2. **EXECUTIVE SUMMARY**

Seven private waters sites within the United Kingdom were identified as suitable for monitoring. Two of the sites were in Wales, two in Scotland, two in England and one in Northern Ireland. Each site was monitored daily for six weeks on two occasions. The first occasion was in May and June of 2000 and the second was in October and November of 2000.

Samples were taken daily in each period for coliforms, *Escherichia coli*, enterococci, presumptive *Clostridium perfringens* and *Campylobacter*. Additional samples were taken for *E. coli* O157:H7 where water quality data suggested it might be present. A *Cryptosporidium* monitoring cabinet was installed at each site. Daily samples of 1000 litres were taken and processed for *Cryptosporidium* and *Giardia*. Five local laboratories were used to process bacteriological samples and parasitology samples were processed at one laboratory.

Samples were taken at each site for chemistry during the second phase. Additional samples were also taken at four sites for raw water analysis. Samples were taken at two sites for viruses. The findings of the virology samples will be the subject of a second report.

Site 1 was located in the South West of England. The bacteriological quality of the water was excellent. None of the samples taken during phase 1 failed bacteriologically. One parasite sample contained one *Cryptosporidium* oocyst and one sample contained one *Giardia* in phase 1. All phase 2 samples were negative. A filter left in the sampling equipment over the summer months contained one *Giardia* cyst. The volume sampled was in excess of 117,000 litres.

Site 2 was located in Scotland. Sixty five percent of the bacteriological samples failed for coliforms and *E. coli* during phase 1, 25.5% for enterococci and 51% for clostridia. During phase 2, 47% of samples failed for coliforms and *E. coli*, 14.3% failed for enterococci and 16.6% failed for clostridia. None of the samples contained *Campylobacter* and *E. coli* O157. Seventy five percent of samples contained *Cryptosporidium* and 60% contained *Giardia* in phase 1 and 50% of samples contained *Cryptosporidium* and 42.5% contained *Giardia* in phase 2.

Site 3 was in South Wales. None of the bacteriological samples failed in phase 1 and only one sample contained clostridium in phase 2. One sample was positive for *Cryptosporidium* and one for *Giardia* in phase 1. In contrast, 56.6% of the parasitology samples taken in phase 2 were positive for *Cryptosporidium* and 50% for *Giardia*.

Site 4 was in Northern Ireland. Two samples (4.8%) contained coliforms in phase 1. Seven percent of the phase 2 samples contained enterococci and 76.6% contained clostridia. Parasites were absent from all the samples taken in phase 1 but 2.4% of samples in phase 2 were positive for *Cryptosporidium* and 12.1% were positive for *Giardia*.

Site 5 was in Scotland. Ninety three percent of the phase 1 samples contained coliforms, 90.6% contained *E. coli*, 51.2% contained enterococci and 9.3% contained
clostridia. In phase 2, coliforms and E. coli were present in all the samples, enterococci in 69.7% and clostridia in 14%. Two samples were positive for Campylobacter in phase 1 and two samples in phase 2. Escherichia coli O157 was not detected. For Cryptosporidium, 33.3% of the samples were positive for phase 1 and 15.4% positive for Giardia. In phase 2, 56% of samples were positive for Cryptosporidium and 65.9% were positive for Giardia.

Site 6 was in South Wales. Only one sample was positive for coliforms in phase 1 and all the parasitology samples were negative. In contrast, 92.8% of samples were positive for coliforms in phase 2, 64.3% were positive for E. coli, 38% for enterococci and 54.8% for clostridia. Ten percent of the samples were positive for Cryptosporidium in phase 2 and 29% for Giardia.

Site 7 was located in Yorkshire. Here, 83.3% of samples were positive for coliforms in phase 1, 71.4% for E. coli, 47.6% for enterococci and 90.5% for clostridia. Campylobacter was isolated from 6 samples in phase 1 and E. coli O157:H7 was detected in one sample. This isolate was subsequently shown to be toxigenic. In phase 2, 27.3% of samples were positive for coliforms, 26.1% contained E. coli, 6.8% contained enterococci and 61.4% contained clostridia. One further sample contained Arcobacter butzleri. For parasitology, 52.2% of samples contained Cryptosporidium, and 57.7% of samples contained Giardia in phase 1 and 91% of samples contained Cryptosporidium and 84.4% of samples contained Giardia. Filtration and electrochlorination was introduced between phase 1 and phase 2 at this site.

A brief literature review recognises that the majority of waterborne outbreaks are caused by Campylobacter, E. coli O157:H7, and Cryptosporidium. Outbreaks have occurred after heavy rainfall. Association with animal contamination such as carcasses, slurry and direct faecal contamination are amongst the main risk factors.

During both phase 1 and phase 2 there were periods of heavy rainfall. Phase 2 ended as the serious flood problems began in the United Kingdom. Water quality was affected at four of the sites during heavy rainfall. This is reflected in a dramatic increase in indicators, particularly coliforms and E. coli and mirrored by the presence of Campylobacter and increased concentrations of parasites. At site 2, indicator and parasite concentrations are higher in phase 1 than phase 2 whilst the reverse is true for sites 3, 5, 6 and 7.

At sites 4 and 7, in phase 2, where disinfection was installed, clostridia were the best indicators of faecal contamination. In the absence of disinfection, coliforms and E. coli were the best indicators. At site 5, clostridia were of no value in assessing faecal contamination as they were absent from samples in both phase 1 and phase 2.

Extreme hydrological events can result in raw water containing high levels of microorganisms and turbidity. It is clear from the survey at site 7 that treatment and disinfection may not be adequate to protect water quality during extreme weather conditions. It is also clear that treated water quality is most likely to be compromised during these events. Low frequency sampling programmes will not detect such dramatic changes in water quality unless sampling is targeted at heavy rainfall events.
Sites which have proper sanitary surveys and a well protected and treated water supply have no microbiological problems. Sites in rural areas where there is no control over source water quality, water treatment is absent and there is low frequency monitoring, will have periods of high microbiological contamination.

A novel small-scale retrospective examination of laboratory confirmed cases of *Campylobacter*, *Cryptosporidium* and *Giardia* infections in relation to living at a location served by a private supply suggests that there may be an elevation of campylobacteriosis and cryptosporidiosis in this group in comparison to the total population. A prospective epidemiological study is suggested as the only way to adequately characterise the likely burden of disease relating to private supplies.