Infrastructure Design Studio
CONSULTING ENGINEERS

Contents

GREAT HALL & LIBRARY, LINCOLNS INN FIELDS

DRAINAGE STATEMENT

27 July 2015 – Revision B

1. PURPOSE OF THE REPORT

The Honourable Society of Lincoln's Inn seek to refurbish and improve existing kitchen and catering facilities which are currently inadequate for the needs of the Inn. There is also a need to provide expansion space for the existing library alongside new advocacy training and educational facilities to enhance the function of the Inn. In providing these new facilities, the existing Under Treasurer's residence will need be relocated to another part of the Inn.
To achieve the above proposals, planning and listed building consent are sought for five separate applications proposed at Lincoln's Inn:

- Application 1 – Old Hall Kitchen Refurbishment (Submitted to LB Camden Ref 2015/2413/P & 2015/2517/L)
- Application 2 – Great Hall Refurbishment Works (including Old Hall Temporary Kitchen Works)
- Application 3 – East Terrace Development (Excavation to create a two storey basement containing a lecture theatre, advocacy rooms and study areas)
- Application 4 – Library Extension (including demolition of Under Treasurer's House)
- Application 5 – 15 New Square (Change of use from Office B1 to Residential C3)

These alterations will have an impact on the existing drainage systems, which will involve rethinking the current pattern of storm and foul drainage. This report identifies the drainage impact of the proposals and any mitigation measures proposed for consideration by London Borough of Camden (LBC) and Thames Water (TW) during the planning process
This Drainage statement has been prepared as part of applications 2, 3 &4.

2. EXISTING DRAINS

Drainage records for the surrounding streets have been obtained from Thames Water and are shown in Figure 1. These indicate that there is a large public brick combined sewer in Serle Street to the south of Great Hall and a smaller network of public sewers to the east serving Old Square.

Currently all the drainage generated by the Great Hall, Library and the Under Treasurers residence drains towards the public sewers in Old Square. This includes both storm and foul systems, which apart from some isolated branches run as combined drains throughout the existing building.

Extensive CCTV has been undertaken and the CCTV results have been plotted on the basement survey drawing shown in Figure 2. To summarize the CCTV findings; there are numerous instances of extensive cast iron corrosion, large fat deposits, encrustation and generally the drainage is in a poor condition with much of the heavily corroded cast iron drainage deemed near the end of its design life.

The existing kitchen drainage has been retrofitted with extensive grease removal systems such as numerous above ground grease traps and a large below ground grease trap. However grease buildup continues to be a major problem which necessitates quarterly jetting. The continuing grease problems are generated from:

- Oversize combined pipes with associated low velocity.
- Head of runs combining with storm drainage which rapidly cools and consolidates waste/grease and also introduces silts.
- Extensive corrosion and formation of iron nodules to the pipework, which cause the collection of fatty deposits and significantly reduce the flow velocity.
- A foul trap within the existing drainage system.

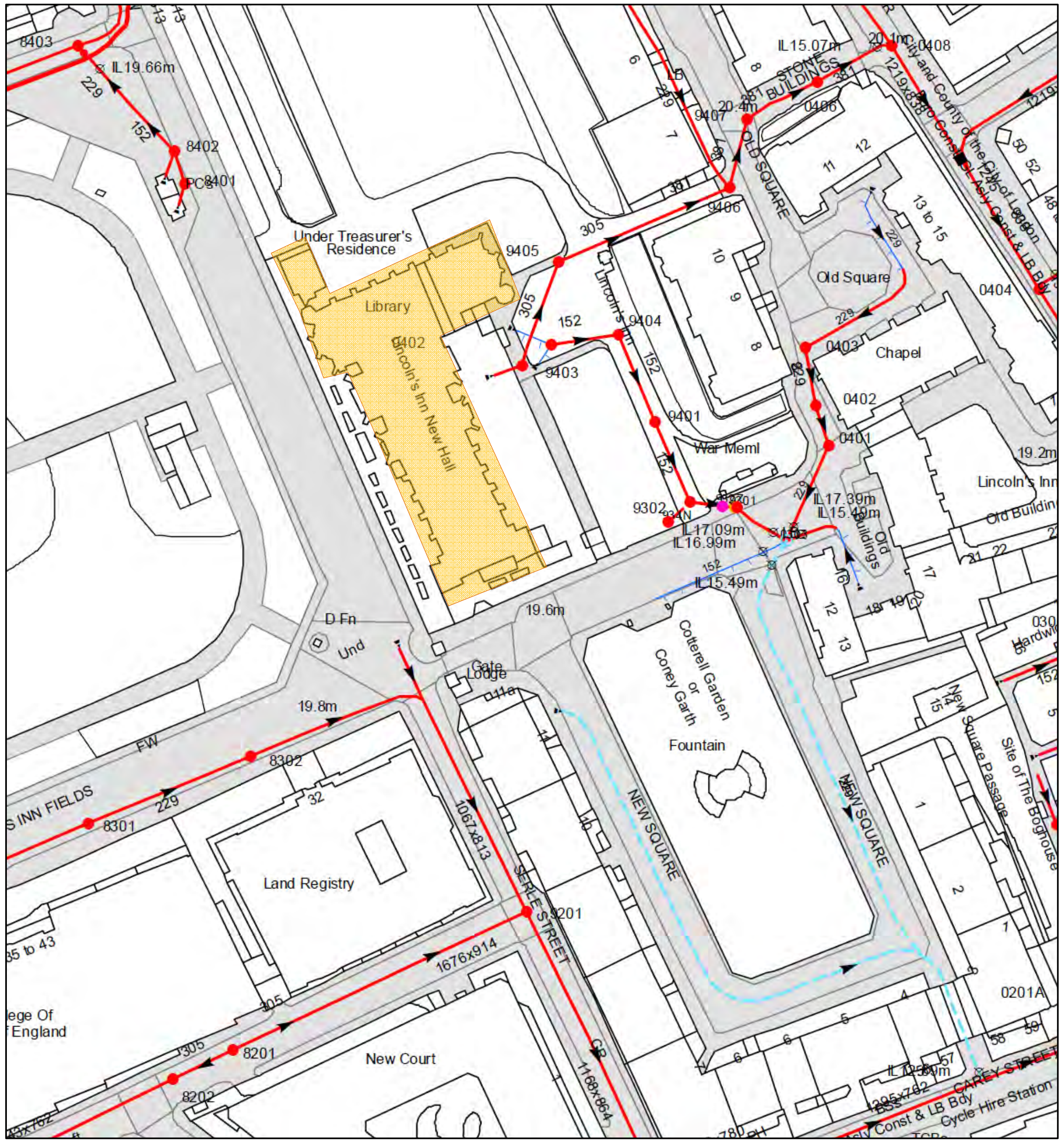

Figure 1 – Thames Water Records

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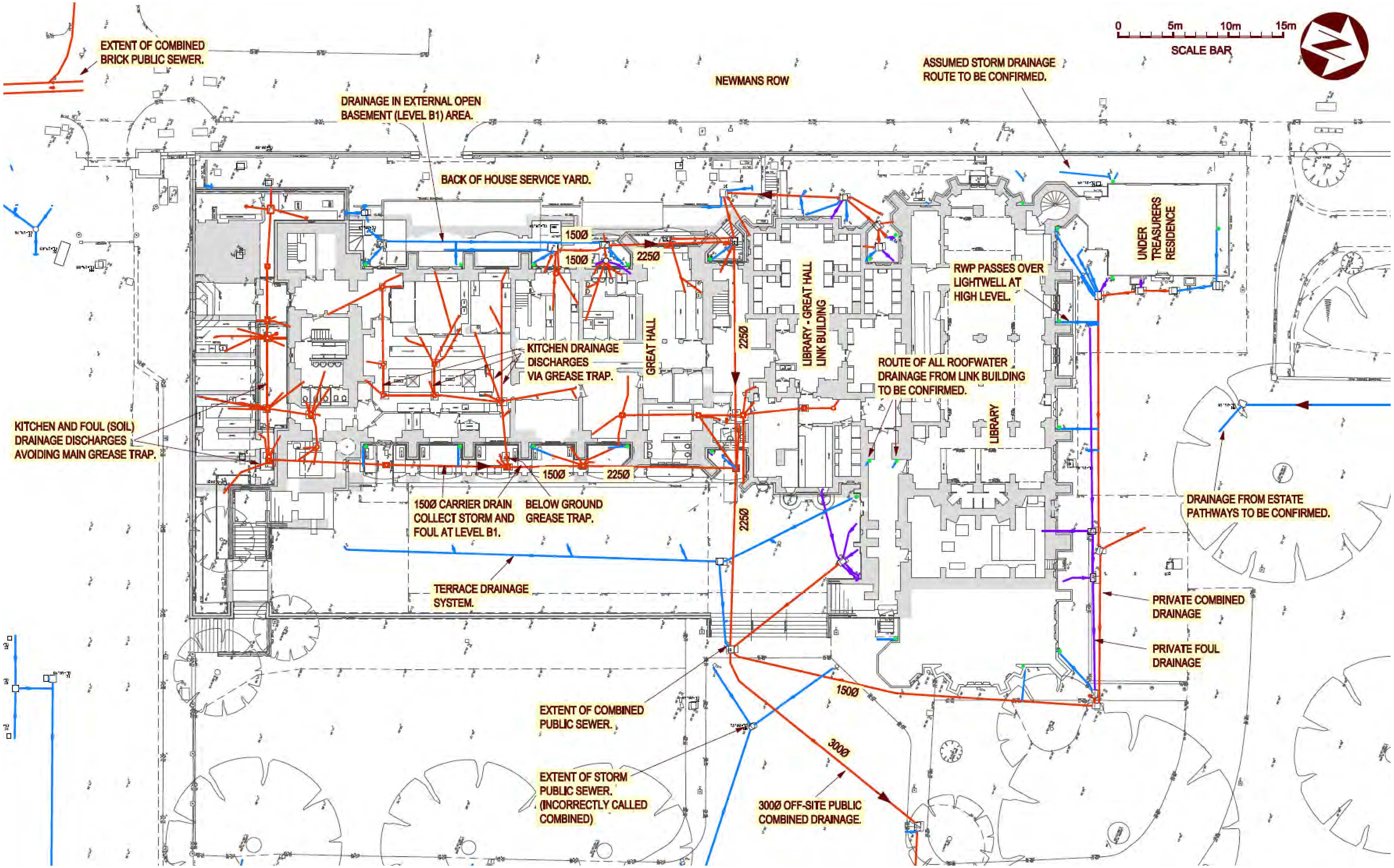

Figure 2 – Existing Drainage – Showing Basement Level and External Areas.

3. PROPOSED DRAINAGE PRINCIPLES

In developing a strategy for the drainage alterations necessary to accommodate the proposed building works the following overarching principles have been considered:

- Where practicable, foul and storm systems should be separated to reduce the risk of foul flooding during extreme rainfall events.
- Where practicable storm drainage should not drop to basement level where it increases flood risk. Removal at high level i.e. just below ground level should be prioritised.
- Kitchen drainage should be collected separately from general foul (soil) drainage so that it can be treated for grease removal before joining the other drainage streams.
- Grease removal must be undertaken as close to source as possible to reduce the extent of below building grease blockage risk.
- Storm drainage should be removed from drainage that potentially carries grease, to minimize risk of storm surcharging of any restricted drainage.
- Corroded and oversized drainage to be replaced.
- Sustainable stormwater drainage provision must be considered to comply with the requirements of Thames Water and London Borough of Camden in order to meet their sustainability objectives under the London Plan, and to minimize any impact on the receiving drainage infrastructure.

4. PROPOSED FOUL DRAINAGE DESIGN

A detailed feasibility has been undertaken on the foul drainage proposals to establish how to resolve existing problems and reduce future maintenance. A schematic layout of the proposed foul drainage is shown in Figure 3.

The existing kitchen drainage system is in poor condition and much of the existing drainage will need to be removed to accommodate the revised kitchen configuration. It is therefore replaced with a new system utilizing correctly sized pipes (100mm diameter) at correct gradients with all storm water removed from kitchen drainage. The existing offsite drainage route to the east will be obstructed by the proposed East Terrace Basement. This would necessitate extensive internal drainage routing which may exacerbate grease problems; it also provides no suitable location for a grease trap and would require much duplication of drainage systems within the basement to resolve the removal of storm drainage. For these reasons it is proposed to discharge the kitchen drainage from the West of the Great Hall. This creates a simple kitchen foul drainage system and enables the grease trap to be located to the service (West) side of the building for ease of maintenance, which has the added benefit of separating maintenance/ cleaning operations from the front of house dining facilities.

An application is required with Thames Water (TW) for foul connection in Newmans Row. The existing public 1067 x 813 sewer is a brick oval and the final form of connection method will require confirmation with TW. To enable the formal S.106 connection application a valid planning approval and appointed contractor is necessary. The foul connection is a departure from the current drainage pattern but given the very low base flow this should be a formality with TW.

A biomass grease trap is provided prior to off-site kitchen discharge and this will be augmented by internal enzyme dosing where the highest grease/fat producing equipment is positioned. High level alarms will be provided so that a rise in flow level can be identified before it becomes critical and suitable action taken to remove the cause.

Conventional foul drainage carrying WC's and other sanitary installations will be discharged to the East of the development as per the existing arrangement.

Toilets at B2 level in both the new East Terrace Basement and Library Extension Basements will drain to pumping stations that will lift the flow to a higher level for off site gravity discharge.

Any of the existing drain branches not used for connections from the proposed development will need to be capped and grouted up or completely removed to avoid rat infestation and possible long term structural issues.

To reduce future grease problems in the below ground drainage network, the use of waste macerators in sinks will be avoided, chemical cleaners will be reviewed to ensure they do not damage the grease biomass ecosystem and regular maintenance and inspection of the grease reduction system will be instigated.

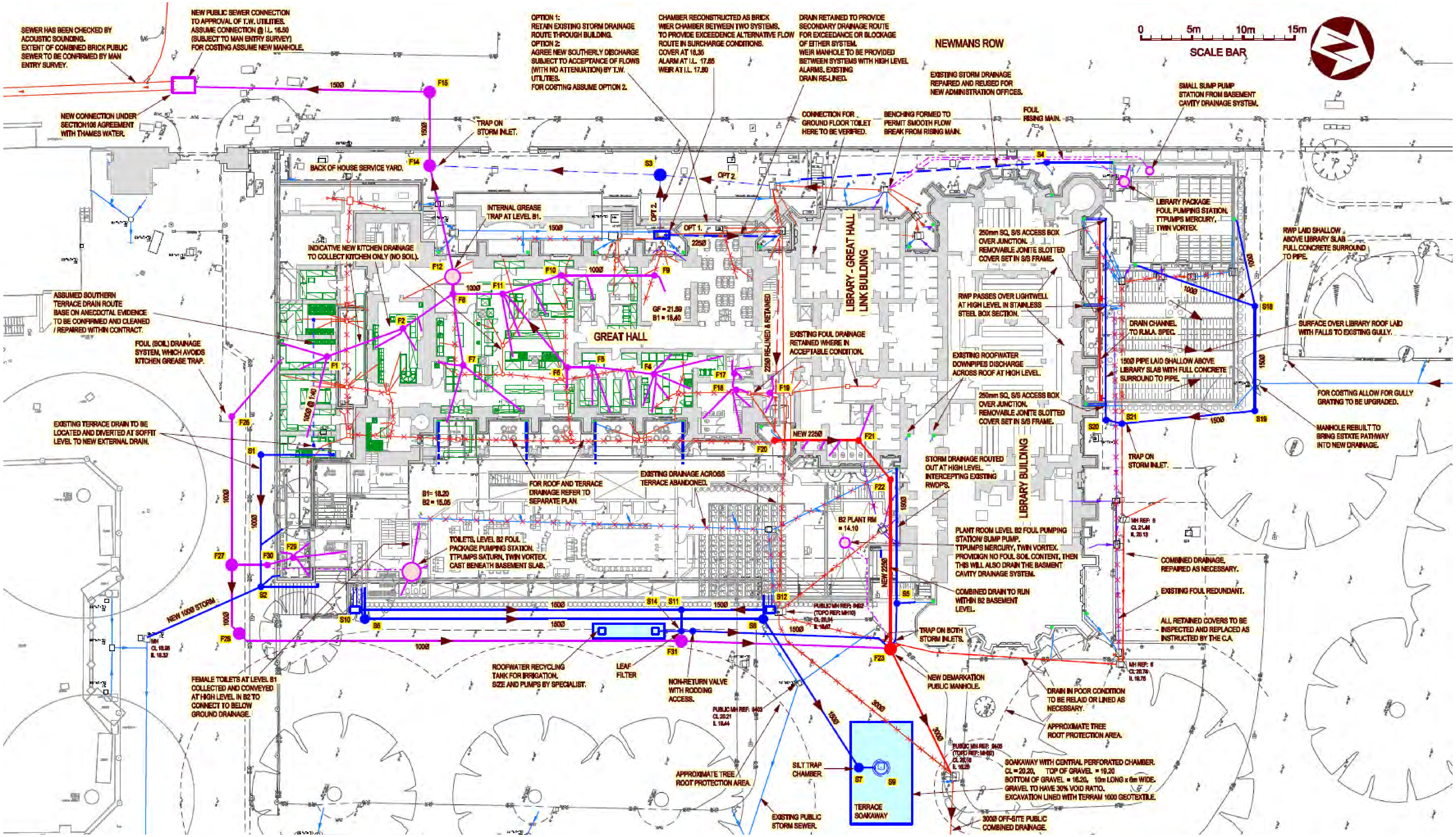

Figure 3 – Proposed Drainage – Showing Basement Level and External Areas

5. PROPOSED STORM DRAINAGE DESIGN

A schematic layout of the proposed storm drainage layout is shown in Figure 3.

In order to assess the capacity of the existing drainage systems and thus provide some guidance as to the level of flood risk under storm conditions, the main existing drain runs have been schematically modelled using industry standard Microdrainage software. The results are shown in Appendix 1 and indicate that with drains in good condition the network is capable of discharging a 100 year combined foul and storm flow without flooding. An amount of surcharging of the drains is required to deal with the 100yr flow but the maximum water level in the drain system is no greater than 500mm below basement slab level. This is encouraging but the CCTV indicates the drain system is not in good condition in a number of areas so the capacity would be somewhat below that modelled, and a risk of local flooding is likely.

Enquiries have been initiated with Thames Water (TW) and London Borough of Camden (LBC) to establish parameters for the revised surface water drainage system.

Thames Water Developer Services have been approached and responded by email 07/05/15. See Figure 4 below.

From: DEVELOPER.SERVICES@THAMESWATER.CO.UK [mailto:DEVELOPER.SERVICES@THAMESWATER.CO.UK]
Sent: 07 May 2015 08:53
To: Martin Jones
Subject: FW: IRef:1010417679 Pre- Development enquiry

Good Morning Mr M Jones,

For Surface Water the first thing we check is if you are able to connect into the sewer, if consented and you have attenuated (this is always advisable as it will be cheaper to provide online storage than to pay to upgrade the public surface water sewer, imagine traffic management, getting the relevant permits, any interaction with any other utilitiy...).

Before discharging surface water Thames Water general policy with regard to disposal of surface water from a site shall be in accordance with the Building Act 2000 clause H3.3. Positive connection to the surface water sewer will only be consented when it can be demonstrated that the hierarchy of disposal methods have been examined and proven to be impracticable. The disposal hierarchy being ;- 1st Soakaways; 2nd Watercourses; 3rd Sewer. Discharges shall be attenuated to reduce the likelihood of flooding downstream of the point of connection.

For a Greenfield site our recommendation is to attenuate to 5l/s/ha (well this is what is required typically by the Asset Planners however it does not warranty that there is capacity on the sewer as the greenfield is not usually draining into the sewer), therefore again recommending this will not warranty capacity on the sewer.

If this is in London then there is another piece of planning legislation to comply with, the London Plan where the developer is encouraged to reduce the SW discharge rates (attached to this email).

I hope this helps. Kind regards,

Faiza

Developer Services

Figure 4 – Developer Services Response.

The TW response is for a hierarchy of stormwater disposal methods which must be considered being;
1st Soakaways;
2nd Watercourses;
3rd Sewer.
TW also refer to the London Plan planning legislation policy 5.13 which follows a similar hierarchy to the TW response and includes an appraisal of source control systems such as porous paving and rainwater recycling, which could assist in reducing both the discharge rate and volume.

London Borough of Camden responded on 20/05/15, See Figure 5.

From: Farthing, Amy [mailto:Amy.Farthing@camden.gov.uk]
Sent: 20 May 2015 13:24
To: Martin Jones
Subject: RE: Development - Great Hall, Lincolns Inn

Hi Martin,

Your email has been forwarded to me, apologies for the delay in responding.

We require London Plan policy 5.13 to be followed. This applies to all major developments (whether new or existing). We will take into consideration any limitations that an existing site poses in terms of achieving the greenfield run off rate, but we are looking for this target (or as close as possible) to be met wherever feasible.

Green infrastructure SuDS and above ground storage/ permeable pavements are favoured in line with the hierarchy. You must demonstrate that the hierarchy stated in LP 5.13 has been followed. There is further guidance available in our CPG3.

I hope this helps

Kind regards

Amy Farthing
Sustainability Officer

Telephone: 020 7974 7611

Figure 5 – London Borough of Camden Response.

LBC also require the London Plan to be followed and where possible would target a greenfield run-off rate to be achieved if feasible. Where greenfield rate is not achievable, a minimum 50% reduction in run off rate for the development is required.

No watercourse is present so the design methodology is to look for infiltration in the first instance, and where/if this is not possible the discharge would need to be to the public combined sewer as per the existing system. LBC SFRA maps identify that the site may lie over Hackney or Lynch Hill Gravel superficial deposits.

A Site Investigation has been undertaken and Gravel has been located. In the areas where soakaways may be viable the gravel is located at a depth of circa 2.9-3.6m, with the water table monitored at circa 5.8m depth.

Therefore soakaways are a viable stormwater drainage option where site constraints permit. A site review has identified 3 main drivers to the possible locations of soakaways, these are:

- Building Regulations part H and BRE365, require any soakaway must be 5m from the building structure.
- Soakaways should not be adjacent to existing basements with questionable waterproofing quality.
- The site is bounded by extensive trees. Any encroachment into the Root Protection Area (RPA) should be avoided unless there is an overriding justification to encroach.

The lawns and pavings to the North of the Library are severely restricted by the extensive tree RPA and the proximity of the existing library basement. The Lawn to the East of the Great Hall Terrace (Benchers Lawn) looks viable, however the RPA from the 3 London Planes here is 15m and encroaches to within 3.5m of the new basement, so significant encroachment into the RPA would be necessary and approval from the Tree Officer would be unlikely. The only viable area is the Benchers Car Park which is to the North of the Benchers Lawn. This will require alteration and diversion to the existing drainage and services in this location.

As Figure 6 and 7 indicate, the overall hard drained area following the development increases from 3734m2 existing to 3952m2 proposed, so an increase of 218m2. Given the terrace is removed to allow installation of the basement, and then reinstated generally to its original form, the terrace area arguably remains as the existing situation, with the only addition being some rooflights to the below ground structure, and these roof lights are largely offset by a new large raised planter on the terrace. The remaining increase in overall site impervious area comes from some additional paving over the Library basement.

The increase in impermeable area necessitates a reduction in discharge to be achieved where possible to satisfy TW and LBC, and at a minimum any new development should be reduced by 50% over the existing rate. Given the existing drainage network is combined drainage and not suitable for infiltration, the drainage that lends itself to being easily separated and collected for infiltration is the reinstated Great Hall Terrace. The catchment area for this is 680m2 (0.068 ha).

Calculations have been undertaken as Appendix 2 using an assumed conservative infiltration rate of 4x10-6 m/s (0.014 m/hr). A soakaway can fit into the Benchers Carpark area, and this location will have minimum excavation impact on the tree RPA and is also sufficiently removed from the existing basement. The soakaway has been designed to contain the 100 year plus 30% Climate Change (CC) storm.
The soakaway has also been checked for the 10 year return period storm as per BRE365 and the time to half empty is 977 minutes (16 hours 17 minutes) which satisfies the BRE design requirements.

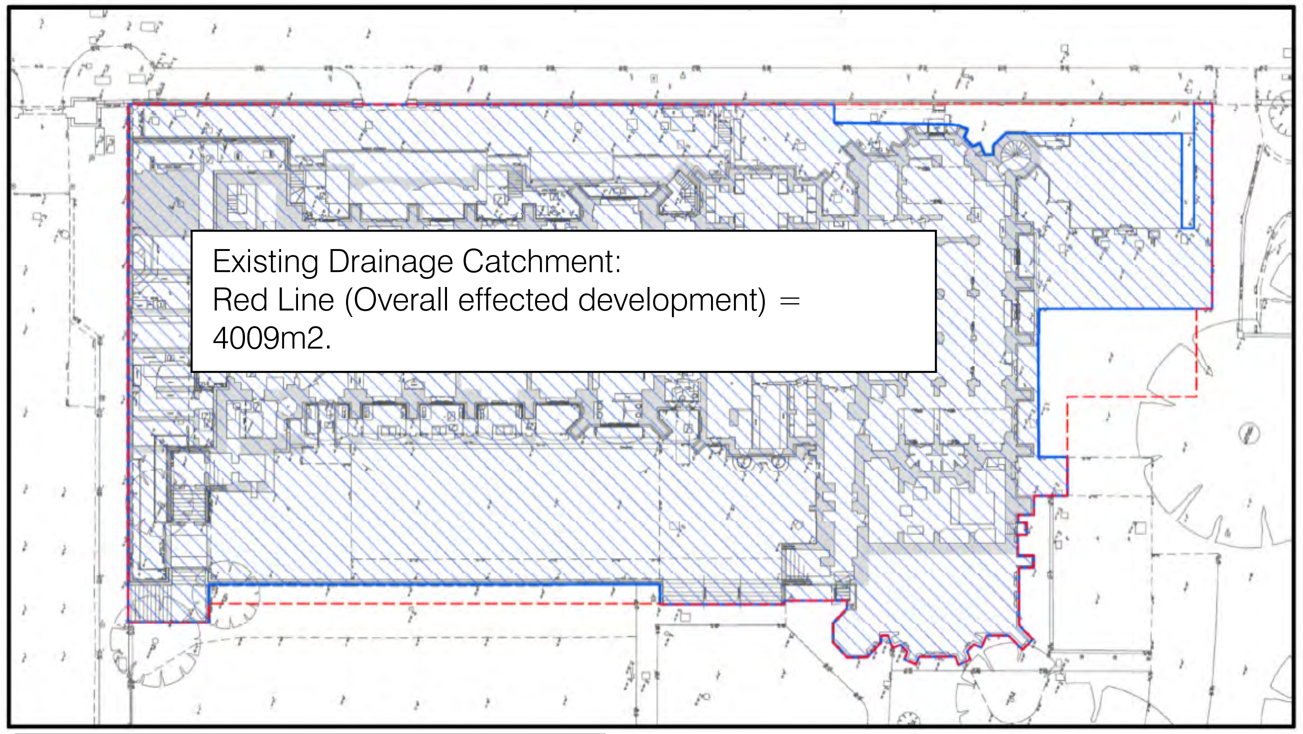

Figure 6 – Existing Drainage Catchment

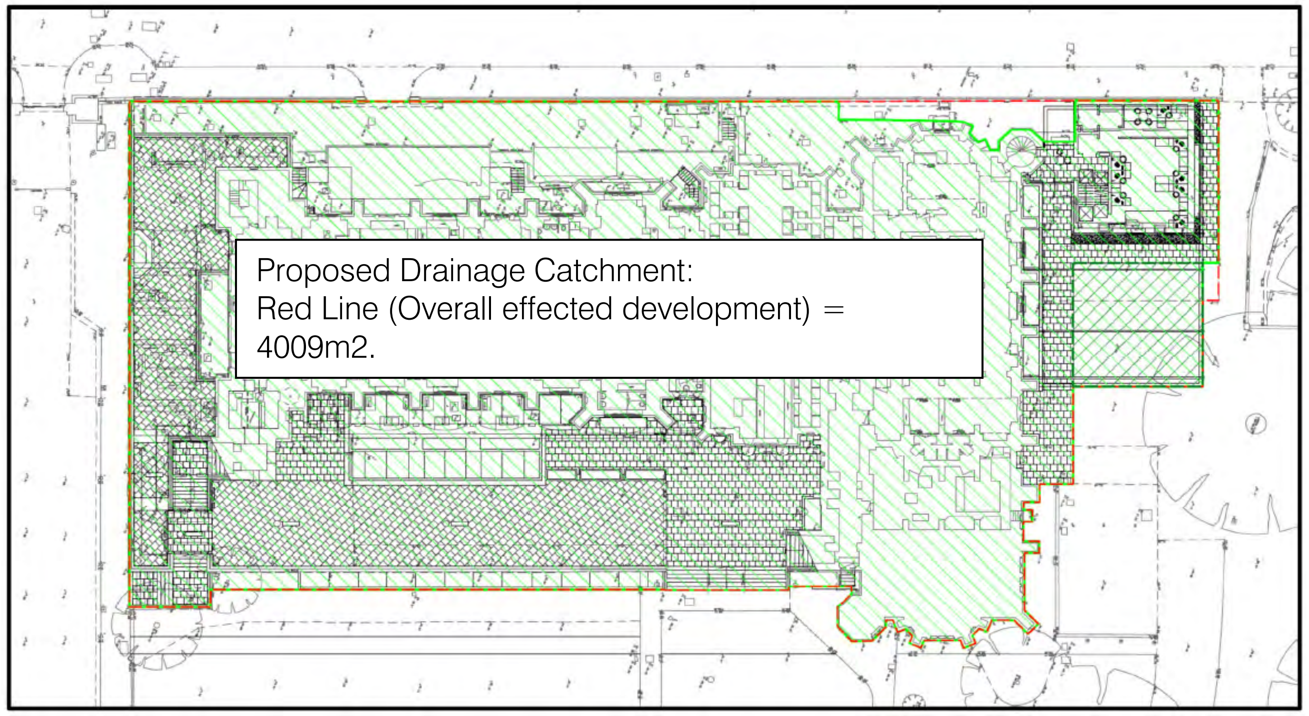

Figure 7 – Proposed Drainage Catchment

With the Terrace dealt with by soakaway, the terrace area is discharged at source and can be entirely removed from the off-site discharge. Therefore the overall site offsite discharge is reduced from 3734m2 to 3272m2, so a reduction in discharge area of 462m2, a 12% total site discharge reduction in both rate and volume.

We consider that given the majority of the site is remaining as existing, the reduction of 12% in overall discharge should satisfy the TW and LBC requirements. In terms of areas which are actually being developed (i.e. excluding the existing retained Great Hall and Library) the reinstated basement areas have a combined area of 1000m2. From this 1000m2, 680m2 of the re-laid terrace is now being redirected to soakaway (removed from the public drainage), therefore the off-site discharge rate and volume from the developed areas is reduced by 68% from 1000m2 to 320m2.

Despite the significant reduction in discharge volume being achieved, the Client's aspirations are to utilize some stormwater recycling where possible for ongoing irrigation purposes. The desirable source for this is roofwater as it is clean with minimal contamination. Given much of the existing roofwater system is incorporated into a combined drainage system, the most practicable area identified for harvesting clean roofwater is the East elevation of the Great Hall. This is to be collected and discharged via an irrigation collection tank. The final size of the harvesting tank will be designed by specialists using water efficiency calculations to establish the most economic storage volume based on catchment and usage.

6. GROUNDWATER DRAINAGE ISSUES

Thames Water will not normally permit the discharge of permanent groundwater dewatering systems into public sewers. This is in order to limit the amount they have to deal with in terms of pumping and water treatment at the receiving sewage treatment plant. The Water Table has been monitored at maximum level circa 14.3m, and the B2 basement is generally at level 15.05m, therefore construction into the groundwater is largely avoided. However to meet the required standard of waterproofing and damp control in the new spaces, there needs to be a 2 stage waterproofing system to BS 8102 (waterproofing basements). To achieve this the East Terrace and Library Extension basements will be fully waterproofed externally but also requires a secondary drainage layer behind the inner skin of walls and on top of the basement slab beneath the floor finishes. This drainage layer will generally have negligible or zero flow but what little flow there is may be collected in small sumps and discharged to the foul system. TW's approval to this system will be sought and should be a formality as it is a widespread approach in London basements.

7. FLOOD RISK & FLOOD PROTECTION MEASURES

In terms of fluvial flooding the development is in Flood Zone 1 and is less than 1 hectare in area so does not require a site specific flood risk assessment according to the requirements of the National Planning Policy Framework (NPPF). In addition to fluvial flood risk it is important to consider localised surface water flood risk. This can be viewed on the Camden web site under their latest strategic flood risk assessment, which contains surface water flood mapping that has been carried out for most of London in recent times. An extract of the mapping is shown in Figure 8. Flood hazard mapping in the SFRA has also been reviewed and there is no significant surface water flooding issue that should be of concern to the Great Hall development. Notwithstanding this there is always a potential risk of rainfall

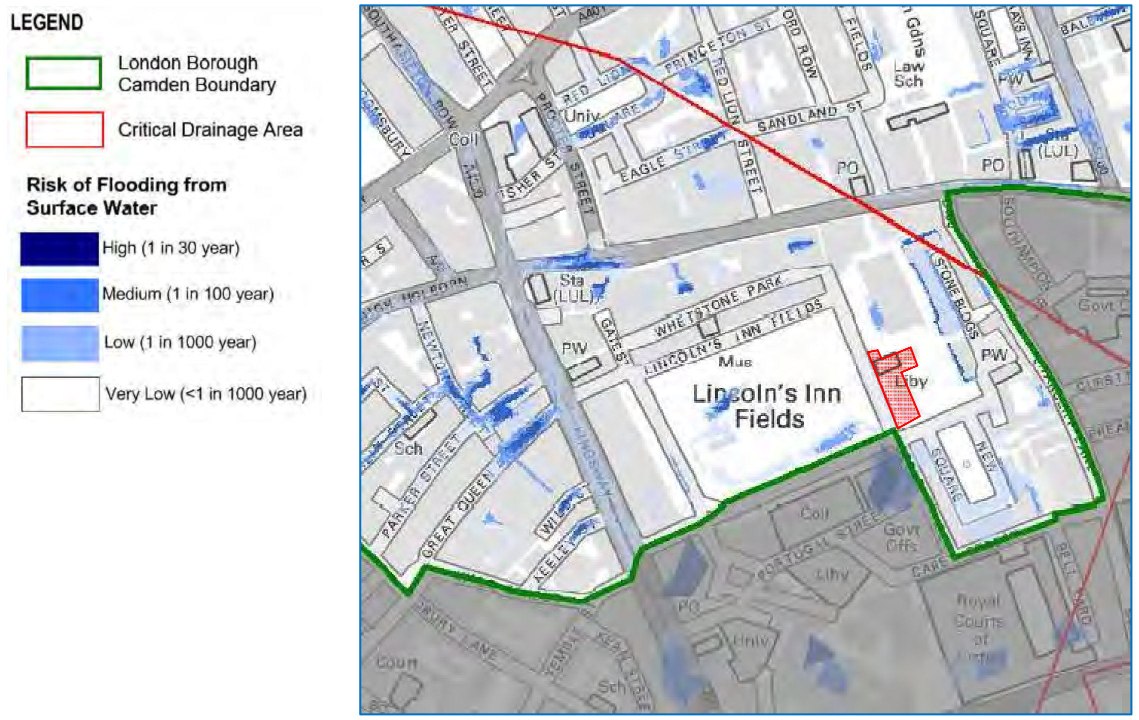

Figure 8 – Surface Water Flood Risk from London Borough of Camden SFRA

events causing very localised ponding and associated flood damage around buildings due to badly routed roofwater, run-off from paved areas or blocked drainage systems. We have therefore also reviewed the perimeter site levels in order to determine areas at highest risk of flooding and potential routing of floodwater.

The presence of large areas of basement is a flood risk concern in itself but there are particular areas that we suggest need flood prevention measures. The lightwells on the west side of the Great Hall have no escape route for stormwater in the event of blockages or surcharges from e.g. TW sewers backing up. We propose to fit alarms to the chambers on this side of the building to warn if high water levels start to develop.

As previously identified, the existing storm network is capable of conveying the 100 year + 30% climate change storm and will surcharge to within 500mm of slab level under these flow conditions. This is considered satisfactory in flood risk terms, especially given the reduction in discharge rate provided by the proposed design and therefore continued use of the storm network in its current format is the basis for this planning application. However we consider there is a low residual risk in the existing principle of passing the majority of flows eastwards through the building at basement level. Therefore post planning it is the intention to negotiate with TW if a split can be made in the storm water so the Western elevation can discharge via a new drainage connection to the sewer in Newmans Row. This would free up capacity in the retained 225 dia under the building, and provide a back-up bifurcation system should a drain blockage or surface flooding occur.

Although TW may challenge a storm connection into Newmans Row on the basis that it changes the local catchment patterns, negotiations will be undertaken with TW on the basis that:

- The local drains are all on the same network so there is minimal change in overall catchment patterns

- Adequate sustainable drainage measures are applied to the drainage on the eastern side of the development to compensate for the slight increase in local catchment area on the west side

If a nominal storm connection to Newmans Row is not permitted, the drainage from the west façade of the Great Hall will continue running as the existing regime through the basement into the existing drainage running eastwards.

The remainder of the building perimeter post development appears to have reasonable flood resilience in that there is generally an escape route for water to a lower ground level which avoids material damage to the buildings.

8. CONCLUSION

The proposed development introduces considerable constraints on the existing drainage but the proposals in this report provide a robust design approach to adjust the system to accommodate the building works proposed whilst at the same time improving the performance of the ailing existing drainage network, and reducing the impact on the public drainage networks.

In order to progress, the next stage of design is to obtain formal approvals from Thames Water and London Borough of Camden Planning Department under the planning process. Once agreement is reached the concept design in this report will be detailed in a coordinated manner with architecture, structure and services, and formal applications for Section 106 drainage connections, Section 185 diversions and any drainage divestment applications can be made as necessary. Once the Thames Water approvals are in place the detailed design would advance to construction status, with the general building drainage approvals carried out under the Building Inspectors supervision in respect of Building Regulations part H.

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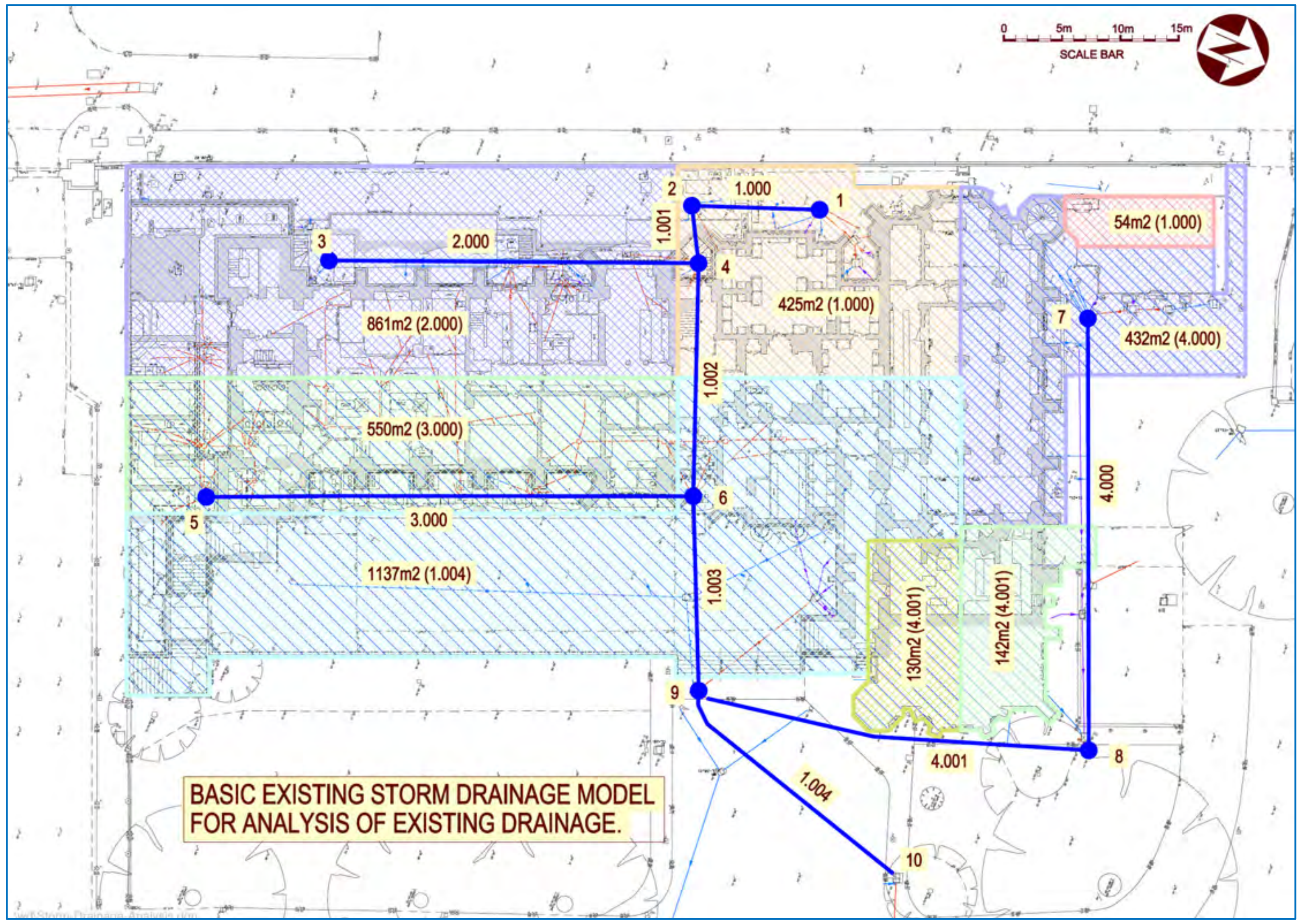
Appendix 1 – Existing Drainage Capacity Analysis



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31 Dyer Street Cirencester Glos GL7 2PP	Lincolns Inn Existing Storm Review	Micro Drainage
Date May 2015 File Existing-Storm-Sim.mdx	Designed by MDS Checked by MJ	
Causeway	Network 2014.1	

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	Add Flow / Climate Change (%)	0
M5-60 (mm)	20.800	Minimum Backdrop Height (m)	0.200
Ratio R	0.440	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	100	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.269	4-8	0.104

Total Area Contributing (ha) = 0.373

Total Pipe Volume (m³) = 7.624

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)	HYD SECT	DIA (mm)	Auto Design
1.000	11.200	0.200	56.0	0.048	5.00	0.0	1.500	o	150	
1.001	5.000	3.155	1.6	0.000	0.00	0.0	1.500	o	150	
2.000	32.000	0.480	66.7	0.086	5.00	0.0	1.500	o	225	
1.002	20.000	0.220	90.9	0.000	0.00	0.0	1.500	o	225	
3.000	42.000	0.405	103.7	0.055	5.00	4.0	1.500	o	225	
1.003	17.000	0.355	47.9	0.000	0.00	0.0	1.500	o	225	

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	58.79	5.16	20.600	0.048	0.0	0.0	0.0	1.17	20.7	7.6
1.001	58.72	5.17	20.400	0.048	0.0	0.0	0.0	6.99	123.6	7.6
2.000	57.66	5.38	17.650	0.086	0.0	0.0	0.0	1.41	55.9	13.4
1.002	56.32	5.66	17.170	0.134	0.0	0.0	0.0	1.20	47.9	20.4
3.000	56.48	5.62	17.355	0.055	4.0	0.0	0.0	1.13	44.8	12.4
1.003	55.52	5.83	16.950	0.189	4.0	0.0	0.0	1.66	66.0	32.4

Appendix 1 – Existing Drainage Capacity Analysis (continued)

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31 Dyer Street Cirencester Glos GL7 2PP	Lincolns Inn Existing Storm Review	Micro Drainage
Date May 2015 File Existing-Storm-Sim.mdx	Designed by MDS Checked by MJ	
Causeway	Network 2014.1	

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)	HYD SECT	DIA (mm)	Auto Design
4.000	37.500	0.910	41.2	0.043	5.00	0.0	1.500	o	150	
4.001	34.000	3.040	11.2	0.027	0.00	0.0	1.500	o	150	
1.004	23.500	0.270	87.0	0.114	0.00	0.0	1.500	o	300	

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)
4.000	57.28	5.46	20.620	0.043	0.0	0.0	0.0	1.37	24.2	6.7
4.001	56.24	5.67	19.710	0.070	0.0	0.0	0.0	2.63	46.5	10.7
1.004	54.34	6.09	16.520	0.373	4.0	0.0	0.0	1.49	105.1	58.9

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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.800	Storm Duration (mins)	30
Ratio R	0.440		

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31 Dyer Street Cirencester Glos GL7 2PP	Lincolns Inn Existing Storm Review	Micro Drainage
Date May 2015 File Existing-Storm-Sim.mdx	Designed by MDS Checked by MJ	
Causeway	Network 2014.1	

Summary of Results for 30 minute 100 year Summer (Storm)

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	1	20.743	-0.007	0.000	1.00	0.0	19.1	OK
1.001	2	20.443	-0.107	0.000	0.18	0.0	19.1	OK
2.000	3	17.878	0.003	0.000	0.63	0.0	33.5	SURCHARGED
1.002	4	17.735	0.340	0.000	1.05	0.0	46.7	SURCHARGED
3.000	5	17.609	0.029	0.000	0.57	0.0	24.6	SURCHARGED
1.003	6	17.492	0.317	0.000	1.20	0.0	72.2	SURCHARGED
4.000	7	20.717	-0.053	0.000	0.74	0.0	17.5	OK
4.001	8	19.798	-0.062	0.000	0.64	0.0	28.8	OK
1.004	9	17.078	0.258	0.000	1.39	0.0	132.5	SURCHARGED

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Appendix 2 – Terrace Soakaway Scheme Calculations.

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31 Dyer Street Cirencester Glos GL7 2PP	HSLI -Great Hall Terrace Soakaway	
Date 17/07/2015 10:00 File SOAKAWAY-1.SRCX	Designed by MDS Checked by MJ	
Causeway	Source Control 2014.1	

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

Half Drain Time : 2191 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	16.895	0.695	0.2	12.3	O K
30 min Summer	17.448	1.248	0.2	22.3	O K
60 min Summer	17.721	1.521	0.2	27.2	O K
120 min Summer	17.980	1.780	0.2	31.9	O K
180 min Summer	18.116	1.916	0.2	34.3	O K
240 min Summer	18.202	2.002	0.2	35.9	O K
360 min Summer	18.312	2.112	0.2	37.8	O K
480 min Summer	18.380	2.180	0.2	39.1	O K
600 min Summer	18.422	2.222	0.2	39.8	O K
720 min Summer	18.448	2.248	0.2	40.3	O K
960 min Summer	18.467	2.267	0.2	40.6	O K
1440 min Summer	18.432	2.232	0.2	40.0	O K
2160 min Summer	18.316	2.116	0.2	37.9	O K
2880 min Summer	18.204	2.004	0.2	35.9	O K
4320 min Summer	18.014	1.814	0.2	32.5	O K
5760 min Summer	17.856	1.656	0.2	29.6	O K
7200 min Summer	17.716	1.516	0.2	27.1	O K
8640 min Summer	17.585	1.385	0.2	24.8	O K
10080 min Summer	17.466	1.266	0.2	22.6	O K
15 min Winter	16.999	0.799	0.2	14.2	O K
30 min Winter	17.599	1.399	0.2	25.0	O K
60 min Winter	17.908	1.708	0.2	30.6	O K
120 min Winter	18.202	2.002	0.2	35.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	138.439	0.0	19
30 min Summer	89.338	0.0	46
60 min Summer	54.817	0.0	74
120 min Summer	32.487	0.0	132
180 min Summer	23.617	0.0	192
240 min Summer	18.732	0.0	250
360 min Summer	13.493	0.0	370
480 min Summer	10.688	0.0	488
600 min Summer	8.914	0.0	606
720 min Summer	7.683	0.0	726
960 min Summer	6.072	0.0	964
1440 min Summer	4.353	0.0	1442
2160 min Summer	3.116	0.0	1840
2880 min Summer	2.456	0.0	2188
4320 min Summer	1.755	0.0	2976
5760 min Summer	1.381	0.0	3760
7200 min Summer	1.146	0.0	4608
8640 min Summer	0.984	0.0	5368
10080 min Summer	0.865	0.0	6152
15 min Winter	138.439	0.0	19
30 min Winter	89.338	0.0	46
60 min Winter	54.817	0.0	74
120 min Winter	32.487	0.0	132

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Causeway	Source Control 2014.1	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
180 min Winter	18.359	2.159	0.2	38.7	O K
240 min Winter	18.459	2.259	0.2	40.5	O K
360 min Winter	18.590	2.390	0.2	42.8	O K
480 min Winter	18.674	2.474	0.2	44.4	O K
600 min Winter	18.729	2.529	0.2	45.3	O K
720 min Winter	18.766	2.566	0.2	46.0	O K
960 min Winter	18.803	2.603	0.2	46.7	O K
1440 min Winter	18.798	2.598	0.2	46.6	O K
2160 min Winter	18.697	2.497	0.2	44.8	O K
2880 min Winter	18.555	2.355	0.2	42.2	O K
4320 min Winter	18.306	2.106	0.2	37.7	O K
5760 min Winter	18.082	1.882	0.2	33.7	O K
7200 min Winter	17.875	1.675	0.2	30.0	O K
8640 min Winter	17.683	1.483	0.2	26.5	O K
10080 min Winter	17.505	1.305	0.2	23.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
180 min Winter	23.617	0.0	190
240 min Winter	18.732	0.0	248
360 min Winter	13.493	0.0	364
480 min Winter	10.688	0.0	482
600 min Winter	8.914	0.0	598
720 min Winter	7.683	0.0	714
960 min Winter	6.072	0.0	946
1440 min Winter	4.353	0.0	1400
2160 min Winter	3.116	0.0	2048
2880 min Winter	2.456	0.0	2360
4320 min Winter	1.755	0.0	3240
5760 min Winter	1.381	0.0	4136
7200 min Winter	1.146	0.0	4984
8640 min Winter	0.984	0.0	5800
10080 min Winter	0.865	0.0	6568

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Appendix 2 – Terrace Soakaway Scheme Calculations (continued).

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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)	20.800	Shortest Storm (mins)	15
Ratio R	0.440	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Pipe Network

Volume in Pipe Network (m^3)	5	Dia of Outfall Pipe (m)	0.2
Slope of Outfall Pipe (1:X)	150	Roughness of Outfall Pipe (mm)	0.600

Time Area Diagram

Total Area (ha) 0.068

Time (mins) From:	To:	Area (ha)
0	4	0.068

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Model Details

Storage is Online Cover Level (m) 20.200

Trench Soakaway Structure

Infiltration Coefficient Base (m/hr)	0.01400	Trench Width (m)	6.0
Infiltration Coefficient Side (m/hr)	0.01400	Trench Length (m)	10.0
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	0.30	Cap Volume Depth (m)	3.000
Invert Level (m)	16.200	Cap Infiltration Depth (m)	1.000