



Design & Access Statement

E04759

APPENDIX F

Flood Risk Assessment

Ranikhet Primary School, Spey Rd, Reading RG30 4ED

Stage D Flood Risk & Drainage Strategy Report

Hantsfile Ref:			Job No: E04759		
Rev	Description	Date	Originator	Checked	Approved
-	First Issue	21.10.2020	S Baker	L Weller	D Ryder
A	Second Issue	03.02.2021	S Baker	L Weller	D Ryder



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Director of Economy, Transport and Environment, The Castle, Winchester

Introduction

Hampshire County Councils Property Services have commissioned HCC's Engineering Consultancy to undertake a flood risk and drainage strategy report.

The flood risk and drainage strategy report shall review the existing and proposed situation to ascertain the impact of the development.

This Assessment has been prepared in accordance with Communities & Local Government, National Planning Policy Framework (NPPF), Planning Practice Guidance (PPG) and the requirements of the Lead Local Flood Authority (LLFA)

Overview of the Development

The proposed development is to construct a new school building, whilst retaining the existing during the construction phase and subsequently demolishing the existing building once the new building can be occupied. The existing Synthetic Turf Pitch (STP) is to remain, new parking and hard paved surfaces will be constructed on the footprint of the existing building once demolished, Appendix B.

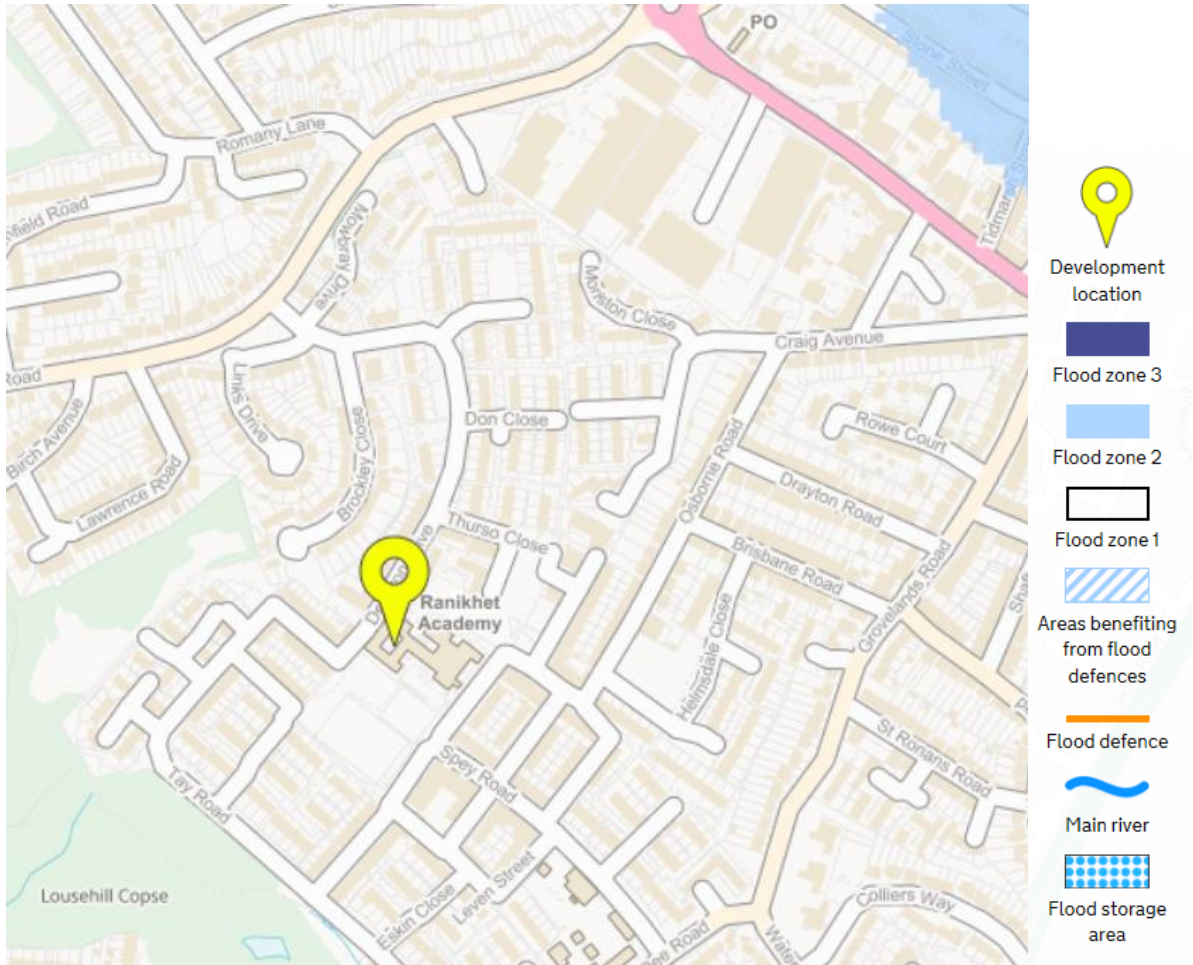
The site is located on Spey Road, Reading, within an urbanised area, the total area of the site is approximately 1.8ha.

Site levels vary 8m in height south west to north east and 6m in height north to south.

Flood Risk

Environment Agency (EA) flood maps (fig 1) confirm that the entire site is situated within Flood Zone 1 where the annual probability of flooding from Rivers or the Sea is less than 0.1%.

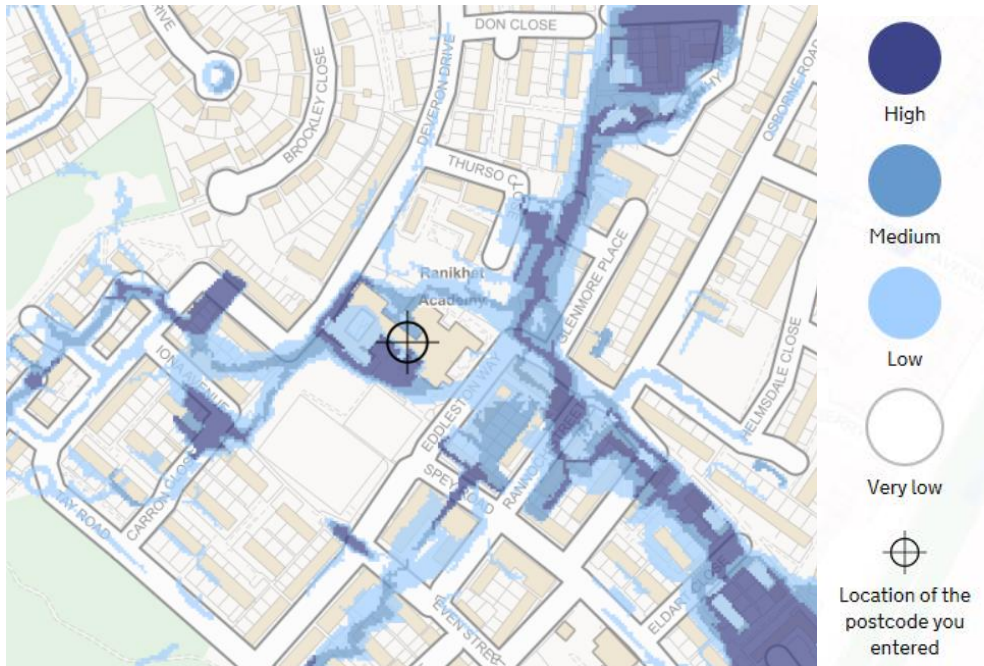
Environment Agency Flood Map (fig 1)



(<https://flood-map-for-planning.service.gov.uk>)

Environment Agency (EA) surface water flood maps (fig 2) confirm that most of the site is at “high” risk of surface water flooding where the annual probability of flooding from surface water is greater than 3.3%. The contributory factors to the surface water flooding should be investigated and addressed prior to developing this site.

Environment Agency Pluvial Flood Map (fig 2)



(<https://flood-warning-information.service.gov.uk/>)

Environment Agency mapping has confirmed that the site lies within a groundwater source protection zone.

According to the Environment Agency (EA) main river map (fig 3) there is a main river 1km North of the site.

Environment Agency Main River Map (fig 3)



(<https://environment.maps.arcgis.com>)

Ground Conditions

A field investigation, undertaken during August 2020, comprised 3no. cable percussive boreholes, 9no. mini percussive boreholes, 10no. hand excavated trial pits, 2no hand excavated pits with in-situ CBR testing and 1no dynamic probe.

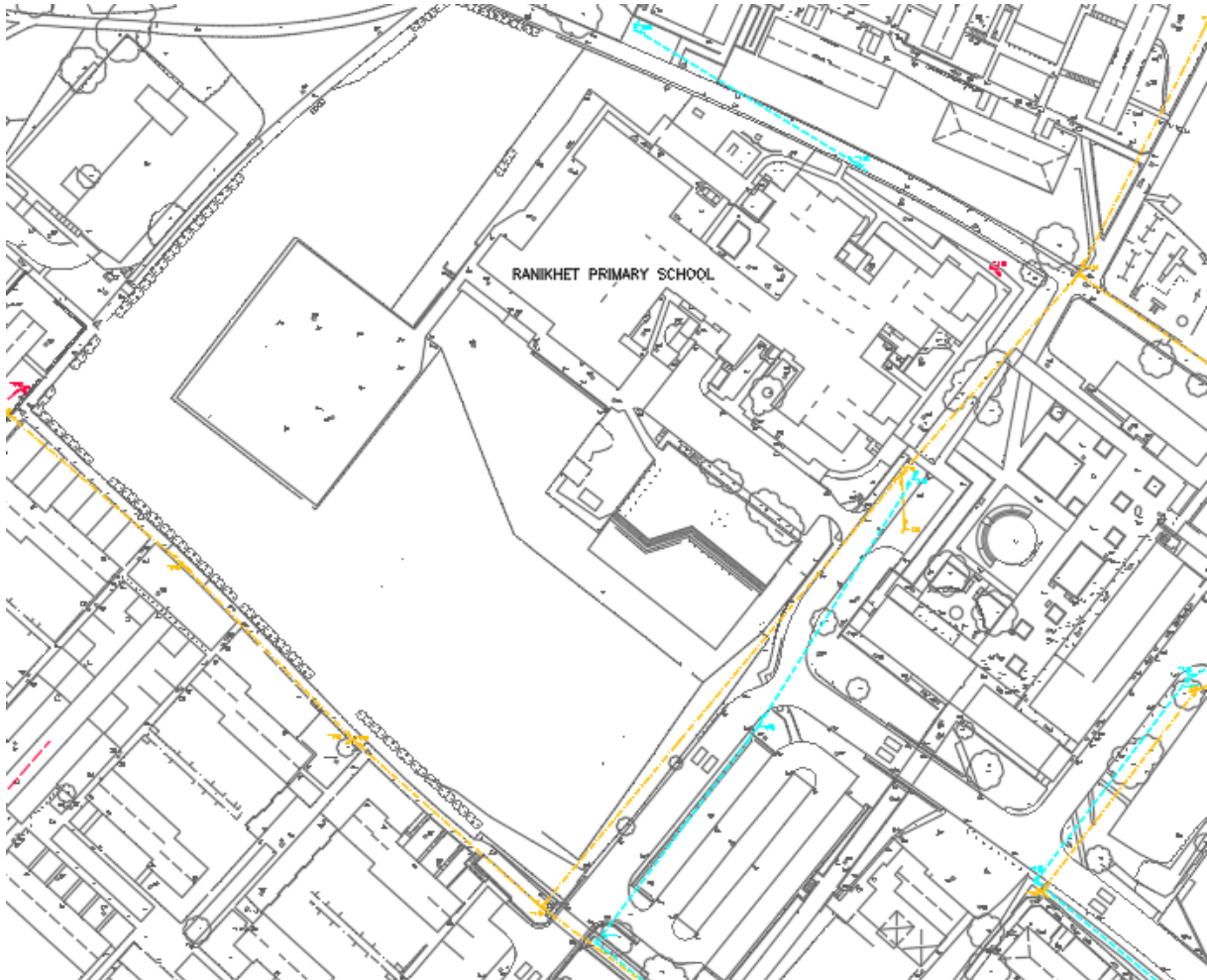
The ground conditions encountered by the investigation generally comprised Made ground underlain by the Lambeth Group and/or Seaford and Newhaven Chalk Formations. The Made Ground was variable and extended to depths ranging from 0.23m to 2.40m bgl. The Lambeth Group comprised firm to stiff clays and loose to dense sands that extended to depths ranging from 0.15m to 14.30m bgl. The deeper Lambeth deposits from BH03 are potentially associated with an infilled solution feature at the site. The Seaford and Newhaven Chalk Formations comprised structureless chinks of Grade Dm that became structured with depth that extend to the maximum investigated depth of 20m bgl.

Groundwater was encountered at a depth of between 17.90 and 18.00m bgl.

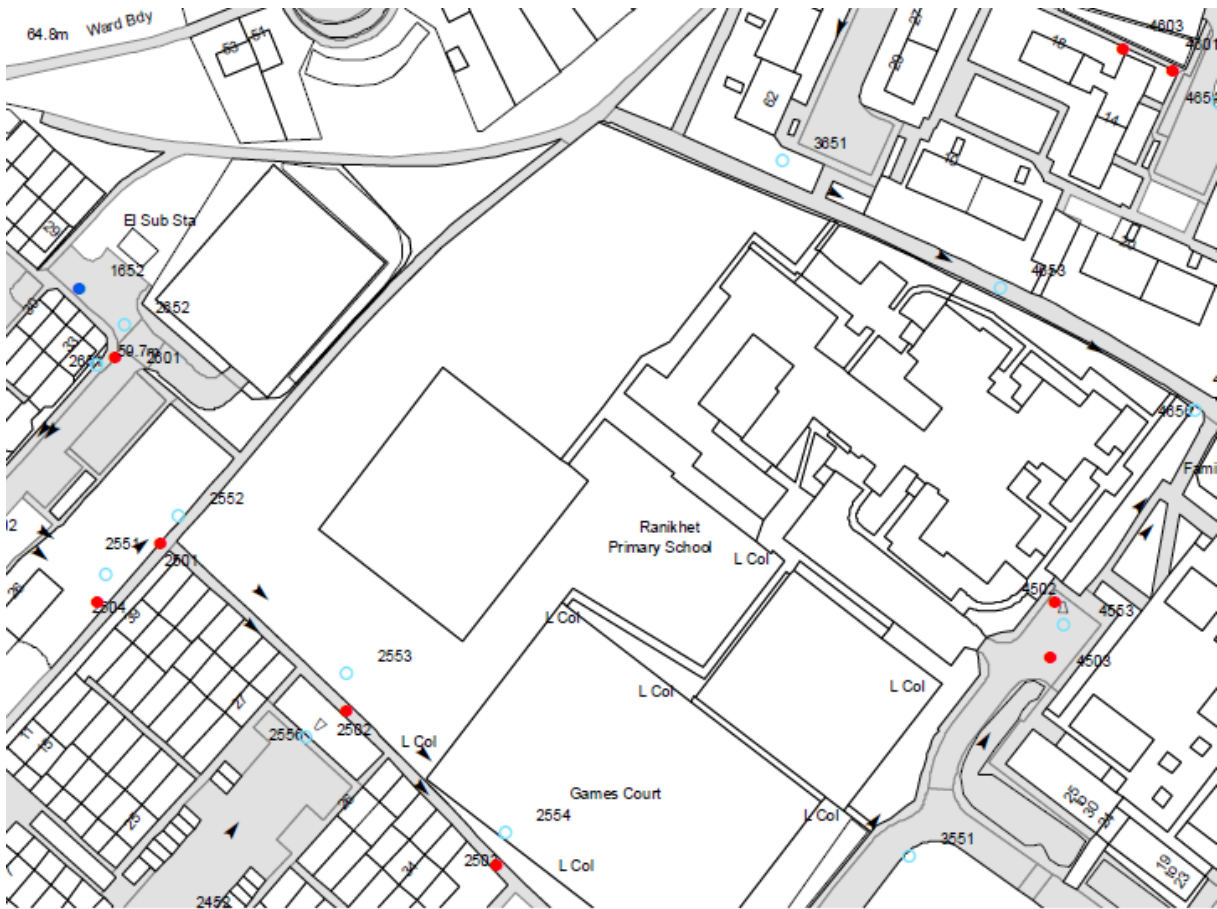
Foul Water

The topographical survey and Thames Water sewer records, figures 4 & 5, indicate a 225mm diameter foul water sewer running along both the south west and south east boundaries of the site.

Topographical Survey Extract 2 (2008) (fig 4)



Thames Water Asset Location Search Record (2011) (fig 5)



Foul water sewers are shown as orange, surface water shown as cyan and unknown drainage runs are shown in red, figure 4. Figure 5 shows foul manholes in red and surface water manholes in blue (note: pipelines are missing from sewer records).

A radar ground penetrating radar survey has confirmed the presence of a foul water drainage system that discharges to the foul water sewer within Eddleston Way, Appendix A.

The existing drainage system will need to remain live until such point that the new building is occupied and the existing building is demolished.

It is not anticipated that there will be a significant increase in foul flows from the site as a result of redevelopment.

Surface Water

The topographical survey and Thames Water sewer records, figures 4 & 5, indicate a 300mm diameter surface water sewer running along both the south west and south east boundaries of the site.

A ground penetrating radar survey of the site confirms that there is an existing surface water drainage system present that discharges to the 300mm surface water sewer located in Eddleston Way, Appendix A.

Existing surface water run-off rates

The existing site is 17,727sqm in size, the existing hard paved and roof area equates to 11,925sqm. The existing run-off rates have been calculated in Table 1 below.

Return Period	Rainfall	Run-off Rate
1:1	(29.220mm/hr)	= 96.79l/s
1:30	(71.613mm/hr)	= 237.21l/s
1:100	(92.745mm/hr)	= 307.21l/s

Table 1

As part of the redevelopment of the site the existing 3,495sqm STP will remain, it is intended to leave this as separate, existing connection, to the surface water sewer and therefore this runoff rates will not be considered. Run-off rates for the existing STP have been calculated in Table 2 below.

Return Period	Rainfall	Run-off Rate
1:1	(29.220mm/hr)	= 28.36l/s
1:30	(71.613mm/hr)	= 69.52l/s
1:100	(92.745mm/hr)	= 90.03l/s

Table 2

The remaining hard paved area, excluding the STP is 8,430sqm. Run-off rates have been calculated in Table 3 below.

Return Period	Rainfall	Run-off Rate
1:1	(29.220mm/hr)	= 68.42l/s
1:30	(71.613mm/hr)	= 237.21l/s
1:100	(92.745mm/hr)	= 307.21l/s

Table 3

Proposed Run-off Rates

The proposed re-development of the site will reduce the hard paved area from 8,430sqm to 6,724sqm (Existing STP not included). The proposed run-off rates will be restricted to the below run-off rates.

This provide a 15% reduction for the 1:1 year storm, 58% reduction for the 1:30 year storm and a 67% reduction for the 1:100 year storm, which is a betterment over the existing drainage regime.

Return Period	Rainfall	Run-off Rate
1:1	(29.220mm/hr)	= 58l/s
1:30	(71.613mm/hr)	= 100l/s
1:100	(92.745mm/hr)	= 100l/s
1:100+40%	(129.843mm/hr)	= 100l/s

Table 4

As a result of redevelopment of the site the existing run-off rates will be reduced (Table 4 proposed rates less than Table 3 existing rates).

During construction, the new building will be temporarily connected to the surface water sewer at an unrestricted flow rate, whilst the existing building is demolished to allow room to install the attenuation tank.

Existing & Proposed Volume of Run-off Rates

The hard-paved area will be reduced by 1,706sqm as a result of re-development and therefore the volume of run-off will be reduced.

Ordinary Watercourse Consent

There are no proposed alterations to any ordinary watercourse and therefore consent is not sought nor required.

SuDS Hierarchy of Systems and Justification of Usage

We have reviewed and taken into consideration the Environment Agency SuDS Hierarchy for SuDS systems which are noted below in order of preference:

1. Living Roofs
2. Basins and Ponds
3. Filter Strips and Swales
4. Infiltration Devices
5. Permeable Surfaces and Filter Drains
6. Tanked Systems

Below is the response to these systems identifying the most suitable system for the scheme.

1. Living and green roofs impose a large load on the roof structure and require relatively flat roofs to insure water retention. The proposed buildings will be constructed using lightweight roofs. This deems green roofs as being unfeasible for this project.
2. The use of open basins and ponds is not feasible due to the compact nature of the site.
3. Filter strips and swales are not feasible due to the compact nature of the site.
4. Shallow ground Infiltration devices are not feasible due a variation of ground conditions, low to weak density chalk and the presences of existing structures, foundations etc, within areas suitable for soakaway location.
5. Permeable surfaces as non-infiltration (tanked) systems are feasible.
6. A positive surface water storage tank systems with restricted connection to the surface water sewer is feasible.

Urban Creep

Urban creep is the conversion of permeable surfaces to impermeable over time e.g. surfacing of front gardens to provide additional parking spaces, extensions to existing buildings, creation of large patio areas. Much research has been carried out in to the effect of urban creep and its effect on the drainage systems which cater for urban areas. It has been shown that, over the lifetime of a development, urban creep can increase impermeable areas by as much as 10%.

Due to the nature of the development being a school site, any further increases in hard paved areas would require further planning applications and drainage storage requirement would be reviewed, on this basis therefore urban creep has not been applied.

Storm Design Exceedance

It is difficult to completely guard against flooding since extreme events greater than the design standard event are always possible, however, it is practicable to minimise the risk by careful design of the layout of the development such that internal flooding is avoided. Areas of hard standing can be laid to falls away from buildings to provide a significant volume of surface storage during extreme events with flows directed to areas where damage and disruption to operations will be minimised.

The FFL of the building is set above the surrounding car park and road levels and therefore any exceedance water will be directed away from the building to the new car park.

Water Quality Criteria

Water quality criteria will be met through the use of proprietary filter manholes and swales.

The new surface water drainage system should be designed as recommended by Building Regulations and the SUDS manual. The system should be capable of draining the site, without flooding, during a 1 in 30 year storm whilst retaining the 1 in 100 year storm flows plus 40% allowance for climate change within the site boundary without putting existing buildings, the proposed development and any third party land at risk from flooding. For more extreme storms, flood routing is to be identified and the risk of flooding to buildings minimised as far as reasonably practicable.

Future Maintenance of System

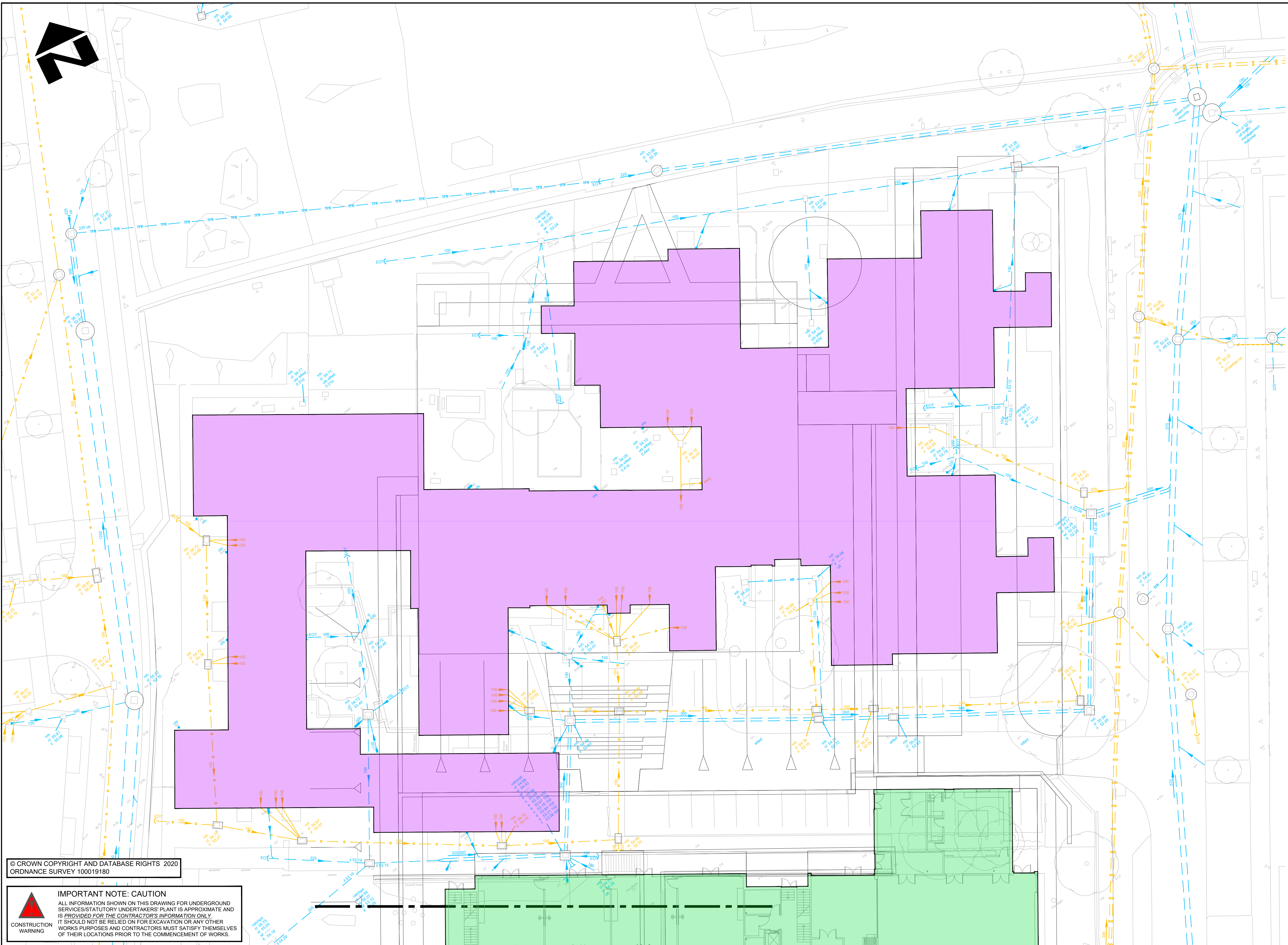
Following construction, a maintenance document for the system will be provided to the school site manager which will detail the constructed systems maintenance requirements.

It is the school's responsibility to maintain the system to prevent the increase in the risk of flooding on and off site as a result of system failure.

Proposed Site Surface Water Drainage Strategy

It is proposed to discharge the surface water to the existing drainage systems at no greater than the existing run-off rates an attenuation system will be designed to cater for the 1:100 year +40 storm return period, refer to Appendix B for a drainage layout and calculations.

Appendix A



- NOTES**
- GENERAL**
- DO NOT SCALE FROM THIS DRAWING. REFER TO FIGURED DIMENSIONS ONLY. THE CONTRACTOR SHOULD CHECK ALL DIMENSIONS ON SITE.
 - ALL DIMENSIONS IN MILLIMETRES AND ALL LEVELS ARE IN METRES UNLESS NOTED OTHERWISE.
 - THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT ARCHITECT AND ENGINEERING DETAILS, DRAWINGS AND SPECIFICATIONS.
 - ANY DISCREPANCIES SHOULD BE REPORTED TO THE ARCHITECT AND/OR ENGINEER IMMEDIATELY, SO THAT CLARIFICATION CAN BE SOUGHT PRIOR TO THE COMMENCEMENT OF WORK.

DRAINAGE LEGEND

EXISTING FEATURES

- EXISTING SURFACE WATER SEWER/DRAIN AND MANHOLE
- EXISTING FOUL WATER SEWER/DRAIN AND MANHOLE
- AREA OF EXISTING BUILDING
- AREA OF PROPOSED BUILDING

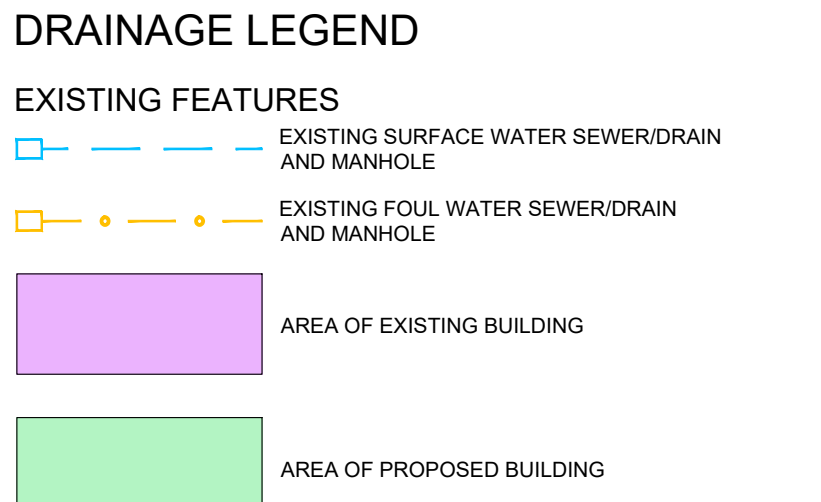
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IMPORTANT NOTE: CAUTION

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PARTS OF THIS DRAWING SHOULD BE SHOWN IN COLOUR. IF THIS NOTE IS NOT RED REPRINT A COLOURED COPY

										CLIENT HCC PROPERTY SERVICES HAMPSHIRE COUNTY COUNCIL CULTURE, COMMUNITIES AND BUSINESS SERVICES				CONSULTANT  Hampshire County Council  STUART JARVIS BSc DipTP FCIHT MRTPI: DIRECTOR OF ECONOMY, TRANSPORT & ENVIRONMENT				SCALE @ A1 1:200 SCALE @ A3 1:100 SHEET No. 1 OF 2		SCHEME RANIKHET PRIMARY SCHOOL		DRAWING TITLE EXISTING DRAINAGE GENERAL ARRANGEMENT	
S2	P01	INITIAL ISSUE						06.10.2020		SPB	BLB												
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													HCC PROPERTY SERVICES HAMPSHIRE COUNTY COUNCIL CULTURE, COMMUNITIES AND BUSINESS SERVICES	 	EXISTING DRAINAGE GENERAL ARRANGEMENT
										STUART JARVIS BSc DipTP FCIHT MRTPI: DIRECTOR OF ECONOMY, TRANSPORT & ENVIRONMENT	SCALE @ A1 1:200 SCALE @ A3 1:100 SHEET No. 2 OF 2	SCHEME RANIKHET PRIMARY SCHOOL	DRAWING NUMBER P04759-ECH-XX-XX-DR-C-7002	SUIT S2 ISSUED FOR INFORMATION	REV P01
										S2 P01 INITIAL ISSUE	06.10.2020 SPB BLB	DATE ENG TECH CHKD APPD	SUIT REV	AMENDMENTS	S2 P01 INITIAL ISSUE

Appendix B

Ranhiket Primary School Re-development

Landscape Feasibility

-  Proposed Pedestrian Access
-  Proposed Vehicular Access
-  Building
-  Vehicular macadam
-  Pedestrian macadam
-  Small unit concrete paving
-  Ground cover and low shrub planting
-  Grass
-  Seating
-  Retaining wall
-  Proposed tree
-  Existing tree
-  Fencing 2.4m high perimeter
-  Fencing 2.4m high bespoke front entrance
-  Fencing 3m high Steel mesh MUGA fence
-  Fencing 1.2 high timber fence

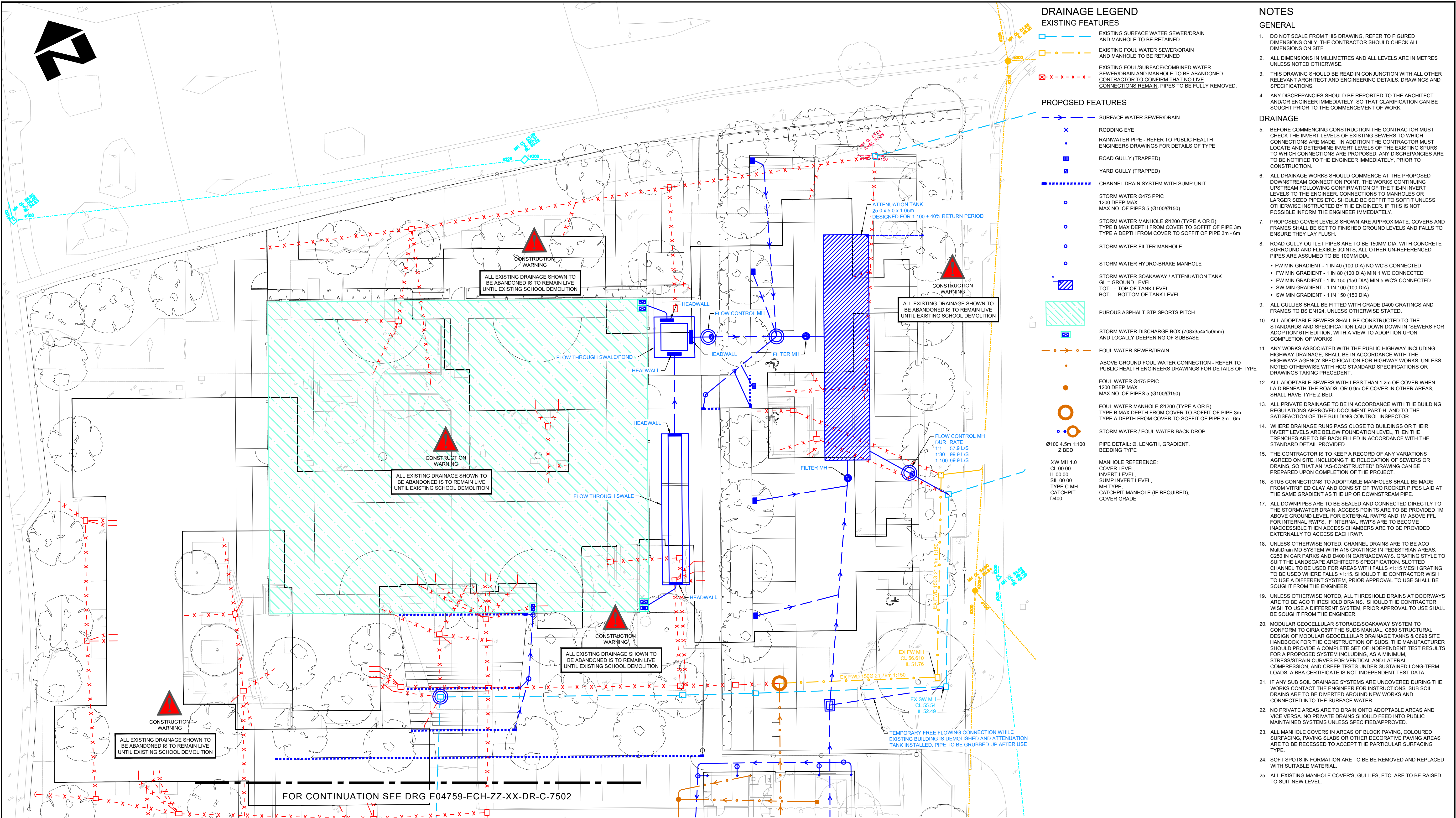
- ① MUGA
- ② Car park 46spaces including 3 disabled and 2 motor cycle stands
- ③ Swale
- ④ Cycle parking
- ⑤ Fire / maintenance access inc drop kerbs to street level
- ⑥ Front entrance
- ⑦ Parent / pupil entrance
- ⑧ School garden area
- ⑨ Access to STP



Stage D
E04759-HCC-XX-SK-L-1200
January 2020



Appendix C

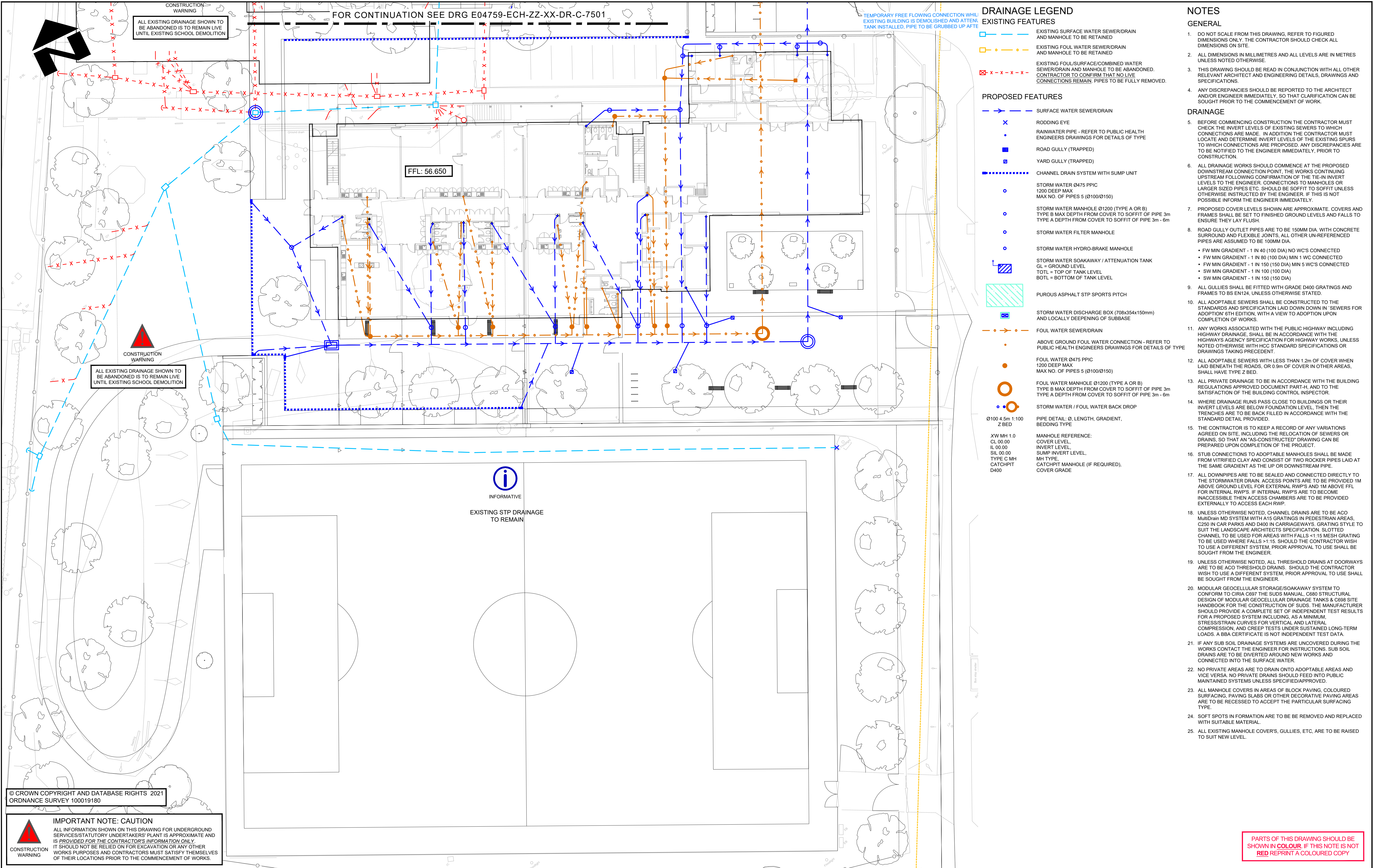


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								HCC PROPERTY SERVICES HAMPSHIRE COUNTY COUNCIL CULTURE, COMMUNITIES AND BUSINESS SERVICES				 Hampshire County Council				SCALE @ A3 1:400					
																SHEET No. 1 OF 2					
S2	P02	REVISED TO SUIT LATEST LANDSCAPE ARCHITECTS STAGE D LAYOUT						02.02.2021	MJL	-	SPB	DMR	STUART JARVIS BSc DipTP FCIHT MRTPI: DIRECTOR OF ECONOMY, TRANSPORT & ENVIRONMENT				DRAWING NUMBER E04759-ECH-XX-XX-DR-C-7501		SUIT S2	ISSUED FOR INFORMATION	REV P02
S2	P01	STAGE D ISSUE						23.10.2020	SPB	BLB	-	-									
SUIT	REV	AMENDMENTS						DATE	ENG	TECH	CHKD	APPD									

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S2		P02	REVISED TO SUIT LATEST LANDSCAPE ARCHITECTS STAGE D LAYOUT	02.02.2021	MJL	-	SPB	DMR
S2		P01	STAGE D ISSUE	23.10.2020	SPB	BLB	-	-
SUIT		REV	AMENDMENTS	DATE	ENG	TECH	CHKD	APPD

CLIENT		CONSULTANT		SCALE @ A1 1:200		SCHEME		DRAWING TITLE	
HCC PROPERTY SERVICES		Hampshire County Council		SCALE @ A3 1:400		RANIKHET PRIMARY SCHOOL		PROPOSED DRAINAGE	
HAMPSHIRE COUNTY COUNCIL		Engineering CONSULTANCY		SHEET No. 2 OF 2				GENERAL ARRANGEMENT	
CULTURE, COMMUNITIES AND BUSINESS SERVICES		STUART JARVIS BSc DipTPT FCITP MRTPi DIRECTOR OF ECONOMY, TRANSPORT & ENVIRONMENT		DRAWING NUMBER E04759-ECH-XX-XX-DR-C-7502		SUIT S2		ISSUED FOR INFORMATION	
								REV P02	

Ranikhet
Stage D



Date 21/10/2020

Designed by S Baker

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Micro Drainage

Source Control 2017.1.2

Summary of Results for 1 year Return Period (+40%)

Half Drain Time : 7 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.225	0.225	0.0	47.7	47.7	26.8	O K
30 min Summer	0.241	0.241	0.0	53.4	53.4	28.6	O K
60 min Summer	0.235	0.235	0.0	51.0	51.0	27.9	O K
120 min Summer	0.208	0.208	0.0	41.7	41.7	24.7	O K
180 min Summer	0.188	0.188	0.0	34.8	34.8	22.3	O K
240 min Summer	0.172	0.172	0.0	29.9	29.9	20.5	O K
360 min Summer	0.152	0.152	0.0	23.8	23.8	18.0	O K
480 min Summer	0.137	0.137	0.0	19.8	19.8	16.3	O K
600 min Summer	0.127	0.127	0.0	17.2	17.2	15.1	O K
720 min Summer	0.119	0.119	0.0	15.1	15.1	14.1	O K
960 min Summer	0.107	0.107	0.0	12.5	12.5	12.7	O K
1440 min Summer	0.093	0.093	0.0	9.4	9.4	11.0	O K
2160 min Summer	0.080	0.080	0.0	7.1	7.1	9.4	O K
2880 min Summer	0.072	0.072	0.0	5.8	5.8	8.5	O K
4320 min Summer	0.062	0.062	0.0	4.3	4.3	7.3	O K
5760 min Summer	0.055	0.055	0.0	3.5	3.5	6.5	O K
7200 min Summer	0.051	0.051	0.0	2.9	2.9	6.0	O K
8640 min Summer	0.048	0.048	0.0	2.6	2.6	5.6	O K
10080 min Summer	0.045	0.045	0.0	2.3	2.3	5.3	O K
15 min Winter	0.243	0.243	0.0	53.9	53.9	28.8	O K
30 min Winter	0.254	0.254	0.0	57.9	57.9	30.1	O K
60 min Winter	0.234	0.234	0.0	50.7	50.7	27.8	O K
120 min Winter	0.194	0.194	0.0	37.0	37.0	23.1	O K
180 min Winter	0.170	0.170	0.0	29.1	29.1	20.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	40.459	0.0	51.2	19
30 min Summer	26.283	0.0	66.6	26
60 min Summer	16.619	0.0	84.3	40
120 min Summer	10.297	0.0	104.5	70
180 min Summer	7.744	0.0	117.9	102
240 min Summer	6.320	0.0	128.3	132
360 min Summer	4.742	0.0	144.4	192
480 min Summer	3.844	0.0	156.1	252
600 min Summer	3.265	0.0	165.7	312
720 min Summer	2.857	0.0	174.0	374
960 min Summer	2.315	0.0	188.0	494
1440 min Summer	1.722	0.0	209.7	736
2160 min Summer	1.281	0.0	234.1	1100
2880 min Summer	1.039	0.0	253.3	1460
4320 min Summer	0.773	0.0	282.3	2184
5760 min Summer	0.626	0.0	305.2	2880
7200 min Summer	0.532	0.0	324.2	3672
8640 min Summer	0.466	0.0	340.7	4360
10080 min Summer	0.417	0.0	355.3	5096
15 min Winter	40.459	0.0	57.4	18
30 min Winter	26.283	0.0	74.6	26
60 min Winter	16.619	0.0	94.4	40
120 min Winter	10.297	0.0	117.1	72
180 min Winter	7.744	0.0	132.1	102

Ranikhet
Stage D



Date 21/10/2020

Designed by S Baker

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Micro Drainage

Source Control 2017.1.2

Summary of Results for 1 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m ³)	Status
240 min Winter	0.153	0.153	0.0	24.2	24.2	18.2	O K
360 min Winter	0.132	0.132	0.0	18.4	18.4	15.7	O K
480 min Winter	0.119	0.119	0.0	15.1	15.1	14.1	O K
600 min Winter	0.109	0.109	0.0	12.9	12.9	13.0	O K
720 min Winter	0.102	0.102	0.0	11.3	11.3	12.1	O K
960 min Winter	0.091	0.091	0.0	9.2	9.2	10.9	O K
1440 min Winter	0.079	0.079	0.0	6.9	6.9	9.3	O K
2160 min Winter	0.068	0.068	0.0	5.2	5.2	8.0	O K
2880 min Winter	0.061	0.061	0.0	4.2	4.2	7.2	O K
4320 min Winter	0.052	0.052	0.0	3.1	3.1	6.2	O K
5760 min Winter	0.047	0.047	0.0	2.5	2.5	5.5	O K
7200 min Winter	0.043	0.043	0.0	2.1	2.1	5.1	O K
8640 min Winter	0.040	0.040	0.0	1.9	1.9	4.8	O K
10080 min Winter	0.038	0.038	0.0	1.7	1.7	4.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
240 min Winter	6.320	0.0	143.7	132
360 min Winter	4.742	0.0	161.8	194
480 min Winter	3.844	0.0	174.8	254
600 min Winter	3.265	0.0	185.6	314
720 min Winter	2.857	0.0	194.9	376
960 min Winter	2.315	0.0	210.6	498
1440 min Winter	1.722	0.0	234.9	734
2160 min Winter	1.281	0.0	262.2	1100
2880 min Winter	1.039	0.0	283.7	1452
4320 min Winter	0.773	0.0	316.2	2196
5760 min Winter	0.626	0.0	341.8	2840
7200 min Winter	0.532	0.0	363.1	3648
8640 min Winter	0.466	0.0	381.6	4344
10080 min Winter	0.417	0.0	398.0	5160

Ranikhet
Stage D



Date 21/10/2020

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Micro Drainage

Source Control 2017.1.2

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.700	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.677

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0 4	0.229	4 8	0.224	8 12	0.224

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	Ranikhet Stage D	
Date 21/10/2020	Designed by S Baker	
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Model Details

Storage is Online Cover Level (m) 1.050

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	125.0	125.0	1.100	125.0	191.0	1.200	0.0	191.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0394-1000-1050-1000
Design Head (m) 1.050
Design Flow (l/s) 100.0
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 394
Invert Level (m) 0.000
Minimum Outlet Pipe Diameter (mm) 450
Suggested Manhole Diameter (mm) Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.050	100.0	Kick-Flo®	0.877	91.6
Flush-Flo™	0.557	99.9	Mean Flow over Head Range	-	76.9

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)	Depth (m)	Flow (l/s)
0.100	10.9	0.800	95.3	2.000	136.8	4.000	191.9	7.000	252.5
0.200	38.9	1.000	97.6	2.200	143.3	4.500	203.3	7.500	261.2
0.300	74.8	1.200	106.7	2.400	149.5	5.000	214.1	8.000	269.6
0.400	97.3	1.400	115.0	2.600	155.5	5.500	224.3	8.500	277.8
0.500	99.6	1.600	122.7	3.000	166.7	6.000	234.1	9.000	285.7
0.600	99.8	1.800	129.9	3.500	179.8	6.500	243.5	9.500	293.4

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Micro Drainage	Source Control 2017.1.2	

Summary of Results for 30 year Return Period (+40%)

Half Drain Time : 8 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.504	0.504	0.0	99.7	99.7	59.9	O K
30 min Summer	0.575	0.575	0.0	99.9	99.9	68.3	O K
60 min Summer	0.526	0.526	0.0	99.9	99.9	62.4	O K
120 min Summer	0.384	0.384	0.0	96.7	96.7	45.6	O K
180 min Summer	0.323	0.323	0.0	82.9	82.9	38.4	O K
240 min Summer	0.288	0.288	0.0	70.3	70.3	34.2	O K
360 min Summer	0.243	0.243	0.0	54.1	54.1	28.9	O K
480 min Summer	0.216	0.216	0.0	44.5	44.5	25.6	O K
600 min Summer	0.197	0.197	0.0	38.0	38.0	23.4	O K
720 min Summer	0.183	0.183	0.0	33.2	33.2	21.7	O K
960 min Summer	0.162	0.162	0.0	26.8	26.8	19.3	O K
1440 min Summer	0.137	0.137	0.0	19.8	19.8	16.3	O K
2160 min Summer	0.116	0.116	0.0	14.4	14.4	13.8	O K
2880 min Summer	0.103	0.103	0.0	11.5	11.5	12.2	O K
4320 min Summer	0.087	0.087	0.0	8.4	8.4	10.3	O K
5760 min Summer	0.077	0.077	0.0	6.7	6.7	9.2	O K
7200 min Summer	0.071	0.071	0.0	5.6	5.6	8.4	O K
8640 min Summer	0.066	0.066	0.0	4.9	4.9	7.8	O K
10080 min Summer	0.062	0.062	0.0	4.3	4.3	7.3	O K
15 min Winter	0.584	0.584	0.0	99.9	99.9	69.3	O K
30 min Winter	0.653	0.653	0.0	99.9	99.9	77.5	O K
60 min Winter	0.532	0.532	0.0	99.9	99.9	63.2	O K
120 min Winter	0.341	0.341	0.0	88.5	88.5	40.5	O K
180 min Winter	0.283	0.283	0.0	68.5	68.5	33.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	99.134	0.0	125.7	19
30 min Summer	64.584	0.0	163.8	27
60 min Summer	40.269	0.0	204.4	42
120 min Summer	24.400	0.0	247.7	72
180 min Summer	18.022	0.0	274.5	100
240 min Summer	14.479	0.0	294.0	130
360 min Summer	10.575	0.0	322.1	190
480 min Summer	8.465	0.0	343.8	250
600 min Summer	7.118	0.0	361.3	310
720 min Summer	6.176	0.0	376.2	370
960 min Summer	4.934	0.0	400.7	492
1440 min Summer	3.591	0.0	437.5	734
2160 min Summer	2.611	0.0	477.2	1100
2880 min Summer	2.081	0.0	507.2	1468
4320 min Summer	1.511	0.0	552.1	2204
5760 min Summer	1.203	0.0	586.1	2864
7200 min Summer	1.007	0.0	613.7	3640
8640 min Summer	0.871	0.0	637.0	4320
10080 min Summer	0.771	0.0	657.2	5088
15 min Winter	99.134	0.0	140.8	19
30 min Winter	64.584	0.0	183.5	28
60 min Winter	40.269	0.0	228.9	44
120 min Winter	24.400	0.0	277.5	72
180 min Winter	18.022	0.0	307.4	100

Ranikhet
Stage D



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Summary of Results for 30 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m ³)	Status
240 min Winter	0.249	0.249	0.0	56.1	56.1	29.5	O K
360 min Winter	0.208	0.208	0.0	41.5	41.5	24.7	O K
480 min Winter	0.184	0.184	0.0	33.5	33.5	21.8	O K
600 min Winter	0.167	0.167	0.0	28.2	28.2	19.8	O K
720 min Winter	0.155	0.155	0.0	24.6	24.6	18.3	O K
960 min Winter	0.137	0.137	0.0	19.6	19.6	16.3	O K
1440 min Winter	0.116	0.116	0.0	14.4	14.4	13.7	O K
2160 min Winter	0.098	0.098	0.0	10.4	10.4	11.6	O K
2880 min Winter	0.087	0.087	0.0	8.3	8.3	10.3	O K
4320 min Winter	0.074	0.074	0.0	6.1	6.1	8.7	O K
5760 min Winter	0.065	0.065	0.0	4.8	4.8	7.8	O K
7200 min Winter	0.060	0.060	0.0	4.0	4.0	7.1	O K
8640 min Winter	0.056	0.056	0.0	3.5	3.5	6.6	O K
10080 min Winter	0.052	0.052	0.0	3.1	3.1	6.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
240 min Winter	14.479	0.0	329.3	132
360 min Winter	10.575	0.0	360.8	192
480 min Winter	8.465	0.0	385.0	252
600 min Winter	7.118	0.0	404.7	312
720 min Winter	6.176	0.0	421.4	372
960 min Winter	4.934	0.0	448.8	494
1440 min Winter	3.591	0.0	490.0	730
2160 min Winter	2.611	0.0	534.5	1080
2880 min Winter	2.081	0.0	568.1	1468
4320 min Winter	1.511	0.0	618.4	2196
5760 min Winter	1.203	0.0	656.5	2936
7200 min Winter	1.007	0.0	687.3	3560
8640 min Winter	0.871	0.0	713.4	4392
10080 min Winter	0.771	0.0	736.1	5112

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.700	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.677

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From:	To:	From:	To:	From:	To:
0	4	0.229	4	8	0.224
				8	12
					0.224

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Model Details

Storage is Online Cover Level (m) 1.050

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	125.0	125.0	1.100	125.0	191.0	1.200	0.0	191.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0394-1000-1050-1000
Design Head (m) 1.050
Design Flow (l/s) 100.0
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 394
Invert Level (m) 0.000
Minimum Outlet Pipe Diameter (mm) 450
Suggested Manhole Diameter (mm) Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.050	100.0	Kick-Flo®	0.877	91.6
Flush-Flo™	0.557	99.9	Mean Flow over Head Range	-	76.9

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)	Depth (m)	Flow (l/s)
0.100	10.9	0.800	95.3	2.000	136.8	4.000	191.9	7.000	252.5
0.200	38.9	1.000	97.6	2.200	143.3	4.500	203.3	7.500	261.2
0.300	74.8	1.200	106.7	2.400	149.5	5.000	214.1	8.000	269.6
0.400	97.3	1.400	115.0	2.600	155.5	5.500	224.3	8.500	277.8
0.500	99.6	1.600	122.7	3.000	166.7	6.000	234.1	9.000	285.7
0.600	99.8	1.800	129.9	3.500	179.8	6.500	243.5	9.500	293.4

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

Half Drain Time : 10 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.739	0.739	0.0	99.9	99.9	87.8	O K
30 min Summer	0.886	0.886	0.0	99.9	99.9	105.2	O K
60 min Summer	0.833	0.833	0.0	99.9	99.9	99.0	O K
120 min Summer	0.598	0.598	0.0	99.9	99.9	71.0	O K
180 min Summer	0.428	0.428	0.0	98.3	98.3	50.9	O K
240 min Summer	0.350	0.350	0.0	91.4	91.4	41.6	O K
360 min Summer	0.288	0.288	0.0	70.5	70.5	34.2	O K
480 min Summer	0.253	0.253	0.0	57.8	57.8	30.1	O K
600 min Summer	0.230	0.230	0.0	49.3	49.3	27.3	O K
720 min Summer	0.212	0.212	0.0	42.9	42.9	25.2	O K
960 min Summer	0.187	0.187	0.0	34.5	34.5	22.2	O K
1440 min Summer	0.157	0.157	0.0	25.2	25.2	18.6	O K
2160 min Summer	0.132	0.132	0.0	18.3	18.3	15.6	O K
2880 min Summer	0.116	0.116	0.0	14.5	14.5	13.8	O K
4320 min Summer	0.098	0.098	0.0	10.4	10.4	11.6	O K
5760 min Summer	0.087	0.087	0.0	8.3	8.3	10.3	O K
7200 min Summer	0.079	0.079	0.0	6.9	6.9	9.3	O K
8640 min Summer	0.073	0.073	0.0	6.0	6.0	8.7	O K
10080 min Summer	0.068	0.068	0.0	5.2	5.2	8.1	O K
15 min Winter	0.868	0.868	0.0	99.9	99.9	103.1	O K
30 min Winter	1.016	1.016	0.0	99.9	99.9	120.6	O K
60 min Winter	0.898	0.898	0.0	99.9	99.9	106.6	O K
120 min Winter	0.506	0.506	0.0	99.7	99.7	60.1	O K
180 min Winter	0.344	0.344	0.0	89.6	89.6	40.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	128.336	0.0	162.8	20
30 min Summer	84.360	0.0	214.0	29
60 min Summer	52.892	0.0	268.5	44
120 min Summer	32.091	0.0	325.8	74
180 min Summer	23.662	0.0	360.4	102
240 min Summer	18.958	0.0	385.0	130
360 min Summer	13.760	0.0	419.1	190
480 min Summer	10.974	0.0	445.7	250
600 min Summer	9.199	0.0	467.0	310
720 min Summer	7.961	0.0	485.0	370
960 min Summer	6.333	0.0	514.4	492
1440 min Summer	4.580	0.0	558.0	734
2160 min Summer	3.307	0.0	604.4	1096
2880 min Summer	2.622	0.0	639.0	1468
4320 min Summer	1.888	0.0	690.1	2160
5760 min Summer	1.494	0.0	728.2	2896
7200 min Summer	1.245	0.0	758.8	3672
8640 min Summer	1.073	0.0	784.4	4360
10080 min Summer	0.946	0.0	806.5	5016
15 min Winter	128.336	0.0	182.3	20
30 min Winter	84.360	0.0	239.7	30
60 min Winter	52.892	0.0	300.7	48
120 min Winter	32.091	0.0	364.9	76
180 min Winter	23.662	0.0	403.6	102

Ranikhet
Stage D



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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m ³)	Status
240 min Winter	0.296	0.296	0.0	73.4	73.4	35.2	O K
360 min Winter	0.243	0.243	0.0	54.1	54.1	28.9	O K
480 min Winter	0.213	0.213	0.0	43.4	43.4	25.3	O K
600 min Winter	0.193	0.193	0.0	36.5	36.5	22.9	O K
720 min Winter	0.178	0.178	0.0	31.6	31.6	21.1	O K
960 min Winter	0.157	0.157	0.0	25.2	25.2	18.6	O K
1440 min Winter	0.132	0.132	0.0	18.3	18.3	15.6	O K
2160 min Winter	0.111	0.111	0.0	13.2	13.2	13.1	O K
2880 min Winter	0.098	0.098	0.0	10.5	10.5	11.6	O K
4320 min Winter	0.083	0.083	0.0	7.6	7.6	9.8	O K
5760 min Winter	0.073	0.073	0.0	6.0	6.0	8.7	O K
7200 min Winter	0.067	0.067	0.0	5.0	5.0	7.9	O K
8640 min Winter	0.062	0.062	0.0	4.3	4.3	7.3	O K
10080 min Winter	0.058	0.058	0.0	3.8	3.8	6.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
240 min Winter	18.958	0.0	431.2	132
360 min Winter	13.760	0.0	469.4	190
480 min Winter	10.974	0.0	499.2	250
600 min Winter	9.199	0.0	523.1	312
720 min Winter	7.961	0.0	543.2	372
960 min Winter	6.333	0.0	576.1	492
1440 min Winter	4.580	0.0	624.9	726
2160 min Winter	3.307	0.0	676.9	1088
2880 min Winter	2.622	0.0	715.7	1448
4320 min Winter	1.888	0.0	772.9	2160
5760 min Winter	1.494	0.0	815.6	2896
7200 min Winter	1.245	0.0	849.9	3672
8640 min Winter	1.073	0.0	878.6	4288
10080 min Winter	0.946	0.0	903.3	5000

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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)	18.700	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.677

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From:	To:	From:	To:	From:	To:
0	4	0.229	4	8	0.224
				8	12
					0.224

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Model Details

Storage is Online Cover Level (m) 1.050

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	125.0	125.0	1.100	125.0	191.0	1.200	0.0	191.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0394-1000-1050-1000
Design Head (m) 1.050
Design Flow (l/s) 100.0
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 394
Invert Level (m) 0.000
Minimum Outlet Pipe Diameter (mm) 450
Suggested Manhole Diameter (mm) Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.050	100.0	Kick-Flo®	0.877	91.6
Flush-Flo™	0.557	99.9	Mean Flow over Head Range	-	76.9

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)	Depth (m)	Flow (l/s)
0.100	10.9	0.800	95.3	2.000	136.8	4.000	191.9	7.000	252.5
0.200	38.9	1.000	97.6	2.200	143.3	4.500	203.3	7.500	261.2
0.300	74.8	1.200	106.7	2.400	149.5	5.000	214.1	8.000	269.6
0.400	97.3	1.400	115.0	2.600	155.5	5.500	224.3	8.500	277.8
0.500	99.6	1.600	122.7	3.000	166.7	6.000	234.1	9.000	285.7
0.600	99.8	1.800	129.9	3.500	179.8	6.500	243.5	9.500	293.4