Crawley, Gatwick Airport and the River Mole catchment

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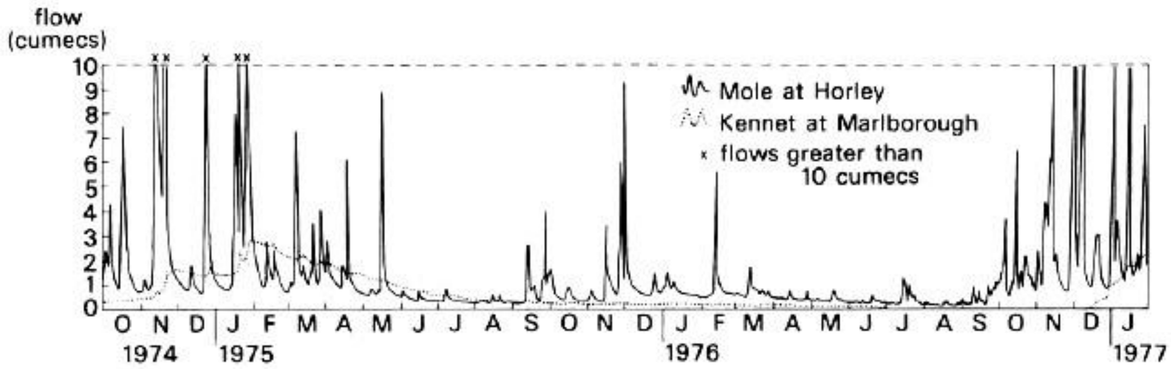
Two thirds of the solid geology of the River Mole catchment consists of bedrock made up of impermeable Wealden Clays and Greensand. This means that rainfall is unable to sink into the rocks and quickly runs off into streams. Because of this, the Mole is a 'flashy' river, rising and falling rapidly in storm conditions when 25mm of rain or more falls in a short period, especially when the ground is saturated due to significant previous precipitation. Comparisons made by Knapp[1] between the River Kennet, which is based on permeable chalk, at Marlborough and the River Mole at Horley show this clearly (Figure 1).

Figure 1 Comparison between River Mole (impermeable bedrock) and River Kennet (permeable bedrock)



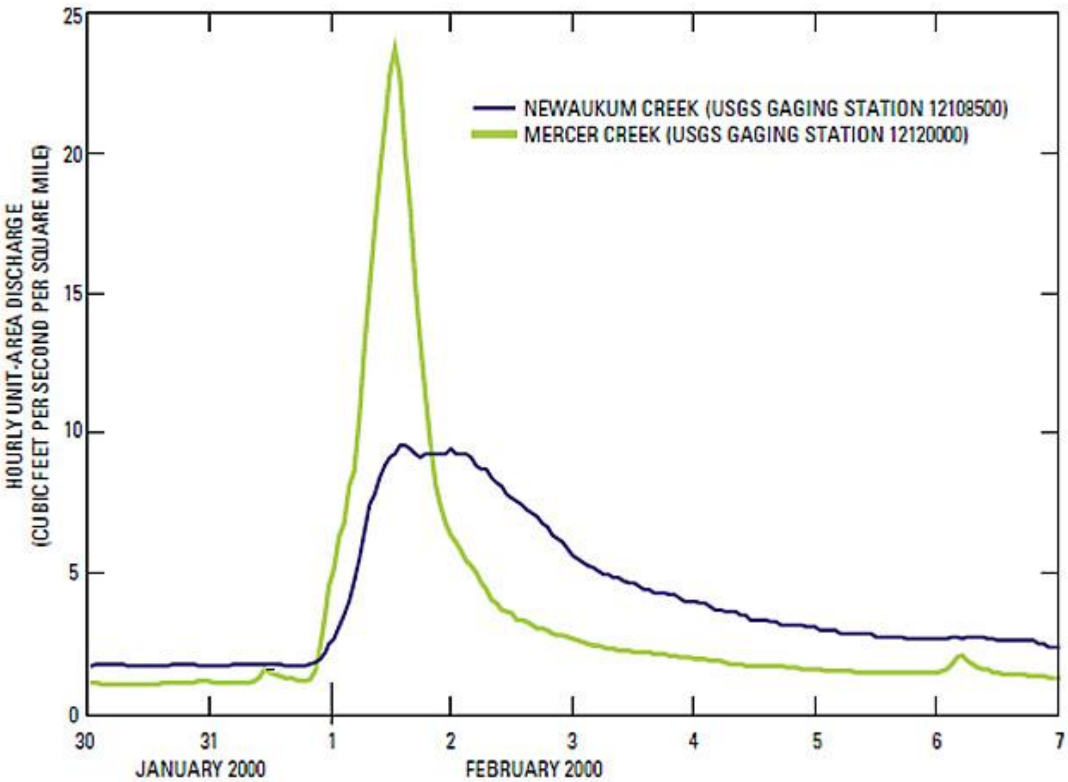
Long-term hydrographs for the River Mole and River Kennet 1974-7 showing flood and drought conditions. Flows (in cubic metres per second) are averages per day

Similarly, run-off from streams in urban areas makes for more dramatic rises in river levels than run-off from rural streams. This is shown in Konrad's fact sheet produced by the US Geological Survey[2] (Figure 2). The fact sheet states: 'In undeveloped areas such as forests and grasslands, rainfall and snowmelt collect and are stored on vegetation, in the soil column, or in surface depressions. When this storage capacity is filled, run-off flows slowly through soil as subsurface flow. In contrast, urban areas, where much of the land surface is covered by roads and buildings, have less capacity to store rainfall and snowmelt. Construction of roads and buildings often involves removing vegetation, soil, and depressions from the land surface. The permeable soil is replaced by impermeable surfaces such as roads, roofs, parking lots, and sidewalks that store little water, reduce infiltration of water into the ground, and accelerate run-off to ditches and streams.

'Even in suburban areas, where lawns and other permeable landscaping may be common, rainfall and snowmelt can saturate thin soils and produce overland flow, which runs off quickly. Dense networks of ditches and culverts in cities reduce the distance that run-off must travel overland or through subsurface flow paths to reach streams and rivers.' [As Crawley (100,000+ residents) and Horley (20,000+ residents) have developed, the watercourses have been diverted into a total of 75 culverts with an overall length of 5,430 metres.] 'Once water enters a drainage network, it flows faster than either overland or subsurface flow. With less storage capacity for water in urban basins and more rapid run-off, urban streams rise more quickly during storms and have higher peak discharge rates than do rural streams. In addition, the total volume of water discharged during a flood tends to be larger for urban streams than for rural streams.'

To all intents and purposes the Mole constitutes a 'small stream basin', particularly in the upper reaches. According to Konrad, 'The hydrologic effects of urban development often are greatest in small stream basins where, prior to development, much of the precipitation falling on the basin would have become subsurface flow, recharging aquifers or discharging to the stream network further downstream. Urban development can completely transform the landscape in a small stream basin, unlike in larger river basins where areas with natural vegetation and soil are likely to be retained.'

Figure 2 **Urban and rural streams**



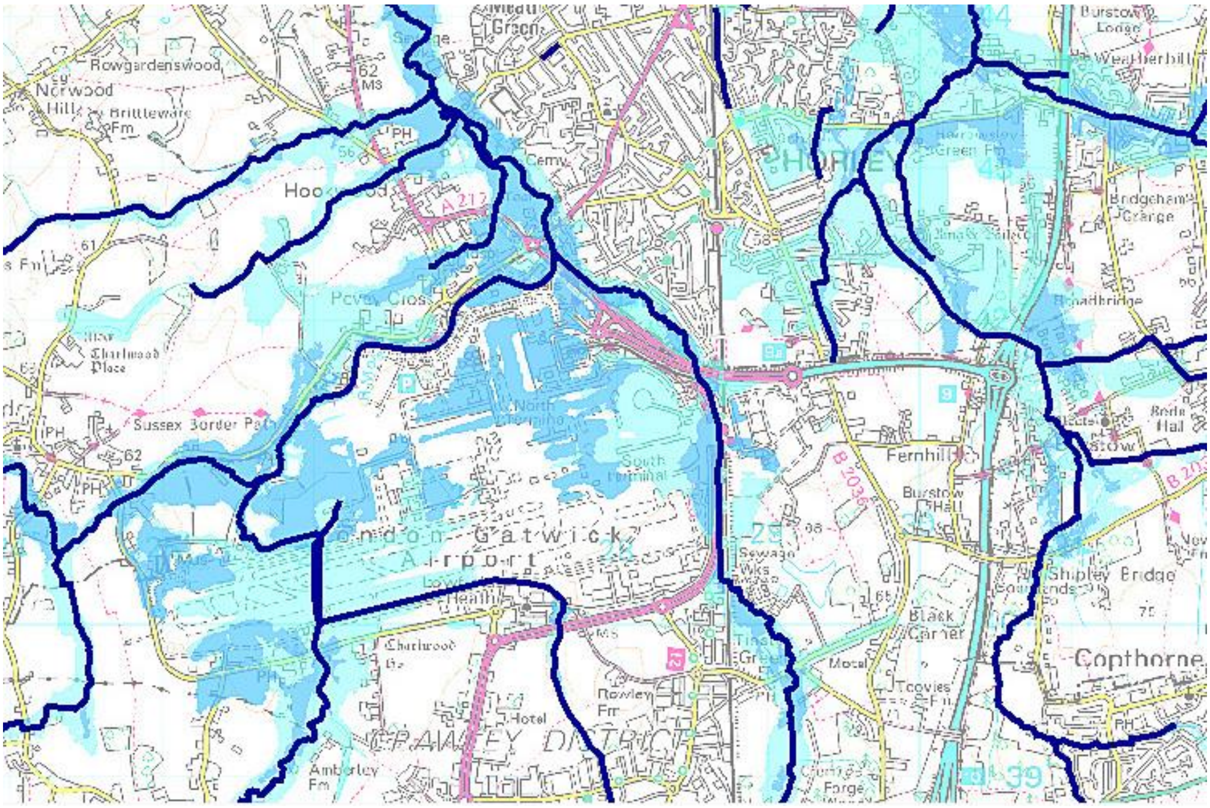
Streamflow in Mercer Creek, an urban stream in western Washington, increases more quickly, reaches a higher peak discharge, and has a larger volume during a one-day storm on February 1, 2000, than streamflow in Newaukum Creek, a nearby rural stream. Streamflow during the following week, however, was greater in Newaukum Creek.

In addition, the Mole has ridges and hills in close proximity and elevated ground always tends to increase the intensity of rainfall through what is known to meteorologists as the 'seeder-feeder mechanism'. The December rainfall totals for Dorking and Leatherhead were 210mm and 215mm respectively, whereas the figure for Heathrow Airport, which has little in the way of elevated ground close by, was less than 100mm. Varied elevation explains why, in 24 hours on 23-24 December 2013, Pease Pottage and Reigate had 70mm of rain and Charlwood had a lower total, 58mm. The Pease Pottage figure, combined with the huge amount of development consisting of impermeable surfaces that has occurred locally, makes the flooding in several parts of Crawley (including Bewbush, Ifield, Langley Green, Maidenbower, Three Bridges and Tinsley Green) and at Gatwick Airport including the North Terminal understandable. (Flooding is either pluvial, from surface water, or fluvial, from watercourses; pluvial flooding usually disperses into watercourses, adding to their flows.) One unnamed resident of Tinsley Green, quoted in the local press, said that the flooding in Crawley was worse than in any other area she saw driving to Brighton and back on the morning of 24 December.

Nationwide, flood defences are often seen as a 'magic bullet' which, almost by definition, permanently removes any threat of fluvial flooding. This view is somewhat naive, in part because stopping water flooding one area often results in its flooding other areas, as shown dramatically in the USA with the Mississippi and its levees in 2011. The argument is especially unconvincing when large-scale urban development is occurring or is planned on a floodplain, where inundations are an entirely natural and environmentally valuable process. Crawley is built on a floodplain and as the Environment Agency[3] points out: 'The decision to site Gatwick Airport across three watercourses means that it is vulnerable to flooding from all three watercourses as well as local drainage. Run-off from main airfield paving flows by gravity to a storage pond and is then discharged by pumps directly to the River Mole. As the 1 in 100 chance flood level in the Mole is at the same level as the ground level at the North Terminal, the system is totally dependent on the pumps and on-site storage, with the latter likely to be inadequate at times of prolonged high rainfall due to its modest volume.

'It is estimated that there is currently a 1 in 20 (5%) chance of Main River flooding closing Gatwick Airport, and with 10% increase in flows due to climate change, this increases to a 1 in 12 (8%) chance. The probability of flooding of the North Terminal area due to backing up from local drainage depends on the storm duration and intensity and it is understood that the on-site drainage capacity was designed for a 1 in 5 (20%) probability event.' The map below (Environment Agency) shows the Flood Zones around Gatwick Airport and Horley. Flood Zone 2 (pale blue) comprises land having between a 1 in 100 and 1 in 1000 annual probability of flooding. Flood Zone 3 (mid-blue) comprises land having a 1 in 100 or greater annual probability of flooding. The Flood Zones 'show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements.'

Watercourses and Flood Zones at Gatwick Airport and Horley



On the admission of a spokeswoman for Gatwick Airport quoted in thisislocallondon.co.uk on 8 January 2014, an unspecified quantity of water was pumped into the River Mole from at least one flood storage reservoir/ balancing pond at the airport on 24 December 2013. She said: 'The reservoir will have been opened. The river flooded in a way which was unexpected in terms of the modelling we have conducted with the Environment Agency. The problems we had were because it was unexpected.' This action – effected under the terms of an Environment Agency permit – did not cause the damaging flooding at Leatherhead and other areas, but it can hardly have helped. Perhaps the permit and its validity require reassessment, since to some observers there may be a suspicion that the rule 'I'm all right, Jack' applies with Gatwick Airport.

The Environment Agency's Upper Mole Flood Alleviation Scheme (UMFAS) was estimated to cost £15 million, of which the British taxpayer would contribute £11 million, GAL £4 million and Crawley Borough Council £100,000. The fairness of this division could make for an intriguing discussion. Be that as it may, the Scheme involved raising Tilgate Dam and river restoration and environmental mitigation works in Grattons Park (both already effected); creating a flood detention reservoir at Worth Farm (expected to be operational early in 2014); replacing the existing dam at Clay's Lake with a new and higher dam (scheduled for summer 2014); and installing a flood detention reservoir at Ifield. The last-named has been put on hold, seemingly because of major cutbacks in funding for the Environment Agency by the Department for Environment.

Gatwick Airport has spent £20 million on a flood resilience scheme for the South Terminal and is spending £8 million on an additional on-site flood resilience scheme. Despite the substantial expenditure, on 16 October 2013 the South Terminal experienced flooding in an electrical substation, forcing a switch of passengers to the North Terminal. Even assuming that these works and those included in UMFAS are all completed within two or three years, can either the Environment Agency or GAL guarantee that, given an extreme weather event, there will be no flooding in Crawley, Horley or at Gatwick Airport? That alleviation in the upper reaches of the Mole will automatically be beneficial for all those who live close to the river downstream? This is to be doubted if, say, 50mm or more of precipitation were to fall rapidly on saturated ground, as it may well in the short-term let alone the long-term given the local topography and recent rainfall records. On 17 January 2014, after 36.8mm of rain fell in 24 hours at Charlwood, six flood warnings were issued for the River Mole and its tributaries, including at Gatwick Airport.

Sutton and East Surrey Water plc's data from Redhill go back to 1910. Of the five occasions in that period when there has been more than 1,000mm of rain in one year, three have been this century, in 2000, 2002 and 2012. The annual figure has been above the long-term average in another seven years since 2000. There has also been an increase in the number of months with at least 100mm of rainfall. For the two 34-year periods since World War II (1946-1979 and 1980-2013), the respective figures are 57 and 78 months. In other words, the frequency has changed from once every seven months to once every five months. Looking to the future, in a paper researched for Ofwat, Sanderson[4] concludes:

1. winter rainfall events are projected to become more frequent;
2. during winter, the biggest increases in frequency of five- and ten-year rainfall events are projected to occur over Essex, Sussex and Kent; and
3. during summer, the biggest increases in frequency of five- and ten-year rainfall events are projected to occur over central southern England (Berkshire, Hampshire and Surrey).

Given that it was constructed on a floodplain with a number of watercourses running through the site, the fact that Gatwick Airport is located where it is must be seen as somewhat eccentric. So how eccentric, not to say misguided, would it to be to use 900 hectares of greenfield site to create a second runway involving a vast quantity of impermeable surfaces? To build the associated infrastructure, led by tens of thousands of new homes and numerous roads, in an area vulnerable to flooding? Even with the consistent use of Sustainable Drainage Systems (SuDS), which in the most effective examples can involve significant land take, making them unpopular with developers, could there ever be certainty that the local watercourses would not sometimes behave 'in a way which was unexpected in terms of the modelling'? Could there ever be certainty that there would not be a significant cost on occasions to homeowners living close to the Mole and its tributaries, to the environment and to wildlife? No guarantees made on this particular subject would be likely to convince an observer possessing the capacity to make reasoned judgements based on evidence.

[1]Knapp, B. J. (1979). Elements of geographical hydrology. George Allen & Unwin, London.
[2]Konrad, C. P. (2003). Effects of Urban Development on Floods, Fact Sheet FS-076-03. US Geological Survey, Tacoma.
[3]Environment Agency (2011). Upper Mole Flood Alleviation Scheme, Environmental Statement. Bristol.
[4]Sanderson, M. (2010). Changes in the frequency of extreme rainfall events for selected towns and cities (for: Ofwat). Met Office, Exeter.