Hagerstown Wastewater Treatment Plant Incident 9/3-5/2003

Prepared by
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Metropolitan Washington Council of Governments
September 5, 2003 at 10 am

Important Note: these are approximate order of magnitude calculations. More detailed modeling would provide refined estimates.

Dilution calculations:

Assume Hagerstown plant is at 30 mgd (45 cfs)

At Shepherdstown, flow on 9/4 was 7000 cfs.
Dilution ~ 7000/45 = 155 to 1.

At Point of Rocks, flow on 9/5 was 20000 cfs.
Dilution ~ 20000/45 = 444 to 1.

At Little Falls, flow on 9/5 was 38000 cfs, but probably will fall to 20000 cfs.
Dilution ~ 38000/45 = 844 to 1.

Thus overall approximate dilution is 400 to 1. (plus or minus 50%).

[Note: USGS gage at Antietam Creek near Shepherdstown indicated a flow of 915 cfs morning of 9/5. Thus initial dilution is occurring in creek, but overall dilution calculation would be about the same in the Potomac.]

Bacterial die-off calculation:

[Reference: Thomann, Robert V. and John A. Mueller. **Principles of Surface Water Quality Modeling and Control.** Harper & Row, Publishers, 1987. Chapter 5.]

Assume Kb is net death rate of fecal coliform bacteria (net death rate is a function of "natural" death due to temperature, salinity, and predation, sunlight, loss/gain due to settling and resuspension, and aftergrowth rate).

Assume Potomac River temperature is at 20 degrees C. (Actually was 23 deg C and falling at Little Falls on 9/5 am).

Assume Kb at 20 degrees C for fecal coliform is 1/day.

[Note – at 20 degrees C, no temperature adjustment of Kb needed]

[Temperature adjustment formula is:

$$\text{Adjust Kb for T degrees C: } Kb(T) = Kb(20)*(1.07)^{T-20}$$]

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Bacterial die-off:

N = N0*exp(-Kb*t) where t is time in days

where N0 is initial bacterial concentration and N is concentration at time t

Reported N0 at Hagerstown on evening of 9/3 was 910,000 mpn/100 ml but dropped to 12,000 mpn/100 ml on 9/4.

ICPRB estimates 1-2 days to reach various water intakes in region (event began at 1040 pm on 9/3/03 (e.g., 2240 hrs 9/3/03). Likely that impact is being felt at this time at least at upper end of Washington region intakes.

Therefore at 1 day, for N0 = 910000* exp (-1.0*1) = 335000 mpn/100ml (63% reduction)
For N0 = 12000, at day 1 reduced concentration would be 4400 mpn/100 ml

At 2 days, N0 = 910000, N = 123000 mpn/100 ml (86% reduction)
At 2 days, N0 = 12000, N = 1600 mpn/100 ml

Total bacterial reduction:

Remaining bacteria at day N is diluted by 400 to 1; travel time to Washington region (per ICPRB estimates is approximately between 1 and 2 days):

At 1 days, 335000/400 = 840 mpn/100 ml (about a factor of 1100 to 1 total reduction)
At 1 days, 4400/400 = 11 mpn/100 ml

At 2 days, 123000/400 = 310 mpn/100 ml (about a factor of 3000 to 1 total reduction)
At 2 days, 1600/400 = 4 mpn/100 ml

Data in COG water quality database reported by US Geological Survey over many years indicates median fecal coliform values in free flowing Potomac River are around 100 mpn/100 ml, with peaks as high as 10,000 to 100,000 mpn/100ml.

Conclusion: 4 – 11 mpn/100 ml will not be detectable; 310 – 840 mpn/100 ml might be noticeable but still well below peak levels that are routinely handled by Potomac River water treatment facilities. **However, the likelihood is high that due to recent rains**

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plus the effects of Hagerstown, concentrations will exceed the 200 mpn/100 ml standard for contact recreation.

Conclusion: even if concentration estimates are off by a factor of 100 or even 1000 (very unlikely), water treatment plants in Washington region handle this circumstance routinely over the course of the year; **therefore there is no concern regarding the safety of water supplies in the Washington region resulting from the Hagerstown WWTP incident.**

Relative to contact recreation there are potential concerns in Antietam Creek and in the Potomac River. Maryland Department of the Environment has directed that Antietam Creek be closed and posted with warning signs.