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Report on

SALTBOX SITE – BOGNOR REGIS

FLOOD RISK ASSESSMENT

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Revision History

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1. Executive Summary

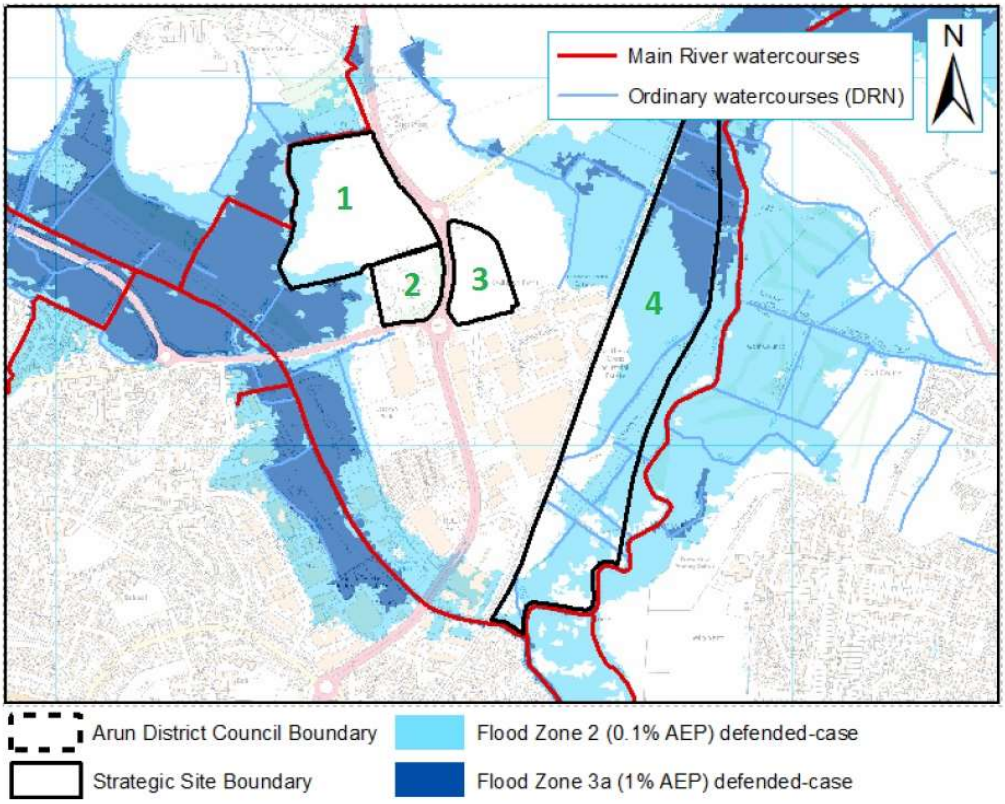
Kirksaunders (KSA) has been commissioned by Landlink Estates to undertake a site-specific Flood Risk Assessment (FRA) for the proposed Saltbox site development north of Bognor Regis.

Enterprise Bognor Regis is a 70 hectare commercial and employment development opportunity located on the northern edge of Bognor Regis in West Sussex.

It comprises four adjoining sites that can support a mix of business accommodation for advanced manufacturing, warehousing, offices and small business/studio units (B1, B2 & B8 uses). The development parcels are listed as follows:

1. Salt Box
2. Rowan Caravan Park
3. Oldlands Farm
4. Airfield Park

Table 1: Flood Zones Map (Present Day) with Enterprise Bognor Regis Parcels Illustrated.



This FRA relates to the Saltbox parcel only, listed above as parcel number 1 on figure 1.

Full planning permission is sought for the Phase 1 development of 6.492 hectares of employment space (B1, B2 and B8) with associated parking, landscaping and public open space. In addition, outline planning permission is sought for the Phase 2 development of 5.512 hectares for additional

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employment units, warehousing, hotel, drive thru's, public house, gym and associated works. Based on Table 2 (Flood Risk Vulnerability Classification) of the NPPF Planning Practice Guide, the Proposed Development is classified as 'Less Vulnerable'.

The site is located within Flood Zones 1, 2 and 3. However coastal flood defences protect the site from tidal flooding up to the 0.5% (1 in 200 year) annual probability event and the modelled level of flood risk from fluvial sources is less than 1% (1 in 100 year) annual probability to all built development. As all built development is effectively in Flood Zones 1 or 2 the Proposed Development is considered appropriate development in accordance with Table 3 of the NPPF Technical Guidance.

Flood risk to and arising from the Proposed Development has been classified as low to negligible and the proposed buildings are located outside all areas of higher risk.

A drainage strategy has been prepared to support the Proposed Development through the planning process. The strategy demonstrates the Proposed Development can comply with the requirements of the NPPF and does not increase flood risk either to or from the Proposed Development.

This FRA demonstrates that the Proposed Development site can be drained in a sustainable manner through attenuation and infiltration and that the development is not at flood risk from all sources and will not increase flood risk to other parties.

This FRA has been reissued in September 2017 to revision P4, to take account of the updated Strategic Flood Risk Assessment (SFRA) and main modification version of the local plan.

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2. Planning Policy

2.1 National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) provides a clear and concise framework to ensure sustainability through planning and development. The framework sets out the Government's expectations as to how planning policies should be applied. The NPPF replaces previous Guidance and Policy set out in PPS25:- Development and Flood Risk.

The NPPF identifies flood risk as a specific material consideration in Section 10; "Meeting the challenge of climate change, flooding and coastal change" which provides guidance in determining planning applications whilst reducing the current and future threats of flood risk.

As outlined in the NPPF, a Flood Risk Assessment is generally required for any site which is designated as being within Flood Zone 2 and Flood Zone 3, including minor developments or changes in use. FRA's are required within Flood Zone 1 areas for development over 1 hectare; or less than 1 hectare but may be affected by sources of flooding other than rivers and sea and for sites which may encounter critical drainage problems as notified by the Environment Agency.

There are four levels to the designated Flood Zones, with Zone 1 being the 'least risk' and Zone 3b being a functional floodplain. The Flood Zones are defined as follows:

- Flood Zone 1 has a low risk of flooding having a less than 1 in 1,000 annual probability of river or sea flooding.
- Flood Zone 2 has a moderate risk of flooding with land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
- A Flood Zone 3A has high risk of flooding with a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea in any year.
- Flood Zone 3B is land considered to act as functional flood plain

The above criteria does not account for any previous flood defences, unless otherwise stated, and estimate current levels of risk not taking into account future uncertainties of climate change.

The NPPF builds on previous legislation to empower Local Authorities in implementing suitable plans to mitigate flood risk. The NPPF expects Local Authorities to adopt a risk-based approach at all levels of planning by applying the 'Source – Pathway – Receptor' model to development in flood-susceptible areas.

Local Plans are guided by the NPPF and should account for the future uncertainty of climate change and avoid development in areas which are vulnerable to flooding. Unavoidable development in flood risk zones must undergo a Sequential Test to assess the extent of flood risk, followed by an Exception test to demonstrate that the site has wider sustainable benefits that outweigh flood risk, that the site is previously developed land and that the development will be safe for the lifetime of the development.

Local Plans should be supported by a Strategic Flood Risk Assessment to develop policies which involve contributions from all stakeholders such as the Environment Agency and other statutory bodies.

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2.2 The Water Resources Act 1991

The Water Resources Act 1991 (Section 105) also requires the Environment Agency to exercise a general supervision over all flood defence matters, including flood plains and washlands which accommodate waters during periods of flood. The Environment Agency is a statutory consultee in the planning process, providing current information on Flood Risk Maps. The EA are able to define the extent of the flood plain that is under threat from flood risk.

2.3 Further Guidance

Further Guidance from CIRIA publication 'C624 Development and Flood Risk Guidance for the Construction Industry'[1] define three levels of FRA which can be undertaken:

FRA Level	Description/Scope
Level 1	**Screening Study** to identify whether there is any flooding or surface water management issues related to a development site that may warrant further consideration. This should be based on readily available existing information, including the SFRA, Environment Agency Flood Map and Standing Advice. The Screening Study will ascertain whether a FRA is required.
Level 2	**Scoping Study** to be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding or that the site may increase flood risk due to increased run-off. This Study should confirm the sources of flooding which may affect the site and should include the following: - an appraisal of the availability and adequacy of existing information; - a qualitative appraisal of the flood risk posed to the site, and potential impact of the development on flood risk elsewhere; - an appraisal of the scope of possible measures to reduce the flood risk to acceptable levels. The Scoping Study may identify that sufficient quantitative information is already available to complete a FRA appropriate to the scale and nature of the development.
Level 3	**Detailed Study** to be undertaken if the Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. The Study should include: - quantitative appraisal of the potential flood risk to the development; - quantitative appraisal of the potential impact of development site on flood risk elsewhere;

[1] CIRIA Publication: *C624 Development and Flood Risk – Guidance for Construction Industry*, 2004

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	- quantitative demonstration of the effectiveness of any proposed mitigation measures.

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3. Local Planning Policy

3.1 Updated Strategic Flood Risk Assessment (SFRA) for Arun District Council

This work was commissioned to update the Strategic Flood Risk Assessment for the District outside of the National Park. This was necessary to support decisions around Main Modifications to the Arun Local Plan 2011-2031 during the period of suspension during the examination process. The SFRA Level 1 published in August 2016 and also a hybrid report incorporating Levels 1 & 2. The hybrid report sets out the current situation regarding flooding from differing sources across the District, supported by Appendices A - I, followed by a broad assessment of strategic sites/locations being considered by the Local Plan with more detailed assessments of the flood risk for each, contained in Appendix J, which the Bognor enterprise zone is included from pages 25 – 34.

3.2 General Summary of SFRA Recommendations

3.2.1 Site allocations

It is recommended that the outputs from this study are used as an evidence base for the allocation of potential development areas, directing new development to areas of lowest risk. The Council should use the information provided within this SFRA to apply the Sequential Test to their potential site allocations.

The Level 2 detailed site summary tables provided in Appendix A should be used by the Council to apply the Exception Test. In order to pass the Exception Test, a number of criteria will need to be met:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk;
- It must be demonstrated that the development will be safe, without increasing flood risk elsewhere, and where possible, reduce flood risk overall;
- These tables also provide information and guidance for developers at the detailed flood risk assessment and planning application stage.

3.3 Policy

3.3.1 Future development

The Council should consult the Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', published in March 2014, when reviewing planning applications for proposed developments at risk of flooding. Planning permission for development affecting watercourses should normally only be granted where

- the natural watercourse system which provides drainage of land is not adversely affected;
- a minimum 8m width access strip is provided adjacent to the top of both banks of any Main River (5m for Ordinary Watercourses) for maintenance purposes and is appropriately landscaped for open space and biodiversity benefits;
- it would not result in the loss of open water features through draining, culverting or enclosure by other means and culverts are opened up where ever possible;
- surface water drainage is delivered by SuDS;

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- betterment in the surface water runoff regime is achieved; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk; and
- the application is compliant with the conditions set out by the Lead Local Flood Authority (LLFA).

At the planning application stage, developers need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent, inform development zoning within the site and prove, if required, whether the Sequential and Exception Tests can be satisfied. The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk.

3.3.2 Surface water management

Planners should be aware of the conditions set by the LLFA for surface water management so that development proposals and applications are compliant with the Council's policy. These policies should also be incorporated into the Local Plan.

3.3.3 Infrastructure and Access

Safe access and egress will need to be demonstrated at development sites. Consideration of alternative access and egress routes should be made in the event that primary routes are inundated with flood water. Resilience measures will be required if buildings are situated in the flood risk area, and opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought.

3.3.4 Green Infrastructure and WFD

Opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought. In addition, opportunities where it may be possible to improve the WFD status of watercourses, for example by opening up culverts, weir removal, and river restoration, should be considered. Green infrastructure should be considered within the mitigation measures for surface water runoff from development.

3.3.5 Strategic solutions

The information provided in the SFRA should be used as a base for investigating potential strategic flood risk solutions within Arun District. Opportunities to incorporate strategic flood risk solutions, such as storage areas, defences, land raising and attenuation ponds should be investigated as part of potential development proposals.

3.3.6 Assessing Flood Risk and Developments

- The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within the district;

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- A site-specific FRA is required for all developments which are located in the Environment Agency's Flood Zones 2 and 3, or developments greater than 1ha in size in Flood Zone 1. They are also required for developments less than 1ha in Flood Zone 1 where there is a change in use to a more vulnerable development where they could be affected by sources of flooding other than rivers and the sea (e.g. surface water drains, reservoirs). All developments located in areas of Flood Zone 1 highlighted as having critical drainage problems must also be accompanied by an FRA. The FRA should be proportionate to the degree of flood risk, as well as the scale, nature and location of the development;
- It is recommended that the impact of climate change to a proposed site is considered in FRAs and that the percentage increases which relate to the proposed lifetime of the development and the vulnerability classification of the development is identified and taken into account. The Environment Agency and LLFA should be consulted to confirm a suitable approach to climate change in light of the latest guidance;
- Arun District Council, the Environment Agency and LLFA should be consulted to confirm the level of assessment required and to provide any information on any known local issues;
- When assessing sites not identified in the Local Plan (windfall sites), developers should use evidence provided in this SFRA to apply the Sequential Test as well as provide evidence to show that they have adequately considered other reasonably available sites.

3.3.7 Promotion of SuDS

Planners should be aware of the conditions set by the LLFA for surface water management so that development proposals and applications are compliant with the Council's policy. These policies should also be incorporated into the Local Plan.

- A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. New or re-development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff.
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough to allow for SuDS techniques that are designed to encourage infiltration;
- 2016s3756 - Arun District Council Level 1 and Level 2 SFRA - Final Report (v5 November 2016).docx 115;
- Where sites lie within or close to Groundwater Source Protection Zones or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Further guidance can be found in the CIRIA SuDS manual on the level of water quality treatment required for drainage via infiltration. Further restrictions may still be applicable and guidance should be sought from the LLFA;
- Developers need to ensure that new development does not increase the surface water runoff rate from the site and should therefore contact the LLFA and other key stakeholders at an early stage to ensure surface water management is undertaken and that SuDS are promoted and implemented, designed to overcome site-specific constraints;
- In coastal areas consideration should be given to increased volumes of discharge from new development particularly in areas where discharges are affected by tide levels. The effect of changes to mean sea level as a consequence of climate change must also be taken into account;

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- Arun District Council will need to consider drainage schemes for major applications, but it is advised developers utilise the LLFA's Polices and Guidance to develop their drainage scheme for minor applications.

3.3.8 Use of SFRA data and future updates

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated information is available prior to commencing a detailed Flood Risk Assessment.

The SFRA should be periodically updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. New information on flood risk may be provided by Arun District Council, the Highways Authority, West Sussex County Council, Southern Water and the Environment Agency. It is recommended that the SFRA is reviewed internally on an annual basis, allowing a cycle of review, by checking with the above bodies for any new information to allow a periodic update.

3.3.9 Note on the Environment Agency Flood Map for Planning

Where outlines are not informed by detailed hydraulic modelling, the Flood Map for Planning is based on generalised modelling to provide an indication of flood risk. Whilst the generalised modelling is generally accurate on a large scale, they are not provided for specific sites or for land where the catchment of the watercourse falls below 3km2. For this reason, the Flood Map for Planning may not be of an appropriate resolution to be used as application evidence, where details are material with respect to possible flooding for individual properties or sites and for any sites with watercourses on, or adjacent to the site. Accordingly, for site specific assessments it may be necessary to perform more detailed studies in circumstances where flood risk is an issue.

3.3.10 Implications of potential future development

It is noted in the SFRA that developers should ensure that third party property and land are not adversely affected by future development, both in terms of flood risk and other environmental factors (e.g. water quality and ecology). Future development at this site may have potential to influence the following receptors:

- Property and land located in the adjacent areas of Shripney, South Bersted
- Industrial Estate and Felpham;
- The Lidsey Rife, Shripney Manor Ditch and ordinary watercourses flowing
- through the site boundary;
- Settlements downstream of these watercourses, such as North Bersted, Felpham and Bognor Regis.

3.4 Sequential and Exception Test

3.4.1 Sequential Test (General)

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The NPPF 2012 requires a Sequential Approach to ensure preference is given to land within Flood Zone 1 prior to Flood Zones 2 and 3. It also ensures that flood vulnerability of the development proposals is taken into consideration when locating development in Flood Zones 2 and 3.

3.4.2 Sequential Test (Specific to the Bognor Enterprise Zone) Background

During the suspension period of the Arun Local Plan 2011-2031 examination, further work relating to flood risk was done. As a result of this and due to challenge over the content of the 2014 submitted document, a new document was produced to inform Main Modifications. This reflects the latest information from the new evidence documents, such as any changes to flood extents and as much detail as possible regarding expected delivery. This document is titled 'Arun Sequential and Exception test to inform Main Modifications', February 2017.

The opportunity was taken during the examination suspension period of the Local Plan to update and undertake a number of further evidence documents to support the local plan. It is understood that the following directly related to flood risk and have informed the content of this document:

- Arun DC (June 2016). Littlehampton Economic Growth Area (LEGA) Development Delivery Study Arun DC (Aug. 2016);
- Level 1 Strategic Flood Risk Assessment (SFRA);
- Arun DC (Sept. 2016). Level 2 Strategic Flood Risk Assessment; and
- Arun DC (Oct. 2016). Strategic Surface Water Management Study (SSWMS).

3.4.3 Sequential Test (Specific to the Bognor Enterprise Zone) Details

Following the screening process, a total of 12 sites have been identified as potentially suitable, to be taken forward for consideration within the Sequential Test, to inform the Main Modifications of the local plan, of which the Bognor Enterprise Zone was one, and hence the Salt Box Parcel was included.

The majority of the Bognor Enterprise Zone flooding, occurs outside our Saltbox development boundary, with the exception of the western boundary, which is located outside the area of proposed buildings.

Does this pass the Sequential Test? No. The site is intended for employment ('Less Vulnerable'), the hotel and pub ('More Vunerable') and is considered suitable for development are all development is located outside areas of Flood Zone 3a. However, the site is indicated to suffer from more than one form of flooding, which requires further consideration.

Exception Test Required? Yes. Consideration is needed to ensure the continued safety of the sites and their users from flooding throughout the development lifetime, with no consequent increase in flood risk downstream arising from development proposals. Upgrade if the flood defences serving the LEC Airfield site would be required before this site could be developed.

3.4.4 Exception Test (General)

The Exception test is a method to demonstrate and help ensure that the flood risk will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites with

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lower flood risks are not available. For the Exception Test to be passed, the following must be demonstrated:

- The development provides sustainability benefits to the community that outweigh the flood risk, informed by the SFRA if applicable;
- A FRA must establish that the development will be safe, without increasing the flood risk on site or elsewhere, and where possible will reduce the overall flood risk.

As stated above the NPPF paragraph 104 states that "For individual developments on sites allocated in development plans through the Sequential Test, applicants need not apply the Sequential Test.
The advice regarding flooding matters in the NPPF is supplemented by additional guidance in the National Planning Policy Guidance (NPPG). Table 3 sets out the Flood Risk Vulnerability and Flood Zone "Compatibility". Outdoor sports and recreation is defined within the Water-Compatible Development classification and car parking is defined as Less Vulnerable Development. According to Table 3 such use classifications are acceptable within a Flood Zone 2 and 3 provided that the Sequential Test is passed. (There is no requirement to pass the Exception Test).

The normal approach for a Sequential Test is to demonstrate that there are no sequentially preferable "reasonably available" sites at a lower flood risk (i.e. in flood Zone 1 or 2) within a defined area. Such an approach is feasible when there are realistic available options to site a new development in alternative locations.

3.4.5 Exception Test (Specific to the Bognor Enterprise Zone)

The Bognor Enterprise Zone was assessed for the Western Site, which the Saltbox parcel was included. See figure 2 below for an extract of the Arun Sequential and Exception test to inform Main Modifications.

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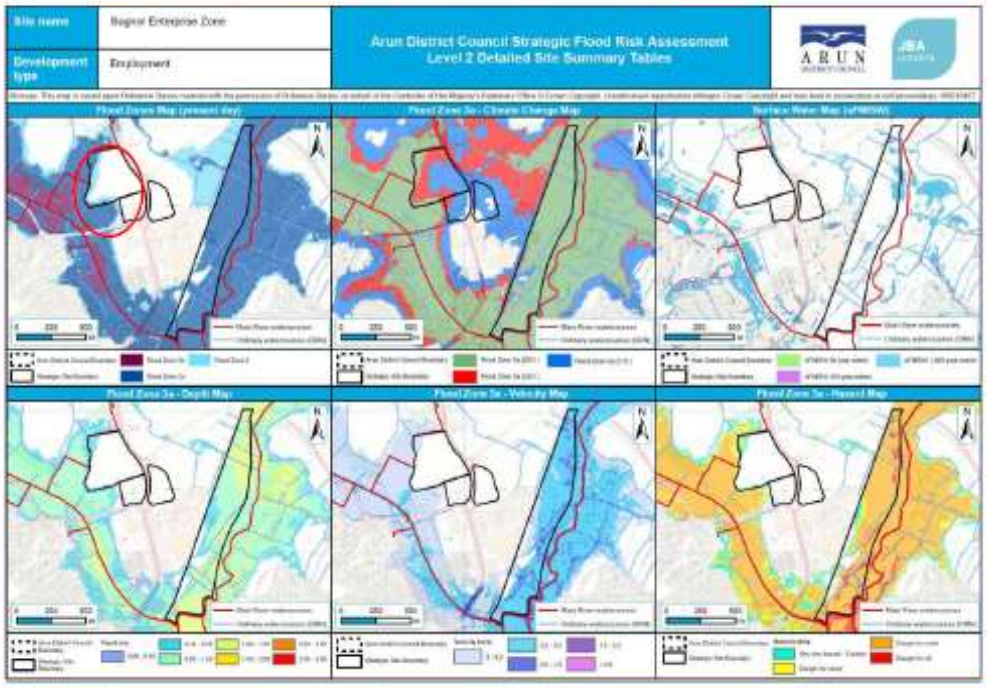
Table 2: Extract of the Arun Sequential and Exception test to inform Main Modifications

Bognor Enterprise Zone (Western Sites – Salt Box / Rowan Park)



Size and Use	14.9ha	Employment		
Development Lifetime	50-100 Years			
Are there any alternate sites in a lower risk flood zone?	No, all alternates have gone through the sequential test or are contained within this Exception Test. No other sites of a comparable size were available for these uses.			
Proportion of site in Flood Zone 3	Present	2031	2061	2111
	8%	14%	51%	96%
Proportion of site in Flood Zone 2	6%			

Flood Mechanisms

Although flood defences are present, which generally protect the sites from fluvial and tidal flooding now and in the future (2111), some minor ingress is seen on the north western boundary associated with the Aldingbourne Rife. Flood maps from Appendix J of the Level 2 SFRA indicate low flow velocities (0.0-0.2m/s) and flood depths (0.1m-0.5m).

Surface water flooding is indicated to be low, although is noted to contribute to flooding within the adjacent watercourses.

Groundwater flooding is noted within the site, although no data is available with which to quantify this.

Design Considerations (on-site)

- Strategic level flood risk management measures are proposed in the northern section of the Salt Box site to free up development land within the area. This should be accounted for within

the development masterplan.

- Masterplanning to apply a site level sequential approach locating development in areas at least risk of flooding.
- Based on consideration of the defended flood outlines it is unlikely that impacts to floodplain storage will arise from development, although this should be fully assessed with floodplain compensation provided where required.
- Flood proof measures to be incorporated within the development design, including:
  - Setting of finished floor levels / entry points for services; and
  - Flood resilience measures.
- A commitment must be made to the long term management, maintenance and upgrade of flood defences serving the site, including contributions to tidal defences.
- Residual flood risks to the site should be fully assessed, including the impacts of overtopping and breach or failure of flood defences.
- Emergency response requirements to be fully assessed through the production of a Flood Management Plan.
- Significant surface water storage and water quality treatment requirements linked to potentially contaminating nature of site use. Source control measures are recommended including green roofs, lined permeable paving, rain gardens and swales. Oil separators to be specified where required. Further assessment required to ensure feasibility of delivery outside of the floodplain.
- Groundwater and percolation monitoring is required to inform the effective design of surface water attenuation / SuDS measures and determine the feasibility of infiltration methods for surface water disposal. Refer to *General Recommendations*.
- SuDS / surface water storage / flow conveyance measures may require lining to prevent groundwater emergence and to address water quality issues associated with underlying contaminated soils.
- SuDS measures should be situated remote from the Rifes / watercourses to maximise performance.
- Peak flows and downstream tidal locking within adjacent watercourses should be considered when designing site drainage and attenuation.
- Drainage arrangements to include exceedance pathways for overland flow.
- Opportunities to reduce discharges from the site and improve flood risk within the wider catchment to be fully investigated, including creating space for flooding and the use of SuDS (e.g. green roofs, water butts).
- Green corridors to be established through daylighting of culverts / naturalisation of watercourses, to reduce sedimentation and increase fluvial storage and conveyance capacity, subject to EA / LLFA approval.
- A site specific Flood Risk Assessment should be completed which considers the potential sources of flooding (including climate change), the associated hazard and required flood mitigation measures, safe access and egress, and the flood risk from ordinary watercourses, which may not be captured within the flood zone maps.

Refer also to *General Recommendations* section at rear of report which expands on the points noted above.

Design Considerations (off-site)

- Off Site SuDS measures are recommended including formalising the floodplain on the Lidsey Rife to provide additional flood storage.
- Introduction of lowered areas, ponds or reed beds within the Bersted Brooks nature reserve to

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increase flood storage and enhance wildlife. ▪ Aldingbourne Rife Integrated Flood Risk Management and Works (ARIFRM) study is due to be published in spring 2017. This may have implications for consideration of flood risk at the site. ▪ Upgrade of the Waste Water Treatment Works	
Expected Delivery	Developers
SA Conclusions	
The site is of sufficient scale to provide significant opportunities for employment. It is in a strategically advantageous position as it is within close proximity to residential settlements (South Bersted, North Bersted, Bognor Regis), and public transport alternatives. Development of the site will contribute to the regeneration of Bognor Regis and would improve efficiency in land use as the site contains some elements of previously developed land. The site contains areas at high risk from flooding (Flood Zone 3). However, the site is allocated for employment land, which is considered a 'less vulnerable' use, and which is considered appropriate within Flood Zone 3. This is subject to demonstration (via a site specific FRA) that flood mitigation can be achieved which ensures the safety of the development from flooding throughout its lifetime and which will not increase flood risk to other areas. The design of the development should also incorporate improvements to mitigate the impacts on the transport network and the landscape. Delivery of the site may be affected by the timing schedule for the upgrade of the Lidsey WWTW.	
Exception Test Conclusions	It is considered that the flood risks identified within the site can be appropriately managed through the incorporation of flood mitigation and resilient design. It is recommended that groundwater monitoring be undertaken at the earliest opportunity to establish areas of the site at greatest risk and to inform the site masterplan and drainage design arrangements. Proposed surface water management measures and funding for sewer network upgrades would have a beneficial impact on flooding within the wider district, including the Bognor Enterprise Zone, downstream.
Compliance for Allocation	Yes

3.4.6 Exception text conclusion and general requirements

Following application of the Exception test it can be demonstrated that the Saltbox site is considered to provide wider sustainability benefits to the community that outweigh flood risk. It has also been demonstrated that, where required, flood mitigation and management measures can be employed which will ensure the safety of the proposed strategic sites throughout their anticipated lifetime and which, in many instances, reduce the flood risk within the wider community.

The Arun District catchment is predominated by elevated groundwater and tidally influenced watercourses, both of which affect the management of flood risk. The district is also characterised by rural and coastal areas, many of which carry an environmental designation.

As a result of these factors there are a number of specific requirements which should be applied across all strategic sites and which are outlined below. These are in addition to the site-specific recommendations sited throughout the report. NB, not been tailored for this FRA.

- Groundwater monitoring and percolation testing during the winter period is required to determine the feasibility of infiltration methods for the disposal of surface water runoff. A minimum monitoring period of 6 months is recommended to capture the influence of significant storm activity and seasonal variation on groundwater elevation.

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- The main constraint to the delivery of surface water management across the district is high groundwater, which prevents the use of deep infiltration measures such as soakaways. Attenuation measures have therefore been recommended as the main storage component for strategic sites, storing surface water and discharging to local watercourses at controlled rates.
- Flood conveyance and attenuation storage measures may require the installation of impermeable liners to prevent the ingress of groundwater and to achieve the required level of flood storage.
- Many of the catchment areas exhibit low topographical relief, with difficulty in achieving gravitational drainage using traditional piped networks. For most sites, it is therefore recommended that swales or permeable paving be installed as the primary method of flow conveyance.
- Local watercourses also exhibit shallow gradients leading to slow flows and sedimentation. Where possible development should remediate these watercourses, incorporating a two-stage channel, comprising a narrow lower channel to increase the velocities of normal flows, with a stepped overflow capacity to accommodate runoff from storm activity. This will be subject to EA / LLFA approval.
- Many of the district's main rivers and coastal outfalls are tidally affected, as a result surface water cannot always freely drain. This needs to be considered within the design of surface water management measures specified for sites.
- SuDS measures should be incorporated throughout sites as close as possible to the source of runoff, to promote infiltration at source and reduce off-site discharges of surface water. Site drainage should follow the SuDS hierarchy considering infiltration, harvesting, slowing, storage, conveying and treatment on site where possible; controlled discharge to watercourse, and as a final option restricted discharge to surface water sewers.
- Opportunities for amenity and ecological enhancement should be promoted wherever possible. This includes the opening of culverted watercourses, input of additional swales, and naturalisation of watercourses, wherever possible, to increase the presence green infrastructure throughout the district.
- A site-specific Flood Risk Assessment should be completed which considers the potential sources of flooding (including climate change), the associated hazard and required flood mitigation measures, safe access and egress, and the flood risk from ordinary watercourses, which is not included within the indicative flood maps.

3.4.7 Arun Strategic Surface Water Management Study Stage 2 Report August 2016

The Enterprise Bognor Regis as a whole, is a site designated for industrial units and is within both tidal and fluvial flood zones 2 and 3. Due to the high percentage of impermeable area and the industrial use of the site, storage at source and pollution control is particularly important for the surface water management.

Green roofs are recommended across the site to capture the first occurrence of rainfall. Lined permeable paving is also recommended to both capture, store and convey surface water flow. Additional storage could be provided in the form of rain gardens or swales throughout the site. Downpipes from the green roofs could connect directly into the swales, instead of using deep pipework.

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Due to the large amount of hardstanding and industrial use of the site, there is a risk of pollution to surface water, typically from oil spills from vehicles. The site will require pollution prevention measures under the Environment Agency's Pollution Prevention Guidelines (PPG3). Oil interceptors are often used for removing oil from surface water; however, the SuDS measures recommended can provide this function without the need for underground tanks. The granular subbase of the permeable paving acts to filter oil from surface water. Additionally, a geotextile membrane designed to remove hydrocarbons can be installed within the subbase of the paving. Tree pits could also be incorporated to provide surface water treatment through filtration and phytoremediation.

3.4.8 Arun Strategic Surface Water Management Study Stage 2 Report August 2016. Additional supporting information 'Record of meeting/discussion 11/05/16 (Section 1.2 relating to the meeting minutes Bognor Enterprise Zone)';

- Area highlighted on plan as a potential surface water management area is already a flood compensation area. Various issues due to water not draining – assume this is resolved for the purposes of this study;
- Potential to increase area;
- Standing water issues with flood tunnels and adjacent service road adjacent to the Oldlands Farm site need to be resolved;
- Tesco's car park is designed to flood regularly;
- Proposed impermeable area less than previously suggested. Potential for more natural SuDs features;
- Potential to utilise excavated material from flood compensation areas;
- To raise land (out of floodplain) on Enterprise site. Alternatively raise units above flood level, or design to allow flooding.
- Culverts under railway line – may need additional culverts for drainage;
- Network Rail to be involved';
- The Brooks - confirm ownership and look to extend beyond the Arun district boundary;
- A29 realignment could potentially affect site;
- ADC to confirm the Bognor golf course development proposals;
- Potential SuDS opportunities;
- Aldingbourne Rife project currently undertaken by EA has additional information on reducing flood risk within the area;
- Close public consultation will be required with Shripney Village.

Note, not all of the items listed above relate specifically to the Saltbox application.

3.4.9 Implications of the Environment Agency's FCERM programme (extract taken from Appendix J of the Arun SFRA Update)

There are several FCERM schemes that cover different parts of Arun District. It is recommended that the outcomes and actions from these schemes are considered in the development proposals for this site. The FCERM schemes relevant to the Bognor Enterprise Zone as a whole include:

- Lidsey Surface Water Management Plan (SWMP) and Actions – the scheme was managed by West Sussex County Council, and the SWMP was published in October 2014 to help understand

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the flood risk from local sources and establish a long-term action plan for surface water management;

- Aldingbourne Rife Integrated Flood Risk Management Project – the project is investigating approaches in which flood risk from combined sources can be managed within the Aldingbourne Rife catchment. The project is managed by the Environment Agency;
- Arun Partnership Watercourse Management – extensive capitalised improvement work is planned in order to improve the condition of the assets throughout the District and contribute to recommendations of the local strategies currently being prepared. This scheme is managed by Arun District Council and is expected to commence between 2016 and 2018.

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4. Scope of Flood Risk Assessment

4.1 General

The detail and complexity of a Flood Risk Assessment should reflect the level of risk to the site. The NPPF lists the general requirements of a Flood Risk Assessment and provides that Flood Risk Assessments should:

- be proportionate to the risk and appropriate to the scale, nature, and location of the site;
- consider the risk of flooding arising from development in addition to the risk of flooding to the site;
- take the impacts of climate change into account;
- consider both the potential adverse and beneficial effects of flood risk management infrastructure including raised defences, flow channels, flood storage areas and other artificial features together with the consequences of their failure;
- consider the vulnerability of those that could occupy and use the site, taking account of the Sequential and Exception Tests and the vulnerability, including arrangements for safe access;
- consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and identify flood risk reduction measures, so that assessments are fit for the purpose of the decisions being made;
- consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes;
- include the assessment of the remaining (known as 'residual') after risk reduction measures have been considered and demonstrate that this is acceptable for the particular development or land use;
- consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of development may affect drainage systems; and
- be supported by appropriate data and information, including historical information on previous events.

4.2 Sources of Flooding

Based on the CIRIA Report 624, Table A2, and as shown above, the following potential sources of flooding could be considered to apply to the site:

- Fluvial – Flooding as a result of rising water levels in nearby river;
- Overland Flow – Flooding as a result of overland surface water run-off from higher ground; and
- Infrastructure Failure – Flooding as a result of failure of infrastructure designated to store or carry water or pipe blockage.

4.3 Site Overview

Flood risk at the site is generally low from rivers, the sea and intense rainfall (surface water flooding).

Groundwater flooding may also be likely, with the available datasets showing the entire site to be located within a 1km grid square where between 25-50% of the 1km2 area may be susceptible to groundwater flooding.

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It is acknowledged that additional site investigation will be completed to confirm the exact depth of ground water across the site. The monitoring should be completed over a worst case seasonal scenario, and depths should be plotted over the proposed site plan and co-ordinated with the finished site levels.

A small proportion of the Saltbox site is located in Flood Zone 3a, meaning that it has greater than 1% and 0.5% annual probability of flooding from the Rivers and Sea respectively. Much of the land in Flood Zone 3a is located across western-most boundary of the Saltbox parcel of the site.

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5. Flood Risk Assessment

5.1 General Requirements for the Site-Specific Flood Risk Assessment

- The peak flows of the Lidsey Rife and the Shripney Manor Ditch, and potential flooding of the site, should be considered when designing site drainage and attenuation;
- Assessment of runoff should include allowances for climate change effects, and discharge rates from the site should not increase downstream;
- Safe access and egress would need to be demonstrated. This should include consideration of the effects of climate change to ensure that access and egress remains safe throughout the lifetime of the development;
- New development should seek opportunities to reduce the overall level of flood risk at the site and in surrounding areas. This may include:
    - reducing volume rate and runoff;
    - relocating development to zones with lower flood risk, and
    - creating space (where possible) for flooding
- Consultation with the Local Authority and the Environment Agency should be undertaken at an early stage.

5.2 Actual Flood Risk (Overview)

A raised wall and embankment is located at Bognor Regis Promenade (located between Gloucester Road to the west, Sea Road to the east, and to the south of Felpham Pumping station) which provides protection against ingress of coastal flood water. Whilst Flood Zones (representing an undefended case) show flooding in Flood Zone 3a (0.5% AEP tidal event), the site and the surrounding area has a less than a 0.5% annual probability of tidal flooding when defences are considered.

Actual fluvial flood risk is present from the Aldingbourne Rife, and Shripney Manor Ditch. Flood Risk from ordinary watercourses is not captured by this flood risk information and should be considered as development proposals are taken forward. The actual fluvial flood risk is shown in as Table 1 of this report.

Proposed infrastructure in locations of actual risk should be implemented along with appropriate measures so that development is safe from fluvial flood risk. A commitment must be made to the long-term management and maintenance of such measures and to any additional requirements to address the residual risk that may be attached. The commitment required to long term contributions to the tidal defences should also be included when developing development details.

The maps provided within appendix J of the SRFA (Page 34) display the predicted depth, velocity and hazard rating of flood water at the site in the Flood Zone 3a event. These provide an indication of the level of hazard from fluvial flooding.

Flood depths and velocities are typically predicted to be up to 0.50m and 0.20m/s, respectively where flooding is predicted on the site.

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Given the relatively short length of the Shripney Manor Ditch flowing along the site's western boundary, the timing of the rise and fall in flood levels associated with a flood event will be fairly consistent for the western parcel of the site. However, since it contributes to the Aldingbourne Rife that subsequently discharges to the sea at Bognor, consideration should be given to the potential effects of reduced discharges during high tide events.

It has been noted in the SFRA that there may be longer duration of flooding, but also potential for double peaked events if rainfall over the Lidsey Rife and Barnham Rife catchments varies. Ground levels are relatively flat, with relatively wide and extensive flooding predicted, suggesting flood water may be resident on floodplain for some time (e.g. several days) before it is able to drain away.

Any groundwater flooding will typically last for longer durations than fluvial and surface water flooding, often for periods of days/weeks.

5.3 Flood Zones (General)

The map shown in figure 1 of this report displays the location of Flood Zones at the site.

There is a band of Flood Zone 3a, much of which is located across western-most boundary of the site. A significant proportion of the site is located in Flood Zone 1; the lowest flood risk zone. Ordinary watercourses may also present a flood risk that is not captured in the Flood Zone information.

The Shripney Manor Ditch runs along the majority of the western boundary, and can be seen on page 11 of the part 1 of Appendix B to the SFRA update.

5.4 Fluvial Flooding

Three Main Rivers are located in the vicinity of the site (refer to figures in Appendix D), these are:

- Aldingbourne Rife, 200m to the west;
- Lidsey Rife, 600m to the east;
- Shripney Manor Ditch which forms the boundary to the north and most of the west of the site, before flowing (north east to south west) into the Aldingbourne Rife.

The Site drains to the Shripney Manor Ditch and the Aldingbourne Rife. The Site is located within the Arun Internal Drainage District (IDB), which is managed by the Environment Agency as the Internal Drainage Board (IDB). There are a number of ordinary watercourses located in and within the vicinity of the site managed by the Arun IDB, these include the following:

- Oldlands Farm Ditch;
- Bersted Brooks to the west of the Rowan Caravan Park that flows southwards and then beneath Rowan Way to join a drainage channel that runs westwards along the southern side of Rowan Way (refer to figure in Appendix D);
- Several unnamed drainage ditches on the western boundary of the site that flow into the Aldingbourne Rife.

To establish the risk from fluvial flooding, modelled flood levels have been obtained from the Environment Agency. The modelled flood level for the 0.1% (1 in 1000 year) annual probability fluvial flood event is 1.67m AOD for the Site. This indicates that the majority of the site is not affected by this

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event. No further information is available for more frequent fluvial flood events from the Environment Agency's modelling.

The land adjacent to the Shripney Manor Ditch is predominantly soft landscaped, and it is intended that proposed site levels for the buildings and external areas are to be situated away from this zone and designed to be higher than these levels by a minimum of 600mm and or a minimum of 150mm above the existing site levels.

The risk of flooding from fluvial sources to the developed area of the Site is considered to be low for the majority of the site and moderate for a small area as part of the Proposed Development is located within Flood Zone 2 and 3, however the risk to the majority of the site from fluvial flooding is less than 1% (1 in 100 year) annual probability.

The Proposed Development will not impact on the floodplain as there will be no development in areas of the site subject to fluvial flood risk. The Proposed Development will have no impact on flood risk from this source on neighbouring property.

5.5 Pluvial and Overland Flow

Climate change is predicted to increase rainfall intensity in the future by up to 105%, 53 under the new range of allowances published by the Environment Agency. This will increase the likelihood and frequency of surface water flooding, particularly in impermeable urban areas. Changes to predicted rainfall should be incorporated into flood risk assessments and drainage and surface water attenuation schemes associated with developments.

The Environment Agency's Flood Map for Surface Water (refer to Appendix D) shows that the site is mostly at very low risk of surface water flooding less than 0.1% (1 in 1000 year) chance in any given year. However, there are some small isolated areas of low risk (less than 1 in 100 (1%) but greater than or equal to 1 in 1000 (0.1%) chance in any given year).

The site is located outside of the smaller event magnitudes tested as part of the uFMfSW extent.

The risk of pluvial or overland flooding to the Application Site is considered to be low to negligible.

By developing the site, there is a risk of pluvial/overland flows from the Proposed Development increasing. The risk of flooding to and arising from the Proposed Development, regarding pluvial/overland flow, is moderate as overland flow will to be manged through SuDS and flow routes to less vulnerable areas such as soft landscaped areas and car parks and the proposed surface water management and drainage strategy for the site will be designed as to manage surface water flows from the development Site.

5.5 Coastal flood risk

5.5.1 General Bognor Enterprise Zone

In coastal locations, the risk of flooding is linked to the stability of the coastline. If the coast is eroding, then the potential effect is that tidal flood defences near to the sea will be lost and flood risk will increase. To maintain an appropriate standard of safety from flooding it is sometimes necessary to implement works to slow down or stop the rate of coastal erosion and so maintain the integrity of the

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tidal defences. The Shoreline Management Plan 37 describes the arrangements and strategy for managing coastal erosion and the influential measures.

More detailed strategies have been developed to address coastal erosion and flood risk, describing the approach to meeting the outcomes of the SMP, and these are described in the following documents:

- Rivers Arun to Adur flood and erosion management strategy (2010)38;
- River Arun to Pagham flood and coastal erosion risk management strategy (2015)39;
- Pagham to East Head coastal defence strategy (2009)40.

Historic flooding information held by the Environment Agency does not report historic coastal flooding events (refer to Appendix H of the SFRA) within Arun District, but it should be noted that this dataset cannot be guaranteed to capture all events. Incidences of wave overtopping events are known to have occurred in the district, but it unclear whether these resulted in flooding.

Climate change is predicted to influence the rate of sea level rise, in addition to offshore wind speed and extreme wave height. However, sea level rise will influence the tidal levels which propagate upstream along the tidal rivers in the district, thereby impacting flood risk. Guidance on required net sea level rise allowances (after adjustment for land movement changes) is presented within the updated guidance released by the Environment Agency. The adjustments to the allowances from previous guidance are less marked.

5.5.2 Defences

Preparation of the SFRA has included within Section 6.0, a high-level review of available information on formal flood defences and involved interrogation of existing evidence on asset condition and standards of protection. Details of the flood defence locations and condition were provided by the Environment Agency for the purpose of preparing this assessment, in addition to some supplementary explanation on asset performance. Defences are categorised as either raised flood defences (e.g. walls/embankments) or flood storage areas (FSAs). The assessment has considered man-made defences and not natural defences which may arise for instance due to the presence of naturally high ground adjacent to a settlement.

This site is not protected by any formal flood defences within the immediate vicinity of the site. However, coastal flood defences to the south at Butlins in Bognor Regis offer a standard of protection of approximately 1 in 200 years (0.5%) from tidal flooding. A foreshore and wave return wall forms the primary defence, with a concrete wall forming the secondary defence. These are fronted by a shingle beach which is controlled by timber and rock groynes.

The foreshore and wave return wall measures approximately 800m in length and the crest levels vary between 6.5m AOD and 5.64m AOD. The concrete secondary defence mirrors the primary defence in both length and crest level.

Environment Agency records show the foreshore and wave return wall to be in good condition, whilst the concrete wall is in both fair and poor condition along its length.

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The Environment Agency's detailed flood mapping (refer to Appendix C) shows that a large part of the Site is located within Flood Zones 2 and 3. The Environment Agency's modelled flood level for the 0.5% (1 in 200 year) annual probability tidal event is 2.74m AOD.

This mapping shows the flood risk without the presence of flood defences. The tidal flood risk area in Bognor Regis which affects this site protected by coastal flood defences.

The coastal flood defences provide a standard of protection of 0.5% (1 in 200 year) annual probability. Therefore, the site is at a residual risk of flooding in the event that these tidal defences fail or are overtopped.

It is acknowledged that part of the Proposed Development is located in Flood Zone 2 and 3, however due to the presence of coastal flood defences the residual risk to the site from tidal flooding is less than 0.5% (1 in 200 year) annual probability. Also, the proposed development will be comprised of 'Less Vulnerable' employment, and More Vunerable hotel and pub Site uses appropriate to the Flood Zone.

The Proposed Development will have no impact on flood risk from this source on neighbouring property.

5.5.3 Additional Note

Appendix J of the SFRA includes site summaries for all the locations that were being considered for inclusion in the Main Modifications, including Bognor Enterprise. In particular, responding to a question from the new Inspector there is an additional bullet point that is being inserted into policy SP1 a Strategic Approach, specifically covering the need to take account of the coastal topography and incorporation of adaptations to deal with climate change particularly in high risk flood areas.

5.6 Flood history

The Arun SFRA Update 2016 Appendix H, showing historic flood map for the Bognor Enterprise Zone as a whole, shows that the northern part of land has flooded in the past. However, this area is outside the Saltbox application site. In addition, dataset does not necessarily capture all historic flooding and further information provided by the Environment Agency confirms that the area also flooded during 2012.

5.7 Infrastructure Failure

Southern Water sewer records do not show any Southern Water infrastructure within the Application Site. Assets are located to the south of the site in Bognor Regis and to the north in Shripney.

No other records have been made available of sewer flooding at the Application Site.

Southern Water has not been consulted regarding capacity of their infrastructure to meet the increased demand for foul sewerage provision from the Proposed Development.

All surface water drainage will be routed to the nearby watercourses via adequate water quality control measures and therefore there will be no impact from the Proposed Development on the local public

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surface water sewer system. It is acknowledged that the Aldingbourne Rife already fails due to discharges from Tangmere further north. We understand this will be addressed as part of Southern Water's business plan.

5.8 Artificial Sources

Flooding can occur because of infrastructure failure, for example breach and/or overtopping of retaining structures for raised bodies of water such as canals or reservoirs.

The site does not lie within the inundation area of any reservoirs. There are no raised sections of canal within 500m of the Application Site.

The risk of flooding from dam and canal infrastructure at the Application Site is considered to be negligible.

The site is not within a 500m search radius of any dams or canal infrastructure.

The risk of flooding to and arising from the Proposed Development, regarding artificial sources, is negligible.

5.9 Groundwater

AStGWF mapping indicates that the site is located within a 1km grid area where the susceptibility to groundwater flooding is >=25% but <50%.

The areas at risk of groundwater flooding are based on the Environment Agency's strategic-scale map which shows the Areas Susceptible to Groundwater Flooding (AStGWF) on a 1km square grid. The data shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge and has been used to define areas at risk of groundwater flooding.

Chalk aquifers such as that which underlies the Application Site are more likely to cause groundwater flooding because of its geological formation. However, it notes that there are no historical records of groundwater flooding in Arun District.

Existing borehole records for the Application Site do not indicate groundwater near the surface, which are included as Appendix F of this report.

Basements or underground car parks are not proposed as part of the Proposed Development. It is considered unlikely there will be any laterally continuous barrier to ground water created by the Proposed Development. The results of the proposed groundwater monitoring will be considered as part of the detailed design.

The Proposed Development will not exacerbate the risk of groundwater flooding to the surrounding area.

5.10 Groundwater Source Protection Zone

The site is not located within any Environment Agency designated Source Protection Zone.

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6. Residual Risks and Impacts

6.1 Residual Risks

Table 2 outlines the initial qualitative assessment of risk posed by the potential source of flooding, the mechanisms for flooding and the likely consequences. The tables also include potential mitigation measures to minimise the residual risk.

Categories of risk have been qualitatively defined as:

- 'High' Risk: flooding is likely to result in significant damage to property and pose a significant risk to life;
- 'Medium' Risk: flooding may result in possible minor damage to property but flood progress would allow adequate time for residents to be warned and safely evacuated to higher ground or appropriate places of safety;
- 'Low' Risk: flooding is unlikely to result in any damage to property damage and pose little or no risk to life.

6.2 Flood Probability

The SFRA and EA show that the development site areas are largely situated within Flood Zone 1 with small areas of the site situated within Flood Zone 2 and 3. The EA Flood data and levels show that the site would be affected from fluvial flooding. However, there is no development planned within these areas.

The SFRA and EA Flood information show that the 1 in 100-year climate change flood level is 1.330m AOD for the site. The proposed site levels will be designed to be above this.

6.3 Flood Impact

The Proposed Development will not impact on the floodplain as there will be no development in areas of the site subject to fluvial flood risk and due to the presence of coastal flood defences the residual risk to the site from tidal flooding is less than 0.5% (1 in 200 year) annual probability for areas of built development subject to tidal flooding.

The Proposed Development will have no impact on flood risk from this source on neighbouring property.

6.4 Impact of Displaced Water

Development of the site will not result in the displacement of floodwaters.

According to information published by the EA new development must provide level for level and volume for volume compensation as a replacement for volumes lost from the flood plain through development with new flood plain volume by reducing nearby ground levels. The compensatory volume must be at the same level (within reasonable working limits) as the lost storage. The proposals ensure that there is no loss in flood plain storage as a direct result of the development by not increasing levels within the 1 in 100-year climate change flood event. The proposed levels within the flood extents will be at or below that of the existing ground level, therefore providing an overall increase of the existing flood

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plain volume. In tidal areas, raising ground levels is unlikely to impact on maximum tidal levels so the provision of compensatory storage should not be necessary.

The proposed redevelopment will not have any significant impact on the volumes of storage available on site.

6.5 SRFA Residual Risks

It is worth noting, the SFRA (refer to section 6.6) does not assess the probability of failure other than noting that such events are very rare. However, in accordance with NPPF, all sources of flooding need to be considered. If a breach or overtopping event were to occur, then the consequences to people and property could be high. There is also advice within the SFRA that developers should be aware that any site that is at or below defence level may be subject to flooding if an event occurs that exceeds the design capacity of the defences, or the defences fail and this should be considered when building resilience into low level properties.

6.6 Impact of Fluvial Morphology

It is considered there will be no impact on the fluvial morphology as a result of this development.

Table 2: Qualitative Assessment of Residual Flood Risk

Flood Hazard	Flood Mechanism and Possible Consequence	Initial Assessment of Risk	Comments/Recommended Mitigation Measures	Residual Risk
Tidal		MODERATE	All built development is located is areas assessed as having less than 0.5% annual probability (equivalent to the 1 in 200 year) of tidal flooding. Safe and dry access to the Proposed Development is available from the A29 for all events up to the 0.5% annual probability (1 in 200 year) tidal and 0.1% annual probability (1 in 1,000 year) fluvial events. Despite this it is recommended that all buildings have finished floor levels set a minimum of 600mm above the existing ground levels, providing mitigation from localised flooding from extreme events.	
Fluvial Flooding	Site located within a Flood Zone 3 shown on	MODERATE	All built development (i.e. residential dwellings, and	LOW

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Flood Hazard	Flood Mechanism and Possible Consequence	Initial Assessment of Risk	Comments/Recommended Mitigation Measures	Residual Risk
	the EA/SFRA maps, considered high risk of fluvial flooding. Site is affected by a 1 in 100-year flood level of 16.330m AOD including climate change.		onsite highways) are located is areas assessed as having less than 1% annual probability (equivalent to the 1 in 100 year) of river flooding. Safe and dry access to the Proposed Development is available from the A29 for all events up to the 0.5% annual probability (1 in 200 year) tidal and 0.1% annual probability (1 in 1,000 year) fluvial events. Despite this it is recommended that all buildings have finished floor levels set a minimum of 150mm above the existing ground levels, providing mitigation from localised flooding from extreme events.	
Pluvial and Overland Flooding	Minor overland/ surface water flooding due to surface water ponding in low lying areas of the site	LOW	Overland flow to be manged through SuDS and flow routes to less vulnerable areas such as soft landscaped areas in the form of swales and car parks with raised kerbs.	LOW
Infrastructure Failure	Minor flooding from culverted watercourse	LOW	The culverted watercourse situated west of the site is a maintained watercourse and the risk and likelihood of this blocking and flooding is fairly low.	LOW
Artificial Sources		LOW		LOW
Groundwater		LOW		LOW

6.7 Climate Change

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The NPPF outlines the importance of Climate Change with respect to planning. The issues of Climate Change are discussed with impacts likely on sea levels, peak rainfall intensities, peak river flows, wind speeds and wave heights.

The national maps were updated in March 2017 taking into account the new Emsworth to Littlehampton model. The revised peak river flows are shown as table 3 below.

Table 3: Peak river flow allowances

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
South East	Upper end	25%	50%	105%
	Higher central	**15%**	**30%**	**45%**
	Central	10%	20%	35%

6.7 Climate Change SFRA

Hydraulic modelling was completed as part of the updated SFRA to provide updated climate change flood mapping in the Arun District for Flood Zone 3a. This modelling followed the latest guidance for climate change in FRAs/SFRAs released by the Environment Agency in February 2016 (and updated in April 2016).

Climate change for fluvial events was based on the Higher Central estimates for the years 2031, 2061 and 2111. Arun District is within the South-East River Basin District and therefore allowances were: 2031 = +15% flows, 2061 = +30% flows and 2111 = + 45% flows.

For tidal/coastal models, undefended case still water levels and defended case still water levels with wave overtopping simulations have been completed to inform future flood risk within the Arun District. Again, climate change allowance predictions are for the years 2031, 2061 and 2111, with present day outputs for comparison.

The site is likely to be affected by fluvial flooding and the additional climate change effects in terms of increases in peak river flows and rainfall intensities will therefore affect the site. These have been taken into account and the FRA demonstrates how these risks are to be managed so that the development is safe which is supported by the proposed drainage strategy section of this report.

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7. Drainage Strategy

7.1 General Design

The NPPF requires that flood risk to land and property is not increased as a result of development.

Changes in the volume and rate of surface water runoff from the development as a result of increases in impermeable land uses could increase the risk of flooding downstream unless sufficient steps are taken within the Proposed Development to prevent this happening.

A fundamental principle of sustainable development in terms of flood defence is the reduction of surface water run-off from new developments. It is best practice that the surface water drainage arrangements should be such that the volumes and peak discharge rates of surface water leaving a development site are no greater than the rates prior to the Proposed Development, and where possible are returned to those associated with the greenfield conditions of the site. Any increase in run-off (rates and/or volumes) above the pre-development (or greenfield) volumes must be attenuated on site.

The drainage network is to be designed as a gravity system to accommodate run off from a:

- 1 in 2 year storm event with no surcharge,
- The network is to be checked for a 1 in 30-year storm event with surcharge permitted but with no surface flooding,
- The network is to be checked for a 1 in 100-year storm event with surface flooding permitted providing that there is no risk of flooding to buildings and there is no off site overland flow.

7.2 Existing Site Drainage Regime

The site is classified as a Greenfield development, with a gross area of approximately 12 ha. The site is not currently served by an existing sewer system; therefore, it is assumed that the site drains via infiltration and overland flows towards watercourses on the boundaries of the site.

As the Proposed Development area is less than 50ha, the Institute of Hydrology (IoH) Report 124

Flood Estimation for Small Catchments (1994) method has been used to estimate the Greenfield site peak flow rate, which is an approved methodology specified within the Environment Agency's Rainfall Runoff Management for Developments Report4.

Table 4 summarises the Greenfield discharge rates for 1 ha of developable area and the estimated discharge rates for the current site. Full calculations are provided in the drainage calculation pack in Appendix.

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Table 4 – Greenfield Runoff Rates

Annual Rainfall Event	Greenfield Runoff Rates (litres/sec/ha)	Development Runoff Rates (litres/ sec)
Qbar	2.90	34.20
1 in 1 year	2.40	28.30
1 in 30 year	6.50	76.70
1 in 100 year	9.10	107.40

7.3 Proposed Drainage Strategy

For the purposes of this Planning Application the site has been split into two phases. Phase 1 is seeking full planning permission with an area of 6.492ha and Phase 2 is seeking only outline permission with a total area of 5.512ha.

The Proposed Development will result in a net increase of impermeable area at the Application site. Of the total site area, an area of 8.3 ha will be developed. It has been assumed that the Percentage Impervious (PIMP) factor at the site will be 80% of the developed area. Therefore, it has been assumed for this drainage strategy that the Proposed Development will have a total impermeable area of 6.65ha.

It is proposed that the development will discharge to the watercourse flowing along the Western boundary of the site; Aldingbourne Rife (Ordinary Watercourse). In order to comply with the guidance for providing long-term storage as outlined in the Environment Agency's Rainfall Runoff Management for Developments, the proposed discharge rate from the Site has been restricted to 2 l/s/ha.

Table 5 – Proposed Peak Surface Water Discharge Flow Rates

Annual Rainfall Event	Proposed Flow Rates (litres/ sec)	Proposed Betterment (%)
1 in 1 year	23.60	17%
1 in 30 year	23.60	70%
1 in 100 year	23.60	78%
1 in 100 year +45% C/C	23.60	N/A

Due to the requirement to provide a betterment on the existing surface water discharge rates post development for all storm events up to and including the 100-year return period +45% allowance for climate change, the surface water will be restricted via flow control devices and attenuated with a total required storage volume of approximately 7,650m^3. There is potential scope for the storage volume to be rationalised at a later stage following detailed design and further hydraulic modelling.

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It is proposed that onsite attenuation will be provided by a series of attenuation basins and permeable pavements. The site control structures will be located primarily in the topographical low points of each catchment. These will be in the form of retention/detention basins.

These structures will be designed to attenuate flow prior to discharge to the ordinary watercourse via a control structure to achieve the maximum allowable peak discharge rates for the 1 in 1 the 1 in 30 and 1 in 100-year events (plus a 45% allowance for climate change). The location of the retention/detention basin will not be within an area designated as public open space. It will however provide significant ecological and amenity benefit for the residents.

The site has been split into three catchment areas each with individual outfalls to the watercourse. The proposed surface water discharge rates and attenuation requirements are further broken down in Table 6 below:

Table 6 – Proposed Peak Surface Water Discharge Flow Rates

Catchment	Proposed Flow Rates (litres/ sec)	Proposed Attenuation (m^3)
1	11.30	3900
2	2	500
3	10.30	3250

As per the Environment Agency's Rainfall Runoff Management for Developments, long term storage can be provided to store the additional runoff caused by the development compared to the volume that would have been contributed from the Site in its Greenfield state. The current design rule is to use the 100-year 6-hour event to determine this additional volume.

<u>Long term storage can be incorporated through one of three basic approaches:</u>

1. Ensure that the drainage system provides sufficient infiltration volume to dispose of the volume difference,
2. Design a storage system which only comes into effect above a storm size threshold (effectively an off-line design) which captures the required volume and discharges at the appropriate rate,
3. Design a storage system which comes into effect for all events (effectively an on-line design) that captures the required volume difference which is designed to empty at a rate of less than 2 l/s/ha.

Approaches 1 and 2 provide the long-term storage volume in a separate system from the attenuation storage or offset the volume of runoff via infiltration devices. This allows the long-term storage to be activated for specific events and the volume difference discharged at the appropriate rate or infiltrated to ground, in order to mimic the behaviour of the Site in its Greenfield state.

The drainage strategy for the site proposes to adopt approach 3. By storing the additional volume in a central storage area, the long-term storage volume will be appropriately activated and discharged at a

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rate (2 l/s/ha) that would mimic the Greenfield behaviour of the Site, which is the overall aim of providing long term storage.

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8. Sustainable Urban Drainage Systems (SuDS)

8.1 SuDS constraints

Most source control techniques are likely to be suitable for the Saltbox site.

Infiltration may be suitable. Mapping suggests a medium risk of groundwater flooding and areas of the site have been designated as containing historic landfill. Therefore, a further site investigation should be carried out and the potential for infiltration techniques should be assessed. Infiltration should typically be avoided in areas where the depth to the water table is <1m. However, shallow soakage tests results should be carried out to confirm if infiltration is suitable and permit the use of shallow infiltration features. All tests to be in accordance with BRE 365. The attenuation volumes stated within this report, do not take account of infiltration. Once detailed site investigation has been completed, there may be a surplus volume provided if infiltration is deemed to be achievable.

Mapping suggests that the site slopes are suitable for all forms of detention. A liner may be required to prevent the possible egress of groundwater and address any contamination issues from designated landfill within the site boundary.

All filtration techniques are likely to be suitable. A liner may be required to prevent the possible egress of groundwater and address any contamination issues from designated landfill within the site boundary.

All forms of conveyance are likely to be suitable. As a general note, where the slopes are >5% features should follow contours, or utilise check dams to slow flows. A liner may be required to prevent the possible egress of groundwater and address any contamination issues from designated landfill within the site boundary.

For the Saltbox site, proposed site gradients are not expected to be greater than 5%.

8.2 SuDS selection

The following destinations must be considered for surface runoff in order of preference:

1. Discharge into the ground (infiltration)
2. Controlled discharge to a surface water body
3. Controlled discharge to a surface water sewer

Surface water must not be discharged into the foul sewer system. Infiltration structures include soakaways, basins, swales and permeable paving. Discharge to surface water bodies and surface water sewers must be restricted to an agreed rate.

8.3 Flow exceedance routes

The drainage design should show flow routes through the proposed development, demonstrating where surface water will be conveyed for three types of flow:

1. Low flow routes Regular flow from source control features such as permeable pavements should travel in low flow channels through the development in a controlled way contributing to landscape quality.

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2. Overflows in the event of local blockages or surcharge a simple overflow arrangement should allow water to bypass the obstruction and return to the management train sequence until conditions return to normal.

3. Exceedance routes When SuDS are overwhelmed by exceptional rainfall, then exceedance routes are required to protect people and property. These provide unobstructed overland flow routes from the development and should be considered for all drainage schemes.

The proposed levels have been designed, to fall towards the west. Hence in the event of an exceedance, the overland flow path will direct the water towards the storm water outfall and away from the proposed buildings. The levels will not increase flooding offsite as a result of the development.

8.4 Responsibilities for SuDS maintenance

Development shall not commence until full details of the maintenance and management of the SuDS system is set out in a site-specific maintenance manual and submitted to, and approved in writing, by the Local Planning Authority.

As a minimum requirement, the manual is to include:

(a) details of financial management of the site including arrangements made in the event that the management company (or any subsequent management company) is no longer able to fulfil its duties; and

(b) arrangements for the replacement of major components at the end of the manufacturers recommended design life.

Further information on maintenance and management of SuDS is provided in section 8.6 of the main SFRA report.

8.5 Implementation of SuDS for the Saltbox Site

The proposed drainage strategy which can be found as appendix D of this report, demonstrates that a combination of permeable paving, swales, and ponds can be incorporated within the design.

This is in accordance with the advice within the SFRA and Arun Strategic Surface Water Management Study, in particular the workshop section appendices B and C which refers to the Bognor Regis Enterprise site as a whole.

All SuDS should be designed in accordance with CIRIA 753. In summary, the updated SuDS Manual incorporates the very latest research, industry practice and guidance. In delivering SuDS there is a requirement to meet the framework set out by the Government's 'non-statutory technical standards' and the revised SuDS Manual complements these but goes further to support the cost-effective delivery of multiple benefits.

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9. Conclusions

Kirksaunders (KSA) has been commissioned by Landlink Estates to undertake a site-specific Flood Risk Assessment (FRA) for the proposed Saltbox site development north of Bognor Regis, Sussex.

Full planning permission is sought for the Phase 1 development of 6.492 hectares of employment space (B1, B2 and B8) with associated parking, landscaping, and public open space. In addition, outline planning permission is sought for the Phase 2 development of 5.512 hectares for additional employment units, warehousing, hotel, drive thru's, public house, gym and associated works. Based on Table 2 (Flood Risk Vulnerability Classification) of the NPPF Planning Practice Guide, the Proposed Development is classified as 'Less Vulnerable' employment and 'More Venerable' hotel and pub sites.

The site is located within Flood Zones 1, 2 and 3. No development is proposed within flood zones 2 and 3.

The updated SRFA dated November 2016 and the main modification version of the local plan have been considered within this site-specific FRA.

The surface water network for the site is designed to convey and store surface water from site for all storms up to and including the 1 in 30-year storm event without flooding on site habitable spaces or to adjoining properties with controlled flooding during the 1 in 100-year storm event (plus a 45% allowance for climate change). It is proposed that the Site discharge at 2 l/s/ha to comply with the rate and volume of runoff requirements.

The total required storage volume for the Site is 7,650m3. There may be scope for the storage volume to be rationalised at a later stage following detailed design and specific hydraulic modelling. This attenuation volume will be provided in the form of retention/detention basins, swales and permeable pavements.

A drainage strategy has been prepared to support the Proposed Development through the planning process. The strategy demonstrates the Proposed Development can comply with the requirements of the NPPF and does not increase flood risk either to or from the Proposed Development.

The proposed areas of car parking will require treatment in line with the water quality parameters for the outfall watercourse / stream.

The on-site drainage should be maintained and inspected on a regular basis to ensure it remains fit for purpose. Maintenance plans are to be submitted in accordance with the approving authorities' requirements. Which shall include access roads to the detention basins for ongoing maintenance.

This FRA demonstrates that the Proposed Development site can be drained in a sustainable manner through attenuation and infiltration and that the development is not at flood risk from all sources and will not increase flood risk to other parties. All SuDS are to be designed and implemented in accordance with CIRCIA 753.

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Appendix A – Site Masterplan

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Appendix B – Site Phasing Plan

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Appendix C – Topographical Survey

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Appendix D – Proposed Drainage Strategy

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Appendix E – Proposed Drainage Calculations

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Appendix F – Historic Borehole Logs

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