5.0 Flooding, Hydrology and Water Resources

5.1 Introduction

This ES Chapter has been prepared by Mewies Engineering Consultants Ltd (M-EC) who have 9 years competent experience in undertaking Hydrology chapters and reports for inclusion within an Environmental Statement. M-EC are members of professional organisations including the Chartered Institution of Water and Environmental Management (CIWEM) and the Institution of Civil Engineers (ICE).

The assessment evaluates the impact of the proposed development in terms of flood risk, water quality, water resources and drainage during both construction and occupation phases.

The includes an assessment of the potential effects of the proposed development on surface water quantity and quality, groundwater quantity and quality, and flood risk as a result of the change in land use and regime.

Cumulative effects arising from the effect of the proposed development in conjunction with development of the wider Keresley Sustainable Urban Extension (SUE) have also been considered.

A Flood Risk Assessment (FRA) and Drainage Strategy (*Appendix 5.1*) has been prepared and should be read alongside this ES Chapter.

Table 5.1 details the Figures and Appendices that support this Chapter.

Table 5.1 - Figures and Appendices	
Figures	Title
Figure 5.1	Flood Zone Plan from Strategic Flood Risk Assessment
Appendices	**Title**
Appendix 5.1	Flood Risk Assessment and Drainage Strategy
Appendix 5.2	EA Consultation
Appendix 5.3	Coventry City LLFA Consultation
Appendix 5.4	M-EC Phase II Ground Investigation
Appendix 5.5	Clean Water Maps

5.2 Scoping, Consultation and Overview of Potential Effects

An EIA scoping assessment has been undertaken which identified the following receptors that could be impacted by the proposed development:

- The Hall Brook
- On-site Ponds
- Groundwater
- Human population

Potential effects that could be caused by the proposed development include:

- Potential adverse and beneficial effects on flood risk of the human population on-site or off-site.
- Potential adverse and beneficial effects on the water quality of surface water receptors.
- Potential adverse and beneficial effects on the water quality of groundwater.

Consultations for the proposed development have been undertaken with the Environment Agency (EA), Coventry City Council as the Lead Local Flood Authority (LLFA) and Severn Trent Water (STW). The EA response is included in *Appendix 5.2*, with the LLFRA response included in *Appendix 5.3*. The EA would not comment on this application as it is located in Flood Zone 1.

A public consultation was undertaken on 26th June 2018 at Keresley. The feedback obtained from this consultation highlighted that the combined sewer on Fivefield Road has had foul flooding incidents in the past. This has been addressed in *Section 5.4.1*.

5.3 Assessment Methodology

The assessment of likely significant effects has been based on a review of published data and this is included as part of the FRA in *Appendix 5.1*. The data used to assess the potential significant effects include:

- Topographical data for the existing site;
- British Geological Survey Mapping;[1]
- Flood Zone Maps from the EA;
- Existing STW apparatus maps and Development Enquiry;
- Land-use data and layouts for the existing and developed site;
- Flood Estimation Handbook (FEH) catchment descriptors;
- Magic Map[2]

Consultations with the EA, LLFA, STW and a public consultation were undertaken to inform the assessment. Published standards and best practice guidance have been followed including:

- BRE Digest 365[3]
- CDM Regulations[4]
- CIRIA (C753) The SuDS Manual[5]

[1] British Geological Survey (2018) **Geology of Britain Viewer** (Available from: http://mapapps.bgs.ac.uk/geologyofbritain/home.html)

[2] Natural England (2018) **Magic Map Application** (Available from: http://magic.gov.uk/MagicMap.aspx)

[3] BRE (2007) **BRE Digest 365**

[4] Health and Safety Executive (2015) **Managing Health and Safety in Construction**

[5] CIRIA (2015) **CIRIA (C753) The SuDS Manual**

- CIRIA (C768) Construction of SuDS[6]
- EA Climate Change Allowances[7]
- Sewers for Adoption (England and Wales)[8]
- National and local Planning Policies

The criteria for assessing the significance of the potential effects have been based on a qualitative assessment of the receptor sensitivity and the predicted magnitude of change from the baseline as a result of the proposed development. The nature of the receptor has been defined as shown in *Table 5.2*, and the criteria used to assess the nature of the impact has been set out in *Table 5.3*.

Table 5.2 – Nature of Receptor

Value	Description
High	Very high/high importance and rarity with limited potential for substitutes. International/national scale importance.
Medium	Medium importance and rarity with limited potential for substitutes. National or local scale importance.
Low	Low importance and rarity. Local scale importance.
Negligible	Very low importance and rarity. Local scale importance.

Table 5.3 – Nature of Impact

Magnitude	Change predicted as a result of the proposed development (may be benficial or adverse)
High	Loss of resource and/or severe damage to key elements of feature (adverse). Major improvement of resource quality and/or restoration of feature or key attribute (beneficial).
Medium	Partial loss of resource. Partial loss of or damage to key elements of a feature (adverse). Improvement of key attributes of feature (beneficial).

[6] CIRIA (2017) **CIRIA (C768) Guidance on the Construction of SuDS**

[7] EA (2017) **Flood Risk Assessments: Climate Change Allowances** (Available from: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances)

[8] Water UK (2018) **Sewers for Adoption 8** (Available from: https://www.water.org.uk/publications/policy-positions-and-briefings/sewers-adoption)

Table 5.3 – Nature of Impact	
Magnitude	**Change predicted as a result of the proposed development (may be benficial or adverse)**
Low	Some measurable change to feature with a minor loss to a one or more key elements (adverse). Minor benefits to one or more key elements (beneficial).
Negligible	Very minor loss to characteristics of the feature (adverse). Very minor benefit to characteristics of the feature (beneficial).

Table 5.4 – Significance of Effect					
		Nature of Receptor			
		High	**Medium**	**Low**	**Negligible**
Nature of Impact	**High**	Substantial	Substantial	Moderate	Negligible
	Medium	Substantial	Moderate	Minor	Negligible
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

The significance of the effects arising from the proposed development is based on a combination of the nature of the receptor and the nature of the impact, as set out in *Table 5.4*.

This ES Chapter has made the following assumptions to produce this assessment;

- All the information contained in this report, including any conclusions, are based on the information available to M-EC at the time of writing the report and assumes that the information provided is accurate. The conclusions drawn by M-EC could therefore differ if the information is found to be inaccurate, incomplete, out of date or misleading.
- The hydrological function of the fishing ponds will be subsumed by the wider drainage proposals.

5.4 Baseline Conditions

This section sets out the baseline conditions which the proposed development will be assessed against.

5.4.1 Flood Risk and Drainage

The existing water environment at the site has been assessed as part of the FRA in *Appendix 5.1*. This should be referred to for an in-depth assessment of the existing flood risks, with a summary of the main conclusions provided below.

Fluvial Flooding from Rivers

The entire site is located within EA Flood Zone 1, with no main rivers located in close vicinity to the site. Therefore, there is no flood risk to the site from main rivers, watercourses or the sea.

Pluvial (Surface Water) Flooding

The Hall Brook flows from the north-western boundary through the centre of the main site towards the south east. This is an ordinary watercourse rather than a Main River and includes a pond towards the centre of the site.

As part of the Coventry City Council Strategic Flood Risk Assessment (SFRA)[9], a detailed hydraulic model of the Hall Brook has been prepared using ISIS-TUFLOW and ESTRY-TUFLOW. This provides an accurate map of the current surface water flood extents of the Hall Brook on-site, with different extents being classified as Flood Zone 3a (SWFZ3a), Flood Zone 3b (SWFZ3b) and Flood Zone 2 (SWFZ2).

Examination of the results specific to this site identifies that the actual flood extents are generally contained within the channel, although SWFZ2 extents encroach on the southern part of the site, as shown in Figure 5.1.

Based upon the latest Surface Water Flood Risk Mapping[10], most of the site is at very low risk of surface water flooding due to the site's steep topography, with only a few areas at low risk. The areas designated at higher risk are related to the watercourses that run through the site.

Overall, the site has a low risk of surface water flooding.

Groundwater Flooding

The entire site is designated by the EA as being located in a High Groundwater Vulnerability Zone and in Zone 3 of the Groundwater Source Protection Zone. A Phase II Ground Investigation completed in June 2018, conducted groundwater monitoring and this information is included in *Appendix 5.4*.

Borehole WS18, which is located in the east of the site, detected groundwater 0.45m and 0.87m below ground level. All other boreholes across the site where the proposed development will be located detected groundwater at depths greater than 2m below ground

[9] JBA Consulting (2015) **Coventry City Level 1 and 2 Strategic Flood Risk Assessment** (Available from: http://www.coventry.gov.uk/downloads/file/19112/coventry_sfra_final_report_2015)

[10] EA (2018) **Long term flood risk map for England** (Available from: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?map=RiversOrSea)

level. This indicates that the high groundwater table at borehole WS18 is localised to that part of the site.

Overall, the site is at low risk of groundwater flooding.

Surface Water Drainage

Discussions with members of the public during the public consultation on 26th June 2018 reported that the 150mm diameter combined sewer along Fivefield Road has flooded in the past during heavy rainfall. This is likely to be due to this sewer being under-capacity. This sewer is outside the site's boundary and is operated and maintained by STW so it will therefore be subject to ongoing monitoring and maintenance by STW to prevent future flooding. No sewer flood incidents have been reported within the site's boundary from the 150mm diameter foul public sewer.

The EA's Flood Risk from Reservoir mapping shows that the site is not at risk of being inundated due to failure of reservoirs.

There are three artificial ponds which will be removed during construction to facilitate development of the site.

The two ponds at the east of the site outfall into an overflow ditch which connects into a small pond to the south that is located outside the site boundary. Surface water from this pond subsequently flows south along the eastern boundary into a minor ditch, which connects into the Hall Brook at the south eastern corner of the site.

The third pond is located at the south east of the main site. No outfall was located on this pond and it is likely that if this pond exceeds its capacity, water will flow south east towards the Hall Brook. Due to the embankment surrounding the pond, there is a residual risk of flooding if this embankment fails and releases a high volume of water into the Hall Brook, which could potentially cause a risk of flooding downstream.

As the artificial ponds will not be retained as part of the proposed development, there will be no flood risk from these sources.

Table 5.5 provides a summary of the potential risks posed by different flooding sources for the existing site.

Table 5.5 – Summary of Baseline Flood Risks from All Sources

Source	Potential Flood Risk to Site			
	High	Medium	Low	None
Fluvial				✓
Pluvial (surface water)			✓	
Groundwater			✓	
Tidal				✓
Reservoir				✓
Artificial waterbodies (to be removed)				✓
Artificial drainage systems				✓

The existing agricultural buildings on-site either drain to a private drainage system below ground or use rainwater harvesting to provide water for the livestock in the fields. Further investigation on this will be required in due course.

The remainder of the site drains via the natural topography of the land at greenfield runoff rates. Consequently, surface water runoff will primarily flow towards the Hall Brook located in the centre of the site. Some surface water may enter the ponds located within the site before flowing into the Hall Brook. Surface water in the north western site will flow towards the Ancient Woodland located to the north east of the site before gravitating towards the Hall Brook. Soakage tests conducted to BRE 365 standards (see *Appendix 5.4*) indicate that the site has limited infiltration into the ground so the majority of surface water from the site will runoff into the Hall Brook.

5.4.2 Surface Water Receptors

Surface water runoff from the site will affect the water quality of the surrounding area. The main surface water receptor is the Hall Brook watercourse, which is part of the River Sowe catchment (Sowe - Conf Breach Bk to conf Withy Bk).

The EA uses the Water Framework Directive to classify the water quality of surface waters found in main rivers. This combines several river characteristics to determine an overall water quality classification for the river based on ecological and chemical components[11].

The EA have assessed the water quality status of the River Sowe catchment (waterbody ID: GB109054044110), with the most recent available assessment being carried out in 2016[12]. The results of this assessment indicated that this catchment had a poor water quality status due to the ecological component being ranked as poor.

The Warwickshire Avon Catchment Plan[13] identifies the Coventry Brooks and Rivers as a priority sub-catchment area for enhancement.

The site is not located within a drinking water safeguard zone for surface water.

It is also likely that the existing pond located by Hall Brook would receive some surface water runoff and act as a receptor for surface water. The current water quality of this pond is unknown and has not been fully assessed to date.

5.4.3 Groundwater Receptors

A Phase II Ground Investigation conducted soakage tests on the site (*Appendix 5.4*).

The results indicate that infiltration rates on-site are very low and consequently, it is likely that there would be limited groundwater recharge from the site. However, groundwater monitoring undertaken as part of the Phase II Ground Investigation detected high groundwater in borehole WS18, located near to the north eastern ponds. Therefore, there is the possibility that these ponds are linked to a perched groundwater table in this location and groundwater recharge could occur through these ponds.

---

[11] EA (2011) **WFD Classification Method Statement** (Available from: http://www.thames21.org.uk/wp-content/uploads/2012/09/Classification-Method-Statement-FINAL.pdf)

[12] EA (2016) **EA – CDE – Sowe – conf Breach Bk to conf Withy Bk** (Available from: http://environment.data.gov.uk/catchment-planning/WaterBody/GB109054044660)

[13] Warwicjshire Avon Catchment Partnership (2017) **Warwickshire Avon Catchment Plan** (Available from: http://severnriverstrust.com/wp-content/uploads/2017/04/Warwickshire-Avon-Catchment-Plan.pdf)

5.4.4 Water Resources

As foul water drainage is not strictly an environmental receptor, this is addressed solely in the Flood Risk Assessment and Drainage Strategy included in *Appendix 5.1*.

5.5 Mitigation Measures

This section proposes several mitigation measures to be implemented in the construction and occupation phase of the proposed development. These measures will reduce the risks from the proposed development to the water environment.

5.5.1 Inherent Mitigation Measures

Flood Risk and Drainage

The proposed development does not locate buildings in the surface water flood extents of the Hall Brook to minimise the risk to the buildings and future residents. This will also ensure that there is no displacement of water from the flood extents of the Hall Brook, so flood risk downstream of the site will not be affected.

The proposed layout includes several paths that will cross the Hall Brook to link the development on either side of the watercourse. A bridge to link these paths will be designed to ensure that flows will not be impeded for the 1 in 100 year return period with a 35% allowance for climate change (EA higher central allowance category for peak river flows in the Severn River Basin), with the bridge's soffit set at least 300mm above the Hall Brook water level for this event.

It is proposed that the finished floor levels (FFLs) of all proposed buildings close to the watercourse are set at least 300mm above the 1 in 100 year water levels, plus 35% climate change. The finished floor level of all other buildings will be set at least 150mm above ground level. This will reduce the flood risk to future residents from both the Hall Brook and surface water runoff across the site.

A Drainage Strategy has been produced and is shown in *Appendix 5.1*. A summary of the key points of this strategy are included below:

- The drainage system will protect the proposed development from flooding up to and including a 1 in 100 year storm event, plus 40% climate change (for rainfall intensity).
- Soakage tests to BRE 365 standards (see *Appendix 5.4*) have indicated that infiltration rates are insufficient to allow disposal of surface water via infiltration. Therefore, surface water runoff will be discharged into the Hall Brook at the agreed greenfield runoff rate of 5 litres per second to minimise flood risk downstream. No surface water will be discharged to the public sewers or public highways located around the site.
- Surface water runoff from the site will be managed by SuDS. A variety of SuDS will be utilised including cascading attenuation basins, swales and permeable paving. This will attenuate surface water runoff from the proposed development on-site.
- SuDS will provide additional ecological and amenity benefits.
- To ensure that these systems are fully functional, it is important that these systems are properly maintained. Therefore, a maintenance plan has been proposed as part of the Flood Risk Assessments (*Appendix 5.1*).

Consequently, the drainage system will minimise the flood risk from surface water runoff on-site and would not increase flood risk elsewhere.

Surface Water Receptors

Surface water runoff from the drainage system will be discharged into the Hall Brook. To ensure that the water entering the Hall Brook receives adequate treatment for water quality, the SuDS components have been assessed in the Flood Risk Assessments (*Appendix 5.1*) using the simple index method set out in CIRIA (C753) The SuDS Manual.

This assessment confirmed that the pollution mitigation offered by the swales and attenuation basins exceeds the requirements of C753. Therefore, this confirms that the correct level of water treatment will be provided for surface water runoff before it enters the Hall Brook.

There are opportunities to enhance Hall Brook as part of a riparian corridor, which would include:

- Removing existing culverts within the Hall Brook and replacing with a naturalised channel.
- Modifying and protecting river banks with plants.
- Managing the existing vegetation to maximise the riparian habitat potential.

Alterations to the watercourse will require the consent of the LLFA and should not increase flood risk downstream of the Hall Brook.

Groundwater Receptors

Due to the limited infiltration into groundwater, the removal of the artificial ponds and the surface water drainage system discharging into the Hall Brook, no mitigation is proposed for groundwater receptors.

5.5.2 Standard Mitigation Measures

Standard construction mitigation measures will be implemented during the construction phase to prevent impacts on flood risk, surface water receptors and groundwater receptors. These are set out in the draft Construction Environmental Management Plan (CEMP) in *Appendix 4.1*.

5.5.3 Actionable Mitigation Measures

No actionable mitigation measures are proposed.

5.6 Assessment of Environmental Impacts

5.6.1 Impact Assessment

Construction Phase

Flood Risk

With the proposed mitigation measures in place, the proposed development will have a **negligible** effect on the flood risk of the site or the wider area.

For further clarification of the impact the construction phase is expected to have on flood risk, please refer to *Table 5.6*.

Surface Water Receptors

The water quality of Hall Brook should not be affected during construction if all the mitigation measures proposed are implemented and adhered to. Therefore, the construction phase is predicted have **a negligible** effect on the Hall Brook.

Groundwater Receptors

Infiltration rates into the ground are low and the proposed drainage system will discharge surface water into the Hall Brook. However, if groundwater is encountered as a result of excavations on-site, the proposed mitigation measures will minimise the effect the construction phase will have on groundwater quality. The mitigation measures proposed for surface water receptors should also ensure that groundwater is protected.

Consequently, there is expected to be a **negligible** effect on groundwater from the construction phase of the proposed development.

Table 5.6 - Summary of Impact Assessment – Construction Phase						
Receptor	**Sensitivity/ Importance/ Value**	**Description of Impact**	**Inherent & Standard Mitigation Measures**	**Nature of Effect**	**Type of Effect**	**Significance of Effect**
Human Population	High	Flood risk downstream of the Hall Brook	Discharge into the Hall Brook, either from surface water runoff or groundwater, will be released at the agreed greenfield runoff rates for the site, with on-site storage provided. For construction mitigation see draft CEMP in *Appendix 4.1*.	Negligible	Temporary Medium-term Indirect	Negligible
		Flood risk to the site from the Hall Brook.	No location of structures, equipment or plant within the Hall Brook surface water flood extents. For construction mitigation see draft CEMP in *Appendix 4.1*.	Negligible	Temporary Medium-term Direct	Negligible
		Flood risk to the site from surface water.	For construction mitigation see draft CEMP in *Appendix 4.1*.	Negligible	Temporary Medium-term Direct	Negligible
		Flood risk to the site from groundwater	For construction mitigation see draft CEMP in *Appendix 4.1*.	Negligible	Temporary Medium-term Direct	Negligible
		Flood risk from artificial sources	Artificial ponds shall be removed. For construction mitigation see draft CEMP in *Appendix 4.1*.	Negligible	Temporary Short-term Indirect	Negligible

Hall Brook	Low	Water quality	For construction mitigation see draft CEMP in *Appendix 4.1*.	Negligible	Temporary Medium-term Direct and/or Indirect	Negligible
Groundwater	High	Water quality	For construction mitigation see draft CEMP in *Appendix 4.1*.	Negligible	Permanent Medium-term Direct	Negligible

Occupation Phase

Flood Risk

By storing water on-site and discharging at the agreed rate, there will be no significant increase in flows within the Hall Brook. The Hall Brook channel and flood extents will remain undeveloped, so there will be no expected increase in flood risk downstream. Flood risk to the proposed development has been managed and reduced to levels that are not significant.

With the proposed mitigation in place, the proposed development will have a **negligible** effect on the flood risk of the site and the wider area.

Surface Water Receptors

The proposed development will have a **moderate beneficial** effect on the Hall Brook by utilising techniques to enhance the Hall Brook riparian corridor. This will improve the riparian habitats and biodiversity along the watercourse. This will have additional beneficial effect downstream of the Hall Brook and contribute to improving the overall Water Framework Directive status of the Sowe catchment.

Groundwater Receptors

There will be **negligible** effects on groundwater due to the lack of infiltration identified from soakage tests conducted on-site.

Surface water runoff will be discharged into the Hall Brook watercourse, via SuDS, and therefore, surface water runoff is not expected to affect the groundwater below the site.

Table 5.6 - Summary of Impact Assessment – Occupation Phase						
Receptor	**Sensitivity/ Importance/ Value**	**Description of Impact**	**Inherent & Standard Mitigation Measures**	**Nature of Effect**	**Type of Effect**	**Significance of Effect**
Human Population	High	Flood risk downstream of the Hall Brook	Surface water runoff to be stored on-site and discharged at the agreed rate. No removal of watercourse structures that may increase Hall Brook flows. No addition of buildings within the Hall Brook flood extents. Paths crossing the Hall Brook will not restrict the watercourse flows.	Negligible	Temporary Long-term Indirect	Negligible
		Flood risk to the site from the Hall Brook.	No location of structures in the Hall Brook flood extents. Set finished flood level above the flood extents.	Negligible	Temporary Long-term Direct	Negligible
		Flood risk to the site from surface water.	To be managed by SuDS.	Negligible	Temporary Long-term Direct	Negligible
		Flood risk to the site from groundwater	Flood resistant and resilient techniques will be used for at least 600m above the water table. No basements or reduction in ground levels will take place where high groundwater is detected.	Negligible	Temporary Long-term Direct	Negligible
Hall Brook	Medium	Water quality	Using appropriate SuDS to provide treatment for surface water runoff. Use river restoration techniques to improve the Hall Brook riparian corridor.	Medium Positive	Temporary Long term Direct	Moderate Beneficial
	Medium	Riparian habitats	Use river restoration techniques to enhance the Hall Brook riparian corridor.	Medium Positive	Temporary Long term Direct	Moderate Beneficial
Groundwater	High	Water quality	N/A	Negligible	Permanent Long-term Direct	Negligible

5.6.2 Residual Impact Assessment

As no actionable mitigation is proposed, residual effects will be as set out in *Section 5.6.1*.

5.7 Cumulative Impact Assessment

5.7.1 Flood Risk and Drainage

In combination with development of the wider Keresley SUE, surface water runoff into the Hall Brook will be reduced below greenfield runoff rates by attenuating surface water on-site through the use of SuDS. The reduction in surface water runoff will be highest for the larger storm events, which is when surface water flooding is most likely to occur.

This will reduce the flood risk of urban areas downstream of the Hall Brook and will have a cumulative **moderate beneficial** effect on surface water flood risk off-site.

5.7.2 Surface Water Receptors

The cumulative effects of the occupational phase of the wider Keresley SUE to the Hall Brook is likely to have a **minor beneficial** effect on the watercourse.

Water treatment with SuDS will be provided for development of the SUE, while enhancement of the Hall Brook riparian corridor will improve both the water quality and biodiversity value of the Hall Brook.

5.7.3 Groundwater Receptors

With suitable mitigation measures implemented during both the construction and occupation phases, the cumulative effects on groundwater quality would be **negligible**.

5.8 Summary

This ES Chapter has assessed the likely significant environmental effects on the water environment of the construction and occupation phases of the proposed development. This includes assessing the effects on flood risk, drainage, water quality and water resources.

The proposed development has the potential to affect:

- The flood risk to the general population, both on and off site
- Existing surface water receptors including the Hall Brook.
- Groundwater.

Measures have been incorporated into design of the proposed development though an appropriate Drainage Strategy to mitigate potential effects during the occupation phase. Standard mitigation measures are also proposed for the construction phase and will form part of a Construction Environment Management Plan.

After the proposed mitigation measures have been implemented, the construction phase is expected to have **negligible** effects on the flood risk and water quality of surface water and groundwater receptors.

The occupation phase is expected to a have a **moderate beneficial** effect on the water quality and ecology of the Hall Brook. Potential effects on flood risk on-site and off-site, and water quality of groundwater receptors are expected to be **negligible** with the proposed mitigation in place.

Cumulative effects with development of the wider Keresley SUE are expected to result in **moderate beneficial** effects on flood risk and **minor beneficial** effects on water quality within the Hall Brook, with all other effects deemed to be **negligible**.

Figure 5.1: Flood Zone Plan from SRFA