APPENDIX 5.9
CLIMATE CHANGE AND FLOOD RISK MANAGEMENT

1. CLIMATE CHANGE

1.1 Importance of climate change

The Phase 1 and 2 IWMS reports stressed the need to consider the effects of climate change in the long-term planning of Ashford, noting in particular:

- The time-scale of development - Ashford will be developed over a 30-year period meaning that the drainage system designed now needs to remain effective in, say, 80-100 years' time.
- The density of development – in particular the high density of development in the centre of Ashford, gives little room for future drainage improvements. It would appear prudent therefore to allow for potential increased runoff due to climate change from day one.

1.2 A summary of climate change issues

The scientific community's knowledge of climate change is continually evolving. It is helpful to summarise the current consensus of option here, for those unfamiliar with this complex debate. Climate change is important to hydrological analysis in that there is an implicit assumption in many hydrological methods that future rainfalls and river flows will exhibit, in the long term, the same characteristics as those in the available historic data sets.

In the short term, the climate at any one location is of course changing all the time as a result of the random interaction between the ocean and the atmosphere. There are also longer-term factors such as variations in solar activity or the emissions from volcanoes that may exert a particular influence on global climate for a period of years. A key issue is whether there are any medium to long-term trends that would invalidate the assumption that the climate variability observed in the period of records may be taken to be a good guide to what will happen in the next few decades.

Evidence from Antarctic ice cores suggest that global temperatures today are approximately 8 - 10°C warmer than they were in the depths of the last ice age, about 20,000 years ago. Climatic change on this scale is due to changes in the earth's orbit and tilt of its axis around the sun. Such change is too gradual to take into account within the planning horizons applicable to the design of stormwater drainage systems. Nevertheless, the 142 year instrumental record of global mean near-surface temperatures appears to indicate a rise of 0.8°C between 1860 and the present (UKCIP, 2002). Virtually all of this increase has occurred since 1910, with a steep rise of 0.5°C since the mid-1970s.

The Intergovernmental Panel on Climate Change (IPCC) has concluded that a large part of the warming since the 1970's is probably due to human activities and cannot be explained solely by our understanding of the natural variability of the climate system. The prime cause of this warming is thought to be the emission greenhouse gases, principally CO^2 and water vapour. According to the IPCC, and others, the climate of the future will be determined by two factors:

- the amount of man-made emissions of greenhouse gases and other pollutants; and
- the response of the climate system to these emissions.

A number of organisations such as the Hadley Centre for Climate Prediction and Research, at the UK Meteorological Office, are actively trying to predict future climatic change by means of atmospheric and ocean circulation models. The Hadley Centre provides predictions of likely climate change in respect of average annual (and sometimes monthly) values for mean temperature, total rainfall and potential evapotranspiration for selected planning horizons. The most up to date set of climate change scenarios for the UK (known as UKCIP02) were published in April 2002 (UKCIP, 2002). This report presents a set of four scenarios of future climate change for the UK based on current understanding of the science of climate change. Four scenarios are presented labelled "Low Emissions", "Medium-Low Emissions", "Medium-High Emissions" and "High Emissions". Each represents a possible pathway for future emissions, and illustrates the impact of this very major cause of uncertainty.

The UKCIP02 scenarios are considered to represent an advance in the description of future UK climates as compared to the scenarios published in 1998 (Hulme & Jenkins, 1998). This advance stems from the use of new global emissions scenarios, and because the UKCIP02 scenarios are based on a series of climate modelling experiments completed by the Hadley Centre using their most recently developed models.

The UKCIP02 future climate scenarios suggest that, by the 2080s, the climate of the UK will be different to that of the last few decades. The following statements are copied from the section of the Executive Summary of the UKCIP02 report that deals with how the UK climate is likely to change:

- "Average annual temperatures across the UK may rise by between 2°C and 3.5°C, depending on the scenario. In general there will be greater warming in the south and east than in the northwest…, and there may be more warming in summer and autumn than in autumn and spring".
- "The temperature of UK coastal waters will increase, although not as rapidly as over land, with the greatest warming in the south".
- "Snowfall amounts will decrease significantly throughout the UK, perhaps by between 30 and 90% by the 2080s".
- "Summer soil moisture by the 2050s may be reduced by about 30% over large parts of England for the High Emissions scenario, and by 40% or more by the 2080s".
- "The seasonal distribution of precipitation will change, with winters becoming wetter and summers perhaps drier across the UK and with the biggest relative changes in the south and east. Precipitation in the High Emissions scenario may decrease in summer by 50% by the 2080s in the southeast and increase in winter by up to 30%".
- "Extreme winter precipitation will become more frequent. By the 2080s, winter daily precipitation intensities that are experienced once every two years, on average, may become up to 20% heavier".

The UKCIP02 climate change predictions about seasonal storm rainfall totals are of particular relevance to the design of drainage through Ashford. Section 2.3 of the UKCIP02 report (which deals with trends in precipitation) states that although there is no long-term trend in annual precipitation, there are discernable trends in the seasonality of UK precipitation. This section of the UKCIP02 report makes the following more detailed claims:

- The proportion of precipitation received in winter (i.e. December, January and February) relative to summer (i.e. June, July and August) has changed over time, with the winters getting wetter and the summers getting drier;
- The contribution of the most intense rainstorms to total precipitation has increased across the whole country during the last 40 years;
- The proportion of winter precipitation that falls in five day or longer sequences of "heavy" rain is also increasing;
- In summer, the opposite has occurred and the contribution of intense rainstorms to the summer total has decreased; and
- There are less consistent and generally smaller trends in precipitation intensity in spring and autumn.

Much of the evidence for the predictions made about the likely changes in UK precipitation stems either from a paper entitled "Observed trends in the daily intensity of United Kingdom precipitation" (Osborn et al, 2000), or from predictions from the Regional Climate Model.

A close inspection of the material presented in the paper by Osborn et.al. reveals that the statements about summer rainfalls seem to hold throughout mainland Britain. However, the quoted trends for winter rainfalls are generally much more pronounced northern and western areas of the UK, than in the south and east.

Further material presented in Figure 53 of the UKCIP02 report, which compares observed probabilities of exceedence of daily rainfall totals with corresponding model-predicted values, reveals that the Regional Climate Model has a wet bias. It is apparent from this figure that the Regional Climate Model over-predicts daily rainfall totals in the winter months, and that this overestimation is most pronounced for the larger daily rainfall events in south-eastern and south-western England. It is therefore conceivable that the increased winter rainfall intensities predicted by the Regional Climate Model under the various Climate Change Scenarios are also overestimates.

1.3 Implications of climate change on UK design

For the design of drainage systems the key issue is not simply a matter of whether the numbers of rainfall-days increase or decrease, but whether there is a significant change in rainfall depth-duration-frequency values. It should also be recognised, however, that Flood and Coastal Defence Project Appraisal Guidance Document 4 (MAFF, 2000), produced by the Environment Agency/ Defra, includes guidance on dealing with the design uncertainties that stem from climate change. This document recommends using sensitivity analysis to assess the impact of potential changes due to climate change. In particular the document recommends that the sensitivity analyses carried out for river flood alleviation schemes should take account of potential increases of up to 20% in peak flows over the next 50 years. The principle of adding a precautionary allowance of 20% to "high and extreme rainfall and river flow" has been repeated in a recent paper by Hawkes et al, 2003.

There is some evidence that the overall impact of the climate change, envisaged by the UKCIP02 scenarios, on flood peaks may be less than previously envisaged. For example, a paper by Reynard et al, 2004 suggests that 10% may be a more reasonable increase in peak flows for the south-east of England. Nevertheless, official guidance remains to add a precautionary allowance of 20% to "high and extreme rainfall and river flow" and it therefore remains prudent at this time to assume the higher 20% figure for the design of drainage systems in Ashford.

1.4 References

Flood Estimation Handbook (Institute of Hydrology, 1999).

Flood Studies Report (NERC, 1975).

Flood Studies Supplementary Report No.16 (Institute of Hydrology, 1985).

Hawkes, P., Surendran, S., and Richardson. (2003). "Use of UKCIP02 Climate-Change Scenarios in Flood and Coastal Defence", Water and Environmental Management Journal Vol. 18 No.4.

Hulme, N., and Jenkins GJ. (1998). "Climate change Scenarios for the UK"; Scientific Report, UKCIP Technical Report No. 1, Climate Research Unit, Norwich

Ministry of Agriculture, Fisheries and Food (now Defra). (2000). "Flood and Coastal Defence Project Appraisal Guidance – Approaches to Risk". PCDPAG4.

Osborn, JO., Hulme, M., Jones, PD., and Basnett, TA. (2000). "Observed trends in the daily intensity of United Kingdom precipitation". International Journal of Climatology. 20 p347-364.

Reynard, N., Crooks, S., Wilby, R., and Kay, A. (2004). "Climate change and flood frequency in the UK", paper presented at Defra conference, York, 2004.

United Kingdom Climate Impacts Programme. (2002). "Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report". Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Norwich, April 2002.