6.9 Flood warning and emergency planning

6.9.1 Emergency planning

Emergency planning is one option to help manage flood related incidents. From a flood risk perspective, emergency planning can be broadly split into three phases: before, during and after a flood. The measures involve developing and maintaining arrangements to reduce, control or mitigate the impact and consequences of flooding and to improve the ability of people and property to absorb, respond to and recover from flooding.

6.9.2 NPPF

In development planning, a number of emergency planning activities are already **integrated** in national building control and planning policies e.g. the NPPF Flood Risk Vulnerability and Flood Zone 'Compatibility' table seeks to avoid inappropriate development in areas at risk from all sources of flooding. However; safety is a key consideration for any new development and includes residual risk of flooding, the availability of adequate flood warning systems for the development, safe access and egress routes and evacuation procedures.

The NPPF Planning Practice Guidance outlines how developers can ensure safe access and egress to and from development in order to demonstrate that development satisfies the second part of the Exception Test. As part of an FRA, the developer should review the acceptability of the proposed access in consultation with Solihull Metropolitan Borough Council (where appropriate) and the Environment Agency.

There are circumstances where a flood warning and evacuation plan[12] is required and / or advised:

- It is a requirement under the NPPF that a flood warning and evacuation plan is prepared for sites at risk of flooding used for holiday or short-let caravans and camping and are important at any site that has transient occupants (e.g. hostels and hotels) and for essential ancillary sleeping or residential accommodation for staff required by uses in this category [water-compatible development], subject to a specific warning and evacuation plan.
- The Environment Agency and DEFRAs standing advice for undertaking flood risk assessments for planning applications states that details of emergency escape plans will be required for any parts of the building that are below the estimate flood level.

It is recommended that Emergency Planners at Solihull Metropolitan Borough Council (where appropriate) are consulted prior to the production of any emergency flood plan.

In addition to the flood warning and evacuation plan considerations listed in the NPPF / PPG, it is advisable that developers also acknowledge the following:

- How to manage the consequences of events that are un-foreseen or for which no warnings can be provided e.g. managing the residual risk of a breach.
- Proposed new development that places additional burden on the existing response capacity of the Councils will not normally be considered to be appropriate.
- Developers should encourage those owning or occupying developments, where flood warnings can be provided, to sign up to receive them. This applies even if the development is defended to a high standard.
- The vulnerability of site occupants.
- Situations may arise where occupants cannot be evacuated (e.g. prisons) or where it is safer to remain "in-situ" and / or move to a higher floor or safe refuge area (e.g. at risk of a breach). These allocations should be assessed against the outputs of the SFRA and where applicable, a site-specific Flood Risk Assessment to help develop emergency plans.

Further emergency planning information links:

- 2004 Civil Contingencies Act
- DEFRA (2014) National Flood Emergency Framework for England

12 Flood warning and evacuation plans may also be referred to as an emergency flood plan or flood response plan.

- How to register with the Environment Agency's Flood Warnings Direct service
- National Flood Forum
- GOV.UK Make a Flood Plan guidance and templates
- FloodRe
- Coventry, Solihull and Warwickshire Council resilience team website

6.9.3 Flood warnings

Emergency planning is one option to help manage flood related incidents. From a flood risk perspective, emergency planning can be broadly split into three phases: before, during and after a flood. The measures involve developing and maintaining arrangements to reduce, control or mitigate the impact and consequences of flooding and to improve the ability of people and property to absorb, respond to and recover from flooding.

Flood warnings can be derived and, along with evacuation plans, can inform emergency flood plans or flood response plans. The Environment Agency is the lead organisation for providing warnings of fluvial flooding (for watercourses classed as Main Rivers) and coastal flooding in England. Flood Warnings are supplied via the Floodline Warnings Directive (FWD) service, to homes and business within Flood Zones 2 and 3.

Within the borough, there are four flood alert areas (FAA) and six flood warning areas (FWA). These are shown in Appendix B.

6.10 Cross boundary considerations

The topography and location of the borough means that all the major watercourses such as the River Blythe and River Cole flow through the study area. As such, future development, both within and outside the borough can have the potential to affect flood risk to existing development and surrounding areas, depending on the effectiveness of SuDS and drainage implementation. Solihull has boundaries with the following Local Authorities:

- Birmingham City Council
- Bromsgrove District Council
- Coventry City Council
- North Warwickshire Borough Council
- Stratford-on-Avon District Council
- Warwick District Council

Neighbouring authorities were contacted and, where possible, Local Plans and SFRAs were reviewed to assess whether there are any proposed developments that may affect flood risk in the borough. Details of any known cross-boundary flooding issues were also requested. Based on the responses received, there is nothing to suggest there will be any developments proposed in neighbouring authorities that would adversely affect flood risk within Solihull. None of the neighbouring authorities reported any known cross boundary flooding issues.

The only notable reference to potential cross-boundary issues was in the LFRMS. In times of flood, foul water can enter the surface water network (as stated in the River Trent CFMP) and negatively impact water quality in the Tame, Anker and Mease sub-catchments.

Development control should ensure that the impact on receiving watercourses from development in Solihull has been sufficiently considered during the planning stages and appropriate mitigation measures put in place to ensure there is no adverse impact on flood risk or water quality. The Water Management policy P11, listed in the LFRMS, refers to ensuring that there is no deterioration of water quality and that where possible, development should seek to reduce the flood risk to third party land.

Table 6-4: Summary of flood risk in Solihull Metropolitan Borough

Settlement	Fluvial flood risk	Surface water flood risk	Reservoir inu
Balsall Common	Elevated above the surrounding watercourses, Balsall Common is located in Flood Zone 1. Whilst there is the River Blythe Tributary and two unnamed drains which are not covered by the Environment Agency's Flood Zones given the topographical location it is unlikely to flood from fluvial sources.	The majority of surface water flood risk falls to areas in the vicinity of the River Blythe Tributary, and two unnamed drains in the west and north east. Additional risk is predominantly confined to dry valleys leading to the three watercourses which present significant risk to properties.	None
Meriden	As the watercourses in the vicinity of the settlement are classed as Ordinary Watercourses, fluvial flood risk is not shown in the Environment Agency's Flood Zones. Fluvial flood risk could potentially come from the primary flow path of an unnamed drain which flows under the B4104.	Surface water flooding up to the 1% AEP is relatively minor with small flow routes following roads such as Leys Lane. However, at 0.1% AEP a significant flow route is present from Alspath Road, crossing The Croft and Main Road, flooding predominately open spaces and gardens, towards the unnamed drain and lake near Meriden Hall in the south. There is also significant risk to properties in the vicinity of the unnamed watercourse in the west of Meriden.	There is medium to low inundation in Meriden s
Hampton in Arden	The majority of Hampton in Arden is situated on relatively high ground west of the railway. This area is located in Flood Zone 1 as it is elevated from the watercourses surrounding it. Properties east of the railway along Lapwing Drive and The Crescent are split by the primary flow path of an unnamed drain. Although the Flood Zones do not extend as far as Hampton in Aden, the surrounding flood plains are flat, wide and would act as a flow route during flood events.	The majority of surface water flood risk falls to areas in the vicinity of existing watercourses with additional risk predominantly confined to roads such as High Street and Meriden Road	None
Dorridge	The primary fluvial flood risk in Dorridge is the unnamed drain in the south which has many properties in its immediate vicinity, as well as an unnamed tributary of the River Blythe and Cuttle Brook. The majority of properties are located on elevated land and located in Flood Zone 1. The rivers which rise within Dorridge are ordinary watercourses and are not covered by the Environment Agency's Flood Zones; however, given the topography of the area it is unlikely to flood from fluvial sources.	The surface water flood risk to Dorridge is predominantly via run-off from surrounding dry valleys towards the surrounding watercourses. In the 0.1% AEP event there is significant areas of ponding on Conker Lane (path) with the surface water extent causing risk to properties in the area.	None
Marston Green	The Flood Zones along the Low Brook in Marston Green are narrow north of the railway covering a few properties on Sycamore Crescent and Farndon Avenue. However, north of Alcott Lane, Flood Zone 2 is comparatively wider covering properties in Gloucester Way, Lincoln Grove and Cambridge Drive as Low Brook and Hatchford Brook meet at their confluence. A few properties along Holly Lane are within Flood Zone 2. South of the railway the Flood Zones are wide and cover buildings associated with Birmingham International Airport.	Surface water flooding is largely confined to the close vicinity of existing watercourses. Mapping also shows surface water ponding in open spaces and gardens. However, there is a large flow route through Birmingham International Airport towards Low Brook. .	None
Knowle	As the watercourses in the vicinity of the settlement are small, fluvial flood risk is not shown in the Environment Agency's Flood	The majority of properties within Knowle are not within surface water flood risk extents. However, properties in the vicinity of the Purnell's	None

Settlement	Fluvial flood risk	Surface water flood risk	Reservoir inu
Kingshurst	Flood Zones show the main fluvial flood risk is from the River Cole, which flows from west to east through the south of Kingshurst. The Flood Zones are located predominantly within the rural flood plain and with limited impact upon the settlement. The exception is Corinne Croft and Ford Bridge where several properties are located in Flood Zones 2 and 3.	The majority of properties in Kingshurst are not within surface water extents. Areas at risk tend to be roads, which are conduits for run-off from the surrounding hills (e.g. Gilson Way, Fordbridge Road, Meriden Drive). There are a few properties at risk along Fordbridge Road during the 0.1% AEP event.	None
Castle Bromwich	Castle Bromwich is not located near any Main Rivers or Ordinary Watercourses and is entirely located within Flood Zone 1.	The majority of properties within Castle Bromwich are not within surface water extents in the 1% AEP event. However; a significant number of overland flow routes, via local roads and dry valleys, present a risk to properties in the higher return periods.	None
Solihull	Flood Zones show the main fluvial flood risk is from the River Cole, Westly Brook, Hatchford Brook, Alders Brook and an unnamed drain through Hillfield. Although the Flood Zones on these main watercourses are narrow due to the densely urbanised nature of Solihull they provide significant flood risk to properties.	Mapping shows surface water flood risk for the 1% AEP event in Solihull is relatively minor, with ponding on roads and in open space, with a minor flow route following the River Cole in the south east. However, in the 0.1% AEP event the surface water extent covers significant amount of Solihull with the majority of the road network at risk from surface water flooding. Properties in the vicinity of existing watercourses and flow routes through dry valleys are at risk in the higher return periods.	Inundation from Olton r properties in Ulverley G Elmdon, with high risk f Ulverley Green and Olt
Dickens Heath	Flood risk from the majority of the watercourses flowing through Dickens Heath are not shown in the Environment Agency's Flood Zones. However, there is potentially some fluvial flood risk from numerous unnamed drains and residual risk from breaches of the Stratford-upon-Avon canal.	Mapping shows surface water flood risk in Dickens Heath is in isolated pockets in the 1% AEP, the largest along Griffin Lane with several notable flow routes following existing watercourses including the Stratford-upon-Avon canal. However, risk is widespread in the 0.1% AEP, following the path of the roads and waterways. Numerous residential and commercial areas are at risk from a 0.1% AEP. Areas most affected include Yarn Lane and Rumbush Lane.	None
Cheswick Green	Cheswick Green is partially located within Flood Zones 2 and 3 of the River Blythe and Mount Brook; the majority of properties within the Flood Zones are located in the south west at the confluence of the two watercourses, primarily along Coppice Walk, Cheswick Way and Watery Lane.	The majority of surface water flood risk falls to areas in the vicinity of existing watercourses with additional risk predominantly confined to roads and ponding in rural areas and gardens. Areas notably at risk include Coppice Walk, Watery Lane and Saxon Wood Road. The majority of risk is from a 1% or higher AEP event.	Inundation from Earlsw affect Cheswick Green the south of the village River Blythe

7 FRA requirements and flood risk management guidance

7.1 Over-arching principles

This SFRA focuses on delivering a strategic assessment of flood risk within Solihull Metropolitan Borough. Due to the strategic scope of the study, prior to any construction or development, site-specific assessments will need to be undertaken for individual development proposals (where required) so all forms of flood risk at a site are fully addressed. It is the responsibility of the developer to provide an FRA with an application.

It should be acknowledged that a detailed FRA may show that a site is not appropriate for development of a particular vulnerability or even at all. Where the FRA shows that a site is not appropriate for a particular usage, a lower vulnerability classification may be appropriate.

7.2 Requirements for site-specific flood risk assessments

7.2.1 What are site specific FRAs?

Site specific FRAs are carried out by (or on behalf of) developers to assess flood risk to and from a site. They are submitted with planning applications and should demonstrate how flood risk will be managed over the development's lifetime, taking into account climate change and vulnerability of users.

Paragraph 068 of the NPPG Flood Risk and Coastal Change Planning Practice Guidance sets out a checklist for developers to assist with site specific flood risk assessments.

Site specific FRAs are required in the following circumstances:

- Proposals for new development (including minor development and change of use) in Flood Zones 2 and 3
- Proposals for new development (including minor development and change of use) in an area within Flood Zone 1 which has critical drainage problems (as notified to the LPA by the Environment Agency)
- Proposals of 1 hectare or greater in Flood Zone 1
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding
- Proposals of less than one hectare in Flood Zone 1 where they could be affected by sources of flooding other than rivers and the sea (e.g. surface water)

7.2.2 Objectives of site specific FRAs

Site specific FRAs should be proportionate to the degree of flood risk, as well as appropriate to the scale, nature and location of the development. Site specific FRAs should establish

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether a proposed development will increase flood risk elsewhere;
- whether the measures proposed to deal with the effects and risks are appropriate;
- the evidence, if necessary, for the local planning authority to apply the Sequential Test; and
- whether, if applicable, the development will be safe and pass the Exception Test.

FRAs for sites located in Solihull should follow the approach recommended by the NPPF (and associated guidance) and guidance provided by the Environment Agency and Solihull Metropolitan Borough Council. Guidance and advice for developers on the preparation of site specific FRAs include

- Standing Advice on Flood Risk (Environment Agency);
- Flood Risk Assessment for Planning Applications (Environment Agency); and
- Site-specific Flood Risk Assessment: CHECKLIST (NPPF PPG, Defra).

Guidance for local planning authorities for reviewing flood risk assessments submitted as part of planning applications has been published by Defra in 2015 – Flood Risk Assessment: Local Planning Authorities.

7.3 Flood risk management guidance – mitigation measures

Mitigation measures should be seen as a last resort to address flood risk issues. Consideration should first be given to minimising risk by planning sequentially across a site. Once risk has been minimised as far as possible, only then should mitigation measures be considered.

7.3.1 Site layout and design

Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development.

The NPPF states that a sequential, risk-based approach should be applied to try to locate more vulnerable land use away from flood zones, to higher ground, while more flood-compatible development (e.g. vehicular parking, recreational space) can be located in higher risk areas. However, vehicular parking in floodplains should be based on the nature of parking, flood depths and hazard including evacuation procedures and flood warning.

Waterside areas, or areas along known flow routes, can act as Green Infrastructure, being used for recreation, amenity and environmental purposes, allowing the preservation of flow routes and flood storage, and at the same time providing valuable social and environmental benefits contributing to other sustainability objectives. Landscaping should ensure safe access to higher ground from these areas, and avoid the creation of isolated islands as water levels rise.

7.3.2 Making space for water

The NPPF sets out a clear policy aim in Flood Zone 3 to create space for flooding by restoring functional floodplain.

All new development close to rivers should consider the opportunity presented to improve and enhance the river environment. Developments should look at opportunities for river restoration and enhancement as part of the development. Options include backwater creation, de-silting, in-channel habitat enhancement and removal of structures. When designed properly, such measures can have benefits such as reducing the costs of maintaining hard engineering structures, reducing flood risk, improving water quality and increasing biodiversity. Social benefits are also gained by increasing green space and access to the river.

The provision of a buffer strip can 'make space for water', allow additional capacity to accommodate climate change and ensure access to the watercourse and structures is maintained for future maintenance purposes.

It also enables the avoidance of disturbing riverbanks, adversely impacting ecology and having to construct engineered riverbank protection. Building adjacent to riverbanks can also cause problems to the structural integrity of the riverbanks and the building itself, making future maintenance of the river much more difficult.

Solihull Metropolitan Borough Council can use Section 106 agreements of the Town and Country Planning Act 1990 to use planning to manage flood risk; in line with the 'Making Space for Water' concept, Section 106 agreements can be put in place to ensure new SuDS features will be maintained in the future.

Catchment and floodplain restoration

Floodplain restoration represents the most sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state, and by creating space for naturally functioning floodplains working with natural processes.

Although the restoration of floodplain is difficult in previously developed areas where development cannot be rolled back, the following measures should be adopted:

- Promoting existing and future brownfield sites that are adjacent to watercourses to naturalise banks as much as possible. Buffer areas around watercourses provide an opportunity to restore parts of the floodplain
- Removal of redundant structures to reconnect the river and the floodplain. There are a number of culverted sections of watercourse located throughout the district which if returned to a more natural state would potentially reduce flood risk to the local area
- Apply the Sequential Approach to avoid new development within currently undefended floodplain.

For those sites considered within the Local Plan and / or put forward by developers, that also have watercourses flowing through or past them, the sequential approach should be used to locate development away from these watercourses. This will ensure the watercourses retain their connectivity to the floodplain. Loss of floodplain connectivity in rural upper reaches of tributaries which flow through urban areas in the District, could potentially increase flooding within the urban areas. This will also negate any need to build flood defences within the sites. It is acknowledged that sites located on the fringes of urban areas within the district are likely to have limited opportunity to restore floodplain in previously developed areas.

7.3.3 Raised floor levels

The raising of internal floor levels within a development avoids damage occurring to the interior, furnishings and electrics in times of flood.

If it has been agreed with the Environment Agency that, in a particular instance, the raising of floor levels is acceptable finished flood levels should be set a minimum of 600mm above the 1% AEP plus climate change peak flood level. The additional height that the floor level is raised above the maximum water level is referred to as the “freeboard”. Additional freeboard may be required because of risks relating to blockages to the channel, culvert or bridge and should be considered as part of an FRA.

Allocating the ground floor of a building for less vulnerable, non-residential, use is an effective way of raising living space above flood levels.

Single storey buildings such as ground floor flats or bungalows are especially vulnerable to rapid rise of water (such as that experienced during a breach). This risk can be reduced by use of multiple storey construction and raised areas that provide an escape route. However, access and egress would still be an issue, particularly when flood duration covers many days.

Similarly, the use of basements should be avoided. Habitable uses of basements within Flood Zone 3 should not be permitted, whilst basement dwellings in Flood Zone 2 will be required to pass the Exception Test. Access should be situated 600mm above the design flood level and waterproof construction techniques used.

7.3.4 Development and raised defences

Construction of localised raised floodwalls or embankments to protect new development is not a preferred option, as a residual risk of flooding will remain. Compensatory storage must be provided where raised defences remove storage from the floodplain. It would be preferable for schemes to involve an integrated flood risk management solution.

Temporary or demountable defences are not acceptable forms of flood protection for a new development but might be appropriate to address circumstances where the consequences of residual risk are severe. In addition to the technical measures the proposals must include details of how the temporary measures will be erected and decommissioned, responsibility for maintenance and the cost of replacement when they deteriorate.

7.3.5 Modification of ground levels

Modifying ground levels to raise the land above the required flood level is an effective way of reducing flood risk to a particular site in circumstances where the land does not act as conveyance for flood waters. However, care must be taken at locations where raising ground levels could adversely affect existing communities and property; in most areas of fluvial flood risk, raising land above the floodplain would reduce conveyance or flood storage in the floodplain and could adversely impact flood risk downstream or on neighbouring land.

Compensatory flood storage should be provided, and would normally be on a level for level, volume for volume basis on land that does not currently flood but is adjacent to the floodplain (in order for it to fill and drain). It should be in the vicinity of the site and within the red line of the planning application boundary.

Raising ground levels can also deflect flood flows, so analyses should be performed to demonstrate that there are no adverse effects on third party land or property.

Raising levels can also create areas where surface water might pond during significant rainfall events. Any proposals to raise ground levels should be tested to ensure that it would not cause increased ponding or build-up of surface runoff on third party land.

Any proposal for modification of ground levels will need to be assessed as part of a detailed flood risk assessment.

7.3.6 Developer contributions

In some cases, and following the application of the sequential test, it may be necessary for the developer to make a contribution to the improvement of flood defence provision that would benefit both proposed new development and the existing local community. Developer contributions can also be made to maintenance and provision of flood risk management assets, flood warning and the reduction of surface water flooding (i.e. SuDS). The LFRMS Action Plan reinforces that developers may be required to make necessary contributions to the cost of SuDS and flood risk management activities.

DEFRA’s Flood and Coastal Risk Management Grant in Aid (FCRMGiA)[13] can be obtained by operating authorities to contribute towards the cost of a range of activities including flood risk management schemes that help reduce the risk of flooding and coastal erosion. Some schemes are only partly funded by FCRMGiA and therefore any shortfall in funds will need to be found from elsewhere when using Resilience Partnership Funding, for example local levy funding, local businesses or other parties benefitting from the scheme.

For new development in locations without existing defences, or where the development is the only beneficiary, the full costs of appropriate risk management measures for the life of the assets proposed must be funded by the developer.

However, the provision of funding by a developer for the cost of the necessary standard of protection from flooding or coastal erosion does not mean the development is appropriate as other policy aims must also be met. Funding from developers should be explored prior to the granting of planning permission and in partnership with the Council and the Environment Agency.

The appropriate route for the consideration of strategic measures to address flood risk issues is the LFRMS. The LFRMS should describe the priorities with respect to local flood risk management, the measures to be taken, the timing and how they will be funded. It will be preferable to be able to demonstrate that strategic provisions are in accordance with the LFRMS, can be afforded and have an appropriate priority.

The Environment Agency is also committed to working in partnership with developers to reduce flood risk. Where assets are in need of improvement or a scheme can be implemented to reduce flood risk, the Environment Agency request that developers contact them to discuss potential solutions.

Community Infrastructure Levy

The Community Infrastructure Levy (CIL) allows local authorities to raise funds from developers undertaking new building projects in their administrative area. The CIL rate is set locally, within a

13 Principles for implementing flood and coastal resilience funding partnerships (Environment Agency, 2012)

Charging Schedule. The CIL can be used for a variety of local infrastructure needs arising from new development in the Borough including flood defences. Further information on CIL can be found on the Councils website.

7.4 Flood risk management guidance – resistance measures

Measures designed to keep flood water out of properties and businesses.

There may be instances where flood risk to a development remains despite implementation of such planning measures as those outlined above. For example, where the use is water compatible, where an existing building is being changed, where residual risk remains behind defences, or where floor levels have been raised but there is still a risk at the 1 in 1,000-year scenario. In these cases, (and for existing development in the floodplain), additional measures can be put in place to reduce damage in a flood and increase the speed of recovery. These measures should not normally be relied on for new development as an appropriate mitigation method. Most of the measures should be regarded as reducing the rate at which flood water can enter a property during an event and considered an improvement on what could be achieved with sand bags. They are often deployed with small scale pumping equipment to control the flood water that does seep through these systems. The effectiveness of these forms of measures are often dependant on the availability of a reliable forecasting and warning system to user the measures are deployed in advance of an event. The following measures are often deployed:

Permanent barriers

Permanent barriers can include built up doorsteps, rendered brick walls and toughened glass barriers.

Temporary barriers

Temporary barriers consist of moveable flood defences which can be fitted into doorways and/or windows. The permanent fixings required to install these temporary defences should be discrete and keep architectural impact to a minimum. On a smaller scale temporary snap on covers for airbricks and air vents can also be fitted to prevent the entrance of flood water.

Community resistance measures

These include demountable defences that can be deployed by local communities to reduce the risk of water ingress to a number of properties. The methods require the deployment of inflatable (usually with water) or temporary quick assembly barriers in conjunction with pumps to collect water that seeps through the systems during a flood.

7.5 Flood risk management guidance – resilience measures

Measures designed to reduce the impact of water that enters property and businesses.

Flood-resilient buildings are designed and constructed to reduce the impact of flood water entering the building. These measures aim to ensure no permanent damage is caused, the structural integrity of the building is not compromised and the clean up after the flood is easier. Interior design measures to reduce damage caused by flooding include

- electrical circuitry installed at a higher level with power cables being carried down from the ceiling rather than up from the floor level;
- water-resistant materials for floors, walls and fixtures; and
- non-return valves to prevent waste water from being forced up bathroom and kitchen plugs, or lavatories.

7.6 Reducing flood risk from other sources

7.6.1 Groundwater

Groundwater flooding has a very different flood mechanism to any other and for this reason many conventional flood defence and mitigation methods are not suitable. The only way to fully reduce flood risk would be through building design (development form), ensuring floor levels are raised above the water levels caused by a 1 in 100-year plus climate change event. Site design would also need to preserve any flow routes followed by the groundwater overland to ensure flood risk is not increased downstream.

Infiltration SuDS can cause increased groundwater levels and subsequently may increase flood risk on or off of the site. Developers should provide evidence and ensure that this will not be a significant risk.

When redeveloping existing buildings, it may be acceptable to install pumps in basements as a resilience measure. However, for new development this is not considered an acceptable solution.

7.6.2 Surface water and sewer flooding

Developers should discuss public sewerage capacity with the water utility company at the earliest possible stage. The development must improve the drainage infrastructure to reduce flood risk on site and the wider area. It is important that a drainage impact assessment shows that this will not increase flood risk elsewhere, and that the drainage requirements regarding runoff rates and SuDS for new development are met.

If residual surface water flood risk remains, the likely flow routes and depths across the site should be modelled. The site should be designed so that these flow routes are preserved and building design should provide resilience against this residual risk.

When redeveloping existing buildings, the installation of some permanent or temporary flood-proofing and resilience measures could protect against both surface water and sewer flooding. Non-return valves prevent water entering the property from drains and sewers. Non-return valves can be installed within gravity sewers or drains within a property's private sewer upstream of the public sewerage system. These need to be carefully installed and must be regularly maintained. Consideration must also be given to attenuation and flow ensuring that flows during the 100-year plus climate change storm event are retained within the site if any flap valves shut. This must be demonstrated with suitable modelling techniques.

7.6.3 Sustainable Drainage Systems

Sustainable Drainage Systems (SuDS) aim to mimic the natural processes of greenfield surface water drainage by encouraging water to flow along natural flow routes and thereby reduce runoff rates and volumes during storm events while providing some water treatment benefits. SuDS also have the advantage of providing effective blue and green infrastructure and ecological and public amenity benefits when designed and maintained properly.

The inclusion of SuDS within developments should be seen as an opportunity to enhance ecological and amenity value, and promote green infrastructure, incorporating above ground facilities into the development landscape strategy. SuDS must be considered at the outset, during preparation of the initial site conceptual layout to ensure that enough land is given to design spaces that will be an asset to the development rather than an after-thought. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA).

More detailed guidance on the use of SuDS is providing in Section 8.

8 Surface water management and SuDS

8.1 What is meant by surface water flooding?

Surface water flooding describes flooding from sewers, drains, and ditches that occurs during heavy rainfall.

Surface water flooding includes

- **pluvial flooding:** flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (overland surface runoff) before it either enters the underground drainage network or watercourse or cannot enter it because the network is full to capacity;
- **sewer flooding:** flooding that occurs when the capacity of underground water conveyance systems is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters which may cause water to back up and flood around buildings or in built up areas. Sewer flooding can also arise from operational issues such as blockages or collapses of parts of the sewer network; and
- **overland flows entering the built up area from the rural/urban fringe:** includes overland flows originating from groundwater springs.

8.2 Role of the LLFA and Local Planning Authority in surface water management

From April 2015 local planning policies and decisions on planning applications relating to major development or major commercial development should ensure that Sustainable Drainage Systems for management of run-off are put in place. The approval of sustainable drainage solution lies with the Local Planning Authority.

In April 2015 Solihull Metropolitan Borough Council was made a statutory consultee on the management of surface water and, as a result, will be required to provide technical advice on surface water drainage strategies and designs put forward for new major developments.

Major developments are defined as

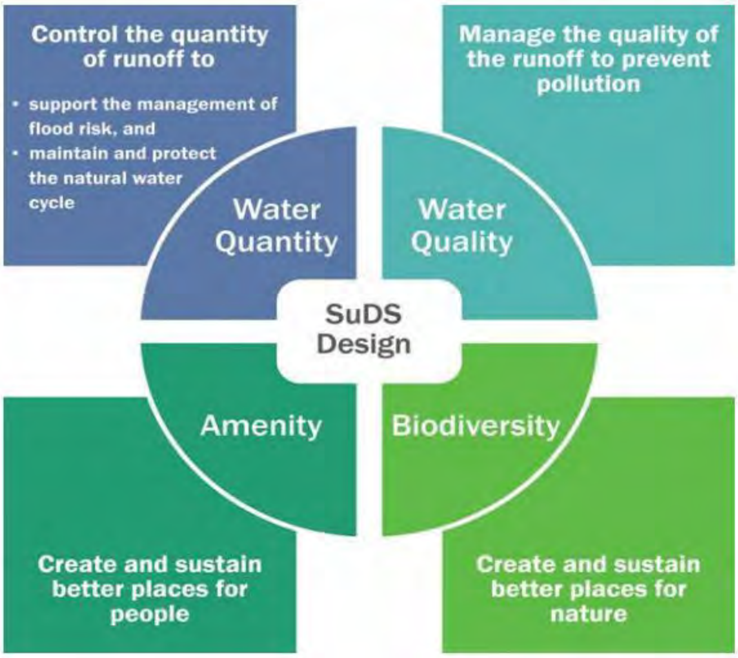
- residential development: 10 dwellings or more, or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known; and
- non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square metres or more or, where the floor area is not yet known, a site area of one hectare or more.

The LLFA will also provide advice on minor development on a non-statutory basis.

When considering planning applications, local planning authorities should seek advice from the relevant flood risk management bodies, principally the LLFA on the management of surface water (including what sort of SuDS they would consider to be reasonably practicable), satisfy themselves that the proposed minimum standards of operation are appropriate and ensure, through the use of planning conditions or planning obligations, that there are clear arrangements for on-going maintenance over the development's lifetime. Judgement on what SuDS system would be reasonably practicable should be through reference to Defra's 'Non-statutory technical standards for SuDS' document and should take into account design and construction costs.

It is essential that developers consider sustainable drainage at an early stage of the development process – ideally at the master-planning stage. This will assist with the delivery of well designed, appropriate and effective SuDS. Proposals should also comply with the key SuDS principles regarding solutions that deliver multiple long-term benefits. These four principles are shown in Figure 8-1.

Figure 8-1: Four pillars of SuDS design



Source: The SuDS Manual (C753)

8.3 Sustainable Drainage Systems (SuDS)

Sustainable Drainage Systems (SuDS) are designed to maximise the opportunities and benefits that can be secured from surface water management practices.

S SuDS provide a means of dealing with the quantity and quality of surface water whilst offering additional benefits over traditional systems of improving amenity and biodiversity. The correct use of SuDS can also allow developments to counteract the negative impact that urbanisation has on the water cycle by promoting infiltration and replenishing ground water supplies. SuDS if properly designed can improve the quality of life within a development offering addition benefits such as:

- Improving air quality
- Regulating building temperatures
- Reducing noise
- Providing education opportunities
- Cost benefits over underground piped systems

Given the flexible nature of SuDS they can be used in most situations within new developments as well as being retrofitted into existing developments. SuDS can also be designed to fit into the majority of spaces. For example, permeable paving could be used in parking spaces or rainwater gardens into traffic calming measures.

If is a requirement for all new major development proposals to ensure that Sustainable Drainage Systems for management of runoff are put in place. Likewise, minor developments should also ensure sustainable systems for runoff management are provided. The developer is responsible for ensuring the design, construction and future/ongoing maintenance of such a scheme is carefully and clearly defined, and a clear and comprehensive understanding of the existing catchment hydrological processes and existing drainage arrangements is essential.

8.3.1 Types of SuDS System

There are many different SuDS techniques that can be implemented in attempts to mimic pre-development drainage (Table 8-1). Techniques can include soakaways, infiltration trenches, permeable pavements, grassed swales, green roofs, ponds and wetlands and these do not necessarily need to take up a lot of space. The suitability of the techniques will be dictated in part by the development proposal and site conditions. Advice on best practice is available from the Environment Agency and the Construction Industry Research and Information Association (CIRIA) e.g. the CIRIA SuDS Manual C753 (2015).

Table 8-1: Examples of SuDS techniques and potential benefits

SuDS Technique	Flood Reduction	Water Quality Treatment & Enhancement	Landscape and Wildlife Benefit
Living roofs	✓	✓	✓
Basins and ponds Constructed wetlands Balancing ponds Detention basins Retention ponds	✓ ✓ ✓ ✓ ✓	✓ ✓ ✓ ✓ ✓	✓ ✓ ✓ ✓ ✓
Filter strips and swales	✓	✓	✓
Infiltration devices Soakaways Infiltration trenches and basins	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓
Permeable surfaces and filter drains Gravelled areas Solid paving blocks Porous pavements	✓ ✓ ✓ ✓	✓ ✓ ✓ ✓	
Tanked systems Over-sized pipes/tanks Storm cells	✓ ✓ ✓		

8.3.2 Treatment

A key part of the four pillars of SuDS is to provide the maximum improvement to water quality through the use of the “SuDS management train”. To maximise the treatment within SuDS, CIRIA recommends[14] the following good practice is implemented in the treatment process:

1. **Manage surface water runoff close to source:** This makes treatment easier due to the slower velocities and also helps isolate incidents rather than transport pollutants over a large area.
2. **Treat surface water runoff on the surface:** This allows treatment performance to be more easily inspected and managed. Sources of pollution and potential flood risk is also more easily identified. It also helps with future maintenance work and identifying damaged or failed components.
3. **Treat a range of contaminants:** SuDS should be chosen and designed to deal with the likely contaminants from a development and be able to reduce them to acceptably low levels.
4. **Minimise the risk of sediment remobilisation:** SuDS should be designed to prevent sediments being washed into receiving water bodies or systems during events greater than what the component may have been designed.
5. **Minimise the impact of spill:** Designing SuDS to be able to trap spills close to the source or provide robust treatment along several components in series.

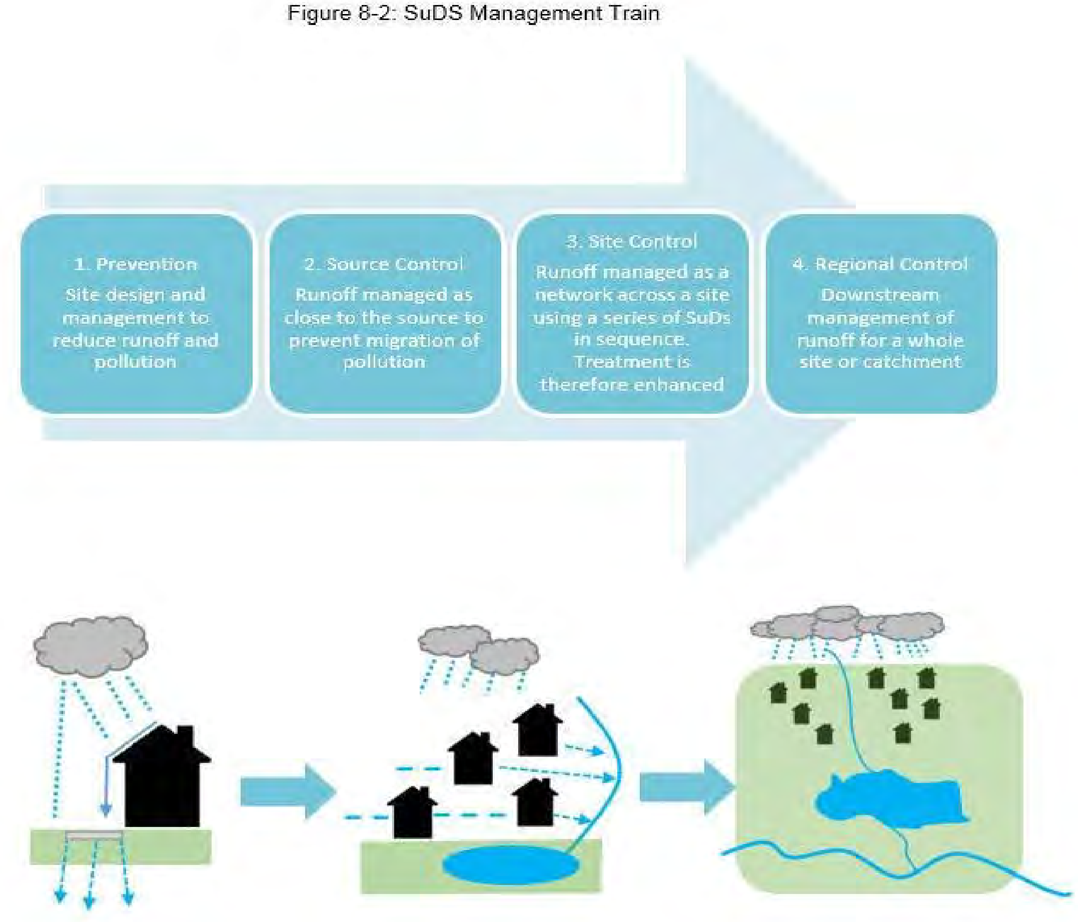
The number of treatment stages required depends primarily on the source of the runoff. A drainage strategy will need to demonstrate that an appropriate number of treatment stages are delivered.

14 C753 CIRIA SuDS Manual (2015)

8.3.3 SuDS Management

SuDS should not be used individually but as a series of features in an interconnected system designed to capture water at the source and convey it to a discharge location. Collectively this concept is described as a SuDS Management Train (see Figure 8-2). The number of treatment stages required within the Management Train depends primarily on the source of the runoff and the sensitivity of the receiving waterbody or groundwater. A drainage strategy will need to demonstrate that an appropriate number of treatment stages are delivered.

Figure 8-2: SuDS management train



SuDS components should be selected based on design criteria and how surface water management is to be integrated within the development and landscaping setting. By using a number of SuDS features in series it is possible to reduce the flow and volume of runoff as it passes through the system as well as minimising pollutants which may be generated by a development.

8.3.4 Overcoming SuDS constraints

The design of a SuDS system will be influenced by a number of physical and policy constraints. These should be taken into account and reflected upon during the conceptual, outline and detailed stages of SuDS design. Table 8-2 details some possible constraints and how they may be overcome.

Table 8-2: Example SuDS design constraints and possible solutions

Considerations	Solution
Land availability	SuDS can be designed to fit into small areas by utilising different systems. For example, features such as permeable paving and green roofs can be used in urban areas where space may be limited.

Considerations	Solution
Contaminated soil or groundwater below site	SuDS can be placed and designed to overcome issues with contaminated groundwater or soil. Shallow surface SuDS can be used to minimise disturbance to the underlying soil. The use of infiltration should also be investigated as it may be possible in some locations within the site. If infiltration is not possible linings can be used with features to prevent infiltration.
High groundwater levels	Non-infiltrating features can be used. Features can be lined with an impermeable line or clay to prevent the egress of water into the feature. Additional, shallow features can be utilised which are above the groundwater table.
Steep slopes	Check dams can be used to slow flows. Additionally, features can form a terraced system with additional SuDS components such as ponds used to slow flows.
Shallow slopes	Use of shallow surface features to allow a sufficient gradient. If the gradient is still too shallow pumped systems can be considered as a last resort.
Ground instability	Geotechnical site investigation should be done to determine the extent of unstable soil and dictate whether infiltration would be suitable or not.
Sites with deep backfill	Infiltration should be avoided unless the soil can be demonstrated to be sufficiently compacted. Some features such as swales are more adaptable to potential surface settlement.
Open space in floodplain zones	Design decisions should be done to take into consideration the likely high groundwater table and possible high flows and water levels. Features should also seek to not reduce the capacity of the floodplain and take into consideration the influence that a watercourse may have on a system. Facts such as siltation after a flood event should also be taken into account during the design phase.
Future adoption and maintenance	Local Planning Authority should ensure development proposals, through the use of planning conditions or planning obligations, have clear arrangements for on-going maintenance over the development's lifetime.

For SuDS techniques that are designed to encourage infiltration, it is imperative that the water table is low enough and a site-specific infiltration test is conducted early on as part of the design of the development. Infiltration should be considered with caution within areas of possible subsidence or sinkholes. Where sites lie within or close to groundwater protection zones (GSPZs) or aquifers, further restrictions may be applicable and guidance should be sought from the LLFA.

8.4 Sources of SuDS guidance

Part of Solihull Metropolitan Borough Council's responsibility as a LLFA is to be a statutory consultee to the planning process for surface water on all major developments. As part of this role the LLFA will also advise on surface water drainage applications based on National Planning Practice Guidance[15] and non-statutory technical standards for sustainable drainage schemes[16].

The Water Management policy P11, listed in the LFRMS, states that developers will be expected to undertake thorough risk assessments of the impact of proposals on surface and groundwater systems. SuDS should be incorporated into all new development and where possible retrofitted into renovation schemes. Where Sustainable Drainage Systems are possible, the Council will expect that these will contribute towards a range of wider sustainability benefits, as well as flood alleviation and water quality.

8.4.1 C753 CIRIA SuDS Manual (2015)

The C753 CIRIA SuDS Manual (2015)[17] replaces and updates the previous version (C697) providing up to date guidance on planning, design, construction and maintenance of SuDS. The document is designed to help the implementation of these features into new and existing

[15] National Planning Practice Guidance (2015) http://planningguidance.communities.gov.uk/blog/guidance/flood-risk-and-coastal-change/
[16] Non-Statutory Guidance for Sustainable Drainage Schemes (2015) https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards
17 C753 CIRIA SuDS Manual (2015):
http://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx

developments, whilst maximising the key benefits regarding flood risk and water quality. The manual is divided into five sections ranging from a high level overview of SuDS, progressing to more detailed guidance with progression through the document. It is recommended that developers and the LPA utilise the information within the manual to help design SuDS which are appropriate for a development.

8.4.2 Surface Water Advice Note – Using SuDS on new developments (June 2015)

When considering SuDS as part of a major planning application, local planning authorities need to satisfy themselves that the minimum standard of operation is appropriate for SuDS, and ensure through the use of planning conditions that clear arrangements are in place for their ongoing maintenance over the lifetime of the development.

The NPPF expects local planning authorities to give priority to the use of SuDS in determining planning applications. Where SuDS are used, it must be established that these options are feasible, can be adopted and properly maintained and would not lead to any other environmental problems. This is a material planning consideration for all major applications as of the 6 April 2015 and should therefore be given full consideration in an application.

8.4.3 Non-Statutory Technical Guidance, Defra (March 2015)

Nom-Statutory Technical guidance has been developed by Defra to sit alongside PPG to provide non-statutory standards as to the expected design and performance for SuDS.

In March 2015, the latest guidance was released providing amendments as to what is expected by the LPA to meet the National standards. The guidance provides a valuable resource for developers and designers outlining peak flow control, volume control, structural integrity of the SuDS, and flood considerations both within and outside the development as well as maintenance and construction considerations. It considers the following: flood risk inside and outside the development, peak flow, volume control, structural integrity, designing for maintenance considerations and construction.

The LPA will make reference to these standards when determining whether proposed SuDS are considered reasonably practicable.

8.4.4 Surface Water Management plan

At the time of publishing this SFRA, Solihull Metropolitan Borough Council were in process of creating a Surface Water Management Plan.

8.5 Other surface water considerations

8.5.1 Groundwater Vulnerability Zones

The Environment Agency have published new groundwater vulnerability maps in 2015. These maps provide a separate assessment of the vulnerability of groundwater in overlying superficial rocks and those that comprise the underlying bedrock. The maps show the vulnerability of groundwater at a location based on the hydrological, hydrogeological and soil properties within a one-kilometre grid square.

Two maps are available:

- Basic groundwater vulnerability map: this shows the likelihood of a pollutant discharged at ground level (above the soil zone) reaching groundwater for superficial and bedrock aquifers and is expressed as high, medium and low vulnerability
- Combined groundwater vulnerability map: this map displays both the vulnerability and aquifer designation status (principal or secondary). The aquifer designation status is an indication of the importance of the aquifer for drinking water supply.

The groundwater vulnerability maps should be considered when designing SuDS. Depending on the height of the water table at the location of the proposed development site, restrictions may be placed on the types of SuDS appropriate to certain areas.

8.5.2 Groundwater Source Protection Zones (GSPZ)

In addition to the AStGWF data the Environment Agency also defines Groundwater Source Protection Zones in the vicinity of groundwater abstraction points. These areas are defined to protect areas of groundwater that are used for potable supply, including public/private potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks. The Groundwater SPZ requires attenuated storage of runoff to prevent infiltration and contamination. The definition of each zone is shown below:

- Zone 1 (Inner Protection Zone) – Most sensitive zone: defined as the 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres
- Zone 2 (Outer Protection Zone) – Also sensitive to contamination: defined by a 400-day travel time from a point below the water table. This zone has a minimum radius around the source, depending on the size of the abstraction
- Zone 3 (Total Catchment) - Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source. In confined aquifers, the source catchment may be displaced some distance from the source. For heavily exploited aquifers, the final Source Catchment Protection Zone can be defined as the whole aquifer recharge area where the ratio of groundwater abstraction to aquifer recharge (average recharge multiplied by outcrop area) is >0.75. Individual source protection areas will still be assigned to assist operators in catchment management
- Zone 4 (Zone of special interest) – A fourth zone SPZ4 or 'Zone of Special Interest' usually represents a surface water catchment which drains into the aquifer feeding the groundwater supply (i.e. catchment draining to a disappearing stream). In the future this zone will be incorporated into one of the other zones, SPZ 1, 2 or 3, whichever is appropriate in the particular case, or become a safeguard zone

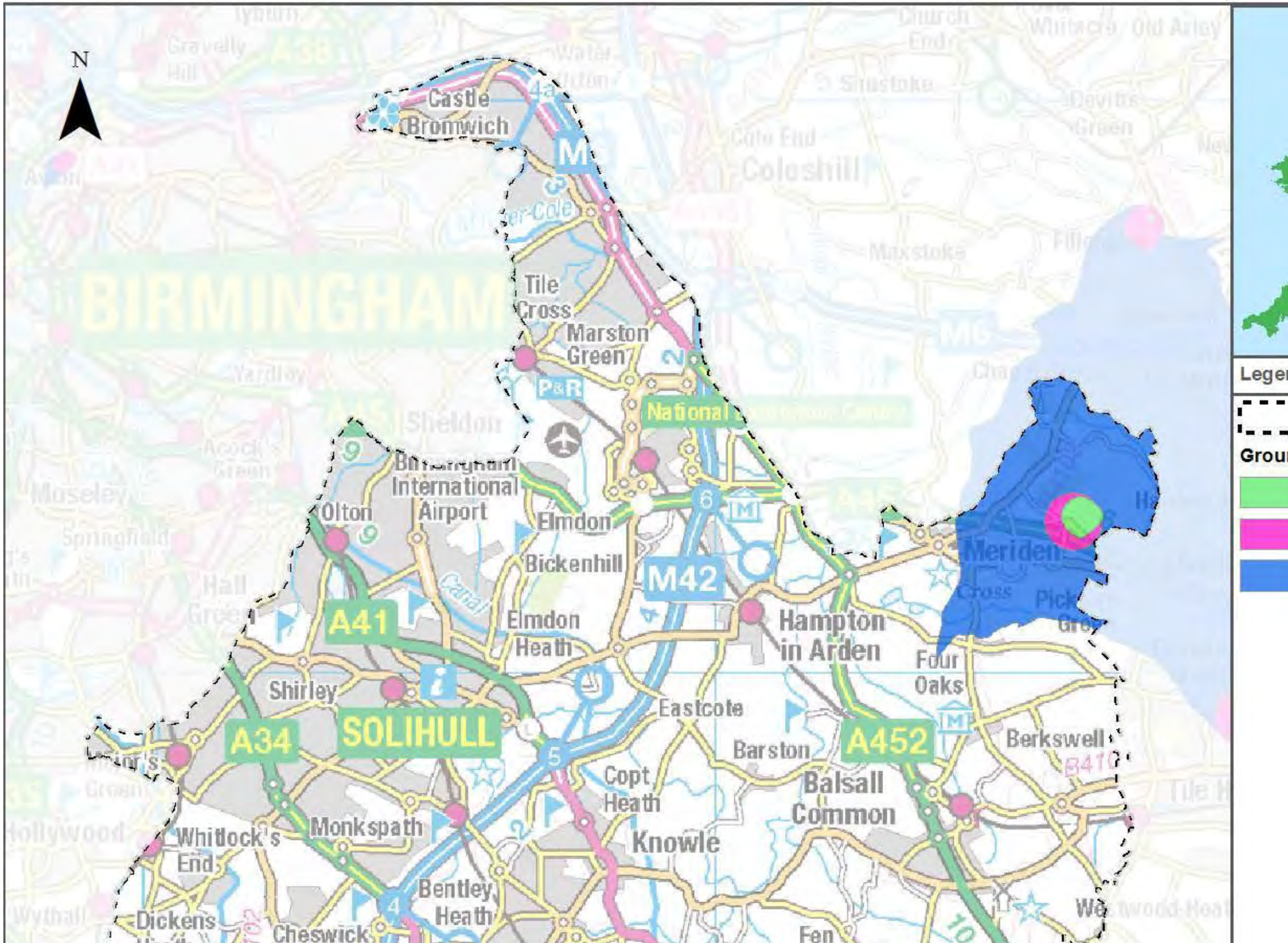
The location of the Groundwater SPZs in relation to the borough are shown in Figure 8-3. The majority of the district is located outside of a Groundwater Source Protection Zone. In the north eastern corner, over Meriden, there is an area of Zone 1 which includes a small extent of Zone 2 and Zone 3 centred east of Eaves Green. Depending on the nature of the proposed development and the location of the development site with regards to the SPZs, restrictions may be placed on the types of SuDS appropriate to certain areas. For example, infiltration SuDS are generally accepted within Zone 3, whereas in Zones 1 or 3, the Environment Agency will need to be consulted and infiltration SuDS may only be accepted if correct treatments and permits are put in place. Any restrictions imposed on the discharge of site generated runoff by the Environment Agency will be determined on a site by site basis using risk-based approach.

8.5.3 Nitrate Vulnerable Zones

Nitrate Vulnerable Zones (NVZs) are areas designated as being at risk from agricultural nitrate pollution. Nitrate levels in waterbodies are affected by surface water runoff from surrounding agricultural land entering receiving waterbodies.

The whole of the Solihull Metropolitan Borough Council is classed as a surface water NVZ. The level of nitrate contamination will potential influence the choice of SuDS and should be assessed as part of the design process

Figure 8-3: Groundwater Source Protection Zones



9 Strategic flood risk solutions

9.1 Introduction

Strategic flood risk solutions may offer a potential opportunity to reduce flood risk in the district. The following sections outline different options which could be considered for strategic flood risk solutions. Any strategic solutions should ensure they are consistent with wider catchment policy and the local policies set out by Solihull Metropolitan Borough Council.

9.2 Flood storage schemes

Flood storage schemes aim to reduce the flows passed downriver to mitigate downstream flooding. Development increases the impermeable area within a catchment, creating additional and faster runoff into watercourses. Flood storage schemes aim to detain this additional runoff, releasing it downstream at a slower rate, to avoid any increase in flood depths and/or frequency downstream. Methods to provide these schemes include[18]:

- enlarging the river channel;
- raising the riverbanks; and/or
- constructing flood banks set back from the river.

Flood storage schemes have the advantage that they generally benefit areas downstream, not just the local area.

9.2.1 Promotion of SuDS

Surface water flood risk is present in the area. By considering SuDS at an early stage in the development of a site, the risk from surface water can be mitigated to a certain extent within the site as well as reduce the risk that the site poses to third party land. Regionally SuDS should be promoted on all new developments to ensure the quantity and quality of surface water is dealt with sustainably to reduce flood risk. Given the various policies and guidance available on SuDS, developers should use this information to produce technically proficient and sustainable drainage solutions that conform with the non-statutory standards for SuDS (2015).

9.3 Catchment and Floodplain restoration

Compared to flood defences and flood storage, floodplain restoration represents the most sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state, and by creating space for naturally functioning floodplains working with natural processes.

Although the restoration of floodplain is difficult in previously developed areas where development cannot be rolled back, the following measures should be adopted:

- Promoting existing and future brownfield sites that are adjacent to watercourses to naturalise banks as much as possible. Buffer areas around watercourses provide an opportunity to restore parts of the floodplain
- Removal of redundant structures to reconnect the river and the floodplain.
- Apply the Sequential Approach to avoid new development within the floodplain.

For those sites considered within the Local Plan and / or put forward by developers, that also have watercourses flowing through or past them, the sequential approach should be used to locate development away from these watercourses. This will ensure the watercourses retain their connectivity to the floodplain. Loss of floodplain connectivity could potentially increase flooding.

9.3.1 Upstream natural catchment management

Opportunities to work with natural processes to reduce flood and erosion risk as well as benefit the natural environment and reduce costs of schemes should be sought, through integrated catchment management. It also requires partnership working with neighbouring authorities, organisations and water management bodies.

18 http://evidence.environment-agency.gov.uk/FCERM/en/FluvialDesignGuide/Chapter10.aspx?pagenum=2

Consideration of 're-wilding' rivers upstream could provide cost efficiencies as well as considering multiple sources of flood risk; for example, reducing peak flows upstream such as through felling trees into streams or building earth banks to capture runoff, could be cheaper and smaller-scale measures than implementing flood walls for example. With flood prevention schemes, consideration needs to be given to the impact that flood prevention has on the WFD status of watercourses. It is important that any potential schemes do not have a negative impact on the ecological and chemical status of waterbodies.

9.3.2 Structure Removal and / or modification (e.g. Weirs)

Structures, both within watercourses and adjacent to them can have significant impacts upon rivers including alterations to the geomorphology and hydraulics of the channel through water impoundment and altering sediment transfer regime, which over time can significantly impact the channel profile including bed and bank levels, alterations to flow regime and interruption of biological connectivity, including the passage of fish and invertebrates.

Many artificial in-channel structures (examples include weirs and culverts) are often redundant and / or serve little purpose and opportunities exist to remove them where feasible. The need to do this is heightened by climate change, for which restoring natural river processes, habitats and connectivity are vital adaptation measures. However, it also must be recognised that some artificial structures may have important functions or historical/cultural associations, which need to be considered carefully when planning and designing restoration work.

In the case of weirs, whilst weir removal should be investigated in the first instance, in some cases it may be necessary to modify a weir rather than remove it. For example, by lowering the weir crest level or adding a fish pass. This will allow more natural water level variations upstream of the weir and remove a barrier to fish migration.

9.3.3 Bank Stabilisation

Bank erosion should be avoided and landowners encouraged to avoid using machinery and vehicles close to or within the watercourse.

There are several techniques that can be employed to restrict the erosion of the banks of a watercourse. In an area where bankside erosion is particularly bad and/or vegetation is unable to properly establish, ecologically sensitive bank stabilisation techniques, such as willow spiling, can be particularly effective. Live willow stakes thrive in the moist environment and protect the soils from further erosion allowing other vegetation to establish and protect the soils.

9.3.4 Re-naturalisation

There is potential to re-naturalise a watercourse by re-profiling the channel, removing hard defences, re-connecting the channel with its floodplain and introducing a more natural morphology (particularly in instances where a watercourse has historically been modified through hard bed modification). Detailed assessments and planning would need to be undertaken to gain a greater understanding of the response to any proposed channel modification.

9.4 Flood defences

Flood mitigation measures should only be considered if, after application of the Sequential Approach, development sites cannot be located away from higher risk areas. If defences are constructed to protect a development site, it will need be demonstrated that the defences will not have a resulting negative impact on flood risk elsewhere, and that there is no net loss in floodplain storage.

10 Summary

10.1 Overview

This SFRA 2016 document replaces the Level 1 SFRA originally published by Solihull Metropolitan Borough Council in January 2008. This Level 1 SFRA delivers a strategic assessment of risk from all sources of flooding in Solihull. It also provides an overview of policy and provides guidance for planners and developers.

10.2 SFRA summary

10.2.1 Sources of flood risk

- The historical flood record shows that the borough has been subject to flooding from several sources of flood risk, with the principal risk from fluvial and surface water sources. There is also an indication that blockages of undersized culverts have been an issue. Notable flood events include July 2007, June 2012, November 2012, September 2015, June 2016 and September 2016
- The key watercourses flowing through the study area are the River Blythe and its tributaries. Tributaries of the River Blythe include, but are not limited to the River Cole, Mount Brook, Alder Brook, Purnell's Brook, Shadow Brook, and Hollywell Brook. The Kingshurst Brook, the Hatchford Brook and several other Main River and ordinary watercourses flow through the borough. The River Blythe flows through much of the borough. However, the areas it flows through are predominantly rural and the fluvial flood risk from the River Blythe to property in this area is minimal. The River Cole, a tributary of the Blythe, flows through Kingshurst in the north and south east of Solihull. Whilst the River Cole has relatively narrow floodplains, it flows through areas that are heavily urbanised and as such, produces a higher flood risk to properties in the Kingshurst, Chelmsley Wood and Solihull wards. Several other Main Rivers and ordinary watercourses also present a fluvial flood risk.
- There are no formal flood defences in the borough
- Solihull has experienced several historic surface water / drainage related flood events caused by several mechanisms such as culvert blockage. The RoFfSW further shows several prominent overland flow routes; these predominantly follow topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas
- The sewers are managed by Severn Trent Water. The Hydraulic Sewer Flooding Risk Register (HFRR) was supplied for use in this assessment. The HFRR register is a database of recorded historical sewer flooding incidents, on a post-code basis. A total of 185 recorded flood incidents in the Solihull Metropolitan Borough were listed in the HFRR register. The most frequently flooded localities are Solihull town, Dorridge, and Hampton-in-Arden. 20 incidents were recorded during June and July 2007. A further 12 incidents were recorded in August 1999, 9 incidents were recorded in November 2012 and August 2004. July 2007 and November 2012 are also recorded historical fluvial and blockages indicating that there may be some interaction between the fluvial and surface water drainage networks. However, most the dates do not correlate to significant historic fluvial or surface water flood events, indicating that the events listed in the HFRR are isolated incidents.
- There are no records of flooding from reservoirs impacting properties inside the study area. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is relatively low
- There are two canals flowing through the borough; the Grand Union Canal and the Stratford-upon-Avon Canal. There is one record of a canal breach with in the borough, on the Grand Union Canal, dated November 1997

10.2.2 Climate change

Climate change modelling for the watercourses in Solihull has been undertaken based on the new climate change guidance, using a combination of existing Environment Agency hydraulic models and Jflow modelling, run for the 2080s period for all three allowance categories.

The Flood Zone 2 extent is comparatively like the 100-year plus 20% allowance for climate change across Solihull. Due to the nature of the topography, the flood zones are largely confined and subsequently, the flood extent is not significantly different when a 20% or 30% or 50% allowance for climate change is used. Whilst the flood extent in more constrained catchments may not increase significantly, the flood depth and hazard may. The Hatchford Brook, Low Brook and Kingshurst Brook appear to be more sensitive to increases in the climate change allowances.

10.2.3 Key policies

There are many relevant regional and local key policies which have been considered within the SFRA, such as the CFMPs, RBMPs, the PFRA and LFRMS. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

10.2.4 Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and FRAs have been documented, along with guidance for planners and developers. Links have been provided for various guidance documents and policies published by other Risk Management Authorities such as the LLFA and the Environment Agency.

11 Recommendations

A review of national and local policies has been conducted against the information collated on flood risk in this SFRA, along with assessment of the proposed sites brought forward into the Level 2 assessment. Following this, several recommendations have been made for the Council to consider as part of Flood Risk Management in Solihull.

11.1 Development management

11.1.1 Sequential approach to development

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 borough.

New development and re-development of land should wherever possible seek opportunities to reduce overall level of flood risk at the site, for example by:

- Reducing volume and rate of runoff through the use of SuDS, as informed by national and local guidance
- Relocating development to zones with lower flood risk
- Creating space for flooding
- GI should be considered within the mitigation measures for surface water runoff from potential development and consider using Flood Zones 2 and 3 as public open space

11.1.2 Site-specific flood risk assessments

Site specific FRAs are required by developers to provide a greater level of detail on flood risk and any protection provided by defences and, where necessary, demonstrate the development passes part b of the Exception Test.

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), inform development zoning within the site and prove, if required, whether the Exception Test can be passed. 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. Any flood risk management measures should be consistent with the wider catchment policies set out in the CFMP, FRMPs and LFRMS.

11.1.3 Sequential and Exception tests

The SFRA has identified that areas of Solihull are at high risk of flooding from both fluvial and surface water sources. Therefore, a large number of proposed development sites will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the NPPF. The Council should use the information in this SFRA when deciding which development sites to take forward in their Local Plan.

It is recommended that the Council considers using the SFRA climate change maps when applying the Sequential Test for site allocations and windfall sites.

Developers should consult with the Council, the Environment Agency and Severn Trent Water, at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

11.1.4 Windfall sites

Windfall sites are sites that have not been specifically identified in the Local Plan or other Council assessment documents, that do not have planning permission and have unexpectedly become available. Local authorities can to make a realistic allowance for windfall development based on past trends.

The acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms[19].

11.1.5 Council review of planning applications

The Council should consult the Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', last updated 15 April 2015, when reviewing planning applications for proposed developments at risk of flooding. When considering planning permission for developments, planners may wish to consider the following:

- Will the natural watercourse system which provides drainage of land be adversely affected?
- Will a minimum 8m width access strip be provided adjacent to the top of both banks of any Main River (5m for Ordinary Watercourses, 20m for Commissioner watercourses and 9m for IDB watercourses), for maintenance purposes and is appropriately landscaped for open space and biodiversity benefits?
- Will the development ensure no loss of open water features through draining, culverting or enclosure by other means and will any culverts be opened up?
- Have SuDS been given priority as a technique to manage surface water flood risk?
- Will there be a betterment in the surface water runoff regime; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk?
- Is the application compliant with the conditions set out by the LLFA?

11.1.6 Drainage strategies and SuDS

Planners should be aware of the conditions set by the LLFA for surface water management and ensure development proposals and applications are compliant with the Council's policy. These policies should also be incorporated into the Local Plan. Wherever possible, SuDS should be promoted:

- It should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, and site layout and design, will prevent properties from flooding from surface water. A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. All 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
- Where sites lie within or close to Groundwater SPZs 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, and the LLFA's SuDS guidance and requirements
- Consideration must also be given to residual risk and maintenance of sustainable drainage and surface water systems
- SuDS proposals should contain an adequate number of treatments stages to ensure any pollutants are dealt with on site and do not have a detrimental impact on receiving waterbodies
- The promotion and adoption of water efficient practices in new development will help to manage water resources and work towards sustainable development and will help to reduce any increase in pressure on existing water and wastewater infrastructure

[19] http://webarchive.nationalarchives.gov.uk/20140328084622/http:/www.environment-agency.gov.uk/static/documents/Sequential_test_process_4.pdf

11.1.7 Cumulative impact of development and cross-boundary issues

The cumulative impact of development should be considered at the planning application and development design stages and the appropriate mitigation measures undertaken to ensure flood risk is not exacerbated, and in many cases the development should be used to improve the flood risk

Development control should ensure that the impact on receiving watercourses from development in Solihull has been sufficiently considered during the planning stages and appropriate mitigation measures put in place to ensure there is no adverse impact on flood risk or water quality, both within Solihull and the wider area.

11.1.8 Residual risk

The risk to development from reservoirs is residual but developers should consider reservoir flooding during the planning stage. They should seek to contact the reservoir owner to obtain information and should apply the sequential approach to locating development within the site. Developers should also consult with relevant authorities regarding emergency plans in case of reservoir breach.

Any development within the vicinity of either of the canals flowing through the borough should consider the residual risk from the canal, including the possibility of breach. Consideration should be given to the potential for safe access and egress in the event of rapid inundation of water due to a breach with little warning.

11.1.9 Safe access and egress

Safe access and egress will need to be demonstrated at all development sites and emergency vehicular access should be possible during times of flood. Finished Floor Levels should be 600mm above the 1 in 100-year (1% AEP) flood level, plus an allowance for climate change.

11.1.10 Future flood management

- Development should take a sequential approach to site layout
- Upstream storage schemes are often considered as one potential solution to flooding. However, this is not a solution for everywhere. Upstream storage should be investigated fully before being adopted as a solution
- Floodplain restoration represents a sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state,

11.2 Technical recommendations

11.2.1 Potential modelling improvements

- The Environment Agency's Flood Zone maps do not cover every watercourse (for example if <3km^2 catchment area). Hydraulic modelling may be required for more detailed flood risk assessment studies, following on from Section 19 reports, or as part of a Level 2 SFRA, to provide the required detail to support a site's development. If a watercourse or drain is shown on OS mapping but is not covered by a Flood Zone, this does not mean there is no potential flood risk. A model would likely be required at detailed site-specific level to confirm the flood risk to the site.
- Any existing hydraulic models which are represented in 1D-only could be upgraded in future to 1D-2D hydraulic models, if it is deemed necessary (for example if properties are at flood risk or a flood event has occurred and more detailed information is required, or to support the Exception Test). This type of model would provide a greater level of floodplain flood risk information, for example depths, velocity and hazard in the floodplain.
- Locations where surface water flooding is the predominant flood risk could be investigated further by use of surface water hydraulic modelling, or in combination with fluvial modelling, to assess the interactions between the two in more detail. Similarly, for any locations which suffer from sewer flooding or sewer capacity issues; this data can be incorporated into hydraulic models to more accurately represent the surface water system.

- At site-specific level, any developments shown to be at residual flood risk, for example from a breach or overtopping scenario (e.g. reservoir, canal, perched watercourse), may require modelling.

11.2.2 Updates to SFRA

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 (more accurate) information is available prior to commencing a site-specific FRA.

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 the Council (in its role as LLFA), the Highways Authority, Severn Trent Water or the Environment Agency. It is recommended that the SFRA is reviewed internally on an annual basis, allowing a cycle of review, followed by checking with the above bodies for any new information to allow a periodic update.

Appendices

This page has intentionally been left blank

A Mapping of all sources of flood risk across the borough

A.1 How to use these maps

These are a series of interactive maps that show all sources of flooding in Solihull Metropolitan Borough, as well as other supporting map layers.

Clicking on a grid square in the Index Map will open a separate interactive PDF map that has options for turning on and off the map layers of interest.

Further information on the source and background of the information contained within the interactive PDF can be found in this report and by clicking on the 'Background to Mapping Information' box in this map and the interactive PDFs.

This page has intentionally been left blank

B Flood warning coverage

This page has intentionally been left blank

C Preferred Options

This page has intentionally been left blank

JBA consulting

Offices at
Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

Registered Office
South Barn
Broughton Hall
SKIPTON
North Yorkshire
BD23 3AE
United Kingdom

t:+44(0)1756 799919
e:info@jbaconsulting.com

Jeremy Benn Associates Ltd
Registered in England 3246693

Visit our website
www.jbaconsulting.com

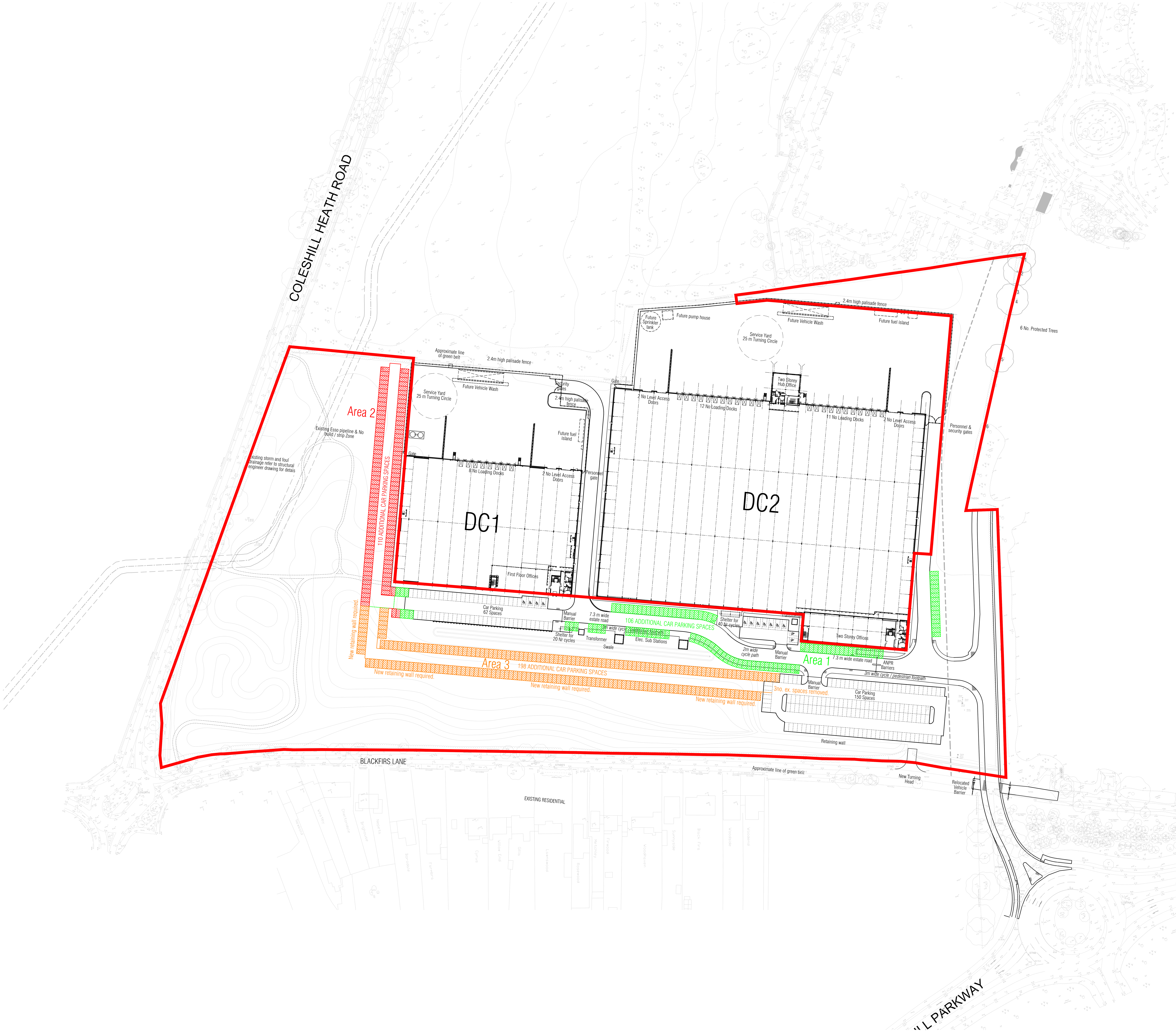
11 Appendix C

C.1 Proposed Site Plan

C.2 Proposed Drainage Strategy

C.3 Proposed Levels Plan

C.4 Additional Parking to Utilise Existing Drainage Network



notes

this drawing and design is the copyright of aja architects llp and must not be reproduced in part or in whole without prior written consent. contractors must verify all dimensions on site before commencing work or preparing shop drawings If in doubt ASK.

Where this drawing contains any Ordnance Survey mapping material, it has been reproduced under license number 100052278.
Ordnance Survey © Crown copyright

0m 25m 50m 75m
Scale

N

Car Parking

Existing	209 no. spaces (inc. 3no. removed)
Area 1 (green)	106 no. spaces
Area 2 (red)	110 no. spaces
Area 3 (orange)	198 no. spaces
Overall Total	626 no. spaces.

no.	date	revision	by
C	170920	Proposed application boundary amended.	aips
B	140920	Proposed application boundary amended.	aips
A	110920	Proposed application boundary shown. Silos added in DC1 yard. ANPR barriers added adjacent DC2 offices.	aips

aja architects

aja architects llp
1170 Elliott Court
Herald Avenue
Coventry Business Park
COVENTRY CV5 6UB

T: 024 7625 3200
F: 024 7625 3210

E: aja@aja-architects.com
W: www.aja-architects.com

aja architects llp is a limited liability partnership registered in England No. OC326721

client

International Automotive Components Group Limited

project

Additional Car Parking
IAC
Birmingham Interchange

drawing

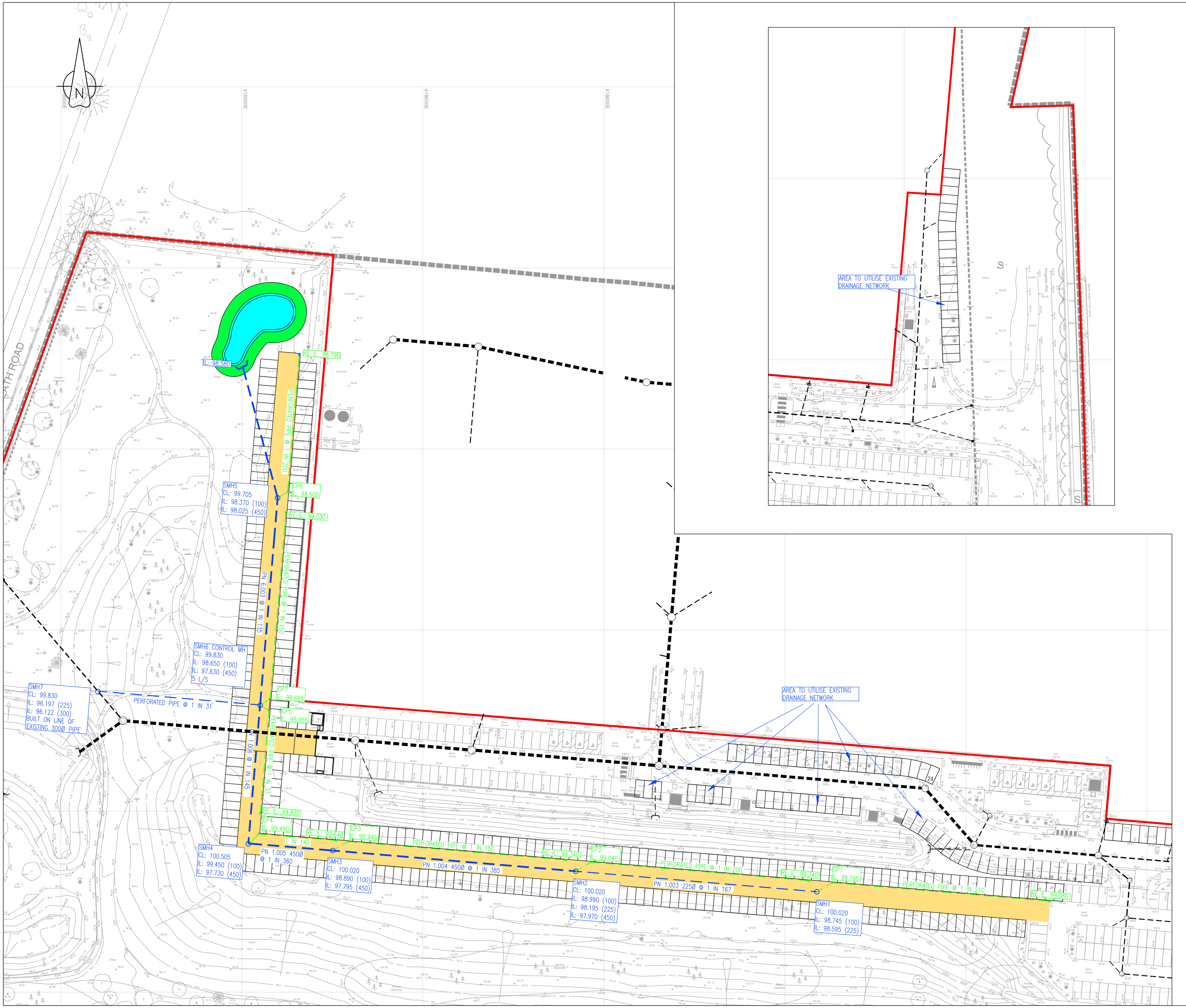
Site Layout Plan
with potential addtional car parking spaces
OPTION 1

scale 1:1000 @ A1 drawn KT

checked aips date 13-09-19

no

6632 - 01 REV C



NOTES

A1

General:

1. This drawing is to be read in conjunction with all relevant Architects, Engineers and Specialists drawings and specifications.
2. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
3. The contractor is to check and verify all dimensions and levels before commencing work.
4. Any discrepancies noted on site are to be reported to the Engineer immediately.
5. Background plan based on topographic survey data created by others and supplied for the purpose of carrying our engineering works. We cannot be held responsible for the content, completeness and accuracy provided to us by others. Topographical survey taken from **Greenhatch** plan reference:

- **37828_T (8/9/20).**

6. Architectural layout taken from **CBRE** plan reference:

- **2136 – PL001 – 2 (24 September 2019).**

Drainage:

1. Do not scale this drawing. All dimensions must be checked / verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant Architects, Engineers and Specialists drawings and specifications.
3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
4. Any discrepancies noted on site are to be reported to the Engineer immediately.
5. The base specification for drainage works shall be the Water Authority Association 'Sewers for Adoption (7th Edition).
6. For details of ground conditions refer to the Ground Investigation Report.
7. The following pipe strengths shall be adopted unless noted otherwise:
   – Pipes 150mm diameter up to and including 225mm to be clayware to BS EN 295 Class 160.
   – Pipes over 300mm diameter to be concrete to BS 5911 Class M.
8. All pipe runs to be laid with flexible joints.
9. All pipes entering and exiting manholes are to be connected with pipe soffits level unless noted otherwise.
10. Bedding and surround to be as follows :–

Location	Cover to Soffit	Bedding
Roads	>1.2m	Class 'S' granular bed and surround.
	<1.2m	Class 'X' Concrete surround.
Hard and soft landscaping	>0.6m	Class 'S' granular bed and surround.
	<0.6m	Class 'X' Concrete surround.

12. The following concrete mixes are to be used (all in accordance with BS 5800):

Location	Mix Reference.
Concrete surround to pipes	ST4
Concrete base and surround to manholes	ST4

The above concrete mixes have been selected for BS 5800 Class 2 Sulphates.

13. All precast concrete products (ie pipes, manholes rings etc.) shall be of suitable concrete mix to cater for Class 2 sulphates.
14. Pre–formed channels are to be used in manholes where applicable.
15. Granolithic concrete benching to be steel trowelled to a dense smooth face neatly shaped and finished to all branch connections and laid in accordance with the Specification.
16. All connections to be turned in direction of flow using pipe bends.
17. Manhole covers and frames to be ductile iron medium duty Grade D400 circular or rectangular to BS EN124 positions inside vehicular trafficked areas.
18. First flexible joint in pipes adjacent to a manhole shall be a maximum of 600mm from inside face of manhole, connecting to rocker pipe.
    The length of rocker pipe is as follows:–

Pipe Diameter	Length of Rocker pipe
150mm–600mm	600mm

19. Manholes with outgoing pipes greater than 600mm diameter shall be fitted with guard bars, safety chains or other safety devices.
20. The Principle Contractor shall be responsible for checking the existing line and invert levels of any connection points for both the foul and surface water systems, prior to undertaking installation of any new drainage works. Any deviation to the levels and positions indicated on the drawing should be brought to the immediate attention of the Project Engineer.
21. All inverts specified are outgoing (except backdrop). All pipe are to be laid soffits levels U.N.O.
22. All Foul pipes to be 100mm Diameter & Storm to 150mm Diameter unless marked otherwise.
23. All connections to be made by purpose made junctions as far as practicable.
24. Manhole covers in block paved areas to be recessed to receive required surface finish.
25. The contractor is to protect existing and new buried pipes (particularly shallow pipes) and tree roots from damage caused by loads imposed by construction plant.

NO PART OF THIS DOCUMENT MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM OR STORED IN ANY RETRIEVAL SYSTEM OF ANY NATURE WITHOUT THE WRITTEN PERMISSION OF THE BAYNHAM MEIKLE PARTNERSHIP LIMITED AS COPYRIGHT HOLDER EXCEPT AS AGREED FOR USE ON THE PROJECT FOR WHICH THE DOCUMENT WAS ORIGINALLY ISSUED.

KEY

- EXISTING STORM DRAINAGE
- PROPOSED STORM DRAINAGE
- PROPOSED PERFORATED PIPE
- PROPOSED CELLULAR TANK
- PROPOSED PERMEABLE PAVING

FOR INFORMATION

Rev	Date	Description	By	Chkd By
A	17/12/2020	AMENDED TO SUIT LATEST LAYOUT.	JH	GL
–	25/09/2020	First Issue	JH	GL

Revision Schedule

Project Title

ADDITIONAL CAR PARKING
PROLOGIS PARK – BIRMINGHAM INTERCHANGE

Drawing Title

PROPOSED DRAINAGE PLAN

Drawn by	Checked by	Project Engineer		
JH	GL	GL		
Date	Scale	Project No	Drawing No	Rev
SEPT 20	1:500	12992	100	A

BAYNHAM MEIKLE
Consulting Structural & Civil Engineers
8 Meadow Road, Edgbaston, Birmingham B17 8BU
Tel: 0121 434 4100 Fax: 0121 434 4073 Email: admin@bm-p.co.uk

NOTES

A1

General:

1. This drawing is to be read in conjunction with all relevant Architects, Engineers and Specialists drawings and specifications.
2. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
3. The contractor is to check and verify all dimensions and levels before commencing work.
4. Any discrepancies noted on site are to be reported to the Engineer immediately.
5. Background plan based on topographic survey data created by others and supplied for the purpose of carrying our engineering works. We cannot be held responsible for the content, completeness and accuracy provided to us by others. Topographical survey taken from **Greenhatch** plan reference:
   - **37828_T (8/9/20).**
6. Architectural layout taken from **CBRE** plan reference:
   - **2136 – PL001 – 2 (24 September 2019).**

NO PART OF THIS DOCUMENT MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM OR STORED IN ANY RETRIEVAL SYSTEM OF ANY NATURE WITHOUT THE WRITTEN PERMISSION OF THE BAYNHAM MEIKLE PARTNERSHIP LIMITED AS COPYRIGHT HOLDER EXCEPT AS AGREED FOR USE ON THE PROJECT FOR WHICH THE DOCUMENT WAS ORIGINALLY ISSUED.

KEY

- EXISTING LEVELS
- 100.210 + PROPOSED LEVELS
- PROPOSED GABION FACE
- PROPOSED SHEET PILING RETAINING WALL

FOR INFORMATION

Rev	Date	Description	By	Chkd By
A	17/09/2020	UPDATED TO SUIT LATEST LAYOUT.	JH	GL
–	25/09/2020	First Issue	JH	GL

Revision Schedule

Project Title

ADDITIONAL CAR PARKING PROLOGIS PARK – BIRMINGHAM INTERCHANGE

Drawing Title

PROPOSED LEVELS PLAN

Drawn by JH | Checked by GL | Project Engineer GL

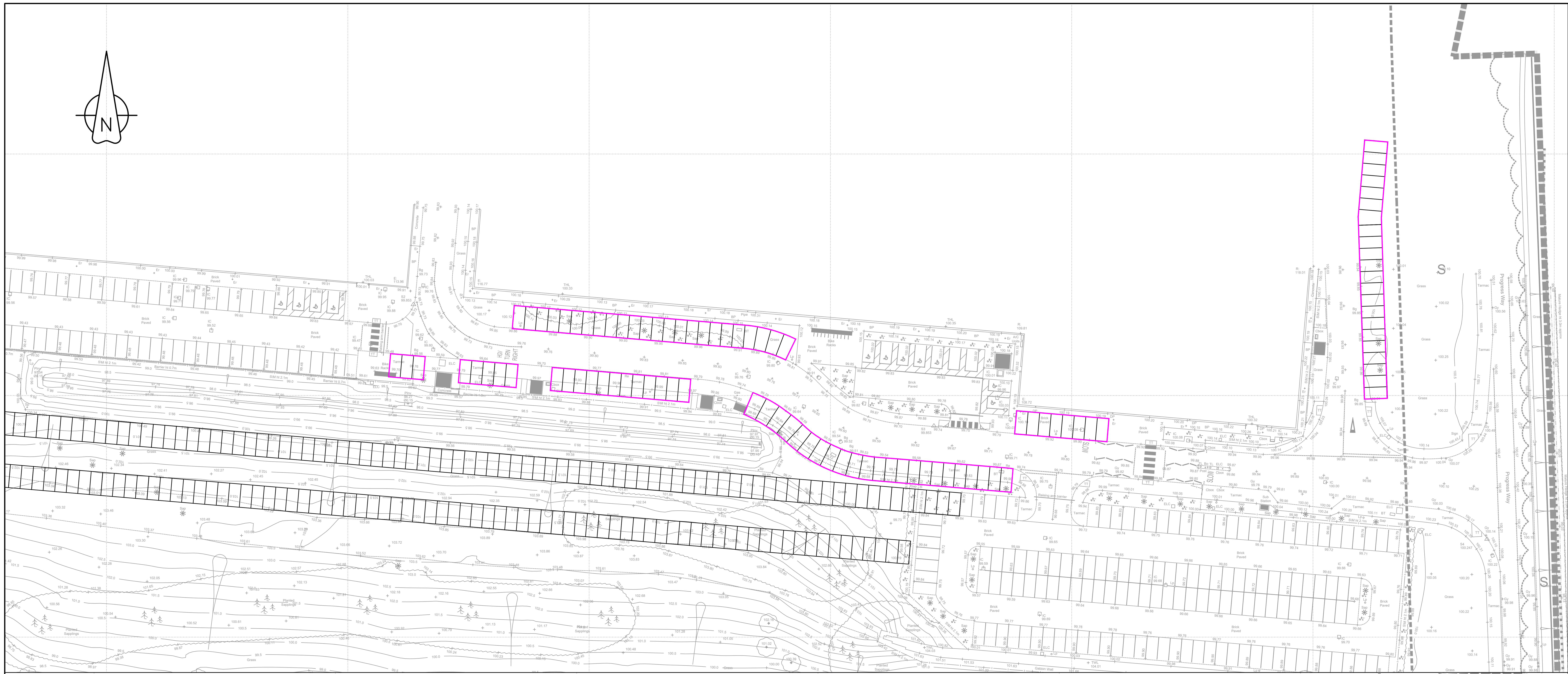
Date	Scale	Project No	Drawing No	Rev
SEPT 20	1:500	12992	101	A

BAYNHAM MEIKLE

Consulting Structural & Civil Engineers

8 Meadow Road, Edgbaston, Birmingham B17 8BU

Tel: 0121 434 4100 *Fax:* 0121 434 4073 *Email:* admin@bm-p.co.uk



NOTES

A1

General:

1. This drawing is to be read in conjunction with all relevant Architects, Engineers and Specialists drawings and specifications.
2. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
3. The contractor is to check and verify all dimensions and levels before commencing work.
4. Any discrepancies noted on site are to be reported to the Engineer immediately.
5. Background plan based on topographic survey data created by others and supplied for the purpose of carrying our engineering works. We cannot be held responsible for the content, completeness and accuracy provided to us by others. Topographical survey taken from **Greenhatch** plan reference:
   - **37828_T (8/9/20).**
6. Architectural layout taken from **CBRE** plan reference:
   - **2136 – PL001 – 2 (24 September 2019).**

NO PART OF THIS DOCUMENT MAY BE REPRODUCED OR TRANSMITTED IN ANY FORM OR STORED IN ANY RETRIEVAL SYSTEM OF ANY NATURE WITHOUT THE WRITTEN PERMISSION OF THE BAYNHAM MEIKLE PARTNERSHIP LIMITED AS COPYRIGHT HOLDER EXCEPT AS AGREED FOR USE ON THE PROJECT FOR WHICH THE DOCUMENT WAS ORIGINALLY ISSUED.

KEY

PROPOSED PARKING SPACES TO UTILISE EXISTING DRAINAGE NETWORK

KEY

PROPOSED ADDITIONAL HARD STANDING TOTAL: 733m2

PROPOSED ADDITIONAL SOFT LANDSCAPING TOTAL: 82m2

FOR INFORMATION

Rev	Date	Description	By	Chkd By
A	17/12/2020	AMENDED TO SUIT UPDATED LAYOUT.	JH	GL
-	25/09/2020	First Issue	JH	GL

Revision Schedule

Project Title

ADDITIONAL CAR PARKING
PROLOGIS PARK – BIRMINGHAM INTERCHANGE

Drawing Title

ADDITIONAL PARKING TO UTILISE EXISTING DRAINAGE NETWORK

Drawn by JH	Checked by GL	Project Engineer GL		
Date	Scale	Project No	Drawing No	Rev
SEPT 20	1:500	12992	104	A

BAYNHAM MEIKLE
Consulting Structural & Civil Engineers
8 Meadow Road, Edgbaston, Birmingham B17 8BU
Tel: 0121 434 4100 Fax: 0121 434 4073 Email: admin@bm-p.co.uk

12 Appendix D

D.1 Microdrainage Calculations

D.2 Existing Calculations with additional drainage area.

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	30.000	0.142	211.3	0.033	8.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	30.000	0.143	209.8	0.033	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.002	4.919	0.050	98.4	0.032	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.003	66.806	0.400	167.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	30.000	0.150	200.0	0.035	8.00	0.0	0.600	o	150	Pipe/Conduit	
2.001	30.000	0.150	200.0	0.035	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.002	4.919	0.050	98.4	0.035	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.004	67.356	0.175	384.9	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	39.67	8.73	99.080	0.033	0.0	0.0	0.0	0.69	12.1	3.5
1.001	37.99	9.45	98.938	0.066	0.0	0.0	0.0	0.69	12.2	6.8
1.002	37.75	9.56	98.795	0.098	0.0	0.0	0.0	0.78	6.1«	10.0
1.003	35.60	10.66	98.595	0.098	0.0	0.0	0.0	1.01	40.1	10.0
2.000	39.72	8.71	99.340	0.035	0.0	0.0	0.0	0.71	12.5	3.8
2.001	38.07	9.41	99.190	0.070	0.0	0.0	0.0	0.71	12.5	7.2
2.002	37.84	9.52	99.040	0.105	0.0	0.0	0.0	0.78	6.1«	10.8
1.004	33.76	11.75	97.970	0.203	0.0	0.0	0.0	1.03	163.8	18.6

©1982-2020 Innovyze

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
3.000	30.000	0.200	150.0	0.034	8.00	0.0	0.600	o	150	Pipe/Conduit	🔒
3.001	30.000	0.200	150.0	0.034	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
3.002	4.919	0.050	98.4	0.034	0.00	0.0	0.600	o	100	Pipe/Conduit	🔒
1.005	23.427	0.065	360.4	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
4.000	10.546	0.075	140.6	0.014	8.00	0.0	0.600	o	150	Pipe/Conduit	🔒
4.001	10.546	0.075	140.6	0.014	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
4.002	3.628	0.040	90.7	0.024	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
1.006	38.381	0.100	383.8	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
5.000	14.093	0.432	32.6	0.023	8.00	0.0	0.600	o	150	Pipe/Conduit	🔒
5.001	14.093	0.433	32.5	0.023	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
5.002	2.914	0.305	9.6	0.023	0.00	0.0	0.600	o	100	Pipe/Conduit	🔒
6.000	37.691	0.190	198.4	0.036	8.00	0.0	0.600	o	150	Pipe/Conduit	🔒
6.001	3.200	0.035	91.4	0.036	0.00	0.0	0.600	o	100	Pipe/Conduit	🔒
7.000	37.409	0.555	67.4	0.043	8.00	0.0	0.600	o	450	Pipe/Conduit	🔒
6.002	57.383	0.425	135.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
3.000	39.95	8.61	99.340	0.034	0.0	0.0	0.0	0.82	14.5	3.7
3.001	38.50	9.22	99.140	0.068	0.0	0.0	0.0	0.82	14.5	7.1
3.002	38.26	9.33	98.940	0.102	0.0	0.0	0.0	0.78	6.1«	10.6
1.005	33.19	12.12	97.795	0.305	0.0	0.0	0.0	1.07	169.4	27.4
4.000	40.98	8.21	99.640	0.014	0.0	0.0	0.0	0.85	14.9	1.6
4.001	40.44	8.42	99.565	0.028	0.0	0.0	0.0	0.85	14.9	3.1
4.002	40.30	8.47	99.490	0.052	0.0	0.0	0.0	1.06	18.7	5.7
1.006	32.27	12.74	97.730	0.357	0.0	0.0	0.0	1.03	164.1	31.2
5.000	41.18	8.13	99.820	0.023	0.0	0.0	0.0	1.77	31.3	2.6
5.001	40.83	8.27	99.388	0.046	0.0	0.0	0.0	1.77	31.3	5.1
5.002	40.78	8.28	98.955	0.069	0.0	0.0	0.0	2.52	19.8	7.6
6.000	39.29	8.88	98.780	0.036	0.0	0.0	0.0	0.71	12.5	3.8
6.001	39.13	8.95	98.600	0.072	0.0	0.0	0.0	0.80	6.3«	7.6
7.000	40.87	8.25	98.580	0.043	0.0	0.0	0.0	2.48	394.3	4.8
6.002	37.88	9.50	98.055	0.115	0.0	0.0	0.0	1.75	278.0	11.8

©1982-2020 Innovyze

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
8.000	25.661	0.172	149.2	0.032	8.00	0.0	0.600	o	150	Pipe/Conduit	
8.001	25.661	0.173	148.3	0.032	0.00	0.0	0.600	o	150	Pipe/Conduit	
8.002	3.250	0.035	92.9	0.030	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.007	44.962	1.433	31.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
8.000	40.18	8.52	99.030	0.032	0.0	0.0	0.0	0.82	14.5	3.5
8.001	38.92	9.04	98.858	0.064	0.0	0.0	0.0	0.82	14.5	6.7
8.002	38.76	9.11	98.685	0.094	0.0	0.0	0.0	0.80	6.3«	9.9
1.007	31.82	13.06	97.630	0.635	0.0	0.0	0.0	2.34	93.2	54.7

©1982-2020 Innovyze

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
RE	99.680	0.600	Open Manhole	100	1.000	99.080	150				
DUMMY	99.855	0.917	Open Manhole	100	1.001	98.938	150	1.000	98.938	150	
CP1	99.940	1.145	Open Manhole	450	1.002	98.795	100	1.001	98.795	150	
SMH1	100.020	1.425	Open Manhole	1200	1.003	98.595	225	1.002	98.745	100	25
RE	99.940	0.600	Open Manhole	100	2.000	99.340	150				
DUMMY	99.940	0.750	Open Manhole	100	2.001	99.190	150	2.000	99.190	150	
CP2	99.940	0.900	Open Manhole	450	2.002	99.040	100	2.001	99.040	150	
SMH2	100.020	2.050	Open Manhole	1350	1.004	97.970	450	1.003	98.195	225	
								2.002	98.990	100	670
RE	99.940	0.600	Open Manhole	100	3.000	99.340	150				
DUMMY	100.190	1.050	Open Manhole	100	3.001	99.140	150	3.000	99.140	150	
CP3	100.440	1.500	Open Manhole	450	3.002	98.940	100	3.001	98.940	150	
SMH3	100.515	2.720	Open Manhole	1350	1.005	97.795	450	1.004	97.795	450	
								3.002	98.890	100	745
RE	100.440	0.800	Open Manhole	100	4.000	99.640	150				
DUMMY	100.440	0.875	Open Manhole	100	4.001	99.565	150	4.000	99.565	150	
CP4	100.440	0.950	Open Manhole	450	4.002	99.490	150	4.001	99.490	150	
SMH4	100.505	2.775	Open Manhole	1350	1.006	97.730	450	1.005	97.730	450	
								4.002	99.450	150	1420
RE	100.420	0.600	Open Manhole	100	5.000	99.820	150				
DUMMY	100.420	1.032	Open Manhole	100	5.001	99.388	150	5.000	99.388	150	
CP5	99.755	0.800	Open Manhole	450	5.002	98.955	100	5.001	98.955	150	
RE	99.390	0.610	Open Manhole	100	6.000	98.780	150				
CP6	99.360	0.770	Open Manhole	450	6.001	98.600	100	6.000	98.590	150	
pond	99.580	1.000	Open Manhole	100	7.000	98.580	450				
SMH5	99.705	1.680	Open Manhole	1350	6.002	98.055	450	6.001	98.565	100	160
								7.000	98.025	450	
RE	99.630	0.600	Open Manhole	100	8.000	99.030	150				
DUMMY	99.630	0.772	Open Manhole	100	8.001	98.858	150	8.000	98.858	150	
CP7	99.630	0.945	Open Manhole	450	8.002	98.685	100	8.001	98.685	150	
SMH6	99.830	2.200	Open Manhole	1350	1.007	97.630	225	1.006	97.630	450	
								5.002	98.650	100	895
								6.002	97.630	450	
								8.002	98.650	100	895
	98.980	2.783	Open Manhole	0		OUTFALL		1.007	96.197	225	

©1982-2020 Innovyze

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
RE	418772.836	285125.163	418772.836	285125.163	Required	
DUMMY	418742.944	285127.705	418742.944	285127.705	Required	
CP1	418713.052	285130.247	418713.052	285130.247	Required	
SMH1	418708.825	285127.732	418708.825	285127.732	Required	
RE	418706.271	285130.824	418706.271	285130.824	Required	
DUMMY	418676.379	285133.367	418676.379	285133.367	Required	
CP2	418646.487	285135.909	418646.487	285135.909	Required	
SMH2	418642.259	285133.393	418642.259	285133.393	Required	
RE	418639.157	285136.533	418639.157	285136.533	Required	
DUMMY	418609.265	285139.075	418609.265	285139.075	Required	
CP3	418579.373	285141.617	418579.373	285141.617	Required	
SMH3	418575.145	285139.102	418575.145	285139.102	Required	
RE	418575.434	285141.953	418575.434	285141.953	Required	
DUMMY	418564.925	285142.842	418564.925	285142.842	Required	
CP4	418554.399	285143.490	418554.399	285143.490	Required	

©1982-2020 Innovyze

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
SMH4	418551.801	285140.958	418551.801	285140.958	Required	
RE	418555.144	285149.700	418555.144	285149.700	Required	
DUMMY	418556.337	285163.742	418556.337	285163.742	Required	
CP5	418557.530	285177.785	418557.530	285177.785	Required	
RE	418565.850	285275.683	418565.850	285275.683	Required	
CP6	418562.656	285238.128	418562.656	285238.128	Required	
pond	418550.296	285272.645	418550.296	285272.645	Required	
SMH5	418559.906	285236.491	418559.906	285236.491	Required	
RE	418562.148	285232.149	418562.148	285232.149	Required	
DUMMY	418559.976	285206.580	418559.976	285206.580	Required	
CP7	418557.816	285181.019	418557.816	285181.019	Required	
SMH6	418555.049	285179.201	418555.049	285179.201	Required	
	418510.233	285183.017			No Entry	

©1982-2020 Innovyze

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	150	RE	99.680	99.080	0.450	Open Manhole	100
1.001	o	150	DUMMY	99.855	98.938	0.767	Open Manhole	100
1.002	o	100	CP1	99.940	98.795	1.045	Open Manhole	450
1.003	o	225	SMH1	100.020	98.595	1.200	Open Manhole	1200
2.000	o	150	RE	99.940	99.340	0.450	Open Manhole	100
2.001	o	150	DUMMY	99.940	99.190	0.600	Open Manhole	100
2.002	o	100	CP2	99.940	99.040	0.800	Open Manhole	450
1.004	o	450	SMH2	100.020	97.970	1.600	Open Manhole	1350
3.000	o	150	RE	99.940	99.340	0.450	Open Manhole	100
3.001	o	150	DUMMY	100.190	99.140	0.900	Open Manhole	100
3.002	o	100	CP3	100.440	98.940	1.400	Open Manhole	450
1.005	o	450	SMH3	100.515	97.795	2.270	Open Manhole	1350
4.000	o	150	RE	100.440	99.640	0.650	Open Manhole	100
4.001	o	150	DUMMY	100.440	99.565	0.725	Open Manhole	100
4.002	o	150	CP4	100.440	99.490	0.800	Open Manhole	450

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	30.000	211.3	DUMMY	99.855	98.938	0.767	Open Manhole	100
1.001	30.000	209.8	CP1	99.940	98.795	0.995	Open Manhole	450
1.002	4.919	98.4	SMH1	100.020	98.745	1.175	Open Manhole	1200
1.003	66.806	167.0	SMH2	100.020	98.195	1.600	Open Manhole	1350
2.000	30.000	200.0	DUMMY	99.940	99.190	0.600	Open Manhole	100
2.001	30.000	200.0	CP2	99.940	99.040	0.750	Open Manhole	450
2.002	4.919	98.4	SMH2	100.020	98.990	0.930	Open Manhole	1350
1.004	67.356	384.9	SMH3	100.515	97.795	2.270	Open Manhole	1350
3.000	30.000	150.0	DUMMY	100.190	99.140	0.900	Open Manhole	100
3.001	30.000	150.0	CP3	100.440	98.940	1.350	Open Manhole	450
3.002	4.919	98.4	SMH3	100.515	98.890	1.525	Open Manhole	1350
1.005	23.427	360.4	SMH4	100.505	97.730	2.325	Open Manhole	1350
4.000	10.546	140.6	DUMMY	100.440	99.565	0.725	Open Manhole	100
4.001	10.546	140.6	CP4	100.440	99.490	0.800	Open Manhole	450
4.002	3.628	90.7	SMH4	100.505	99.450	0.905	Open Manhole	1350

©1982-2020 Innovyze

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.006	o	450	SMH4	100.505	97.730	2.325	Open Manhole	1350
5.000	o	150	RE	100.420	99.820	0.450	Open Manhole	100
5.001	o	150	DUMMY	100.420	99.388	0.882	Open Manhole	100
5.002	o	100	CP5	99.755	98.955	0.700	Open Manhole	450
6.000	o	150	RE	99.390	98.780	0.460	Open Manhole	100
6.001	o	100	CP6	99.360	98.600	0.660	Open Manhole	450
7.000	o	450	pond	99.580	98.580	0.550	Open Manhole	100
6.002	o	450	SMH5	99.705	98.055	1.200	Open Manhole	1350
8.000	o	150	RE	99.630	99.030	0.450	Open Manhole	100
8.001	o	150	DUMMY	99.630	98.858	0.622	Open Manhole	100
8.002	o	100	CP7	99.630	98.685	0.845	Open Manhole	450
1.007	o	225	SMH6	99.830	97.630	1.975	Open Manhole	1350

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.006	38.381	383.8	SMH6	99.830	97.630	1.750	Open Manhole	1350
5.000	14.093	32.6	DUMMY	100.420	99.388	0.882	Open Manhole	100
5.001	14.093	32.5	CP5	99.755	98.955	0.650	Open Manhole	450
5.002	2.914	9.6	SMH6	99.830	98.650	1.080	Open Manhole	1350
6.000	37.691	198.4	CP6	99.360	98.590	0.620	Open Manhole	450
6.001	3.200	91.4	SMH5	99.705	98.565	1.040	Open Manhole	1350
7.000	37.409	67.4	SMH5	99.705	98.025	1.230	Open Manhole	1350
6.002	57.383	135.0	SMH6	99.830	97.630	1.750	Open Manhole	1350
8.000	25.661	149.2	DUMMY	99.630	98.858	0.622	Open Manhole	100
8.001	25.661	148.3	CP7	99.630	98.685	0.795	Open Manhole	450
8.002	3.250	92.9	SMH6	99.830	98.650	1.080	Open Manhole	1350
1.007	44.962	31.4		98.980	96.197	2.558	Open Manhole	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.007		98.980	96.197	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	8
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.400		

©1982-2020 Innovyze

Online Controls for Storm

Hydro-Brake® Optimum Manhole: SMH6, DS/PN: 1.007, Volume (m³): 18.0

Unit Reference	MD-SHE-0095-5000-1750-5000
Design Head (m)	1.750
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	95
Invert Level (m)	97.630
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.750	5.0
Flush-Flo™	0.415	4.5
Kick-Flo®	0.847	3.6
Mean Flow over Head Range	-	4.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	4.2	3.000	6.4	7.000	9.6
0.200	4.1	1.400	4.5	3.500	6.9	7.500	9.9
0.300	4.4	1.600	4.8	4.000	7.4	8.000	10.2
0.400	4.5	1.800	5.1	4.500	7.8	8.500	10.5
0.500	4.4	2.000	5.3	5.000	8.2	9.000	10.8
0.600	4.3	2.200	5.6	5.500	8.6	9.500	11.1
0.800	3.8	2.400	5.8	6.000	8.9		
1.000	3.9	2.600	6.0	6.500	9.3		

©1982-2020 Innovyze

Storage Structures for Storm

Porous Car Park Manhole: DUMMY, DS/PN: 1.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	64.8
Membrane Percolation (mm/hr)	1000	Length (m)	6.0
Max Percolation (l/s)	108.0	Slope (1:X)	211.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.265	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: DUMMY, DS/PN: 2.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	68.0
Membrane Percolation (mm/hr)	1000	Length (m)	6.0
Max Percolation (l/s)	113.3	Slope (1:X)	200.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.340	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: DUMMY, DS/PN: 3.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	66.5
Membrane Percolation (mm/hr)	1000	Length (m)	6.0
Max Percolation (l/s)	110.8	Slope (1:X)	200.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.590	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: DUMMY, DS/PN: 4.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	29.0
Membrane Percolation (mm/hr)	1000	Length (m)	6.0
Max Percolation (l/s)	48.3	Slope (1:X)	150.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.840	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: DUMMY, DS/PN: 5.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	51.3
Membrane Percolation (mm/hr)	1000	Length (m)	6.0
Max Percolation (l/s)	85.5	Slope (1:X)	33.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.165	Cap Volume Depth (m)	0.450

Porous Car Park Manhole: RE, DS/PN: 6.000

Infiltration Coefficient Base (m/hr)	0.00000	Max Percolation (l/s)	69.0
Membrane Percolation (mm/hr)	1000	Safety Factor	2.0

©1982-2020 Innovyze

Porous Car Park Manhole: RE, DS/PN: 6.000

Porosity	0.30	Slope (1:X)	200.0
Invert Level (m)	98.780	Depression Storage (mm)	5
Width (m)	41.4	Evaporation (mm/day)	3
Length (m)	6.0	Cap Volume Depth (m)	0.450

Tank or Pond Manhole: pond, DS/PN: 7.000

Invert Level (m) 98.580

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	214.0	1.000	432.0

Porous Car Park Manhole: DUMMY, DS/PN: 8.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	55.8
Membrane Percolation (mm/hr)	1000	Length (m)	6.0
Max Percolation (l/s)	93.0	Slope (1:X)	150.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.030	Cap Volume Depth (m)	0.450

©1982-2020 Innovyze

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 8
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	RE	15 Winter	1	+0%	30/15 Summer				99.135
1.001	DUMMY	30 Winter	1	+0%	30/15 Summer				99.004
1.002	CP1	15 Winter	1	+0%	1/15 Summer				98.911
1.003	SMH1	15 Winter	1	+0%	30/15 Summer				98.655
2.000	RE	15 Winter	1	+0%	100/15 Summer				99.396
2.001	DUMMY	30 Winter	1	+0%	30/15 Summer				99.259
2.002	CP2	15 Winter	1	+0%	1/15 Summer				99.166
1.004	SMH2	120 Winter	1	+0%	1/120 Winter				98.550
3.000	RE	15 Winter	1	+0%	30/15 Summer				99.391
3.001	DUMMY	30 Winter	1	+0%	30/15 Summer				99.203
3.002	CP3	15 Winter	1	+0%	1/15 Summer				99.065
1.005	SMH3	120 Winter	1	+0%	1/60 Winter				98.552
4.000	RE	15 Winter	1	+0%	100/15 Summer				99.673
4.001	DUMMY	30 Winter	1	+0%	100/15 Summer				99.602
4.002	CP4	15 Winter	1	+0%	30/15 Summer				99.549
1.006	SMH4	120 Winter	1	+0%	1/30 Winter				98.551
5.000	RE	15 Winter	1	+0%					99.849

©1982-2020 Innovyze

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	RE	-0.095	0.000	0.29			3.4	OK	
1.001	DUMMY	-0.084	0.000	0.36		9	4.3	OK	
1.002	CP1	0.016	0.000	1.19			6.3	SURCHARGED	
1.003	SMH1	-0.165	0.000	0.16			6.3	OK	
2.000	RE	-0.094	0.000	0.30			3.6	OK	
2.001	DUMMY	-0.081	0.000	0.38		9	4.6	OK	
2.002	CP2	0.026	0.000	1.26			6.7	SURCHARGED	
1.004	SMH2	0.130	0.000	0.06			8.4	SURCHARGED	
3.000	RE	-0.099	0.000	0.25			3.5	OK	
3.001	DUMMY	-0.087	0.000	0.32		8	4.4	OK	
3.002	CP3	0.025	0.000	1.26			6.7	SURCHARGED	
1.005	SMH3	0.307	0.000	0.04			5.5	SURCHARGED	
4.000	RE	-0.117	0.000	0.11			1.5	OK	
4.001	DUMMY	-0.113	0.000	0.12		7	1.7	OK	
4.002	CP4	-0.091	0.000	0.33			4.1	OK	
1.006	SMH4	0.371	0.000	0.03			5.0	SURCHARGED	
5.000	RE	-0.121	0.000	0.08			2.4	OK	

©1982-2020 Innovyze

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
5.001	DUMMY	8640 Winter	1	+0%					99.389
5.002	CP5	15 Winter	1	+0%	100/15 Summer				98.982
6.000	RE	60 Winter	1	+0%	100/15 Winter				98.810
6.001	CP6	15 Winter	1	+0%	30/15 Summer				98.667
7.000	pond	30 Winter	1	+0%	100/60 Summer				98.590
6.002	SMH5	120 Winter	1	+0%	1/120 Winter				98.548
8.000	RE	15 Winter	1	+0%	100/15 Summer				99.080
8.001	DUMMY	30 Winter	1	+0%	30/15 Summer				98.923
8.002	CP7	30 Winter	1	+0%	1/15 Summer				98.808
1.007	SMH6	120 Winter	1	+0%	1/15 Summer				98.550

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
5.001	DUMMY	-0.149	0.000	0.00			0.1	OK	
5.002	CP5	-0.073	0.000	0.17			2.6	OK	
6.000	RE	-0.120	0.000	0.09		23	1.1	OK	
6.001	CP6	-0.033	0.000	0.77			4.0	OK	
7.000	pond	-0.440	0.000	0.00			1.6	OK	
6.002	SMH5	0.043	0.000	0.01			3.4	SURCHARGED	
8.000	RE	-0.100	0.000	0.24			3.3	OK	
8.001	DUMMY	-0.085	0.000	0.36		9	5.0	OK	
8.002	CP7	0.023	0.000	1.32			6.8	SURCHARGED	
1.007	SMH6	0.695	0.000	0.05			4.5	SURCHARGED	

©1982-2020 Innovyze

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 8
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	RE	15 Winter	30	+0%	30/15 Summer				99.366
1.001	DUMMY	30 Winter	30	+0%	30/15 Summer				99.297
1.002	CP1	15 Summer	30	+0%	1/15 Summer				99.286
1.003	SMH1	60 Winter	30	+0%	30/15 Summer				99.112
2.000	RE	15 Winter	30	+0%	100/15 Summer				99.463
2.001	DUMMY	30 Winter	30	+0%	30/15 Summer				99.390
2.002	CP2	15 Winter	30	+0%	1/15 Summer				99.380
1.004	SMH2	60 Winter	30	+0%	1/120 Winter				99.079
3.000	RE	15 Winter	30	+0%	30/15 Summer				99.691
3.001	DUMMY	15 Winter	30	+0%	30/15 Summer				99.615
3.002	CP3	15 Winter	30	+0%	1/15 Summer				99.593
1.005	SMH3	60 Winter	30	+0%	1/60 Winter				99.066
4.000	RE	15 Winter	30	+0%	100/15 Summer				99.705
4.001	DUMMY	15 Winter	30	+0%	100/15 Summer				99.692
4.002	CP4	15 Winter	30	+0%	30/15 Summer				99.662
1.006	SMH4	60 Winter	30	+0%	1/30 Winter				99.052
5.000	RE	15 Winter	30	+0%					99.866

©1982-2020 Innovyze

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	RE	0.136	0.000	0.71			8.2	SURCHARGED	
1.001	DUMMY	0.209	0.000	0.78		8	9.1	SURCHARGED	
1.002	CP1	0.391	0.000	2.82			15.0	SURCHARGED	
1.003	SMH1	0.292	0.000	0.33			12.7	SURCHARGED	
2.000	RE	-0.027	0.000	0.73			8.7	OK	
2.001	DUMMY	0.050	0.000	0.82		9	9.9	SURCHARGED	
2.002	CP2	0.240	0.000	2.39			12.7	SURCHARGED	
1.004	SMH2	0.659	0.000	0.14			20.8	SURCHARGED	
3.000	RE	0.201	0.000	0.61			8.5	FLOOD RISK	
3.001	DUMMY	0.325	0.000	1.01		5	14.0	SURCHARGED	
3.002	CP3	0.553	0.000	3.34			17.8	SURCHARGED	
1.005	SMH3	0.821	0.000	0.24			34.2	SURCHARGED	
4.000	RE	-0.085	0.000	0.27			3.6	OK	
4.001	DUMMY	-0.023	0.000	0.61		4	8.2	OK	
4.002	CP4	0.022	0.000	1.26			15.8	SURCHARGED	
1.006	SMH4	0.872	0.000	0.28			40.5	SURCHARGED	
5.000	RE	-0.104	0.000	0.20			5.9	OK	

©1982-2020 Innovyze

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
5.001	DUMMY	720 Winter	30	+0%					99.403
5.002	CP5	60 Winter	30	+0%	100/15 Summer				99.043
6.000	RE	240 Winter	30	+0%	100/15 Winter				98.928
6.001	CP6	60 Winter	30	+0%	30/15 Summer				98.968
7.000	pond	240 Winter	30	+0%	100/60 Summer				98.926
6.002	SMH5	60 Winter	30	+0%	1/120 Winter				98.977
8.000	RE	15 Winter	30	+0%	100/15 Summer				99.131
8.001	DUMMY	60 Winter	30	+0%	30/15 Summer				99.078
8.002	CP7	60 Winter	30	+0%	1/15 Summer				99.063
1.007	SMH6	60 Winter	30	+0%	1/15 Summer				99.033

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
5.001	DUMMY	-0.135	0.000	0.02			0.6	OK	
5.002	CP5	-0.012	0.000	0.25			3.9	OK	
6.000	RE	-0.002	0.000	0.13		113	1.6	OK	
6.001	CP6	0.268	0.000	1.47			7.6	SURCHARGED	
7.000	pond	-0.104	0.000	0.02			6.0	OK	
6.002	SMH5	0.472	0.000	0.02			6.3	SURCHARGED	
8.000	RE	-0.049	0.000	0.58			8.0	OK	
8.001	DUMMY	0.070	0.000	0.61		11	8.4	SURCHARGED	
8.002	CP7	0.278	0.000	2.58			13.3	SURCHARGED	
1.007	SMH6	1.178	0.000	0.05			4.5	SURCHARGED	

©1982-2020 Innovyze

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 8
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	RE	15 Winter	100	+40%	30/15 Summer				99.586
1.001	DUMMY	60 Winter	100	+40%	30/15 Summer				99.412
1.002	CP1	30 Winter	100	+40%	1/15 Summer				99.408
1.003	SMH1	360 Winter	100	+40%	30/15 Summer				99.312
2.000	RE	15 Winter	100	+40%	100/15 Summer				99.703
2.001	DUMMY	30 Winter	100	+40%	30/15 Summer				99.490
2.002	CP2	15 Summer	100	+40%	1/15 Summer				99.492
1.004	SMH2	360 Winter	100	+40%	1/120 Winter				99.308
3.000	RE	15 Winter	100	+40%	30/15 Summer				99.919
3.001	DUMMY	30 Winter	100	+40%	30/15 Summer				99.702
3.002	CP3	15 Summer	100	+40%	1/15 Summer				99.696
1.005	SMH3	360 Winter	100	+40%	1/60 Winter				99.308
4.000	RE	15 Winter	100	+40%	100/15 Summer				99.882
4.001	DUMMY	15 Winter	100	+40%	100/15 Summer				99.859
4.002	CP4	15 Winter	100	+40%	30/15 Summer				99.790
1.006	SMH4	360 Winter	100	+40%	1/30 Winter				99.307
5.000	RE	15 Winter	100	+40%					99.883

©1982-2020 Innovyze

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	RE	0.356	0.000	1.27			14.8	FLOOD RISK	
1.001	DUMMY	0.324	0.000	0.69		29	8.1	SURCHARGED	
1.002	CP1	0.513	0.000	3.05			16.2	SURCHARGED	
1.003	SMH1	0.492	0.000	0.20			7.6	SURCHARGED	
2.000	RE	0.213	0.000	1.30			15.6	FLOOD RISK	
2.001	DUMMY	0.150	0.000	0.92		19	11.0	SURCHARGED	
2.002	CP2	0.352	0.000	2.83			15.1	SURCHARGED	
1.004	SMH2	0.888	0.000	0.10			15.9	SURCHARGED	
3.000	RE	0.429	0.000	1.10			15.3	FLOOD RISK	
3.001	DUMMY	0.412	0.000	1.01		13	14.0	SURCHARGED	
3.002	CP3	0.656	0.000	3.63			19.3	SURCHARGED	
1.005	SMH3	1.063	0.000	0.17			23.8	SURCHARGED	
4.000	RE	0.092	0.000	0.54			7.2	SURCHARGED	
4.001	DUMMY	0.144	0.000	1.14		3	15.3	SURCHARGED	
4.002	CP4	0.150	0.000	2.19			27.5	SURCHARGED	
1.006	SMH4	1.127	0.000	0.19			28.0	SURCHARGED	
5.000	RE	-0.087	0.000	0.37			10.7	OK	

©1982-2020 Innovyze

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
5.001	DUMMY	120 Winter	100	+40%					99.429
5.002	CP5	360 Winter	100	+40%	100/15 Summer				99.309
6.000	RE	360 Winter	100	+40%	100/15 Winter				99.310
6.001	CP6	360 Winter	100	+40%	30/15 Summer				99.307
7.000	pond	360 Winter	100	+40%	100/60 Summer				99.302
6.002	SMH5	360 Winter	100	+40%	1/120 Winter				99.305
8.000	RE	15 Winter	100	+40%	100/15 Summer				99.325
8.001	DUMMY	360 Winter	100	+40%	30/15 Summer				99.308
8.002	CP7	360 Winter	100	+40%	1/15 Summer				99.308
1.007	SMH6	360 Winter	100	+40%	1/15 Summer				99.305

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
5.001	DUMMY	-0.109	0.000	0.17			4.8	OK	
5.002	CP5	0.254	0.000	0.35			5.3	SURCHARGED	
6.000	RE	0.380	0.000	0.12		553	1.4	FLOOD RISK	
6.001	CP6	0.607	0.000	0.61			3.2	FLOOD RISK	
7.000	pond	0.272	0.000	0.02			8.7	FLOOD RISK	
6.002	SMH5	0.800	0.000	0.02			5.7	SURCHARGED	
8.000	RE	0.145	0.000	1.04			14.4	SURCHARGED	
8.001	DUMMY	0.300	0.000	0.30		264	4.1	SURCHARGED	
8.002	CP7	0.523	0.000	1.19			6.1	SURCHARGED	
1.007	SMH6	1.450	0.000	0.05			4.9	SURCHARGED	

©1982-2020 Innovyze

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.006	o	900	SMH33	99.620	96.765	1.955	Open Manhole	1800
1.007	o	900	SMH34	99.580	96.690	1.990	Open Manhole	1800
1.008	o	900	SMH35	99.500	96.595	2.005	Open Manhole	1800
8.000	o	300	SWALE	98.450	97.450	0.700	Open Manhole	1200
9.000	o	600	POND	98.110	96.505	1.005	Open Manhole	1500
1.009	o	150	SMH36	98.700	96.465	2.085	Open Manhole	1800

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.006	36.556	487.4	SMH34	99.580	96.690	1.990	Open Manhole	1800
1.007	47.653	501.6	SMH35	99.500	96.595	2.005	Open Manhole	1800
1.008	64.334	494.9	SMH36	98.700	96.465	1.335	Open Manhole	1800
8.000	73.902	182.5	SMH36	98.700	97.045	1.355	Open Manhole	1800
9.000	30.183	754.6	SMH36	98.700	96.465	1.635	Open Manhole	1800
1.009	51.052	42.9		98.230	95.275	2.805	Open Manhole	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.009		98.230	95.275	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	3
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

©1982-2020 Innovyze

Simulation Criteria for Storm

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.400		

©1982-2020 Innovyze

Online Controls for Storm

Complex Manhole: SMH36, DS/PN: 1.009, Volume (m^3): 58.7

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0217-2400-0800-2400
Design Head (m)	0.800
Design Flow (l/s)	24.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	217
Invert Level (m)	96.465
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	24.0
Flush-Flo™	0.333	24.0
Kick-Flo®	0.615	21.2
Mean Flow over Head Range	-	19.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.3	1.200	29.1	3.000	45.3	7.000	68.3
0.200	21.3	1.400	31.4	3.500	48.8	7.500	70.6
0.300	23.9	1.600	33.4	4.000	52.0	8.000	72.9
0.400	23.8	1.800	35.4	4.500	55.1	8.500	74.7
0.500	23.1	2.000	37.2	5.000	58.0	9.000	76.9
0.600	21.6	2.200	39.0	5.500	60.7	9.500	79.0
0.800	24.0	2.400	40.6	6.000	63.4		
1.000	26.7	2.600	42.3	6.500	65.9		

Orifice

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 97.265

©1982-2020 Innovyze

Storage Structures for Storm

Porous Car Park Manhole: SMH35, DS/PN: 1.008

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	7.3
Membrane Percolation (mm/hr)	1000	Length (m)	80.0
Max Percolation (l/s)	162.2	Slope (1:X)	400.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	98.800	Membrane Depth (mm)	0

Swale Manhole: SWALE, DS/PN: 8.000

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	301.9
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	97.450	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5	Include Swale Volume	Yes

Tank or Pond Manhole: POND, DS/PN: 9.000

Invert Level (m) 96.505

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	389.4	0.500	1934.1	1.600	3207.8

©1982-2020 Innovyze

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 3
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	SMH1	15 Winter	1	+0%	100/15 Summer	100/15 Summer		
1.001	SMH2	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
1.002	SMH3	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
2.000	SMH4	15 Winter	1	+0%	100/15 Summer			
3.000	SMH5	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
3.001	SMH6	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
4.000	SMH7	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
3.002	SMH9	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
3.003	SMH10	15 Winter	1	+0%	30/15 Summer			
1.003	SMH11	15 Winter	1	+0%	100/15 Summer			
1.004	SMH12	15 Winter	1	+0%	30/15 Winter			
1.005	SMH13	30 Winter	1	+0%	30/15 Winter			
5.000	SMH14	15 Winter	1	+0%	100/15 Summer			
5.001	SMH15	15 Winter	1	+0%	100/15 Summer			
5.002	SMH16	15 Winter	1	+0%	100/15 Summer			
5.003	SMH17	15 Winter	1	+0%	100/15 Summer	100/15 Summer		
6.000	SMH18	15 Winter	1	+0%	30/15 Summer	100/15 Summer		

©1982-2020 Innovyze

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SMH1	99.127	-0.143	0.000	0.28			14.5	OK	4
1.001	SMH2	98.578	-0.177	0.000	0.35			33.7	OK	4
1.002	SMH3	98.392	-0.143	0.000	0.53			46.0	OK	4
2.000	SMH4	98.735	-0.155	0.000	0.21			20.4	OK	
3.000	SMH5	98.749	-0.121	0.000	0.41			19.5	OK	4
3.001	SMH6	98.203	-0.117	0.000	0.46			19.8	OK	2
4.000	SMH7	98.698	-0.122	0.000	0.41			20.5	OK	4
3.002	SMH9	98.072	-0.113	0.000	0.71			40.6	OK	2
3.003	SMH10	98.029	-0.111	0.000	0.71			40.3	OK	
1.003	SMH11	97.568	-0.532	0.000	0.18			102.1	OK	
1.004	SMH12	97.455	-0.525	0.000	0.20			101.3	OK	
1.005	SMH13	97.392	-0.518	0.000	0.12			78.1	OK	
5.000	SMH14	98.845	-0.175	0.000	0.11			5.1	OK	
5.001	SMH15	98.548	-0.247	0.000	0.07			5.0	OK	
5.002	SMH16	98.278	-0.397	0.000	0.03			5.1	OK	
5.003	SMH17	97.847	-0.378	0.000	0.06			8.6	OK	1
6.000	SMH18	97.917	-0.348	0.000	0.21			61.4	OK	5

©1982-2020 Innovyze

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
6.001	SMH19	15 Winter	1	+0%	30/15 Winter	100/15 Summer		
6.002	SMH20	15 Winter	1	+0%	100/15 Summer	100/15 Summer		
5.004	SMH21	15 Winter	1	+0%	30/15 Winter			
5.005	SMH22	15 Winter	1	+0%	30/15 Winter	100/15 Summer		
5.006	SMH23	15 Winter	1	+0%	30/15 Winter			
5.007	SMH24	15 Winter	1	+0%	30/15 Winter			
5.008	SMH25	15 Winter	1	+0%	30/15 Winter			
7.000	SMH26	30 Winter	1	+0%	30/30 Summer	100/15 Summer		
7.001	SMH27	30 Winter	1	+0%	30/15 Summer	100/15 Summer		
7.002	SMH28	30 Winter	1	+0%	30/15 Winter	100/15 Summer		
5.009	SMH29	30 Winter	1	+0%	30/15 Winter	100/15 Summer		
5.010	SMH30	30 Winter	1	+0%	30/15 Summer	100/15 Winter		
5.011	SMH31	30 Winter	1	+0%	30/15 Summer	100/15 Winter		
5.012	SMH32	30 Winter	1	+0%	30/15 Summer			
1.006	SMH33	30 Winter	1	+0%	30/15 Summer			
1.007	SMH34	30 Winter	1	+0%	30/15 Summer			
1.008	SMH35	30 Winter	1	+0%	30/15 Summer			
8.000	SWALE	15 Winter	1	+0%	100/15 Summer			
9.000	POND	240 Winter	1	+0%	30/30 Winter			
1.009	SMH36	30 Winter	1	+0%	1/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
6.001	SMH19	97.896	-0.309	0.000	0.28			104.0	OK
6.002	SMH20	97.879	-0.421	0.000	0.30			104.2	OK
5.004	SMH21	97.749	-0.381	0.000	0.39			110.6	OK
5.005	SMH22	97.699	-0.391	0.000	0.31			107.5	OK
5.006	SMH23	97.640	-0.385	0.000	0.29			102.4	OK
5.007	SMH24	97.589	-0.371	0.000	0.38			100.1	OK
5.008	SMH25	97.549	-0.376	0.000	0.40			110.7	OK
7.000	SMH26	97.464	-0.621	0.000	0.03			23.3	OK
7.001	SMH27	97.463	-0.542	0.000	0.05			36.6	OK
7.002	SMH28	97.453	-0.457	0.000	0.06			25.5	OK
5.009	SMH29	97.451	-0.434	0.000	0.17			114.1	OK
5.010	SMH30	97.429	-0.391	0.000	0.26			175.9	OK
5.011	SMH31	97.402	-0.348	0.000	0.37			251.8	OK
5.012	SMH32	97.374	-0.311	0.000	0.75			272.5	OK
1.006	SMH33	97.360	-0.305	0.000	0.45			309.3	OK
1.007	SMH34	97.323	-0.267	0.000	0.43			305.5	OK
1.008	SMH35	97.270	-0.225	0.000	0.39		26	296.6	OK
8.000	SWALE	97.580	-0.170	0.000	0.39		5	30.7	OK
9.000	POND	96.970	-0.135	0.000	0.12			22.2	OK
1.009	SMH36	97.194	0.579	0.000	0.90			23.9	SURCHARGED

©1982-2020 Innovyze

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
6.001	SMH19	5
6.002	SMH20	5
5.004	SMH21	
5.005	SMH22	4
5.006	SMH23	
5.007	SMH24	
5.008	SMH25	
7.000	SMH26	5
7.001	SMH27	5
7.002	SMH28	3
5.009	SMH29	2
5.010	SMH30	1
5.011	SMH31	
5.012	SMH32	
1.006	SMH33	
1.007	SMH34	
1.008	SMH35	
8.000	SWALE	
9.000	POND	
1.009	SMH36	

©1982-2020 Innovyze

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 3
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	SMH1	15 Winter	30	+0%	100/15 Summer	100/15 Summer		
1.001	SMH2	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
1.002	SMH3	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
2.000	SMH4	15 Winter	30	+0%	100/15 Summer			
3.000	SMH5	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
3.001	SMH6	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
4.000	SMH7	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
3.002	SMH9	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
3.003	SMH10	15 Winter	30	+0%	30/15 Summer			
1.003	SMH11	15 Winter	30	+0%	100/15 Summer			
1.004	SMH12	15 Winter	30	+0%	30/15 Winter			
1.005	SMH13	15 Winter	30	+0%	30/15 Winter			
5.000	SMH14	15 Winter	30	+0%	100/15 Summer			
5.001	SMH15	15 Winter	30	+0%	100/15 Summer			
5.002	SMH16	15 Winter	30	+0%	100/15 Summer			
5.003	SMH17	30 Winter	30	+0%	100/15 Summer	100/15 Summer		
6.000	SMH18	15 Winter	30	+0%	30/15 Summer	100/15 Summer		

©1982-2020 Innovyze

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.000	SMH1	99.197	-0.073	0.000	0.69			35.4	OK
1.001	SMH2	99.009	0.254	0.000	0.84			82.0	SURCHARGED
1.002	SMH3	98.855	0.320	0.000	1.32			114.0	SURCHARGED
2.000	SMH4	98.780	-0.110	0.000	0.52			49.9	OK
3.000	SMH5	98.935	0.065	0.000	0.95			44.6	SURCHARGED
3.001	SMH6	98.467	0.147	0.000	1.00			42.7	SURCHARGED
4.000	SMH7	98.887	0.067	0.000	0.94			47.3	SURCHARGED
3.002	SMH9	98.331	0.146	0.000	1.55			88.6	SURCHARGED
3.003	SMH10	98.206	0.066	0.000	1.57			88.3	SURCHARGED
1.003	SMH11	98.100	0.000	0.000	0.42			235.1	OK
1.004	SMH12	97.991	0.011	0.000	0.42			212.8	SURCHARGED
1.005	SMH13	97.968	0.058	0.000	0.28			177.0	SURCHARGED
5.000	SMH14	98.875	-0.145	0.000	0.28			12.5	OK
5.001	SMH15	98.580	-0.215	0.000	0.18			12.5	OK
5.002	SMH16	98.310	-0.365	0.000	0.08			12.0	OK
5.003	SMH17	98.181	-0.044	0.000	0.11			15.4	OK
6.000	SMH18	98.329	0.064	0.000	0.51			148.4	SURCHARGED

PN	US/MH Name	Level Exceeded
1.000	SMH1	4
1.001	SMH2	4
1.002	SMH3	4
2.000	SMH4	
3.000	SMH5	4
3.001	SMH6	2
4.000	SMH7	4
3.002	SMH9	2
3.003	SMH10	
1.003	SMH11	
1.004	SMH12	
1.005	SMH13	
5.000	SMH14	
5.001	SMH15	
5.002	SMH16	
5.003	SMH17	1
6.000	SMH18	5

©1982-2020 Innovyze

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
6.001	SMH19	15 Winter	30	+0%	30/15 Winter	100/15 Summer		
6.002	SMH20	30 Summer	30	+0%	100/15 Summer	100/15 Summer		
5.004	SMH21	30 Summer	30	+0%	30/15 Winter			
5.005	SMH22	30 Winter	30	+0%	30/15 Winter	100/15 Summer		
5.006	SMH23	30 Winter	30	+0%	30/15 Winter			
5.007	SMH24	15 Winter	30	+0%	30/15 Winter			
5.008	SMH25	15 Winter	30	+0%	30/15 Winter			
7.000	SMH26	30 Winter	30	+0%	30/30 Summer	100/15 Summer		
7.001	SMH27	30 Winter	30	+0%	30/15 Summer	100/15 Summer		
7.002	SMH28	15 Winter	30	+0%	30/15 Winter	100/15 Summer		
5.009	SMH29	15 Winter	30	+0%	30/15 Winter	100/15 Summer		
5.010	SMH30	15 Winter	30	+0%	30/15 Summer	100/15 Winter		
5.011	SMH31	15 Winter	30	+0%	30/15 Summer	100/15 Winter		
5.012	SMH32	15 Winter	30	+0%	30/15 Summer			
1.006	SMH33	15 Winter	30	+0%	30/15 Summer			
1.007	SMH34	15 Winter	30	+0%	30/15 Summer			
1.008	SMH35	15 Winter	30	+0%	30/15 Summer			
8.000	SWALE	15 Winter	30	+0%	100/15 Summer			
9.000	POND	360 Winter	30	+0%	30/30 Winter			
1.009	SMH36	15 Winter	30	+0%	1/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
6.001	SMH19	98.248	0.043	0.000	0.75			280.0	SURCHARGED
6.002	SMH20	98.191	-0.109	0.000	0.72			245.1	OK
5.004	SMH21	98.163	0.033	0.000	0.86			243.4	SURCHARGED
5.005	SMH22	98.124	0.034	0.000	0.54			188.4	SURCHARGED
5.006	SMH23	98.104	0.079	0.000	0.52			182.3	SURCHARGED
5.007	SMH24	98.082	0.122	0.000	0.85			222.9	SURCHARGED
5.008	SMH25	98.066	0.141	0.000	0.89			244.2	SURCHARGED
7.000	SMH26	98.103	0.018	0.000	0.06			52.1	SURCHARGED
7.001	SMH27	98.090	0.085	0.000	0.12			88.2	SURCHARGED
7.002	SMH28	98.049	0.139	0.000	0.29			114.6	SURCHARGED
5.009	SMH29	98.046	0.161	0.000	0.47			319.3	SURCHARGED
5.010	SMH30	98.030	0.210	0.000	0.70			481.8	SURCHARGED
5.011	SMH31	98.001	0.251	0.000	0.98			661.2	SURCHARGED
5.012	SMH32	97.958	0.273	0.000	1.88			687.0	SURCHARGED
1.006	SMH33	97.927	0.262	0.000	1.14			788.1	SURCHARGED
1.007	SMH34	97.850	0.260	0.000	1.05			753.0	SURCHARGED
1.008	SMH35	97.751	0.256	0.000	0.97		38	735.8	SURCHARGED
8.000	SWALE	97.663	-0.087	0.000	0.83		7	65.0	OK
9.000	POND	97.324	0.219	0.000	0.14			25.2	SURCHARGED
1.009	SMH36	97.619	1.004	0.000	1.92			50.9	SURCHARGED

©1982-2020 Innovyze

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
6.001	SMH19	5
6.002	SMH20	5
5.004	SMH21	
5.005	SMH22	4
5.006	SMH23	
5.007	SMH24	
5.008	SMH25	
7.000	SMH26	5
7.001	SMH27	5
7.002	SMH28	3
5.009	SMH29	2
5.010	SMH30	1
5.011	SMH31	
5.012	SMH32	
1.006	SMH33	
1.007	SMH34	
1.008	SMH35	
8.000	SWALE	
9.000	POND	
1.009	SMH36	

©1982-2020 Innovyze

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 3
Number of Online Controls 1 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	SMH1	15 Winter	100	+40%	100/15 Summer	100/15 Summer		
1.001	SMH2	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
1.002	SMH3	30 Winter	100	+40%	30/15 Summer	100/15 Summer		
2.000	SMH4	15 Winter	100	+40%	100/15 Summer			
3.000	SMH5	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
3.001	SMH6	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
4.000	SMH7	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
3.002	SMH9	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
3.003	SMH10	30 Winter	100	+40%	30/15 Summer			
1.003	SMH11	30 Winter	100	+40%	100/15 Summer			
1.004	SMH12	30 Winter	100	+40%	30/15 Winter			
1.005	SMH13	30 Winter	100	+40%	30/15 Winter			
5.000	SMH14	15 Winter	100	+40%	100/15 Summer			
5.001	SMH15	30 Winter	100	+40%	100/15 Summer			
5.002	SMH16	15 Winter	100	+40%	100/15 Summer			
5.003	SMH17	15 Winter	100	+40%	100/15 Summer	100/15 Summer		
6.000	SMH18	30 Winter	100	+40%	30/15 Summer	100/15 Summer		

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.000	SMH1	100.076	0.806	5.814	1.08			55.7	FLOOD
1.001	SMH2	99.964	1.209	3.766	1.08			105.0	FLOOD
1.002	SMH3	99.805	1.270	5.504	1.51			131.0	FLOOD
2.000	SMH4	99.762	0.872	0.000	0.94			90.5	SURCHARGED
3.000	SMH5	99.687	0.817	6.797	1.31			61.8	FLOOD
3.001	SMH6	99.660	1.340	0.261	1.25			53.6	FLOOD
4.000	SMH7	99.607	0.787	7.213	1.29			64.9	FLOOD
3.002	SMH9	99.528	1.343	3.186	2.02			115.7	FLOOD
3.003	SMH10	99.471	1.331	0.000	1.87			105.3	FLOOD RISK
1.003	SMH11	99.390	1.290	0.000	0.47			263.6	FLOOD RISK
1.004	SMH12	99.364	1.384	0.000	0.53			268.6	FLOOD RISK
1.005	SMH13	99.340	1.430	0.000	0.42			265.8	SURCHARGED
5.000	SMH14	99.484	0.464	0.000	0.50			22.6	SURCHARGED
5.001	SMH15	99.455	0.660	0.000	0.29			20.1	SURCHARGED
5.002	SMH16	99.450	0.775	0.000	0.19			29.6	SURCHARGED
5.003	SMH17	99.445	1.220	0.029	0.36			51.8	FLOOD
6.000	SMH18	99.438	1.173	38.249	0.64			185.9	FLOOD

PN	US/MH Name	Level Exceeded
1.000	SMH1	4
1.001	SMH2	4
1.002	SMH3	4
2.000	SMH4	
3.000	SMH5	4
3.001	SMH6	2
4.000	SMH7	4
3.002	SMH9	2
3.003	SMH10	
1.003	SMH11	
1.004	SMH12	
1.005	SMH13	
5.000	SMH14	
5.001	SMH15	
5.002	SMH16	
5.003	SMH17	1
6.000	SMH18	5

©1982-2020 Innovyze

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
6.001	SMH19	30 Winter	100	+40%	30/15 Winter	100/15 Summer		
6.002	SMH20	15 Winter	100	+40%	100/15 Summer	100/15 Summer		
5.004	SMH21	15 Winter	100	+40%	30/15 Winter			
5.005	SMH22	15 Winter	100	+40%	30/15 Winter	100/15 Summer		
5.006	SMH23	15 Summer	100	+40%	30/15 Winter			
5.007	SMH24	15 Summer	100	+40%	30/15 Winter			
5.008	SMH25	15 Summer	100	+40%	30/15 Winter			
7.000	SMH26	30 Winter	100	+40%	30/30 Summer	100/15 Summer		
7.001	SMH27	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
7.002	SMH28	15 Winter	100	+40%	30/15 Winter	100/15 Summer		
5.009	SMH29	15 Winter	100	+40%	30/15 Winter	100/15 Summer		
5.010	SMH30	15 Winter	100	+40%	30/15 Summer	100/15 Winter		
5.011	SMH31	30 Winter	100	+40%	30/15 Summer	100/15 Winter		
5.012	SMH32	30 Winter	100	+40%	30/15 Summer			
1.006	SMH33	30 Winter	100	+40%	30/15 Summer			
1.007	SMH34	30 Winter	100	+40%	30/15 Summer			
1.008	SMH35	30 Winter	100	+40%	30/15 Summer			
8.000	SWALE	60 Winter	100	+40%	100/15 Summer			
9.000	POND	360 Winter	100	+40%	30/30 Winter			
1.009	SMH36	30 Winter	100	+40%	1/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
6.001	SMH19	99.429	1.224	44.028	0.95			351.6	FLOOD
6.002	SMH20	99.422	1.122	22.755	1.36			463.5	FLOOD
5.004	SMH21	99.441	1.311	0.000	1.45			410.4	FLOOD RISK
5.005	SMH22	99.461	1.371	21.232	1.10			382.8	FLOOD
5.006	SMH23	99.635	1.610	0.000	1.03			363.3	FLOOD RISK
5.007	SMH24	99.705	1.745	0.000	1.25			328.2	SURCHARGED
5.008	SMH25	99.688	1.763	0.000	1.29			352.9	SURCHARGED
7.000	SMH26	99.330	1.245	55.483	0.14			108.8	FLOOD
7.001	SMH27	99.351	1.346	65.781	0.28			198.7	FLOOD
7.002	SMH28	99.491	1.581	42.835	0.40			160.7	FLOOD
5.009	SMH29	99.653	1.768	8.568	0.71			478.8	FLOOD
5.010	SMH30	99.758	1.938	7.140	1.05			720.6	FLOOD
5.011	SMH31	99.556	1.806	0.000	1.49			1002.2	FLOOD RISK
5.012	SMH32	99.481	1.796	0.000	3.07			1120.7	FLOOD RISK
1.006	SMH33	99.303	1.638	0.000	1.84			1272.6	SURCHARGED
1.007	SMH34	99.021	1.431	0.000	1.76			1264.1	SURCHARGED
1.008	SMH35	98.697	1.202	0.000	1.66			1257.0	SURCHARGED
8.000	SWALE	97.964	0.214	0.000	0.72		26	56.5	SURCHARGED
9.000	POND	97.792	0.687	0.000	0.21			38.5	SURCHARGED
1.009	SMH36	98.307	1.692	0.000	3.05			80.9	SURCHARGED

©1982-2020 Innovyze

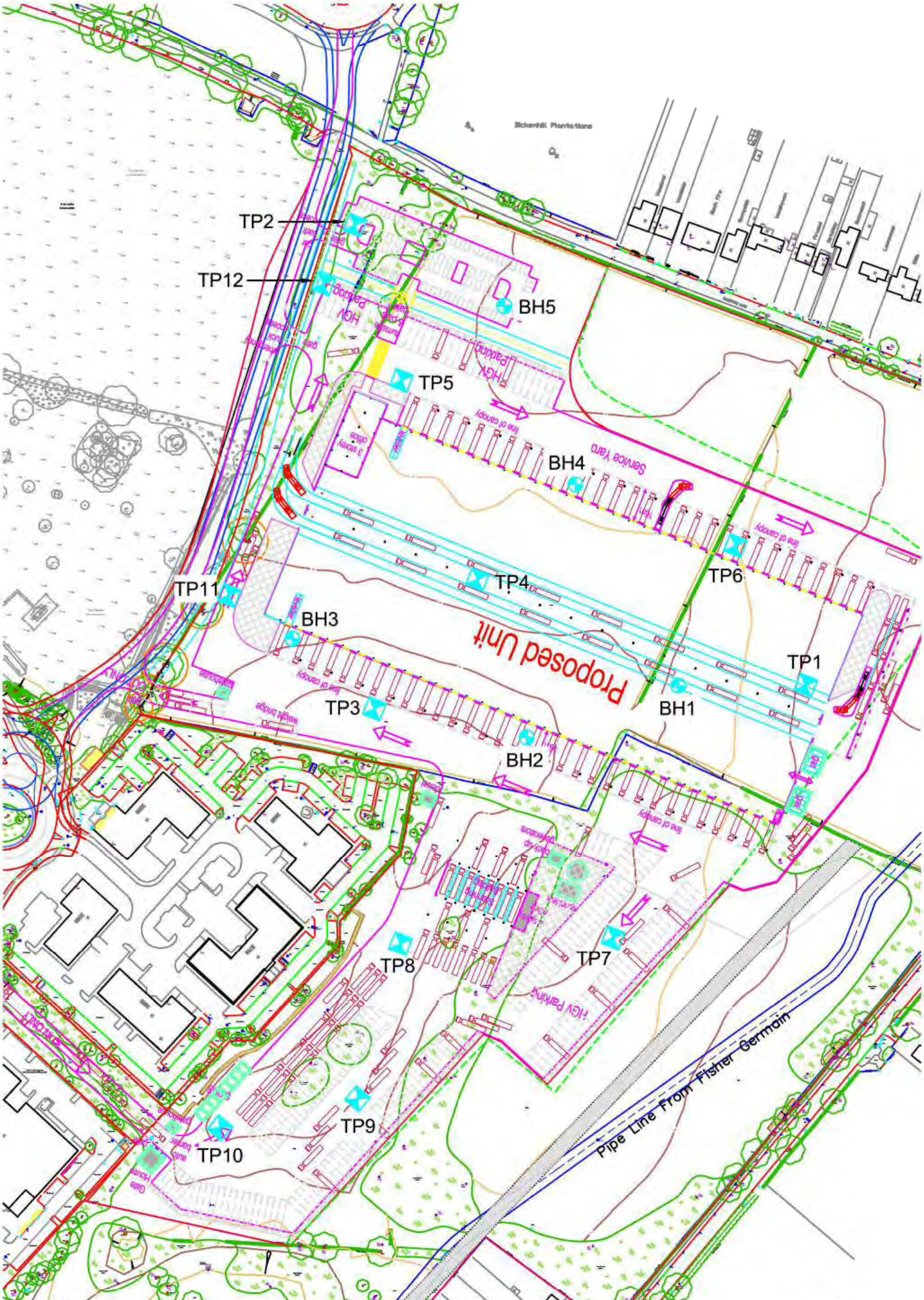
100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Level Exceeded
6.001	SMH19	5
6.002	SMH20	5
5.004	SMH21	
5.005	SMH22	4
5.006	SMH23	
5.007	SMH24	
5.008	SMH25	
7.000	SMH26	5
7.001	SMH27	5
7.002	SMH28	3
5.009	SMH29	2
5.010	SMH30	1
5.011	SMH31	
5.012	SMH32	
1.006	SMH33	
1.007	SMH34	
1.008	SMH35	
8.000	SWALE	
9.000	POND	
1.009	SMH36	

©1982-2020 Innovyze

13 Appendix E

E.1 Ground Investigation Report Extracts



Scale :	N.T.S.
Drawn By :	P.L.E.
Job No:	52152
Fig:	A1.1

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

SITE PLAN

Solihull Parkway, Birmingham Business Park, Birmingham.

IAN FARMER ASSOCIATES	Site	Borehole Number
	Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 10.00m	100.80	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	04/12/2013		1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00 0.00-0.50 0.25	D1 B1 E1					(0.50)	TOPSOIL comprising of soft to firm friable dark brown slightly silty clayey gravelly fine to medium sand with some rootlets and occasional roots. Gravel is fine to coarse subrounded to rounded quartz.			
0.50 0.50-1.00	D2 B2				100.30	0.50				
1.00	D3					(1.50)	Possible MADE GROUND: Loose mixed dark brown, orange brown clayey slightly silty gravelly becoming slightly gravelly medium sand with rare rootlets to 1.00m. Gravel is fine to coarse becoming fine to medium subrounded to rounded quartz.			
1.50-1.95 1.50-1.95	SPT N=9 D4	1.00	DRY	1,1/2,3,2,2			From 1.50m; Orange brown occasionally dark brown.			
2.00 2.00-2.50	D5 B3				98.80	2.00	Loose becoming medium dense orange brown fine to medium SAND.			
2.50-2.95 2.50-2.95	SPT N=9 D6	2.00	2.00	2,2/3,2,2,2						
3.00	D7						From 2.00m; Slightly gravelly. Gravel is fine to coarse subrounded to rounded quartz.			
3.50-3.95 3.50-3.95	SPT N=15 D8	3.00	3.00	3,3/3,4,4,4			From 3.50m to 4.50m; Brown.			
4.00	D9								▼1	
4.50-4.95 4.50-4.95	SPT N=16 D10	4.00	4.00	2,3/3,5,4,4			From 4.50m; Not gravelly.			
5.00	D11			Moderate(1) at 5.00m, rose to 4.25m in 20 mins, not sealed.			From 5.00m; Damp.		∇1	
6.00-6.45	SPT N=14	6.00	5.00	3,3/3,4,4,3		(8.45)				
6.50	D12									
7.50-7.95	SPT N=17	7.00	5.00	3,4/4,4,5,4						
8.00	D13						From 8.00m to 9.50m; Slightly gravelly.			
9.00-9.45	SPT N=20	9.00	6.00	4,4/4,5,5,6						
9.50	D14									
				04/12/2012:6.10m						

Remarks
Depth to water recorded at 2.50m, 3.50m and 4.50m SPT tests may be due to adding water to assist drilling the borehole or could possibly be masking a groundwater strike.
Plain standpipe installed to 1.00m surrounded with bentonite, slotted standpipe installed to 7.00m surrounded with pea gravel, fitted with a gas tap and a stop cock cover.
0.50 hour collecting water to assist with drilling the borehole.
Water added from 1.50m to 6.00m. Excavating from 0.00m to 1.20m for 1 hour.

Scale (approx)	Logged By
1:50	EM
Figure No. A2.1	

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Borehole Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 10.00m	100.80	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	04/12/2013		2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00-10.45 10.00-10.45	SPT N=23 D15	10.00	6.00	1,2/4,6,6,7			... as previous			
					90.35	10.45				
							Complete at 10.45m			

Remarks

Scale (approx)	Logged By
1:50	EM

Figure No. A2.1

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Borehole Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	BH2

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 10.00m	102.20	Baynham Meikle Partnership	52152
	Location SP 187 855	**Dates** 04/12/2013	**Engineer**	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
0.00	D1						
0.00-0.50	B1					(0.50)	MADE GROUND:Mixed topsoil comprising soft to firm friable dark brown some orange brown sandy gravelly silty clay with some rootlets and occasional roots. Sand is fine to medium. Gravel is fine to coarse subrounded to rounded quartz.
0.25	E1						
0.50	D2				101.70	0.50	
0.50-1.00	B2					(0.50)	Possible MADE GROUND: Mixed soft to firm occasionally friable dark brown, orange brown and red brown sandy gravelly silty clay with occasional rootlets and roots. Sand is fine to medium. Gravel is fine to coarse subrounded to rounded quartz.
1.00	D3				101.20	1.00	
						(0.50)	Mixed firm to stiff red brown silty CLAY with rare black flecks and firm red occasionally light brown sandy silty CLAY. Sand is fine to medium.
1.50-1.95	SPT N=9	1.00	DRY	2,2/2,2,3,2	100.70	1.50	
1.50-1.95	D4						
2.00	D5					(1.50)	Firm to stiff becoming fissured laminated red brown silty CLAY with occasional black flecks to 2.00m and occasional silty pockets and lenses from 2.00m. Fissures and laminations are extremely close. From 2.50m; Slightly gravelly. Gravel is fine to coarse subrounded to rounded quartz. Not fissured or laminated.
2.50-2.95	SPT N=6	2.00	DRY	1,0/2,1,2,1			
2.50-2.95	D6						
2.50-3.00	B3						
3.00	D7				99.20	3.00	
						(1.00)	Loose red brown slightly clayey slightly gravelly medium SAND with some pockets of very soft red brown silty clay and red brown sandy silty clay to 3.50m. Gravel is fine to medium subrounded to rounded quartz. From 3.50m; Damp. Not clayey.
3.50-3.95	SPT N=9	3.00	3.00	2,2/2,2,3,2			
3.50-3.95	D8						
3.50-4.00	B4						
4.00	D9				98.20	4.00	Medium dense red brown fine to medium SAND.
4.50-4.95	SPT N=15	4.00	4.00	2,3/4,4,3,4			
4.50-4.95	D10						
5.00	D11						
6.00-6.45	SPT N=15	6.00	5.00	3,3/4,3,4,4			
6.50	D12						
						(6.45)	
7.50-7.95	SPT N=18	7.50	5.00	2,3/3,4,6,5			
8.00	D13						
9.00-9.45	SPT N=20	9.00	6.00	4,4/4,5,5,6			
9.50	D14						
10.00-10.45	SPT N=28	10.00	5.00	3,4/5,6,8,9			

Remarks
Groundwater not observed but recorded as standing at 8.00mbgl at the end of drilling.
Depth to water recorded during SPT tests may be due to adding water to assist drilling the borehole and could be masking a groundwater strike.
Plain standpipe installed to 1.00m surrounded with bentonite, slotted standpipe installed to 7.00m surrounded with pea gravel, fitted with a gas tap and a stop cock cover.
0.50 hour collecting water to assist with drilling the borehole.
Water added from 3.00m to 6.00m. Excavating from 0.00m to 1.20m for 1 hour.

Scale (approx)	Logged By
1:50	EM

Figure No. A2.2

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site			Borehole Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN			BH2

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 10.00m	102.20	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	04/12/2013		2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00-10.45	D15						... as previous			
				04/12/2013:8.00m	91.75	10.45	Complete at 10.45m			

Remarks

Scale (approx)	Logged By
1:50	EM

Figure No. A2.2

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Borehole Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	**BH3**

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 10.00m	101.90	Baynham Meikle Partnership	52152

	Location	Dates	Engineer	Sheet
	SP 187 855	03/12/2013		1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records
0.00	J1			
0.00-0.50	B1			
0.25	E1			
0.50	J2			
0.50-1.00	B2			
1.00	J3			
1.50-1.95	SPT N=19	1.50	DRY	4,4/5,5,4,5
1.50-1.95	D1			
2.00	D2			
2.00-2.50	B3			
2.50-2.95	D3			
2.50-2.95	U1 Failed	2.50	DRY	40 blows
2.50-3.00	B4			
3.00-3.45	SPT N=9	3.00	DRY	1,0/2,2,3,2
3.00	D4			
3.50-3.95	SPT N=9	3.50	DRY	2,2/3,2,2,2
3.50-3.95	D5			
4.00	D6			
4.50-4.95	SPT N=12	4.50	DRY	3,3/2,4,3,3
4.50-4.95	D7			
5.00	D8			
				Moderate(1) at 5.20m, rose to 3.70m in 20 mins, not sealed.
5.50-5.95	SPT N=16	5.50	4.00	2,3/4,4,3,5
6.50	D9			
7.00-7.45	SPT N=18	7.00	6.00	3,4/4,5,5,4
8.00	D10			
8.50-8.95	SPT N=28	8.50	7.00	4,5/5,6,8,9
9.50	D11			
10.00-10.45	SPT N=29	10.00	6.00	5,5/6,5,8,10

Level (mOD)	Depth (m) (Thickness)	Description
101.40	(0.50) 0.50	TOPSOIL comprising soft to firm friable dark brown sandy gravelly silty clay with occasional pockets of soft red brown silty clay, rootlets and roots. Sand is fine to medium. Gravel is fine to coarse subrounded to rounded quartz.
100.40	(1.00) 1.50	Possible MADE GROUND: Mixed firm to stiff red brown occasionally dark brown slightly gravelly silty clay and firm to stiff red brown occasionally dark brown slightly gravelly sandy silty clay with occasional rootlets. Sand is fine to medium. Gravel is fine to coarse subrounded to rounded quartz.
99.90	(0.50) 2.00	Mixed firm to stiff red brown silty CLAY with occasional black flecks and firm to stiff red brown slightly gravelly sandy silty CLAY. Sand is fine to medium. Gravel is fine to medium subrounded to rounded quartz.
99.40	(0.50) 2.50	Very soft occasionally friable red brown slightly gravelly sandy very silty CLAY. Sand is fine to medium. Gravel is fine to medium subrounded to rounded quartz.
98.40	(1.00) 3.50	Slightly damp loose red brown clayey slightly gravelly to gravelly fine to medium SAND with occasional becoming some pockets of soft red brown sandy silty clay. Gravel is fine to coarse subrounded to rounded quartz. From 3.00m; Slightly gravelly. Not damp.
	(6.95)	Loose becoming medium dense red brown medium SAND At 8.00m; With occasional clay pockets. From 8.00m; Slightly gravelly. Gravel is fine to medium subrounded to rounded quartz.

Remarks
Plain standpipe installed to 1.00m surrounded with bentonite, slotted standpipe installed to 7.00m surrounded with pea gravel, fitted with a gas tap and a stop cock cover.
0.50 hour collecting water to assist with drilling the borehole.
Water added from 3.00m to 6.00m. Excavating from 0.00m to 1.20m for 1 hour.

Scale (approx)	Logged By
1:50	EM

Figure No. A2.3

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Borehole Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	BH3

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 10.00m	101.90	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	03/12/2013		2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00-10.45	D12						... as previous			
				03/12/2013:5.50m	91.45	10.45	Complete at 10.45m			

Remarks	Scale (approx)	Logged By
	1:50	EM
	Figure No. A2.3	

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Borehole Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	BH4

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 10.00m	99.60	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	03/12/2013		1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00 0.00-0.40 0.25	D1 B1 E1						MADE GROUND: Dark greyish brown slightly clayey slightly gravelly silty fine to medium sand with occasional rootlets, decomposing organic matter, rare sandy pockets and charcoal fragments. Gravel is fine to coarse subangular to rounded flint and quartz.			
0.50	D2					(1.00)				
1.00 1.00-1.50	D3 B2				98.60	1.00	Loose becoming medium dense reddish brown slightly gravelly silty medium SAND. Gravel is fine to coarse subrounded to rounded quartz.			
1.50-1.95 1.50-1.95	SPT N=9 D4	1.00	DRY	2,2/2,2,2,3						
2.00	D5									
2.50-2.95 2.50-2.95	SPT N=13 D6	2.50	DRY	2,3/3,4,3,3						
3.00	D7									
3.50-3.95 3.50-3.95	SPT N=12 D8	3.50	DRY	2,3/3,4,3,2					▼1	
4.00	D9						From 4.00m; Not gravelly.			
4.50-4.95 4.50-4.95	SPT N=17 D10	4.50	4.00	3,3/2,4,6,5 Moderate(1) at 4.70m, rose to 3.90m in 20 mins, not sealed.					∇1	
5.00	D11									
						(9.45)				
6.00-6.45 6.00-6.45	SPT N=19 D12	6.00	5.00	4,4/3,5,5,6						
6.50	D13									
7.00-7.50	B3									
7.50-7.95 7.50-7.95	SPT N=20 D14	7.50	5.00	4,4/5,4,5,6			From 7.50m; Slightly gravelly.			
8.00	D15									
9.00-9.45 9.00-9.45	SPT N=28 D16	9.00	6.00	3,4/4,6,8,10						
9.50	D17									
10.00-10.45	SPT N=26	10.00	7.00	3,4/5,6,8,7						

Remarks
Plain standpipe installed to 1.00m surrounded with bentonite, slotted standpipe installed to 7.00m surrounded with pea gravel, fitted with a gas tap and a stop cock cover.
0.50 hour collecting water to assist with drilling the borehole.
Water added from 1.50m to 5.00m. Excavating from 0.00m to 1.20m for 1 hour.

Scale (approx)	Logged By
1:50	LH

Figure No. A2.4

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Borehole Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	BH4

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 10.00m	99.60	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	03/12/2013		2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
10.00-10.45	D18						... as previous			
				03/12/2013:7.10m	89.15	10.45	Complete at 10.45m			

Remarks	Scale (approx)	Logged By
	1:50	LH
	Figure No. A2.4	

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES	Site: Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	Borehole Number: BH5

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 10.00m	98.70	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	02/12/2013		1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.40	B1						MADE GROUND: Dark greyish brown mottled dark reddish brown slightly gravelly silty fine to medium sand with occasional rootlets, rare decomposing organic matter and brick fragments. Gravel is fine to coarse subangular to rounded quartz and flint.		
0.25	E1								
0.50	D1					(1.00)			
					97.70	1.00	Medium dense dark reddish brown slightly gravelly silty fine to medium SAND with rare clay pockets. Gravel is fine to coarse subrounded to rounded quartz and flint.		
1.00	D2								
1.00-1.50	B2								
1.50-1.95	SPT N=12	1.50	DRY	2,2/2,3,4,3		(1.00)			
1.50-1.95	D3								
					96.70	2.00	Medium dense reddish brown silty medium SAND.		
2.00	D4								
2.50-2.95	SPT N=13	2.50	DRY	3,3/3,4,3,3					
2.50-2.95	D5								
3.00	D6								
3.50-3.95	SPT N=12	3.50	DRY	2,3/3,2,4,3			From 3.50m; Very silty.		
3.50-3.95	D7								
4.00	D8								▼1
4.50-4.95	SPT N=16	4.50	4.00	3,3/5,4,3,4					
4.50-4.95	D9								
5.00	D10			Moderate(1) at 5.00m, rose to 4.10m in 20 mins, not sealed.		(6.30)			∇1
5.50-5.95	SPT N=24	5.50	5.00	3,3/4,3,8,9					
5.50-5.95	D11								
6.50	D12								
7.00-7.45	SPT N=25	7.00	5.00	3,3/3,5,8,9					
7.00-7.45	D13								
8.00	D14								
					90.40	8.30	Medium dense dark reddish brown slightly gravelly becoming gravelly silty fine to medium SAND. Gravel is fine to medium subrounded to rounded quartz and flint.		
8.50-8.95	SPT N=29	8.50	8.00	4,4/6,8,7,8					
8.50-8.95	D15								
8.50-9.00	B3								
9.00	D16								
9.50	D17					(2.15)	From 9.50m; Reddish brown.		
10.00-10.45	SPT N=28	10.00	6.00	4,5/5,5,8,10					

Remarks
Depth to water recorded at 4.50m SPT test may be due to adding water to assist drilling the borehole or could possibly be masking a groundwater strike.
0.50 hour collecting water to assist with drilling the borehole.
Groundwater at 5.50m after casing removed.
Water added from 3.00m to 10.00m. Excavating from 0.00m to 1.20m for 1 hour.

Scale (approx)	Logged By
1:50	LH
Figure No. A2.5	

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Borehole Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	BH5

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
Cable Percussion	150mm cased to 10.00m	98.70	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	02/12/2013		2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.00-10.45	D18						... as previous		
					88.25	10.45			
				02/12/2013:6.00m			Complete at 10.45m		

Remarks	Scale (approx)	Logged By
	1:50	LH
	Figure No. A2.5	

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Trial Pit Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	TP1

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Machine dug	0.85m x 3.80m x 2.80m	99.00	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	03/12/2013		1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.15	E1				(0.60)	MADE GROUND: Dark greyish brown slightly clayey slightly gravelly very silty fine to medium sand with occasional rootlets, decomposing organic matter and rare charcoal. Gravel is fine to medium subangular to rounded flint and quartz.		
0.45	B1			98.40	0.60			
0.70	B2					Reddish brown slightly gravelly silty fine to medium SAND with rare rootlets from 0.70m. Gravel is fine to medium subangular to subrounded flint and quartz.		
1.40	B3				(2.20)			
1.90	B4							
2.60	B5			96.20	2.80	Complete at 2.80m		

Plan

Remarks

From 1.20m trial pit walls collapsing.
Groundwater not encountered.

Scale (approx)	Logged By	Figure No.
1:50	LH	A2.6

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Trial Pit Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	TP2

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Machine Dug	0.80m x 3.50m x 2.90m	99.20	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	04/12/2013		1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.15	E1				(0.30)	MADE GROUND: Dark greyish brown slightly clayey gravelly very silty fine to medium sand with occasional rootlets, decomposing organic matter, brick fragments and rare charcoal fragments. Gravel is fine to coarse subangular to rounded quartz, flint and rare chalk.		
0.20	B1			98.90	0.30			
0.50	B2				(0.40)	Brown slightly gravelly silty fine to medium SAND with occasional rootlets and decomposing organic matter. Gravel is fine to medium subangular to rounded quartz and flint.		
				98.50	0.70			
1.00	B3					Reddish brown slightly silty slightly gravelly fine to medium SAND. Gravel is fine to coarse subangular to rounded quartz and flint.		
1.75	B4				(2.20)			
2.75	B5							
				96.30	2.90	Complete at 2.90m		

Plan

Remarks

Groundwater not encountered.

Scale (approx)	Logged By	Figure No.
1:50	LH	A2.7

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Trial Pit Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	TP3

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Machine Dug	0.80m x 3.60m x 3.10m	102.90	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	03/12/2013		1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.10 0.20	E1 B1			102.60	(0.30) 0.30	MADE GROUND: Dark greyish brown clayey sandy gravelly silt with occasional rootlets, decomposing organic matter and rare brick fragments. Gravel is fine to coarse subangular to rounded flint and quartz.		
0.50	B2			102.15	(0.45) 0.75	Light brown mottled reddish brown clayey silty gravelly fine to medium SAND with occasional clayey pockets and black speckling. Gravel is fine to coarse subangular to rounded flint and quartz.		
1.00 1.50	B3 B4			100.95	(1.20) 1.95	Reddish brown mottled light yellow slightly gravelly clayey sandy SILT with occasional clayey pockets. Sand is fine to medium. Gravel is fine to medium subangular to rounded flint and quartz.		
2.00 2.00 2.50 2.50 3.00 3.00	HV 88kPa B5 HV 90kPa B6 HV 34kPa B7			99.80	(1.15) 3.10	Firm reddish brown sandy silty CLAY with occasional sandy pockets. Sand is fine to medium. From 2.80m; Soft.		
						Complete at 3.10m		

Plan

Remarks

Groundwater not encountered.

Scale (approx)	Logged By	Figure No.
1:50	LH	A2.8

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Trial Pit Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	TP4

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Machine Dug	0.80m x 3.20m x 3.10m	100.60	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	03/12/2013		1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.15 0.30 0.40 0.50	E1 B1 HV 100kPa B2			100.25	(0.35) 0.35	MADE GROUND: Dark greyish brown slightly gravelly sandy clayey silt with occasional rootlets, decomposing organic matter and rare charcoal fragments. Gravel is fine to coarse subangular to subrounded quartz and flint.		
1.00 1.50 1.50 2.00 2.00	B3 HV 156kPa B4 HV 162kPa B5			98.50	(1.75) 2.10	Firm reddish brown mottled light yellow brown slightly gravelly sandy silty CLAY with rare sandy pockets and rootlets. Gravel is fine to coarse subangular to subrounded quartz. From 1.10m to 1.20m; Rare mottling.		
2.50 3.00	B6 B7			97.50	(1.00) 3.10	Reddish brown slightly gravelly silty fine to medium SAND with rare pockets of light blue grey sand. Gravel is fine to coarse subrounded flint and quartz.		
						Complete at 3.10m		

Plan

Remarks

Groundwater not encountered.

Scale (approx)	Logged By	Figure No.
1:50	LH	A2.9

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Trial Pit Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	**TP5**

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Machine Dug	0.80m x 3.60m x 3.10m	99.70	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	04/12/2013		1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.10	E1				(0.35)	MADE GROUND: Dark greyish brown slightly clayey gravelly very silty fine to medium sand with occasional rootlets, decomposing organic matter and rare plastic fragments. Gravel is fine to coarse subangular to rounded quartz and flint.		
0.20	B1			99.35	0.35			
0.50	B2				(0.30)	Brown slightly gravelly very silty fine to medium SAND with occasional rootlets and decomposing organic matter. Gravel is fine to coarse subangular to rounded quartz and flint.		
				99.05	0.65	Reddish brown slightly gravelly silty fine to medium SAND. Gravel is fine to coarse subangular to rounded quartz and flint.		
1.00	B3							
1.60	B4							
					(2.45)			
2.10	B5							
2.80	B6							
				96.60	3.10	Complete at 3.10m		

Plan

Remarks

Groundwater not encountered.

Scale (approx)	Logged By	Figure No.
1:50	LH	A2.10

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Trial Pit Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	TP6

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Machine Dug	0.85m x 3.60m x 2.40m	100.00	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	03/12/2013		1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.25	E1				(0.50)	MADE GROUND: Dark greyish brown slightly clayey slightly gravelly very silty fine to medium sand with occasional rootlets, decomposing organic matter and rare plastic fragments. Gravel is fine to coarse subangular to rounded flint and quartz.		
0.40	B1			99.50	0.50			
0.70	B2					Reddish brown slightly gravelly silty medium SAND. Gravel is fine to medium subrounded to rounded quartz and flint.		
1.20	B3				(1.90)			
1.80	B4							
						From 2.10m; Gravelly.		
2.30	B5			97.60	2.40			
						Complete at 2.40m		

Plan

Remarks

From 1.20m trial pit walls collapsing.
Groundwater not encountered.

Scale (approx)	Logged By	Figure No.
1:50	LH	A2.11

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Trial Pit Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	TP11

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Machine Dug	0.75m x 3.70m x 3.00m	100.10	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	04/12/2013		1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
0.10	E1				(0.30)	MADE GROUND: Dark greyish brown slightly clayey slightly gravelly very sandy silt with occasional rootlets, decomposing organic matter, rare brick and plastic fragments. Gravel is fine to coarse subangular to rounded flint and quartz.
0.25	B1			99.80	0.30	
					(0.20)	Light greyish brown mottled reddish brown clayey silty gravelly fine to medium SAND. Gravel is fine to medium subangular to rounded quartz and flint.
0.45	B2			99.60	0.50	
					(0.60)	Reddish brown slightly gravelly very sandy clayey SILT. Sand is fine to medium. Gravel is fine to medium subangular to rounded flint and quartz.
1.00	B3			99.00	1.10	
1.70	B4					Firm friable reddish brown slightly gravelly sandy silty CLAY with rare black speckling. Gravel is fine to coarse subangular to rounded flint and quartz.
2.10	B5				(1.90)	From 2.20m; Stiff and fissured.
2.90	B6			97.10	3.00	
						Complete at 3.00m

Plan

Remarks

Groundwater not encountered.

Scale (approx)	Logged By	Figure No.
1:50	LH	A2.16

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved

IAN FARMER ASSOCIATES

Site	Trial Pit Number
Solihull Parkway, Birmingham Business Park, Birmingham, B37 7YN	TP12

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
Machine Dug	0.80m x 4.10m x 2.70m	99.30	Baynham Meikle Partnership	52152
	Location	**Dates**	**Engineer**	**Sheet**
	SP 187 855	04/12/2013		1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.10	E1				(0.30)	MADE GROUND: Dark greyish brown slightly clayey slightly gravelly very silty fine to medium sand with occasional rootlets, decomposing organic matter, rare brick, plastic, porcelain and charcoal fragments. Gravel is fine to medium subrounded to rounded quartz and flint.		
0.25	B1			99.00	0.30			
0.70	B2					Reddish brown slightly gravelly silty medium SAND. Gravel is fine to coarse subangular to rounded quartz and flint.		
1.30	B3				(2.40)			
2.10	B4							
				96.60	2.70	Complete at 2.70m		

Plan

Remarks

Groundwater not encountered.

Scale (approx)	Logged By	Figure No.
1:50	LH	A2.17

Produced by the GEOtechnical DAtabase SYstem (GEODASY) (C) all rights reserved