

## **Appendix F - What are the sources of flooding?**

The causes of flooding can be very complex, often flooding can occur as a result of a combination of factors and it can be difficult to identify the sources of a flood at the time an event takes place.

Flood risk may arise from either local sources or as a consequence of more widespread influences. For the purposes of managing flood risk, sources of risk are identified as either 'strategic' or 'local'.

### **Sources of Strategic Flood Risk**

Strategic Flood Risk is primarily the responsibility of the Environment Agency and is defined as flooding that occurs from;

- Main rivers
- Large Raised Reservoirs
- The sea

### **Sources of Local Flood Risk**

Local Flood Risk is defined as flooding that occurs from;

- Surface run-off
- Groundwater
- Sewers (partly or wholly influenced by precipitation)
- Ordinary watercourses

A more detailed description of the sources of flood risk is provided in the following sections of this document:

### **Sources of Local Flood Risk**

#### **Surface Run-off**

Surface run-off (also known as pluvial flooding), is defined by the Flood and Water Management Act 2010 as "rainwater (including snow and other precipitation) which: [a.] Is on the surface of the ground (whether or not it is moving), and [b] Has not entered a watercourse, drainage system, or public sewer."

#### **Why does this occur?**

Flooding from surface run-off occurs as a result of exceptionally intense or prolonged rainfall, which overloads the capacity of existing drainage systems. Flooding from surface run-off can also occur if drainage systems are blocked, broken, or simply undersized.

Flooding from surface run-off also occurs when the ground is geologically resistant to water penetration so that water is unable to soak away into the subsoil and rock strata. There are

also three reasons why ground may subsequently become resistant to water penetration either:

- a) due to the deliberate application of paving, tarmac or other water resistant materials;
- b) due to natural causes, such as the soil surface being baked hard by the sun, or frozen solid by the cold; or
- c) when the soil surface becomes saturated with water to a point where the rate at which soil can absorb further water is impeded and water flows across the surface.

### **Groundwater Flooding**

Section 6 of the Flood and Water Management Act 2010 states that ““Groundwater” means all water which is below the surface of the ground and in direct contact with the ground or subsoil”.

#### **Why does this occur?**

Water that seeps below ground collects within spaces in the rock and soil strata (often above an impervious layer of geology). The water establishes a level below ground known as the water table. The water table rises when water enters the catchment faster than it can drain away through fissures or to a watercourse.

The water that collects in the rock and soil strata below ground flows from areas where the ground level is high to areas where the ground level is low. In low-lying areas the water table is usually nearer to the surface and during very wet periods the water table can rise up to the surface causing groundwater flooding.

Groundwater flooding takes longer to go away. This is because groundwater moves much slower than surface water and will take time to flow away underground.

Groundwater flooding is more difficult to prevent than other forms of surface water flooding. There are some areas where groundwater flooding has been dealt with by installing pumps to remove groundwater and so lower the water table. However these only have a localised effect and still require somewhere to discharge the water.

### **Sewer Flooding**

Sewers can be publicly owned (by a Water Utilities Company) or privately owned. In addition, they can receive foul water, combined foul and surface water or just surface water flows. The different types of sewer flooding are set out below;

‘Precipitation influenced sewer flooding’ occurs when the sewer network cannot cope with the volume of water that is entering it. This is often experienced during times of heavy

rainfall when large amounts of surface water overwhelm the sewer network exceeding its design capacity, causing flooding.

‘System influenced sewer flooding’ happens when pipes within the network become blocked or the assets managing flows within the network fail. This falls outside the Flood and Water Management Act 2010 definition of ‘Flood’ and is not a source of Local Flood Risk. Instead it is the responsibility of the Water and Sewerage Companies and is regulated by the Water Industry Act 1991.

‘Outfall influenced Sewer Flooding’ is a form of restriction where the outfall of a sewer is unable to discharge water at its normal design rate because the water level in the receiving watercourse is partially or fully obstructing the discharge aperture.

### **Watercourses or fluvial flooding**

Flooding from watercourses (also known as ‘fluvial flooding’) occurs when a watercourse cannot accommodate the volume of water that is flowing into it.

For the purposes of flood risk management fluvial flooding is separated into 2 categories, these are flooding from;

- Ordinary Watercourses – a source of local flood risk
- Main River – a source of strategic flood risk

In general terms this distinction refers to the relative size of the watercourses involved, with Ordinary Watercourses (usually but not always) being smaller than Main Rivers.

### **Why does this occur?**

The ability of a watercourse to accommodate flood water depends upon the capacity of the watercourse's channel, its' floodplain<sup>2</sup> and the amount of water that enters its catchment during a flood event. When a watercourse becomes overloaded, flooding beyond the area of the flood plain can occur. Where rivers are separated from their flood plain by embankments or flood defences this may lead to flooding from overtopping or due to a breach of those banks and defences.

<sup>2</sup> *the area where water is allowed to overflow from a watercourse in a controlled manner, to temporarily increase storage capacity*

While the storage capacity of the river and the functional flood plain can be determined by assessment of the watercourse, it is important to recognise that the rate of inundation can be affected by factors that are remote from the river itself. The flow of water in a watercourse is dependent upon the rate of run-off from the entire river catchment.

Measures that might increase the rate of water flowing into a watercourse can be remote from the flooding that occurs as a result of any works. Significant reductions in flooding can be achieved if the rate of water flowing into river systems can be effectively managed at source.

## **Sources of Strategic Flood Risk**

### **Flooding from Main Rivers**

Flooding from Main Rivers forms one of the categories of fluvial flooding, (see 5.13 above). The “Main River” designation delineates those watercourses where the Environment Agency is the responsible regulatory body. Section 113 of the Water Resources Act 1991 defines “main river” as; “A watercourse shown as such on a main river map...”

### **Reservoir Flooding**

Reservoir flooding normally arises from the complete or partial failure of a reservoir structure caused by;

- erosion due to seepage,
- overtopping of the dam beyond its design level or
- damage to the structure.

The legislation that covers this area of flood risk is the Reservoirs Act 1975. It places a number of requirements on owners and managers of large raised reservoirs of a volume of 25,000 cubic meters and over (there are proposals to reduce this volume to 10,000 cubic metres and over in 2014). The enforcement authority for reservoirs in England is the Environment Agency (EA). The EA ensure that reservoirs are inspected regularly and that essential safety work is carried out. In addition, these reservoirs are registered by the EA who may also require a flood plan to be developed if the reservoir is considered ‘high risk’.

When assessing the risk posed by large raised reservoirs consideration is given to the impact on people downstream. Flood risk mapping was undertaken in 2009 to identify the largest areas that might be flooded if a reservoir were to fail and release the water it holds. It is worth noting that reservoir flooding is extremely unlikely to happen. There has been no loss of life in the United Kingdom from reservoir flooding since 1925.

### **Coastal Flooding**

Much of Norfolk is very low lying, with many areas at, or below sea level at high tide. In areas where land is below sea level, inundation from the sea would be considerable.

#### **Why does this occur?**

Coastal flooding is linked to changes in sea level. Short term changes in sea level can result from;

- tidal changes
- changes in barometric pressure and,
- strong winds.

In the long term, higher sea levels are expected as a result of climate change.

On Norfolk's coast the greatest coastal flood risk is likely to occur when a combination of tidal and barometric pressure effects operate together to create a "storm surge", (as was experienced in the flooding of 1953 and more recently in December 2013).

High sea levels also cause rivers flowing into the sea to be held back, leading to higher water levels within the rivers and a greater risk of fluvial flooding. This will be exacerbated if heavy rainfall accompanies a storm surge, adding extra volume to river flows and drainage systems.

### **Residual Risk**

Residual risk is that remaining after applying the sequential approach to the location of development and taking mitigating actions. Examples of residual flood risk include: the failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, overtopping of an upstream storage area, or failure of a pumped drainage system; failure of a reservoir, or; a severe flood event that exceeds a flood management design standard, such as a flood that overtops a raised flood defence, or an intense rainfall event which the drainage system cannot cope with.

Areas behind flood defences are at particular risk from rapid onset of fast-flowing and deep water flooding, with little or no warning if defences are overtopped or breached.