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Strategic Assessment of Flood Risk

6 Strategic Assessment of Flood Risk

6.1 Plans and Mapping

6.1.1 *Flood Zone Maps*

The Environment Agency has produced Flood Zone maps for the whole country to identify areas that are at risk of flooding from rivers. The Flood Zones are defined as follows:

- Flood Zone 1 comprises land with less than a 1 in 1000 year chance of annual probability of flooding from rivers.
- Flood Zone 2 comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding in any year.
- Flood Zone 3 is sub divided in two categories as follows:
  - Flood Zone 3a comprises land assessed as having a 1 in 100 or greater annual probability of river flooding in any year.
  - Flood Zone 3b is classed as functional floodplain and therefore at a higher risk of flooding than Flood Zone 3a. PPS25 defines a functional floodplain as land where water has to flow or be stored in times of flood. PPS25 states that this land would flood with an annual probability of 1 in 20 or is designed to flood in an extreme (1 in 100 year) flood (or at another agreed probability).

> The EA's Flood Zone maps assume no flood defences are in place. The reason for this is because, although flood defences may reduce the risk of flooding, there will always be a residual risk due to a breach or overtopping.

The Flood Zone maps included in this SFRA report have used the EA's maps and supplemented them with additional information as follows.

The extents of June 2007 flood provided by the EA have been incorporated as part of Flood Zone 2. These flood extents are to become the new Flood Zone 2 outline on the next issue of the EA's maps.

Flood Zone 3 has been defined by showing the worst-case outline of the original Flood Zone 3 outline taken from the EA's maps, combined with the 100 year outline taken from the hydraulic models.

Flood Zone 3b (functional floodplain) has been produced by combining the 1 in 25 year outline taken from the hydraulic model combined with designated flood storage areas and washlands. It should be noted that, at this stage, the actual extents of Flood Zone 3b is being agreed between the Environment Agency and the prospective councils. The outlines shown on the Flood Zone maps are for indicative purposes only.

Areas that would be Flood Zone 3b but are already developed have been downgraded to Flood Zone 3a.

As discussed in section 3.3 there is no climate change modelling/flood extents available for the catchment area. However, professional judgement has been used to assess the likely impact of climate change for key locations taking into account the flood outlines. Refer to Section 6.3 for more information.

Refer to the following drawings in Appendix D for the Flood Zone maps:

Drawing Name	Drawing Number
Flood Zones - Chesterfield	55328/C/F/01
Flood Zones – Bolsover Overview	55328/B/F/O
Flood Zones – Bolsover Area 01	55328/B/F/01
Flood Zones – Bolsover Area 02	55328/B/F/02
Flood Zones - North East Derbyshire Overview	55328/NE/F/O
Flood Zones - North East Derbyshire Area 01	55328/NE/F/01
Flood Zones - North East Derbyshire Area 02	55328/NE/F/02
Flood Zones - North East Derbyshire Area 03	55328/NE/F/03

6.1.2 *Historical Flooding*

Locations at risk of flooding have been identified through the Environment Agency's Flood Zone maps and historical flooding records, information from each of the LPAs, Derbyshire County Council, Yorkshire Water and Severn Trent Water.

A register of flood risk locations has been created from the data collection stage. Details of each location can be found in Appendix A. A reference number on the register relates to the following drawing in Appendix D:

Drawing Name	Drawing Number
Historic Flooding, Flood Storage and Defences - Chesterfield Overview	55328/C/HF/O
Historic Flooding, Flood Storage and Defences - Chesterfield Area 01	55328/C/HF/01
Historic Flooding, Flood Storage and Defences - Chesterfield Area 02	55328/C/HF/02
Historic Flooding, Flood Storage and Defences - Chesterfield Area 03	55328/C/HF/03
Historic Flooding, Flood Storage and Defences - Bolsover Overview	55328/B/HF/O
Historic Flooding, Flood Storage and Defences - Bolsover Area 01	55328/B/HF/01
Historic Flooding, Flood Storage and Defences - Bolsover Area 02	55328/B/HF/02
Historic Flooding, Flood Storage and Defences - Bolsover Area 03	55328/B/HF/03
Historic Flooding, Flood Storage and Defences - Bolsover Area 04	55328/B/HF/04
Historic Flooding, Flood Storage and Defences - Bolsover Area 05	55328/B/HF/05
Historic Flooding, Flood Storage and Defences - Bolsover Area 06	55328/B/HF/06
Historic Flooding, Flood Storage and Defences - Bolsover Area 07	55328/B/HF/07
Historic Flooding, Flood Storage and Defences - Bolsover Area 08	55328/B/HF/08
Historic Flooding, Flood Storage and Defences - Bolsover Area 09	55328/B/HF/09
Historic Flooding, Flood Storage and Defences - Bolsover Area 10	55328/B/HF/10
Historic Flooding, Flood Storage and Defences – North East Derbyshire Overview	55328/B/NE/O
Historic Flooding, Flood Storage and Defences – North East Derbyshire Area 01	55328/NE/HF/01
Historic Flooding, Flood Storage and Defences – North East Derbyshire Area 02	55328/NE/HF/02
Historic Flooding, Flood Storage and Defences – North East Derbyshire Area 03	55328/NE/HF/03
Historic Flooding, Flood Storage and Defences – North East Derbyshire Area 04	55328/NE/HF/04
Historic Flooding, Flood Storage and Defences – North East Derbyshire Area 05	55328/NE/HF/05
Historic Flooding, Flood Storage and Defences – North East Derbyshire Area 06	55328/NE/HF/06
Historic Flooding, Flood Storage and Defences – North East Derbyshire Area 07	55328/NE/HF/07
Historic Flooding, Flood Storage and Defences – North East Derbyshire Area 08	55328/NE/HF/08

6.1.3 *Development sites*

Potential development sites and development commitments have been provided by Chesterfield Borough Council, Bolsover District Council and North East Derbyshire District Council based on Local Plan Development sites and known land availability.

Development sites comprise a mixture of the following:

- Commitments – Sites which currently have either outline or detailed planning permission. These sites can not be influenced by the SFRA unless the planning application lapses or a major change to the planning application is received. There are development site commitments for Chesterfield, Bolsover and North East Derbyshire;

- Local Plan Development sites – Areas which have been identified in the Local Development Plan for future redevelopment. These development sites generally cover a large area but do not relate directly to a specific development site. Development of these areas would come forward as and when land becomes available. Local Plan Development sites cover Chesterfield, Bolsover and North East Derbyshire;
- Site Testing – Known land availability with preliminary aspirations for the type of development to be located there. These development sites can be directly influenced by the SFRA. Site testing development sites are located in Bolsover only.

A list of development sites has been compiled and this can be found in Appendix B. Flood risk reviews at each development site are contained in an development site matrix in the addendum of this report. A reference number on the list of development sites and on the development site matrix relates to the following drawing in Appendix D:

Drawing Name	Drawing Number
Development Sites - Chesterfield Overview	55328/C/A/O
Development Sites - Chesterfield Area 01	55328/C/A/01
Development Sites - Chesterfield Area 02	55328/C/A/02
Development Sites - Chesterfield Area 03	55328/C/A/03
Development Sites - Chesterfield Area 04	55328/C/A/04
Development Sites - Chesterfield Area 05	55328/C/A/05
Development Sites - Chesterfield Area 06	55328/C/A/06
Development Sites - Chesterfield Area 07	55328/C/A/07
Development Sites - Chesterfield Area 08	55328/C/A/08
Development Sites - Chesterfield Area 09	55328/C/A/09
Development Sites - Chesterfield Area 10	55328/C/A/10
Development Sites - Chesterfield Area 11	55328/C/A/11
Development Sites - Chesterfield Area 12	55328/C/A/12
Development Sites - Bolsover Overview	55328/B/A/O
Development Sites - Bolsover Area 01A	55328/B/A/01- A
Development Sites - Bolsover Area 01B	55328/B/A/01- B
Development Sites - Bolsover Area 01C	55328/B/A/01- C
Development Sites - Bolsover Area 01D	55328/B/A/01 - D
Development Sites - Bolsover Area 01E	55328/B/A/01 - E
Development Sites - Bolsover Area 01F	55328/B/A/01 - F
Development Sites - Bolsover Area 02A	55328/B/A/02 - A
Development Sites - Bolsover Area 02B	55328/B/A/02 - B
Development Sites - Bolsover Area 02C	55328/B/A/02 - C
Development Sites - Bolsover Area 03	55328/B/A/03
Development Sites - Bolsover Area 04	55328/B/A/04
Development Sites - Bolsover Area 05	55328/B/A/05
Development Sites - Bolsover Area 06	55328/B/A/06
Development Sites - Bolsover Area 07	55328/B/A/07
Development Sites - Bolsover Area 08	55328/B/A/08
Development Sites - Bolsover Area 09A	55328/B/A/09 - A
Development Sites - Bolsover Area 09B	55328/B/A/09 - B
Development Sites - Bolsover Area 10A	55328/B/A/10 - A
Development Sites - Bolsover Area 10B	55328/B/A/10 - B
Development Sites - Bolsover Area 11	55328/B/A/11
Development Sites - Bolsover Area 12	55328/B/A/12
Development Sites - Bolsover Area 13	55328/B/A/13
Development Sites - Bolsover Area 14	55328/B/A/14
Development Sites - Bolsover Area 15	55328/B/A/15
Development Sites - Bolsover Area 16	55328/B/A/16
Development Sites - Bolsover Area 17	55328/B/A/17
Development Sites - North East Derbyshire Overview	55328/NE/A/O
Development Sites - North East Derbyshire Area 01	55328/NE/A/01
Development Sites - North East Derbyshire Area 02	55328/NE/A/02
Development Sites - North East Derbyshire Area 03	55328/NE/A/03
Development Sites - North East Derbyshire Area 04	55328/NE/A/04
Development Sites - North East Derbyshire Area 05	55328/NE/A/05
Development Sites - North East Derbyshire Area 06	55328/NE/A/06
Development Sites - North East Derbyshire Area 07	55328/NE/A/07

Development Sites - North East Derbyshire Area 08	55328/NE/A/08
Development Sites - North East Derbyshire Area 09	55328/NE/A/09
Development Sites - North East Derbyshire Area 10	55328/NE/A/10

6.1.4 *Assets*

Information on the location and condition of assets was obtained from the Environment Agency and supplemented with further information provided by each council. An asset has been defined as 'something which could cause flooding if it failed' and includes culverts, weirs, flap valves, outfalls etc. Assets for each area are shown on the following drawings in Appendix D:

Drawing Name	Drawing Number
Assets - Chesterfield	55328/C/AS/01
Assets - Bolsover Overview	55328/B/AS/O
Assets - Bolsover Area 01	55328/B/AS/01
Assets - Bolsover Area 02	55328/B/AS/02
Assets - North East Derbyshire Overview	55328/NE/AS/O
Assets - North East Derbyshire Area 01	55328/NE/AS/01

6.2 Flood risk profile

A flood defence breach analysis has not been carried out as part of this study. An assessment has been made of the flood risk to people in the study area, based on professional judgement and national guidance. The assessment has been carried out at defended areas or areas at risk of fluvial flooding where hydraulic modelling data exists. The results of this analysis have been used to judge which potential future development sites, or parts of potential development sites, are at a greater flood risk. Certain types of development (i.e. residential) can be directed away from these high risk zones.

6.2.1 *Flood defence breach and overtopping*

In a major flood event where a river is confined within flood defences, there may be a difference between the water level on one side of the flood defence and the ground level in the defended area behind that defence. If that defence were then to fail, whether through the collapse of a floodwall or the breaching of an embankment, there would be a sudden inrush of flood water into the defended area. The velocity and depth of water cascading through a breach could be significant enough to be a hazard to people. The premature failure of a flood defence structure is by its nature a residual risk, but its potentially fatal consequences dictate that it be given serious consideration in a flood risk assessment (especially in relation to new development).

As flood water pours through a breach it will disperse, and its velocity and depth will decrease with distance from the breach. At some distance from the breach the velocity and depth of water will have diminished to a point where an adult is capable of standing upright in the flow. This is deemed to be the outer edge of the rapid inundation hazard zone. The distance of this point from the defence line and the width of the hazard zone, will be determined by the flood level / ground level difference (head of water) and the width of the breach.

Defences with an indicative SoP less than 100 years are likely to be overtopped during a severe flooding event. Tables 9 and 10 provide a guide to the danger to people at various distances behind flood defences for overtopping and breaching respectively (assuming that either will occur during the lifetime of the development).

Table 9 shows the flood hazard with distance from a flood defence for breaches with different water levels above floodplain level, assuming a flat and clear flood plain (as extracted from the EA/DEFRA document FD2321/TR2 – Flood Risks to People Phase 2, March 2006).

Table 9: Danger to people from breaching relative to distance from defence

Distance from breach (m)	Head above floodplain (m) 0.5	1	2	3	4	5	6
100	Danger for some	Danger for most	Danger for all	Danger for all	Danger for all	Danger for all	Danger for all
250		Danger for some	Danger for all	Danger for all	Danger for all	Danger for all	Danger for all
500		Danger for some	Danger for some	Danger for all	Danger for all	Danger for all	Danger for all
1000			Danger for some	Danger for most	Danger for all	Danger for all	Danger for all
1500			Danger for some	Danger for some	Danger for most	Danger for all	Danger for all
2000				Danger for some	Danger for some	Danger for most	Danger for all
2500					Danger for some	Danger for some	Danger for most
3000						Danger for some	Danger for some
3500							Danger for some
4000							
4500							
5000							

Key:
- Danger for some
- Danger for most
- Danger for all

The following table shows the flood hazard for overtopping with distance from a flood defence for different water levels above the defence crest, assuming a flat and clear floodplain (as extracted from the EA/DEFRA document FD2321/TR2 – Flood Risks to People Phase 2, March 2006).

Table 10: Danger to people from overtopping relative to distance from defence

Distance from defence (m)	Head above crest level (m) 0.5	1	2	3
100	Danger for some	Danger for all	Danger for all	Danger for all
250	Danger for some	Danger for all	Danger for all	Danger for all
500		Danger for most	Danger for all	Danger for all
1000		Danger for some	Danger for all	Danger for all
1500		Danger for some	Danger for most	Danger for all
2000			Danger for some	Danger for all
2500			Danger for some	Danger for most
3000			Danger for some	Danger for most
3500			Danger for some	Danger for some
4000				Danger for some
4500				Danger for some
5000				Danger for some

Key:
- Danger for some
- Danger for most
- Danger for all

Danger to people is estimated using a formula for calculating the flood hazard rating, which can be expressed as a combination of flood depth, velocity and debris. Hydraulic modelling or the use of results from an existing assessment is needed to accurately predict flood depth and velocity.

The Flood Risks to People project has developed the following equation to relate the flood hazard to flood depth, velocity and debris factor:

Flood Hazard Rating = $((v + 0.5) * D) + DF$

Where:

v = velocity (m/s)

D = depth (m)

DF = debris factor

Table 11 can be used to estimate the danger to people if velocities and depths are known (as extracted from the EA/DEFRA document FD2320/TR2 – Framework and guidance for assessing and Managing Flood Risk for New Development – Full documentation and tools, March 2005).

Table 11: Danger to people for different combinations of depth and velocity

Velocity (m/s)	Depth of flooding (m)											
	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00	2.50
0.00				Some	Some	Some	Most	Most	Most	Most	All	All
0.10				Some	Some	Most	Most	Most	Most	Most	All	All
0.25				Some	Most	Most	Most	Most	Most	All	All	All
0.50				Most	Most	Most	Most	Most	Most	All	All	All
1.00			Some	Most	Most	Most	Most	All	All	All	All	All
1.50			Some	Most	Most	Most	All	All	All	All	All	All
2.00		Some	Some	Most	Most	All	All	All	All	All	All	All
2.50		Some	Some	Most	All	All	All	All	All	All	All	All
3.00		Some	Some	All	All	All	All	All	All	All	All	All
3.50		Some	Most	All	All	All	All	All	All	All	All	All
4.00		Some	Most	All	All	All	All	All	All	All	All	All
4.50	Some	Some	Most	All	All	All	All	All	All	All	All	All
5.00	Some	Some	Most	All	All	All	All	All	All	All	All	All

Key:
- Danger for some
- Danger for most
- Danger for all

> For locations within Chesterfield, Bolsover and North East Derbyshire located within Flood Zone 1 that are a significant distance away from flood defences; the flood hazard is low. For the majority of the defences in the study area, the head above the floodplain was unknown. An assessment was made based on the type of the defences (i.e for new developments located close to soft defences such as earth embankments, a breach scenario is more likely to occur). The flood risk matrix includes results from sites that are at risk from a breach (See Addendum).

> The majority of the flood defences in the study area have a SoP below 100 years and, as such, are likely to be overtopped during a severe flooding event. For most of the defences, the head above crest level was unknown.
>
> The flood risk matrix includes results from sites that are at risk from overtopping (See Addendum).

6.2.2 *Areas of main concern in Chesterfield*

The areas in Chesterfield at potential risk of breach are:

- The Derby Road (St Augustines) area of Chesterfield (River Rother)
- The Rother-Hipper confluence u/s of Station Bridge (Rivers Rother and Hipper)
- The Holland Road (Old Whittington) area of Chesterfield (River Rother)
- Slitting Mill Farm, (River Rother)
- Chatsworth Road, area near Chesterfield (River Hipper)
- Ravenside Retail Park, Chesterfield (River Hipper)
- Horns Bridge Roundabout (A617), Chesterfield (River Rother)

6.2.3 *Areas of main concern in Bolsover*

River Erewash is adjacent to the boundaries of Bolsover District Council. Properties adjacent to the BDC boundary are protected by flood embankments along the right river bank to a 1 in 100 year standard of protection. A breach analysis for developments behind these defences may be required.

6.2.4 *Areas of main concern in North East Derbyshire*

There do not appear to be any major flood defences in NE Derbyshire where breach could significantly affect existing or future development sites.

6.3 Climate change

Current consensus is that climate change will result in changes to flooding in the UK in the 21st century. The main changes will be in rainfall patterns and sea levels. Changes in rainfall patterns could result in increases in the intensity and frequency of storms and the depths and duration of seasonal rainfall. Such changes will affect the way in which a river catchment responds.

Rivers: - The current guidance recommends increasing peak river flow by 10% up to 2025 and 20% thereafter.

Rainfall Intensity (Run-off):- When designing surface water drainage for a new development, the impact of climate change should also be taken into account. It is predicted that climate change will increase the intensity of storms and the volume of rainwater. The existing guidance for assessing the impact of climate change on peak rainfall is summarised in Table 12 below.

Table 12: Recommended increases in peak rainfall intensities

	1990 to 2025	**2025 to 2055**	**2055 to 2085**	**2085 to 2115**
Peak rainfall intensity	+ 5%	+ 10%	+ 20%	+ 30%

Current EA guidance (Planning policy statement 25: development and flood risk - practice guide, January 2008) in relation to climate change for the design lives for different types of development are as follows:

- 30 years for retail development
- 60 years for commercial development
- 100 years for residential development and critical infrastructure

6.3.1 *Climate change impacts*

Current extents of fluvial flooding in the study area are unlikely to increase significantly due to climate change. Although flood levels in the rivers are likely to increase, the change in horizontal extent is unlikely to be excessive. The exception to this rule would be for an area which is currently protected against flooding from either raised man-made defences or natural raised ground, which could be overtopped due to increased river levels.

The only flood defence identified as being to an indicative SoP of 100 years is located along the River Erewash, adjacent to Bolsover DC boundary. As such, climate change is unlikely to have a significant effect on flood risk planning within the catchment.

Climate change could, however, increase the frequency of flooding at undefended sites or cause existing flood defences to be overtopped more often. This could cause the following:

- Areas of Flood Zone 1 could become Flood Zone 2;
- Areas of Flood Zone 2 could become Flood Zone 3;
- Areas of Flood Zone 3a could become functional floodplain (Flood Zone 3b);
- Current SoP of defences could decrease.

6.4 Land use changes for Chesterfield

The Regional Spatial Strategy (RSS8) sets out proposals for the sustainable development of the region's economy, infrastructure, housing and other land uses. The guiding principle is a sequential approach to finding land for most kinds of development which means that major urban areas and previously developed land should be looked at first.

An increase in arable farming can lead to a loss of ponds, bogs and mosses, which has improved agricultural drainage. This trend of improving field drainage is likely to continue; therefore the time between storms and flood peaks may reduce in the future across the study area, increasing flood risk.

Many tributaries of the main rivers within the study area are forested. It is believed that afforestation can reduce runoff and flood risk if undertaken in a sustainable manner. Although afforestation outside floodplains is beneficial and it can be considered as a catchment wide alleviation measure, afforestation within floodplains is more complex and can cause both positive and negative effects and would need to be subject to a detailed catchment wide hydrological survey. A draft policy on this topic is included in Section 9.

Deforestation would have an opposite effect and should be managed appropriately.

Washlands have the potential to reduce flood peaks by elevating storage and attenuating runoff volumes. Flood risk can also be reduced by further using the upstream reservoirs for flood storage.

A major impact to surface water flooding in built-up areas has been caused by urban-creep (e.g. paving of drives and gardens). New legislation is due to be issued in October which may require planning applications for similar future developments. A draft policy on this topic is also included in Section 9.

> Urbanisation, deforestation, afforestation, agricultural intensification or other land use changes can potentially affect runoff and river flows.

6.5 Risk from assets

The flood risk associated with assets has been investigated throughout the study area. In assessing these assets, culverts, outfalls, weirs, flap valves, penstocks, sluices, and gabions have been included.

Weirs are constructed to raise upstream water levels. Flood levels will generally be higher upstream of the weir and lower immediately after the weir. If a weir falls into disrepair or is removed, flood levels become more consistent on the stretch of watercourse, which could lead to increased flood risk immediately downstream of the weir. If a weir were to become blocked or raised due to an accumulation of debris this could lead to higher water levels upstream and an increased flood risk.

Flap valves are designed for use on the discharge end of pipes to prevent backflow or intrusion into the pipe. Typical applications include discharges to rivers, reservoirs, ponding basins and standpipes. Failure of a flap valves only tends to be an issue if they are located at sites protected by natural high ground or raised man made defences. Surcharged flow in the river could cause backflow through the pipe and flooding from manholes behind the defences or raised areas.

There are a number of outfalls, weirs and culverts within the study area. Many of the assets are located along the rural areas of the rivers, or adjacent to industrial estates. Many of the rivers are rural in nature. Watercourses that are allowed to flow in their natural floodplains in times of flood and are allowed to follow their natural course are generally less problematic than urban watercourses. Where there are culverts, outfalls and weirs, in the more rural areas the impacts from blockages and flooding will tend to be small.

> The known existing assets in the study area can be seen in the drawings in Appendix D. This includes culverts, outfalls, weirs, flap valve, penstocks, sluices, and gabions. These assets should be regularly maintained and, if needed, upgraded in order to prevent localised flooding.

6.5.1 Assets in Chesterfield

6.5.1.1 Outfalls and Flap Valves

Throughout Chesterfield there are a number of outfalls, predominantly associated with the River Rother, River Drone and River Doe Lea. Outfalls into rivers are generally fitted with a flap valve if it is likely to become surcharged during periods of high river flows. Flapped outfalls can become damaged or blocked and stay open allowing water from the river to back up the system. Another potential risk is for the flap valves to seize shut (e.g. due to rust) causing flow to back up behind the valve. Both these mechanisms have the potential to cause flooding and it is important that all major outfalls are maintained regularly.

One location in particular which should be considered is St Augustines.

Location of outfalls and flap valves are shown on the asset drawings in Appendix D.

6.5.1.2 Culverts

Installing new culverts on watercourses is to be avoided where possible. Installing a culvert will limit the capacity of water which can flow along the channel as it creates a finite area for the water to occupy. Culverts can cause afflux, which is a raised water level upstream of the entrance to the culvert. Also, there are maintenance issues to consider such as a blockage or collapse.

The River Hipper is shown to be culverted in a number of sections upstream of the confluence with the River Rother, which are included in the hydraulic model. The model shows there are two culverts at Brampton (Factory Street and Dock Walk) one of which causes a backwater effect in extreme flood conditions, and the other is surcharged during the 5-year storm and completely overtopped for storm with return periods greater than 1 In 75 years.

6.5.2 Assets in Bolsover

There are three sluices on the River Doe Lea in the western area of Bolsover. Sluices could cause or exacerbate flood risk due to untimely or inappropriate operation or failure to close during a flood.

The majority of assets in Bolsover are along the rural reaches of the watercourses and, as such, the consequence of failure is low.

> The only known assets within the Bolsover area are along the rural reaches of the River Doe Lea and Normanton Brook. The consequence of increased flooding due to these assets is low.

6.5.3 Assets in North East Derbyshire

There are few weirs along the River Drone and The Moss. Most of these are adjacent to either low vulnerability industrial properties or to rural areas and, as such, the consequence of failure is fairly low.

There are a number of outfalls along the River Drone, and the River Rother. Some of them are along their rural reaches, while others are next to residential areas, such as upstream of the railway bridge, Chesterfield Road, Dronfield. For the location of weirs, refer to the asset plans in Appendix D.

The River Drone is also shown to be culverted for a long section along Sheffield Road to Soaper Lane, Dronfield. The area upstream of this culvert is likely to be at a higher risk of fluvial flooding. Regular inspection and maintenance of this culvert should be carried out.

> The known assets within the NEDDC are along the River Drone and the River Rother. Parts of the assets along the River Drone are near residential developments, in Dronfield. These assets should be regularly maintained and, if needed, upgraded in order to prevent localised flooding.

6.6 Flood risk from reservoirs

> The allocation matrix includes results for sites located close to reservoirs (see Appendix B).

Reservoirs in the catchment are used to store water for various uses such as water supply, recreation or flood storage. Flood control reservoirs alleviate flooding by attenuating the peak fluvial flows and releasing flow downstream in a controlled manner.

Safe operation and management of reservoirs is required to manage the associated flood risk. A dam failure could have major consequences, including loss of life.

Reservoirs impounding over 25,000m^3 of water fall under the Reservoirs Act 1975. Under this Act, reservoir owners (Undertakers) have ultimate responsibility for the safety of the reservoir. They must appoint a Panel Engineer (a specialist civil engineer who is qualified and experienced in reservoir safety) to continuously supervise the reservoir and to carry out periodic inspections. For large reservoirs covered by the Act, the consequences of failure would be very high; however, the likelihood of failure would be very low and, as such, the overall risk is generally low.

Reservoirs (or other impounded bodies of water) with storage of capacities less than 25,000m^3 can still pose a significant hazard if failure were to occur. As these bodies of water are not covered by the Reservoirs Act and are less likely to undergo routine inspection and maintenance, they can present a higher flood risk due to a higher likelihood of failure.

Developments within the potential area of risk should consider the reservoir in detail. Generally, if the reservoir is covered by the Act, breach assessment would not normally be required. However, development within the potential destruction zone could increase the number of people who would be at risk and, as such, the volume of people who may need to be evacuated in an emergency. The Emergency Planning department of the council should be consulted to ensure that new development in these locations would not put an unacceptable burden on the department and can be accommodated by the existing evacuation procedures. Operation of smaller reservoirs (or other bodies of water) may have to be considered in more detail to ensure new and existing developments are not at an unacceptable risk, which could include hydraulic modelling and breach assessment.

Poor maintenance of private and abandoned reservoirs could also cause sedimentation to occur. The accumulation of sediments in reservoirs can lead to a range of problems, including:

- Increased flood risk on influent streams due to raised bed levels in the reservoir;
- Loss of flood storage capacity causing increased spillway flows;
- Blockage of scour pipe affecting the ability to drain the reservoir in an emergency;
- Build up of sediment against the upstream face of the dam, adversely affecting the stability of the structure.

> The consequences of failure of large reservoirs (more the 25,000m^3 of water) would be very high; however, the likelihood would be very low. Hydraulic modelling and breach analysis may be required for private and abandoned reservoirs. Future maintenance of small reservoirs (and other impounded bodies of water) should be given serious consideration.

6.6.1 *Reservoirs in Chesterfield*

There are a number of reservoirs within Chesterfield but it is not known which are officially covered by the Reservoirs Act 1975. It would appear that the majority are private due to their small plan areas. All of the known existing reservoirs in the study area can be seen on the asset drawings in Appendix D.

Locations which should be given particular attention are as follows:

- Brampton – Walton Dam
- Staveley/Poolsbrook.

Other reservoirs within the District appear to be low-lying and, as such, the flood risk is considered to be low.

6.6.2 *Reservoirs in Bolsover*

Specific information on the location of reservoirs in the catchment was not provided by the council. However, the colour OS maps have been reviewed to determine the location of the reservoirs within the district. It is unknown which are covered by the Reservoirs Act.

Privately owned Harlesthorpe Dam, in Clowne is a known source of flood risk to properties, on Creswell Road and Station Rd. Also, fields downstream of the dam, adjacent to the watercourse, have a history of being waterlogged.

6.6.3 *Reservoirs in North East Derbyshire*

There are numerous reservoirs within the District and the following appear large enough to be covered by the Reservoirs Act 1975.

- Brampton – Upper, Middle and Lower Linacre
- Ogston – Ogston Reservoir
- Northedge – Press Reservoirs
- Wingerworth – Wingerworth Lido

There are various other reservoirs and impounded bodies of water which may need a more detailed assessment. Locations which should be given particular attention are as follows:

- Holymoorside – Old Mill Pond
- Ford Fishing Pond

6.7 Mitigation for Flood Zones

Mitigation of flood risk should be the final consideration for development (see Table 1.2 of PPS25 practical guide). Prior to determining what type of mitigation which may be required, consideration should be given to the following:

- Avoidance/prevention - Allocate developments to areas of least flood risk and apportion development types vulnerable to the impact of flooding to areas of least risk. Then,
- Substitution - Substitute less vulnerable development types for those incompatible with the degree of flood risk. Then,
- Control - Implement measures to reduce flood frequency to existing developments. Appropriate design of new developments. And finally,
- Mitigation - Implement measures to mitigate residual risks.

Mitigation measures could include the following:

- Flood resistance techniques (preventing ingress of water);
- Flood resilience measures (allowing water to enter properties but designing to minimise damage caused);
- Implementation of Emergency Planning Documents, flood warnings and evacuation procedures.

Flood resistance techniques could include improvements to existing flood defences, land raising, non habitable ground floors, and secondary defences such as flood storage and drainage improvements.

This section aims to advise on the mitigation measures to be considered in each Flood Zone to ensure the development is appropriate. This does not override what is stated in PPS25 regarding appropriate development in Flood Zones, nor does this override the Sequential and Exception Tests and the other flood risk management options stated above.

6.7.1 Flood Zone 3b

Development within this Flood Zone should be avoided all together if possible. Only water-compatible uses and essential infrastructure would be appropriate. Should this type of development go ahead it should be constructed to:

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

6.7.2 Flood Zone 3a

Water-compatible, essential infrastructure and less vulnerable uses of land may be appropriate in this Flood Zone. More vulnerable or highly vulnerable uses should only be permitted if they pass the exception test.

Development behind defences should only take place if the defences are constructed to the required SoP and are in a good condition. The Environment Agency's NFCDD provides this information and has been used for this report. However, the information on the NFCDD is not exhaustive. The requirement is to provide protection up to the 1 in 100 year fluvial event. If possible, developments should be set back from defences, outside of the flood envelope or breach envelope.

Development within the flood envelope behind defences should have finish floor levels above the 1 in 100 year fluvial flood or breach level. Sufficient freeboard, to take into account climate change and modelling uncertainties should be added onto this level. It is generally accepted that finished floor levels should be set at 300mm above the 100 year plus climate change level or 600mm above the 100 year flood level. If no flood level information is available, 600mm above surrounding ground levels may be acceptable but, in most cases, hydraulic modelling will be required to confirm the predicted flood levels.

Undefended areas should also have finished floor levels set above the 1 in 100 year fluvial flood level with sufficient freeboard to take account of climate change.

> Land raising must be accompanied by compensatory provision or flood storage either on or off site. Even when the development is behind defences flood compensation storage may be required for land raising if secondary flooding (e.g. flooding from flood locked rivers) is possible.

Where possible, consideration should be given to making the ground floor uninhabitable by designing ground floor car parking or putting other public areas here.

> For defended areas in particular, the focus should be on safety to residents from residual risk (e.g. breach of a flood defence). However, all development should consider safe access and egress in times of flood. Flood risk that threatens public safety and the structural integrity of buildings should not be considered.

6.7.3 *Flood Zone 2*

Water-compatible, less vulnerable and more vulnerable uses of land and essential infrastructure may be appropriate in this Flood Zone. If development does take place in this Flood Zone, finished floor levels should be set above the 1 in 100 fluvial flood levels. Again, an appropriate freeboard allowance should be added to take into account climate change and modelling uncertainties.

6.7.4 *Flood Zone 1*

All types of development should be appropriate in this Flood Zone. The predominant flood risk issues relating to sites in Flood Zone 1 will be other forms of flooding and surface water run-off from the site.

6.7.5 *Flood Resistance and Flood Resilience*

The companion guide to PPS25 states that, in all flood risk areas, a basic level of flood resistance and resilience should be considered to limit the impact of a flood event. Flood resistant and resilience measures can be described as:

- **Flood resistance,** or ‘dry proofing’, where flood water is prevented from entering the building. For example using flood barriers across doorways and airbricks, or raising floor levels.
- **Flood resilience,** or ‘wet proofing’, accepts that flood water will enter the building and allows for this situation through careful internal design for example raising electrical sockets and fitting tiled floors. The finishes and services are such that the building can quickly be returned to use after the flood.

Examples of both flood-resistant and flood resilient designs are given in “Flood resilient and resistant construction – guidance for new build” (CLG/Defra/EA, May 2007: Improving the flood performance of new buildings: Flood Resilient Construction) Available from www.communities.gov.uk.

6.7.6 *Surface water mitigation*

The surface water disposal for new developments should be managed in a way that does not increase flood risk for downstream properties.

No flooding should occur for rainfall events with return periods of 1 in 30 years or less. For events with a return-period in excess of 1 in 30 years, surface flooding of open spaces such as landscaped areas or car parks is acceptable for short periods, but the layout and landscaping of the site should aim to route water away from any vulnerable property.

No flooding of property should occur as a result of a 1 in 100 year storm event (including an appropriate allowance for climate change).

The developed rate of run-off into a watercourse, or other receiving water body, should be no greater than the existing rate of run-off for the same event (including an allowance for climate change). Volume of run-off should be reduced where possible using infiltration techniques or a reduction in impermeable area.

Section 5.18 to 5.51 of the companion guide to PPS25 and Appendix A3 in 'CIRIA RP624 Development and flood risk – guidance for the construction industry' provides more details and practical examples of flood risk mitigation measures.

6.8 Existing Defences below the Required Standard of Protection

Ideally, developed urban areas behind flood defences should be protected against a 1 in 100 year fluvial flood. PPS25 Annex G section G2 states that 'development should not normally be permitted where flood defences, properly maintained and in combination with agreed warning and evacuation arrangements, would not provide an acceptable standard of safety taking into account climate change'.

Generally, defences in the catchment are not to a SoP of 1 in 100 years.