is subject to approval by the Planning Department.

Total floor area = 115, 500 sq.ft.  
All floor areas are footprint GIA's.

204no. car parking spaces.

Project Proposed Development, Houghton Main, Grimethorpe.

Client Strategic Sites Ltd. Title Site Layout - 16

ACCESS / DDA COMPLIANCE CHECK		DATE
RISK ASSESSMENT CHECK		
VERIFICATION STATUS	VERIFIED BY	DATE
Information	NAC	05/08

Date	May. 2008	Drawing No.	E9515(SK)17B
Drawn	SW	Scale	1:1500 @ A3
REV	DESCRIPTION	CK'D	DATE
"A"	Yard/parking to 30K unit amended.	KD	06/06
"B"	Yard/parking to 30K unit amended. 9-11K units amended.	KD	06/06

W<sup>M</sup> SAUNDERS PARTNERSHIP LLP | WSP

ARCHITECTS  
CONSULTING ENGINEERS  
QUANTITY SURVEYORS  
COST CONSULTANTS  
INTERIOR DESIGNERS  
PROJECT MANAGERS  
BUILDING SURVEYORS  
CDM CO-ORDINATORS

Sheppard Lockton House, Cafferata Way,  
Newark on Trent, Notts. NG24 2TN  
Tel: 01636 704 361  
Fax: 01636 702 809

Also at: Leeds, Nottingham,  
London, Cardiff.  
e-mail: newark@wm-saunders.co.uk  
website: www.wm-saunders.co.uk

**APPENDIX C**

kevin dean

---

From: jenny.henman@yorkshirewater.co.uk  
Sent: 11 February 2008 17:01  
To: kevin dean  
Subject: water info



Houghton Main  
Layout Plan.jpg

Kevin,

Further to your letter dated the 22nd January regarding the site at Houghton Main, Grimethorpe.

I have no record of any Section 104 sewers for the site or adjoining site but we have carried out a sewer requisition of a pumping station and rising main from the local Waste Water Treatment works to the south of your site.

Please see the enclosed plan. The plan shows your area of development within the green boundary of the developable land.

I am unsure what the pumping stations designed flows from the area was designed to cater for - for this you will be able to contact our planning section @ Planning.Sewerage@yorkshirewater.co.uk where they can, for a fee, advise you of the allowable discharge rates from the site. I will pass your correspondence through to them.

Thanking You Jenny Henman

Site layout and location plan (See attached file: Houghton Main Layout Plan.jpg)

---

Do you want to know what land and property we've for sale or to let or find out what to do if we're working on your land? Do you want to know how we're involved in the planning development process or what projects our sister company, Keyland Developments, are involved with? Then visit <http://www.yorkshirewater.com/landandproperty> to see a brand new section on our website.

YORKSHIRE WATER - WINNER OF THE UTILITY OF THE YEAR AWARD 2004, 2005 AND 2006

The information in this e-mail is confidential and may also be legally privileged. The contents are intended for recipient only and are subject to the legal notice available at <http://www.keldagroup.com/email.htm> Yorkshire Water Services Limited Registered Office Western House Halifax Road Bradford BD6 2SZ Registered in England and Wales No 2366682



Future Office Development

Distribution Centre

Future Residential Development

Little Houghton WwTW

Transfer Raising Main to Darfield WwTW



creating a better place



Environment Agency

Wm Saunders Partnership LLP  
Sheppard Lockton House  
Cafferata Way  
Newark-on-Trent  
Nottinghamshire  
NG24 2TN

Our Ref : RFI/2007/3492  
Your Ref :

Date : 23 January 2008

25 JAN 2008		
Job No: 4515		
File: 60		
	Seen	Action
		✓
DEAD FILE		
TO FILE		

Dear Kevin

**PROPOSED DEVELOPMENT, HOUGHTON MAIN, GRIMETHORPE, SOUTH YORKSHIRE**

Thank you for your letter dated 18 December 2007 regarding the above and subsequent payments of 24 December 2007 and 7 January 2008.

**Development Control**

Our indicative "Flood Zone Maps" show the identified site to be in PPS25 zone 1.

We have no record of flooding to this site.

The River Dearne is situated to the west of the site. If it is proposed to drain the site to a watercourse any surface water drainage from the site would have to be attenuated to a maximum of 5 litres/second/hectare for the impermeable area, the balancing facility designed to accommodate a 1 in 30 year storm flow from the site and a 1 in 100 year flow retained within the site without causing flooding to property.

**Environment Management**

There are no Waste Management Licence sites within 250 meters of the above site area.

**Groundwater**

The site lies upon Pennine Middle Coal Measures overlain by Alluvium, Silt, Sand and Gravel. Groundwater Vulnerability map Sheet 12 classifies the soil as predominantly high leaching.

Phoenix House, Global Avenue, Leeds, LS11 8PG  
Customer services line: 08708 506 506  
Email: enquiries@environment-agency.gov.uk  
www.environment-agency.gov.uk

VAT No: 662 4901 34



INVESTOR IN PEOPLE

There are 2 historic landfill sites in the vicinity:

National Coal Board  
Coalite and Chemical Products Ltd.  
SE 4110 0760

Commercial Landfill  
SE 4210 0740

### Planning

The site is located in flood zone 1 but because it is over a hectare in size it would still need to do a flood risk assessment. This would need to assess surface water run off from the site and we would recommend that the applicant look at Appendix E and F in Planning Policy Statement 25 for some guidance. If a flood risk assessment was not submitted with the application then we would object to it.

There may be issues with contaminated land on the site due to the proximity of the old railway cutting. This would need to be investigated before submission of an application.

This information is provided subject to the enclosed notice which you should read.

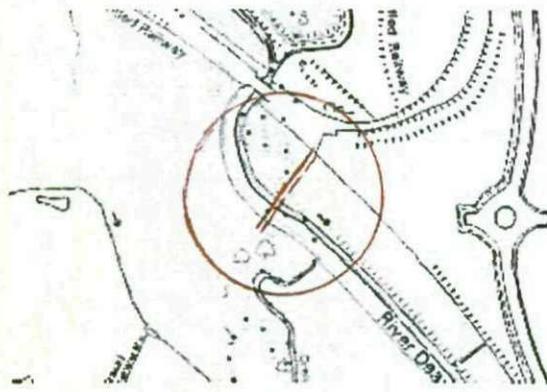
Yours sincerely



**CHERYL BEECH**  
**EXTERNAL RELATIONS**

**APPENDIX D**

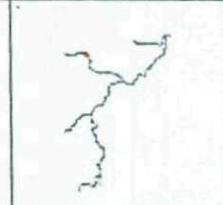
**Location Plan**



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**Cross Section References**

River: DRN  
 Reach: 01  
 Chainage: 14806  
 Section Type: SECTION  
 OS NGR: SE 41440 06383  
 Survey Dwg Ref: N/A  
 Photograph Ref: DEAR\_14806.JPG

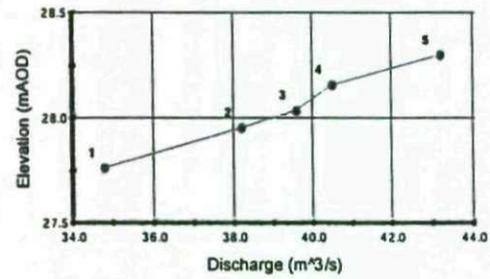


**Next**

Section D/s: 14554  
 Section U/s: 14998D



**Rating Curve**



Number represents model profile number

**Summary of Results**

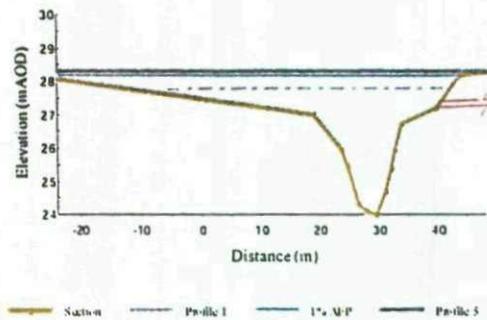
Profile No	AEP (%)	Flow (m³/s)	Water Level (mAOD)	Velocity (m/s)
1	4.00	34.8	27.762	0.79
2	2.00	38.2	27.953	0.80
3	1.33	39.6	28.034	0.80
4	1.00	40.5	28.154	0.80
5	0.67	43.2	28.296	0.80

Level of Left Bank 28.060 mAOD

Level of Right Bank 27.850 mAOD

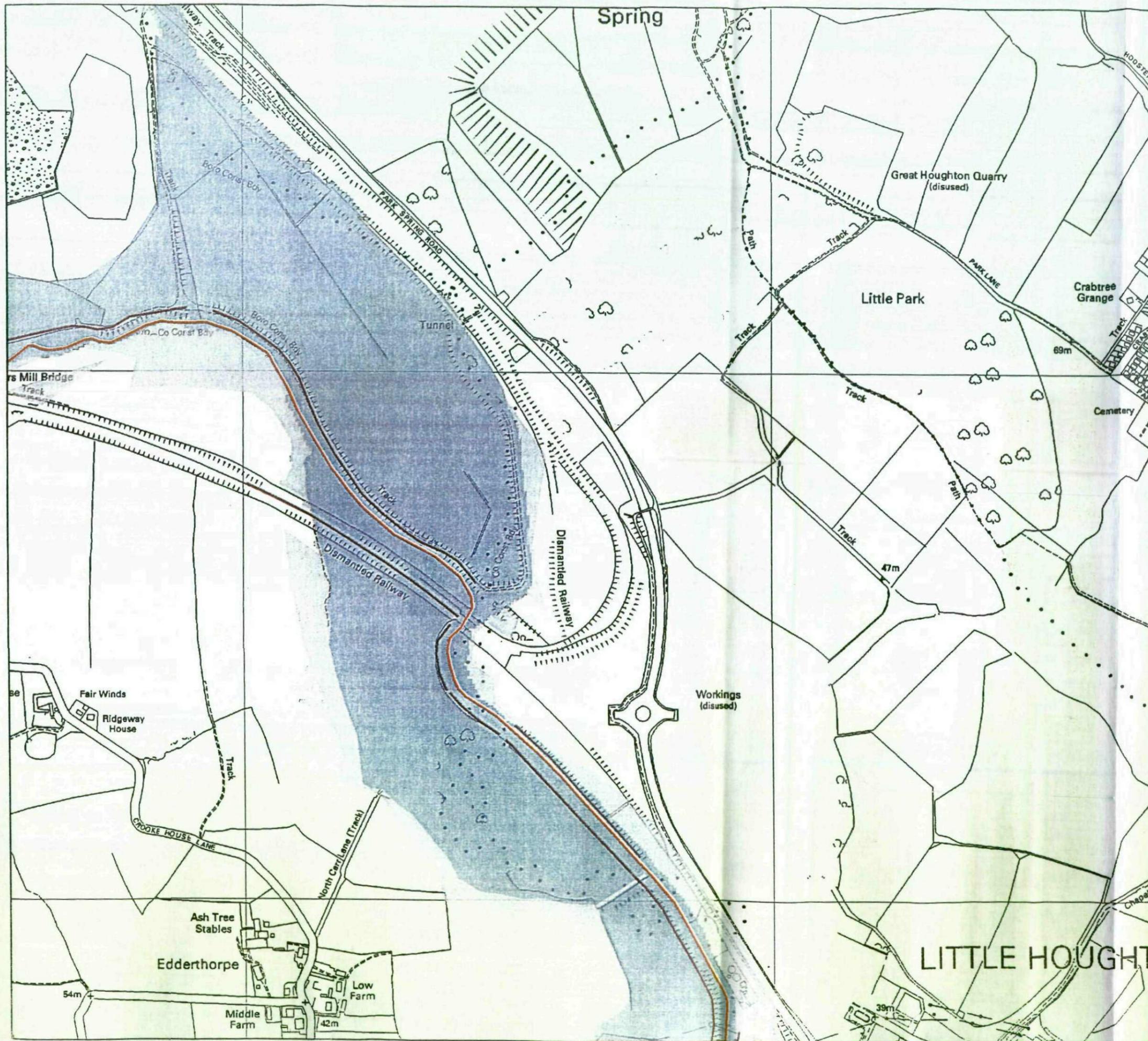
AEP Annual Exceedance Probability = 1/T, where T = Return Period (Years)

**Cross Section Profile**



— Section — Profile 1 — 1\* A/P — Profile 5

DRN: 01: CROSS SECTION NUMBER 14806



Environment Agency

www.environment-agency.gov.uk

General Enquiries: 08708 506 506  
 General Enquiries (Minicom): 08702 422 549

**FLOOD ZONE DATA FOR ENGLAND**

**Information - User Note**

The Flood Zones have been produced in accordance with the requirements of government planning Policy on Development and Flood Risk (Planning Policy Guidance PPG25 in England dated July 2001 and the Draft Technical Advice Note TAN15 in Wales dated July 03). The Flood Zones are for planning consultations.

The Flood Zones are based on information available at that time and will benefit from updates as better information becomes available. For example changes in hydrological river response, observations following flood events or improved modelling techniques. No consideration has been given to climate change at this time.

It should be noted that locations adjacent to rivers, not included at this stage of the survey, maybe at risk of flooding. When in doubt the Environment Agency should be consulted.

These maps may also be used by Local Authority Emergency Planners when producing Major Incident Flood Response Plans. The extents of any Flood Warning Service provided by the Environment Agency is contained within the Local Flood Warning Plan

Zone 3 (England) and Zone C (Wales) is the Agency's best estimate of the areas of land with a 100 to 1 (1%) chance or greater of flooding each year from rivers in catchments greater than 3 sq.km or with 200 to 1 (0.5%) chance or greater of flooding each year from the sea, without the presence of any defences.

Zone 2 (England) and Zone B (Wales) is the Agency's best estimate of the areas of land that could flood under extreme conditions with a 1000 to 1 or (0.1%) chance of flooding each year from rivers and the sea without the presence of defences.

**Flood Zone Data For England**

- main river
- flood zone 2
- flood zone 3
- areas benefiting from flood defences
- flood map flood defences

06/03/02

Scale: 1:7,000

when reproduced @ A3

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LITTLE HOUGHTON



**Environment Agency**

www.environment-agency.gov.uk

General Enquiries: 08708 506 506  
 General Enquiries (Minicom): 08702 422 549

**Flood Extent and Flood Levels - Information**

The extent of flooding is only shown for those watercourses surveyed after the flood event. Other flooding may have occurred which is not shown. This is the best information currently available.

**Flooding History:  
 Flood Levels &  
 Flood Extents**

**Legend**

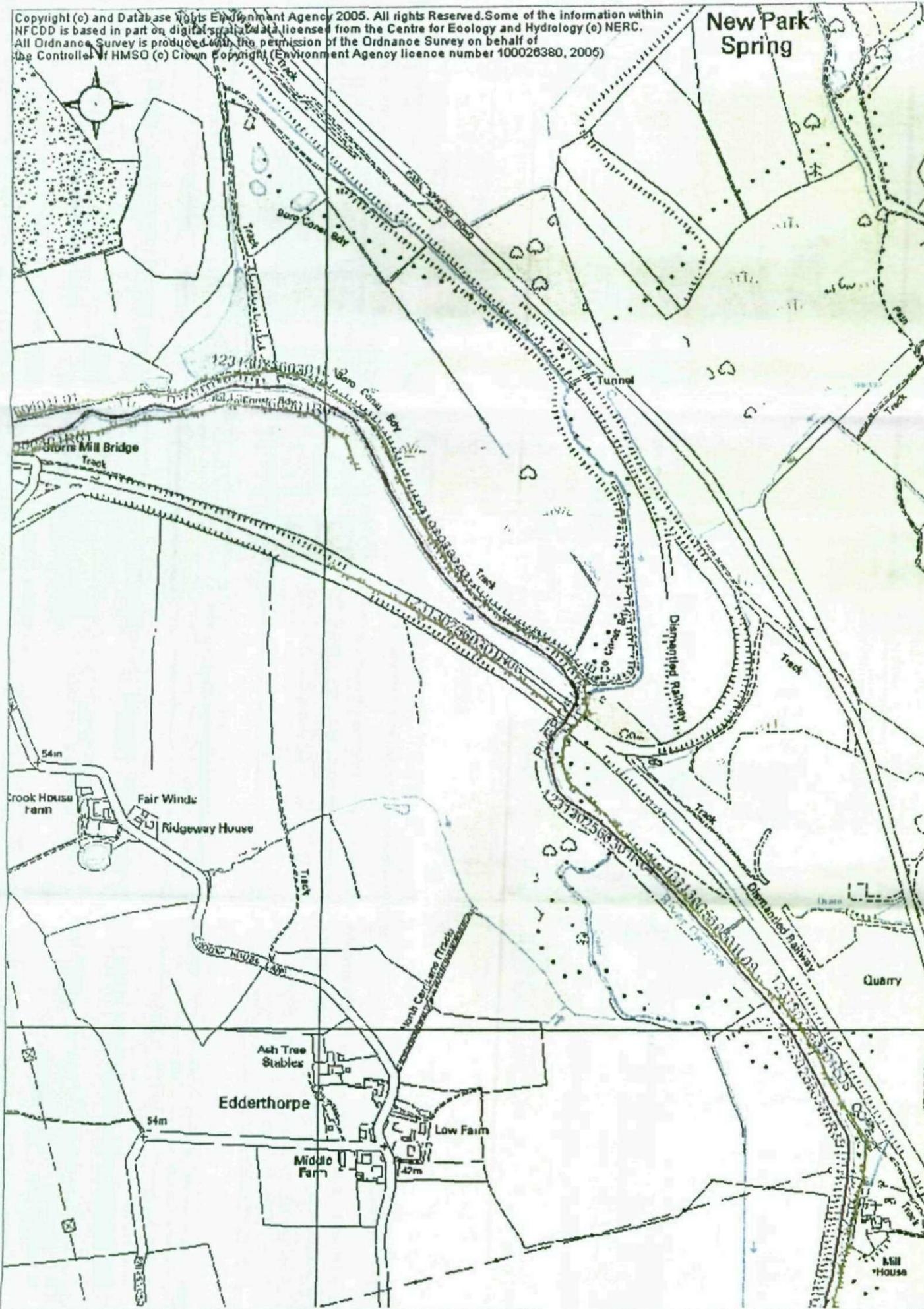
- Main River
- Autumn 2000 Flood Event Flood Level (m)
- River Don 1947 Flood Event Flood Extent
- Autumn 2000 Flood Event Flood Extent

06/03/2

**Scale: 1:7,000**  
 when reproduced @ A3

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	Defence
	Overall Condition: .. 0
	Overall Condition: .. 1
	Overall Condition: .. 2
	Overall Condition: .. 3
	Overall Condition: .. 4
	Overall Condition: .. 5
	Overall Condition: .. 6
	Overall Condition: .. 7
	Overall Condition: .. 8
	Overall Condition: .. 9
	Watercourse

- print Compass
- print Logo
- print Legend

Map Image Width:  mm  
 Map Image Height:  mm

Print... Close

APPENDIX E

Sheppard Lockton House

9515 SSL Houghton Main

Cafferata Way

Grimethorpe

Newark NG24 2TN

Flood Risk Assessment

Date 18 June 2008

Designed By DM

File POROUS CAR PARK.SRC

Checked By

Micro Drainage

Source Control W.11.2



### Porous Car Park Details

Infil Coef - Base (m/hr)	0.071640	Cover Level (m)	32.025
Membrane Percolation (mm/hr)	70	Slope (1:x)	200.0
Safety Factor	1.5	Max Percolation (l/s)	46.7
Porosity	0.95	Depression Storage (mm)	5
Length (m)	80.0	Evaporation (mm/day)	3
Width (m)	30.0	Cap Volume (m)	31.800
Invert Level (m)	31.500		

### Filtration Control

Permeability Coefficient (m/s)	0.000019	Area (m <sup>2</sup> )	5026.5
Safety Factor	10.0	Invert Level (m)	31.500
Bed Depth (m)	1.200		

Sheppard Lockton House

9515 SSL Houghton Main

Cafferata Way

Grimethorpe

Newark NG24 2TN

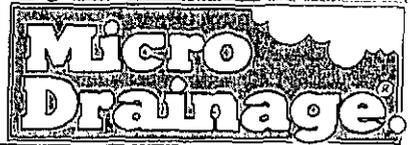
Flood Risk Assessment

Date 18 June 2008

Designed By DM

File POROUS CAR PARK.SRC

Checked By



Micro Drainage

Source Control W.11.2

Summary of Results for 30 year Return Period (+10%)

Half Drain Time : 68 minutes

Storm Duration (mins)	Maximum Control (l/s)	Maximum Filtration (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m <sup>3</sup> )	Status
15 Summer	11.2	16.5	27.7	31.7078	0.2077	123.1	O K
30 Summer	11.4	18.4	29.8	31.7313	0.2312	152.4	O K
60 Summer	11.5	19.2	30.7	31.7418	0.2417	166.4	O K
120 Summer	11.5	19.2	30.7	31.7413	0.2412	165.6	O K
180 Summer	11.4	18.6	30.1	31.7343	0.2342	156.2	O K
240 Summer	11.3	18.0	29.3	31.7258	0.2257	145.2	O K
360 Summer	11.2	16.7	27.9	31.7098	0.2097	125.2	O K
480 Summer	11.1	15.5	26.6	31.6948	0.1947	108.1	O K
600 Summer	11.0	14.4	25.4	31.6813	0.1812	93.4	O K
720 Summer	10.9	13.4	24.3	31.6683	0.1682	80.7	O K
960 Summer	10.7	11.6	22.4	31.6463	0.1463	60.8	O K
1440 Summer	10.4	8.8	19.2	31.6103	0.1103	34.7	O K
2160 Summer	10.1	5.8	15.9	31.5723	0.0723	14.9	O K
2880 Summer	9.9	3.7	13.6	31.5483	0.0482	6.7	O K
4320 Summer	9.7	0.6	10.3	31.5188	0.0188	1.0	O K
5760 Summer	9.7	0.8	10.5	31.5218	0.0217	1.3	O K
7200 Summer	9.7	0.4	10.1	31.5168	0.0168	0.8	O K
8640 Summer	9.6	0.2	9.9	31.5118	0.0118	0.4	O K
10080 Summer	9.6	0.1	9.7	31.5068	0.0068	0.1	O K
15 Winter	11.3	17.7	29.0	31.7218	0.2217	140.1	O K
30 Winter	11.5	19.7	31.2	31.7478	0.2477	174.6	O K
60 Winter	11.6	20.7	32.3	31.7598	0.2597	192.1	O K
120 Winter	11.6	20.5	32.1	31.7578	0.2577	189.1	O K
180 Winter	11.5	19.7	31.2	31.7478	0.2477	175.0	O K
240 Winter	11.4	18.8	30.2	31.7358	0.2357	158.7	O K
360 Winter	11.2	16.9	28.2	31.7128	0.2127	128.9	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	83.64	18
30 Summer	54.45	31
60 Summer	33.89	52
120 Summer	20.48	86
180 Summer	15.09	120
240 Summer	12.09	154
360 Summer	8.84	220
480 Summer	7.07	284
600 Summer	5.94	348
720 Summer	5.16	410
960 Summer	4.12	530
1440 Summer	3.00	766
2160 Summer	2.18	1120
2880 Summer	1.73	1468
4320 Summer	1.26	2096
5760 Summer	1.00	2904
7200 Summer	0.84	3576
8640 Summer	0.72	4304
10080 Summer	0.64	4976
15 Winter	83.64	18
30 Winter	54.45	31
60 Winter	33.89	58
120 Winter	20.48	92
180 Winter	15.09	130
240 Winter	12.09	166
360 Winter	8.84	236

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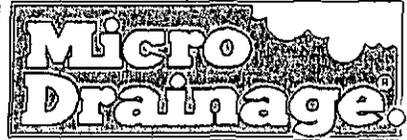
Summary of Results for 30 year Return Period (+10%)

Storm Duration (mins)	Maximum Control (l/s)	Maximum Filtration (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m <sup>3</sup> )	Status
480 Winter	11.1	15.2	26.3	31.6913	0.1912	104.5	O K
600 Winter	10.9	13.7	24.6	31.6723	0.1722	84.4	O K
720 Winter	10.8	12.3	23.1	31.6548	0.1548	68.0	O K
960 Winter	10.5	9.9	20.4	31.6243	0.1243	43.9	O K
1440 Winter	10.2	6.2	16.4	31.5783	0.0783	17.5	O K
2160 Winter	9.9	2.6	12.5	31.5408	0.0407	4.7	O K
2880 Winter	9.7	0.6	10.3	31.5188	0.0188	1.0	O K
4320 Winter	9.7	0.3	10.0	31.5138	0.0138	0.5	O K
5760 Winter	9.6	0.2	9.9	31.5118	0.0118	0.4	O K
7200 Winter	9.6	0.0	9.6	31.5018	0.0018	0.0	O K
8640 Winter	0.0	0.0	0.0	31.5000	0.0000	0.0	O K
10080 Winter	0.0	0.0	0.0	31.5000	0.0000	0.0	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
480 Winter	7.07	302
600 Winter	5.94	364
720 Winter	5.16	426
960 Winter	4.12	546
1440 Winter	3.00	778
2160 Winter	2.18	1104
2880 Winter	1.73	1560
4320 Winter	1.26	2164
5760 Winter	1.00	2856
7200 Winter	0.84	3544
8640 Winter	0.72	0
10080 Winter	0.64	0

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#### Porous Car Park Details

Infil Coef - Base (m/hr)	0.071640	Cover Level (m)	32.025
Membrane Percolation (mm/hr)	70	Slope (1:x)	200.0
Safety Factor	1.5	Max Percolation (l/s)	46.7
Porosity	0.95	Depression Storage (mm)	5
Length (m)	80.0	Evaporation (mm/day)	3
Width (m)	30.0	Cap Volume (m)	31.800
Invert Level (m)	31.500		

#### Filtration Control

Permeability Coefficient (m/s)	0.000019	Area (m <sup>2</sup> )	5026.5
Safety Factor	10.0	Invert Level (m)	31.500
Bed Depth (m)	1.200		

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

Half Drain Time : 80 minutes

Storm Duration (mins)	Maximum Control (l/s)	Maximum Filtration (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m <sup>3</sup> )	Status
15 Summer	11.7	21.1	32.8	31.7653	0.2652	200.7	O K
30 Summer	11.9	23.7	35.7	31.7983	0.2982	253.4	O K
60 Summer	12.1	25.2	37.3	31.8168	0.3167	285.0	O K
120 Summer	12.1	25.5	37.5	31.8198	0.3197	290.6	O K
180 Summer	12.1	25.0	37.1	31.8143	0.3142	280.9	O K
240 Summer	12.0	24.3	36.3	31.8058	0.3057	266.4	O K
360 Summer	11.8	23.0	34.8	31.7888	0.2887	237.9	O K
480 Summer	11.7	21.8	33.5	31.7733	0.2732	213.1	O K
600 Summer	11.6	20.6	32.2	31.7588	0.2587	191.1	O K
720 Summer	11.5	19.5	31.0	31.7453	0.2452	171.6	O K
960 Summer	11.3	17.6	28.9	31.7208	0.2207	138.9	O K
1440 Summer	11.0	14.3	25.3	31.6803	0.1802	92.6	O K
2160 Summer	10.6	10.7	21.3	31.6348	0.1348	51.9	O K
2880 Summer	10.4	8.1	18.5	31.6018	0.1018	29.4	O K
4320 Summer	10.0	4.6	14.6	31.5573	0.0573	9.3	O K
5760 Summer	9.8	1.9	11.7	31.5343	0.0342	3.3	O K
7200 Summer	9.7	0.9	10.7	31.5243	0.0242	1.7	O K
8640 Summer	9.7	0.8	10.6	31.5228	0.0227	1.5	O K
10080 Summer	9.7	0.6	10.3	31.5193	0.0192	1.1	O K
15 Winter	11.8	22.5	34.3	31.7823	0.2822	227.4	O K
30 Winter	12.1	25.4	37.5	31.8193	0.3192	289.1	O K
60 Winter	12.3	27.2	39.5	31.8423	0.3422	328.5	O K
120 Winter	12.3	27.5	39.8	31.8453	0.3452	333.8	O K
180 Winter	12.2	26.8	39.0	31.8368	0.3367	319.7	O K
240 Winter	12.1	25.8	38.0	31.8248	0.3247	299.0	O K
360 Winter	11.9	23.9	35.8	31.8003	0.3002	257.2	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	128.29	19
30 Summer	84.23	32
60 Summer	52.66	60
120 Summer	31.80	90
180 Summer	23.35	124
240 Summer	18.64	160
360 Summer	13.54	228
480 Summer	10.79	294
600 Summer	9.04	358
720 Summer	7.82	422
960 Summer	6.22	548
1440 Summer	4.49	786
2160 Summer	3.24	1144
2880 Summer	2.57	1500
4320 Summer	1.85	2204
5760 Summer	1.46	2936
7200 Summer	1.22	3488
8640 Summer	1.05	4360
10080 Summer	0.92	4976
15 Winter	128.29	19
30 Winter	84.23	32
60 Winter	52.66	60
120 Winter	31.80	96
180 Winter	23.35	134
240 Winter	18.64	172
360 Winter	13.54	244

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

Storm Duration (mins)	Maximum Control (l/s)	Maximum Filtration (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m <sup>3</sup> )	Status
480 Winter	11.8	22.1	33.9	31.7783	0.2782	220.8	O K
600 Winter	11.6	20.5	32.1	31.7578	0.2577	189.6	O K
720 Winter	11.5	19.0	30.5	31.7388	0.2387	162.7	O K
960 Winter	11.2	16.3	27.5	31.7053	0.2052	120.1	O K
1440 Winter	10.8	12.1	22.8	31.6518	0.1518	65.6	O K
2160 Winter	10.3	7.6	17.9	31.5958	0.0958	26.2	O K
2880 Winter	10.0	4.7	14.7	31.5588	0.0587	9.8	O K
4320 Winter	9.7	0.9	10.7	31.5243	0.0242	1.7	O K
5760 Winter	9.7	0.9	10.6	31.5233	0.0232	1.5	O K
7200 Winter	9.7	0.5	10.2	31.5178	0.0178	0.9	O K
8640 Winter	9.7	0.3	9.9	31.5133	0.0133	0.5	O K
10080 Winter	9.6	0.1	9.7	31.5088	0.0088	0.2	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
480 Winter	10.79	314
600 Winter	9.04	380
720 Winter	7.82	444
960 Winter	6.22	570
1440 Winter	4.49	808
2160 Winter	3.24	1148
2880 Winter	2.57	1496
4320 Winter	1.85	2204
5760 Winter	1.46	2840
7200 Winter	1.22	3544
8640 Winter	1.05	4328
10080 Winter	0.92	4968

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Tank/Pond Details

Invert Level (m) 30.400 Ground Level (m) 31.600

Depth (m)	Area (m <sup>2</sup> )								
0.00	742.5	1.20	1305.8	2.40	1305.8	3.60	1305.8	4.80	1305.8
0.20	847.1	1.40	1305.8	2.60	1305.8	3.80	1305.8	5.00	1305.8
0.40	955.8	1.60	1305.8	2.80	1305.8	4.00	1305.8		
0.60	1068.4	1.80	1305.8	3.00	1305.8	4.20	1305.8		
0.80	1185.1	2.00	1305.8	3.20	1305.8	4.40	1305.8		
1.00	1305.8	2.20	1305.8	3.40	1305.8	4.60	1305.8		

Hydro-Brake Outflow Control

Design Head (m) 1.200 Hydro-Brake Type MD6 Invert Level (m) 30.400  
 Design Flow (l/s) 14.4 Diameter (mm) 151

Depth (m)	Flow (l/s)								
0.10	5.0	0.80	12.5	2.00	18.4	4.00	26.1	7.00	34.5
0.20	11.3	1.00	13.3	2.20	19.3	4.50	27.6	7.50	35.7
0.30	13.3	1.20	14.4	2.40	20.2	5.00	29.1	8.00	36.8
0.40	13.2	1.40	15.5	2.60	21.0	5.50	30.6	8.50	38.0
0.50	12.7	1.60	16.5	3.00	22.6	6.00	31.9	9.00	39.1
0.60	12.4	1.80	17.5	3.50	24.4	6.50	33.2	9.50	40.2

Weir / Flume Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Crest Level (m) 31.500

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Summary of Results for 30 year Return Period (+10%)

Storm Duration (mins)	Maximum Control (l/s)	Maximum Overflow (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Overflow Volume (m <sup>3</sup> )	Maximum Volume (m <sup>3</sup> )	Status
15 Summer	13.3	0.0	13.3	30.7433	0.3432	0.0	286.1	O K
30 Summer	13.3	0.0	13.3	30.8303	0.4302	0.0	368.4	O K
60 Summer	13.3	0.0	13.3	30.9103	0.5102	0.0	447.9	O K
120 Summer	13.3	0.0	13.3	30.9768	0.5768	0.0	516.9	O K
180 Summer	13.3	0.0	13.3	31.0043	0.6043	0.0	546.3	O K
240 Summer	13.3	0.0	13.3	31.0158	0.6158	0.0	558.4	O K
360 Summer	13.3	0.0	13.3	31.0178	0.6178	0.0	561.0	O K
480 Summer	13.3	0.0	13.3	31.0138	0.6138	0.0	556.4	O K
600 Summer	13.3	0.0	13.3	31.0068	0.6068	0.0	549.1	O K
720 Summer	13.3	0.0	13.3	30.9983	0.5983	0.0	540.0	O K
960 Summer	13.3	0.0	13.3	30.9783	0.5783	0.0	518.3	O K
1440 Summer	13.3	0.0	13.3	30.9308	0.5307	0.0	469.1	O K
2160 Summer	13.3	0.0	13.3	30.8577	0.4577	0.0	395.6	O K
2880 Summer	13.3	0.0	13.3	30.7923	0.3922	0.0	331.9	O K
4320 Summer	13.2	0.0	13.2	30.6958	0.2957	0.0	242.6	O K
5760 Summer	12.1	0.0	12.1	30.6388	0.2387	0.0	192.4	O K
7200 Summer	11.3	0.0	11.3	30.6018	0.2017	0.0	160.5	O K
8640 Summer	10.1	0.0	10.1	30.5813	0.1812	0.0	143.1	O K
10080 Summer	9.1	0.0	9.1	30.5653	0.1652	0.0	129.9	O K
15 Winter	13.3	0.0	13.3	30.7813	0.3812	0.0	321.3	O K
30 Winter	13.3	0.0	13.3	30.8772	0.4772	0.0	414.5	O K
60 Winter	13.3	0.0	13.3	30.9658	0.5657	0.0	505.2	O K
120 Winter	13.3	0.0	13.3	31.0408	0.6408	0.0	585.6	O K
180 Winter	13.3	0.0	13.3	31.0733	0.6733	0.0	621.4	O K
240 Winter	13.3	0.0	13.3	31.0883	0.6883	0.0	638.2	O K
360 Winter	13.3	0.0	13.3	31.0963	0.6963	0.0	647.0	O K
480 Winter	13.3	0.0	13.3	31.0893	0.6893	0.0	639.5	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	83.64	23
30 Summer	54.45	37
60 Summer	33.89	66
120 Summer	20.48	126
180 Summer	15.09	184
240 Summer	12.09	242
360 Summer	8.84	340
480 Summer	7.07	394
600 Summer	5.94	456
720 Summer	5.16	520
960 Summer	4.12	656
1440 Summer	3.00	926
2160 Summer	2.18	1316
2880 Summer	1.73	1676
4320 Summer	1.26	2380
5760 Summer	1.00	3064
7200 Summer	0.84	3752
8640 Summer	0.72	4488
10080 Summer	0.64	5152
15 Winter	83.64	23
30 Winter	54.45	37
60 Winter	33.89	66
120 Winter	20.48	124
180 Winter	15.09	180
240 Winter	12.09	238
360 Winter	8.84	348
480 Winter	7.07	452

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Summary of Results for 30 year Return Period (+10%)

Storm Duration (mins)	Maximum Control (l/s)	Maximum Overflow (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Overflow Volume (m <sup>3</sup> )	Maximum Volume (m <sup>3</sup> )	Status
600 Winter	13.3	0.0	13.3	31.0778	0.6778	0.0	626.5	O K
720 Winter	13.3	0.0	13.3	31.0663	0.6663	0.0	614.0	O K
960 Winter	13.3	0.0	13.3	31.0378	0.6378	0.0	582.7	O K
1440 Winter	13.3	0.0	13.3	30.9683	0.5683	0.0	507.8	O K
2160 Winter	13.3	0.0	13.3	30.8562	0.4562	0.0	393.9	O K
2880 Winter	13.3	0.0	13.3	30.7592	0.3592	0.0	300.6	O K
4320 Winter	12.2	0.0	12.2	30.6433	0.2432	0.0	196.2	O K
5760 Winter	10.7	0.0	10.7	30.5898	0.1897	0.0	150.3	O K
7200 Winter	9.0	0.0	9.0	30.5643	0.1643	0.0	129.1	O K
8640 Winter	7.9	0.0	7.9	30.5463	0.1463	0.0	114.1	O K
10080 Winter	7.0	0.0	7.0	30.5323	0.1323	0.0	102.7	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
600 Winter	5.94	488
720 Winter	5.16	560
960 Winter	4.12	714
1440 Winter	3.00	1010
2160 Winter	2.18	1408
2880 Winter	1.73	1760
4320 Winter	1.26	2424
5760 Winter	1.00	3064
7200 Winter	0.84	3816
8640 Winter	0.72	4496
10080 Winter	0.64	5240

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

Storm Duration (mins)	Maximum Control (l/s)	Maximum Overflow (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Overflow Volume (m <sup>3</sup> )	Maximum Volume (m <sup>3</sup> )	Status
15 Summer	13.3	0.0	13.3	30.9052	0.5052	0.0	443.1	O K
30 Summer	13.3	0.0	13.3	31.0343	0.6343	0.0	578.5	O K
60 Summer	13.3	0.0	13.3	31.1528	0.7528	0.0	711.8	O K
120 Summer	13.3	0.0	13.3	31.2543	0.8543	0.0	832.2	O K
180 Summer	13.3	0.0	13.3	31.2993	0.8993	0.0	887.9	O K
240 Summer	13.3	0.0	13.3	31.3218	0.9218	0.0	915.6	O K
360 Summer	13.3	0.0	13.3	31.3393	0.9393	0.0	937.7	O K
480 Summer	13.3	0.0	13.3	31.3388	0.9388	0.0	937.6	O K
600 Summer	13.3	0.0	13.3	31.3303	0.9303	0.0	926.6	O K
720 Summer	13.3	0.0	13.3	31.3208	0.9208	0.0	914.7	O K
960 Summer	13.3	0.0	13.3	31.2998	0.8998	0.0	888.5	O K
1440 Summer	13.3	0.0	13.3	31.2538	0.8538	0.0	831.8	O K
2160 Summer	13.3	0.0	13.3	31.1808	0.7808	0.0	744.2	O K
2880 Summer	13.3	0.0	13.3	31.1073	0.7073	0.0	659.8	O K
4320 Summer	13.3	0.0	13.3	30.9668	0.5668	0.0	506.3	O K
5760 Summer	13.3	0.0	13.3	30.8392	0.4392	0.0	377.3	O K
7200 Summer	13.3	0.0	13.3	30.7448	0.3447	0.0	287.4	O K
8640 Summer	13.0	0.0	13.0	30.6843	0.2842	0.0	232.5	O K
10080 Summer	12.2	0.0	12.2	30.6438	0.2437	0.0	196.5	O K
15 Winter	13.3	0.0	13.3	30.9583	0.5582	0.0	497.6	O K
30 Winter	13.3	0.0	13.3	31.0988	0.6988	0.0	649.8	O K
60 Winter	13.3	0.0	13.3	31.2283	0.8283	0.0	800.8	O K
120 Winter	13.3	0.0	13.3	31.3403	0.9403	0.0	938.9	O K
180 Winter	13.3	0.0	13.3	31.3913	0.9913	0.0	1004.8	O K
240 Winter	13.4	0.0	13.4	31.4178	1.0178	0.0	1039.6	O K
360 Winter	13.6	0.0	13.6	31.4423	1.0423	0.0	1071.6	O K
480 Winter	13.6	0.0	13.6	31.4478	1.0478	0.0	1078.8	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	128.29	24
30 Summer	84.23	38
60 Summer	52.66	68
120 Summer	31.80	126
180 Summer	23.35	186
240 Summer	18.64	246
360 Summer	13.54	364
480 Summer	10.79	480
600 Summer	9.04	550
720 Summer	7.82	604
960 Summer	6.22	726
1440 Summer	4.49	994
2160 Summer	3.24	1408
2880 Summer	2.57	1812
4320 Summer	1.85	2560
5760 Summer	1.46	3280
7200 Summer	1.22	3896
8640 Summer	1.05	4584
10080 Summer	0.92	5248
15 Winter	128.29	24
30 Winter	84.23	38
60 Winter	52.66	66
120 Winter	31.80	124
180 Winter	23.35	182
240 Winter	18.64	240
360 Winter	13.54	354
480 Winter	10.79	466

Sheppard Lockton House  
Cafferata Way  
Newark NG24 2TN

9515 SSL Houghton Main  
Grimethorpe  
Flood Risk Assessment

Date 18 June 2008  
File POND.SRC

Designed By DM  
Checked By

Micro Drainage

Source Control W.11.2



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

Storm Duration (mins)	Maximum Control (l/s)	Maximum Overflow (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Overflow Volume (m³)	Maximum Volume (m³)	Status
600 Winter	13.6	0.0	13.6	31.4428	1.0428	0.0	1071.8	O K
720 Winter	13.5	0.0	13.5	31.4308	1.0308	0.0	1056.4	O K
960 Winter	13.4	0.0	13.4	31.4023	1.0023	0.0	1019.3	O K
1440 Winter	13.3	0.0	13.3	31.3438	0.9438	0.0	943.9	O K
2160 Winter	13.3	0.0	13.3	31.2428	0.8428	0.0	818.4	O K
2880 Winter	13.3	0.0	13.3	31.1358	0.7358	0.0	692.0	O K
4320 Winter	13.3	0.0	13.3	30.9183	0.5182	0.0	456.2	O K
5760 Winter	13.3	0.0	13.3	30.7413	0.3412	0.0	284.1	O K
7200 Winter	12.4	0.0	12.4	30.6538	0.2537	0.0	205.3	O K
8640 Winter	11.3	0.0	11.3	30.6023	0.2022	0.0	160.8	O K
10080 Winter	10.1	0.0	10.1	30.5813	0.1813	0.0	143.2	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
600 Winter	9.04	576
720 Winter	7.82	678
960 Winter	6.22	770
1440 Winter	4.49	1072
2160 Winter	3.24	1520
2880 Winter	2.57	1960
4320 Winter	1.85	2724
5760 Winter	1.46	3336
7200 Winter	1.22	3960
8640 Winter	1.05	4504
10080 Winter	0.92	5240