5.0 SURFACE WATER MANAGEMENT

5.1 Pre-Development Surface Water Run-off

5.1.1 The total site covers 11.436ha, however the proposed development area (excludes those areas onsite to remain undeveloped such as the POS areas) and will cover 8.394ha based on the indicative planning proposals. At present the development area is 100% permeable and is understood to drain naturally to the onsite land drainage ditches and Ordinary Watercourses. These features are considered to ultimately drain to Barton Brook.

5.1.2 The peak rates and volumes of run-off generated by the development area have been calculated for the peak events shown in **Table 1** (full details **Appendix J**). The surface water run-off rates have been calculated using the FEH Statistical Method.

Site Area	Run-Off Rates				Run-Off Volumes	
	1 In 1 Year	1 In 30 Year	1 In 100 Year	QBar	1 In 2 Year	1 In 100 Year
8.394ha	79.3l/s	154.9l/s	189.5l/s	91.1l/s	961.0cu.m	2967.2cu.m

Table 1: Pre-Development Surface Water Run-Off Rates (Betts Hydro, 2019)

5.2 Post Development Surface Water Run-Off

5.2.1 At present the indicative proposals show the development area to cover 8.394ha of the wider site. Based on the planning layout we have estimated that the post-development impermeable areas will increase om 0ha to approximately 55% of the development area (4.617ha). The unrestricted post-development run-off rates have been detailed in **Table 2**.

Site Area	Run-Off Rates			Run-Off Volumes	
	1 In 1 Yr	1 In 30 Yr	1 In 100 Yr +CC	1 In 1 Year	1 In 100 Year
4.617ha	194.9l/s	445.0l/s	840.3l/s	106.2cu.m	357.7cu.m

Table 2: Post-Development Un-Restricted Run-Off Rates (Betts Hydro, 2019)

5.2.2 The proposals will be to restrict the rate of discharge from the development to mimic a pre-development greenfield situation (**Table 1**), betterment in the form of permeable surfaces will also be considered as part of detailed design where feasible to reduce surface water run-off rates.

5.3 Sustainable Drainage Systems (SuDS)

5.3.1 In accordance with national and local planning policy, peak surface water discharge rates from new development should be appropriately managed and where possible reduced. To manage surface water run-off policy shows that preference should always be given to Sustainable Drainage Systems (SuDS) over the traditional methods of buried sewers wherever possible and practical. SuDS can address the four key sustainability objectives embedded in this policy including providing space for water (water quantity), improving water quality and biodiversity, along with providing valuable amenity/recreational space within new development sites.

5.3.2 Multiple benefits to using SuDS include the improvement of biodiversity, aesthetics, ecology and water quality. It would be beneficial to implement wider green space/Public Open Space area(s) in one or more locations within site, where SuDS features could be implemented. Opportunities should also be taken to provide soft landscaping where at all possible on site to assist in minimising surface water run-off. Given the indicative layout, there will likely be the opportunity to incorporate SuDS methods such as swales, ponds or basins (**Figure 6**) to provide a degree of treatment before flows are carried offsite.

Figure 6: SuDS Photographs (SusDrain, 2012)

5.3.3 It would also be recommended that permeable paving and bio-filtration (tree pits) be considered in non-adopted areas where at all feasible. By including measures such as these the surface water run-off is being dealt with at source and this will assist locally with surface water management (subject to optimum ground conditions). If infiltration is not feasible then a connection into the main drainage systems is needed, but the presence of the permeable surfaces will still allow the first 5mm of rainfall to be dealt with at source as identified in the SuDS Manual (CIRIA 753).

5.3.4 Promoting SuDS to deal with surface water at the source, will limit the required attenuation and in turn reduce the volume of surface water in the nearby watercourse and sewer infrastructure. There may be the potential to utilise some SuDS features for conveyance/attenuation of surface water flows within the proposed drainage strategy measures including a pond/basin will be included to assist with the attenuation, opposed to the traditional below ground storage methods. Detailed design should confirm whether this site would be suitable for incorporation of SuDS following more detailed analysis of levels, ground conditions and attenuation requirements.

5.4 Methods of Surface Water Management

5.4.1 At present the development area covers 11.436ha and the proposed impermeable area is assumed to increase from 0% to 55%. There are three methods that have been reviewed for the management and discharge of surface water. These may be applied individually or collectively to form a complete strategy and should be applied in the order of priority listed below:

- Discharge via infiltration
- Discharge to watercourse
- Discharge to public sewerage system

5.5 Discharge via Infiltration

5.5.1 Any impermeable areas that can drain to soakaway or an alternative method of infiltration would significantly improve the sustainability of any surface water systems. The Cranfield Soil and AgriFood Institute (CSAI), Soilscapes viewer identifies the soils to be slowly permeable, seasonally wet, slightly acid but base-rich loamy and clayey. The British Geology Survey (BGS) mapping data indicates that the underlying strata consists of Sherwood Sandstone at bedrock level with Devensian Till at superficial deposit levels.

5.5.2 Based on the ground conditions identified by the published online datasets, it can be considered that infiltration would not likely provide a viable drainage solution for all the development site due to the impermeable strata. This is supported by the soil classification being 0.47, as identified on catchment characteristics. This is a high classification on the scale which runs from 0.1 (very permeable) to 0.5 (cohesive), which suggests that the underlying soil structure would not promote infiltration-based solutions to managing surface water at shallow depths.

5.5.3 The mapping is however large scale and infiltration rates can vary on a site by site basis, furthermore the presence of Sandstones at depth (bedrock geology) could suggest that infiltration based solutions at depth would be feasible . It would be recommended further investigation in the form of Soakaway Testing to BRE365, takes place following planning approval to confirm the site would not be suitable for any infiltration-based solutions even in part, to assist with reducing the run-off discharging from the site to the nearby watercourse network.

5.6 Discharge to Watercourse

5.6.1 Assuming infiltration is not suitable for managing all the surface water run-off generated by the development, the next method in the drainage hierarchy is discharge surface water to a watercourse. Most of the site drains naturally either to ground overtime (in natural low spots in the site) or to the Main River network (Barton Brook) to the south via the series of onsite land drainage ditches and Ordinary Watercourses. Drainage investigation of the onsite land drainage networks has been carried out and confirmed that the onsite watercourses ultimately drain to Barton Brook to the south, although in some cases the existing channels are in poor condition and the channel route has been lost, meaning conveyance of flows are partly overland, rather than directly via a formal connection (see drainage investigation plan in **Appendix M**).

5.6.2 The surface water run-off generated by the proposed development is therefore proposed to mimic the existing situation and discharge into Barton Brook using the existing ordinary watercourses located on the site, where practical (as illustrated in **Figure 7**). Detailed design will need to be carried out to confirm whether a site wide gravity solution can be achieved. Although, the site naturally drains to Barton Brook at present, when the proposed development levels are considered, it is likely that multiple outfalls to the onsite watercourses will be required to accommodate the proposals. There may be a requirement for deep infrastructure or part pumped solutions to ensure the most southerly and northerly part of the site can achieve connections to the watercourses bisecting the site.

5.6.3 Consents will be required from Lancashire County Council who are the Lead Local Flood Authority, for any new outfall structures on the Ordinary Watercourses, and any culverting (to accommodate crossings shown on the layout). Agreement would also

be required for the proposed rates of discharge to the Ordinary Watercourses onsite, to ensure no increase risk to others result from the site. As the proposed point of connection to the Ordinary Watercourses is located within the site boundary there would be no consent required form third party land owners for routing offsite, however there will be a requirement to improve the lengths of Ordinary Watercourse routes offsite to Barton Brook and therefore discussion with adjacent riparian land owners will be required.

Figure 7: Preliminary Proposed Drainage Plan extract (Betts Hydro, 2019)

5.6.4 Some of the onsite watercourses have been identified to be in poor condition, there are blockages on existing culvert lengths and some of the open channel ditches are partly in-filled. This restricts the natural conveyance within the main channels and can result in overland flows across parts of the site in high intensity rainfall events. Improvements in the existing drainage ditches and watercourses crossing the site will be required as part of the proposals, the main watercourse routes, which are to be retained will need to be reinstated where the conveyance within the main channels has historically been restricted due to poor maintenance.

5.6.5 In accordance with both LCC and the EA, there is a requirement to maintain an easement from existing Ordinary Watercourses and Main Rivers. The EA and LCC both require an 8m easement to be maintained from the Top of Bank of the watercourses into the development area. The easement should provide clear and unimpeded access for future maintenance no fencing, walls or buildings should be present within the designated easement. Further discussion with LCC, will be required to confirm whether the existing drainage ditches onsite will also require to be maintained within

the proposals, these are currently shown to remain within the development proposals where practical.

5.6.6 As illustrated in the Preliminary Drainage Plan (**Figure 7**) we have identified that an alternative surface water outfall location to the south of site may be possible, subject to relevant agreements with third party landowners. This alternative option is where the Ordinary Watercourse from site re-opens downstream of the culvert as this part is understood to be lower than the site and may offer an option to achieve a gravity solution across the site. This outfall location is outside of the land controlled by the developer and therefore third-party land consent would need to be obtained for works in this area.

5.6.7 As the site naturally falls towards Barton Brook to the south and the existing onsite drainage features ultimately drain to this watercourse there may be scope to agree a new formal connection from the site to this Main River to achieve a single point of connection. Further discussion with the LLFA and the EA is required along with consent from Riparian Landowners for any offsite routing.

Proposed Discharge Rates

5.6.8 In accordance with the SuDS Manual (CIRIA 753) and the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015) all sites should endeavour to achieve as close to pre-development greenfield rates as is viable. Based on the development area, the pre-development greenfield rate (QBar) is calculated to be 91.1l/s using the FEH Statistical Method (see summary in **Appendix J**). The proposals are to restrict surface water run-off to mimic a pre-development greenfield situation, the overall rate of discharge rate (above) would need to be proportioned between the no. of outfalls. This will need to be considered in more detail during formal detailed design, when the technical details are reviewed.

Impermeable Area (4.617ha)	1 In 1 Year	1 In 30 Year	1 In 100 Year + 40% CC
Restricted Run-Off Rate	91.1l/s	91.1l/s	91.1l/s
Estimated Stormwater Storage Volume	268cu.m-593cu.m	1083cu.m-1716cu.m	2635cu.m-3653cu.m

Table 3: Estimated Stormwater Storage Requirements (Betts Hydro, 2019)

5.6.9 It would be beneficial to implement SuDS features where at all feasible, subject to ground investigation and a detailed levels review. If designed appropriately the SuDS features such as a pond/basin could potentially aid in the attenuation requirements for the proposals (if located appropriately) and provide added benefits in terms of water quality improvements. Indicative attenuation locations have been illustrated in the Preliminary Drainage Plan (**Figure 7**). Detailed design will be required to confirm whether SuDS can be incorporated. It is likely due to engineering constraints that some traditional storage in oversized pipes/crates will also be required. At present indicative proposals allow for the inclusion of SuDS, including ponds/basins, where multiple outfalls are required, then additional attenuation is likely to be required for each outfall.

5.7 Discharge to Public Sewer Network

5.7.1 Should infiltration be proved not feasible then the surface water flows generated are proposed to discharge to the watercourse and not the existing sewer network. An existing public combined sewer (150mm dia.) crosses land west of Garstang Road,

approximately 200m from the site. This would be the nearest alternative option, subject to arrangements. Due to the locations of the watercourse in relation to the site there are no proposals to discharge to the public sewer network.

5.8 Climate Change

5.8.1 There are indications that the climate in the UK is changing significantly and it is widely believed that the nature of climate change will vary greatly by region. Current expert opinion indicates the likelihood that future climate change would produce more frequent short duration and high intensity rainfall events with the addition of more frequent periods of long duration rainfall. It is believed that the impact of climate change means there is likely to be a long-term increase in the average sea levels, with an expectation that sea levels will rise gradually. An increase in flood water levels means that future flooding events will occur more frequently and will have a greater impact.

5.8.2 In light of the future uncertainties Climate Change should be accounted for within the design of all new developments. The recently published Environment Agency document '*Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities*' supersedes Defra's policy statement on Flood Risk and Coastal Erosion Risk Management (2009) and should be used for future proposals. Climate change factors have been considered and any increase in the level of flood risk (to the site) from climate change is likely to be related to the increase in rainfall intensity and duration and its impact upon the surface water drainage system.

5.8.3 In accordance with the updated Climate Change projections provides estimated changes to rainfall intensity (**Table 5**) and based on the design life of the development (100yrs) the "total potential change figures for the 2080's has been utilised.

PROJECTIONS	TOTAL POTENTIAL CHANGE ANTICIPATED FOR THE 2080'S
Upper End Estimate	40%
Central Change Factor	20%

Table 4: Change to Extreme Rainfall Intensity Compared to 1961-1990 Baseline (Environment Agency, 2016)

6.0 FOUL WATER MANAGEMENT

6.1 Due to the existing land-use onsite, no existing foul water connections to the public sewer network are present. Review of the UU sewer records identifies an existing public foul water sewer (150mm dia.) to run south within Woodlands Way to the south-west and a subsequent foul water sewer (150mm dia.) running south within Garstang Road to the south-west. Furthermore, a public foul water sewer is also shown to run north within Garstang Road to the north-west of the site, a connection length is shown to run into this system from the north-western corner of the site. See full records included in **Appendix C**.

6.2 The foul water flows generated by the development are proposed to discharge to the public foul water sewer in Garstang Road via the newly proposed site entrance. An alternative point of connection would be to the public foul water sewer located within Woodlands Way. Further discussion with UU will be required to confirm their preferred point of connection and capacity constraints. Initial discussion has been carried out where UU confirmed a connection to Woodlands Way would be acceptable however as there is a new site entrance being made to Garstang Road, this may offer a better route to connection to the main system within Garstang Way.

6.3 Based on the proposals for the construction of up to 151no. residential units for Phase 2, the approximate peak foul water flows generated by the development are 7l/s. This is based on 4000 litres per dwelling per 24 hours; the guidance contained within Sewers for Adoption (SfA). Detailed design will confirm the full technical details based on the engineering constraints. It is not clear whether a full gravity system can be achieved, at this time and it has therefore assumed that a pumped solution would be required. The proposals will need to account for this pumping station in accordance with UU standard requirements. Consent from UU will be required for works to the public sewer infrastructure. It is recommended that early discussion is undertaken to confirm acceptance of the strategy and identify any additional constraints.

7.0 SUMMARY AND CONCLUSIONS

7.1 This Flood Risk Assessment and Drainage Management Strategy has been prepared to support an outline planning application for the construction of a residential development on land adjacent to Cardwell Farm in Barton. The proposed development site covers 11.436ha in total and is currently undeveloped agricultural land with a series of existing land drainage features present.

Flood Risk

7.2 The site is located wholly within Flood Zone 1 based on the Environment Agency Flood Map for Planning. The proposals are for a residential led development, which is considered 'More Vulnerable' within Planning Practice Guidance and is confirmed to be appropriate within Flood Zone 1, providing there is no increase in flood risk elsewhere due to the proposals. Consultations with the Environment Agency, Preston City Council, Lancashire County Council and United Utilities have previously been undertaken and did not identify any historical flooding to the site or within the neighbouring areas.

7.3 This assessment has considered all the potential sources of flood risk and the site is at low risk of flooding associated with most sources reviewed. The primary source of flood risk is from surface water flooding where the risk varies from 'very low' to 'high' across the site. The areas at highest flood risk coincide with naturally low-lying areas or the existing onsite drainage features such as ponds and watercourses. The risk from surface water flooding will be effectively managed post-development through the implementation of mitigation measures proposed within this assessment.

7.4 The key mitigation measures to be implemented include appropriate levels design, inclusion of suitable surface water management infrastructure and making space for water through retaining existing conveyance routes through the site. To minimise residual flood risks it would be recommended that natural drainage routes through the site be maintained and enhanced, along with ensuring the FFLs are raised sufficiently above the external levels (following any re-grades) to ensure that safe avenues for overland flow or exceedance have been included in the proposals.

Drainage Strategy

7.5 To ensure surface water flood risks are not increased, it is important to ensure surface water runoff is appropriately in accordance with the sustainable drainage hierarchy. The sustainable drainage hierarchy identifies three methods of surface water discharge, these should be reviewed in the order of priority being discharge via infiltration, to a watercourse and finally to public sewerage system.

7.6 The ground conditions published online, suggest that infiltration is unlikely provide a full viable surface water drainage solution for the site given the cohesive nature of the upper strata. A part infiltration solution may be achievable at depth given the presence of sandstones, although Soakaway Testing needs to be undertaken at the next stage in the application to confirm. Assuming infiltration is not feasible, the next method in the drainage hierarchy should be discharge to a watercourse.

7.7 The majority of site naturally drains to the watercourse network (Barton Brook) to the south of the site via the onsite watercourse network, the proposals would therefore be to mimic the existing situation and discharge surface water run-off generated by the development to the watercourse network. Detailed design will need to confirm

feasibility of a site wide gravity solution, it is likely that multiple connections to the watercourses on the site will be required and it is not clear at this stage whether all of the site can achieve a gravity connection without routing through land outside of the developers control. Consents will be required from Lead Local Flood Authority (Lancashire County Council) for any works to/effecting the Ordinary Watercourse, including agreement of the proposed discharge rates.

7.8 Onsite drainage investigations have been carried out and the routes of existing onsite ditches confirmed that the Ordinary Watercourse and drainage ditches ultimately connect into Barton Brook. Furthermore, the investigation has identified that some culverted lengths of the existing Ordinary Watercourse are in poor condition and will need to be improved or re-routed through site as part of the development. Improvements in the existing drainage ditches and watercourses crossing the site will be required as part of the proposals, the main watercourse routes, which are to be retained will need to be reinstated where the conveyance within the main channels has historically been restricted due to poor maintenance.

7.9 In accordance with the SuDS Manual and the Non-Statutory Technical Standards for Sustainable Drainage Systems, all sites should endeavour to achieve as close to pre-development greenfield rates as viable. The pre-development greenfield run-off rate (QBar) for the development area is 70.9l/s, this rate of discharge rate will need to be proportioned between the no. of proposed outfalls and will be considered in more detail as part of detailed design.

7.10 Restricting the rate of discharge will generate an onsite stormwater storage requirement which will be catered for on the site prior to discharge to the watercourse. It would be beneficial to implement SuDS features where at all feasible, if designed appropriately the SuDS features potentially aid in the attenuation requirements for the proposals and provide added benefits in terms of water quality improvements. At present indicative proposals allow for the inclusion of SuDS, including ponds/basins, where multiple outfalls are required, then additional attenuation is likely to be required for each outfall. It is likely due to engineering constraints that some traditional storage in oversized pipes/crates will also be required. Detailed design will be required to confirm whether SuDS can be incorporated.

7.11 This Flood Risk Assessment and Drainage Management Strategy has been prepared in consultation with the relevant interested parties and incorporates their comments where possible. The report is commensurate with the scale and nature of the development proposals and in summary, the development can be considered appropriate in accordance with the Planning Practice Guidance.

8.0 RECOMMENDATIONS

8.1 For 'more vulnerable' development located within Flood Zone 1, it is typical to set the Finished Floor Levels (FFL) of residential dwellings to a minimum of 150mm above the existing ground levels. By ensuring the FFLs are raised sufficiently above the external levels (following any re-grade) should mitigate any risk of flooding from a variety of sources, including groundwater and surface water run-off risks at the proposed development.

8.2 Any overland flows generated by the proposed development must be controlled, safe avenues directing overland flow away from any existing and proposed buildings are advised. As with any development it is also advised that external levels fall away from property to minimise the flood risk from a variety of sources.

8.3 In accordance with both LCC there is a requirement to maintain an easement from existing Ordinary Watercourses. The LCC require an 8m easement to be maintained from the Top of Bank of the watercourse into the development area. The easement should provide clear and unimpeded access for future maintenance no fencing, walls or buildings should be present within the designated easement. Furthermore, land drainage ditches are located onsite and further discussion with the LLFA (LCC) and the LPA (PCC) will be required to confirm whether these assets have any associated constraints such as easements or culverting considerations.

8.4 To minimise the flood risk to the neighbouring property and proposed dwellings it is proposed that the surface water run-off generated by the proposals be managed effectively with the peak rates of run-off being restricted to the equivalent of the pre-development situation

8.5 In accordance with the LPA and UU requirements, Soakaway Testing to BRE365 may be required to be undertaken to evidence that discharge to ground will not be a viable solution. This can be undertaken as part of the next stage in the application process and an alternative strategy has been identified within this assessment.

8.6 Some of the onsite watercourses have been identified to be in poor condition, there are blockages on existing culvert lengths and some of the open channel ditches are partly in-filled. This restricts the natural conveyance within the main channels and can result in overland flows across parts of the site in high intensity rainfall events. Improvements in the existing drainage ditches and watercourses crossing the site will be required as part of the proposals, the main watercourse routes, which are to be retained will need to be reinstated where the conveyance within the main channels has historically been restricted due to poor maintenance.

8.7 Detailed drainage design will need to be carried out to confirm whether a site wide gravity surface water solution can be achieved. It is likely that multiple outfalls to the onsite watercourses will be required to accommodate the proposals and there may be a requirement for deep infrastructure or part pumped solutions to ensure the most southerly and northerly part of the site can achieve connections to the watercourses bisecting the site.

8.8 Consents will be required from Lancashire County Council who are the Lead Local Flood Authority, for any new outfall structures on the Ordinary Watercourses, and any

culverting (to accommodate crossings shown on the layout). Agreement would also be required for the proposed rates of discharge to the Ordinary Watercourses onsite, to ensure no increase risk to others result from the site. Alternatively, should a connection or works within third party land be required, then consents will be required from riparian landowners and early discussion would be advised.

8.9 The proposed onsite surface water drainage system will need to be sized to contain the 30yr return period event wholly below ground with overland run-off from storm events up to and including the 1 in 100yr return period storm event with a 40% allowance for climate change being contained onsite.

8.10 Consent from UU will be required for works to the public sewer infrastructure to accommodate the foul water flows generated by the site. It is not clear whether a full gravity foul water system can be achieved, at this time and it has therefore assumed that a pumped foul water solution would be required. The proposals will need to account for this pumping station in accordance with UU standard requirements. It is recommended that early discussion is undertaken to confirm acceptance of the strategy and identify any additional constraints.

8.11 It is important that should any drainage systems not be offered for adoption to either the United Utilities or Lancashire County Council then an appropriate maintenance regime should be scheduled with a suitably qualified management company for these private drainage systems

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