Chapter 10 Flood Risk Assessment

Turley

Appendix 10.1 Flood Risk and Drainage, Report prepared by Curtins

Turley

North Bierley WWTW Re-development

Flood Risk and Outline Drainage Strategy Study

Curtins Ref: 60304-FRA-SB

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1.0 Project Background

1.0.1 Curtins has been appointed by Keyland Developments Ltd to prepare a site specific Flood Risk Assessment (FRA) for the proposed redevelopment of the former North Bierley Waste Water Treatment Works.

1.0.2 It is understood that this new mixed development (residential and commercial) will be constructed on land occupied by the former Yorkshire Water sewage treatment facility.

1.0.3 The outcome of the study will be used to support an outline planning application in order to demonstrate the current flood risk status and to ascertain that development of the site area will not increase flood risk either to the site itself or others within the local drainage catchment.

2.0 Scope of Flood Risk and Drainage Strategy Study

2.0.1 The main aim of this study is to carry out desktop research to establish the flood and drainage constraints of the proposed development site area. The current development proposal is for the construction of both housing and commercial properties with associated access roads and public open space. A new car park will also be provided close to the existing site entrance for the nearby school.

2.0.2 On this basis, the study will consider:-

- Primary flood risk from tidal and river sources
- Surface water flood risk
- Other secondary flood risks
- Surface Water disposal hierarchy
- Outline surface water drainage and outfall requirements
- Outline foul water drainage and discharge requirements
- Mitigation measures required to ensure the site is flood safe and does not increase flood risk to others

2.0.3 In order to establish the flood risk and outline drainage strategy requirements Curtins have assessed information available from the following Authorities/Bodies:-

- Lead Local Flood Authority (LLFA) – Kirklees M.D.C (WWTW site area)
- Lead Local Flood Authority (LLFA) – City of Bradford M.D.C. (School car park)
- Yorkshire Water (STW) – via the pre-development enquiry process
- The Environment Agency (EA)

2.0.4 In order to carry out the assessment the following data will be utilised:-

- Environment Agency online flood mapping
- Environment Agency detailed flood mapping (no flood levels available)

- Site specific hydrological and hydraulic modelling of the Hunsworth Beck
- Yorkshire Water pre-development enquiry response and sewer mapping
- Site topographical, gpr and utility survey drawings
- Site geo-environmental Phase 1 and Phase 2 studies

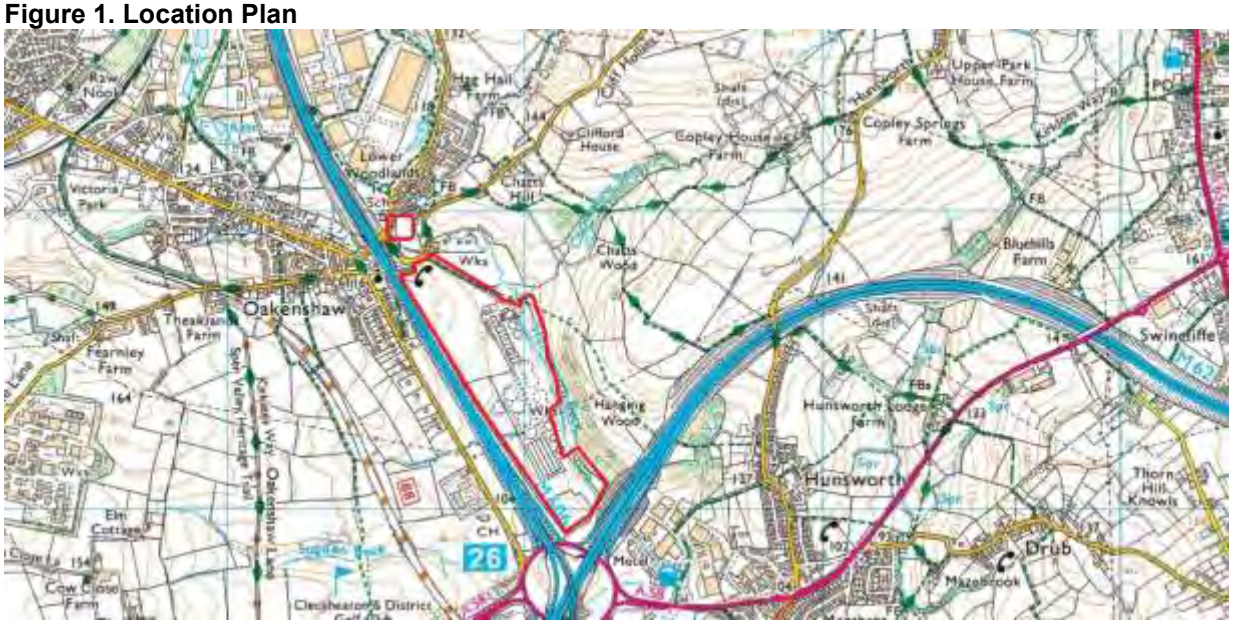
3.0 Site Location, Current Use and Development Proposals

3.1 Site Location

3.1.1 The proposed application area is located at the intersection of the M62 and M606 motorways (junction 26), approximately 5.5 kilometres south of Bradford city centre in a local village area known as Oakenshaw. The site is accessed from Cliff Hollins Lane to the north via Oakenshaw village

3.1.2 The following OS based mapping in figure 1 shows the approximated location of the application area.

Figure 1. Location Plan



Approximate proposed location shown outlined **RED**.

3.1.3 The northern boundary of the application area is formed by Cliff Hollins Lane and the existing site access road.

3.1.4 The eastern boundary of the application area is generally formed by the watercourse known as the Hunsworth Beck, although some of the application area does cross to the eastern banks (for precise application outlines refer to Architects redline plan).

3.1.5 The southern boundary of the application area is formed by the landscaped embankments of the M62 Motorway.

3.1.6 The western boundary of the application area is formed by the landscaped embankments of the M606 motorway.

3.2 Current Use

3.2.1 The former waste water treatment works (WWTW) facility upon the site has been decommissioned for some time, with a new pumping station and transfer main in place to convey sewage onwards to a treatment facility south of the M62 motorway.

3.2.2 Remaining areas of the application area are undeveloped greenfield land some of which is currently farmed.

3.2.3 A GoogleEarth aerial photograph image is shown below in figure 2 showing the approximate area of land being studied (outlined red). The existing site access road from Cliff Hollins Lane can be seen as on the image, as well as the remaining filter beds and areas where demolition has taken place. The new transfer pumping station is located to the north of these redundant filter beds, and the large diameter transfer main runs along the eastern boundary adjacent to the Hunsworth Beck

Figure 2. Aerial Photograph

Approximate proposed application area shown outlined **RED**

3.2.4 The site has an overall area of 23 Hectares (57 Acres). This excludes the area of the proposed school car parking area to the north of the site access close to the junction of Mill Car Hill Road and Cliff Hollins Lane.

3.3 Development Proposals

3.3.1 Development proposals for the site consist of both commercial and residential development. The residential area is proposed to be located to the north western section with the proposed commercial areas occupying the central and southern areas of the application area.

3.3.2 The existing sewage transfer station and pipework will remain in place but all other remaining structures such as buildings and filter beds associated with the former WWTW will be demolished and removed to allow construction of the new development.

3.3.3 A new access road will be formed into the site off Cliff Hollins Lane to service both the new residential and commercial development areas.

3.3.4 A new car park will be provided on land to the north for the adjacent school.

3.3.5 New foul and surface water drainage facilities will be provided to service the development. Areas of the new landscaping within the development will be needed to provide SuDs features for the new surface water drainage system.

3.3.6 The development proposals are shown upon the architect's plans forming part of the planning submission documents as well as the outline drainage strategy drawing contained within the Appendix of this report.

3.3.7 On the basis of the proposed development and overall site area, the following sections of this report consider both flood risk and drainage strategy in compliance with the NPPF requirements in order to support a planning application.

4.0 Flood Risk

4.1 Flood Risk - National Planning Policy Framework (NPPF)

4.1.1 In March 2012 the Department of Communities and Local Government superseded PPS 25 with the NPPF. A technical guidance report is provided covering flood risk and minerals policy. The NPPF has been revised as of April 2015 to promote the use of SuDs drainage within schemes.

4.1.2 The NPPF sets out inappropriate development in areas at risk of flooding be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere. For these purposes:-

- areas at risk of flooding' means land within flood zones 2 and 3; or land within flood zone 1 which has critical drainage problems and which has been notified to the local planning authority by the Environment Agency
- 'flood risk' means risk from all sources of flooding – including from rivers and the sea, directly from rainfall on the ground surface and rising ground water, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

4.1.3 The Sequential and Exception Test - The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. The flood zones are the starting point for the sequential approach. These flood zones refer to the probability of sea and river flooding only, ignoring the presence of existing defences.

4.1.4 Strategic Flood Risk Assessments (SFRA) refine information on the probability of flooding, taking sources of flooding and the impacts of climate change into account. These provide the basis for applying the Sequential Test on the basis of the flood zones in table 1. Where table 1 indicates the need to apply the Exception test, the scope of the SFRA will be widened to consider the impact of the flood risk management infrastructure on the frequency, impact, speed of onset, depth and velocity of flooding within flood zones considering a range of flood risk management maintenance scenarios. Where a SFRA is not available, the Sequential Test will be based on the Environment Agency flood zones.

4.1.5 The overall aim should be to steer new development to Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, local planning authorities allocating land in local plans or determining planning applications for development at any particular location should take into account the flood risk vulnerability of land uses (see table 2) and consider reasonably available sites in Flood Zone 2, applying the Exception Test if required (see table 3). Only where there are no reasonably available sites in Flood Zones 1 and 2 should the suitability of sites in Flood Zone 3 be considered, taking into account the flood risk vulnerability of land uses and applying the Exception test if required.

Table 1 Flood Zones

(NOTE: these flood zones refer to the probability of river and sea flooding ignoring the presence of defences)

Zone 1 Low Probability
Definition
This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding (<0.1%)
Appropriate Uses
All uses of land are appropriate in this zone

Zone 2 Medium Probability
Definition
This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 01%) in any year.

Appropriate uses
Essential infrastructure and the water-compatible, less vulnerable and more vulnerable uses of land as set out in table 2, are appropriate in this zone. The highly vulnerable uses are only appropriate in this zone if the Exception Test is passed.

Zone 3a High Probability
Definition
This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year

Appropriate uses
The water compatible and less vulnerable uses of land (table 2) are appropriate in this zone. The highly vulnerable uses should not be permitted in this zone.
The more vulnerable uses and essential infrastructure should only be permitted in this zone if the Exception Test is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.

Zone 3b The Functional Flood Plain
Definition
This zone comprises land where water has to flow or be stored in times of flood.

Local planning authorities should identify in their SFRA areas of functional flood plain and its boundaries accordingly, in agreement with the Environment Agency. The identification of functional flood plain should take account of local circumstances and not be defined solely on rigid probability parameters. But land which would flood with an annual probability of 1 in 20 (5%) or greater in any year, or is designed to flood in an extreme (0.1%) flood should provide a starting point for consideration and discussion to identify functional flood plain.

Appropriate uses
Only the water-compatible uses and essential infrastructure listed in table 2 that has to be there should be permitted in this zone. It should be designed and constructed to:

- remain operational and safe for users in times of flood
- result in no net loss of flood plain storage
- not impede water flows, and
- not increase flood risk elsewhere

Essential infrastructure in this zone should not pass the Exception Test.

Table 2 Flood Risk Vulnerability Classification

Essential Infrastructure

- Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk.
- Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood.
- Wind turbines.

Highly Vulnerable

- Police stations, Ambulance stations and Fire stations and command centres and telecommunications required during flooding.
- Emergency dispersal points.
- Basement dwellings,
- caravans, mobile homes and park homes intended for permanent residence.
- Installations requiring hazardous substance consent.

More Vulnerable

- Hospitals.
- Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
- **Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels.**
- Non–residential uses for health services, nurseries and educational establishments.
- Landfill and sites used for waste management facilities for hazardous waste
- Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

Less Vulnerable

- Police, ambulance and fire stations which are *not* required to be operational during flooding.
- **Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in 'more vulnerable'; and assembly and leisure.**
- Land and buildings used for agriculture and forestry.
- Waste treatment (except landfill and hazardous waste facilities).
- Minerals working and processing (except for sand and gravel working).
- Water treatment works which do not need to remain operational during times of flood.
- Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).

Water-Compatible Development

- Flood control infrastructure.
- Water transmission infrastructure and pumping stations.
- Sewage transmission infrastructure and pumping stations.
- Sand and gravel workings.
- Docks, marinas and wharves.
- Navigation facilities.
- MOD defence installations.
- Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.
- Water-based recreation (excluding sleeping accommodation).
- Lifeguard and coastguard stations.
- Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.
- Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to specific warning and evacuation plan.

Table 3 Flood Risk Vulnerability and Flood Zone 'Compatibility'

	Flood Risk Vulnerability classification	Essential Infrastructure	Water compatible	Highly Vulnerable	**More Vulnerable**	**Less Vulnerable**
Flood Zone	**Zone 1**	√	√	√	√	√
	Zone 2	√	√	Exception Test Required	√	√
	Zone 3a	Exception Test Required	√	x	**Exception Test Required**	√
	Zone 3b Functional Floodplain	Exception Test Required	√	x	x	x

√ Development **is appropriate** **x** Development **should not be permitted**

4.1.6 A site specific flood risk assessment is carried out by, or on behalf of, a developer to assess the risk to a development site and demonstrate how flood risk from all sources will be managed, and taking climate change into account. There should be iteration between the different levels of flood risk assessment, for example the site specific FRA and the local Strategic Flood Risk Assessment (SFRA).

4.1.7 Initial observation of the flood mapping with respect to Table 1 suggest that although most of the application area is located in a low risk Zone 1 area, some areas of the site directly adjacent to the Hunsworth Beck fall within the high risk Zone 3 with an intrusion of Zone 2 medium risk into the site around the area of former circular filtration tanks.

4.1.8 From Table 2 it can be assumed that the proposed site is considered as both: -

- More Vulnerable - Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels.
- Less Vulnerable - Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in 'more vulnerable'; and assembly and leisure.

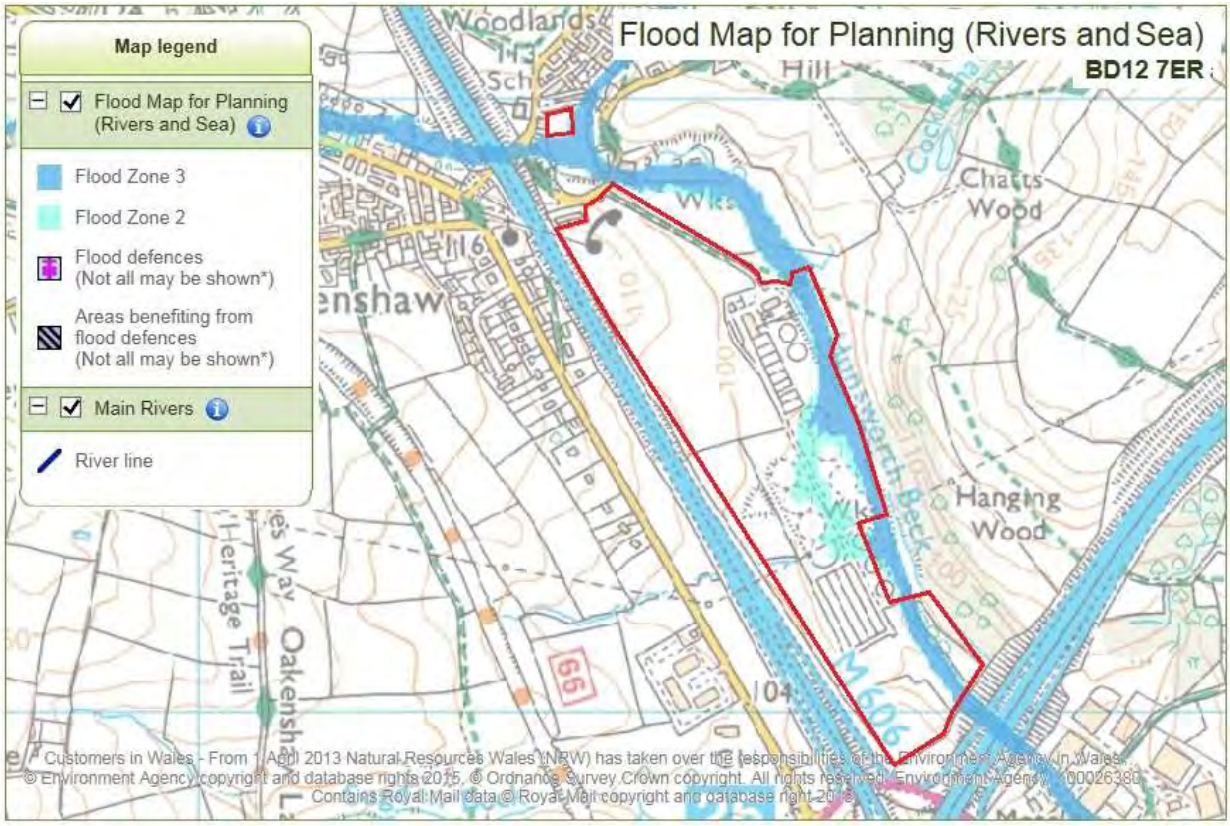
4.1.9 With the encroachment of Zone 2 and Zone 3 High Risk areas into the western edges of the proposed site potentially triggering Sequential Test and Exception Test requirements, the need for passing these tests and the evidence required is considered further, after the following detailed flood risk zone assessment.

4.2 Flood Risk – Environment Agency Online Flood Data

4.2.1 To assess the NPPF flood risk classification for the site area the first step is to inspect the Environment Agency web based flood mapping data.

4.2.2 An extract of this mapping to be used for planning purposes is shown in Figure 3 below which identifies risk of flooding from rivers and sea.

Figure 3. Extract of Environment Agency Flood Map for Planning (Risk of Flooding From River and Sea)



Approximate site extents shown outlined **RED**.

4.2.3 It can be seen from this mapping that the application area (shown outlined red) has the Hunsworth Beck either adjacent or within the redline area of the site. The high risk Zone 3 typically follows the route of the watercourse, although an intrusion of Zone 2 occurs around the area of the former settlement tanks. There is also Zone 3 high risk identified around the proposed school car park area at the confluence of High Royds Beck and Low Moor Beck which then forms Hunsworth Beck (shown in more detail on Environment Agency's detailed flood mapping). No risk is identified from the Cockleshaw Beck to the north east, the un-named beck from Oakenshaw and the Sudgen (and Stubs Beck just of the plan) to the south west.

4.2.4 On the basis that there are areas of Zone 3 identified within the redline area, the NPPF requires that that Sequential Testing evidence will be provided. Other supporting documents within the planning submission are considered to provide this evidence.

4.2.5 On the assumption that the Sequential Test evidence is satisfactorily demonstrated it will also be necessary to pass the Exception Test.

4.2.6 In order to establish the level of flood risk in more detail, in the first instance Product 4 information and a licence for usage was requested from the Environment Agency. This is considered further below.

4.3 Flood Risk – Environment Agency Product 4 Detailed Flood Risk Mapping

4.3.1 Product 4 flood mapping (and user licence) was obtained from the Environment Agency on the 16th of April 2014. An extract of this mapping is contained within the Appendix of this report. It was confirmed by the Environment Agency on issue of the mapping that they had no supporting modelled flood levels.

4.3.2 It can be seen from the detailed mapping that the flood outlines of both Zone 2 and Zone 3 concur with that shown on the online maps, with the only difference being the flood outline edges being slightly more defined.

4.3.3 As noted previously, the Zone 3 outline generally follows the channel of the Hunsworth Beck and the incoming Low Moor Beck and High Royds Beck to the north.

4.3.4 At this stage of the assessment it should be noted that it would appear that the mapping does not take into consideration the transfer main structure that has taken place along the western edge of the Hunsworth Beck within the former treatment works site as part of the decommissioning process. This area is defined on the topographical survey contained within the appendix of this report.

4.3.5 Ground profiling for the proposed development units will not be able to encroach into the area of the transfer main and as such the plateauing will have to commence from the security fence around this area. This may well result in most, if not all of the developable areas, being outside of the areas of the high risk Zone 3 flood encroachment.

4.3.6 In order to understand this further an image of the Environment Agency flood mapping has been overlaid onto the site masterplan. An extract is contained within Appendix B of this report. It can be seen that Unit 4 may be at risk based on the Environment Agency flood mapping.

4.3.7 This accuracy of the Environment Agency mapping is considered in more detail in Section 4.7.

4.4 Flood Risk – Environment Agency Surface Water Flood Risk Mapping

4.4.1 In January 2014 the Environment Agency published additional flood risk mapping on their website to compliment the Planning Maps (River and Tidal Zoning) with the primary one being surface water flood risk mapping which is generally a conglomeration of risks identified by SFRA modelling and information supplied by the local Sewage Undertaker (Yorkshire Water in this case). Other mapping includes risk from reservoir flooding as well as identifying areas where flood warnings and alerts are given.

4.4.2 An extract of the surface water flood risk mapping follows in Figure 4)

Figure 4. Extract of Environment Agency Flood Mapping Risk of Flooding From Surface Water

Approximate application area shown outlined RED.

4.4.3 It can be seen from this mapping that there is potentially more risk associated with surface water flood than there is identified on the 'planning river and tidal flood risk' map. The site area can now be seen to have areas of risk within it associated by the eastern and western Becks:-

Upper tributaries to Hunsworth Beck (Low Moor Beck and High Royds Beck)

Where the Low Moor Beck and High Royds Beck combine to form the Hunsworth Beck, a widespread area of risk is shown to the low lying land to the eastern and western banks of the beck.

Cockleshaw Beck

An area of low risk is identified to the east on the line of the incoming Cockleshaw Beck. There is also an area directly opposite to the west but this is considered to be as a result of the existing road ways within the decommissioned works.

Un-named Beck from Oakenshaw

This watercourse is known to run in culvert below the M606 motorway. After a short section of open channel, the watercourse is further culverted southwards past the linear settlement tanks and then eastwards through to an outfall into the Hunsworth Beck. This line of risk identified for the watercourse merges into a large areas of risk within the site generally around the southern area of the site.

Sugden and Stubs Becks

Unlike the Planning River and Tidal risk map, the surface water risk map shows potential risk from the

Sugden and Stubs Beck. Although the becks are at the southernmost limits of the site and are believed to be culverted below the M62/M606 Junction 26 Roundabout, the mapping would suggest that there is risk that overland flooding will occur around the Junction 26 roundabout which subsequently back flows northwards into the site. Observation of levels on the topographical survey and elevations around the roundabout from GoogleEarth would suggest this may be possible subject to major volumes of flood waters entering the roundabout carriageway. The flood waters are typically looking for the lowest areas of land to flow by gravity towards the Hunsworth Beck.

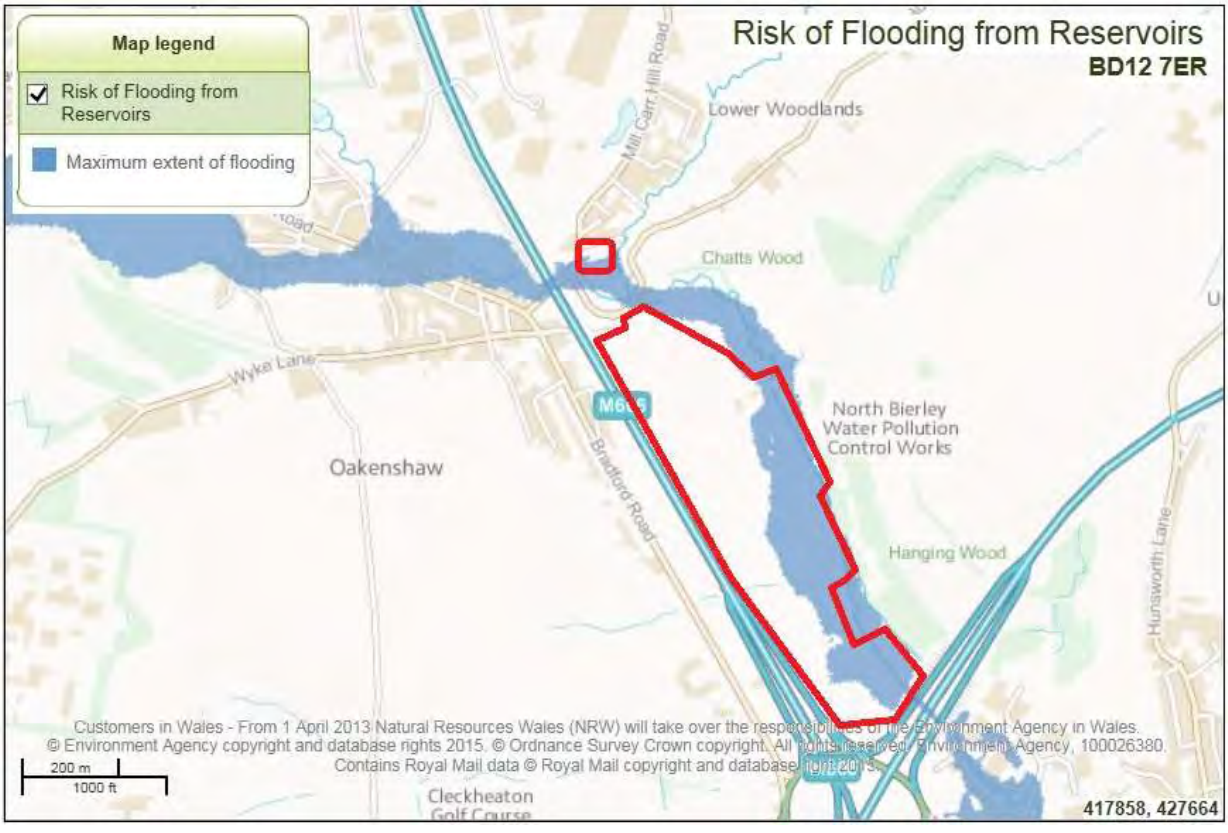
4.4.4 It should also be noted that the motorway roundabout junction is undergoing major improvement works. As the works involve widening of the carriageway it is assumed drainage is improved and thus there being a likely improvement in control of flood routing along the watercourses natural route and not off into adjoining land.

4.4.5 Methods of mitigating this risk if this risk remains on completion of the highway improvements are considered later in this report.

4.5 Flood Risk – Environment Agency Risk of Flooding from Reservoirs Mapping

4.5.1 An extract of the Environment Agency's web based risk maps for reservoir flooding is shown below in figure 5.

Figure 5. Extract of Environment Agency Flood Mapping Risk of Flooding From Reservoirs



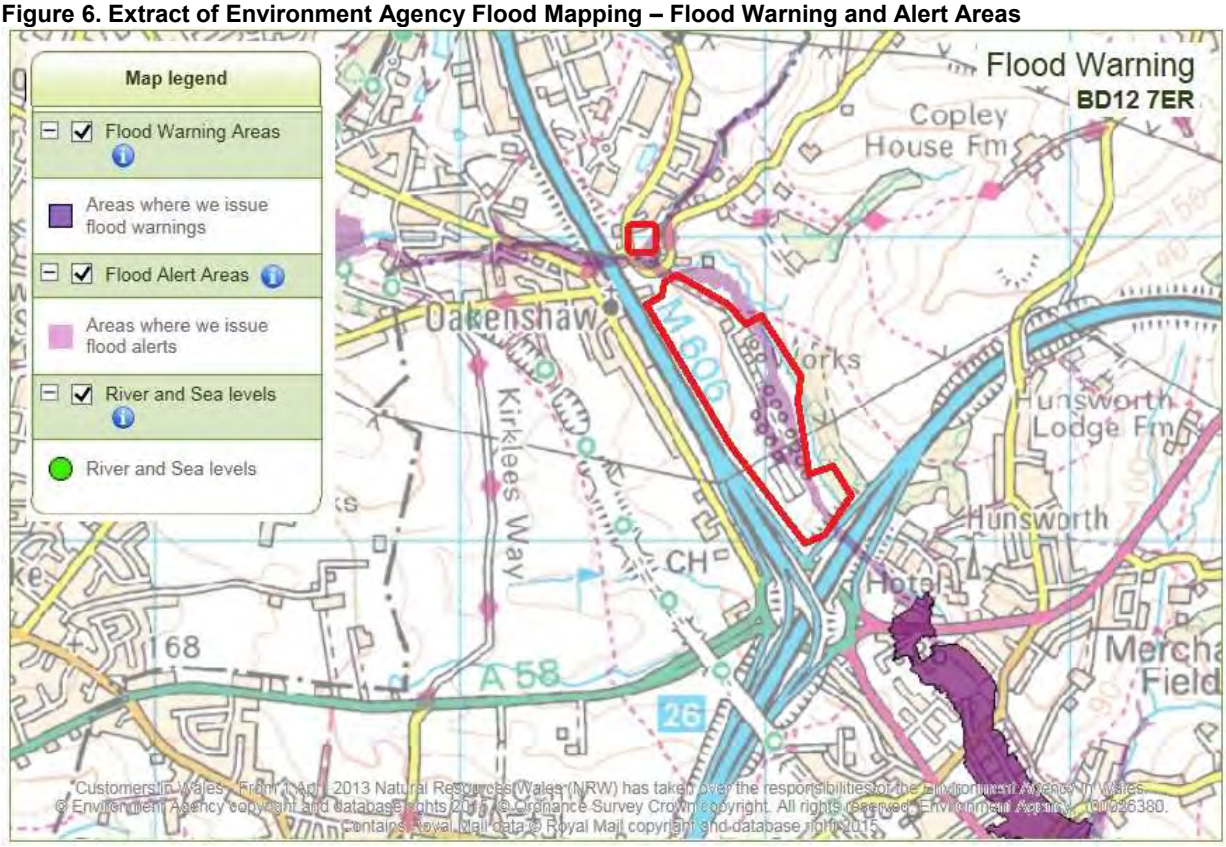
Approximate application area shown outlined RED.

4.5.2 The areas identified at risk can be seen to follow the general line of the Hunsworth Beck. Interrogation of the mapping shows that the risk is related to two reservoirs, located at the northern reaches of the Low Moor Beck. These are the Park Dam and Harold Park reservoirs. Both are under the control of Bradford Council and are thus considered to be maintained to a high standard and therefore present a low risk to the proposed development.

4.6 Flood Risk – Environment Agency Flood Warning and Alert Areas

4.6.1 An extract of the Environment Agency's web based flood warning and flood alert areas follows below in figure 6.

Figure 6. Extract of Environment Agency Flood Mapping – Flood Warning and Alert Areas



Approximate application area shown outlined RED.

4.6.2 The length of Hunsworth Beck through the site is shaded to denote that flood alerts are available. It is not until south of the M62 where the watercourse is classified as a main river, that flood warnings are given.

4.6.3 On the basis that there will be extensive ground modelling to form the level plateaus for the proposed development set at flood safe levels, it is envisaged that it will not be necessary for occupiers to necessarily link into the flood alert system on the basis that finished floor levels will be set to be flood safe, although it may be considered by those directly adjacent to the Beck in order to be aware of when there is potential risk of flooding to external yard and parking areas.

4.7 Lead Local Flood Authority (LLFA) & Strategic Flood Risk Assessment (SFRA).

4.7.1 Consultation has been held with both Kirklees and Bradford Councils under their new role as Lead Local Flood Authority (as of April 2015). As the Hunsworth Beck running through the site is not classified as a main river at this point, the Environment Agency have confirmed that the LLFA's will be the main consutlees with regard to flood and drainage matters within the planning process.

4.7.2 Strategic Flood Risk Assessments (SFRA's) are in place for the Hunsworth Beck and its tributary watercourses. The main former WWTW site, falls within the Calder Valley SFRA jointly commissioned by Kirklees Council and its neighbouring authorities. The proposed car park opposite the school falls just outside of Kirklees Councils control and SFRA, falling under the jurisdiction of Bradford City Council and their supporting SFRA.

4.7.3 The flood mapping within the SFRA's has been reviewed and can be confirmed to concur with that of the Environment Agency's mapping available both on line and via the Product 4 information provided.

4.7.4 As noted in Section 4.3 the Product 4 information supplied by the Environment Agency does not contain any modelled flood levels which has subsequently been confirmed as being unavailable, albeit it does raise a question as to how the precise flood outlines were generated. A similar question has been asked of Kirklees as to whether any modelled levels were used within the preparation of the SFRA. Again this has been confirmed as negative with detailed information only available for sections of the watercourse further south with 'main river' status.

4.7.5 Liaison has taken place with both LLFA's.:-

<u>City of Bradford Metropolitan District Council LLFA</u>

CBMDC's LLFA officer has advised that they have no particular interest in the car park in terms of flood risk other than they would require a SuDs approach to the drainage to ensure no increase in flood risk to the site or others.

<u>Kirklees Council LLFA</u>

Extensive dialogue has taken place with Kirklees Councils LLFA officer after an initial enquiry was made to the Environment Agency's flood risk team, which confirmed that as the main river status of the Hunsworth Beck does not extend north of the M62 motorway that planning application flood matters lie sole with the LLFA.

This has confirmed that no detailed flood level information is available and the only way of determining this in detail given the proposed extensive ground re-profiling works would be to run pre and post development hydraulic models of the Hunsworth Beck.

The scope for this has been agreed with the LLFA officer, and survey works of the beck channel and features such as the M62 culvert have been completed to allow a modelling exercise to be carried out.

The LLFA officer also advised that consideration should be given to re-naturalising the channel of the beck (e.g. removing any man made features where possible) and daylighting any culverts (such as the one currently diverting the watercourse from Oakenshaw around the former settlement tanks)

It was also advised that surface water drainage run off should replicate the original Greenfield rate.

4.7.6 On this basis a hydrological modelling exercise has been commissioned for the Hunsworth Beck and its feeder tributaries to ascertain the site specific flood outlines and levels.

4.8 Site specific hydrological Flood Modelling

4.8.1 Curtins have employed the services of Flood Risk Consultancy Ltd (FRC) to carry out a hydrological and hydraulic modelling of the Hunsworth Beck through the main site area to gain a more accurate understanding of the potential flood outlines and levels. The documents and flood mapping outcomes of the assessment is contained in Appendix C

4.8.2 The assessment has been scoped in liaison with the LLFA and takes into consideration features along the watercourse such as weirs and bridges together with the risks of increased flood levels due to partial blockages associated with such features.

4.8.3 A ‘worst case’ 100 and 1000 year events flood outline map is provided as the conclusion of the assessment based on modelled flood levels and actual recorded ground and river channel levels for the topographical survey.

4.8.4 The modelled flood outlines can be seen not to follow those as shown on the Environment Agency Product 4 mapping, and as anticipated, stay within the deep channel of the Beck through the main area of the WWTW with no spill out to the areas of the circular settlement tanks.

4.8.5 As the modelling takes into consideration various part blockage scenarios, areas of flood risk breaking out of the watercourse channel are mapped both to the north and south of the site. The area to the north is as a result of the low lying farm land at this point and the southern area due to the restrictions generated by the modelled blockage scenarios at the M62 Motorway culvert inlet.

4.8.6 On this basis with the modelling showing extreme flood flows retained ‘within channel’ for the main reach through the site, it is regarded that the proposed development areas that sit close to the watercourse will remain flood safe, particularly when considered that the plateaus will be formed from the fence line of the WWTW pipework area.

4.8.7 The existing access road is slightly overtopped (approx. 130mm) by the northern flood area, but it should be noted that this access road is realigned to the west forming the access to the residential area, thus avoiding the flood outline.

4.8.9 Furthermore, as the flood outline generally remains ‘in channel’, it can be considered that in raising ground levels in areas to form plot plateaus, that there will be no loss of flood storage area.

4.9 Secondary Flood Risks

4.9.1 It is an important part of a flood risk assessment to consider any other secondary flood risks not assessed in the preceding paragraphs.

4.9.2 Surface water flooding from the new drainage system can present risk. This can be mitigated by design to modern standards (Sewers for Adoption and Building Regulations) and will ensure the development of the site does not increase flood risk either to itself or others. Outline proposal are considered in the following outline drainage strategy section of this report.

4.9.3 Ground water can present a flood risk both in terms of high ground water when basements are present but also in terms of springs creating flows of water at surface level. A review of the available Phase 2 Geo-environmental study has been carried out by Wardell Armstrong and no potential ground water issues have been identified. As the works involve extensive plateauing for the industrial plots, suitable land drainage features will need to be considered at detail design stage particularly around embankments.

4.9.4 Surface water run of from adjacent area can be another secondary flood risk issue. This has been considered in the preceding section regarding surface water flood risk, with the main risk being identified as flooding entering the site from the motorway junction roundabout. Suitable mitigation measures such as protective bunding at the site edge or forming ground levels to route any overland flows away from buildings and towards the beck can be considered at detail design stage.

4.9.5 Flooding from existing sewers and culverts can also present secondary flood risk. The transfer main installed following the decommissioning of the treatment works is very complex facility with a large pumping station and above ground pipework which includes river overflows at critical points along its route adjacent to the Hunsworth Beck. The system is an asset of Yorkshire Water (not a public sewer) and is maintained accordingly, so although constantly transferring a large volume of sewage which could potentially cause serious flooding, can be considered to present a low risk to the development.

4.10 Primary Flood Risk Summary and Mitigation Recommendations

4.10.1 The preceding sections have assessed flood risk from all potential sources, and with the aid of detailed hydrological and hydraulic modelling of the Hunsworth Beck through the main site area has determined that some areas of the site in its current state (i.e. a decommissioned waste water treatment works with transfer facility) are potentially at risk from primary and surface water flooding during extreme weather events.

4.10.2 These risks will require mitigation to ensure the proposed development remains flood safe and does not increase flood risk to other either upstream or downstream. These can be summed up as:-

a) River flooding during the 100 year event (Zone 3) from the Hunsworth Beck, generally confined to within the watercourses bank edges of which a large percentage falls within the fenced off area of

the transfer pipework. Some out of bank areas are identified by the modelling exercise. There is also a slightly greater risk of intrusion into the site area during a 1000 year event (Zone2)

b) Risk from surface water flooding from watercourses running from west of the M606 (unnamed watercourse form Oakenshaw and Sugden/Stubs Becks), albeit this appears to be as a result of the M62/M606 roundabout junction acting as a conveyance route.

4.10.3 The new car park for the school is not considered in this assessment as a car park is not a sensitive use and is permitted to flood. The parking area does generally fit between the flood outlines of the adjacent becks and finished paving levels will be set at a similar level to the adjoining road for access purposes so will be well above the peak flood levels.

4.10.4 It is proposed the following should be considered within the detail design to provide mitigation to the assessed risks:-

a) River Flooding from Hunsworth Beck
   i. Ensure all residential and commercial buildings and their servicing access roads are placed outside of the 100 year flood outlines determined by the FRC model.
   ii. Ensure the proposed development ground model for the new commercial building plateaus adjacent to the Hunsworth Beck will not affect the river profile or the storage provided within the areas to the north and south shown to be within the FRC modelled 100 year flood extents.

b) Consider options for re-naturalising the Hunsworth Beck channel profile including removing any weirs and redundant footbridges which may present risk of debris build up/blockages

c) Opening up sections of the existing culverted section of Oakenshaw watercourse and routing through the development to ensure that any surface water flooding is contained to parking or landscaped areas at a safe shallow depth

d) Providing suitable earthwork bunding and/or cut off channels to the southern end of the site to ensure that should any surface water flooding which may route from the M62/M606 junction roundabout is contained and directed towards the Hunsworth Beck and away from developed areas.

e) Providing land drains to all embankments to ensure surface water run off from landscaped areas is suitably contained and routed to the Hunsworth Beck and not into the proposed new adoptable drainage system.

4.10.5 In consideration of these risks identified in 4.92 and in following the guidance of 4.93 above the site can be considered to be easily mitigated against the risks, providing a flood safe development that will not increase flood risk to others.

4.10.6 The following section considers drainage strategy to also demonstrate that in developing the former waste water treatment works that the new drainage systems will not increase flood risk either to the site or others.

5.0 Surface Water Drainage Impact Assessment

5.1 SuDs Surface Water Disposal Hierarchy

5.1.1 The NPPF and Building Regulations is specific on hierarchy for the disposal of surface water sewer from both new (Greenfield) and re-development (Brownfield) sites. Where ground conditions permit disposal should be via infiltration to the ground. Should this not be viable, disposal should be to a watercourse or waterbody, and as a last resort to a sewer.

5.1.2 The Wardell Armstrong phase 2 geo-environmental investigation suggests the use of infiltration to be limited. Soakage tests to the west, north and south were completely negative. Two positive BRE365 tests (e.g. $f > 1 \times 10^{-5}$m/s) were achieved close to the Hunsworth Beck in TP101 and TP103 although in consideration this was as a likely result of the proximity to the watercourse. The southern areas of the site are also recorded to have extensive mining history with shafts recorded. On this basis, it is considered that infiltration as an overall Section 104 Water Industry Act adoptable drainage strategy is not viable, although potential may exist for some localised features such as embankment toe drains. It is therefore proposed that the receptor for surface water disposal from the sites main drainage system will be the Hunsworth Beck.

5.1.3 Liaison with the LLFA (Kirklees Councils) has established that in terms of surface water drainage assessment and in line with April 2015 SuDs updates to the NPPF, that run off from the site must replicate the original pre-development run off rate. Therefore the proposed development area will be assessed at greenfield run off rates. Bradford Councils LLFA officer also advised that the proposed school car park area should utilise SuDs and discharge at greenfield rates.

5.2 Catchment Analysis

5.2.1 Development proposals for the former WWTW site include both commercial ‘shed’ type units and associated service yards with an area designated for residential development to the north west of the application area.

5.2.2 Although it is considered that the proposed residential development will generally follow existing ground levels, it will be necessary to carry out major ‘cut and fill’ earthworks to form the level plateaus for the commercial units. As a result, earth embankments will be formed between the varying plateaus and also at the interface with undeveloped surrounding ground levels. These slopes will need drainage to ensure run off does not present a flood risk, but as this is usually considered as land drainage by the adopting sewer authority (Yorkshire Water) it should be prevented from entering the main adoptable drainage network. It is proposed that embankment drainage of slopes falling from undeveloped land is collected

by a land drainage system and discharged directly to the watercourses, thus replicating the pre-development run off scenario.

5.2.3 On the basis of the above the catchment area and therefore the area used to calculate greenfield run off from the commercial and residential areas will be only that of the actual areas where buildings, roads and SuDs features are to be placed. All other external landscaped areas will continue to drain via land drainage to the Hunsworth and Oakenshaw Becks.

5.2.4 A catchment area plan is included within the appendix of this report. Areas measured are as follows:-

Residential	4.70Ha	47,000m2
Commercial	8.50Ha	85,000m2
School Car Park	0.12Ha	1,220m2

5.3 Greenfield Run-off Rate Methodology

5.3.1 Typically to assess the allowable greenfield run off rate (Qbar) for the three site areas, Microdrainage 'Source Control' software would been utilised, using the ICPSuds method as the areas are below 50 Hectares.

5.3.2 Discussions with the LLFA officer at Kirklees Council has confirmed that their current guidance is that a standard run off rate of 5 litres/second/hectare (l/s/ha) should be used across the district based on the drained areas of the site. A similar rate is considered appropriate by Bradford Councils LLFA.

5.4 Proposed Greenfield Run-off Rate(s)

5.4.1 A copy of the Architects masterplan has been overlaid with catchment outlines broken down into the main commercial area, the residential area and the school car park and the areas measured. A copy of this drawing 60314-D100 is contained within Appendix D.

5.4.2 The measures areas included areas of the open attenuation basins as these are upstream of the flow control device and thus provide an area for catchment of rainfall.

5.4.3 Using the Kirklees standard 5 l/s/ha, the estimated greenfield run off rates (Qbar) for each area are as table below:-

Catchment Reference	Approx Area (m2)	Area (Ha)	Qbar Calculation	Qbar
Commercial Area	85,000	8.50	8.50Ha x 5 l/s/Ha	42.5 l/s
Residential Area	47,000	4.70	4.70Ha x 5 l/s/Ha	23.5 l/s
School Car Park	1,220	0.12	0.12Ha x 5 l/s/Ha	~~0.6~~ 2l/s***

***Assumes a minimum flow of 2 l/s using a Controflow flow control device

5.5 Proposed Discharge Points

5.5.1 It is proposed that drainage will be split into three specific areas consisting of the commercial area, residential area and school car park, all with their own individual discharge points to the Hunsworth Beck.

5.5.2 Survey work carried out on behalf of the client has identified two drains which can potentially be utilised as below:-

- The first is the piped length of Oakenshaw watercourse. It is proposed to 'daylight' this culvert and divert through the new commercial area, but maintain its confluence with the Hunsworth Beck. It is proposed that surface water from the commercial site will discharge to this diverted section of watercourse on the basis that at the lower end of the site, the WWTW transfer pipe land sits between the site boundary and main watercourse channel. .

  The overall area of this part of the site is approximately **8.50 hectares**. Assuming **95%** impermeable area, this gives a proposed catchment area of approximately **8.1 hectares** with an allowable discharge rate of **42.5 litres a second**.

- The second close to the former entrance to the works, which runs across the adjacent field to the Hunsworth Beck currently providing drainage to the access road running southwards from Cliff Hollins Lane. It is proposed this is utilised to drain surface water from the residential area.

  The overall area of this part of the site is approximately **4.70 hectares**. Assuming **65%** impermeable area, this gives a proposed catchment area of approximately **3.1 hectares** with an allowable discharge rate of **23.5 litres a second**.

A copy of the survey is contained in the appendix, and both drains are marked upon the drainage strategy drawings.

5.5.3 It is proposed that the new school car park will have a small diameter piped outfall direct to the adjacent watercourse.

The overall area of the car park is approximately **0.122 hectares**. Assuming **100%** impermeable area, this gives a proposed catchment area of approximately **0.122 hectares** with an allowable discharge rate of **2 litres a second** (based on minimum achievable flow control orifice diameter)**.**

5.6 Typical Attenuation Requirements

5.6.1 In order to establish approximate attenuation volumes for outline design purposes Microdrainage 'Quick Storage Estimate' has been used based on the calculated greenfield run off rates for the worst case scenario of a 100 year return period extreme event with 30% climate change allowance.

Figure 8. Microdrainage Quick Storage Estimate Attenuation Assessment – Commercial Area

Figure 9. Microdrainage Quick Storage Estimate Attenuation Assessment – Residential Area

Figure 10. Microdrainage Quick Storage Estimate Attenuation Assessment – School Car Park

5.6.2 Using a typical rule of thumb guide of midway between the upper and lower limits it is anticipated that attenuation volume requirements will be as tabled below:

Catchment Reference	Lower Volume (m^3)	Upper Volume (m^3)	Typical 100yr+CC Attenuation volume required (m^3)
Commercial Area	5084	7385	(5084 + 7385) / 2 = **6235**
Residential Area	1709	2532	(1709 + 2532) / 2 = **2125**
School Car Park	51	78	(51 + 78) / 2 = **64.5**

5.6.3 With the intention that all main drainage within the commercial and residential areas will be adopted by Yorkshire Water under a Section 104 agreement of the Water Industry Act, current Sewers for Adoption practice is to store at least the 30 year storm volume below ground with the exceedance up to 100 year storm events contained in depressions within the site that do not present flood risk. With the current LLFA push towards a greater use of SuDs within development drainage schemes, for the purpose of the outline derange strategy all attenuation volume is shown as open balancing features (e.g. landscaped depressions) at approximately 2 metres maximum depth.

5.6.4 Site drainage for the residential and commercial site area will consist of separate foul and surface water systems designed, constructed and adopted in accordance with Sewers for Adoption and Building Regulations.

5.6.5 The volume of attenuation required for the car park will be provide within the 30% void ration sub-base of the permeable paving system. Assuming the full area of the car park is constructed in permeable paving with an area of 1220m^2 and an approximate sub-base depth of 300mm the attenuation volume provided will be approximately 1220m^2 x 0.3m dp x 0.3 void ratio = **110m^3** therefore greater than 64.5m^3. This gives the opportunity to reduce permeable construction by utilising permeable construction for the parking bays only with impermeable hunting lanes or vice versa.

5.7 SuDs Features

5.7.1 In order to incorporate SuDs into the system in accordance with NPPF April 2015 update requirements dry attenuation basins are proposed within the site as the primary storage feature. Some storage volume will be achieved within the main pipe runs, which will be adopted by Yorkshire Water under a Section 104 Water Industry Act agreement.

5.7.2 The drainage systems to the commercial and residential area will require detailed design in accordance with Sewers for Adoption to Yorkshire Waters technical approval.

5.7.3 Prior to April 2015 the 30 year plus climate change events, typically would be contained within oversized attenuation pipework and events in excess of this up to the 100 year plus climate change allowed to

surcharge out of the system and to fill the landscaped attenuation basin. With the greater emphasis on SuDs post April 2015, for the purpose of this outline drainage strategy it is assumed the bulk of attenuation for both residential and commercial areas will be provided in dry landscaped attenuation basins. Whether these are adopted by Yorkshire Water or maintained by a contracted Facilities Management company will have to be confirmed at detail design stage depending on what SuDs adoption procedures are in place at the time.

5.7.4 Where site levels are plateaued to from large level areas for the commercial plots, this will result in large embankments sloping from or to existing ground level. Large steeply sloping embankments are likely to require some form of land drainage typically at the toe of the slope. These land drainage systems will not be able to enter the publicly adoptable drainage system. Consideration on how this drainage can be connected and discharged to the Hunsworth Beck is shown within the outline drainage proposals

5.7.5 An outline drainage scheme drawing is contained within the appendix of this report.

5.8 Surface Water Drainage Assessment Conclusion

5.8.1 On the basis that the drainage system will be designed at detail design stage in accordance with Sewers for Adoption and Building Regulations with on site attenuation and an offsite discharge to the existing Hunsworth Beck watercourse mimicking the pre WWTW construction greenfield run off scenarios, it can be considered that in developing and draining the site, as well as building the school car park, that there will be no increase in flood risk either to the site itself or others within the local catchment.

6.0 Foul Water Drainage Impact Assessment

6.1 Existing Foul Water Catchment

6.1.1 The WWTW was decommissioned in recent years. Incoming public sewer flows from the north are piped by public sewer from Cliff Hollins Lane towards a reception chamber in the north west corner of the current boundary. From this structure a large diameter transfer pipe conveys all the incoming sewerage to the east along the western bank of the Hunsworth Beck. To the south another new structure with overflow to the river, drops the flows into a syphonic system which conveys the flows below the M62 motorway and onwards to the current WWTW. Although the incoming pipework is regarded as public sewer, all pipework from the reception chamber (e.g. transfer main and syphon) are not classified as a public sewer, but as a Yorkshire Water Asset.

6.2 Pre-Development Enquiry

6.2.1 A pre-development enquiry (PDE) was made to Yorkshire Water's Technical Sewage team. This identified that the transfer pipework and syphon system were not public sewers and that no connection could be made to them.

6.2.2 On this basis it was advised that the most suitable connection point would be upstream of the former works inlet chamber. On the basis that the site falls away in level to the south from this point it was also considered that pumping up to this connection point would be very likely.

6.3 Proposed Foul Water Network

6.3.1 As the proposed residential area sits directly to the west of the former site inlet structure it is envisage that all residential foul water drainage will connect to the public sewer by gravity. This will be confirmed by detail design, but for outline planning purposes it is assumed ground levels shown on the topographical survey promote a direct outfall by gravity.

6.3.2 Foul water from the new commercial units will be collected by a Section 104 Adoptable foul sewer within the new access road which will flow southwards following the fall of the ground with Unit 5 being the lowest lying plot plateau on the site. In this area it will be necessary to locate an adoptable foul water pump station to lift foul water back to the proposed discharge point upstream of the former inlet structure. An approximate location is identified on the outline drainage proposals.

6.3.3 The new residential housing masterplan takes into account the existing public sewer easements with no structures being places within 3 metres of the centre line.

6.3.4 On the assumption that all main gravity and pumped drainage including the pump station will be adopted by Yorkshire Water, the risk of flooding from providing new foul water drainage to the site to serve both residential and commercial developments is considered **LOW**.

7.0 Conclusion

7.0.1 **The site is shown on Environment Agency mapping to be located generally within a Zone 1 low risk flood zone with some minor encroachment of high risk Zone 3. Detailed hydrological and hydraulic modelling of the Hunsworth Beck has provided clarification of the flood flows through the Hunsworth Beck and confirmed all of the proposed developable area to be within the low risk Zone 1**

7.0.2 **The main area of the site is shown on Environment Agency surface water flood mapping to be at some risk from surface water flooding primarily from flood routing from the nearby motorway junction. This has been assessed as low risk in recognition of ongoing highway improvements works, but suitable mitigation measures have also been proposed to protect developable areas of the site.**

7.0.3 **No other secondary flood risks are considered to pose a risk to the site.**

7.0.4 **The new site drainage system will be two separate systems (FW & SW) and surface water will be reduced in to greenfield run off rates and incorporate SuDs measures in accordance with the West Yorkshire and York Region SuDs Guidance (2015).**

7.0.5 **Under the requirements of the NPPF this FRA can be considered suitable to support the planning application to demonstrate the low flood risk of flood from rivers and sea, low risk of flooding from surface water and that the foul and surface water drainage proposals will not increase flood risk either on site or off site.**

7.0.7 **It is recommended that a detailed drainage design is developed up for construction based on the outline proposals contained in this report which will ensure that there is no increase in flood risk.**