intrado
Consulting Engineers

FLOOD RISK ASSESSMENT & DRAINAGE STRATEGY

For

PROPOSED DEVELOPMENT AT BURSTON GARDEN CENTRE, ST ALBANS, AL2 2DS

REF : IR20077/DS1

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Third							

1. Introduction

Intrado Consulting Engineers have been appointed to undertake a Flood Risk Assessment (FRA) and Drainage Strategy in support of a circa 3.7 hectare proposed care village development.

This report is produced for the sole benefit of Castleoak Care Partnership from whom it was commissioned and has been prepared in response to their particular requirements and brief. This strategy may not be relied upon by any other party.

The Contracts (Rights of Third Parties) Act 1999 shall not apply to this report and the provisions of the said Act are expressly excluded from this report. This strategy may not be used for any purpose other than that for which it was commissioned.

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2. The Site

The proposals are for the construction of 45 bungalows and 80 assisted living apartments on the site of the existing site of Burston Garden Centre. The site address is North Orbital Road, St Albans, AL2 2DS at National Grid Reference 513690 203660, refer to Figure 2.1. The site has an area of approx. 3.7Ha

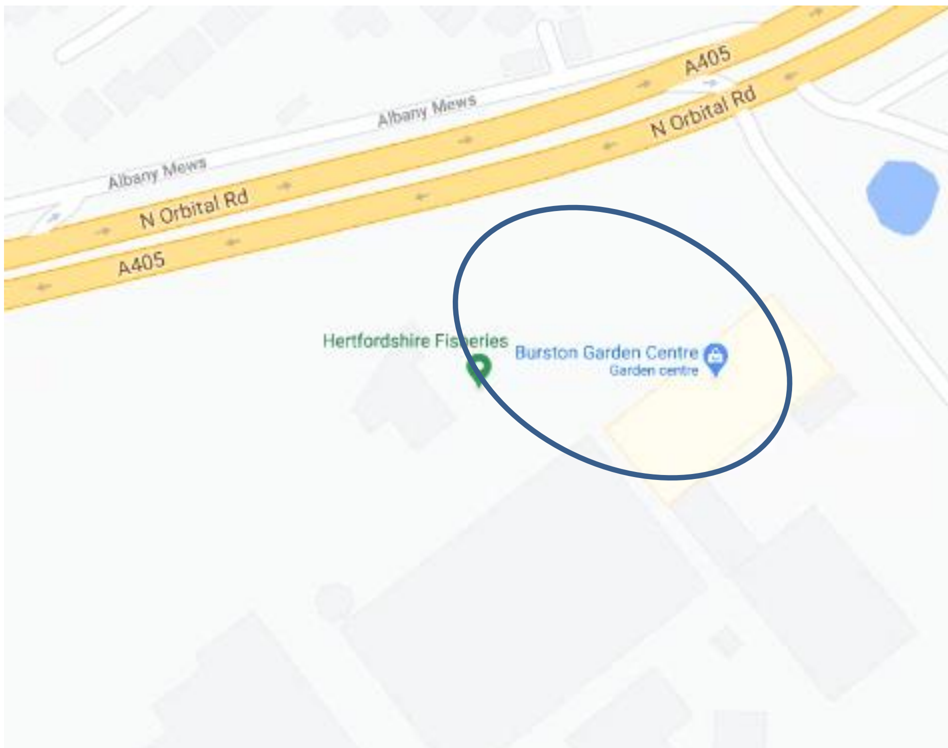

Figure 2-1 – Site Location

3. Assessment of Flood Risk

3.1 Potential Sources of Flooding

There are a number of potential sources of flooding and these include flooding from:

- rivers or fluvial sources;
- the sea or tidal sources;
- surface water or pluvial sources;
- groundwater;
- sewers; and
- reservoirs, canals, and other artificial sources.
-

The flood risk from each of these potential sources is discussed below.

3.1.1 Flooding from Rivers or Fluvial Flooding and Sea or Tidal Flooding

The Environment Agency "Flood Map or Planning" shows the site is at low risk (less than 1 in 1000 annual probability of river flooding).

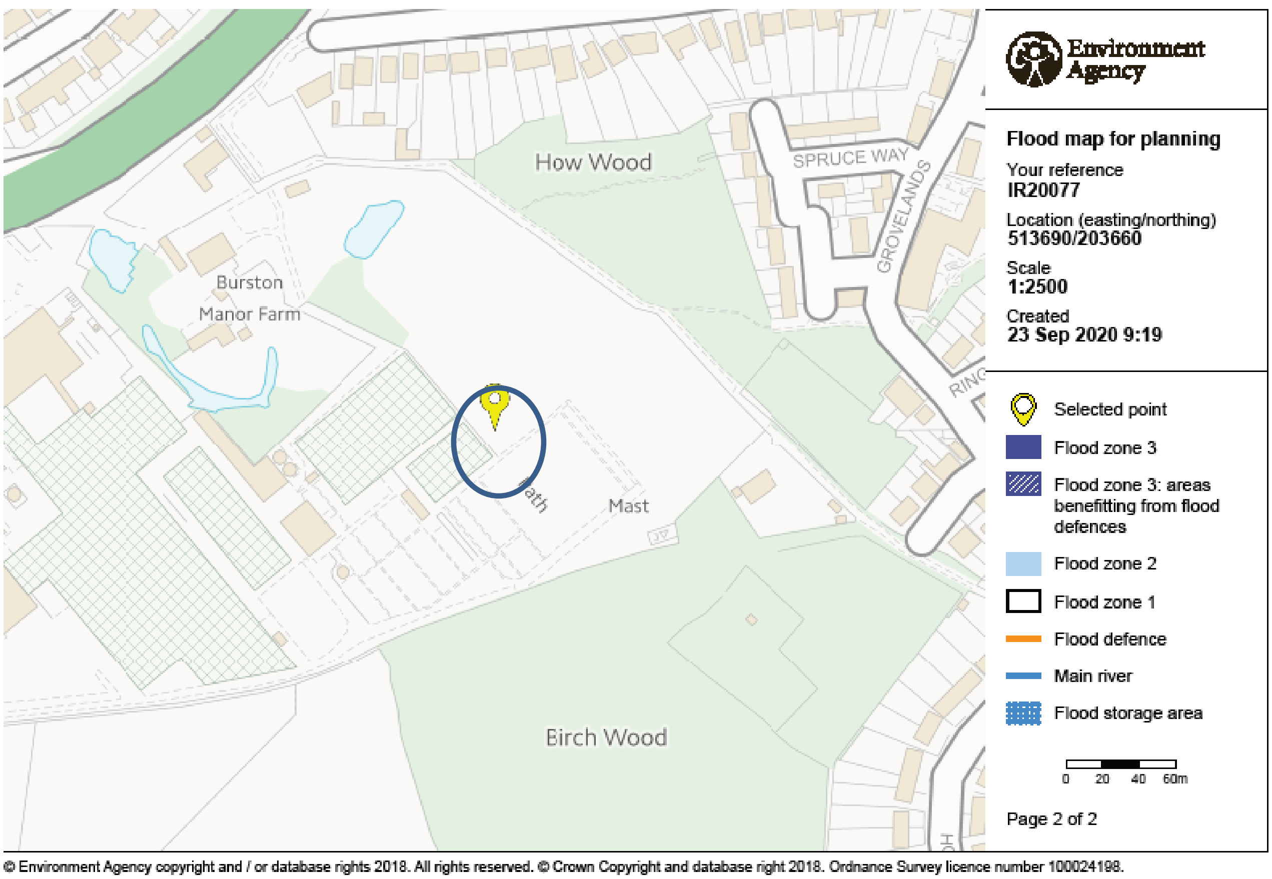

Figure 3-1 – Environment Agency 'Flood Map For Planning"

3.1.2 Flooding from Surface Water or Pluvial Flooding

Environment Agency "Flood Map for Planning". The mapping shows the site is not at a risk of flooding from surface water.

3.1.3 Flooding from Groundwater

On review of Dacorum Borough Council St Albans City & District Council Three Rivers District Council Watford Borough Council Strategic Flood Risk Assessment Volume I August 2007 there does not appear to be any know ground water issues on the site or the nearby areas.

3.1.4 Flooding from Sewers

There are no surface water or combined sewers within the proximity of the site.

3.2 Flood Risk Summary

A summary of the potential sources of flooding and the flood risk arising from them is presented in Table 3-1

Potential Sources Of Flooding	Significant Flood Risk at the Site (Y/N)
Rivers or Fluvial Flooding	N
Sea or Tidal Flooding	N
Surface Water or Pluvial Flooding	N
Groundwater	N
Sewers	N
Reservoirs, Canals and other Artificial Sources	N

Table 3-1 – Summary of the Potential Sources of Flooding

The site is therefore considered to be entirely within Flood Zone 1, at low risk of flooding and suitable for a vulnerable development as detailed in Table 3 of NPPG.

4. Existing Surface Water

The site has both greenfield and brownfield areas. The survey by Clifton Surveys has recorded some of the existing surface water sewers where the surface water system discharges to the ditch/watercourse at the south west boundary. The existing surface water discharges at an uncontrolled rate.

The total site consists of circa 3.6ha of which 0.8ha is impermeable - buildings, greenhouses, hardstanding, and other structures. The remainder of the site is soft landscaping. The Wallingford method was utilised to calculate the combined runoff rate for the greenfield run off with the results as shown in the Table 4-1.

Return Period	**Greenfield Discharge Rate (l/s)**
1	8.9
30	21.7
100	27.9

Table 4-1 Greenfield Run off Rates

5. Proposed Surface Water

The proposed development is for 45 bungalows and 80 assisted living apartments with associated access road and parking areas. The impermeable areas of the proposed development are 1.08ha.

SuDS Design Guidance for Hertfordshire March 2015 is guidance for developers involved in the design and development of SuDS in Hertfordshire. It promotes an integrated approach to SuDS and landscape design and establishes a set of local design criteria to help shape the development of SuDS in respect of the County's unique environmental context. The contents of which has been used to inform the current design.

The surface water will be designed for 100-year storm event with a 30% climate change allowance as indicated within section 7.2.5 of the Suds Design Guidance for Hertfordshire document. A 10% increase to allow for urban creep has also been included in the calculations.

It is proposed to manage the surface water run-off from the development via the following interception mechanisms as summarised in Table 5-1.

SuDS Management Train Mechanism	Application	Potential Suitable Suds Features
Source Control	For the interception of surface water run-off at the source.	Permeable pavement
Conveyance	To convey surface water run-off from 'Source Control' mechanisms to 'Site Control'	Swales Permeable pavement
Site Control	Provides the required surface water attenuation prior to controlled discharge to the culvert	Swales Permeable pavement Attenuation basins

Table 5-1 Summary of Surface Water Management Strategy SuDS Options

The current design has four attenuation basins, permeable paving and swales to provide conveyance and storage within the management train. Hydrobrakes and orifice plates are present within the system to hold the water in each feature maintaining the 10 l/s discharge into the ditch. The holding of water in open storage features will allow some of the surface water run off to be lost via evapotranspiration.

The micro drainage calculations for all storm events up to and including the 100 year event plus 30% climate change and 10% urban creep are in Appendix A.

A summary of the results is in Table 5-2 below.

Return Period	**Greenfield Discharge Rate (l/s)**
1	8.2
30	9.9
100 + 40%	9.9

Table 5-2 Post Development Run off Rates

In accordance with Section 26 of the SuDS manual, the surface water run off generated from the buildings, car park and access are considered to have a low pollution hazard level (see Table 5-3).

Land Use	Pollution Hazard Level	Pollution Hazard Indices		
		Total Suspended Solids (TSS)	Metals	Hydro-Carbons
Non-Residential Car Park	Low	0.5	0.4	0.4
Low traffic Roads<300 movements per day	Low	0.5	0.4	0.4
Residential Roof	Very Low	0.2	0.2	0.05

Table 5-3 - Pollution Hazard Potential for Proposed Development

Type of SuDS component	Mitigation Indices		
	Total Suspended Solids (TSS)	Metals	Hydro-Carbons
Pervious Pavement	0.7	0.6	0.7
Swale	0.5	0.6	0.6
Detention Basin	0.5	0.5	0.6

Table 5-4 – Mitigation Indices

The SuDS mitigation indices, Table 5.4, are therefore sufficient to deal with the pollution levels with one treatment stage. However, in the majority of cases there are two and sometimes three treatment stages.

The attenuation features aim to, as far as practicably possible, prevent discharge from the site for the majority of rainfall events less than 5mm. Refer to Appendix B for the proposed drainage layout.

The management of the surface water at the surface provide us with opportunities to add both amenity biodiversity value to the development. The harder SuDS features such as permeable paving are used to provide parking areas for the residents within the streets and courtyards. Softer SuDs features such as the attenuation basins and swales are within the green open spaces and woodland walks. The Quantity Data Template from SuDS Design Guidance for Hertfordshire can be found in Appendix C.

6. Foul Drainage

The nearest public foul system is in the North Orbital road to the north east of the site. From the site levels on the topographical survey, it will be necessary to have an on-site pumping station to pump the flows up to the public sewer. From the information available to date further survey work and liaison with Thames Water to determine the point of connection of the foul sewer.

7. Principal Operation and Maintenance Requirements

The drainage design has considered the construction of the drainage elements. They can all be constructed by a competent contractor with minimal risk in terms of Health & Safety.

7.1 Pervious Pavement

The permeable paving will be Tobermore paving or similar approved. The indicative maintenance costs of the permeable paving as supplied by Tobermore are £0.5 - £1 per m^3 of storage volume.

Permeable paving lasts 20-25 years before requiring replacement of filter material. This is one of the longest lifespans of all SUDS options (Understanding permeable and impermeable surfaces, 2009, p.25).

Tobermore has advised that research has concluded that the infiltration capacity of a newly installed Hydropave Concrete Block pavement is over 4,000mm per hour. The bedding course and sub-base aggregates will have even higher infiltration capacity. The UK guidelines require the infiltration rate of the surface joints to be 400mm and hour which is only 10% of the actual rate of newly installed permeable paving. Even allowing for clogging over the long term there is a large factor of safety built in.

The permeable paving loading category is 2 -Car parking with zero standard axles (refer to Figure 7-1) provided by Tobermore. Permeable paving is proposed car parking areas only (refer to drawing IR18101-203 P2 for details).

1 DOMESTIC PARKING	2 CAR	3 PEDESTRIAN	4 SHOPPING	5 COMMERCIAL	6 HEAVY TRAFFIC
No Large Goods Vehicles	Emergency Large Goods Vehicles only	One Large Goods Vehicle per week	Ten large Goods Vehicles per week	100 Large Goods Vehicles per week	1000 large Goods Vehicles per week
Zero standard axles	**100 standard axles**	**0.015msa**	**0.15msa**	**1.5msa**	**15msa**
Patio	Car parking bays and aisles	Town/city pedestrian street	Retail development delivery access route	Industrial premises	Main road
Private drive	Railway station platform	Nursery access	School/ college access road	Lightly trafficked public road	Distribution centre
Decorative feature	External car showroom	Parking area to residential development	Office block delivery route	Light industrial development	Bus station (bus every 5 minutes)
Enclosed playground	Sports stadium pedestrian route	Garden centre external display area	Deliveries to small residential development	Mixed retail/ industrial development	Motorway Truck Stop
Footway with zero vehicle overrun	Footway with occasional overrun	Cemetery Crematorium	Garden centre delivery route	Town square	Bus stop
	Private drive/ footway crossover	Motel parking	Fire station yard	Footway with regular overrun	Roundabout
		Airport car park with no bus pickup	Airport car park with bus to terminal	Airport landside roads	Bus lane
		Sports centre	Sports stadium access route/ forecourt		

msa = millions of standard 8,000 kg axles.

Figure 7-1 – Loading Category from Tobermore.

Construction considerations

Sub-base material (coarse graded aggregate) should be placed in layers not exceeding 150mm in thickness or twice the nominal maximum aggregate size. Unlike traditional pavement construction, the open-graded materials should not be fully compacted to eliminate any voids, as this will compromise the performance of the system.

It is likely that excessive compaction will result in the displacement of the open graded aggregate by the compaction equipment. The open-graded material should be compacted such that its maximum density is achieved for the particular aggregate type and grading without compromising the final void percentage offered by the material.

Each layer should be suitably compacted before the next layer is placed to prevent any potential settlement of the pavement after completion.

Due to the nature of both the sub-layers and the block paving, care should be taken during the construction process to prevent dirt or detritus contaminating the sub-base and compromising the permeability of the system. For example, the trafficking of the sub-base as a site access route should not be undertaken. Should other construction or maintenance work take place close to the pavement which may affect the infiltration of the pavement, suitable protective measures should be implemented.

Edge restraints should be sufficiently robust to resist the lateral displacement from imposed loadings placed upon the pavement. The edge restraint may take the form of associated fittings, walls or buildings or be formed from precast concrete, clay or natural stone kerb systems, either existing or newly constructed features. The restraint must provide a consistent vertical face to a level below the laying course material.

Further site-specific requirements will be provided to the contractor once the order has been placed. A recommended operation and maintenance plan for areas of pervious pavement is summarised in Table 7-1.

Maintenance Schedule	Required Action	Minimum Frequency
Routine visual inspections	In general, routine visual inspections are all that is required to determine whether or not remedial maintenance is required. Any infiltration issues are shown up by water ponding on the surface of the paving. If ponding is not visible, then remedial action is not required. If ponding is visible see section on Remedial Action for ponding. In the unlikely event that individual blocks are damaged these should be removed and replaced.	Once a year during or following heavy rainfall.
Regular Maintenance	Brushing with soapy water and a stiff brush will revive the colour of concrete block permeable paving. For a deeper clean of the block surface a pressure washer can be used to maintain the appearance and colour of the paving blocks. A pressure washer set to a light / medium pressure should be all that is required to remove general dirt and grime. High pressure should not be used as this can damage the surface of the blocks.	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.

	Tips: Hold the lance of the pressure washer at a 30 to 45-degree angle to the paved surface to avoid removal of the jointing material. After cleaning is finished, ensure that any jointing material which has been removed is top up with the correct material.	
Occasional Maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Weeds tend not to establish in areas which receive regular trafficking by vehicles. If weeds are an issue, they can be dealt with by using a weed killer containing Glyphosate. The manufacturer's instructions should always be followed, and adequate Health & Safety measures should also be put in place when handling chemicals.	As required – once per year on less frequently used pavements.
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving.	As required.
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to uses, and replace lost joining material.	As required.
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging).
Monitoring	Initial inspection.	Monthly for three months after installation.
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action.	Three-monthly, 48h after large storms in first six months.
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually.

Table 7-1 - Typical Pervious Pavement Operation and Maintenance Requirements

Guidelines to minimise maintenance and ensure the long-term performance of Hydropave Permeable Paving.

<u>Pre- construction (Design stage)</u>

It is essential that the system is designed correctly by a qualified engineer (refer to BS 7533 Part 13). The design and detailing of the project should ensure that soil from soft landscaping is prevented from spilling onto the paving.

<u>During construction.</u>

It is essential that the paving is installed by an experienced contractor who is familiar with installing permeable paving and its components (refer to BS7533 Part 3).
Mud / soil and other contaminants should be prevented from entering the sub-base, bedding course and jointing aggregates.

Do not allow muddy construction traffic to use the paved area once completed.
Do not allow soft landscaping to spill onto the paving surface

After construction.

Do not store materials which may clog up the permeable joints such as soil and mulch on top of the paving.
The joints between to permeable paving should be filled to the top with the correct aggregate.

7.2 Swales

The proposed drainage scheme will utilise a swales area as a mechanism for collection, treatment and conveyance of surface water runoff. The anticipated maintenance and management for the swales associated with the surface water drainage system in outlined in Table 7-2

Maintenance Schedule	Required Action	Minimum Frequency
Regular maintenance	Remove litter (including leaf litter) and debris.	Monthly (or as required).
	Cut grass to sides – to retain grass height within specified design range.	Monthly (during growing season) or as required.
	Manage other vegetation and remove nuisance plants.	Monthly at start then as required.
	Inspect inlets and outlets and overflows for blockages, and clear if required.	Monthly.
	Inspect vegetation coverage.	Monthly for 6 months, quarterly for 2 years, the half yearly.
	Inspect inlet and facility surface for silt accumulation, establish appropriate silt removal frequencies.	Half Yearly.
Occasional Maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required.	As required or if bare soil is exposed over 10% or more of the treatment area.
Remedial Actions	Repair erosion or other damage by re-turfing or reseeding.	As required.
	Remove and dispose of oils or petrol residues using safe standard practices.	As required.

Table 7-2 Typical Swale Operation & Maintenance Requirements

7.3 Attenuation Basin

The proposed drainage scheme will utilise a detention/bioretention area as a mechanism for collection, treatment and attenuation of surface water runoff. The anticipated maintenance and management for the detention basin associated with the surface water drainage system in outlined in Table 7-3.

Maintenance Schedule	Required Action	Minimum Frequency
Regular maintenance	Remove litter (including leaf litter) and debris	Monthly (or as required)
	Cut grass to sides – to retain grass height within specified design range.	Monthly (during growing season) or as required.
	Manage other vegetation and remove nuisance plants.	Monthly at start then as required.
	Inspect inlets and outlets and overflows for blockages, and clear if required.	Monthly
	Inspect vegetation coverage.	Monthly for 6 months, quarterly for 2 years, the half yearly.
	Inspect inlet and facility surface for silt accumulation, establish appropriate silt removal frequencies.	Half Yearly
Occasional Maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required.	As required or if bare soil is exposed over 10% or more of the treatment area.
Remedial Actions	Repair erosion or other damage by re-turfing or reseeding.	As required
	Remove and dispose of oils or petrol residues using safe standard practices.	As required

Table 7-3 Typical Attenuation Basin Operation & Maintenance Requirements

7.4 Underground Piped Systems

A recommend operation and maintenance plan for the piped drainage network is summarised in Table 7-4

Maintenance Schedule	Required Action	Minimum Frequency
Regular maintenance	Ensure drainage intakes are clear or debris/silt.	Monthly (or as required).
Occasional Maintenance	Clear gully pots.	6 monthly.
	Jet clean sewer lines, gully tails and kerb channels to remove grease, grit, sediment and other debris to ensure conveyance capacity is not compromised.	Every 2 years.
	Clear perforated pipework of blockages.	As required.
Intermittent Maintenance	CCTV survey of sewer lines to identify any defects/sign of performance degradation such as: Cracked/deteriorating pipes; Leaking joints/seals at manholes; High water line showing regular high stage in pipes (sign of lack of capacity or downstream constraint); and Suspected infiltration or exfiltration.	Every 2 – 5 years.
Remedial Actions	Repair defects using suitable methods. Effective temporary repairs may be sufficient in short term until scheduled, capital improvements can be made.	As required
Monitoring	Record areas of surface ponding/intake bypassing/ surcharging (photos, inundated areas, depths) during extreme storm events and investigate the reasoning for this post-storm.	As required

Table 7-4 - Typical Pipe System Operation and Maintenance Requirements

7.5 Cellular Storage

A recommend operation and maintenance plan for the piped drainage network is summarised in Table 7-5.

Maintenance Schedule	Required Action	Minimum Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly.	Monthly for the initial three months, thereafter on an annual basis.
Occasional Maintenance	Regular inspection of silt traps, manholes, pipework and pre-treatment devices, with removal of sediment and debris.	As required.

Table 7-5 - Typical Cellular Operation and Maintenance Requirements

7.6 Hydrobrake

Hydro International Hydro-Brake Flow Controls are certified to BBA and the certification includes:

- factors relating to compliance with Building Regulations where applicable;
- factors relating to additional non-regulatory information where applicable;
- independently verified technical specification;
- assessment criteria and technical investigations;
- design considerations;
- installation guidance;
- regular surveillance of production;
- formal three-yearly review.

The products are designed to be installed by a competent contractor, experienced with these types of products.

The units are manufactured from stainless steel of a sufficient strength and thickness to ensure that the products remain fit for purpose throughout their design life.

Under normal operation, the units will deflect by no more than the thickness of the material used for manufacture. This ensures that the volume of the unit available for water flow is not compromised during operation and therefore the hydraulic operation of the unit is not adversely affected by deformation of the unit.

Maintenance of Hydrobrake

Access should be provided for clearing debris from the chamber housing the flow control. In the event that the inlet to the unit becomes blocked, the pivoting bypass door may be operated by pulling the wire rope attached upwards to drain down the chamber and provide access for maintenance. The pivoting bypass door must be returned to the closed position following drain down of the chamber and clearance of the blockage.

Regular inspections should be carried out to ensure that debris that may obstruct the inlet to the flow control is not present in the chamber. The frequency of inspection must be at least once per year and always after high intensity storms and leaf fall.

The unit can be jetted from downstream, in accordance with standard sewer jetting procedures without affecting the hydraulic performance of the system.

Design life of Hydrobrake

The units are made from materials that will not be adversely affected by contaminants likely to be found in normal surface water systems in the UK. In the opinion of the BBA, the units will have a design life in excess of 60 years when installed in surface water systems. At the end of its life the unit is readily recyclable.

8. Conclusions

Intrado Consulting Engineers has been appointed to develop a Flood Risk Assessment and Drainage Strategy to manage surface water runoff resulting from the proposed planning application for the care home at Burston Garden Centre, St Albans.

The potential sources of flood risk at the site have been confirmed with the conclusion that the flood risk to the site was predominantly very low and warrant no further consideration or specific mitigation measures to be applied.

Technical information provided in this report on behalf of the Applicant seeks to demonstrate that a robust and sustainable drainage strategy has been prepared for the site, including residual events. It is proposed that the surface water runoff arising from the development discharges to the existing open ditch at the south of the site at an attenuated rate of 10 l/s to current best practice and sustainable water management guidelines through the use of SuDS. A recommended maintenance plan has been outlined.

The surface water drainage strategy presented in this report demonstrates that adequate SuDS space provision is afforded within the development and that the proposed scheme is feasible and compliant to appropriate best practice and regulatory requirements and can be maintained in accordance with best practise. It is considered that the proposals ensure the safe management and maintenance of surface water runoff.

9. Appendix A

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.421	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	75	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	156.000	0.312	500.0	0.148	5.00	0.0	0.600		\/	38	Pipe/Conduit	
1.001	50.000	0.100	500.0	0.041	0.00	0.0	0.600		\/	38	Pipe/Conduit	
1.002	49.500	0.248	200.0	0.040	0.00	0.0	0.600		o	300	Pipe/Conduit	
2.000	19.200	0.096	200.0	0.113	5.00	0.0	0.600		o	225	Pipe/Conduit	
1.003	38.200	0.076	502.6	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
1.004	38.200	0.076	502.6	0.049	0.00	0.0	0.600		\/	38	Pipe/Conduit	
1.005	20.000	0.040	500.0	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
3.000	100.000	0.200	500.0	0.084	5.00	0.0		0.045	\/	38	Pipe/Conduit	
3.001	13.000	0.065	200.0	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
3.002	39.000	0.195	200.0	0.071	0.00	0.0	0.600		o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.34	6.31	85.500	0.148	0.0	0.0	0.0	1.98	3035.3	20.2
1.001	48.76	6.74	85.188	0.189	0.0	0.0	0.0	1.98	3035.3	25.0
1.002	46.22	7.48	85.088	0.229	0.0	0.0	0.0	1.11	78.3	28.7
2.000	54.46	5.35	84.950	0.113	0.0	0.0	0.0	0.92	36.6	16.7
1.003	43.47	8.40	84.779	0.342	0.0	0.0	0.0	0.69	49.1	40.3
1.004	42.63	8.72	84.403	0.391	0.0	0.0	0.0	1.97	3027.3	45.1
1.005	41.47	9.20	84.327	0.391	0.0	0.0	0.0	0.70	49.2	45.1
3.000	44.30	8.11	85.010	0.084	0.0	0.0	0.0	0.54	823.1	10.1
3.001	43.74	8.30	84.810	0.084	0.0	0.0	0.0	1.11	78.3	10.1
3.002	42.21	8.89	84.745	0.155	0.0	0.0	0.0	1.11	78.3	17.7

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
3.003	85.500	0.155	551.6	0.231	0.00	0.0	0.600		\/	38	Pipe/Conduit	
3.004	10.000	0.020	500.0	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
4.000	39.650	0.198	200.3	0.058	5.00	0.0	0.600		oo	100	Double Pipe	
4.001	28.000	0.140	200.0	0.000	0.00	0.0	0.600		oo	150	Double Pipe	
4.002	30.000	0.150	200.0	0.000	0.00	0.0	0.600		oo	150	Double Pipe	
4.003	12.100	0.061	200.0	0.107	0.00	0.0	0.600		o	300	Pipe/Conduit	
4.004	13.200	0.066	200.0	0.178	0.00	0.0	0.600		o	375	Pipe/Conduit	
4.005	36.000	0.180	200.0	0.000	0.00	0.0	0.600		o	375	Pipe/Conduit	
5.000	10.000	0.050	200.0	0.000	5.00	0.0	0.600		o	225	Pipe/Conduit	
3.005	10.000	0.067	149.3	0.000	0.00	0.0	0.600		o	450	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
3.003	40.44	9.65	84.300	0.386	0.0	0.0	0.0	1.88	2888.9	42.3
3.004	39.91	9.89	84.145	0.386	0.0	0.0	0.0	0.70	49.2	42.3
4.000	50.70	6.22	85.300	0.058	0.0	0.0	0.0	0.54	8.5	8.0
4.001	48.23	6.88	85.052	0.058	0.0	0.0	0.0	0.71	25.0	8.0
4.002	45.87	7.59	84.912	0.058	0.0	0.0	0.0	0.71	25.0	8.0
4.003	45.30	7.77	84.612	0.165	0.0	0.0	0.0	1.11	78.3	20.2
4.004	44.78	7.95	84.552	0.343	0.0	0.0	0.0	1.28	141.1	41.6
4.005	43.42	8.42	84.486	0.343	0.0	0.0	0.0	1.28	141.1	41.6
5.000	55.25	5.18	84.300	0.000	0.0	0.0	0.0	0.92	36.6	0.0
3.005	39.70	9.99	83.975	0.729	0.0	0.0	0.0	1.66	264.3	78.4

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.005		85.650	84.287	0.000	0	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
3.005		85.000	83.908	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	8
Number of Online Controls	5	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.421		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 5, DS/PN: 1.005, Volume (m^3): 58.6

Unit Reference	MD-SHE-0086-3400-1100-3400
Design Head (m)	1.100
Design Flow (l/s)	3.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	86
Invert Level (m)	84.327
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.100	3.4
Flush-Flo™	0.326	3.4
Kick-Flo®	0.679	2.7
Mean Flow over Head Range	-	3.0

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	2.6	1.200	3.5	3.000	5.4	7.000	8.1
0.200	3.3	1.400	3.8	3.500	5.8	7.500	8.3
0.300	3.4	1.600	4.0	4.000	6.2	8.000	8.6
0.400	3.4	1.800	4.3	4.500	6.6	8.500	8.9
0.500	3.3	2.000	4.5	5.000	6.9	9.000	9.1
0.600	3.1	2.200	4.7	5.500	7.2	9.500	9.3
0.800	2.9	2.400	4.9	6.000	7.5		
1.000	3.3	2.600	5.1	6.500	7.8		

Orifice Manhole: 7, DS/PN: 3.001, Volume (m^3): 153.5

Diameter (m) 0.021 Discharge Coefficient 0.600 Invert Level (m) 84.810

Orifice Manhole: 10, DS/PN: 3.004, Volume (m^3): 183.0

Diameter (m) 0.053 Discharge Coefficient 0.600 Invert Level (m) 84.145

Orifice Manhole: 10, DS/PN: 4.001, Volume (m^3): 1.2

Diameter (m) 0.059 Discharge Coefficient 0.600 Invert Level (m) 85.052

Hydro-Brake® Optimum Manhole: 14, DS/PN: 3.005, Volume (m³): 6.2

Unit Reference	MD-SHE-0120-6600-1000-6600
Design Head (m)	1.000
Design Flow (l/s)	6.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	120
Invert Level (m)	83.975
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	6.6
Flush-Flo™	0.299	6.6
Kick-Flo®	0.652	5.4
Mean Flow over Head Range	-	5.7

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	4.3	1.200	7.2	3.000	11.1	7.000	16.6
0.200	6.4	1.400	7.7	3.500	11.9	7.500	17.1
0.300	6.6	1.600	8.2	4.000	12.7	8.000	17.7
0.400	6.5	1.800	8.7	4.500	13.4	8.500	18.2
0.500	6.3	2.000	9.1	5.000	14.1	9.000	18.7
0.600	5.9	2.200	9.6	5.500	14.8	9.500	19.2
0.800	5.9	2.400	10.0	6.000	15.4		
1.000	6.6	2.600	10.3	6.500	16.0		

Storage Structures for Storm

Porous Car Park Manhole: 1, DS/PN: 1.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.5
Membrane Percolation (mm/hr)	1000	Length (m)	141.0
Max Percolation (l/s)	411.3	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	84.690	Cap Volume Depth (m)	0.350

Tank or Pond Manhole: 2, DS/PN: 1.001

Invert Level (m) 85.188

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	210.0	0.700	210.0

Porous Car Park Manhole: 3, DS/PN: 2.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.5
Membrane Percolation (mm/hr)	1000	Length (m)	141.0
Max Percolation (l/s)	411.3	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	84.690	Cap Volume Depth (m)	0.350

Porous Car Park Manhole: 9, DS/PN: 3.003

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	20.0
Max Percolation (l/s)	55.6	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	84.175	Membrane Depth (mm)	0

Tank or Pond Manhole: 10, DS/PN: 4.000

Invert Level (m) 85.300

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	170.0	0.300	263.0

Tank or Pond Manhole: 12, DS/PN: 4.004

Invert Level (m) 84.715

Tank or Pond Manhole: 12, DS/PN: 4.004

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	52.5	0.800	52.5

Tank or Pond Manhole: 13, DS/PN: 4.005

Invert Level (m) 84.574

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	34.0	0.900	34.0

Cellular Storage Manhole: 16, DS/PN: 5.000

Invert Level (m) 84.450 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	92.0	92.0	0.600	0.0	119.0
0.500	92.0	119.0			

1 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 8
Number of Online Controls 5 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.421
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 100.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	8640 Winter	1	+0%					84.944
1.001	2	30 Winter	1	+0%					85.197
1.002	3	60 Winter	1	+0%					85.126
2.000	3	8640 Summer	1	+0%					84.888
1.003	4	60 Winter	1	+0%					84.826
1.004	4	15 Winter	1	+0%					84.477
1.005	5	60 Winter	1	+0%	30/15 Summer				84.508
3.000	6	15 Winter	1	+0%					85.113
3.001	7	240 Winter	1	+0%	30/60 Summer				85.034
3.002	8	15 Winter	1	+0%					84.814
3.003	9	60 Winter	1	+0%					84.342
3.004	10	120 Winter	1	+0%	30/30 Summer				84.353
4.000	10	120 Winter	1	+0%	100/60 Winter				85.326
4.001	10	120 Winter	1	+0%	30/15 Winter				85.120
4.002	10	120 Winter	1	+0%	100/15 Winter				84.934
4.003	11	15 Winter	1	+0%	100/15 Summer				84.720
4.004	12	15 Winter	1	+0%	100/15 Summer				84.697

1 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-1.350	0.000	0.00			0.0	OK	
1.001	2	-0.785	0.000	0.00			1.8	OK	
1.002	3	-0.262	0.000	0.04			2.9	OK	
2.000	3	-0.287	0.000	0.00			0.0	OK*	
1.003	4	-0.253	0.000	0.06			2.9	OK*	
1.004	4	-0.720	0.000	0.00			6.3	OK	
1.005	5	-0.119	0.000	0.07			3.2	OK*	
3.000	6	-0.691	0.000	0.01			11.1	OK	
3.001	7	-0.076	0.000	0.01			0.4	OK*	
3.002	8	-0.231	0.000	0.12			8.7	OK	
3.003	9	-0.752	0.000	0.00			9.4	OK	
3.004	10	-0.092	0.000	0.08			2.5	OK	
4.000	10	-0.074	0.000	0.15			1.2	OK	
4.001	10	-0.082	0.000	0.05			1.2	OK	
4.002	10	-0.128	0.000	0.05			1.2	OK	
4.003	11	-0.192	0.000	0.21			12.8	OK	
4.004	12	-0.229	0.000	0.32			34.1	OK	

1 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
4.005	13	15 Winter	1	+0%	100/15 Summer				84.619
5.000	16	15 Summer	1	+0%	1/15 Winter				84.518
3.005	14	480 Summer	1	+0%	1/15 Summer				84.401

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
4.005	13	-0.241	0.000	0.23			29.5	OK	
5.000	16	-0.007	0.000	0.25		10	7.8	OK	
3.005	14	-0.024	0.000	0.04			6.6	OK	

30 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 8
Number of Online Controls 5 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.421
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 100.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	1440 Winter	30	+0%					84.988
1.001	2	30 Winter	30	+0%					85.211
1.002	3	30 Winter	30	+0%					85.156
2.000	3	8640 Winter	30	+0%					84.956
1.003	4	30 Winter	30	+0%					84.864
1.004	4	15 Winter	30	+0%					84.667
1.005	5	480 Summer	30	+0%	30/15 Summer				84.625
3.000	6	15 Winter	30	+0%					85.173
3.001	7	240 Winter	30	+0%	30/60 Summer				85.165
3.002	8	15 Winter	30	+0%					84.870
3.003	9	30 Winter	30	+0%					84.477
3.004	10	480 Winter	30	+0%	30/30 Summer				84.641
4.000	10	60 Winter	30	+0%	100/60 Winter				85.351
4.001	10	60 Winter	30	+0%	30/15 Winter				85.317
4.002	10	60 Winter	30	+0%	100/15 Winter				84.950
4.003	11	15 Summer	30	+0%	100/15 Summer				84.842
4.004	12	15 Winter	30	+0%	100/15 Summer				84.814

30 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-1.306	0.000	0.00			0.0	OK	
1.001	2	-0.771	0.000	0.00			4.1	OK	
1.002	3	-0.232	0.000	0.12			8.7	OK	
2.000	3	-0.219	0.000	0.01			0.2	OK*	
1.003	4	-0.215	0.000	0.18			8.7	OK*	
1.004	4	-0.530	0.000	0.01			18.8	OK	
1.005	5	-0.002	0.000	0.08			3.4	OK*	
3.000	6	-0.631	0.000	0.03			25.3	OK	
3.001	7	0.055	0.000	0.01			0.5	SURCHARGED*	
3.002	8	-0.175	0.000	0.36			26.2	OK	
3.003	9	-0.617	0.000	0.02		320	54.0	OK	
3.004	10	0.196	0.000	0.13			4.0	SURCHARGED	
4.000	10	-0.049	0.000	0.52			4.3	OK	
4.001	10	0.115	0.000	0.15			3.5	SURCHARGED	
4.002	10	-0.112	0.000	0.15			3.5	OK	
4.003	11	-0.070	0.000	0.60			36.8	OK	
4.004	12	-0.113	0.000	0.82			88.4	OK	

30 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
4.005	13	15 Summer	30	+0%	100/15 Summer				84.756
5.000	16	15 Summer	30	+0%	1/15 Winter				84.683
3.005	14	1440 Winter	30	+0%	1/15 Summer				84.286

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
4.005	13	-0.104	0.000	0.52			65.6	OK	
5.000	16	0.158	0.000	0.22		43	6.6	SURCHARGED	
3.005	14	-0.139	0.000	0.04			6.6	OK	

100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 8
Number of Online Controls 5 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.421
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 100.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	10080 Winter	100	+40%					85.501
1.001	2	30 Winter	100	+40%					85.231
1.002	3	30 Winter	100	+40%					85.188
2.000	3	960 Winter	100	+40%					84.981
1.003	4	30 Winter	100	+40%					84.957
1.004	4	15 Winter	100	+40%					84.863
1.005	5	1440 Winter	100	+40%	30/15 Summer				84.638
3.000	6	15 Winter	100	+40%					85.247
3.001	7	180 Winter	100	+40%	30/60 Summer				85.304
3.002	8	15 Winter	100	+40%					84.924
3.003	9	15 Winter	100	+40%					84.575
3.004	10	720 Winter	100	+40%	30/30 Summer				84.942
4.000	10	15 Winter	100	+40%	100/60 Winter				85.378
4.001	10	30 Winter	100	+40%	30/15 Winter				85.354
4.002	10	15 Winter	100	+40%	100/15 Winter				85.099
4.003	11	15 Winter	100	+40%	100/15 Summer				85.102
4.004	12	15 Winter	100	+40%	100/15 Summer				85.026

100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.793	0.000	0.00			0.3	OK	
1.001	2	-0.751	0.000	0.00			7.3	OK	
1.002	3	-0.200	0.000	0.24			17.9	OK	
2.000	3	-0.194	0.000	0.05			1.7	OK*	
1.003	4	-0.122	0.000	0.36			17.7	OK*	
1.004	4	-0.334	0.000	0.01			35.4	OK	
1.005	5	0.011	0.000	0.08			3.4	SURCHARGED*	
3.000	6	-0.557	0.000	0.06			45.4	OK	
3.001	7	0.194	0.000	0.01			0.6	SURCHARGED*	
3.002	8	-0.121	0.000	0.66			47.7	OK	
3.003	9	-0.519	0.000	0.06		412	134.8	OK	
3.004	10	0.497	0.000	0.16			4.8	FLOOD RISK	
4.000	10	-0.022	0.000	0.72			6.0	OK	
4.001	10	0.152	0.000	0.16			3.8	SURCHARGED	
4.002	10	0.037	0.000	0.26			6.2	SURCHARGED	
4.003	11	0.190	0.000	1.02			62.8	SURCHARGED	
4.004	12	0.099	0.000	1.30			139.3	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
4.005	13	15 Winter	100	+40%	100/15 Summer				84.989
5.000	16	15 Summer	100	+40%	1/15 Winter				84.839
3.005	14	120 Winter	100	+40%	1/15 Summer				85.189

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
4.005	13	0.128	0.000	0.62			79.3	SURCHARGED	
5.000	16	0.314	0.000	0.16		95	5.0	SURCHARGED	
3.005	14	0.764	0.000	0.04			7.2	FLOOD RISK	

10. Appendix B

NOTES

GENERAL

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE IN METRES UNLESS NOTED OTHERWISE.
3. ALL LEVELS RELATE TO ORDNANCE DATUM UNLESS NOTED OTHERWISE.
4. DO NOT SCALE FROM THIS DRAWING. USE FIGURED DIMENSIONS ONLY.
5. ANY DISCREPANCIES TO BE REPORTED IMMEDIATELY TO THE ENGINEER.
6. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, SUBCONTRACTORS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
7. THIS DRAWING IS COPYRIGHT © intrado robbins CONSULTING ENGINEERS.

REV.	DESCRIPTION	BY	DATE
D	ATTENUATION VOLUMES ADDED	CLC	07-12-20
C	UPDATE TO NEW LAYOUT	CLC	04-12-20
B	UPDATE TO SWALES LAYOUT	JJT	30-10-20

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project: CASTLEOAK ST ALBANS

drawing title: STORM WATER DRAINAGE STRATEGY

drawn	chkd	scale	date
AN	CC	1:500 @ A1	OCT 2020

	Job No.	Drawing No.	Rev.
Preliminary ☒ Tender ☐ Construction ☐	IR20077	001	D

11. Appendix C

1. Site details

1.1 Planning reference number

1.2 Site name - Burston Village

1.3 Total site area 3.55 ha

1.3 Site area which is positively drained 1.08 ha

1.4 Developed area 1.08 ha

1.5 Predevelopment use ~~Greenfield / Brownfield~~ / Mixed*

1.6 Site constraints High groundwater table as recorded in the site investigation.

1.7 Type of discharge ~~Infiltration~~ / watercourse / ~~sewer / mixed~~

2. Flow control

2.1 Flow control type Hydrobrakes and Orifices within the system Fixed / Variable*

2.2 Greenfield flow Q1 10 l/s for the site

2.3 Greenfield flow Q100 10 l/s for the site

3. Site storage volume

3.1 Source control provided Yes~~/No~~

3.2 Approach used to calculate storage Fixed Flow rate ~~1~~ / 2 / ~~PDL~~

3.3 Storage - 1 in 1 year - 152 m3 for the site

3.4 Storage - 1in 30 year - 460m3 for the site

3.5 Storage - 1 in 100 year plus CC - 590 m3 for the site

3.6 Long term storage 3 for the site

3.7 Total site storage 796 m3

4. Design checks

4.1 Time taken for 50% of storage to drain down (Note 16) within 24 hours

4.2 All SuDS storage located outside Q100 floodplain Yes/~~No~~

4.3 Provision for blockage / design exceedance (Note 18) Yes/~~No~~