

Flood Risk Assessment  
& Drainage Statement

**Land at  
Stewartby Brickworks  
Stewartby  
Marston Vale  
Bedfordshire**

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**On behalf of  
Hanson Building  
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Report Ref: 2642.FRA&DS  
Flood Risk Assessment & Drainage Statement

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## 1 INTRODUCTION

- 1.1 Stuart Michael Associates Limited, Consulting Engineers (SMA) has prepared this Flood Risk Assessment and Drainage Statement, hereafter referred to as the 'Report', on the instructions of Hanson Building Products Limited, hereafter referred to as the 'Developer'.
- 1.2 The Report supports an outline planning application for: Residential development of approximately 1,200 dwellings, employment developments and educational facilities, together with highways and supporting infrastructure. The proposed developments are to be provided on land at the former Hanson Brickworks, hereafter referred to as the 'Site', situated to the west of the settlement of Stewartby, Bedfordshire.
- 1.3 The purposes of the Report are as follows:
- (i) To confirm that the proposed development will not be subject to flood risk or to show that flood risk can be managed in an acceptable manner.
  - (ii) To demonstrate that the proposed development will not increase risk of flooding elsewhere.
  - (iii) To verify that safe access will be available to all parts of the proposal during flood conditions.
  - (iv) To confirm that satisfactory strategies for disposal of wastewater and surface water runoff from the proposed development are achievable.
- 1.4 The Report presents an assessment of flood risk in accordance with the document 'Planning Policy Statement 25: Development and Flood Risk' (PPS 25), as required by the Environment Agency and the local planning authority.
- 1.5 The Report confirms that the proposed development would satisfy development control guidance policies outlined in various planning strategy documents and would meet the Environment Agency's long-term sustainability objectives.

## 2 POLICY & GUIDANCE

### National

2.1 The Environment Agency requires that flood risk should be assessed and drainage proposals should be confirmed for any planning application for 'major' development.

2.2 The Town and Country Planning (Flooding) (England) Direction 2007 [DCLG Circular 04/2006] confirms that for the purpose of assessing flood risk, 'major' development is defined as:

*Residential development, where the number of dwellings to be provided is 10 or more, or the site area is 0.5 hectares or more; or*

*Non-residential development, where the new floor space to be provided is 1,000 square metres or more, or the site area is 1.0 hectares or more.*

In addition, a 'flood risk area' is defined as:

*Land in an area within Flood Zones 2 or 3; or*

*Land in an area within Flood Zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency.*

2.3 The Environment Agency's National Guidance on development within floodplains is given in the document 'Policy and Protection of Floodplains' The Environment Agency has produced a number of policies concerning floodplains of which, FD-P2 and FD-P3 focus on development as follows:

*FD-P2 – The Environment Agency will advise the Local Authorities to use their planning powers to guide development away from areas that are at risk from flooding.*

*FD-P3 – The Environment Agency will advise Local Authorities to use their planning powers to restrict development that would itself unacceptably increase the risk of flooding to others.*

2.4 The Environment Agency also has a policy specifically relating to Sustainable Drainage Systems, which advises that, the Agency:

*....will promote Sustainable Drainage systems (SUDS) as a technique to manage surface and groundwater regimes sustainably.*

2.5 'Planning Policy Statement 25: Development and Flood Risk (PPS 25)', issued in December 2006 by the Department of Communities and Local Government, provides guidance on how flood risk should be considered during the planning and development process. The requirement to protect both new and established development from increased risk of flooding forms an essential part of the guidance. Moreover, implementation of sustainable drainage systems for new development is encouraged.

2.6 Paragraph D1, Annex D of PPS 25 advises in that:

*The risk-based Sequential Test should be applied at all stages of planning. Its aim is to steer new development to areas at the lowest probability of flooding (Zone 1).*

2.7 Further guidance on development and flood risk is provided within CIRIA report C624 'Development and Flood Risk'.

2.8 Guidance concerning sustainable drainage systems is given in the document CIRIA report C697 'The SUDS Manual' (2007).

2.9 Standards for design and construction of sewers to be adopted by sewerage providers are detailed in the document 'Sewers for Adoption - a design and construction guide for developers', 6th Edition (March 2006), issued by WRc plc.

### **Regional**

2.10 The Site is situated within the East of England Region for development control purposes and is governed by the East of England Plan and the Milton Keynes and South Midlands Sub regional Strategy (MKSMSRS). The Site is located within Marston Vale, which forms part of the Bedford / Kempston / Northern Marston Vale Strategy Area in the MKSMSRS.

### **Local**

2.11 Strategic planning and broad principles for development control guidance are set out in the 'Bedfordshire Structure Plan 2011', which states under Policy 3:

New Development will not be permitted when:

- i) *adequate water resources do not exist or cannot be augmented;*
- ii) *there is a risk to existing resources, water quality, amenity or nature conservation;*
- iii) *the proposal will lead to a deterioration in the quality of underground or surface water, or will interfere with the flow of ground or surface water;*
- iv) *such development would be at direct risk from flooding or likely to increase the risk of flooding elsewhere. (Development includes the raising of land within areas at risk from flooding.)*

2.12 Detailed planning and principles for development control guidance are set out in the 'Bedford Borough Local Plan 2002', which supports the aims of the Structure Plan and states under Policy NE16:

The Borough Council will not permit development where:

- i) it would intensify the risk of flooding; or*
- ii) it would be at unacceptable risk from flooding; or*
- iii) it would prejudice existing flood defences or interfere with the ability to carry out flood control and maintenance work; or*
- iv) it would adversely affect wildlife habitat in the floodplain unless, the Borough Council, in consultation with the Environment Agency and Internal Drainage Board as appropriate, is satisfied that the developer will provide appropriate mitigation, protection and compensatory measures.*

2.13 The Local Plan will be replaced by the emerging Local Development Framework.

2.14 The Bedfordshire and River Ivel Internal Drainage Board and the Environment Agency form part of the Marston Vale Surface Waters Group that was established in 1997. The Marston Vale Surface Water Plan covers the general area around Bedford. The document sets out policies and provides guidance regarding integrated water management.

### 3 THE SITE

#### Location

- 3.1 The proposed development Site is located to the west of Stewartby and approximately 10 km south-west of Bedford between the A421 and B530. The Ordnance Survey national grid reference (O.S.N.G.R.) for the approximate centre of the Site is 501680E, 242670N (TL016426).
- 3.2 The Site comprises the brickworks, owned by Hanson Building Products Limited, which covers approximately 58 hectares and is bounded to the west by the Elstow Brook, a tributary of the Great Ouse, with Stewartby Lake (part of the Marston Vale Country Park) to the south. The L-field landfill site, a former clay pit, lies beyond the Elstow Brook to the north-west. Rookery North, an un-restored clay pit lies to the south-west. Immediately north of Stewartby is arable farmland whilst to the east and south-east are, respectively, the un-restored Coronation Pit and until recently active Quest Pit. Residential areas and the main village centre of Stewartby are located to the east of the Site. The Bletchley to Bedford railway bisects the Site in a general north-south orientation. A plan showing the location of the Site is presented as **Figure 1**.

#### Use

- 3.3 Until recently, the Site was used for brick making. During the 1970's there were approximately 1,800 employees on the Site. In 2003, that figure had reduced to 415 employees; when the brickworks closed, the Site had 354 employees. A new office building is being developed on the western edge of the Site to accommodate 350 employees.

#### Topography

- 3.4 The Site is located on the valley bottom of the Marston Vale, a distinct, broad valley, which is defined to the south by the Greensand Ridge and to the west by the Cranfield Plateau. The resulting basin is essentially a single catchment draining to Elstow Brook, joining the Great Ouse south-east of Bedford.
- 3.5 Ordnance Survey mapping indicates that there is higher ground lying in an arc from Cranfield to Boughton End and to the south of Lidlington. The area to the north of this arc drains towards Stewartby Lake.
- 3.6 Detailed topographical survey information indicates that generally, the Site slopes from south to north. Levels in the south-western corner are in the order of 36.6 m AOD and levels in the south-eastern corner are between 37.4 m AOD and 38.7 m AOD, sloping to levels in the order of 34.4 m AOD in the northern part of the Site. Ground levels vary across the Site with untypically high levels of approximately 39.8 m AOD in the north-eastern part. A plan showing topographical details of the Site is presented as **Figure 2**.

### **Geology and Hydrogeology**

- 3.7 Stewartby and the Site are situated at the centre of the distinct basin of the Marston Vale, defined by the Greensand Ridge to the south-east, Cranfield plateau to the south-west and Kempston / Bedford and the River Great Ouse to the north.
- 3.8 The surrounding landscape is predominantly rural but significantly transformed by clay extraction and landfill. To the south-west of the Site is Rookery North, an un-restored clay pit, and Stewartby Lake, a restored clay pit now part of a country park. To the north-west is the active L-field landfill site, also formerly a clay pit. Immediately north of the village is arable farmland; to the east is the un-restored Coronation Pit and to the south-east is Quest Pit.
- 3.9 Geologically, the Vale is a broad valley underlain by Jurassic Oxford Clay sitting within a fold on the northern side of the Bedfordshire Greensand Ridge. The 1:50,000 British Geological survey map indicates that the predominant geology of the east of the Site is Oxford Clay and the west of the site is Alluvium and Gravel underlain by Clay.
- 3.10 The Site sits on the less constrained flatter areas of the valley bottom. The brickworks benefits from sitting on made ground lying just slightly higher than the surrounding land and the lower clay pits.
- 3.11 Intrusive investigations have revealed that there is up to 2.0 m thickness of made ground across the Site. Typically, the made ground comprises inert fired brick or other construction material.
- 3.12 The Site has a variable and occasionally, high water table, probably with perched water over the Oxford Clay.
- 3.13 Groundwater beneath the Site is considered to be in limited hydraulic continuity with the Elstow Brook and Stewartby Lake.
- 3.14 Environment Agency mapping indicates that the Site is located at a distance exceeding two kilometres from the nearest total catchment (Zone 3) of a Groundwater Source Protection Zone.

### **Watercourses**

- 3.15 The principal watercourse within the locality is the Elstow Brook, which is located adjacent to the west and north-west boundaries of the Site. The Brook provides the outfall for Stewartby Lake, which is controlled by a weir arrangement. The original alignment of the watercourse appears to have been diverted eastwards some years ago to its present course. Downstream, to the north, the Brook follows a natural course towards Bedford. The location of the watercourse is defined on the plan presented as **Figure 3**.

- 3.16 Investigations have identified a drainage ditch adjoining the eastern side of the railway. The ditch conveys flows arising from a small catchment to the south of Stewartby together with runoff from the existing brickworks development on the eastern side of the Site. The southern catchment is relatively small and the runoff from most of the upstream catchment appears to be diverted into Stewartby Lake.
- 3.17 The ditch adjoining the eastern side of the railway connects with a culvert located under the railway and at an angle perpendicular to the alignment of the ditch. The culvert extends across the western part of the Site on that approximate alignment through to the Elstow Brook. The route of the watercourse is indicated between points A, B and C shown on the plan presented as Figure 3.
- 3.18 A ditch is located adjacent to Broadmead Road and extends approximately 800 metres from the Site northwards to a culvert under the railway. The ditch conveys flows northwards from surface water sewers in Stewartby and north-eastern areas of the Site. The ditch is situated on the western side of Broadmead Road for a distance of approximately 600 metres from the Site. The remaining 200 metres of ditch are situated on the eastern side of Broadmead Road. A number of culverts are situated at various positions throughout the 800 metres length of ditch.

### **Surface Water Sewers**

- 3.19 There are public sewers located within Stewartby, to the east of the Site. Anglian Water's public sewer records indicate that the eastern and northern areas of Stewartby are served by sewers that discharge to a ditch located to the north. The ditch provides a continuous watercourse adjacent to Broadmead Road. The watercourse is indicated on the drawing presented as Figure 3.
- 3.20 There are no public surface water sewers located within the western side of Stewartby.
- 3.21 The brickworks has a private surface water sewer network, which has been modified over the years to suit operations.
- 3.22 Sewer records indicate that a large part of the north-western side of the Site is served by surface water pumps, which discharge flows to the lagoon located to the west of the Site. Previously, the water was used in the brick production processes. However, since those operations have reduced the water usage has ceased.
- 3.23 The surface water is pumped to the culverted section of the Elstow Brook to the north. The pumping system is activated manually to maintain the water levels within the lagoon.
- 3.24 Runoff from the south-east of the Site drains towards the existing drainage ditch situated alongside the south eastern side of the railway line. Pumps are used in some areas to provide adequate drainage.

- 3.25 Initial records from 1995 indicate that an area to the east drains to an existing ditch located at Broadmead Road.

### **Wastewater Sewerage**

- 3.26 Stewartby village and the Brickworks Site are served by a foul sewage treatment works situated to the north-west of the village and on the north-eastern boundary of the Site. Treated effluent discharges to the adjoining watercourse. Flows to the treatment works are controlled by two pumping stations; one located within the Brickworks Site and one adjacent to Braodmead Road.
- 3.27 The railway divides the Site into two catchments: east and west. The foul sewers within the eastern catchment are predominately adopted and maintained as public sewers by the sewage undertaker, Anglian Water plc. The existing foul drainage system within the western catchment is privately owned. A private sewer located below the railway connects the private system to the public sewers to the east.
- 3.28 Existing and proposed drainage systems are shown on the foul drainage strategy plan presented as **Figure 4**.

## 4 POTENTIAL SOURCES OF FLOODING

### Flood Zones

- 4.1 Flood Zones are a product of the Environment Agency's flood mapping programme in accordance with Table 1 note (a) of the former PPG25 'Development and Flood Risk'. Flood Zones show the probability of flooding without the presence of defences and significant artificial structures such as bridges, culverts, and embankments or cuttings for railways and motorways. Similarly, Flood Zones do not reflect the effects of catchment management.
- 4.2 Flood Zones show areas that may be at risk from flooding and where further investigations in the form of a Flood Risk Assessment should be used to determine the risk of flooding for a specific location.
- 4.3 Flood Zones shown on the Environment Agency's Flood Map are the main constraints used to inform Local Planning Authorities when to consult the Agency on flood risk in development control decisions. The Environment Agency advises that Flood Zones should only be used for planning consultation purposes.
- 4.4 There are two different kinds of area shown on the Flood Map. Dark blue indicates the area that could be affected by flooding, either from rivers by a flood that has a 1% (1 in 100) or greater chance of happening each year or from the sea by a flood that has a 0.5% (1 in 200) or greater. Light blue shows the additional extent of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1% (1 in 1000) chance of occurring each year. These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures or channel improvements.
- 4.5 Flood Zones shown on the Environment Agency's Flood Map are indicative and there may be additional areas at high risk from flooding that are not shown, such as floodplains associated with minor watercourses and areas subject to localised flooding. Therefore, the Environment Agency advises that the Flood Map should not be used as the sole basis for deciding the full extent of floodplains.

### Coastal and Fluvial Flooding

- 4.6 The Site is located inland and is not within an area shown to be at risk from coastal flooding. The Flood Map indicates that the western part of the Site together with limited areas on the eastern part are situated within Flood Zone 3 'High Risk' with an annual probability of 1.0% or greater and Flood Zone 2 'Medium Risk'. The flooding on the Site is associated with the Elstow Brook. However, the Flood Zones do not take account of any flood defences or management of the catchment. The village of Stewartby is unaffected by Flood Zones 2 and 3. The Flood Zones are indicated on the drawing presented as **Figure 5**.

### **Modelled Flood Levels**

- 4.7 The Bedford and River Ivel Internal Drainage Board has provided further data concerning the floodplain within the Stewartby area. On behalf of the Internal Drainage Board, the consultants Hannah Reed have modelled the Elstow Brook, including the control of flows from Stewartby Lake and the Marsh Leys Flood Alleviation Scheme. Relevant flood level results from the modelling together with a plan indicating specific locations (nodes) for the flood levels are presented as **Appendix A**.
- 4.8 Comparing the modelled flood levels with the Ordnance Survey contours within the catchment indicates that flooding would occur over a lesser extent than indicated by the Flood Zones shown on the Flood Map, particularly in the upper reaches of the Elstow Brook.
- 4.9 Comparing the Site topographical survey with the modelling results reveals that the Site is not at risk from flooding generated by the 1 in 100 year (1% chance of occurrence in any one year) event. Flood levels and typical ground levels are included in the table within Appendix A. However, localised flood risk from the numerous ditches within this area might exist.
- 4.10 Stewartby Lake is located at the upstream end of Elstow Brook and is supplied by smaller tributaries and drainage ditches. The Elstow Brook is culverted at the downstream end of the lake and partially diverted around the existing L-field landfill site. The watercourse remains in open natural channel north of the Site. The smaller, feeder watercourses to the east and west of the Elstow Brook connect locations downstream of Hardwick Bridge.

### **Management of Watercourses and Flood Risk**

- 4.11 Flows from Stewartby Lake are controlled by existing sluice and weir arrangements located at the northern end of the lake. The controls are managed as strategic flood defences by the Internal Drainage Board to regulate northward flows in the downstream section of the Elstow Brook, which is similarly managed.
- 4.12 Areas that have been modelled show that the extent of actual flooding is less than indicated on the Flood Map. Further modelling and management proposals for the catchment should demonstrate that the redevelopment of the Site in association with works on the Developer's other local land holdings could contribute to more effective flood risk management, which could reduce the extent of flooding and facilitate further sustainable growth within Marston Vale.

### **Historical Flooding**

- 4.13 There is no known evidence of significant flooding affecting the Site.

### **Groundwater Flooding**

- 4.14 Geological evidence and the general topographical setting indicate that the Site is unlikely to be at risk from groundwater flooding.
- 4.15 Although there is no evidence of groundwater flooding, deep basements within the Site do become flooded when water levels in the Lagoon become too high. Surface water runoff from the Site supplies the Lagoon and water levels are unlikely to reflect the water table within the area.

### **Overland Flooding**

- 4.16 Overland flow is water flowing over the ground surface that has not entered a natural drainage channel or artificial drainage system. It is caused when the intensity of rainfall exceeds the infiltration capacity of the surface onto which it falls. CIRIA Report C624 'Development and Flood Risk' states that:

*Overland flow can cause localised flooding in natural valley bottoms as normally dry areas become covered in flowing water, and in natural low spots where the water may pond".*

- 4.17 Ordnance Survey topography mapping indicates that during extreme rainfall events overland flows from upstream areas are likely to be limited, due to the presence of the Lakes and drainage ditches that intercept the surface water flows.

### **Flooding from Artificial Drainage Systems**

- 4.18 A small section of the existing catchment is developed and surface water flows that are in excess of the capacity of the existing sewers may cause overland flood flows. Such flows might be directed to the west, across the Site from Stewartby. However, there is no evidence that flooding from the existing surface water sewerage has affected the Site.
- 4.19 Any proposed surface water sewers may also provide additional flood flow routes across the proposed development. Potential flood flow routes would be identified and addressed within the detailed design stage of each development sub-catchment within the Site.

### **Flooding from Infrastructure Failure - Stewartby Lake**

- 4.20 Stewartby Lake has evolved from old clay extraction works occurring below original ground level. There are no raised embankments from the Lake that would be able to fail. The Internal Drainage Board has confirmed that the 1 in 100 year flood level for the lake would be 36.50 m AOD.

- 4.21 Green Lane, which is located to the north of Stewartby Lake is elevated above surrounding ground levels and would provide an informal barrier to any water overtopping the lake. A more detailed survey has been undertaken of this area and this shows that there is a natural flood flow route, for occurrences exceeding the 1 in 100 year event.

#### **Flooding from Infrastructure Failure - Marsh Leys Flood Alleviation Scheme**

- 4.22 A flood alleviation scheme has been undertaken as part of a new development at Marsh Leys. March Leys is located some distance downstream of the proposed development to the south-east of the A421. The scheme comprises a new flood channel and flood alleviation areas.
- 4.23 The Elstow Brook hydraulic modelling by Hannah Reed includes the flood alleviation scheme.

#### **Structures Influencing Local Hydraulics**

- 4.24 The main structure to influence hydraulics within this area is Stewartby Lake. Flows from the lake are controlled and discharged through a weir arrangement to the Elstow Brook, draining northwards. The Elstow Brook has been modified to provide a culvert through the L-field landfill site.

#### **Other Watercourses**

- 4.25 The ditch adjoining the eastern side of the railway, as indicated between points A and B and the culvert between B and C shown on Figure 3, conveys flows arising from a small catchment to the south of Stewartby together with runoff from the existing brickworks development. The 'brickwork' flows will be removed as part of the development proposals. However, residual flows not diverted to Stewartby Lake, from the small southern catchment will persist. In addition, risk of blockage of the culvert at point B will remain.

#### **Climate Change Uncertainty**

- 4.26 PPS 25 advises in Annex B how to understand and interpret climate change. The Government established the UK Climate Impacts Programme (UKCIP), which identified scenarios for climate change. The scenarios will be updated, revised and expanded as part of ongoing work.

## 5 DEVELOPMENT PROPOSALS

- 5.1 The proposal comprises a residential development of approximately 1,200 dwellings (450 and 750 dwellings to the west and east of the railway line respectively); including a proportion of the low energy, sustainable 'Hanson House', together with land allocated for B1, B2 and B8 employment uses.
- 5.2 The proposal includes potential for:
- 7.2 ha of B1 employment development for approximately 1650 employees;
  - Retention of selected buildings suitable for conversion with demolition of brickworks buildings such as sheds, chimneys and kilns inappropriate for conversion or reuse;
  - Vehicular access from existing points on Green Lane and Stewartby Way and new vehicular and pedestrian / cycle access from Broadmead Lane;
  - Biomass boiler and district heating;
  - Recreation and open space;
  - School site and likely health facilities;
  - Additional retail and service space to complement and extend the centre of Stewartby;
  - New community facilities including a possible Heritage Centre / Museum;
  - Improvement to the brickworks rail halt on the Marston Vale line and
  - Retention of selected vegetation, reinforcement and enhancement of landscape with structure / buffer planting and creation of green corridors.
- 5.3 The development will be supported by employment, education and other facilities and designed to be an integral part of Stewartby and enhance the village centre and provide additional facilities.
- 5.4 The Site is to be redeveloped in phases. An illustrative masterplan layout is presented as **Figure 6**.
- 5.5 Pedestrian and vehicle access to the development will be from Broadmead Road and Stewartby Way.
- 5.6 The detailed design of the development proposals will incorporate the advice, recommendations and requirements contained in this Report and given by the Environment Agency.
- 5.7 The floor levels of all habitable dwellings will be elevated by 150 mm above surrounding final ground levels to provide a degree of confidence against any potential minor overland runoff.
- 5.8 Ground levels within the Site may be remodelled to suit drainage and flood protection purposes.

- 5.9 The proposal includes integrated sustainable urban drainage system including open channels, swales, pervious pavements, sub-grade water storage and open retention areas. The residential elements could incorporate additional measures such as rainwater harvesting and water efficient facilities as part of a comprehensive package of features designed to achieve Level 4 / 5 of the Code for Sustainable Homes in all the 'new-build' construction.

## **6 PROPOSED WASTEWATER DRAINAGE**

- 6.1 The existing foul sewage treatment works does not have sufficient residual capacity to provide adequate treatment for the significant increase in flows that will arise from the proposed development. The alternative to providing a substantial replacement treatment works to serve the existing settlement of Stewartby and the proposed development is to construct off-site sewerage to convey untreated sewage to existing public sewer facilities. Anglian Water have advised that the 'Bedford Southern Orbital Foul Collector Sewer', located approximately 3.7 km north of the Site, would provide an appropriate point of discharge for wastewater from the proposed development and Stewartby systems. Therefore, a pumping station will be constructed adjacent to the existing treatment works situated within the eastern catchment and a new off-site pumping main and gravity flow sewerage will be provided to link with the Bedford Southern Orbital Foul Collector Sewer.
- 6.2 The Bedford Southern Orbital Collector Sewer is a high capacity pipeline that discharges to a modern treatment works to the east of Bedford. Anglian Water has advised there is spare capacity in that sewer and that the company does not object to the proposals, in principle.
- 6.3 The existing foul sewage treatment works will be decommissioned following completion and handover of the proposed pumping station and pumping main. Similarly, use of the two small pump stations that control the flows into the treatment works will be terminated.
- 6.4 The new pumping station will be designed to receive gravity flow connections from the existing sewers serving Stewartby and the new sewers on the proposed development.
- 6.5 The western catchment will be provided with a system of gravity flow sewers, which will convey wastewater to a low point within that catchment. A new pumping station and new pumping main will convey flows from the low point to the head of the new gravity system within the eastern catchment.
- 6.6 That pumping main will be located within the proposed and existing road network and under the railway at the existing level crossing to the south of the Site. Alternatively, flows from the western catchment will be conveyed via new infrastructure to the foul sewer systems within the villages to the west of Stewartby.
- 6.7 The existing private sewer network serving the western catchment and including the sewer underneath the railway, will be abandoned or removed, as appropriate.
- 6.8 Off-site sewerage required to link the proposals to public sewers could, subject to confirmation, be requisitioned from Anglian Water under the provisions of Section 98, Water Industry Act, 1991.

## 7 PROPOSED SURFACE WATER DRAINAGE

### General

- 7.1 Any development presents opportunity to incorporate sustainable surface water drainage systems, which might include infiltration techniques or attenuation of flows to protect receiving sewers, watercourses or groundwater. The choice of methods is dependent upon ground conditions and availability of suitable areas within the particular scheme layout.
- 7.2 The development proposals will incorporate sustainable surface water drainage solutions. The guidance given in the CIRIA report C697 'The SUDS Manual' will be followed during the design of the proposed sustainable drainage solution. Runoff will be managed both at source and across the proposed development as a whole.
- 7.3 CIRIA C697 promotes use of source control devices and infiltration systems such as pervious pavements (permeable paving), advising that solid pollutants are filtered out in the construction zone and that the growth of micro-organisms within the sub-base material improves water quality. Similarly, the Environment Agency encourages use of SUDS and advises in their document 'Sustainable Urban Drainage Systems - An Introduction' that for permeable pavements, *"pollutant removal rates have been shown to be high"*.
- 7.4 CIRIA C697 advises that runoff in pervious pavements is stored within and conveyed through the sub-base construction, thus retarding and attenuating the flows. In addition, CIRIA C697 indicates that the surface of a pervious pavement can hold significant amounts of water as surface wetting such that after a period of dry weather 5 mm of rainfall can be contained with no discharge at all.
- 7.5 All surface water flow control systems, including detention basins and pervious pavement constructions, will be designed to meet the requirements of the Environment Agency and Internal Drainage Board to minimise flood risk. The control systems discharging to watercourses will be designed to restrict flows to the equivalent of runoff from the relevant development areas in an undeveloped (or 'green-field') condition. All control systems will be designed to accommodate runoff produced by all rainfall events having a return period of 1 in 100 years (1% chance of occurrence in any one year) plus 30% rainfall allowance to account for the possible effects of climate change. Other parameters will be applied should changes be required by the approving authorities at the detailed design stages.
- 7.6 Soakage testing has not been carried out on the Site. The findings of preliminary intrusive investigations and a desk study indicate that natural Clay and fill material underlie the Site. Such ground conditions are not suitable for use of infiltration systems for disposal of surface water runoff.

- 7.7 The contamination potential of fill within the Site and possible remediation would be the subject of a separate study by others. However, residual risks after remediation might provide further justification not to use infiltration systems for disposal of runoff.
- 7.8 The proposal includes integrated sustainable urban drainage systems including use of open channels, swales (where practical), pervious pavements, sub-grade water storage and open retention areas. Sewer systems will be designed and constructed to meet the sewer adoption standards of Anglian Water. The residential elements could incorporate additional measures such as rainwater harvesting and water efficiency measures as part of a comprehensive package of features designed to achieve Level 4 / 5 of the Code for Sustainable Homes in all the 'new-build' construction.
- 7.9 Anglian Water prefers that adoptable sewers should have a positive outfall to either public sewers or an appropriate watercourse.

### **Drainage Catchments**

- 7.10 For the purpose of developing strategic designs for disposal of surface water runoff, the division of the Site by the railway has resulted in the proposed development being considered as two distinct catchments; the eastern and western catchments.
- 7.11 Surface water runoff from the western catchment will be discharged at controlled flows to the adjoining reach of Elstow Brook situated to the west.
- 7.12 The eastern catchment may be sub-divided into the 'main development' and the 'school site'. Runoff from the main development will be discharged to new off-site sewerage, which will convey flows northwards via Broadmead Road and new off-site facilities to control flows, which will discharge to an existing land drainage system and thence, to the Elstow Brook. Controlled flows of runoff from the school site will be drained to the existing ditch adjoining the northern boundary that conveys flows westward to the Elstow Brook.

### **Layouts**

- 7.13 The indicative layout of the main on-site sewers for both catchments is shown on the plan presented as **Figure 7**.
- 7.14 The indicative layout of the off-site sewerage for the eastern catchment is shown on the plan presented as **Figure 8**.
- 7.15 The indicative longitudinal profile of the off-site sewerage for the eastern catchment is shown on the drawing presented as **Figure 9**.

### **Western Catchment**

- 7.16 The western catchment comprises mainly residential development, with significant areas of employment development contained within the southern section, as indicated on Figure 6.
- 7.17 The large areas of car parking needed for the employment developments present opportunities to provide sustainable drainage solutions to control flows of runoff and improve water quality. Therefore, car parking areas and aisles will be designed using pervious pavements such as porous block surfacing with sub-surface storage facilities constructed above an impermeable lining. Such facilities may be in the form of proprietary storage system such as 'Aquacell' or a similar approved modular product or may comprise open textured free draining sub-base material with at least 30% voids. The pervious pavement systems would also serve runoff from the buildings. Flows discharging from the storage facilities would be restricted to minimise the risk of flooding the receiving sewers.
- 7.18 Within the residential developments, use of pervious pavements will be restricted to areas such as communal car parks and shared private accesses. Where practicable, rainwater harvesting will be incorporated in the surface water disposal systems. Where practicable, surface water runoff arising from the roof areas will be collected in underground storage tanks and recycled for non-potable purposes. Excess water would be discharged to pervious pavement constructions or sewers.
- 7.19 Where appropriate, swales will be used for highway drainage purposes to provide flow control and water quality improvement. However, swales require significant areas of land and present long-term ownership and maintenance issues, which have yet to be resolved for highway or public open space adoption purposes. Deep-seal trapped gullies will be used where swales are inappropriate.
- 7.20 Use of pervious pavements, rainwater harvesting and swales are systems designed to provide source control of runoff prior to discharge to the main sewers.
- 7.21 The main sewers will convey flows to 'outfall 1' on the Elstow Brook, as indicated on Figure 7. Discharges to the watercourse will be restricted by the 'flow control chamber' to flows not exceeding the runoff predicted from the western catchment in an undeveloped state or similar parameters to be determined by the Internal Drainage Board or Environment Agency.
- 7.22 Excess flows detained by the flow control chamber will be diverted to 'surface water attenuation facility 1' for release back through the sewers as flow conditions allow. The attenuation facility will comprise a detention basin (dry balancing pond) or a retention basin (balancing pond incorporating a permanent body of water). The choice of facility will be dependent, primarily, on such issues as safety, adoption and maintenance requirements although ecological and amenity needs may be influential.

- 7.23 An existing culvert is located on an east-west orientation within the northern part of the western catchment. The culvert, indicated between points B and C on Figure 7, conveys flows from the eastern side of the railway to the Elstow Brook. Where practicable, taking account of the development layout, the culvert will be replaced with an open channel designed to establish a 'natural' watercourse, in accordance with the Environment Agency's policy to improve watercourses. The watercourse will be routed to suit the layout of the proposed development. The culvert under the railway will not be affected. The watercourse will continue to convey flows from the small catchment to the south of Stewartby after completion of the proposed development. In addition, risk of blockage of the culvert at point B will remain. Therefore, a headwall and debris screen will be provided at point B to minimise blockage at the inlet to the culvert under the railway.
- 7.24 Preliminary hydraulic designs of the main sewers, excluding the effects of source controls, have been prepared to illustrate 'worst case' conditions; the results are presented as **Appendix B**.

### **Eastern Catchment**

#### *Main Development*

- 7.25 The eastern catchment comprises mainly residential development, with areas of employment development contained within the mid section, as indicated on Figure 6.
- 7.26 In common with the proposals for the western catchment, pervious pavements, rainwater harvesting and swales will be used as appropriate for the residential, community and employment developments within the eastern catchment to provide source control of runoff prior to discharge to the main sewers.
- 7.27 The main sewers will connect to the off-site sewerage to be provided in Broadmead Road. The off-site sewerage will comprise a 'box-section' culvert, incorporating a low-flow channel, which will convey flows northwards to 'outfall 2' and the flow control facilities to be provided on land under control of the Developer.
- 7.28 Outfall 2 is provided by an existing watercourse and culvert adjoining the north-east side of Broadmead Road, as indicated on Figure 7. Discharges to the watercourse will be restricted by the 'flow control chamber' to flows not exceeding the runoff predicted from the eastern catchment in an undeveloped state or similar parameters to be determined by the Internal Drainage Board or Environment Agency.
- 7.29 In addition to flows from surface water sewers in Stewartby, the existing watercourse situated on the west side of Broadmead Road receives unrestricted flows of runoff from areas of the existing brickworks site. The proposed drainage system will, in effect, transfer those unrestricted flows from the watercourse to the off-site culvert.

- 7.30 Excess flows detained by the flow control chamber will be diverted to 'surface water attenuation facility 2' for release back through the sewers as flow conditions allow. The attenuation facility will comprise a detention basin (dry balancing pond) or a retention basin (balancing pond incorporating a permanent body of water). The choice of facility will be dependent, primarily, on such issues as safety, adoption and maintenance requirements although ecological and amenity needs may be influential.
- 7.31 The flow control chamber will restrict discharges to the existing ditch and culvert to flows not exceeding predicted levels of runoff from the Site's eastern catchment in an undeveloped ('green-field') state. Flows will be conveyed to Elstow Brook via the existing ditch and culvert system.
- 7.32 Preliminary hydraulic designs of the main sewers, excluding the effects of source controls, have been prepared to illustrate 'worst case' conditions; the results are presented as **Appendix C**.
- 7.33 Preliminary hydraulic designs of the off-site box-section culvert are included in Appendix C.

#### *School Site*

- 7.34 Runoff from the land allocated for the 'school site' drains to a ditch adjoining the northern boundary. The ditch connects to the Elstow Brook, situated to the west, via a small culvert under the railway. Runoff from the proposed school development will be controlled within the school site and flows will be discharged to the adjoining ditch.
- 7.35 Discharges to the ditch will be restricted to flows not exceeding the runoff predicted from the Site in an undeveloped state or similar parameters to be determined by the Internal Drainage Board or Environment Agency.

#### *Existing Land Drainage*

- 7.36 The existing watercourse adjoining the eastern side of the railway is indicated on Figure 4. The watercourse receives flows from south of Green Lane and from runoff within the Site. The proposed development will redirect all runoff from within the Site to the proposed sewers. Thus, the watercourse will only convey flows from south of Green Lane, through the eastern and western catchments to Elstow Brook.
- 7.37 In accordance with the Environment Agency's policy to improve watercourses, the channel will be remodelled to establish a 'natural' watercourse and buffer zones on the existing alignment. The culvert under the railway will not be affected.

### **Rainwater Harvesting**

- 7.38 Where practicable, rainwater harvesting will be incorporated in the surface water disposal systems. Where practicable, surface water runoff arising from the roof areas will be collected in underground storage tanks and recycled for non-potable purposes. Excess water would discharge to the pervious pavements or sewers.

## **8 FLOOD RISK ASSESSMENT**

8.1 This section of the Report presents the effects and extents of the potential sources of flooding identified within Section 4.

8.2 The Flood Zones shown on the Environment Agency's Flood Map provide an indication of possible flooding to alert planning authorities, amongst others, when making development control decisions. In general, the Flood Map does not provide accurate flood level data for specific sites. Data obtained from verified detailed hydrological and hydraulic modelling should provide superior information as the basis for assessment of flood risk.

### **Flood Mapping and Modelling**

8.3 The Site is located inland and it is not within an area shown to be at risk from coastal flooding.

8.4 The Flood Map shows the western part of the Site to be located within Flood Zones 2 and 3.

8.5 Detailed modelling undertaken by the consultants, Hannah Reed, on behalf of the Internal Drainage Board confirms that the Site is not located within an area at risk from flooding for the 1 in 100 year event (1% annual probability flood) including an allowance for climate change.

8.6 The risk of fluvial flooding is low.

### **Safe Access**

8.7 There are existing accesses to the Site. Those access locations will be retained for both the commercial and residential proposals and for the existing railway crossing.

8.8 The Site and the proposed accesses are not located within the modelled floodplain and therefore, safe access to the proposed development would not be compromised.

### **Floodplain Storage and Flows**

8.9 Detailed flood modelling indicates that the Site is not located within areas susceptible to the effects of the predicted 1 in 100 year return period event, including an additional allowance to account for potential effects of climate change. Therefore, floodplain storage and flood flow conveyance will not be affected.

8.10 Flows from the upstream catchment and Stewartby Lake are controlled by existing sluice and weir arrangements, which regulate the northward flows in the downstream section of the Elstow Brook. Continued management of flows in that manner is likely to maintain a reduced flood risk to areas downstream of the lake.

8.11 Floodwaters from Stewartby Lake could overtop Green Lane and flood Elstow Brook in an extreme event. Therefore, the proposed development will include measures to maintain and protect the flood route. No new buildings will be located within protected flood route, which would be determined at an early stage in the detailed design process.

8.12 Generally, potential for localised flood flow routes within the overall proposed development should be considered. Flows are likely to be directed along the highways and towards Elstow Brook. The flood flow routes for each area of development will be considered part of the detailed design process.

### **Overland Flows**

8.13 The risk of overland flood flows from higher lying land within the catchment is low.

### **River Morphology**

8.14 The Elstow Brook has already been modified and is not located adjacent to any proposed built development. The existing watercourses will be retained on their existing alignments and ecological buffer zones will be incorporated as necessary. Moreover, the proposed development will incorporate sustainable surface water drainage solutions to control flows to existing watercourses. Therefore, the proposal will not increase flows to the minor watercourse located to the east of the Site.

8.15 The proposed development will not have adverse effect on morphology of watercourses.

### **Sewers and other Artificial Drainage Systems**

8.16 Potential blockage of local sewers presents a low risk of flooding. Risk of flood flows from other drainage systems is low.

### **Surface Water Runoff**

8.17 Increases in impermeable area have potential to increase flood risk. However, the Site is almost completely impermeable and the introduction of residential gardens and open spaces as part of the proposed development will reduce the overall impermeable area.

8.18 The surface water drainage systems for the proposed development will include sustainable drainage methods designed to control discharges of runoff to flows similar to those from the Site in an undeveloped state, i.e. 'green-field' runoff. That condition will be applied for all rainfall events, within parameters set by the Environment Agency and the Bedfordshire and River Ivel Internal Drainage Board. Therefore, the risk of overland flows arising from the proposed development is low.

### **Groundwater**

8.19 The proposed development is unlikely to be at risk from groundwater flooding.

### **Infrastructure Failure**

8.20 Infrastructure failure presents the proposed development with only a low risk of flooding.

### **Climate Change**

8.21 Allowances for potential future effects of climate change are included in the strategic designs in accordance with the latest guidance available in documents such as PPS 25. Therefore, the Site is unlikely to be at risk from flooding during the effective lifespan of the proposed development.

## **9 PROPOSED WATER USE EFFICIENCY MEASURES**

- 9.1 Use of water efficiency appliances such as low flush WCs, aerating taps, high efficiency showers, dishwashers and washing machines will be considered in the final design of the development.
  
- 9.2 The new development could include rainwater harvesting facilities incorporating proprietary underground storage tanks and pumps, to collect rainwater for purposes such as toilet flushing, car washing and irrigation of gardens.
  
- 9.3 Use of the foregoing measures would minimise demand on public water supplies and help to meet the Environment Agency's long-term sustainability targets.

## 10 SUMMARY & CONCLUSIONS

### General

- 10.1 The Report supports an outline planning application for residential, employment and educational developments to be provided on land at the former Hanson Brickworks, Stewartby, Bedfordshire.
- 10.2 The Report presents an assessment of flood risk in accordance with the document 'Planning Policy Statement 25: Development and Flood Risk' (PPS 25) and confirms that:
- The proposed development will not be subject to flood risk and that flood risk can be managed in an acceptable manner.
  - The proposed development will not increase risk of flooding elsewhere.
  - Safe access will be available to all parts of the proposed development during flood conditions.
  - Satisfactory strategies for disposal of wastewater and surface water runoff from the proposed development are achievable.
  - The proposed development would satisfy development control guidance policies and meet the Environment Agency's long-term sustainability objectives.

### Existing

- 10.3 Ground and groundwater conditions preclude use of infiltration systems for disposal of surface water runoff.
- 10.4 The Site is not affected by Groundwater Source Protection Zones.
- 10.5 The principal watercourse within the locality is the Elstow Brook, which provides the outfall for Stewartby Lake. The lake flow controls are managed as strategic flood defences by the Internal Drainage Board.
- 10.6 The Bletchley to Bedford railway divides the Site into two catchments; east and west.
- 10.7 A drainage ditch adjoining the eastern side of the railway conveys land drainage flows together with runoff from the existing brickworks. The ditch connects with a culvert located under the railway and extends across the western catchment to the Elstow Brook.

- 10.8 Surface water from sewers in Stewartby and from north-eastern areas of the Site are conveyed northwards by a ditch, located adjacent to Broadmead Road.
- 10.9 The Environment Agency's Flood Map shows the western part of the Site to be located within Flood Zones 2 and 3.
- 10.10 There is no known evidence of significant flooding affecting the Site.
- 10.11 Comparing the Site topographical survey with detailed flood modelling provided by the Internal Drainage Board confirms that the Site is not located within an area at risk from flooding for the 1 in 100 year event (1% annual probability flood) including an allowance for climate change.
- 10.12 The watercourse adjoining the eastern side of the railway receives flows from south of Green Lane and from runoff within the Site. The proposed development will redirect all runoff from within the Site to the proposed sewers. Thus, the watercourse will only convey flows from south of Green Lane, through the eastern and western catchments to Elstow Brook. In accordance with the Environment Agency's policy to improve watercourses, the channel will be remodelled to establish a 'natural' watercourse and buffer zones on the existing alignment. The culvert under the railway will not be affected.
- 10.13 The western catchment has a private surface water sewer network, which discharges to the Elstow Brook.
- 10.14 Foul sewers, including the sewage treatment works, within the eastern catchment are public sewers maintained by Anglian Water. The existing foul drainage system within the western catchment is privately owned. A private sewer located below the railway connects the private system to the public sewers to the east.

#### **Proposal – Wastewater**

- 10.15 The foul sewage treatment works within the Site does not have sufficient residual capacity to provide adequate treatment for the significant increase in flows that will arise from the proposed development. Therefore, a pumping station will be constructed adjacent to the existing treatment works and a new off-site pumping main and gravity flow sewerage will be provided to link with the 'Bedford Southern Orbital Foul Collector Sewer', located approximately 3.7 km north of the Site.
- 10.16 The new pumping station will be designed to receive gravity flow connections from the existing sewers serving Stewartby and the new sewers on the proposed development.

- 10.17 The western catchment will be provided with a system of gravity flow sewers, and a new pumping station and pumping main to convey flows to the head of the new gravity system within the eastern catchment. Alternatively, flows from the western catchment will be conveyed via new infrastructure to the foul sewer systems within the villages to the west of Stewartby.
- 10.18 Off-site sewerage required to link the proposals to public sewers could, subject to confirmation, be requisitioned from Anglian Water under the provisions of Section 98, Water Industry Act, 1991.

#### **Proposal – Surface Water**

- 10.19 The proposal includes integrated sustainable urban drainage systems including open channels, swales, pervious pavements, sub-grade water storage and open retention areas.
- 10.20 The residential elements could incorporate additional measures such as rainwater harvesting and water efficient facilities as part of a comprehensive package of features to minimise demand on public water supplies and help to meet the Environment Agency's long-term sustainability targets.
- 10.21 All surface water flow control systems, including detention basins and pervious pavement constructions, will be designed to meet the requirements of the Environment Agency and Internal Drainage Board to minimise flood risk. The control systems discharging to watercourses will be designed to restrict flows to the equivalent of runoff from the relevant development areas in an undeveloped (or 'green-field') condition. All control systems will be designed to accommodate runoff produced by all rainfall events having a return period of 1 in 100 years (1% chance of occurrence in any one year) plus 30% rainfall allowance to account for the possible effects of climate change. Other parameters will be applied at the detailed design stages, if changes are required by the approving authorities.
- 10.22 Allowances for potential future effects of climate change are included in the strategic designs in accordance with the latest guidance available in documents such as PPS 25. Therefore, the Site is unlikely to increase risk of flooding during the effective lifespan of the proposed development.
- 10.23 Ground levels within the Site may be remodelled to suit drainage and flood protection purposes.

#### *Western Catchment*

- 10.24 Pervious pavements such as porous block surfacing with sub-surface storage facilities will be used for the large areas of car parking within the employment development. The pervious pavement systems would also serve runoff from the buildings. Flows discharging from the storage facilities would be restricted to minimise the risk of flooding the receiving sewers.

- 10.25 Within the residential developments, use of pervious pavements will be restricted to areas such as communal car parks and shared private accesses. Where practicable, rainwater harvesting will be incorporated in the surface water disposal systems.
- 10.26 Surface water runoff from the western catchment will be discharged at controlled flows to Elstow Brook situated to the west. Excess flows will be detained by the 'flow control chamber' and diverted to 'surface water attenuation facility 1' for release back through the sewers as flow conditions allow. The choice of facility will be dependent, primarily, on such issues as safety, adoption and maintenance requirements although ecological and amenity needs may be influential.

#### *Eastern Catchment*

- 10.27 The eastern catchment may be sub-divided into the 'main development' and the 'school site'. Runoff from the main development will be discharged to new off-site sewerage which will convey flows northwards via Broadmead Road and new off-site facilities to control flows, which will discharge to an existing land drainage system and thence, to Elstow Brook.
- 10.28 Runoff from the land allocated for the school site drains to a ditch adjoining the northern boundary. Discharges from the school development will be restricted to flows not exceeding the runoff predicted from the Site in an undeveloped state or similar parameters to be determined by the Internal Drainage Board or Environment Agency.
- 10.29 In common with the proposals for the western catchment, pervious pavements, rainwater harvesting and swales will be used as appropriate for the residential, community and employment developments within the eastern catchment to provide source control of runoff prior to discharge to the main sewers.
- 10.30 The eastern catchment main sewers will connect to the off-site sewerage to be provided in Broadmead Road, which will convey flows northwards to 'outfall 2' and the flow control facilities to be provided on land under control of the Developer.
- 10.31 'Outfall 2' is provided by an existing watercourse and culvert adjoining the north-east side of Broadmead Road. Discharges to the watercourse will be restricted by the flow control chamber.
- 10.32 In addition to flows from surface water sewers in Stewartby, the existing watercourse situated on the west side of Broadmead Road receives unrestricted flows of runoff from areas of the existing brickworks site. The proposed drainage system will, in effect, transfer those unrestricted flows from the watercourse to the off-site culvert.
- 10.33 Excess flows detained by the flow control chamber will be diverted to 'surface water attenuation facility 2' for release back through the sewers as flow conditions allow. The choice of facility will be

dependent, primarily, on such issues as safety, adoption and maintenance requirements although ecological and amenity needs may be influential.

10.34 Flows will be conveyed to Elstow Brook via the existing ditch and culvert system.