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ML Retail Development Ltd

Proposed Residential Development, Bradford Road/Birkby Lane, Bailiff Bridge

FRA & Drainage Strategy

G2708-FRA-01

16th January 201

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Document Control Sheet

Proposed Residential Development, Bradford Road/Birkby Lane, Bailiff Bridge

FRA & Drainage Strategy

Job	Date	Issue	Copy
G2708	16 January 2018	0	

Originator……P Snape……..

Checker……..G Sanderson……..……...

Approver……D Wallbank……..……...

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1. Introduction

Appointment and Brief

1.1. PSA Design Ltd has been commissioned by ML Retail Developments Ltd to undertake a Flood Risk Assessment (FRA) and Drainage Strategy to support a Planning Application for a proposed residential development on land at Bradford Road/Birkby Lane, Bailiff Bridge.

Objectives & Policy

1.2. The National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) set out Government policy aims on development and flood risk for England. The aim is to ensure flood risk is taken into account at all stages of the planning process, to avoid inappropriate developments in areas at risk of flooding, and to direct development away from areas of highest risk.

1.3. This FRA is site specific and will consider the following:-

- the flood risk to the proposed development and whether it could be appropriately designed such that any residual flood risk to either the development, or its users, would be acceptable.
- the potential impact of the proposed development on flood risk elsewhere and whether it could be designed so as not to increase flood risk elsewhere.

2. Site Description and Proposed Development

Site Location

2.1. The site is located off Bradford Road and Birkby Lane, Bailiff Bridge, approximately 1.5 miles north of Brighouse town centre. The National Grid reference is 414908E 425244N

2.2. A site location plan and aerial view is included as **Figure 1.**

Site Description

2.3. The existing site was formerly occupied by the former Clifton Mills which were demolished in 2009. The site is currently vacant with large expanses of hardstanding remaining, remnants of bricks from former buildings, and other areas covered by grassland.

2.4. The application site is approximately 0.6ha and falls steeply from north to south and from east to west, with the highest point on site located in the north-eastern corner (88.15m AOD) and the lowest point in the south-western corner (79.87m AOD).

2.5. The site is located within the village of Bailiff Bridge. Surrounding the site are numerous small businesses, retail units and recent housing developments. Industrial units are situated to the north of the site off Wyke Old Lane. St Aiden's Chapel is located to the north west.

Site Proposal

2.6. The proposed development is for 30 dwellings. The application is for outline planning permission, with access off Wyke Old Lane and Axminster Drive, and all other matters reserved. Therefore at this stage it is only intended to establish the principles of developing the site.

2.7. An indicative layout has been prepared and is included as **Appendix A**. This indicates the 30 dwellings with the associated access routes, driveways and parking areas.

3. Flood Risk Assessment

Flood Zone Classification

3.1. Reference to the online Environment Agency (EA) flood mapping (extract included as **Figure 2A**) shows that the site falls within Flood Zone 1. Flood Zone 1 comprises land that has a low annual probability of flooding (less than 1 in 1000 (<0.1%) from rivers in any year.

3.2. Under the requirements of Planning Practice Guidance (PPG) "Flood Risk & Coastal Change," the Local Authority is required to apply a risk-based sequential test to new developments. This allows them to direct development to areas which are at the lowest probability of flooding.

3.3. With reference to Table 2 from PPG, a development consisting of "dwellings" falls into the "More Vulnerable" category.

3.4. Therefore, in accordance with Table 3, the site proposals would be deemed "appropriate" within Flood Zone 1.

Surface Water Flooding

3.5. **Figure 2b** also includes an extract of the Environment Agency's surface water flood map which shows that development site has a very small area in the north-west corner, adjacent to St Aiden's which is at a low risk of flooding. There is also an area at the southern end of the site which is at low through to a high risk of flooding. The high risk area is in the south west corner.

3.6. During prolonged, exceptionally heavy downpours the ground may become saturated and the land drains, ditches and sewers which carry away surface water may not be able to cope, leading to surface water flooding.

3.7. The proposed development of the site will introduce a formal drainage network and improved flow paths, which will remove the current situation where surface water accumulates in low lying areas and against the site boundaries.

3.8. It is also important to note that the site falls steeply from north-east to south-west and this fall continues beyond the site boundary. Although the mapping indicates potential surface water

flooding, this is unlikely given the steep slope and the introduction of the formal drainage network and improved flow paths noted above.

3.9. It is therefore considered that risk of surface water flooding on the site is low and standard mitigation measures will be sufficient to ensure that the properties remain protected.

3.10. Surface water associated with the development itself is addressed in more detail in Section 4 below.

Source protection zones

3.11. According to the Environment Agency's latest groundwater designation maps the site lies outside a source protection zone.

Flooding from other sources

3.12. Reference to online searches, mapping and local SRFA's has not identified any risk of flooding from any other source. The site is crossed by a culverted watercourse, discussed further in Section 5 below, and it is understood that there have been no instances of flooding from the culvert reported or recorded.

4. Surface Water Management Strategy

4.1. The Environment Agency state that in order to demonstrate that the development is of low risk the FRA should show:

- That it will be feasible to balance surface water run-off to the Greenfield run-off rate, or existing run-off rate in terms of a brownfield development (as in this case) for all events up to the 1 in 100 year storm (including a 30% allowance for climate change as per Calderdale MBC Guidance) and set out how this will be achieved.
- How sustainable drainage techniques (SuDS) will be used with any obstacles to their use clearly justified.

4.2. The primary flood risk generated by a new development is most likely to be the risk posed to others by surface water runoff. The SW drainage arrangements for any development site should therefore aspire to be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development.

4.3. For new development, it may be necessary to provide surface water storage and/or infiltration to limit and reduce both the peak rate of run-off and the total volume discharged from the site.

4.4. The Environment Agency require that, for the range of annual flow rate probabilities, up to and including the 1% annual probability (1 in 100 year event) the developed rate of run-off into a watercourse should be no greater than the undeveloped rate of run-off for the same event. In the case of brownfield sites, drainage proposals will be measured against the existing performance of the site. Water Authorities take a similar approach to that of the Environment Agency, however they ask that flows be restricted to include up to the 3.33% annual probability (1 in 30 year event), whilst demonstrating that the 1 in 100 year event does not pose a threat to the locality (known as designing for exceedance).

4.5. Climate change (CC) will be taken into account by increasing the rainfall intensity by 30% in line with Calderdale MBC Planning Guidance for Flood Risk & Drainage (Calderdale MBC PGFR&D).

5. Existing Site Drainage & Hydrology

5.1. As previously discussed, the proposed development site is currently vacant but was formerly an industrial site consisting of large buildings which were part of Clifton Mills. Therefore, for the purpose of surface water drainage calculations the site will be treated as brownfield.

5.2. Yorkshire Water (YW) records have been acquired and these are included as **Figure 4**. The mapping shows a 225mm diameter combined sewer running across the northern section of the site, from Old Wyke Lane to Bradford Road. This connects into the 225mm/400mm diameter combined sewer on Bradford Road and there is a further 225mm combined sewer on Birkby Lane. There is also a foul sewer on Axminster Drive to the east of the site, which outfalls into the combined sewer on Birkby Lane, and a surface water sewer which outfalls into the culverted watercourse discussed below.

5.3. There is a culverted watercourse running through the site and this is indicated on the layout plan in **Appendix A.** Historical records show the watercourse meandering under the former buildings and it is understood that surface water from the former mill on the site drained directly into the watercourse. Information confirming the drainage of the former buildings was set out in a previous FRA prepared in May 2012 (report 3482/FRA1) for a previous application on this site (112/00698/FUL).

5.4. The previous FRA included a survey of the route of the culverted watercourse from Axminster Drive to the east of the site, through the site and under Bradford Road to its outfall at Clifton Beck. As part of the development to the east off Axminster Drive, the existing culvert was diverted with part of the diversion taking place within the site. The existing 1150mm x 1100mm brick culvert was replaced by a 1200mm diameter pipe over a significant length within the site. The remaining length through the site is the original brick, rectangular culvert.

6. Consideration of Sustainable Drainage Systems

6.1. There are a number of options for the provision of surface water drainage for the proposed development:

- Soakaways for roof run-off and permeable surfacing for roads, drives, car parks and private access road.
- Discharge to local watercourse.
- Discharge to public sewer.
- Discharge to adjacent land drains and ponds.

6.2. The first option to be considered for surface water disposal for all proposed development must be infiltration into the ground. Even when there are alternative sewer connections or watercourses available infiltration must still be utilised unless it is proved unfeasible. Normally to identify the suitability of the ground for infiltration, percolation testing is carried out to calculate the infiltration rate. Where the underlying soil conditions are relatively impermeable, for example clay, the infiltration rate may be too low for soakaways to be designed to adequately cope with large storm events from the entire site.

6.3. Reference to the British Geological Survey (BGS) website, indicates that the site's superficial deposits are alluvium, clay, silt, sand and gravel, overlying mudstone, siltstone, sandstone from the Pennine Lower Coal Measures Formation.

6.4. The superficial deposits are confirmed on "Soilscapes Mapping" which indicates the soil is "Slowly permeable, seasonally wet, acid loamy and clayey soils" with impeded drainage. Extracts of both maps are included as **Figure 3**.

6.5. Therefore, until such time that further ground investigation is carried out it is assumed that soakaways will not be a viable means of dealing with surface water run-off from the site.

6.6. The next preferred hierarchical solution for dealing with surface water run-off from a development is to a watercourse. Information obtained from the survey of the existing drainage indicates that the site previously drained to a culverted watercourse running through the site which outfalls into Clifton Beck to the south-west of the site.

6.7. It is therefore proposed at this stage to assess if a sustainable solution is achievable into the existing culverted watercourse. The layout indicates that a further length of the existing culvert will require diversion, utilising a 1200mm diameter pipe (as existing).

6.8. As discussed above, the proposed surface water drainage solution for a brownfield site should aspire to ensure that run-off rates and volumes will be less than or equal to those of the existing site and where possible provide betterment. Calderdale MBC require developers of brownfield sites to reduce the discharge by 30% when compared to the previous use. The total site area is 0.587 ha. The previous FRA from May 2012 noted that although 100% of this area was likely to have drained to the culvert, it was agreed with Calderdale to restrict the impermeable area to the former roof only i.e. exclude the former yard areas. From historical mapping and aerial photographs, the former roof was estimated at 0.345ha. It is therefore proposed to use this figure which was previously agreed with Calderdale MBC.

6.9. Runoff rates have been calculated from the former impermeable area 3450 sqm (0.345 ha) (based on the Rational Method). Rainfall intensities are based on figures listed within Table 1(a) TRL 595.

- 1 in 1yr event (Q = 2.78 x 50.8mm/hr x 0.345ha) = 49 l/s
- 1 in 30yr event (Q = 2.78 x 111.5mm/hr x 0.345ha) = 107 l/s
- 1 in 100yr event (Q = 2.78 x 143.9mm/hr x 0.345ha) = 138 l/s

6.10. Applying a reduction of 30% as required, it is proposed that the surface water from the development outfalls to the culverted watercourse with a restricted flow of 34 l/s. This is in accordance with guidance set out within Calderdale MBC PGFR&D and is less than the discharge rate agreed in the previously approved planning application of 40l/s.

6.11. Whilst taking cognisance of the draft nature of the layout provided, an assessment has been made of the impermeable areas associated with the proposed development. It will be necessary to re-address these calculations once a final site layout has been agreed. However, for the purpose of this report, this approach is considered sensible and should enable us to identify if a viable and sustainable solution is deliverable**.**

6.12. The impermeable areas have been calculated and are summarised in the Table 1 below.

	Area (m^2)
Total Developable Area	5,870
Buildings (58 houses)	1,380
Roads (incl footways)	930
Drives	665
Total Impermeable (with drives)	2,975
Total Impermeable (without drives)	**2,310**

Table 1: Impermeable Areas

6.13. It can be therefore be seen that the development will reduce the impermeable area contributing to flows into the culverted watercourse when compared to the former Brownfield site. This assumes that the drives to the houses are impermeable. In line with current SuDS best practice, all driveways will be proposed as porous paved or laid to discharge to adjacent landscaped areas.

6.14. The Draft National Standards for Sustainable drainage systems that deals with SuDS covers the whole range of sustainable approaches to surface water drainage management including:

- source control measures including rainwater recycling and drainage.
- infiltration devices to allow water to soak into ground, that can include individual soakaways and communal facilities.
- filter strips and swales, which are vegetated features that hold and drain water downhill mimicking natural drainage patterns.
- filter drains and porous pavements to allow rainwater and run-off to infiltrate into permeable material below ground and provide storage if needed.
- basins and ponds to hold excess water after rain and allow controlled discharge that avoids flooding, and
- Underground storage to hold excess water after rain and allow controlled discharge that avoids flooding.

6.15. Each of the six SuDS considerations listed above are discussed below with reference to their suitability for the proposed development.

SuDS Group	Technique	Likely to be suitable?	Notes
Source Control	Rainwater Harvesting	Yes	Would not feasibly accommodate the full increase of volume of runoff created by the proposed development but would work alongside any attenuated system
Infiltration Devices	Permeable Paving	Probably	Could not feasibly be used across the entire site but certainly an option for driveways
	Infiltration trenches and basins	Unlikely	Ground conditions indicate that it is unlikely to be feasible. Further investigation required.
Filtration	Soakaways	Unlikely	Ground conditions indicate that it is unlikely to be feasible. Further investigation required.
	Open Swales	Possibly	Use for attenuation, evaporation, water quality and slowing water movement down with limited infiltration
	Filter Strips	Possibly	Use for attenuation, evaporation, water quality and slowing water movement down but not for infiltration
Retention/ Detention	Basin / Ponds	Unlikely	Small site with limited space but could possibly be located in public open space at southern end
Underground Storage	Culverts / Tanks / Oversized Pipes	Yes	Suitable for controlling discharge to watercourse or sewer via a piped outfall Adoption and future maintenance should be discussed with Sewerage Undertaker and/or SuDS Approving Body.

SuDS Techniques Review

7. Proposed Drainage Strategy – Surface Water

7.1. As previously discussed, the ground is likely to be unsuitable for infiltration techniques. Until a ground investigation is undertaken to formally assess the infiltration potential of the site, it is proposed that surface water from the development is discharged into the culverted watercourse running through the site. The discharge rate from the site will be reduced and suitable storage provided upstream.

7.2. As the scheme is at outline planning stage, a proposed drainage strategy rather than a final solution has been prepared.

7.3. Whilst taking cognisance of the stage of the application an assessment has been made of the impermeable areas associated with the proposed development. It will be necessary to re-address these calculations at reserve matters stage once final levels and arrangements have been finalised. However, for the purpose of this report, this approach is considered sensible and should enable us to identify if a viable and sustainable solution is deliverable.

7.4. The proposed impermeable area is calculated at **2,310m^2**.

7.5. In line with current SuDS best practice, all driveways will be porous paved or laid to discharge surface water into adjacent landscaping areas. If for any reason at reserved matters stage this isn't feasible due to engineering reasons then it will be possible to revisit the calculations below to account for the extra impermeable area and if necessary flows can be restricted and attenuated on site.

7.6. In calculating the proposed run-off at this stage, to ensure robustness, we have assumed the following:-

- **No infiltration** – If this was available then it would significantly reduce surface water run-off from the site.
- **No Rainwater Harvesting / Water Butts** – Suitably designed rainwater harvesting tanks can significantly reduce the volume of run-off and form an integral part of the attenuated system. A carefully designed system may ensure that no run-off from roof areas is experienced up to the 1 in 1 yr event.
- **No storage within swales** – Swales have a combined advantage of providing a volume of storage, slowing the rate at which water enters the downstream system and providing a certain amount of infiltration into the ground.

7.7. Within the analysis it has also been assumed that 100% of the rainwater falling on the proposed impermeable areas enters the system. It is therefore considered that the analysis undertaken is robust. At detailed design stage, and following further ground investigation it may also be viable to propose a porous pavement solution for the roads as well as the driveways.

7.8. Runoff rates have been calculated from the proposed impermeable area, 2,310sqm (based on the Rational Method). Rainfall intensities are based on figures listed within Table 1(a) TRL 595. The proposed flow rates have been factored up by 30% to account for climatic change.

- 1 in 1yr event (Q = 2.78 x 50.8mm/hr x 0.231ha x 1.3) = 42 l/s
- 1 in 30yr event (Q = 2.78 x 111.5mm/hr x 0. 2315ha x 1.3) = 93 l/s
- 1 in 100yr event (Q = 2.78 x 143.9mm/hr x 0. 231ha x 1.3) = 120 l/s

7.9. It was noted above that it is the intention to utilise porous paving for driveways. However, if this was not possible the impermeable area would be increased by 665 m^2. For comparisons sake, the effects of this are calculated below from the revised total impermeable area of 2,975m^2.

- 1 in 1yr event (Q = 2.78 x 50.8mm/hr x 0.2975ha x 1.3) = 55 l/s
- 1 in 30yr event (Q = 2.78 x 111.5mm/hr x 0. 2975ha x 1.3) = 120 l/s
- 1 in 100yr event (Q = 2.78 x 143.9mm/hr x 0. 2975ha x 1.3) = 155 l/s

7.10. It can be seen from the peak run-off rates set out above (which include a 30% uplift for CC) that the development of the site would not significantly increase the run-off when compared to the former mill site. If permeable drives are used then the run-off would decrease slightly. Comparison of the existing and proposed site, incorporating the above calculations, are summarised in the table below.

	Impermeable Area
Existing Site	**3,450 m²**
Proposed Site (with impermeable drives)	**2,310 m²** (2,975 m²)
Difference	**1,140 m² (-33%)** (- 475 m²) (-14%)

	1 in 1yr Storm (1)	**1 in 30yr Storm** (1)	**1 in 100yr Storm** (1)
Existing Run-Off (l/s)	**49 l/s**	**107 l/s**	**138 l/s**
Proposed Run-Off (l/s) (with impermeable drives)	**42 l/s** (55 l/s)	**93 l/s** (120 l/s)	**120 l/s** (155 l/s)
Run-off Rate Reduction Compared to Existing (with impermeable drives)	**- 7 l/s** (+6 l/s)	**- 14 l/s** (+13 l/s)	**- 18 l/s** (+17 l/s)
Proposed Restricted Run-Off (l/s) to culverted watercourse	**34 l/s** (-15 l/s)	**34 l/s** (-73 l/s)	**34 l/s** (-104 l/s)

Table 2: Existing & Proposed Run-off & Areas

(1) *Proposed Run-off Rates also include an increase of 30% climatic change allowance*

Figures in brackets assume all driveways are impermeable and drained

7.11. The above table shows is that even allowing for a 30% climatic change increase, flows and hence volumes, will be less than existing for all calculated storm events. Even if all the proposed hard surfacing is impermeable, there is only a slight increase in flows.

7.12. However, as noted in Section 6 it is proposed to restrict flow into the culverted watercourse to 34 l/s, to provide the 30% betterment required by Calderdale MBC. Flows entering the culverted watercourse will therefore be significantly reduced, particularly for the higher return periods. As noted above this restricted outflow will require storage to be provided in the system upstream.

7.13. Storage will be provided up to and including the 1 in 100yr storm event plus an allowance of 30% increase for climatic change and 10% for urban creep. This is above and beyond the requirements of a Yorkshire Water adopted drainage system which requires storage up to and including the 1 in 30yr storm event. Flows would also be controlled by introduction of a Hydro-brake flow control manhole prior to surface water entering the culverted watercourse.

7.14. HR Wallingford "Surface Water Storage Requirements for Sites" has been used to calculate the various predicted attenuation requirements and included within **Appendix B**. The calculations cover the development with and without permeable drives. The storage requirements for both scenarios are set out below in Table 3.

Run-off to culverted watercourse restricted to 34 l/s		
	With Permeable Drives (0.231 ha)	**With Impermeable Drives (0.2975 ha)**
Total Storage	**56 m^3**	**72 m^3**

Table 3: Storage Requirements

7.15. It is generally accepted that surface water systems are designed to accommodate the 1 in 30yr + cc event and anything above and beyond that could be allowed to flood the system. This is known as designing for exceedance. At detailed design stage, it may be possible to arrange the layout so that flood waters above and beyond the 1 in 30yr storage requirement are directed to and maintained within landscaped areas, carriageways and parking areas and route water away from property thresholds both on and surrounding the site. The flood water must not migrate onto existing highways surrounding the site or land outwith the development boundary, not should it be allowed to accumulate within key access areas. If this is not achievable then it will be necessary to accommodate the full 1 in 100yr storage requirements within the drainage network.

7.16. It is also important to note that this system takes no account of the peripheral storage that will be available within the remainder of the proposed drainage network and therefore, notwithstanding the techniques outlined in para 7.6, the storage attenuation requirements will inevitably be less.

7.17. In providing this storage and restricting the run-off from the site to 34 l/s, significant benefits arise in terms of run-off and volumes of flood water discharging into the culverted watercourse. The current peak flow into the watercourse is a maximum of 138 l/s for a 1 in 100 year event. This will be reduced to 34 l/s. The excess volumes of water will now be stored on site.

7.18. As previously discussed, the final drainage system will be subject to detailed design and no doubt secured by condition.

Maintenance of proposed SuDS systems.

7.19. It is important during any development process to consider the long-term maintenance of the proposed drainage system. The way this is processed will largely depend on how the system is taken forward at detailed design.

7.20. The SuDS will be reviewed and approved by the Local Planning Authority (LPA) in consultation with the Lead Local Flood Authority (LLFA) to ensure it meets the relevant standards. Although approved by both the LPA and the LLFA the SuDS would remain private and be maintained and managed by the land owner in accordance with the SuDS management plan. This plan could also be secured through planning condition or legal agreement.

7.21. Alternatively, the developer may wish to enter into a S104 Agreement and have the internal sewers adopted and therefore maintained by Yorkshire Water.

7.22. **It has therefore been demonstrated that a SuDS solution that meets with the requirements of current legislation is deliverable within the constraints of the site and will ensure that flood risk both on and off site will not be exacerbated. The reduction in impermeable areas, the introduction of storage and the restricted run-off resulting from the re-development of the site will significantly reduce run-off into the culverted watercourse and ultimately Clifton Beck.**

8. Foul Drainage

8.1. Foul drainage will be assessed in further detail following the development of the detailed site layout and in consultation with Yorkshire Water. There is an existing 225mm diameter combined sewer running through the northern section of the site, a 225/400mm diameter combined sewer on Bradford Road and a 225mm diameter combined sewer on Birkby Lane. It would be the intention to connect the foul system from the development to one of these sewers.

8.2. It is too early in the development process to make any accurate assessment of foul sewage flows from the proposed site; however, taking the current dwelling figures from the proposed layout we can assume 30 no. properties, with an average of 3 bedrooms. Therefore, in accordance with British Water Code of Practice – Flows and Loads – 4, the predicted flow are calculated as follows:-

30Nr x 3 Bed = 30 x 5 = 150 Total P = 150 x 0.8 (Reduction Factor) = 120P

Therefore, estimated total daily load = 120 x 150 = 18,000 l/day

8.3. **Subject to Yorkshire Water approval, it is clear that there is a means of dealing with foul sewage from the proposed site.**

9. Summary

- The site lies within Flood Zone 1 and is therefore suitable for residential development.

- The site was formerly occupied by Clifton Mills and is therefore a brownfield site, with surface water discharging into a culverted watercourse which runs through the site. The culvert has been previously diverted utilising a 1200mm diameter pipe and further diversion would be required to accommodate the proposed layout. This would provide betterment in terms of the structure of the culvert.

- The impermeable area within the site will be reduced by up to 33% under the proposals when compared to the former mill complex. In addition, discharge of surface water will be restricted to 34 l/s, providing the 30% betterment required by Calderdale MBC for brownfield sites. This will significantly reduce the run-off into the watercourse and ultimately Clifton Beck. For the 1 in 100 year event, flows entering the culvert will be reduced by 104 l/s. Storage for up to 72 m^3 will be provided on site, most likely by means of underground storage.

- Drainage proposals will be designed in accordance with the techniques set out within the SuDS Manual.

- Subject to Yorkshire Water approval, foul drainage will be directly or indirectly connected into the existing combined sewer systems within and adjacent to the site.

- Future maintenance of the system can be secured in perpetuity, through the use of a planning condition.

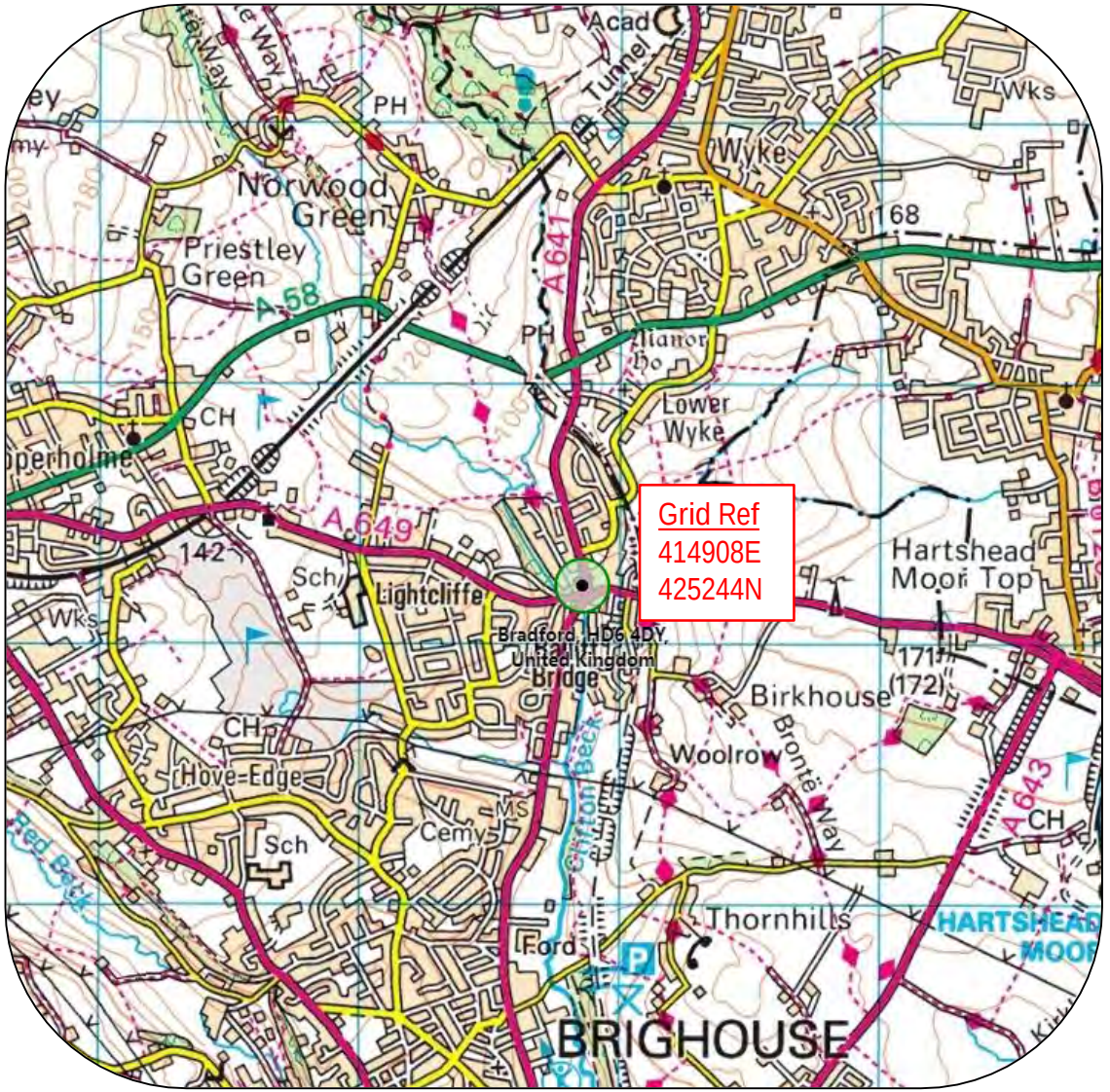
- The delivery of a SuDS surface water system can also be secured through planning condition.

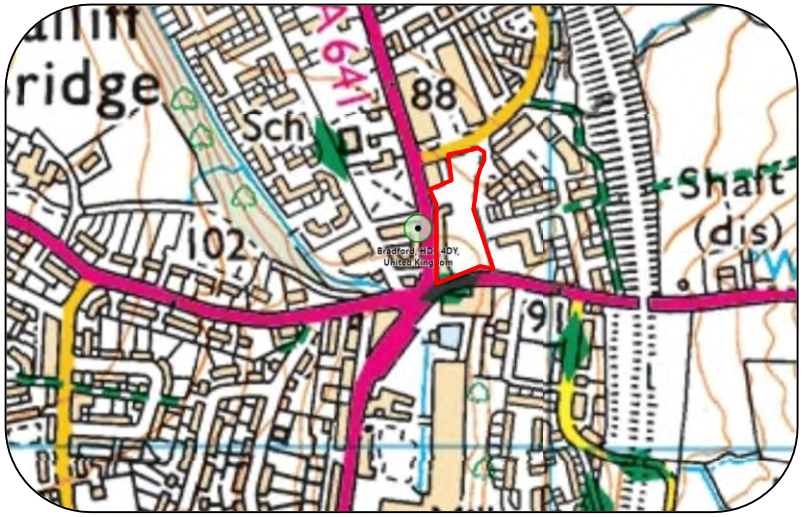
10. Conclusion

The strategy outlined above shows a viable sustainable drainage solution is achievable within the constraints of the site. In addition, the development of the site will significantly reduce the run-off from the site and its contribution to flows within the culverted watercourse and ultimately Clifton Beck. Detailed design of the system following a successful planning application can be delivered to meet with NPPF/PPG, Environment Agency, Yorkshire Water and Local Authority requirements.

Figures & Drawings

Figure 1 - Site Location
Figure 2a – Flood Mapping – Flood Zones & Flood Risk
Figure 2b – Flood Mapping – Surface Water and Reservoirs
Figure 3 – Geological Mapping
Figure 4 – Yorkshire Water Sewer Records





PSA DESIGN engineering your environment CIVIL, STRUCTURAL, GEOTECHNICAL, TRANSPORT	PSA Design The Old Bank House 6 Berry Lane, Longridge Preston, PR3 3JA Tel. 01772 786066	Client	**ML Retail Development LTD**	Drawn	FR	Date	**11th Jan 2017**
		Job	**Bradford Road, Bailiff Bridge - Residential**	Checked		Scale	**NTS**
		Title	**Site Location Plan (indicative site boundaries shown)**	Approved		Rev	

Drawing No. **Figure 1**

Flood Zones

Flood Risk

PSA DESIGN engineering your environment CIVIL, STRUCTURAL, GEOTECHNICAL, TRANSPORT	PSA Design The Old Bank House 6 Berry Lane, Longridge Preston, PR3 3JA Tel. 01772 786066	Client	**ML Retail Development LTD.**	Drawn	FR	Date	**11th Jan 2017**	Drawing No. **Figure 2a**
		Job	**Bradford Road, Bailiff Bridge - Residential**	Checked				
		Title	**Flood Maps – Environment Agency Extract – Flood Zones & Risk**	Approved		Scale	**NTS**	Rev

Surface Water Flooding

Reservoir Flooding

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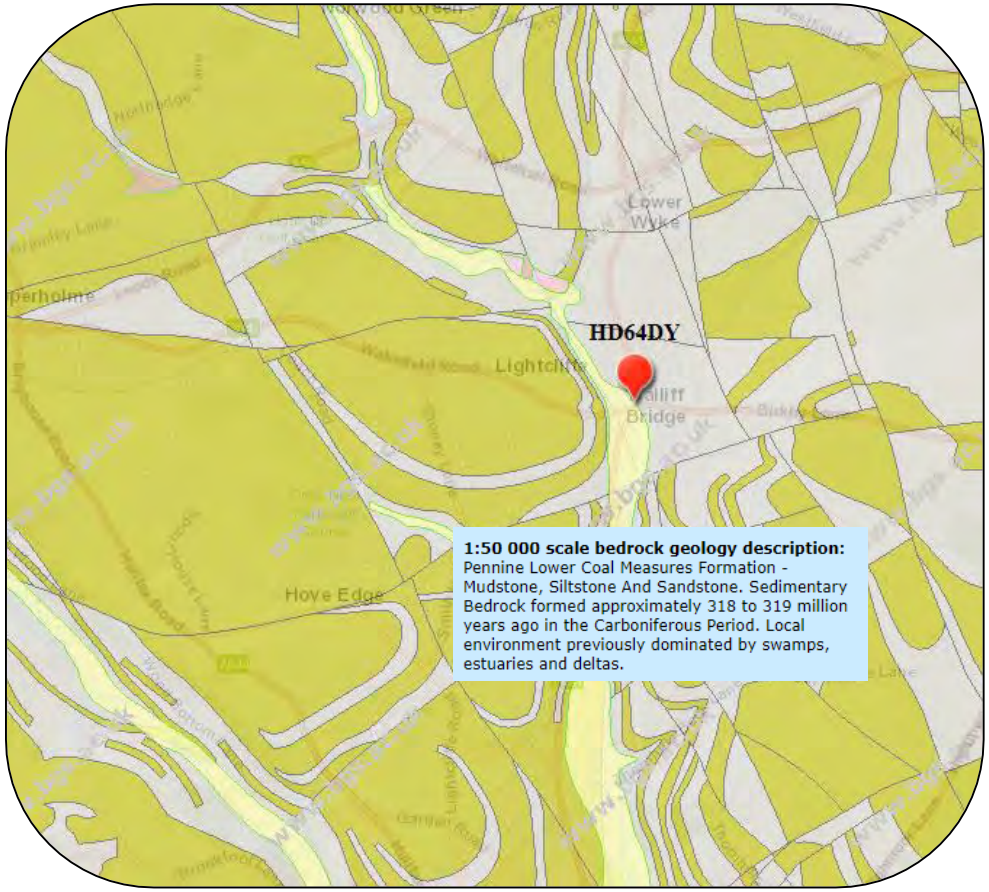
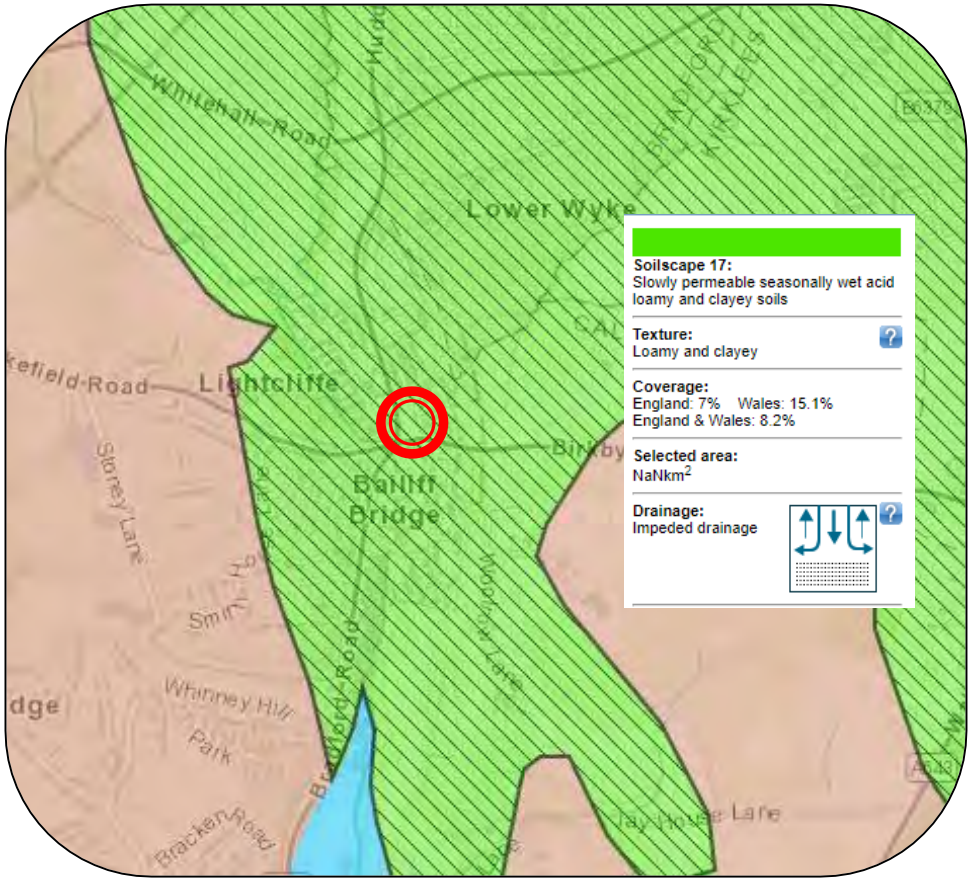
		Job	**Bradford Road, Bailiff Bridge - Residential**	Checked				
		Title	**Flood Maps – Environment Agency Extract – SW & Reservoir**	Approved		Scale	**NTS**	Rev

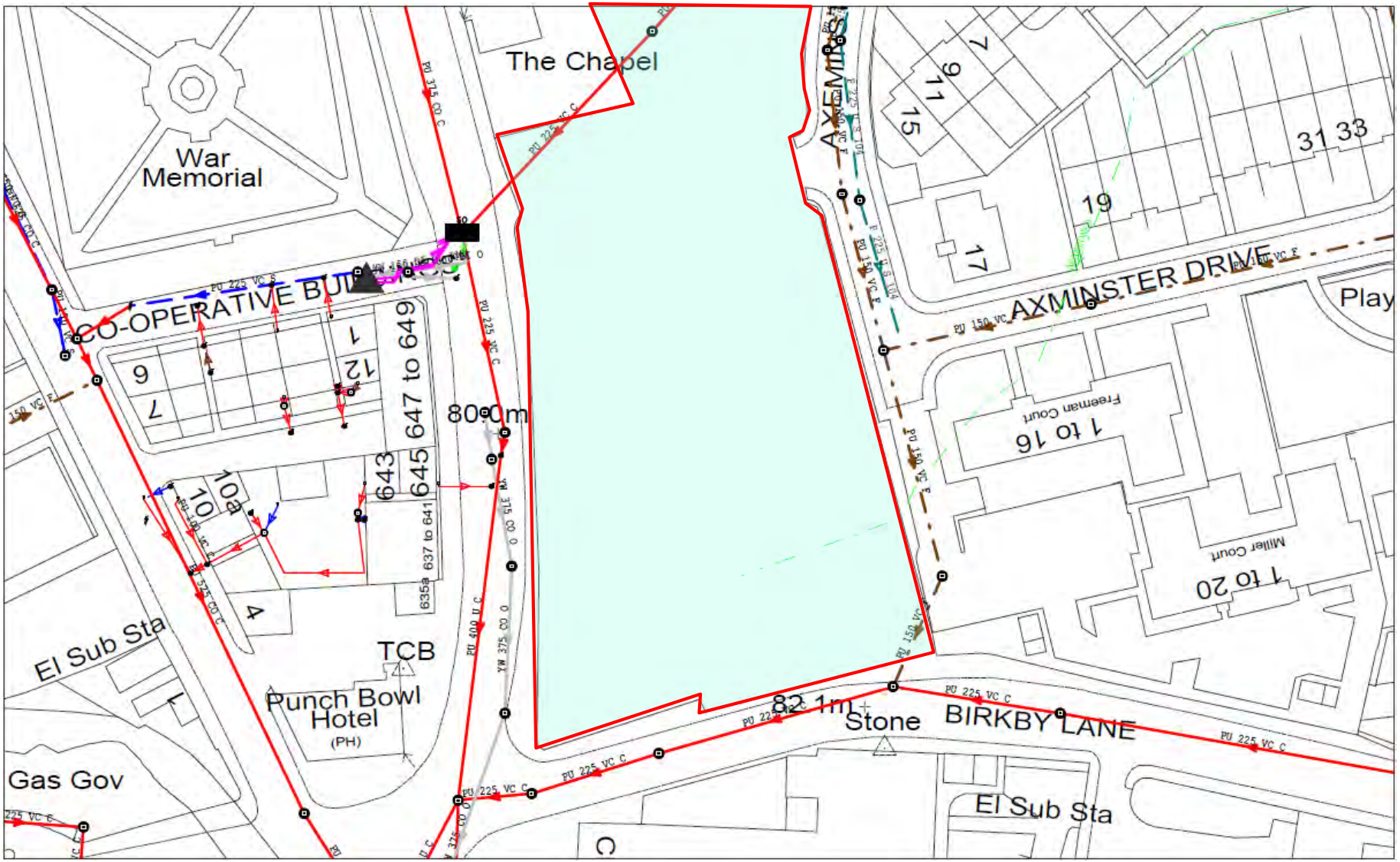


BGS Mapping



Soilscape's Mapping

PSA DESIGN engineering your environment CIVIL, STRUCTURAL, GEOTECHNICAL, TRANSPORT	PSA Design The Old Bank House 6 Berry Lane, Longridge Preston, PR3 3JA Tel. 01772 786066	Client	**ML Retail Devlopment LTD.**	Drawn	FR	Date	**11th Jan 2017**	Drawing No. **Figure 3**
		Job	**Bradford Road, Bailiff Bridge - Residential**	Checked				
		Title	**Geological Mapping**	Approved		Scale	**NTS**	Rev



PSA DESIGN engineering your environment CIVIL, STRUCTURAL, GEOTECHNICAL, TRANSPORT	PSA Design The Old Bank House 6 Berry Lane, Longridge Preston, PR3 3JA Tel. 01772 786066	Client	**ML Retail Devlopment LTD.**	Drawn	FR	Date	**11th Jan 2017**	Drawing No. **Figure 4**
		Job	**Bradford Road, Bailiff Bridge – Residential**	Checked		Scale	**NTS**	Rev
		Title	**Yorkshire Water Sewer Records**	Approved				

Appendix A

Proposed Layout

Health & Safety Notes

1. Contractor must ensure that all work on site is carried out in a safe & satisfactory manner, in accordance with Health & Safety At Work Act 1974, COSHH Regulations 2002 & requirements of C.D.M

WYKE OLD LANE

The Chapel

BRADFORD ROAD

BIRKBY LANE

AXMINSTER DRIVE

NEW ACCESS POINT

NEW FOOTPATH ALIGNMENT 79.66

El Sub Sta

Stone

TCB

83.55

80.01

79.90

83.68

82.96

KEY

79.86 EXISTING LEVEL

79.86 PROPOSED LEVEL

Rev.	Description	Date
A	Additional dwelling indicated	20.10.2017
P1	First Issue	18.10.2017

Client: **Midas Land**

Project: **Bradford Rd/Birkby Lane**
BAILIFF BRIDGE

Drawing Title: **Proposed Site Plan**

Drawn by	Checked by	Date
nd	nd	30.08.2017

Status: **PRELIMINARY** | Scale @ A1: 1:200

Job no.	Dwg.no.	Rev.
8678	SK02	A

Cassidy+Ashton C+A
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Architecture + Building Surveying + Town Planning
7 East Cliff, Preston, Lancashire, PR1 3JE 01772 258 356
10 Hunters Walk, Canal Street, Chester, CH1 4EB 01244 402 900

Appendix B

HR Wallingford Storage Calculations

HR Wallingford
Working with water

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	Graham Sanderson
Site name:	Bradford Road/Birkby Lane
Site location:	Bailiff Bridge

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the drainage scheme.

Site coordinates

Latitude:	53.72344° N
Longitude:	1.77568° W

Reference:	6224729
Date:	2018-01-17T10:16:48

Methodology	IH124

Site characteristics

Total site area (ha)	0.2310
Significant public open space (ha)	0
Area positively drained (ha)	0.231
Pervious area contribution (%)	30
Impermeable area (ha)	0.231
Percentage of drained area that is impermeable (%)	100
Impervious area drained via infiltration (ha)	0
Return period for infiltration system design (year)	10
Impervious area drained to rainwater harvesting systems (ha)	0
Return period for rainwater harvesting system design (year)	10
Compliance factor for rainwater harvesting system design (%)	66
Net site area for storage volume design (ha)	0.23
Net impermeable area for storage volume design (ha)	0.23

* Where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50 % of the 'area positively drained', the 'net site area' and the estimates of Qbar and other flow rates will have been reduced accordingly.

Design criteria

Volume control approach	Use long term storage

	Default	Edited
Climate change allowance factor	1.3	1.3
Urban creep allowance factor	1.1	1.1
Interception rainfall depth (mm)	5	5
Minimum flow rate (l/s)	5	5

Qbar estimation method	Specify Qbar manually
SPR estimation method	Calculate from SOIL type

	Default	Edited
Qbar total site area (l/s)	1.37	34
SOIL type	4	4
HOST class	N/A	N/A
SPR	0.47	0.47

Hydrology

	Default	Edited
SAAR (mm)	837	837
M5-60 Rainfall Depth (mm)	17	17
'r' Ratio M5-60/M5-2 day	0.3	0.3
Rainfall 100 yrs 6 hrs	61	
Rainfall 100 yrs 12 hrs	77.38	
FEH/FSR conversion factor	1.06	1.06
Hydrological region	3	
Growth curve factor: 1 year	0.86	0.86
Growth curve factor: 10 year	1.45	1.45
Growth curve factor: 30 year	1.75	1.75
Growth curve factor: 100 year	2.08	2.08

Site discharge rates

	Default	Edited
Qbar total site area (l/s)	1.37	34
Qbar net site area (l/s)	1.37	34
1 in 1 year (l/s)	5	29.2
1 in 30 years (l/s)	5	59.5
1 in 100 years (l/s)	5	70.7

Estimated storage volumes

	Default	Edited
Interception storage (m^3)	9	9
Attenuation storage (m^3)	82	0
Long term storage (m^3)	0	47
Treatment storage (m^3)	28	28
Total storage *(excluding treatment)* (m^3)	91	56

HR Wallingford
Working with water

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	Graham Sanderson
Site name:	Bradford Road/Birkby Lane
Site location:	Bailiff Bridge

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the drainage scheme.

Site coordinates

Latitude:	53.72344° N
Longitude:	1.77568° W

Reference:	6224729
Date:	2018-01-17T10:13:27

Methodology	IH124

Site characteristics

Total site area (ha)	0.2975
Significant public open space (ha)	0
Area positively drained (ha)	0.2975
Pervious area contribution (%)	30
Impermeable area (ha)	0.2975
Percentage of drained area that is impermeable (%)	100
Impervious area drained via infiltration (ha)	0
Return period for infiltration system design (year)	10
Impervious area drained to rainwater harvesting systems (ha)	0
Return period for rainwater harvesting system design (year)	10
Compliance factor for rainwater harvesting system design (%)	66
Net site area for storage volume design (ha)	0.3
Net impermeable area for storage volume design (ha)	0.3

* Where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50 % of the 'area positively drained', the 'net site area' and the estimates of Qbar and other flow rates will have been reduced accordingly.

Design criteria

Volume control approach	Use long term storage

	Default	Edited
Climate change allowance factor	1.3	1.3
Urban creep allowance factor	1.1	1.1
Interception rainfall depth (mm)	5	5
Minimum flow rate (l/s)	5	5

Qbar estimation method	Specify Qbar manually
SPR estimation method	Calculate from SOIL type

	Default	Edited
Qbar total site area (l/s)	1.77	34
SOIL type	4	4
HOST class	N/A	N/A
SPR	0.47	0.47

Hydrology

	Default	Edited
SAAR (mm)	837	837
M5-60 Rainfall Depth (mm)	17	17
'r' Ratio M5-60/M5-2 day	0.3	0.3
Rainfall 100 yrs 6 hrs	61	
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FEH/FSR conversion factor	1.06	1.06
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Growth curve factor: 1 year	0.86	0.86
Growth curve factor: 10 year	1.45	1.45
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	Default	Edited
Qbar total site area (l/s)	1.77	34
Qbar net site area (l/s)	1.77	34
1 in 1 year (l/s)	5	29.2
1 in 30 years (l/s)	5	59.5
1 in 100 years (l/s)	5	70.7

Estimated storage volumes

	Default	Edited
Interception storage (m^3)	12	12
Attenuation storage (m^3)	129	0
Long term storage (m^3)	0	60
Treatment storage (m^3)	36	36
Total storage *(excluding treatment)* (m^3)	141	72