Cryptosporidium: Occurrence in the Potomas Basin

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A study of *cryptosporidium* levels in selected wastewater plants and water plant intakes was conducted over the past several years (1998-2002) by the Maryland Department of the Environment (MDE), Water Supply Program. Dr. Thaddeus Graczyk of Johns Hopkins University provided all the analytical support for *cryptosporidium* analysis. The method for analysis utilizes a membrane filter dissolution process along with magnetic separation immuno-fluoresence antibody procedure to enhance oocyst recovery. Oocysts were tested for viability, infectivity and genotype.

Nine wastewater plant effluents were sampled over two two-day periods. Each sample was a twenty-four composite sample. Two samples were collected during a wet weather period and two during a dry weather period. All samples were collected at the point of discharge to the receiving stream. Four of the plants use activated sludge for secondary treatment, two use contact growth (trickling filter), two plants followed activated sludge with filtration, and one relied on a series of lagoons.

Seven of the nine plants were found to have *crptosporidium* in their effluent. Twenty-one (21) of the thirty-six (36) samples were positive for *cryptosporidium*. Concentration ranges were between 3 and 590 oocysts per liter. The highest concentrations were measured during plant failures. The oocysts were viable in eighteen samples. Nine samples were found to be infectious. Seven of the nine samples were of genotype II.

The two wastewater plants with no detections both utilized contact growth treatment trains. The mean *cryptosporidium* level in properly functioning filtered activated sludge plants was 8.7 oocysts/liter (n, 6), while the mean value from three unfiltered activated sludge effluents was 25 oocysts/liter (n, 12). The fourth activated sludge plant exclusively serves a prison and had the highest mean effluent concentration of 223 oocysts/liter (n, 4). The effluent from the lagoon treatment system had a mean effluent concentration of 68 oocysts/liter (n, 4). *Cryptosporidium* was not detected in each sample from the activated sludge plants effluents.

Source waters contributing to nine water plants were also sampled for *cryptosporidium*. Samples were collected directly from raw water taps by plant personnel at five treatment plants. All samples were grab samples. At four locations, samples were collected by MDE from streams upstream of the intake locations. Four base-flow samples and four storm events were sampled at each location. Three samples were collected during each storm event. One was collected during the rising limb of the storm, one at peak storm turbidity and one during the falling limb. Three one-gallon containers were filled for each sample. Watershed size ranged from 4.7 to 11,443 square miles. Forested land cover ranged from >99% to as low as 24%. Agricultural land use was as high as 74% in one watershed. Developed land was from less than 1% to as high as 10% in the nine watersheds.

During base flow, seven of nine sites were positive for *cryptosporidium*. The smaller watersheds (< 60 square miles) had a mean value of 0.2 oocysts/liter (n,16) , while the larger watersheds (>500 square miles) had a mean concentration of 7.2 oocysts/liter (n,20). The highest concentration was 20 oocysts/ liter. *Cryptosporidium* was detected in 61% of the base flow samples. During storm events *cryptosporidium* was detected in 85% of the samples and the highest detected concentration was 48 oocysts/liter. The highest median concentration (17 oocysts per liter) was found during peak turbidity periods. Samples were viable and infections and predominantly of genotype II.

A graph of turbidity versus *cryptosporidium* for all samples indicate a significant amount of scatter, but a general trend of elevated *cryptosporidium* when turbidity is elevated. Samples collected from the smaller watersheds had the strongest correlation between turbidity and *cyrptosporidium* levels. The samples from these watersheds also had the most pronounced difference in *cryptospooridium* levels during the storm peak (as determined by turbidity) than the pre or post samples. The samples collected at water plants withdrawing from the Potomac River often showed the highest *cryptosporidium* levels during the falling limb of the storm. This may indicate that significant sources of *cryptosporidium* are from distant parts of the watershed.

The average concentration of oocysts measured in wastewater effluent samples collected for this study during wet weather was about three times higher than that found in water plant influent samples during the peak portion of storm events. Given that the percentage of wastewater flow at water plant intakes on the Potomac is 1% or less during high flow conditions, the loadings of *cryptosporidium* measured in wastewater effluents are believed (by mass balance calculations) to be less than 10% of the total load of *cryptosporidium* to the water plants during storm events. However the finding that the oocysts concentrated in the sediment downstream of wastewater plant effluent makes it difficult to quantify the impact of wastewater plants on *cryptosporidium* levels measured at water plants. The settled oocysts may be vulnerable to resuspension during high flow events and additionally contribute to the levels measured downstream in the water column.

Given the same limitations of not being able to quantify the removal of oocysts in the river, we also ran the numbers to estimate a possible upper bound of the wastewater contribution to the water intakes in the Washington metro area under dry weather flow. Using a median concentration of 20 oocysts/L in the discharge and the average of the two intake values from the metro area, the dry weather contribution ranged from 10% to 66%. This analysis suggests that wastewater sources can be significant under some conditions, but also points to the need to include non point sources of *cryptosporidium* in any control strategy for watershed protection. Non point sources should be further studied to evaluate their role in contributing to *cryptosporidium* levels measured in the raw water sources as these sources appear to be the most significant source for the water plants under adverse conditions.