Determination of the Correlation of the Presence of Cryptosporidium in Treated Water with Other Water Quality Parameters

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2. EXECUTIVE SUMMARY

2.1. Four sites in England were chosen for the project. These are designated as sites A, B, C and D. A brief description of each site is given below. Six laboratories were used for the analytical work. These are designated as laboratories 1 - 6.

2.2. Site A has direct river abstraction. Treatment includes coagulation, rapid gravity filtration, ozone and granular activated carbon and chlorination. Site B abstracts river water into balancing reservoirs. Treatment includes Actiflo flocculation, rapid gravity filtration, ozone, granular activated carbon and chlorination. Site C is a borehole supply with chlorination. Site D takes reservoir water from an aqueduct. The water is treated by microstraining and chlorination.

2.3. Cryptosporidium monitoring units were placed on the treated water at each site. At site A, a unit was used to monitor the water from filter 10 and at site B, a unit was used to monitor the water from filter 8. The treated water only was monitored at sites C and D.

2.4. Daily samples were taken for Cryptosporidium on the units at each site. Hourly samples were taken for aerobic spore bearing bacilli and clostridia using automatic samplers. All the bacteriology samples were analysed during the first 10 days. Following this, subsequent samples were pooled and either all the pooled sample analysed or a proportion of the pooled sample analysed, depending on the numbers of organisms present. All the individual hourly bacteriological samples were analysed by laboratory 5 through the study period.

2.5. Particle counts and turbidity were measured continuously and the information used to determine whether a spike had occurred and, if so, which hourly bacteriological samples should be processed to correspond to the spike.

2.6. Data was analysed statistically by looking at the overall statistics for each parameter at the sites and comparing these with parameters on those days when either Cryptosporidium or Giardia were detected. Temporal plots of the parameters were also produced for each day when parasites were detected.

2.7. Collection of data on the raw water at site A and B has allowed the log reductions of certain parameters to be examined. Operational performance at sites A and B has been assessed over the survey period.

2.8. One hundred and eighty two samples were taken for Cryptosporidium from the treated water at site A and none were positive. Seventy nine samples were taken for Giardia and

none were positive. Of 168 parasitology samples taken from filter 10, 5 were positive for Cryptosporidium and 4 were positive for Giardia. Two of these detections correlate with small increases in clostridia and 3 with increases in aerobic spores. There were nearly 200 instances of increases in spores from the filter during the survey and 28 instances of increases in clostridia. In addition, there were 135 instances of elevated spore levels in the treated water and no instances of elevated clostridia.

The presence of parasites in the filtered water is not reflected in a significant increase in turbidity from the filter but there are increases in particle count data on 4 occasions. Similar increases can be seen when no parasites have been isolated from the filtered water.

Site A had a mean aerobic spore count of 3.3 x 104 colony forming units (cfu) per 100 ml in the raw water, 21 cfu per 100 ml in the filtered water and 8 cfu per 100 ml in the treated water. The average removal performance for the filtered water was 99.94% and for the treated water was 99.98% for the survey. The average clostridia count in the filtered water was 0.3 cfu per 400 ml and in the final water was 0.004 per 400 ml.

The average turbidity removal was 99.5% for the filtered water and 99.6% for the treated water.One hundred and eighty nine samples were taken for Cryptosporidium from site B treated water and 21 were positive. One sample in the treated water correlated an increase in aerobic spores, turbidity and particle counts. For the remainder, there was no correlation with other water quality parameters.

2.9. One hundred and fifty two samples were taken for Cryptosporidium and 153 for Giardia from Site B filter 8. Thirteen of these were positive for Cryptosporidium and 13 for Giardia. Four samples containing parasites had elevated spore counts. None of the samples from the filter which were positive for Cryptosporidium or Giardia correlated with increases in clostridia.

Of the 13 samples positive for Cryptosporidium from filter 8, only 3 correlated with peaks in turbidity and 3 correlate with peaks in particle counts. Of the 13 samples positive for Giardia, six corresponded to small peaks in turbidity with increases from 0.08 to between 0. 14 and 0.2, and 2 correspond to peaks in particle counts. There are a large number of peaks in particle counts and turbidity where parasites have not been detected in the water.

One hundred and seventy two samples of raw water were analysed for Cryptosporidium at site B. Ninety three were positive. The mean value for the survey period was 135 oocysts per 1,000 litres and the maximum value was 3,700 oocysts per 1,000 litres. The mean percentage removal during treatment across the study period was 99.89%.

The mean concentration of aerobic spores in the raw water at site B was 9.8 x 104 cfu per 100 ml. The mean concentration in the filtered water was 102 and in the treated water was 69 cfu per 100 ml. The average reductions were 99.7% for the filtered water and 99.93% for the treated water. The mean clostridia count for the filtered water was 2 per 400 ml and for the treated water was 0. 15 per 400 ml.

The mean value for the turbidity of the raw water at site B was 5 FTU, the filtered water was 0.093 FTU and the treated water was 0.085 FTU. The percentage removal for the filter was 98.14% and for the treated water was 98.3%.

2.10. One hundred and seventy seven samples were taken for Cryptosporidium and Giardia at site C. Two samples were positive for Cryptosporidium and one sample for Giardia. The mean value for clostridia was 0.5 cfu per 400 ml and the mean count for aerobic spores was 3 cfu per 100 ml. There was no correlation with any increase in clostridia spores or aerobic spore-bearing bacilli during the project. In addition, the presence of the parasites in the water did not correlate with an increase in turbidity or particles.

There are numerous spikes in the particle count data observed throughout the monitoring period at site C. They occur on a daily basis. These do not correlate with any increases in bacterial indicators or any evidence of increases in turbidity.

2.11. One hundred and seventy six samples were taken for Cryptosporidium and 177 for Giardia at site D. Of these, 149 were positive for Cryptosporidium and 164 for Giardia. There is no correlation in these counts with the other water quality parameters examined on a day-today basis. Both water quality parameters and parasites show a gradual decline in numbers during the project. Statistical analysis of the data demonstrated a positive correlation between the parasites and other water quality parameters over the study period. The exception was a correlation with Giardia, aerobic spores and clostridia.

2.12. A modification of the method for counting aerobic spore-forming bacteria was developed and this has been accepted for publication in Water Research.