SURFACE WATER DRAINAGE ASSESSMENT & OUTLINE SUDS STRATEGY

19 HOLMDALE ROAD

CAMDEN

LBHGEO

LBH4620suds

October 2020

DOCUMENT CONTROL

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FOREWORD-GUIDANCE NOTES

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The report may present an opinion based upon information received from third parties. However, no liability can be accepted for any inaccuracies or omissions in that information.

1. INTRODUCTION

1.1 BACKGROUND

It is proposed to construct a new basement beneath the existing property at No. 19 Holmdale Road.

The basement is proposed beneath the full footprint of the property, extending to both the front and rear to provide sunken patios.

1.2 BRIEF

LBHGEO have been appointed to prepare a Surface Water Drainage Assessment & Outline SuDS Strategy to support a forthcoming planning application to be submitted to the London Borough of Camden.

1.3 SUDS GUIDANCE

The government advice is that developers should seek opportunities to reduce the overall level of flood risk through the appropriate application of sustainable drainage systems.

Sustainable drainage systems are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible. They provide opportunities to:

- reduce the causes and impacts of flooding;
- remove pollutants from urban run-off at source;
- combine water management with green space with benefits for amenity, recreation and wildlife.

The aim is to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable:

1. into the ground (infiltration);
2. to a surface water body;
3. to a surface water sewer, highway drain, or another drainage system;
4. to a combined sewer.

The London Borough of Camden requires drainage solutions to incorporate SuDS principles as laid out in the Non-Statutory Technical Standards[1] for Sustainable Drainage Systems and the London Plan[2].

For redevelopment sites where there is a net increase in impermeable area, development must include at least one ‘source control’ SuDS measure. Examples of potential Source Control measures include:

- blue/green roof
- rainwater harvesting
- bio-retention
- rain garden
- permeable paving

[1] DEFRA March 2015 Non-Statutory Technical Standards (NSTS) for sustainable drainage systems
[2] London Plan Chapter Five - London’s Responses to Climate Change Policy 5.1.3 Sustainable Drainage

Underground storage/attenuation tanks are not encouraged and are to be used only as a last resort.

The Camden Local plan provides guidance for water and flooding under Policy CC3, where the council will seek to ensure a development reduces the risk of flooding where possible and will require a development to utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy to achieve a greenfield run-off rate where feasible.

Additionally, the Camden Planning Guidance for Sustainability (CPG3) (July 2015, updated March 2018) states the following:

> *"All developments are expected to manage drainage and surface water on-site or as close to the site as possible, using Sustainable Drainage Systems (SUDS) and the hierarchy set out below.*
>
> *The Council will expect plans and application documents to describe how water will be managed within the development, including an explanation of the proposed SUDS, the reasons why certain SUDS have been ruled out and detailed information on materials and landscaping.*
>
> *The Council will expect developments to achieve a greenfield surface water run-off rate once SUDS have been installed. As a minimum, surface water run-off rates should be reduced by 50% across the development."*

1.4 REPORT STRUCTURE

This report describes the site characteristics and the proposed development, following which consideration is then given to the feasibility of different SuDS techniques for this site, in line with the SuDS hierarchy.

An analysis is then presented of surface water run-off and of the attenuation volume that will be required to achieve the required reduction in the predicted run-off rates, taking into account increased rainfall rates due to anticipated climatic change.

A SuDS strategy is then developed including information about the proposed SuDS types, with an aim to reduce the drainage discharge rates as far as can be reasonably achieved in the proposed post-development scenario.

The report is accompanied by detailed calculations and a summary sustainable drainage pro-forma.

2. THE SITE

2.1 SITE LOCATION

The site is located on the eastern side of Holmdale Road in West Hampstead and may be approximately located by the postcode NW3 5HB or by National Grid Reference 525280, 185165.

2.2 TOPOGRAPHICAL SETTING

The site lies on the lower southwestern slopes of Hampstead Hill on land that that falls gently to the southwest.

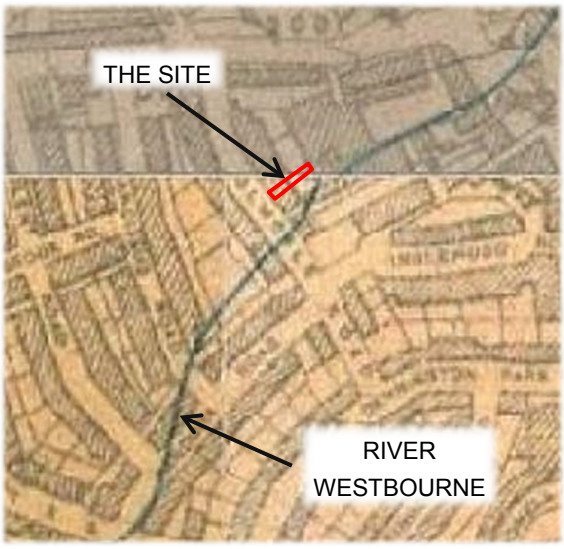
The course of a tributary of the “lost” River Westbourne runs a short distance to the southeast of the site.

The course of the (now culverted) River Westbourne flowed south-westwards a short distance to the southeast of the site.

2.3 GROUND CONDITIONS

Archive data indicates that the site is directly underlain by the London Clay Formation, which is essentially impermeable.

A site investigation to confirm the ground conditions is due to be undertaken in September 2020.



2.4 SITE DESCRIPTION

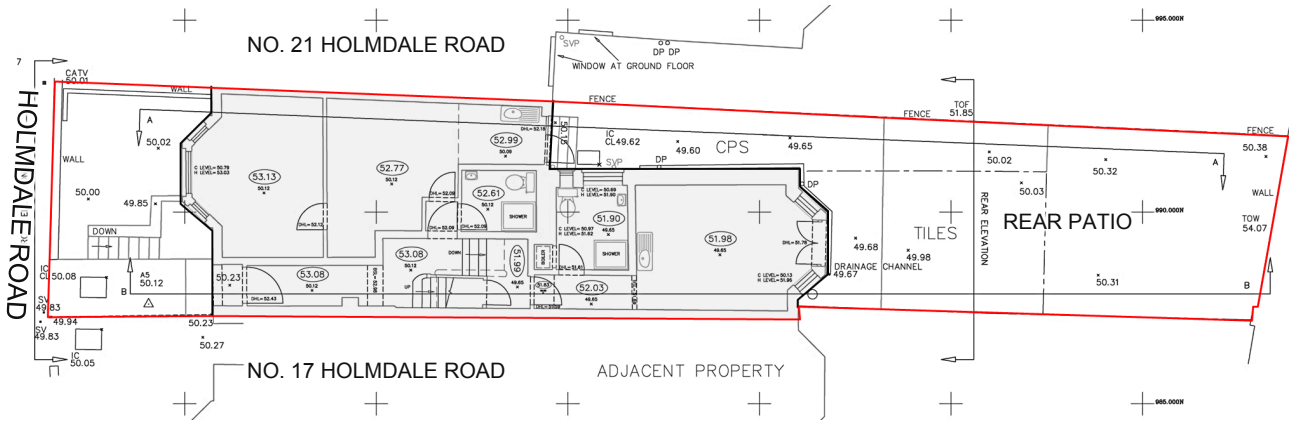
The site is occupied by a three storey Victorian terraced building, with patios to the front and rear. The patios are entirely hard surfaced, with no soft landscaped areas present on site.

The building is understood to be divided into six residential units, with the rear patio area divided by a fence between the two ground floor flats.

The existing ground floor is situated some 200mm above the street level (at approx. +50.2m OD), which steps down towards the rear of the building to a level of approx. +49.7m OD. While both of the neighbouring properties (Nos. 17 and 21 Holmdale Road) comprise partial basements, it is understood that there is only a limited basement area at the front of this site, accessible by a staircase adjacent to the front entrance.

The rear garden boundary is marked by an approximately 4m high brick wall, partially acting as a retaining wall, against the playing fields area of the Emmanuel Church of England Primary School, situated approx. 2m higher than the site. The playing fields extend behind the entire terrace of 15-31 Holmdale Road.

Timber fencing separates the site from the rear gardens of the neighbouring terraced properties, which are situated at approximately similar levels, sloping slightly southwards.



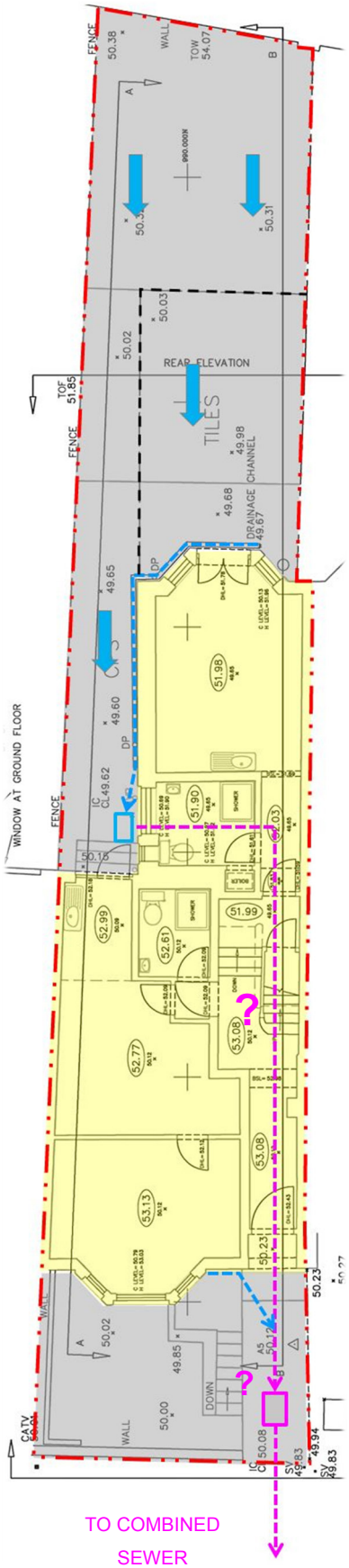
EXISTING SITE PLAN

2.5 EXISTING SURFACE WATER DRAINAGE

The site is entirely hard surfaced and the surface water run-off collected on site is directed towards a public combined sewer running southwards below Holmdale Road.

The rear patio area is gently sloping towards the property; hence the run-off from both the rear patio and the roofs of the rear half of the main building (including the rear extension) appears to be directed towards a drainage manhole at the corner of the rear patio, through downpipes and a drainage channel running along the perimeter of the rear projection.

The drainage then appears to be connected with the foul drains and directed beneath the building towards a sewer manhole at the front of the property, in front of the main entrance.



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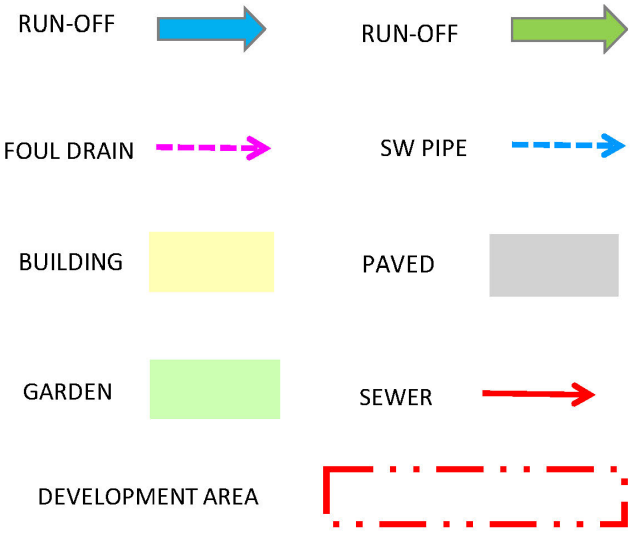
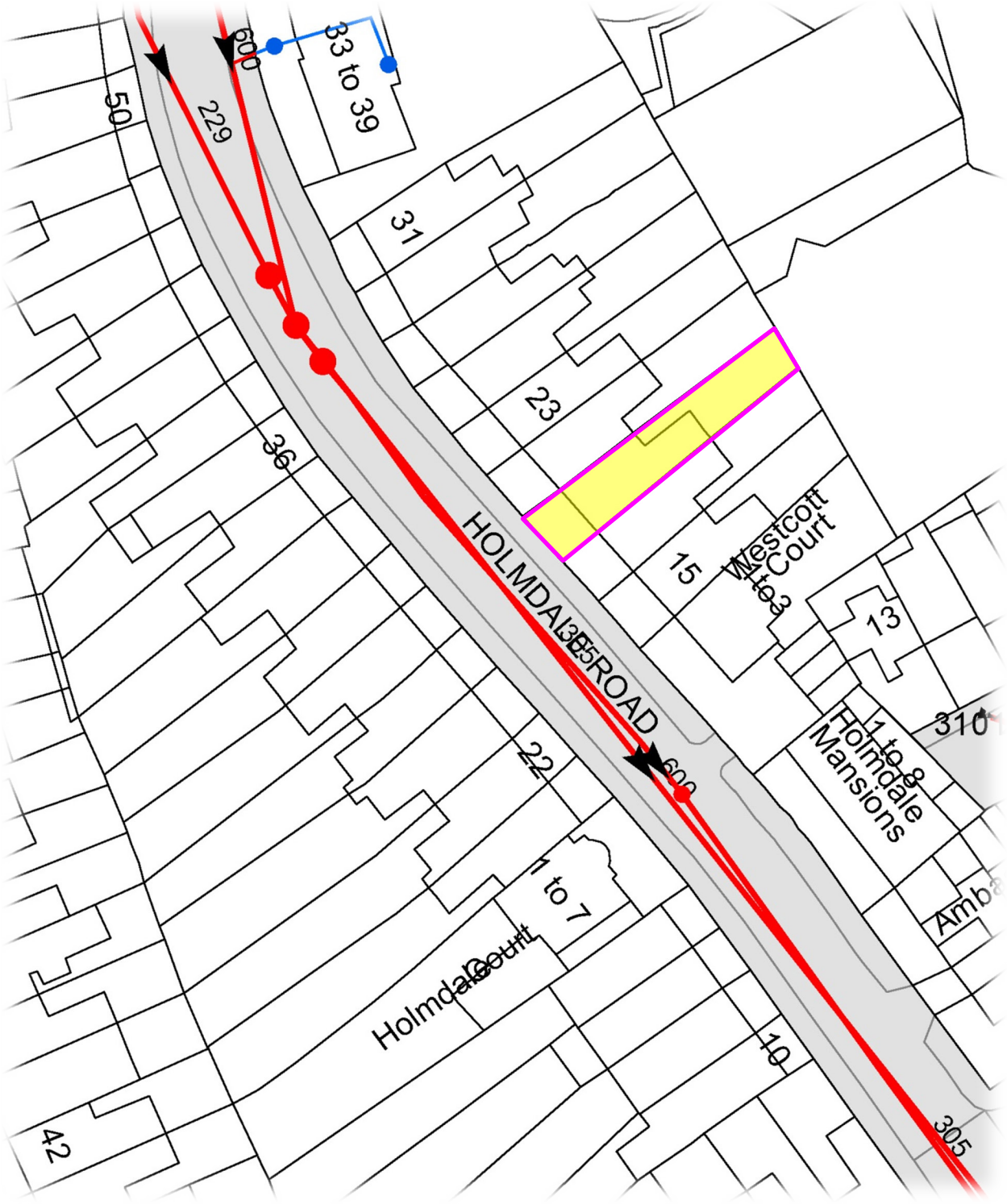


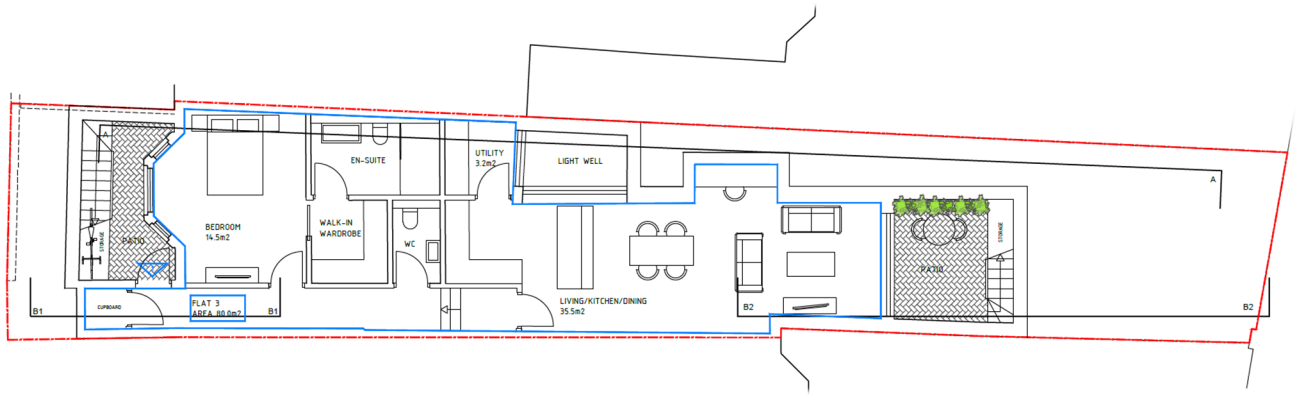


PUBLIC SEWER NETWORK IN THE VICINITY OF THE SITE

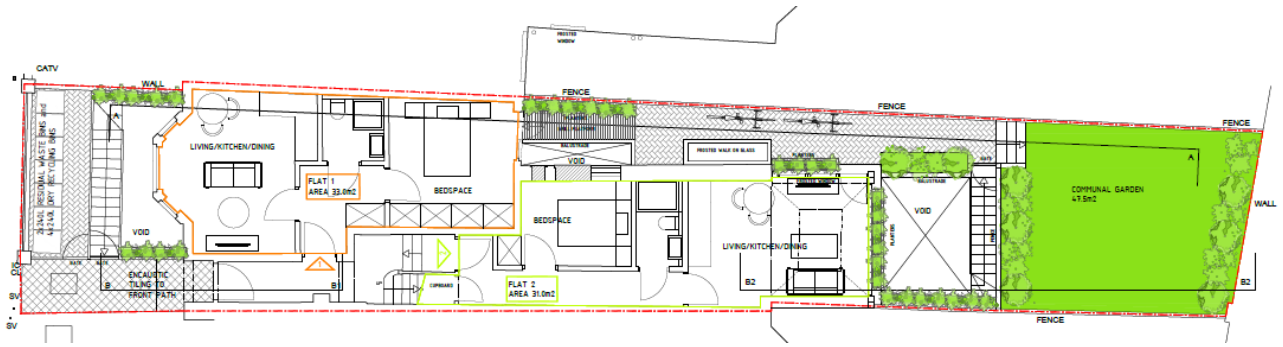
3. PROPOSED DEVELOPMENT

A new basement is to be constructed beneath the entire footprint of the existing property, extending to the front and rear to provide lightwells and sunken patio areas.

A soft landscaped garden area is to be introduced at ground floor level, to the far rear of the site, replacing the currently hard surfaced patio area.



BASEMENT (proposed)



GROUND FLOOR (proposed)

SCHEDULE OF ESTIMATED AREAS										
	EXISTING					PROPOSED				
		Cv	%		%	Proposed	Cv	%		%
FRONT AREAS	33sqm	0.77	18.9%			33sqm	0.77	18.9%		
BUILDING	80sqm	0.77	45.7%	**%IMP**	**100.0%**	87sqm	0.77	49.7%	**%IMP**	**82.9%**
REAR PATIOS	62sqm	0.77	35.4%			25sqm	0.77	14.3%		
GARDENS	0sqm	0.4	0%	**%PER**	**0.0%**	30sqm	0.4	17.1%	**%PER**	**17.1%**
TOTAL DEVELOPMENT AREA	175sqm		100.0%		100.0%	175sqm		100.0%		100.0%

4. SURFACE WATER MANAGEMENT

4.1 SURFACE WATER MANAGEMENT (SWM) OBJECTIVES

The drainage strategy follows the guidance set out in the 2015 CIRIA C753 SuDS Manual; the principle of SuDS design is that surface water runoff is managed for maximum benefit. Biodiversity

4.2 SUDS DISCHARGE HIERACHY

The surface water runoff should be managed using the following techniques, as outlined in order of priority by the following drainage hierarchy:

SuDS Drainage Hierarchy	Suitable for the site? (Y/N)	Comment
Store rainwater for later use	Y	There is limited space for rainwater harvesting, but garden water butts could be included.
Use infiltration techniques	N	The London Clay is unsuitable for soakaway infiltration.
Attenuate rainwater in ponds or open water features for gradual release	N	There is insufficient space to introduce open water garden features at this site.
Attenuate rainwater by storing in tanks or sealed water features for gradual release	Y	There is scope for attenuation storage within pumping chambers to be introduced in the form of below ground storage beneath the front and rear patios.
Discharge rainwater direct to a watercourse	N	There is no available watercourse.
Discharge rainwater to a surface water sewer/drain	N	There is no surface water sewer serving the site.
Discharge rainwater to the combined sewer	Y	The site discharges to the combined sewer beneath Holmdale Road.

The objective is to control the quantity of runoff to support the management of flood risk and maintain and protect the natural water cycle. The hierarchy seeks to ensure that surface water runoff is controlled as near to its source as possible to mimic natural drainage systems and retain water on or near to the site.

Before disposal of surface water to the public sewer is considered, all other options set out in the above hierarchy need to be exhausted.

4.3 FEASIBLE SUDS COMPONENTS

SUDS Component	Description	Suitable for the site? (Y/N)	Comment
Rainwater harvesting	Collection of rainwater runoff from roofs or impermeable areas for reuse.	Y	Water butts could potentially be included.
Green roofs	Vegetated areas installed on the top of buildings provide visual and ecological benefits in addition to surface water runoff reduction and enhanced building performance.	N	There is no potential roof area to be used for attenuation storage.
Blue roofs	Roof design intended to store water providing attenuation storage.	N	
Infiltration systems	Infiltration can contribute to reducing runoff rates and volumes while supporting base flow and groundwater recharge processes.	N	The London Clay is not suitable for infiltration.
Proprietary treatment systems	Proprietary treatment systems are manufactured products which remove specified pollutants from surface water runoff.	N	There is insufficient space.
Filter strips/drains	Filter strips are gently sloping strips of grass that provide treatment of runoff from adjacent impermeable areas. Filter drains are gravel or stone filled trenches which provide temporary subsurface storage for attenuation conveyance and filtration of surface water runoff.	N	There is insufficient space.
Swales	Swales are shallow, flat bottomed, vegetated open channels designed to convey, treat, and attenuate surface water runoff.	N	There is insufficient space.
Bioretention systems	Rain gardens or shallow landscaped depressions that may reduce surface water runoff rates and volumes and/or treat pollution using engineered soils and vegetation.	N	There is insufficient space for anything other than possibly some very small feature within the rear patios.

Trees	Trees aid surface water management through transpiration, inception, infiltration and phytoremediation.	Y	There is little scope for new planting to be introduced.
Pervious Pavements	Pervious pavements facilitate the infiltration of surface water into a subsurface structure where filtration, adsorption, biodegradation or sedimentation may also provide treatment of the runoff.	Y	There is limited scope for permeable paving beneath the rear patio in conjunction with porous sub-bases or proprietary storage features.
Attenuation storage tanks	Attenuation storage tanks provide below-ground void space for the temporary storage of surface water before infiltration, controlled release or use.	Y	There is an opportunity to provide pumped attenuation storage tanks beneath the front and rear patio areas.
Detention basins	Attenuation storage in the form of dry landscaped depressions.	N	Not possible.
Ponds and wetlands	Permanent water filled ponds or wetlands that provide attenuation storage or treatment of surface water runoff.	N	There is insufficient space.

4.4 BENEFITS

The types of benefits that may be achieved by utilising SuDS are categorised by the design objectives outlined in the following section.

4.4.1 WATER QUANTITY

There is scope to reduce runoff rates and volumes through the inclusion of underground attenuation storage tanks incorporated within the front and rear patio of the property. Additional rainwater storage butts may be introduced within the proposed sunken patios. There is also opportunity to provide an area of new soft landscaping to the rear of the site, replacing the current fully hard surfaced area. The aim will be to achieve as close to Greenfield runoff rates as is possible.

4.4.2 WATER QUALITY

The water quality design objective is to manage the quality of runoff to prevent pollution, supporting the management of water quality in the receiving surface waters and groundwater and design system resilience to cope with future change. However, other than possible very small rain garden features in the proposed garden areas there is no scope to include any treatment as part of this development.

4.4.3 AMENITY

The amenity design objective is to create and sustain better places for people by implementing the following criteria for the site:

- Maximise multi-functionality
- Enhance visual character
- Deliver safe surface water management systems
- Support development resilience/adaptability to future change
- Maximise legibility
- Support community environmental learning

There may be some amenity value ascribed to the proposed conversion of hard standing patio into a soft landscaped garden towards the rear of the property.

4.4.4 BIODIVERSITY

The biodiversity design objective is to create and sustain better places for nature by implementing the following criteria for the site:

- Support and protect natural local habitats and species
- Contribute to the delivery of local biodiversity objectives
- Contribute to habitat connectivity
- Create diverse, self-sustaining and resilient ecosystems.

There may be some biodiversity value ascribed to the proposed conversion of hard standing patio into a soft landscaped garden towards the rear of the property.

4.5 SUDS CONSTRUCTION

Rainwater harvesting may be facilitated by means of storage butts located at the front and rear of the property either in the rear garden or in the basement patios, fed by diverted roof drainage from downpipes.

The below ground attenuation storage tanks can be constructed using modular storage boxes laid within additionally excavated areas adjacent to the proposed lightwells and basement patios.

Below-ground storage beneath pervious paving in the patio areas may be achieved either by means of a proprietary system of plastic storage crates or by the use of a high-porosity sub-base material.

Flow control mechanisms, most simply in the form of designed orifice sizes, will be required for the rear attenuation storage tank. In addition, the larger attenuation tank in the front patio will be required to provide a pumped flow control to discharge the attenuated run-off towards the combined sewer.

4.6 MAINTENANCE

There is a need to introduce clear arrangements in place for on-going maintenance over the lifetime of the development.

The SuDS features will require some regular inspection and maintenance to clear any accumulated sediment or debris which may reduce the storage capacity as well as to ensure the inlets and outlets are clear and do not impede the water flow.

Maintenance activities can be broadly categorised as:

- Regular maintenance consists of inspections and basic tasks carried out to a frequent schedule (more frequently than once per year) including inspections, silt, litter or debris removal and vegetation management.

- Occasional maintenance comprises tasks that are required on a much less frequent and predictable basis (eg. annual checks)

- Remedial maintenance describes the intermittent tasks that may be required to rectify faults associated with the system such as inlet and outlet repairs, infiltration surface rehabilitation, replacement of blocked filter materials/fabrics, system rehabilitation immediately following a pollution event.

5. INITIAL DESIGN CONSIDERATIONS

An analysis has been undertaken of the pre- and post- development surface water run-off rates and volumes over a range of storm intensities and durations.

5.1 GREENFIELD RUNOFF RATE

The Greenfield runoff rates from the site have been calculated using the UK SuDS online tool and the Institute of Hydrology (IoH) 124 methodology.

Greenfield Rates:	
Qbar:	0.08 l/sec
1 in 1	0.07 l/sec
1 in 30	0.19 l/sec
1 in 100	0.25 l/sec
1 in 200	0.29 l/sec

5.2 EXISTING RUNOFF RATE

The development affects an area of approximately 175m^2 of which 100% is impermeably surfaced. There are considered to be no present SuDS features.

The existing peak storm runoff for the 1% (1 in 100 year) annual probability 15 min rainfall event on the site is estimated to be 4.8 l/sec. The calculation was based on the Wallingford Procedure and the resulting runoff was calculated using the Modified Rational Method with an M5-60 of 20mm, an 'r' value of 0.42 and a critical rainfall intensity of 99.3 mm/hr.

The rainfall runoff volume for the 1% (1 in 100 year) annual probability, 6 hour duration storm from the existing site is estimated to be 11.1 m^3.

6. PROPOSED SURFACE WATER DRAINAGE SCHEME

The surface water falling on the main roof will be directed towards the attenuation tanks at the front and rear of the site, with a degree of rainfall potentially also collected in the rainwater harvesting butts within the basement patios. The rear attenuation storage tank will be then connected via an orifice flow control with the attenuation storage at the front patio, which will then pump the attenuated flow towards the final discharge to the combined sewer.

The development will introduce new permeable areas of soft landscaped rear garden, causing an increase in share of permeable cover on site to 17.1%.

Calculations indicate that some $10m^3$ of attenuation storage would be required for the 1 in 100 year rainfall event in consideration of up to 40% climate change allowance in order to reduce the proposed discharge rate to the equivalent greenfield run-off rate.

It is envisaged that up to $12m^3$ of attenuation storage could be potentially be provided as follows:

- Attenuation tank at the rear patio (3m x 1m x 2m deep) $6m^3$
- Attenuation tank at the front patio (3m x 1m x 2m deep) $6m^3$

A schematic plan of the proposed SuDS features on site, which would provide the necessary attenuation storage, is presented overleaf.

Not shown on plan:

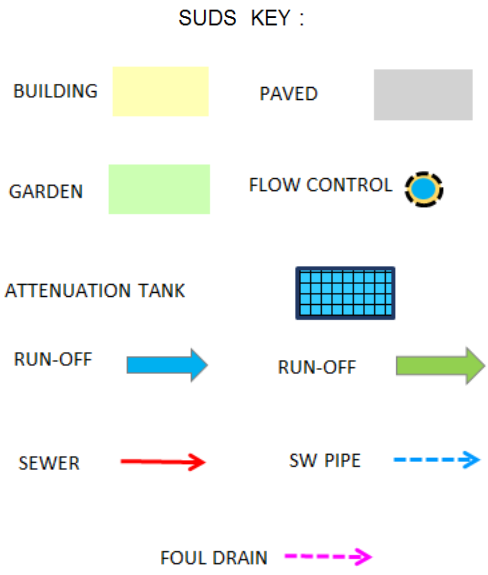
- Possible small rain garden features in rear garden?
- Possible Rainwater Butts in the rear patios

New soft landscaping introduced in the rear garden, potentially also providing new planting on site

Sump collecting surface water run-off from the basement area, pumped towards the proposed attenuation tank.

Below ground attenuation storage tank to 2m depth, providing **approx. 6m^3 of storage**, with **pump flow control** discharge towards an existing drain

Main building roofs draining towards the front and rear patios and hence to the attenuation storage tanks in both of these areas



Below ground attenuation storage tank to 2m depth, providing **approx. 6m^3 of storage**

Final discharge to combined sewer via **pumped flow control**

7. CONCLUSION

This assessment has demonstrated that the developer has sought opportunities to reduce the overall level of flood risk through the appropriate application of sustainable drainage systems.

This assessment demonstrates that there is scope for various SuDS features that can restrain run-off, in accordance with Policy CC3 of the Camden Local Plan, to mitigate the risk of future surface water flooding, taking into account potential climate change.

APPENDIX

SUSTAINABLE DRAINAGE PRO-FORMA

PRELIMINARY DRAINAGE CALCULATIONS

1. Project & Site Details	Project / Site Name (including sub-catchment / stage / phase where appropriate)	19 HOLMDALE ROAD
	Address & post code	NW3 5HB
	OS Grid ref. (Easting, Northing)	E 525280
		N 185165
	LPA reference (if applicable)	
	Brief description of proposed work	Excavation of a new basement below the footprint of the existing building, as well as three lightwell/basement patio areas.
	Total site Area for Attenuation	175 m^2
	Total existing impervious area	175 m^2
	Total proposed impervious area	145 m^2
	Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	No
	Existing drainage connection type and location	Combined Sewer beneath Holmdale Road
	Designer Name	S R L B
	Designer Position	Principal
	Designer Company	LBHGEO

2. Proposed Discharge Arrangements

2a. Infiltration Feasibility

Superficial geology classification	N/A
Bedrock geology classification	London Clay
Site infiltration rate	1.E-09 m/s
Depth to groundwater level	No groundwater table present
Is infiltration feasible?	No

2b. Drainage Hierarchy

	Feasible (Y/N)	*Proposed (Y/N)*
1 store rainwater for later use	Y	Y
2 use infiltration techniques, such as porous surfaces in non-clay areas	N	N
3 attenuate rainwater in ponds or open water features for gradual release	N	N
4 attenuate rainwater by storing in tanks or sealed water features for gradual release	Y	Y
5 discharge rainwater direct to a watercourse	N	N
6 discharge rainwater to a surface water sewer/drain	N	N
7 discharge rainwater to the combined sewer.	Y	Y

2c. Proposed Discharge Details

Proposed discharge location	Combined Sewer beneath Holmdale Road
Has the owner/regulator of the discharge location been consulted?	No - as there will be a reduction in the volume and rate of water entering the TW sewer

3. Drainage Strategy

3a. Discharge Rates & Required Storage

	Greenfield (GF) runoff rate (l/s)	*Existing discharge rate (l/s)*	*Required storage for GF rate (m^3)*	*Proposed discharge rate (l/s)*
Qbar	0.08			
1 in 1	0.07	1.54	2.08	0.07
1 in 30	0.19	3.77	4.62	0.19
1 in 100	0.25	4.84	6.06	0.25
1 in 100 + CC			9.19	0.25
Climate change allowance used		40%		
3b. Principal Method of Flow Control		Orifice		

3c. Proposed SuDS Measures

	Catchment area (m^2)	*Plan area (m^2)*	*Storage vol. (m^3)*
Rainwater harvesting	0		0
Infiltration systems	0		0
Green roofs	0	0	0
Blue roofs	0	0	0
Filter strips	0	0	0
Filter drains	0	0	0
Bioretention / tree pits	0	0	0
Pervious pavements	0	0	0
Swales	0	0	0
Basins/ponds	0	0	0
Attenuation tanks	175		12
Total	175	0	12

4. Supporting Information	4a. Discharge & Drainage Strategy	*Page/section of drainage report*
	Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	Appendix to the SuDS Assessment
	Drainage hierarchy (2b)	Section 4
	Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	Discharge is to be via existing manhole and existing sewer connection - there will be no new connection and a reduction in the volume and rate of water entering the TW sewer
	Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	Appendix to the SuDS Assessment
	Proposed SuDS measures & specifications (3b)	Section 6 & Section 7
	4b. Other Supporting Details	*Page/section of drainage report*
	Detailed Development Layout	P11
	Detailed drainage design drawings, including exceedance flow routes	P19
	Detailed landscaping plans	P11
	Maintenance strategy	Section 4.6
	Demonstration of how the proposed SuDS measures improve:	SuDS Assessment report
	a) water quality of the runoff?	Section 4
	b) biodiversity?	
	c) amenity?	

GREENFIELD RUNOFF

Catchment Area: 175sqm 0.018ha

PO Code : NW3 5HB

Hydrological Region: 6 *From Wallingford on-line tool*

SAAR: 650mm *From Wallingford on-line tool*

SOIL type: 4 *From Wallingford on-line tool*

SPR: 0.47 *Derived as follows:*

SOIL	*Sand*	*Clayey Sand*	*Sandy Clay*	*Clay*	*Rock*
	1	*2*	*3*	*4*	*5*
SPR	*0.1*	*0.3*	*0.37*	*0.47*	*0.53*

From Wallingford on-line tool using IH 124 Method

Qbar: 221.34 *Calculated from SPR and SAAR*

Greenfield Peak Run-off Rate:		*Growth curve Factor*
1 in 1	*188.1 l/sec*	*0.85*
1 in 30	*531.2 l/sec*	*2.40*
1 in 100	*706.1 l/sec*	*3.19*
1 in 200	*827.8 l/sec*	*3.74*

Qbar: 0.08 l/sec

Greenfield Peak Run-off Rate:

1 in 1	**0.07 l/sec**
1 in 30	**0.19 l/sec**
1 in 100	**0.25 l/sec**
1 in 200	**0.29 l/sec**

National Non-Statutory Guidance:
For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.

Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.

SuDs CALCULATIONS	
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RAINFALL PEAK INTENSITY (i)

M5-60 :	20	*From Wallingford Fig A1*
r:	0.42	*From Wallingford Fig A2*

D Duration		Z1	M5-D
5min	5min	0.38	7.6mm
10min	10min	0.55	11.0mm
15min	15min	0.65	13.0mm
30min	30min	0.75	15.0mm
1hr	60min	1.00	20.0mm
2hr	120min	1.20	24.0mm
4hr	240min	1.40	28.0mm
6hr	360min	1.60	32.0mm
10hr	600min	1.70	34.0mm
24hr	1440min	2.20	44.0mm
48hr	2880min	2.50	50.0mm

Z2

D Duration		M5-D	M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	7.6mm	0.62	0.79	0.89	0.97	1.02	1.19	1.36	1.43	1.79
10min	10min	11.0mm	0.61	0.79	0.90	0.97	1.03	1.22	1.41	1.49	1.91
15min	15min	13.0mm	0.61	0.79	0.90	0.97	1.03	1.22	1.41	1.49	1.91
30min	30min	15.0mm	0.62	0.81	0.90	0.97	1.03	1.24	1.44	1.53	1.99
1hr	60min	20.0mm	0.64	0.81	0.90	0.97	1.03	1.24	1.45	1.54	2.03
2hr	120min	24.0mm	0.64	0.81	0.90	0.97	1.03	1.24	1.45	1.54	2.03
4hr	240min	28.0mm	0.66	0.82	0.91	0.97	1.03	1.24	1.44	1.53	2.01
6hr	360min	32.0mm	0.68	0.83	0.91	0.97	1.03	1.22	1.42	1.51	1.97
10hr	600min	34.0mm	0.68	0.83	0.91	0.97	1.03	1.22	1.42	1.51	1.97
24hr	1440min	44.0mm	0.70	0.84	0.92	0.97	1.02	1.19	1.38	1.47	1.89
48hr	2880min	50.0mm	0.72	0.85	0.93	0.98	1.02	1.17	1.34	1.42	1.81

MT-D

D Duration		M5-D	M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	7.6mm	4.7mm	6.0mm	6.8mm	7.4mm	7.8mm	9.0mm	10.3mm	10.8mm	13.6mm
10min	10min	11.0mm	6.7mm	8.7mm	9.9mm	10.7mm	11.3mm	13.4mm	15.5mm	16.4mm	21.0mm
15min	15min	13.0mm	7.9mm	10.3mm	11.7mm	12.6mm	13.4mm	15.9mm	18.3mm	19.4mm	24.8mm
30min	30min	15.0mm	9.3mm	12.2mm	13.5mm	14.6mm	15.5mm	18.6mm	21.6mm	22.9mm	29.9mm
1hr	60min	20.0mm	12.8mm	16.2mm	18.0mm	19.4mm	20.6mm	24.8mm	29.0mm	30.9mm	40.6mm
2hr	120min	24.0mm	15.4mm	19.4mm	21.6mm	23.3mm	24.7mm	29.8mm	34.8mm	37.0mm	48.7mm
4hr	240min	28.0mm	18.5mm	23.0mm	25.5mm	27.2mm	28.8mm	34.7mm	40.3mm	42.9mm	56.3mm
6hr	360min	32.0mm	21.8mm	26.6mm	29.1mm	31.0mm	33.0mm	39.0mm	45.4mm	48.4mm	63.0mm
10hr	600min	34.0mm	23.1mm	28.2mm	30.9mm	33.0mm	35.0mm	41.5mm	48.3mm	51.5mm	67.0mm
24hr	1440min	44.0mm	30.8mm	37.0mm	40.5mm	42.7mm	44.9mm	52.4mm	60.7mm	64.5mm	83.2mm
48hr	2880min	50.0mm	36.0mm	42.5mm	46.5mm	49.0mm	51.0mm	58.5mm	67.0mm	71.0mm	90.5mm

Intensity i

D Duration			M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	56.5mm/hr	72.0mm/hr	81.2mm/hr	88.5mm/hr	93.0mm/hr	108.5mm/hr	124.0mm/hr	130.1mm/hr	163.2mm/hr
10min	10min	0.17hr	40.3mm/hr	52.1mm/hr	59.4mm/hr	64.0mm/hr	68.0mm/hr	80.5mm/hr	93.1mm/hr	98.3mm/hr	126.1mm/hr
15min	15min	0.25hr	31.7mm/hr	41.1mm/hr	46.8mm/hr	50.4mm/hr	53.6mm/hr	63.4mm/hr	73.3mm/hr	77.5mm/hr	99.3mm/hr
30min	30min	0.50hr	18.6mm/hr	24.3mm/hr	27.0mm/hr	29.1mm/hr	30.9mm/hr	37.2mm/hr	43.2mm/hr	45.8mm/hr	59.7mm/hr
1hr	60min	1.00hr	12.8mm/hr	16.2mm/hr	18.0mm/hr	19.4mm/hr	20.6mm/hr	24.8mm/hr	29.0mm/hr	30.9mm/hr	40.6mm/hr
2hr	120min	2.00hr	7.7mm/hr	9.7mm/hr	10.8mm/hr	11.6mm/hr	12.4mm/hr	14.9mm/hr	17.4mm/hr	18.5mm/hr	24.4mm/hr
4hr	240min	4.00hr	4.6mm/hr	5.7mm/hr	6.4mm/hr	6.8mm/hr	7.2mm/hr	8.7mm/hr	10.1mm/hr	10.7mm/hr	14.1mm/hr
6hr	360min	6.00hr	3.6mm/hr	4.4mm/hr	4.9mm/hr	5.2mm/hr	5.5mm/hr	6.5mm/hr	7.6mm/hr	8.1mm/hr	10.5mm/hr
10hr	600min	10.00hr	2.3mm/hr	2.8mm/hr	3.1mm/hr	3.3mm/hr	3.5mm/hr	4.1mm/hr	4.8mm/hr	5.1mm/hr	6.7mm/hr
24hr	1440min	24.00hr	1.3mm/hr	1.5mm/hr	1.7mm/hr	1.8mm/hr	1.9mm/hr	2.2mm/hr	2.5mm/hr	2.7mm/hr	3.5mm/hr
48hr	2880min	48.00hr	0.6mm/hr	0.8mm/hr	0.8mm/hr	0.9mm/hr	0.9mm/hr	1.1mm/hr	1.3mm/hr	1.3mm/hr	1.7mm/hr
48hr	2880min	48.00hr	0.8mm/hr	0.9mm/hr	1.0mm/hr	1.0mm/hr	1.1mm/hr	1.2mm/hr	1.4mm/hr	1.5mm/hr	1.9mm/hr

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LBHGEO

GREENFIELD PEAK RUNOFF

Hydrological Region: 6 *From Wallingford on-line tool* **Qbar: 0.08 l/sec**

Run-Off Q

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	0.07 l/sec	0.07 l/sec	0.08 l/sec	0.09 l/sec	0.10 l/sec	0.13 l/sec	0.15 l/sec	0.19 l/sec	0.25 l/sec
10min	10min	0.17hr	0.07 l/sec	0.07 l/sec	0.08 l/sec	0.09 l/sec	0.10 l/sec	0.13 l/sec	0.15 l/sec	0.19 l/sec	0.25 l/sec
15min	15min	0.25hr	0.07 l/sec	0.07 l/sec	0.08 l/sec	0.09 l/sec	0.10 l/sec	0.13 l/sec	0.15 l/sec	0.19 l/sec	0.25 l/sec
30min	30min	0.50hr	0.07 l/sec	0.07 l/sec	0.08 l/sec	0.09 l/sec	0.10 l/sec	0.13 l/sec	0.15 l/sec	0.19 l/sec	0.25 l/sec
1hr	60min	1.00hr	0.07 l/sec	0.07 l/sec	0.08 l/sec	0.09 l/sec	0.10 l/sec	0.13 l/sec	0.15 l/sec	0.19 l/sec	0.25 l/sec
2hr	120min	2.00hr	0.07 l/sec	0.07 l/sec	0.08 l/sec	0.09 l/sec	0.10 l/sec	0.13 l/sec	0.15 l/sec	0.19 l/sec	0.25 l/sec
4hr	240min	4.00hr	0.07 l/sec	0.07 l/sec	0.08 l/sec	0.09 l/sec	0.10 l/sec	0.13 l/sec	0.15 l/sec	0.19 l/sec	0.25 l/sec
6hr	360min	6.00hr	0.07 l/sec	0.07 l/sec	0.08 l/sec	0.09 l/sec	0.10 l/sec	0.13 l/sec	0.15 l/sec	0.19 l/sec	0.25 l/sec
10hr	600min	10.00hr	0.07 l/sec	0.07 l/sec	0.08 l/sec	0.09 l/sec	0.10 l/sec	0.13 l/sec	0.15 l/sec	0.19 l/sec	0.25 l/sec
24hr	1440min	24.00hr	0.07 l/sec	0.07 l/sec	0.08 l/sec	0.09 l/sec	0.10 l/sec	0.13 l/sec	0.15 l/sec	0.19 l/sec	0.25 l/sec
48hr	2880min	48.00hr	0.07 l/sec	0.07 l/sec	0.08 l/sec	0.09 l/sec	0.10 l/sec	0.13 l/sec	0.15 l/sec	0.19 l/sec	0.25 l/sec

Run-Off Volume

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	0.0 m3	0.0 m3	0.0 m3	0.0 m3	0.0 m3	0.0 m3	0.0 m3	0.1 m3	0.1 m3
10min	10min	0.17hr	0.0 m3	0.0 m3	0.0 m3	0.1 m3	0.1 m3	0.1 m3	0.1 m3	0.1 m3	0.1 m3
15min	15min	0.25hr	0.1 m3	0.1 m3	0.1 m3	0.1 m3	0.1 m3	0.1 m3	0.1 m3	0.2 m3	0.2 m3
30min	30min	0.50hr	0.1 m3	0.1 m3	0.1 m3	0.2 m3	0.2 m3	0.2 m3	0.3 m3	0.3 m3	0.4 m3
1hr	60min	1.00hr	0.2 m3	0.2 m3	0.3 m3	0.3 m3	0.4 m3	0.5 m3	0.5 m3	0.7 m3	0.9 m3
2hr	120min	2.00hr	0.5 m3	0.5 m3	0.6 m3	0.6 m3	0.7 m3	0.9 m3	1.1 m3	1.3 m3	1.8 m3
4hr	240min	4.00hr	0.9 m3	1.0 m3	1.1 m3	1.3 m3	1.4 m3	1.8 m3	2.2 m3	2.7 m3	3.6 m3
6hr	360min	6.00hr	1.4 m3	1.5 m3	1.7 m3	1.9 m3	2.1 m3	2.7 m3	3.3 m3	4.0 m3	5.3 m3
10hr	600min	10.00hr	2.4 m3	2.5 m3	2.8 m3	3.2 m3	3.6 m3	4.5 m3	5.5 m3	6.7 m3	8.9 m3
24hr	1440min	24.00hr	5.7 m3	5.9 m3	6.8 m3	7.7 m3	8.6 m3	10.8 m3	13.2 m3	16.1 m3	21.4 m3
48hr	2880min	48.00hr	11.4 m3	11.8 m3	13.6 m3	15.4 m3	17.1 m3	21.7 m3	26.3 m3	32.1 m3	42.7 m3

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EXISTING PEAK RUNOFF

C_V:	0.77	*Volumetric Run-Off Coefficient*
C_R:	1.3	*Routing Coefficient*

Run-Off Q

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	2.8 l/sec	3.5 l/sec	4.0 l/sec	4.3 l/sec	4.5 l/sec	5.3 l/sec	6.0 l/sec	6.3 l/sec	7.9 l/sec
10min	10min	0.17hr	2.0 l/sec	2.5 l/sec	2.9 l/sec	3.1 l/sec	3.3 l/sec	3.9 l/sec	4.5 l/sec	4.8 l/sec	6.1 l/sec
15min	15min	0.25hr	1.5 l/sec	2.0 l/sec	2.3 l/sec	2.5 l/sec	2.6 l/sec	3.1 l/sec	3.6 l/sec	3.8 l/sec	4.8 l/sec
30min	30min	0.50hr	0.9 l/sec	1.2 l/sec	1.3 l/sec	1.4 l/sec	1.5 l/sec	1.8 l/sec	2.1 l/sec	2.2 l/sec	2.9 l/sec
1hr	60min	1.00hr	0.6 l/sec	0.8 l/sec	0.9 l/sec	0.9 l/sec	1.0 l/sec	1.2 l/sec	1.4 l/sec	1.5 l/sec	2.0 l/sec
2hr	120min	2.00hr	0.4 l/sec	0.5 l/sec	0.5 l/sec	0.6 l/sec	0.6 l/sec	0.7 l/sec	0.8 l/sec	0.9 l/sec	1.2 l/sec
4hr	240min	4.00hr	0.2 l/sec	0.3 l/sec	0.3 l/sec	0.3 l/sec	0.4 l/sec	0.4 l/sec	0.5 l/sec	0.5 l/sec	0.7 l/sec
6hr	360min	6.00hr	0.2 l/sec	0.2 l/sec	0.2 l/sec	0.3 l/sec	0.3 l/sec	0.3 l/sec	0.4 l/sec	0.4 l/sec	0.5 l/sec
10hr	600min	10.00hr	0.1 l/sec	0.1 l/sec	0.2 l/sec	0.2 l/sec	0.2 l/sec	0.2 l/sec	0.2 l/sec	0.3 l/sec	0.3 l/sec
24hr	1440min	24.00hr	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.2 l/sec
48hr	2880min	48.00hr	0.0 l/sec	0.0 l/sec	0.0 l/sec	0.0 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec

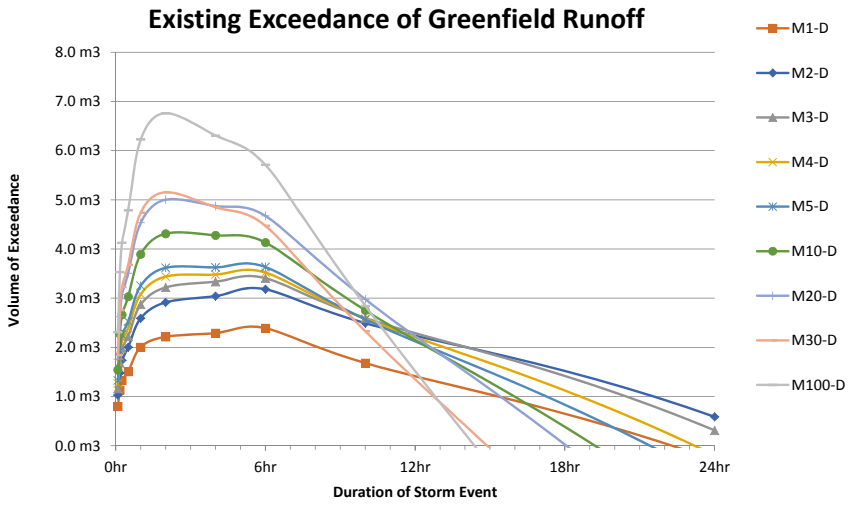
Run-Off Volume

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	0.8 m3	1.1 m3	1.2 m3	1.3 m3	1.4 m3	1.6 m3	1.8 m3	1.9 m3	2.4 m3
10min	10min	0.17hr	1.2 m3	1.5 m3	1.7 m3	1.9 m3	2.0 m3	2.4 m3	2.7 m3	2.9 m3	3.7 m3
15min	15min	0.25hr	1.4 m3	1.8 m3	2.1 m3	2.2 m3	2.3 m3	2.8 m3	3.2 m3	3.4 m3	4.4 m3
30min	30min	0.50hr	1.6 m3	2.1 m3	2.4 m3	2.6 m3	2.7 m3	3.3 m3	3.8 m3	4.0 m3	5.2 m3
1hr	60min	1.00hr	2.2 m3	2.8 m3	3.2 m3	3.4 m3	3.6 m3	4.3 m3	5.1 m3	5.4 m3	7.1 m3
2hr	120min	2.00hr	2.7 m3	3.4 m3	3.8 m3	4.1 m3	4.3 m3	5.2 m3	6.1 m3	6.5 m3	8.5 m3
4hr	240min	4.00hr	3.2 m3	4.0 m3	4.5 m3	4.8 m3	5.1 m3	6.1 m3	7.1 m3	7.5 m3	9.9 m3
6hr	360min	6.00hr	3.8 m3	4.7 m3	5.1 m3	5.4 m3	5.8 m3	6.8 m3	8.0 m3	8.5 m3	11.1 m3
10hr	600min	10.00hr	4.1 m3	4.9 m3	5.4 m3	5.8 m3	6.1 m3	7.3 m3	8.5 m3	9.0 m3	11.7 m3
24hr	1440min	24.00hr	5.4 m3	6.5 m3	7.1 m3	7.5 m3	7.9 m3	9.2 m3	10.6 m3	11.3 m3	14.6 m3
48hr	2880min	48.00hr	6.3 m3	7.5 m3	8.2 m3	8.6 m3	8.9 m3	10.3 m3	11.7 m3	12.4 m3	15.9 m3

Exceedance of Greenfield Run-Off Volume

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	0.8 m3	1.0 m3	1.2 m3	1.3 m3	1.3 m3	1.5 m3	1.8 m3	1.8 m3	2.3 m3
10min	10min	0.17hr	1.1 m3	1.5 m3	1.7 m3	1.8 m3	1.9 m3	2.3 m3	2.6 m3	2.8 m3	3.5 m3
15min	15min	0.25hr	1.3 m3	1.7 m3	2.0 m3	2.1 m3	2.3 m3	2.7 m3	3.1 m3	3.2 m3	4.1 m3
30min	30min	0.50hr	1.5 m3	2.0 m3	2.2 m3	2.4 m3	2.5 m3	3.0 m3	3.5 m3	3.7 m3	4.8 m3
1hr	60min	1.00hr	2.0 m3	2.6 m3	2.9 m3	3.1 m3	3.3 m3	3.9 m3	4.5 m3	4.7 m3	6.2 m3
2hr	120min	2.00hr	2.2 m3	2.9 m3	3.2 m3	3.4 m3	3.6 m3	4.3 m3	5.0 m3	5.2 m3	6.8 m3
4hr	240min	4.00hr	2.3 m3	3.0 m3	3.3 m3	3.5 m3	3.6 m3	4.3 m3	4.9 m3	4.8 m3	6.3 m3
6hr	360min	6.00hr	2.4 m3	3.2 m3	3.4 m3	3.5 m3	3.6 m3	4.1 m3	4.7 m3	4.5 m3	5.7 m3
10hr	600min	10.00hr	1.7 m3	2.5 m3	2.6 m3	2.6 m3	2.6 m3	2.8 m3	3.0 m3	2.3 m3	2.8 m3
24hr	1440min	24.00hr	-0.3 m3	0.6 m3	0.3 m3	-0.2 m3	-0.7 m3	-1.7 m3	-2.5 m3	-4.8 m3	-6.8 m3
48hr	2880min	48.00hr	-5.1 m3	-4.3 m3	-5.4 m3	-6.8 m3	-8.2 m3	-11.4 m3	-14.6 m3	-19.7 m3	-26.8 m3

			C_V:
Catchment Area:	175sqm	100%	
Permeable:	0sqm	0%	0.40
Impermeable:	175sqm	100%	0.77
			0.77



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LBHGEO

POST- DEVELOPMENT PEAK RUNOFF

C_V:	0.71	*Volumetric Run-Off Coefficient*	Climate Change Allowance: 0%
C_R:	1.3	*Routing Coefficient*	

Run-Off Q

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	2.5 l/sec	3.2 l/sec	3.6 l/sec	4.0 l/sec	4.2 l/sec	4.8 l/sec	5.5 l/sec	5.8 l/sec	7.3 l/sec
10min	10min	0.17hr	1.8 l/sec	2.3 l/sec	2.7 l/sec	2.9 l/sec	3.0 l/sec	3.6 l/sec	4.2 l/sec	4.4 l/sec	5.6 l/sec
15min	15min	0.25hr	1.4 l/sec	1.8 l/sec	2.1 l/sec	2.3 l/sec	2.4 l/sec	2.8 l/sec	3.3 l/sec	3.5 l/sec	4.4 l/sec
30min	30min	0.50hr	0.8 l/sec	1.1 l/sec	1.2 l/sec	1.3 l/sec	1.4 l/sec	1.7 l/sec	1.9 l/sec	2.0 l/sec	2.7 l/sec
1hr	60min	1.00hr	0.6 l/sec	0.7 l/sec	0.8 l/sec	0.9 l/sec	0.9 l/sec	1.1 l/sec	1.3 l/sec	1.4 l/sec	1.8 l/sec
2hr	120min	2.00hr	0.3 l/sec	0.4 l/sec	0.5 l/sec	0.5 l/sec	0.6 l/sec	0.7 l/sec	0.8 l/sec	0.8 l/sec	1.1 l/sec
4hr	240min	4.00hr	0.2 l/sec	0.3 l/sec	0.3 l/sec	0.3 l/sec	0.3 l/sec	0.4 l/sec	0.5 l/sec	0.5 l/sec	0.6 l/sec
6hr	360min	6.00hr	0.2 l/sec	0.2 l/sec	0.2 l/sec	0.2 l/sec	0.2 l/sec	0.3 l/sec	0.3 l/sec	0.4 l/sec	0.5 l/sec
10hr	600min	10.00hr	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.2 l/sec	0.2 l/sec	0.2 l/sec	0.2 l/sec	0.3 l/sec
24hr	1440min	24.00hr	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.2 l/sec
48hr	2880min	48.00hr	0.0 l/sec	0.0 l/sec	0.0 l/sec	0.0 l/sec	0.0 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec

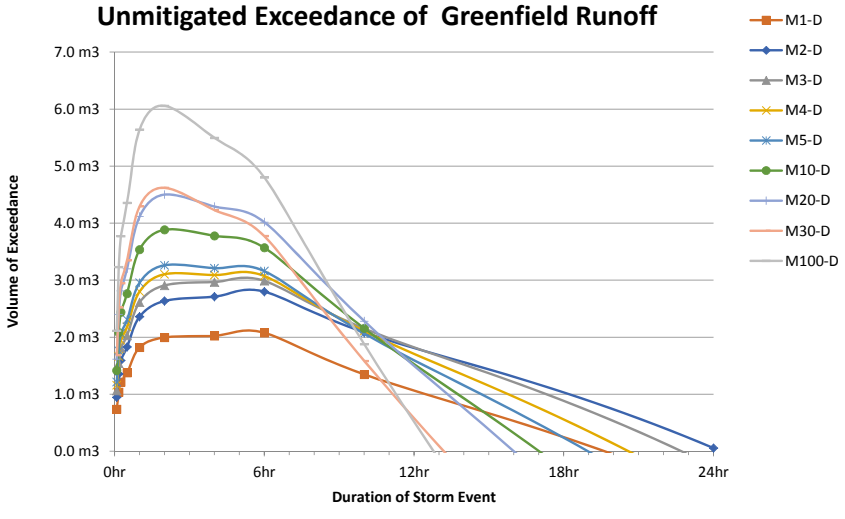
Run-Off Volume

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	0.8 m3	1.0 m3	1.1 m3	1.2 m3	1.2 m3	1.5 m3	1.7 m3	1.7 m3	2.2 m3
10min	10min	0.17hr	1.1 m3	1.4 m3	1.6 m3	1.7 m3	1.8 m3	2.2 m3	2.5 m3	2.6 m3	3.4 m3
15min	15min	0.25hr	1.3 m3	1.7 m3	1.9 m3	2.0 m3	2.2 m3	2.6 m3	2.9 m3	3.1 m3	4.0 m3
30min	30min	0.50hr	1.5 m3	2.0 m3	2.2 m3	2.3 m3	2.5 m3	3.0 m3	3.5 m3	3.7 m3	4.8 m3
1hr	60min	1.00hr	2.1 m3	2.6 m3	2.9 m3	3.1 m3	3.3 m3	4.0 m3	4.7 m3	5.0 m3	6.5 m3
2hr	120min	2.00hr	2.5 m3	3.1 m3	3.5 m3	3.7 m3	4.0 m3	4.8 m3	5.6 m3	6.0 m3	7.8 m3
4hr	240min	4.00hr	3.0 m3	3.7 m3	4.1 m3	4.4 m3	4.6 m3	5.6 m3	6.5 m3	6.9 m3	9.1 m3
6hr	360min	6.00hr	3.5 m3	4.3 m3	4.7 m3	5.0 m3	5.3 m3	6.3 m3	7.3 m3	7.8 m3	10.1 m3
10hr	600min	10.00hr	3.7 m3	4.5 m3	5.0 m3	5.3 m3	5.6 m3	6.7 m3	7.8 m3	8.3 m3	10.8 m3
24hr	1440min	24.00hr	5.0 m3	5.9 m3	6.5 m3	6.9 m3	7.2 m3	8.4 m3	9.8 m3	10.4 m3	13.4 m3
48hr	2880min	48.00hr	5.8 m3	6.8 m3	7.5 m3	7.9 m3	8.2 m3	9.4 m3	10.8 m3	11.4 m3	14.6 m3

Exceedance of Greenfield Run-Off Volume

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	0.7 m3	0.9 m3	1.1 m3	1.2 m3	1.2 m3	1.4 m3	1.6 m3	1.7 m3	2.1 m3
10min	10min	0.17hr	1.0 m3	1.4 m3	1.5 m3	1.7 m3	1.8 m3	2.1 m3	2.4 m3	2.5 m3	3.2 m3
15min	15min	0.25hr	1.2 m3	1.6 m3	1.8 m3	1.9 m3	2.1 m3	2.4 m3	2.8 m3	2.9 m3	3.8 m3
30min	30min	0.50hr	1.4 m3	1.8 m3	2.0 m3	2.2 m3	2.3 m3	2.8 m3	3.2 m3	3.3 m3	4.4 m3
1hr	60min	1.00hr	1.8 m3	2.4 m3	2.6 m3	2.8 m3	3.0 m3	3.5 m3	4.1 m3	4.3 m3	5.6 m3
2hr	120min	2.00hr	2.0 m3	2.6 m3	2.9 m3	3.1 m3	3.3 m3	3.9 m3	4.5 m3	4.6 m3	6.1 m3
4hr	240min	4.00hr	2.0 m3	2.7 m3	3.0 m3	3.1 m3	3.2 m3	3.8 m3	4.3 m3	4.2 m3	5.5 m3
6hr	360min	6.00hr	2.1 m3	2.8 m3	3.0 m3	3.1 m3	3.2 m3	3.6 m3	4.0 m3	3.8 m3	4.8 m3
10hr	600min	10.00hr	1.3 m3	2.1 m3	2.2 m3	2.1 m3	2.1 m3	2.2 m3	2.3 m3	1.6 m3	1.9 m3
24hr	1440min	24.00hr	-0.7 m3	0.1 m3	-0.3 m3	-0.8 m3	-1.3 m3	-2.4 m3	-3.4 m3	-5.7 m3	-8.0 m3
48hr	2880min	48.00hr	-5.6 m3	-4.9 m3	-6.1 m3	-7.5 m3	-8.9 m3	-12.3 m3	-15.5 m3	-20.7 m3	-28.1 m3
			2.1 m3							**4.6 m3**	**6.1 m3**

			C_V:
Catchment Area:	175sqm	100%	
Permeable Garden	30sqm	17%	0.40
Impermeable:	145sqm	83%	0.77
			0.71



SuDs CALCULATIONS	
Project: 19 HOLMDALE ROAD	
POST-DEV. PEAK RUNOFF	
Sheet 5 of 8	
Project Reference: LBH 4620	
Date: 02/11/2020	Rev: 1
Client: Tribi Holdings	

LBHGEO

POST- DEVELOPMENT PEAK RUNOFF + CC

C_V:	0.71	*Volumetric Run-Off Coefficient*	Climate Change Allowance:	40%
C_R:	1.3	*Routing Coefficient*		

Run-Off Q

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	3.5 l/sec	4.5 l/sec	5.1 l/sec	5.5 l/sec	5.8 l/sec	6.8 l/sec	7.8 l/sec	8.1 l/sec	10.2 l/sec
10min	10min	0.17hr	2.5 l/sec	3.3 l/sec	3.7 l/sec	4.0 l/sec	4.3 l/sec	5.0 l/sec	5.8 l/sec	6.2 l/sec	7.9 l/sec
15min	15min	0.25hr	2.0 l/sec	2.6 l/sec	2.9 l/sec	3.2 l/sec	3.4 l/sec	4.0 l/sec	4.6 l/sec	4.8 l/sec	6.2 l/sec
30min	30min	0.50hr	1.2 l/sec	1.5 l/sec	1.7 l/sec	1.8 l/sec	1.9 l/sec	2.3 l/sec	2.7 l/sec	2.9 l/sec	3.7 l/sec
1hr	60min	1.00hr	0.8 l/sec	1.0 l/sec	1.1 l/sec	1.2 l/sec	1.3 l/sec	1.6 l/sec	1.8 l/sec	1.9 l/sec	2.5 l/sec
2hr	120min	2.00hr	0.5 l/sec	0.6 l/sec	0.7 l/sec	0.7 l/sec	0.8 l/sec	0.9 l/sec	1.1 l/sec	1.2 l/sec	1.5 l/sec
4hr	240min	4.00hr	0.3 l/sec	0.4 l/sec	0.4 l/sec	0.4 l/sec	0.5 l/sec	0.5 l/sec	0.6 l/sec	0.7 l/sec	0.9 l/sec
6hr	360min	6.00hr	0.2 l/sec	0.3 l/sec	0.3 l/sec	0.3 l/sec	0.3 l/sec	0.4 l/sec	0.5 l/sec	0.5 l/sec	0.7 l/sec
10hr	600min	10.00hr	0.1 l/sec	0.2 l/sec	0.2 l/sec	0.2 l/sec	0.2 l/sec	0.3 l/sec	0.3 l/sec	0.3 l/sec	0.4 l/sec
24hr	1440min	24.00hr	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.2 l/sec	0.2 l/sec	0.2 l/sec
48hr	2880min	48.00hr	0.0 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec	0.1 l/sec

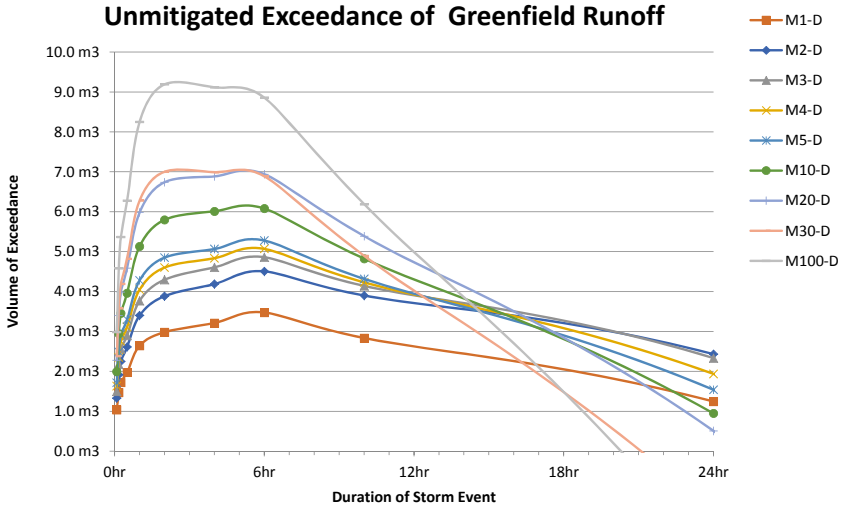
Run-Off Volume

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	1.1 m3	1.4 m3	1.5 m3	1.7 m3	1.7 m3	2.0 m3	2.3 m3	2.4 m3	3.1 m3
10min	10min	0.17hr	1.5 m3	2.0 m3	2.2 m3	2.4 m3	2.6 m3	3.0 m3	3.5 m3	3.7 m3	4.7 m3
15min	15min	0.25hr	1.8 m3	2.3 m3	2.6 m3	2.8 m3	3.0 m3	3.6 m3	4.1 m3	4.4 m3	5.6 m3
30min	30min	0.50hr	2.1 m3	2.7 m3	3.0 m3	3.3 m3	3.5 m3	4.2 m3	4.9 m3	5.2 m3	6.7 m3
1hr	60min	1.00hr	2.9 m3	3.6 m3	4.1 m3	4.4 m3	4.6 m3	5.6 m3	6.5 m3	7.0 m3	9.1 m3
2hr	120min	2.00hr	3.5 m3	4.4 m3	4.9 m3	5.2 m3	5.6 m3	6.7 m3	7.8 m3	8.3 m3	11.0 m3
4hr	240min	4.00hr	4.2 m3	5.2 m3	5.7 m3	6.1 m3	6.5 m3	7.8 m3	9.1 m3	9.7 m3	12.7 m3
6hr	360min	6.00hr	4.9 m3	6.0 m3	6.6 m3	7.0 m3	7.4 m3	8.8 m3	10.2 m3	10.9 m3	14.2 m3
10hr	600min	10.00hr	5.2 m3	6.4 m3	7.0 m3	7.4 m3	7.9 m3	9.3 m3	10.9 m3	11.6 m3	15.1 m3
24hr	1440min	24.00hr	6.9 m3	8.3 m3	9.1 m3	9.6 m3	10.1 m3	11.8 m3	13.7 m3	14.5 m3	18.7 m3
48hr	2880min	48.00hr	8.1 m3	9.6 m3	10.5 m3	11.0 m3	11.5 m3	13.2 m3	15.1 m3	16.0 m3	20.4 m3

Exceedance of Greenfield Run-Off Volume

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	1.0 m3	1.3 m3	1.5 m3	1.6 m3	1.7 m3	2.0 m3	2.3 m3	2.4 m3	3.0 m3
10min	10min	0.17hr	1.5 m3	1.9 m3	2.2 m3	2.3 m3	2.5 m3	2.9 m3	3.4 m3	3.6 m3	4.6 m3
15min	15min	0.25hr	1.7 m3	2.3 m3	2.6 m3	2.8 m3	2.9 m3	3.5 m3	4.0 m3	4.2 m3	5.4 m3
30min	30min	0.50hr	2.0 m3	2.6 m3	2.9 m3	3.1 m3	3.3 m3	4.0 m3	4.6 m3	4.8 m3	6.3 m3
1hr	60min	1.00hr	2.6 m3	3.4 m3	3.8 m3	4.0 m3	4.3 m3	5.1 m3	6.0 m3	6.3 m3	8.3 m3
2hr	120min	2.00hr	3.0 m3	3.9 m3	4.3 m3	4.6 m3	4.9 m3	5.8 m3	6.7 m3	7.0 m3	9.2 m3
4hr	240min	4.00hr	3.2 m3	4.2 m3	4.6 m3	4.8 m3	5.1 m3	6.0 m3	6.9 m3	7.0 m3	9.1 m3
6hr	360min	6.00hr	3.5 m3	4.5 m3	4.9 m3	5.1 m3	5.3 m3	6.1 m3	6.9 m3	6.9 m3	8.9 m3
10hr	600min	10.00hr	2.8 m3	3.9 m3	4.1 m3	4.2 m3	4.3 m3	4.8 m3	5.4 m3	4.9 m3	6.2 m3
24hr	1440min	24.00hr	1.2 m3	2.4 m3	2.3 m3	1.9 m3	1.5 m3	0.9 m3	0.5 m3	-1.5 m3	-2.6 m3
48hr	2880min	48.00hr	-3.3 m3	-2.2 m3	-3.1 m3	-4.3 m3	-5.6 m3	-8.5 m3	-11.2 m3	-16.1 m3	-22.3 m3
											9.2 m3

			C_V:
Catchment Area:	175sqm	100%	
Permeable Garden	30sqm	17%	0.40
Impermeable:	145sqm	83%	0.77
			0.71



SuDs CALCULATIONS	
Project: 19 HOLMDALE ROAD	
POST-DEV. PEAK RUNOFF+CC	
Sheet 6 of 8	
Project Reference: LBH 4620	
Date: 02/11/2020	Rev: 1
Client: Tribi Holdings	

LBHGEO

POST- DEVELOPMENT & SOURCE MITIGATION PEAK RUN-OFF + CC STORAGE

Proposed Discharge Rates: Greenfield x 1

INFLOW

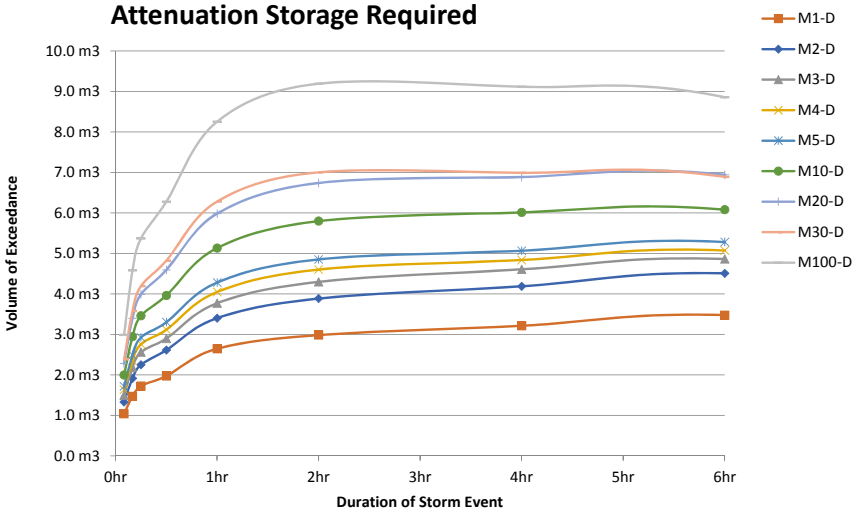
	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	1.1 m3	1.4 m3	1.5 m3	1.7 m3	1.7 m3	2.0 m3	2.3 m3	2.4 m3	3.1 m3
10min	10min	0.17hr	1.5 m3	2.0 m3	2.2 m3	2.4 m3	2.6 m3	3.0 m3	3.5 m3	3.7 m3	4.7 m3
15min	15min	0.25hr	1.8 m3	2.3 m3	2.6 m3	2.8 m3	3.0 m3	3.6 m3	4.1 m3	4.4 m3	5.6 m3
30min	30min	0.50hr	2.1 m3	2.7 m3	3.0 m3	3.3 m3	3.5 m3	4.2 m3	4.9 m3	5.2 m3	6.7 m3
1hr	60min	1.00hr	2.9 m3	3.6 m3	4.1 m3	4.4 m3	4.6 m3	5.6 m3	6.5 m3	7.0 m3	9.1 m3
2hr	120min	2.00hr	3.5 m3	4.4 m3	4.9 m3	5.2 m3	5.6 m3	6.7 m3	7.8 m3	8.3 m3	11.0 m3
4hr	240min	4.00hr	4.2 m3	5.2 m3	5.7 m3	6.1 m3	6.5 m3	7.8 m3	9.1 m3	9.7 m3	12.7 m3
6hr	360min	6.00hr	4.9 m3	6.0 m3	6.6 m3	7.0 m3	7.4 m3	8.8 m3	10.2 m3	10.9 m3	14.2 m3
10hr	600min	10.00hr	5.2 m3	6.4 m3	7.0 m3	7.4 m3	7.9 m3	9.3 m3	10.9 m3	11.6 m3	15.1 m3
24hr	1440min	24.00hr	6.9 m3	8.3 m3	9.1 m3	9.6 m3	10.1 m3	11.8 m3	13.7 m3	14.5 m3	18.7 m3
48hr	2880min	48.00hr	8.1 m3	9.6 m3	10.5 m3	11.0 m3	11.5 m3	13.2 m3	15.1 m3	16.0 m3	20.4 m3

OUTFLOW

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	0.0 m3	0.0 m3	0.0 m3	0.0 m3	0.0 m3	0.0 m3	0.0 m3	0.1 m3	0.1 m3
10min	10min	0.17hr	0.0 m3	0.0 m3	0.0 m3	0.1 m3	0.1 m3	0.1 m3	0.1 m3	0.1 m3	0.1 m3
15min	15min	0.25hr	0.1 m3	0.1 m3	0.1 m3	0.1 m3	0.1 m3	0.1 m3	0.1 m3	0.2 m3	0.2 m3
30min	30min	0.50hr	0.1 m3	0.1 m3	0.1 m3	0.2 m3	0.2 m3	0.2 m3	0.3 m3	0.3 m3	0.4 m3
1hr	60min	1.00hr	0.2 m3	0.2 m3	0.3 m3	0.3 m3	0.4 m3	0.5 m3	0.5 m3	0.7 m3	0.9 m3
2hr	120min	2.00hr	0.5 m3	0.5 m3	0.6 m3	0.6 m3	0.7 m3	0.9 m3	1.1 m3	1.3 m3	1.8 m3
4hr	240min	4.00hr	0.9 m3	1.0 m3	1.1 m3	1.3 m3	1.4 m3	1.8 m3	2.2 m3	2.7 m3	3.6 m3
6hr	360min	6.00hr	1.4 m3	1.5 m3	1.7 m3	1.9 m3	2.1 m3	2.7 m3	3.3 m3	4.0 m3	5.3 m3
10hr	600min	10.00hr	2.4 m3	2.5 m3	2.8 m3	3.2 m3	3.6 m3	4.5 m3	5.5 m3	6.7 m3	8.9 m3
24hr	1440min	24.00hr	5.7 m3	5.9 m3	6.8 m3	7.7 m3	8.6 m3	10.8 m3	13.2 m3	16.1 m3	21.4 m3
48hr	2880min	48.00hr	11.4 m3	11.8 m3	13.6 m3	15.4 m3	17.1 m3	21.7 m3	26.3 m3	32.1 m3	42.7 m3

ATTENUATION STORAGE REQUIRED TO MEET PROPOSED DISCHARGE RATE

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	1.0 m3	1.3 m3	1.5 m3	1.6 m3	1.7 m3	2.0 m3	2.3 m3	2.4 m3	3.0 m3
10min	10min	0.17hr	1.5 m3	1.9 m3	2.2 m3	2.3 m3	2.5 m3	2.9 m3	3.4 m3	3.6 m3	4.6 m3
15min	15min	0.25hr	1.7 m3	2.3 m3	2.6 m3	2.8 m3	2.9 m3	3.5 m3	4.0 m3	4.2 m3	5.4 m3
30min	30min	0.50hr	2.0 m3	2.6 m3	2.9 m3	3.1 m3	3.3 m3	4.0 m3	4.6 m3	4.8 m3	6.3 m3
1hr	60min	1.00hr	2.6 m3	3.4 m3	3.8 m3	4.0 m3	4.3 m3	5.1 m3	6.0 m3	6.3 m3	8.3 m3
2hr	120min	2.00hr	3.0 m3	3.9 m3	4.3 m3	4.6 m3	4.9 m3	5.8 m3	6.7 m3	7.0 m3	9.2 m3
4hr	240min	4.00hr	3.2 m3	4.2 m3	4.6 m3	4.8 m3	5.1 m3	6.0 m3	6.9 m3	7.0 m3	9.1 m3
6hr	360min	6.00hr	3.5 m3	4.5 m3	4.9 m3	5.1 m3	5.3 m3	6.1 m3	6.9 m3	6.9 m3	8.9 m3
10hr	600min	10.00hr	2.8 m3	3.9 m3	4.1 m3	4.2 m3	4.3 m3	4.8 m3	5.4 m3	4.9 m3	6.2 m3
24hr	1440min	24.00hr	1.2 m3	2.4 m3	2.3 m3	1.9 m3	1.5 m3	0.9 m3	0.5 m3	-1.5 m3	-2.6 m3
48hr	2880min	48.00hr	-3.3 m3	-2.2 m3	-3.1 m3	-4.3 m3	-5.6 m3	-8.5 m3	-11.2 m3	-16.1 m3	-22.3 m3
ATTENUATION STORAGE REQUIRED:			3.5 m3	4.5 m3	4.9 m3	5.1 m3	5.3 m3	6.1 m3	6.9 m3	7.0 m3	**9.2 m3**



SuDs CALCULATIONS	
Project: 19 HOLMDALE ROAD	
STORAGE REQUIREMENTS	
Sheet 7 of 8	
Project Reference: LBH 4620	
Date: 02/11/2020	Rev: 1
Client: Tribi Holdings	

LBHGEO

POST- DEVELOPMENT & SOURCE MITIGATION PEAK RUN-OFF + CC STORAGE

Proposed Discharge Rate: **Existing x 50%** **(or greenfield where this is greater)**

INFLOW

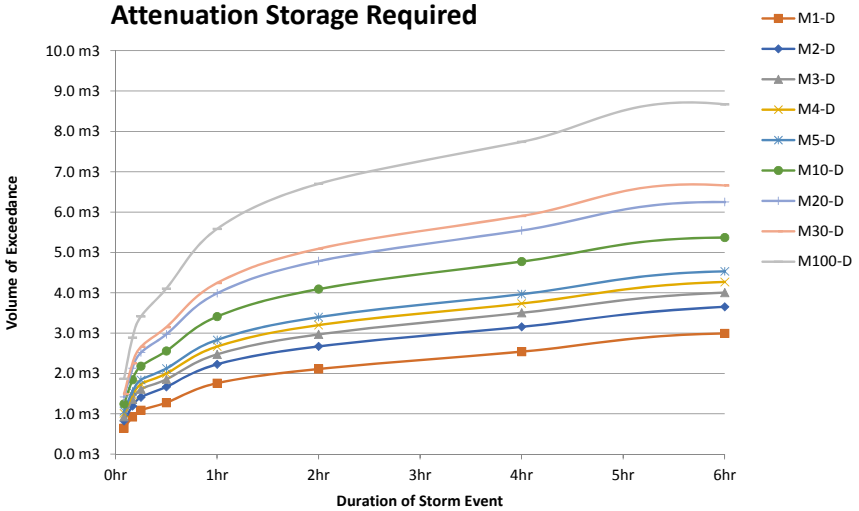
	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	1.1 m3	1.4 m3	1.5 m3	1.7 m3	1.7 m3	2.0 m3	2.3 m3	2.4 m3	3.1 m3
10min	10min	0.17hr	1.5 m3	2.0 m3	2.2 m3	2.4 m3	2.6 m3	3.0 m3	3.5 m3	3.7 m3	4.7 m3
15min	15min	0.25hr	1.8 m3	2.3 m3	2.6 m3	2.8 m3	3.0 m3	3.6 m3	4.1 m3	4.4 m3	5.6 m3
30min	30min	0.50hr	2.1 m3	2.7 m3	3.0 m3	3.3 m3	3.5 m3	4.2 m3	4.9 m3	5.2 m3	6.7 m3
1hr	60min	1.00hr	2.9 m3	3.6 m3	4.1 m3	4.4 m3	4.6 m3	5.6 m3	6.5 m3	7.0 m3	9.1 m3
2hr	120min	2.00hr	3.5 m3	4.4 m3	4.9 m3	5.2 m3	5.6 m3	6.7 m3	7.8 m3	8.3 m3	11.0 m3
4hr	240min	4.00hr	4.2 m3	5.2 m3	5.7 m3	6.1 m3	6.5 m3	7.8 m3	9.1 m3	9.7 m3	12.7 m3
6hr	360min	6.00hr	4.9 m3	6.0 m3	6.6 m3	7.0 m3	7.4 m3	8.8 m3	10.2 m3	10.9 m3	14.2 m3
10hr	600min	10.00hr	5.2 m3	6.4 m3	7.0 m3	7.4 m3	7.9 m3	9.3 m3	10.9 m3	11.6 m3	15.1 m3
24hr	1440min	24.00hr	6.9 m3	8.3 m3	9.1 m3	9.6 m3	10.1 m3	11.8 m3	13.7 m3	14.5 m3	18.7 m3
48hr	2880min	48.00hr	8.1 m3	9.6 m3	10.5 m3	11.0 m3	11.5 m3	13.2 m3	15.1 m3	16.0 m3	20.4 m3

OUTFLOW

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	0.4 m3	0.5 m3	0.6 m3	0.6 m3	0.7 m3	0.8 m3	0.9 m3	1.0 m3	1.2 m3
10min	10min	0.17hr	0.6 m3	0.8 m3	0.9 m3	0.9 m3	1.0 m3	1.2 m3	1.4 m3	1.4 m3	1.8 m3
15min	15min	0.25hr	0.7 m3	0.9 m3	1.0 m3	1.1 m3	1.2 m3	1.4 m3	1.6 m3	1.7 m3	2.2 m3
30min	30min	0.50hr	0.8 m3	1.1 m3	1.2 m3	1.3 m3	1.4 m3	1.6 m3	1.9 m3	2.0 m3	2.6 m3
1hr	60min	1.00hr	1.1 m3	1.4 m3	1.6 m3	1.7 m3	1.8 m3	2.2 m3	2.5 m3	2.7 m3	3.6 m3
2hr	120min	2.00hr	1.3 m3	1.7 m3	1.9 m3	2.0 m3	2.2 m3	2.6 m3	3.1 m3	3.2 m3	4.3 m3
4hr	240min	4.00hr	1.6 m3	2.0 m3	2.2 m3	2.4 m3	2.5 m3	3.0 m3	3.5 m3	3.8 m3	4.9 m3
6hr	360min	6.00hr	1.9 m3	2.3 m3	2.6 m3	2.7 m3	2.9 m3	3.4 m3	4.0 m3	4.2 m3	5.5 m3
10hr	600min	10.00hr	2.4 m3	2.5 m3	2.8 m3	3.2 m3	3.6 m3	4.5 m3	5.5 m3	6.7 m3	8.9 m3
24hr	1440min	24.00hr	5.7 m3	5.9 m3	6.8 m3	7.7 m3	8.6 m3	10.8 m3	13.2 m3	16.1 m3	21.4 m3
48hr	2880min	48.00hr	11.4 m3	11.8 m3	13.6 m3	15.4 m3	17.1 m3	21.7 m3	26.3 m3	32.1 m3	42.7 m3

ATTENUATION STORAGE REQUIRED TO MEET PROPOSED DISCHARGE RATE

	D Duration		M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	0.6 m3	0.8 m3	0.9 m3	1.0 m3	1.1 m3	1.2 m3	1.4 m3	1.5 m3	1.9 m3
10min	10min	0.17hr	0.9 m3	1.2 m3	1.4 m3	1.5 m3	1.6 m3	1.8 m3	2.1 m3	2.3 m3	2.9 m3
15min	15min	0.25hr	1.1 m3	1.4 m3	1.6 m3	1.7 m3	1.8 m3	2.2 m3	2.5 m3	2.7 m3	3.4 m3
30min	30min	0.50hr	1.3 m3	1.7 m3	1.9 m3	2.0 m3	2.1 m3	2.6 m3	3.0 m3	3.2 m3	4.1 m3
1hr	60min	1.00hr	1.8 m3	2.2 m3	2.5 m3	2.7 m3	2.8 m3	3.4 m3	4.0 m3	4.2 m3	5.6 m3
2hr	120min	2.00hr	2.1 m3	2.7 m3	3.0 m3	3.2 m3	3.4 m3	4.1 m3	4.8 m3	5.1 m3	6.7 m3
4hr	240min	4.00hr	2.5 m3	3.2 m3	3.5 m3	3.7 m3	4.0 m3	4.8 m3	5.5 m3	5.9 m3	7.7 m3
6hr	360min	6.00hr	3.0 m3	3.7 m3	4.0 m3	4.3 m3	4.5 m3	5.4 m3	6.3 m3	6.7 m3	8.7 m3
10hr	600min	10.00hr	2.8 m3	3.9 m3	4.1 m3	4.2 m3	4.3 m3	4.8 m3	5.4 m3	4.9 m3	6.2 m3
24hr	1440min	24.00hr	1.2 m3	2.4 m3	2.3 m3	1.9 m3	1.5 m3	0.9 m3	0.5 m3	-1.5 m3	-2.6 m3
48hr	2880min	48.00hr	-3.3 m3	-2.2 m3	-3.1 m3	-4.3 m3	-5.6 m3	-8.5 m3	-11.2 m3	-16.1 m3	-22.3 m3
ATTENUATION STORAGE REQUIRED:			3.0 m3	3.9 m3	4.1 m3	4.3 m3	4.5 m3	5.4 m3	6.3 m3	6.7 m3	**8.7 m3**



SuDs CALCULATIONS	
Project: 19 HOLMDALE ROAD	
STORAGE REQUIREMENTS	
Sheet 8 of 8	
Project Reference: LBH 4620	
Date: 02/11/2020	Rev: 1
Client: Tribi Holdings	

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