PERSEVERANCE MILL,
PADIHAM, BURNLEY

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FLOOD RISK ASSESSMENT

The Alan Johnston Partnership LLP

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1.0 INTRODUCTION

This Flood Risk Assessment (FRA) has been prepared on behalf of Ringstones Maintenance and Construction LLP in connection with a planning application for a residential development, consisting of approximately 56 residential units, with associated works and access roads. The proposed site is located adjacent to Abingdon Road, Padiham. This FRA is required as the total area of the proposed development site is over 1.0ha and parts of the site lie within Flood Zone 2.

This FRA has been prepared in accordance with the general requirements of the National Planning Policy Framework and the Technical Guidance to the National Planning Policy Framework, both published by the Department for Communities and Local Government. This involves the identification of flood risk to new development(s) on the site, the possible effect of this development on flood risk elsewhere and the investigation of the impact on the development as a result of increased sea levels, fluvial flows and larger pluvial events due to increased impermeable areas and climate change.

The purpose of this report is to present a site specific assessment of flood risk based on available information, to identify relevant flood levels affecting the site with respect to a particular probability of flooding. The flood levels identified are dependent on the correctness of the current conditions, as stated in this report and the prediction of future climatic conditions implicit in the National Planning Policy Framework.

For any size of storm event, the procedure will always yield a probability that the event will occur in any year, albeit the probability is smaller for larger events. The predicted storm event has a probability of occurrence in any year and the derived flood level has an associated probability of exceedance. This means that there is always a risk that property flooding could occur one or more times in any year.

Therefore, this report should not be interpreted or relied upon as providing a guarantee against flooding. There is always a residual risk that flooding will occur and it is not possible to predict a zero risk of flooding.

In accordance with National Planning Policy Framework (NPPF) and the associated Technical Guidance document, flood risk must be assessed for all sources including tidal (from the sea), fluvial (from rivers), pluvial (from land), groundwater, sewer and artificial water bodies (e.g. reservoirs, canals, major water supply infrastructure etc.).

More specifically, the development of any site must be carried out in such a way as to mitigate any potential flood risk, both on and off site from all sources of flooding.
2.0 SITE DESCRIPTION

The existing site is located adjacent to Abingdon Road, Padiham. The site is located at National Grid reference SD 79831 33232. The location of the existing site is illustrated in Appendix A and the extent of the area to which the application relates is shown on the enclosed aerial photograph in Appendix B.

The existing site covers a total area of approximately 1.15ha and is a brownfield site. The existing site is currently disused but has been previously developed and used for industrial purposes. Currently the site is 100% impermeable and consists of number of concrete slabs and stockpiled rubble from the demolition of the previous development. An aerial photograph indicating the current site is included within Appendix B.

The site is bounded by residential developments on all sides. To the north, the site is bounded by residential properties on Shakespeare Street and to the west Alboin Street and more residential properties. To the east, the site is bounded by residential properties on Russell Terrace and to the south, Dryden Street and residential and commercial properties.

Green Brook enters the site through the southern boundary and runs through the western area of the site. Immediately prior to entering the site the Brook is culverted and immediately after it exits the site in the north–west corner, it becomes open watercourse again.

The site slopes slightly from south to north with levels varying from approximately 84.20mAOD in the south–west corner to approximately 83.20mAOD in the north–east corner of the site. Various stockpiles of rubble and fly–tipping are dotted around the site. The site is split in two by the culvert and it’s cover slab with the area to the south–west of the culvert slightly higher than the larger area to the north–east of the culvert.

The site is also enclosed by an existing masonry brick wall which is approximately 0.65m – 1.00m high along the southern, western and eastern boundaries. Along the northern boundary of the site there is another existing masonry brick wall which is smaller, at a height of approximately 0.30m – 0.60m high.

Access to the site can be gained from 2no. locations. The first is pedestrian access only, along the northern boundary of the site at the back of Shakespeare Street, where the existing wall drops to existing ground levels to allow access. The second is the vehicular access which is located at the junction of Brook Street and Albion Street, where there is an existing bridge over the culverted watercourse.

An aerial photo is included in Appendix B to illustrate the site at the present day and the topographic survey is included in Appendix C.
2.1 Geology

The British Geological Survey 1:50,000 Bedrock geology maps show that the site has glacial till superficial deposits, with bedrock reported to be of the Pennine Lower Coal Measures Formation, comprising of Mudstones, Siltstones and Sandstones.

The e3p, Preliminary Geo-Environmental Assessment Report, 11–360–L1, dated September 2016 supports this information with exploratory hole records indicating strata comprising of made ground to depths of up to 3.0mbgl, underlain by drift deposits (gravelly clays) superficial deposits to depths of up to 15.0mbgl. The bedrock was not encountered in any of the exploratory hole logs and it is envisaged that it is located at greater depths than 15.0mbgl.

2.2 Hydrogeology

The Environment Agency groundwater maps show that the superficial deposits are classified as a Secondary (undifferentiated) Aquifer, defined as cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non–aquifer in different locations due to the variable characteristics of the rock type.

The bedrock is classified as a Secondary A Aquifer, defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

The Environment Agency groundwater maps also indicate that the development site is not situated within a groundwater Source Protection Zone (SPZ).

The e3p, Preliminary Geo–Environmental Assessment Report, 11–360–L1, dated September 2016 indicates that groundwater was encountered in only one of the exploratory holes across the entire site. Due to the cohesive nature of the made ground and alluvium strata, the shallow groundwater encountered is likely to be perched water, with the actual groundwater table located at depth.

2.3 Hydrology

The development site is situated in the direct catchment of Green Brook. As indicated within section 2.0, Green Brook runs through the western area of the site and is culverted through the entire length through the site, prior to becoming open watercourse again, immediately downstream of the site boundary.

The site is located in Flood Zone 2. Flood Zone 2 is categorized by the Environment Agency as land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%). Therefore, the site is identified by the Environment Agency as having a medium risk of flooding from rivers and streams.
3.0 PROPOSED DEVELOPMENT

The proposed development will occupy the entire 1.15ha site and will consist of 56no. residential units with associated gardens and access roads. To enable a viable scheme, the proposed site levels are constrained by the existing highways and residential developments, at the site boundaries. Therefore, while site levels are to be raised they should tie into the surrounding highways and residential properties. A proposed site plan is attached in Appendix D.

As can be seen from the proposed site plan, the proposed residential units are to be located on either side of the existing culverted Brook, with the access roads located solely to the east of the culvert. The existing masonry walls surrounding the site are to be retained and made good, where necessary.

4.0 PLANNING POLICY

The National Planning Policy Framework (NPPF) sets out the Government’s policy on meeting the challenges of climate change, flooding and coastal change. The NPPF states that:

"Planning plays a key role in helping shape places to secure radical reductions in greenhouse gas emissions, minimising vulnerability and providing resilience to the impact of climate change, and supporting the delivery of renewable and low carbon energy and associated infrastructure. This is central to the economic, social and environmental dimensions of sustainable development. Local planning authorities should adopt proactive strategies to mitigate and adapt to climate change taking full account of flood risk, coastal change and water supply and demand consideration."

This Flood Risk Assessment proposes recommendations to facilitate the proposed development so that it takes into account flood risk at all stages of the development.

4.1 Sequential Test

Based on the site’s location, within Flood Zone 2, the Sequential Test would generally be required. However, the Burnley Local Plan 2016, has identified this site for housing delivery and therefore the Sequential Test is deemed as not required.

4.2 Exception Test

NPPF classifies the development (dwelling houses) as ‘More Vulnerable’ and as the site is located within Flood Zone 2, this development is deemed appropriate. Therefore, the Exception Test is not required.
5.0 FORMS OF FLOODING

The Technical Guidance to the National Planning Policy Framework requires all forms of flooding to be considered.

5.1 Flooding from Rivers

The Flood Risk map is included as Appendix E.

It can be seen from the map that the majority of the site is located in Flood Zone 2 with a chance of flooding between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%).

Through a previous Flood Risk Assessment for the site; Perseverance Mill, Brook Street, Padiham, Flood Risk Assessment & Outline Drainage Strategy, FRA 16 1056, November 2016, by LK Consult Limited, the Environment Agency have been contacted and asked to provide product 4 flood level information for Green Brook. The flood level information and correspondence is attached in Appendix E.

The flood levels are summarised in the table below;

<table>
<thead>
<tr>
<th>Node Point</th>
<th>100 year +30% CC Peak Flood Level (mAOD)</th>
<th>1000 year Peak Flood Level (mAOD)</th>
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<tr>
<td>Node 3</td>
<td>84.38</td>
<td>86.26</td>
</tr>
<tr>
<td>Node 4</td>
<td>82.93</td>
<td>83.14</td>
</tr>
<tr>
<td>Node 5</td>
<td>82.91</td>
<td>83.08</td>
</tr>
</tbody>
</table>

The site is located between Node 3, which is upstream of the site and Node 4, which is downstream of the site. Node 3 is located at the point at which the watercourse is culverted, adjacent to Dryden Road, to the south of the site.

Node 4 is located at the point at which the culverted watercourse becomes an open watercourse again, immediately downstream of the existing bridge over the culverted watercourse, adjacent to the junction of Brook Street and Albion Street, to the north–west corner of the site. Node 5 is located further downstream of Node 4, adjacent to the north–west corner of the proposed site.

As such, the supplied flood levels have been linearly interpolated across the site, with the sketch, attached in Appendix F, providing the design flood levels at intervals across the site.

The design flood levels at each of the cross sections are summarised in the following table;
The 100 year +30% climate change design flood levels have been compared to the lowest proposed site level and lowest proposed finished floor level at the location of each of the cross sections identified above.

The results are indicated in the table below;

<table>
<thead>
<tr>
<th>Cross Section</th>
<th>100 year +30% CC Peak Flood Level (mAOD)</th>
<th>1000 year Peak Flood Level (mAOD)</th>
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<tr>
<td>0</td>
<td>84.13</td>
<td>85.73</td>
</tr>
<tr>
<td>1</td>
<td>83.98</td>
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<td>82.93</td>
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</tr>
<tr>
<td>11</td>
<td>82.91</td>
<td>83.06</td>
</tr>
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As can be seen from the levels comparison above, the lowest proposed level of the site at each cross-section is a minimum of 0.32m above the 100 year +30% climate change flood level and the lowest finished floor level at each cross-section is a minimum of 0.60m above the 100 year
As the proposed site levels comply with the Environment Agency vulnerable developments standing advice, the risk of flooding to the new development from rivers is considered to be acceptable.

As can be seen from the topographic survey, attached in Appendix C, the existing site is bounded by masonry walls along all of its boundaries. The minimum height of the masonry wall to the southern boundary of the site is 86.18m AOD, which is approximately 450mm above the 1000 year flood level at the linearly interpolated section 0–0.

Therefore, as the wall has no access points or openings along the southern boundary, it can be assumed that during a 1000 year flood event the flood water will be retained behind the wall and directed along Dryden Street. As the proposed site works include retaining and making good the existing masonry wall, it can be assumed that the existing scenario will be maintained after completion of the proposed works.

The same can be said for the existing masonry walls along the other boundaries of the site. The lowest masonry wall heights along the boundaries have been compared with the linearly interpolated flood levels at each cross section and the top of wall levels are all above the 1000 year flood levels at each of the cross sections.

To the north–west corner of the proposed site, at the bridge over the existing culvert, there is an opening in the masonry wall to allow for access to the site. Therefore, any flood waters which make it to this area will encroach upon the site. However, the proposed site levels are such that the flood waters will be directed away from the proposed housing plots and towards the far north–west corner of the site.

It should also be noted that during the 100 year + 30% climate change flood event, the flood level at this location is 82.90m AOD. As the minimum site level at this location is approximately 83.25m AOD, this means that this flood event will not encroach upon the site and will be contained within the adjacent highway. Therefore, only flood events in exceedance of the 100 year + 30% climate change flood event will encroach upon the site at this location.

The only other opening in the existing and proposed masonry walls is the access road to the north–east of the proposed site. At this point the interpolated 1000 year flood level is 83.06m AOD and as can be seen from the proposed site plan, this flood level would only slightly encroach upon the site but would be contained within the proposed access road.

The 100 year + 30% climate change flood level has been interpolated as 82.91m AOD which would not encroach upon the existing site but be contained within the adjacent alleyway to the north of the site and fall away from the site to the crossroads between Shakespeare Street and Stockbridge Road, to the north.

Comparing the Environment Agency flood map with the existing masonry wall levels, it can be assumed that the flood map does not take into consideration the actual wall itself. Therefore, it
can be assumed that, as per the existing scenario, the existing masonry walls should retain the flood waters within the surrounding highways and direct the flood waters around the site, to the north.

However, should the existing masonry walls be breached, or overtopped during extreme flood events, the proposed site levels have been designed to ensure that the external ground levels shall fall away from the proposed residential units and directed towards the proposed access roads.

The site is deemed to have a medium risk of flooding from rivers but this does not account for the existing masonry walls which, as per the existing scenario should protect the site from flooding for events up to and including the 1000 year flood event. Therefore, accounting for the existing masonry walls and raised site levels outlined above, the flood risk from rivers to the proposed development can be considered to be low.

5.2 Flooding from the Sea
The site is not at risk of flooding from the sea. The lowest level of the site is approximately 83.20m AOD, i.e. well above tidal flood levels.

5.3 Flooding from Land
Intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems can run quickly off land and result in local flooding.

The Surface Water Flooding map is included in Appendix E. It can be seen from the map that the majority of the site is classified as having a very low to low risk of surface water flooding. Only small areas are classified as having a medium to high risk of surface water flooding. Comparing the topographic survey, in Appendix C, with the surface water flooding map it can be seen that the areas of medium to high risk are located at the base of the rubble mounds.

However, as a part of the new development, these mounds are to be removed and new surface water sewers are to be constructed. Therefore, the new surface water drains should collect the surface water runoff from the proposed development, therefore mitigating the surface water flood risk.

The ground levels on the proposed site are to be raised above the existing levels but will still maintain the existing masonry walls, as outlined in section 5.1. As such, any overland flows will be conveyed around the site via the existing highways and alleyways, as per the existing scenario. Finished floor levels of the proposed housing units should be set above external ground levels to protect against potential inundation from any possible overland flows.

The EA/NRW Historic Flood Map, located within Appendix G also indicates that there are no recorded historic flood events from local drainage/surface water within the site boundary.
As a result of the mitigation measures outlined above and no recorded historic flood events resulting from surface water, the proposed development is considered to be at low risk of flooding from surrounding land.

5.4 Flooding from Groundwater

As outlined in Section 2.2, the e3p, Preliminary Geo–Environmental Assessment Report, 11–360–L1, dated September 2016 indicates that groundwater was encountered in only one of the exploratory holes across the entire site. Due to the cohesive nature of the made ground and alluvium strata, the shallow groundwater encountered is likely to be perched water, with the actual groundwater table located at depth.

Also, the ESI groundwater flood data contained within the Envirocheck Flood Screening Report, attached in Appendix G, indicates that there is a negligible risk of groundwater flooding within the site area and the EA/NRW Historic Flood Map, also located within Appendix G indicates that there are no recorded historic flood events from groundwater/high water table within the site boundary. As such, the site is considered to be at low risk of flooding from groundwater.

5.5 Flooding from Sewers

A record of Public Sewers surrounding and serving the development site has been obtained from United Utilities and this is included in Appendix H.

As can be seen from the United Utilities map, there are a number of existing public sewers located within the immediate vicinity of the site and also two sewers crossing the proposed development site.

There is an existing 225mm diameter public combined water sewer which runs south to north along the alleyway between the back of the existing residential properties on Russell Terrace and the sites eastern boundary, prior to deviating west and running east to west in the alleyway between the sites northern boundary and the back of the existing residential properties on Shakespeare Street. The sewer then discharges into the existing 300mm diameter combined water sewer located on Shakespeare Street.

To the south of the site there is an existing 600mm diameter combined water sewer which runs east to west along Dryden Street. At the junction of Dryden Street and Abingdon Road the sewer deviates north through the proposed site prior to deviating west and exiting the site at the north–west corner. The sewer then passes onto Brook Street where it continues off to the west.

To the west of the site there is an existing 225mm diameter combined sewer which runs south to north along Albion Street. The sewer then deviates north–west at the junction of Alboin Street and Brook Street, prior to continuing in a north–westerly direction along Brook Street and discharging into the 600mm diameter combined water sewer at the junction of Brook Street and Wytham Street.

There is also a 600mm combined brick sewer which passes through the site. The sewer crosses Dryden Street in a north–westerly direction and continues in the same direction through the
southern boundary of the site. The sewer then continues through the site prior to exiting in the north-west corner and travelling along Brook Street.

United Utilities have been consulted regarding historic flood events from the existing sewers and have confirmed that the site is not at risk of flooding from overloaded sewers. The correspondence is attached in Appendix H and comes from the previous flood risk assessment completed for the site by LK Consult.

The EA/NRW Historic Flood Map, located within Appendix G indicates that there are no recorded historic flood events from local drainage/surface water, mechanical failures or obstruction blockages within the site boundary. Therefore, this coupled with the correspondence from United Utilities and the minimal risk of flooding from existing sewers, leads to the conclusion that the site itself is considered to be at low risk of flooding from sewers.

### 5.6 Flooding from Reservoirs, Canals and Other Artificial Sources

The Environment Agency Flood Reservoir Flood Risk map is included in Appendix E. It can be seen from the map that the site is not at risk of flooding from reservoirs. However, the JBA Canal Failure Map, located within Appendix G indicates that the site is at risk of flooding from canal failure. The nearest canal is the Leeds and Liverpool Canal, located approximately 1.1km south of the site.

As the sites levels are being raised and due to the fact that the water levels in canals are controlled makes the likelihood of canal flooding occurring low and therefore the site is considered to be at low risk of flooding from reservoirs, canals and other artificial sources.

### 6.0 DEVELOPMENT AND DRAINAGE STRATEGY

#### 6.1 Effect of Development on Flood Risk

As previously outlined in Section 2.0, the existing site covers a total area of 1.15ha and is currently a brownfield site with 100% impermeable area. Therefore, the introduction of the new garden and greenfield areas from the proposed development, will still lead to a decrease in impermeable areas.

Therefore, the changes to the existing site will decrease the volume of impermeable areas and as such, the proposed development will lead to an decrease in the:

- Volume of surface water ponding on the site
- Volume of surface water runoff leaving the site or discharging into surrounding areas
- Peak discharge rate from the site.
However, site-wide drainage systems are still required to drain the foul and surface water flows arising from the proposed development. Where possible, any existing drainage networks should be utilised. Appropriate design and construction of these systems as set out in Section 6.3 should ensure that there is no increase in offsite flood risk that would otherwise impact downstream areas.

### 6.2 Existing Drainage Systems

As can be seen from the United Utilities map, attached in Appendix H, there are a number of existing public sewers located within the immediate vicinity of the site and also two sewers crossing the proposed development site.

The details of the existing drainage systems within close vicinity of the site are outlined previously, in section 5.5.

It is envisaged that the two combined water sewers running through the site will be maintained with the required sewer easements put in place.

A number of existing connections from the site to the adjacent culvert/watercourse have been identified from both site walkover surveys and a CCTV survey of the existing culvert. The CCTV survey of the culvert indicates numerous connections from the proposed site along the entire length. The CCTV survey report and screenshots from the survey indicating the outfalls are attached in Appendix I.

There are also a number of images attached in Appendix I, from the site itself, which indicate manholes on the existing site which drain to the culvert and also outfalls from the site in the north-west corner direct to the open watercourse.

Due to the number of existing outfalls to the culvert/watercourse and the fact that during site walkover surveys a number of the outfalls where seen to be flowing, it is assumed that the site is classified as a brownfield site and can therefore apply the brownfield discharge rate to the proposed development.

### 6.3 Proposed Drainage Strategy

As outlined above in section 6.1, site-wide drainage systems are required to drain the foul and surface water flows arising from the proposed development. The proposed drainage systems must ensure that there is no increase in offsite flood risk that would otherwise impact downstream areas.

#### 6.3.1 Surface Water Drainage

The Building Regulations – Approved Document H (2002) details a hierarchy of potential methods for disposing of surface water as shown below in order of preference:

- Discharge via infiltration
- Discharge to watercourse
- Discharge to sewer
Considering the hierarchy above, the surface water network for the retained area of the existing site should infiltrate where possible.

As indicated in Section 2.1, e3p, Preliminary Geo-Environmental Assessment Report, 11-360-L1, dated September 2016 supports this information with exploratory hole records indicating strata comprising of made ground to depths of up to 3.0mbgl, underlain by drift deposits (gravelly clays) superficial deposits to depths of up to 15.0mbgl.

Therefore, as a result of the underlying strata, the e3p site investigation report recommends that infiltration drainage is not a viable option for the discharge of surface water. This is due to the potential for inundation settlement and also leaching of contaminants through the made ground as a result of infiltration systems and also the presence of low permeability clays across the site.

As the possibility of infiltration has been ruled out by the site investigation, the intention for the development would be to discharge to watercourse. As indicated in Section 5.1 the nearest watercourse is Green Brook, which is culverted through the proposed site. Therefore, the intention would be for the development to discharge to the culverted watercourse.

The drainage systems should be designed to suit the proposed site layout and topography which aims to provide an efficient design.

In line with Sewers for Adoption (6th Edition), the requirements for the design of a new surface water drainage systems are as follows:

- Below ground piped drainage to be sized to accommodate the 1 in 2 year (50% AEP) design storm without surcharge.
- System to be designed not to flood any part of the site in a 1 in 30 year (3% AEP) design storm.
- For events in exceedance of the 1 in 30 year design storm and up to and including the 1 in 100 year event, site drainage and topography should be designed where practicable to route surface water run–off away from buildings to safe above–ground storage areas on site, thereby preventing this run–off from leaving the site and increasing flood risk elsewhere.

For each design case described above, the design storm is the critical storm duration for the site conditions. In the case of the 1 in 100 year design storm, a 30% increase in the peak rainfall intensity is applied to allow for the estimated worst case impacts of climate change. This is in accordance with Table 5 of the Technical Guidance to the National Planning Policy Framework.

Suitable systems of below ground drainage will be required to contain as a minimum requirement, the 1 in 30 year event. Additionally, surface water run–off from events that exceed the design capacity of the new drainage system, up to and including the 1 in 100 year (+30%) event, will be retained on–site in safe storage areas.
As there are minimal car parking areas or other areas which would contribute to a substantial risk of contamination, it is envisaged that no measures to prevent oil and other contaminants being passed forward to the existing watercourse are required. Therefore, no oil separators or other appropriate pre-treatment methods have been included within the design of the surface water drainage system.

It is proposed that the surface water discharge from the proposed development should be designed to mimic that from the existing site.

Therefore, as previously discussed in section 6.2, the site is considered a brownfield site which is 100% impermeable. As such the requirements set out by the Environment Agency, see correspondence attached in Appendix E, indicates that the site should be restricted to the existing brownfield runoff from the 1 in 30 year rate, with a 30% reduction offered for betterment.

Therefore, the surface water drainage system is to be designed to restrict the discharge to the required rate, up to and including a 1 in 100 year return period plus 30% climate change design storm.

An assessment of the existing surface water run–off from the brownfield site was completed using a standard 3-pipe network in MicroDrainage.

As previously discussed the site is brownfield and 100% impermeable but as the existing buildings have been demolished it has been assumed that some of the runoff will not be conveyed into the existing drainage systems. Therefore, a conservative estimate of 65% of the site is currently drained properly by the existing drainage systems. As such, an area of 0.748ha (65% of total site area) has been used to calculate the existing brownfield runoff rate.

For the existing 1.15ha site, using an existing impermeable area of 0.748ha, an existing 1 in 30 year brownfield discharge rate of 204.0 L/s was generated. The brownfield runoff assessment is attached in Appendix J.

To comply with the Environment Agency requirements, a 30% reduction to offer improvement should be applied, therefore, the maximum surface water discharge rate for the site as a whole was assumed to be 142.8 L/s.

As can be seen from the outline drainage strategy drawing, attached in Appendix K, two separate surface water networks are proposed. The first draining the proposed site and access road to the east of the existing culvert and the second draining the small area to the west of the culvert.

Due to space restrictions, it is therefore proposed to allow the small area to the west of the culvert to drain freely into the existing culvert and restrict the discharge from the larger area to the east to ensure the maximum discharge from both networks totals 142.8 L/s, for storm events up to and including the 1 in 100 year return period plus 30% climate change design storm.
Therefore, for the small area to the west of the culvert, using a proposed impermeable area of 0.048ha, the proposed surface water discharge rate for 1 in 100 year return period plus 30% climate change design storm has been calculated as 21.0 L/s. The calculation is included within Appendix K. As such the site to the east should be restricted to a maximum surface water discharge rate of 121.8 L/s.

From the proposed site layout to the east of the culvert, a post development impermeable area of 0.513ha is indicated. Therefore, using this impermeable area, with the restricted discharge rate of 121.8 L/s for the 1 in 100 year + 30% return period design storm, a storage volume of 28.6m³ is required. The attenuation storage assessment is attached in Appendix J.

As shown on the outline drainage strategy drawing, attached in Appendix K, it is anticipated that the surface water drainage will collect the runoff from the proposed site areas and discharge it to the main drainage run along the proposed access road, where it will discharge to the existing culvert via a vortex flow control device.

The vortex flow control device will restrict the discharge to the required 121.8 L/s, with the attenuation storage, to contain the surcharged runoff, provided in the form of oversized pipes along the proposed access roads.

This surface water drainage proposal and discharge rate should be confirmed via discussions with the Lead Local Flood Authority and United Utilities prior to the commencement of any works.

Due to the invert levels of the existing Green Brook culvert, it is envisaged that the proposed surface water system will be discharged via gravity, with no need for pumping.

### 6.3.2 Foul Water Drainage

Foul water drainage disposal is set out in Part H of the Building Regulations in order of priority the preferred methods are:

1. Public sewer
2. Septic tank
3. Cesspool.

The foul water system shall be designed in accordance with:

- BS EN 752:2008 (Drain and sewer systems outside buildings)
- Sewers for Adoption (6th Edition)
- BS EN 12056-2:2000 (Drainage systems inside buildings)
As can be seen from the drainage strategy drawing, attached in Appendix K, it is envisaged that the foul water discharge from the proposed development will follow the surface water discharge. As per the surface water, there will be two foul networks, with the first draining the proposed site to the east of the existing culvert and the second draining the small area to the west of the culvert.

It is anticipated that the foul water drainage will collect the discharge from the proposed residential plots to the east of the culvert and discharge it to the main drainage run along the proposed access road, where it will discharge to the existing 600mm diameter United Utilities combined sewer which crosses the site.

The second foul water network draining the small area to the west of the culvert, is envisaged to collect the discharge from the proposed residential plots to the west of the culvert and discharge it to the existing 225mm diameter United Utilities combined sewer which runs along Alboin Street, to the west of the site.

It is assumed that the foul water discharges from both networks will be uncontrolled but the location and rate of discharge for the proposed foul sewers should be confirmed via discussions with the Lead Local Flood Authority and United Utilities prior to the commencement of any works.

Due to the anticipated invert levels of the existing United Utilities 600mm diameter combined water sewer running through the proposed site and the existing United Utilities 225mm diameter combined sewer on Alboin Street, it is envisaged that the proposed foul water systems will be discharged via gravity, with no need for pumping.

### 6.4 Managing Residual Flood Risk

The mitigation measures identified previously, in Section 5.0 ensure that the risk of flooding to the proposed development is not only minimised but also mitigated to an acceptable level.

As can be seen from the Environment Agency flood map, attached in Appendix E, the adjacent highway to the north–east of the site is located within Flood Zone 1 and therefore it is envisaged that should it be required access and egress to the site will be achievable during the extreme 1 in 1000 year flood event.

There is a finite risk that the design flood conditions required by current design standards are exceeded by an extreme and rare event. However, with the design and mitigation measures reported such a risk is low and the exceedance flow path routes required to channel flows around the development buildings will be such that no additional flood risk mitigation measures are envisaged to be necessary.
7.0 CONCLUSIONS

- The flood levels along the site have been interpolated using the flood levels provided by the Environment Agency. The flood levels have then been compared to the lowest proposed site levels and finished floor levels at each section and as such has confirmed that the proposed levels are in compliance with the Environment Agency’s vulnerable developments Standing Advice (+600mm FFL above 1 in 100 year + climate change flood level).

- As the proposed development complies with the Environment Agency’s vulnerable developments Standing Advice and will also make good the existing masonry walls surrounding the site, it can be considered to have a low probability of flooding from rivers.

- The site is at a low risk of flooding from surface water and other sources.

- The identified strata indicated that infiltration SUDS techniques are not feasible and therefore surface water discharge from the proposed site should discharge to Green Brook culvert, which passes through the site.

- Even though the site is brownfield and 100% impermeable, the existing buildings have been demolished and therefore a conservative estimate of 65% of the runoff from the site being conveyed into the existing drainage systems has been used.

- The surface water discharge is to be restricted to 142.8 L/s during the 100 year plus 30% climate change design storm. This is the 1 in 30 year brownfield runoff rate with a 30% reduction to offer betterment, as per the Environment Agency requirements. Discussions with the Lead Local Flood Authority and United Utilities should be completed to ensure agreement of this figure and the overall approach.

- Foul water discharge from the proposed site should discharge to the existing United Utilities 600mm diameter combined water sewer which runs through the proposed site and also to the existing 225mm diameter United Utilities combined sewer which runs along Alboin Street, to the west of the site. Discussions with the Lead Local Flood Authority and United Utilities should be completed to ensure agreement of the foul water discharge rate and the overall approach.

8.0 RECOMMENDATIONS

- Oversized pipes and a flow control device should be utilised to ensure surface water flows are limited to the specified discharge rate.

- The external ground levels around proposed residential units shall fall away from the proposed residential buildings with any new levels being designed to ensure any overland flood routes, for events in excess of the 100 Year + 30% CC, exit towards the surrounding highways, for use in exceptional circumstances.
Appendix A  Site Location Plan
Appendix B  Aerial Photograph
Appendix D  Proposed Site Plan
Appendix E  Flood Risk Maps & EA Correspondence
Appendix F  Design Flood Levels Sketch
Appendix G  Envirocheck Flood Screening Report
Appendix H  United Utilities Sewer Records & Correspondence
Appendix I  CCTV Survey Report & Images
Appendix J  Brownfield Runoff & Attenuation Storage Assessments
Appendix K  Outline Drainage Strategy Drawing & Calculations