Protecting the Unique Ecosystem from Contaminated Storm Runoff at Mammoth Cave, KY

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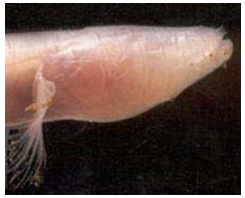
Summary

Mammoth Cave is home to many unique animals that could be harmed by contaminants carried into the cave system during storm events. This project was conducted to determine if leaf-pack filter-systems attenuated storm runoff at seven parking lots in Mammoth Cave National Park. Grab samples were collected at the inlet and outlet of the filter systems, and analyzed for oil and grease, sediments, turbidity, gasoline compounds, nitrate, ammonia, fecal bacteria, dissolved iron, and chemical oxygen demand (COD). For the first sampling round, the filters had not been serviced for 8 years and did very little to remove contaminants. The contaminant concentrations at the outlet were similar to those at the inlet, with the exception of removing 20-70 percent of the oil and grease. After replacing leaf packs and cleaning out debris, the re-conditioned filters did not remove oils and greases and did little to remove copper and ammonia from runoff waters. However, the re-conditioned filters removed up-to 99% of the benzene, toluene, ethyl-benzene and xylene, and, up to 90% of the turbidity, *E. coli*, Chemical Oxygen Demand and iron from the storm runoff. These results indicate that well-maintained filtration systems are more effective than clogged filters at removing many but not all contaminants from parking lot runoff.

Problem: Mammoth Cave is home to many unique animals which are sensitive to contaminants carried into the cave system during storm events.



Photos clockwise
Photo 1. Blind crayfish
Photo 2. Blind KY cave shrimp
Photo 3. Blind cave fish

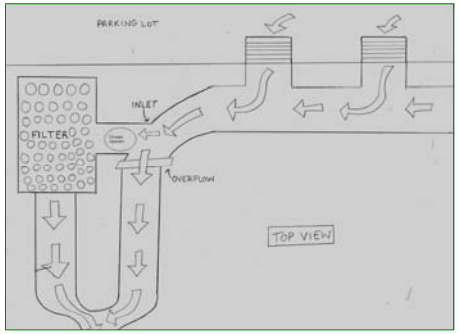
These unique aquatic creatures live in Mammoth Cave, are eyeless, & are listed as rare or endangered.
Photos courtesy of Mammoth Cave National Park Service website & Rick Olson.

Objectives:

The objective of this project was to determine if 8-year old leaf-pack filter-systems attenuated storm runoff from the parking lots at Mammoth Cave National Park.

Tasks to accomplish objectives: The 7 filter-systems had not been serviced in 8-years & were evaluated before and after they were overhauled. Samples were collected at the inlet & outlet of the filter systems & analyzed in the lab.

Storm runoff from the main parking lots is now diverted through an oil-water separator and a leaf-pack filter to remove contaminants. As the flow exceeds the filters' capacity, it will flow out the overflow unfiltered.



Methods & Materials

The efficiency of the filters was evaluated by measuring the contaminants going into and out of the filter systems.

Rain & simulated rain would flow from the parking lots into the filter systems.

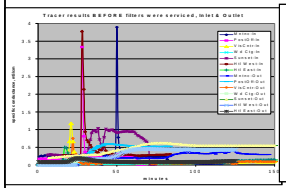
Water samples were collected as the water flowed into the filters and out of the filters.

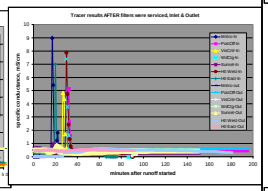
This field work was done prior to & after the filters had been refurbished. Filter system pictured above with parking lot up-gradient. Also shown, new leaf-packs to be placed in refurbished filters

Water samples were brought back to the lab for chemical & biological analysis

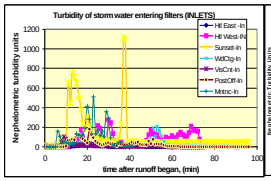
Results

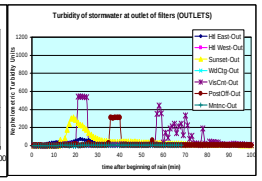
Figures 1a & 1b – show results of the salt tracer into and out of the filters prior to and after servicing the leaf-pack filters. One thing that is noticeable is that prior to servicing, the tracer came out faster and in a definable pulse. After servicing, there were no discernible pulses at the outlet, indicating the tracer stayed in the system longer.



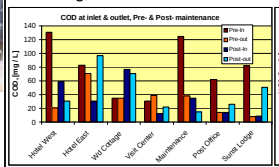


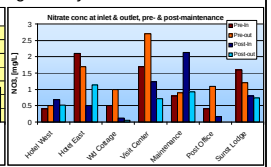
Figures 2a & 2b. Turbidity of stormwater at the inlet & outlet (post-maintenance). Significance of results – the turbidity readings at the inlet show there is not a strong "first flush" phenomenon in these small basins. The turbid materials take varying amounts of time to suspend & travel across the parking lot to the inlet. The outlet was generally less turbid than the inlet waters, indicating the filters are removing suspended solids. Since there was not a strong temporal pattern, the concentration data were summarized using averages.





Figures 3 & 4. Chemical oxygen demand (COD) was reduced by the filters with a few exceptions. Nitrate levels were often higher at the outlet than the inlet prior to servicing the filters. After servicing, the nitrate concentration generally went down.





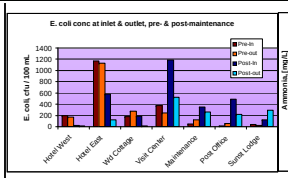


Figure 5. *E. coli* concentrations at the inlet & outlet. Prior to servicing the filters, the *E. coli* concentration going out was equal to the concentration entering. After maintenance, the *E. coli* dropped as it flowed thru the filters.

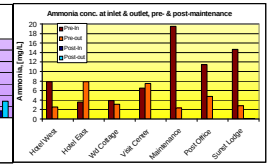


Figure 6. Ammonia concentration at the inlet & outlet. The NH_3 concentrations were much higher in the fall (pre-maintenance). The filters appear to be attenuating the NH_3.

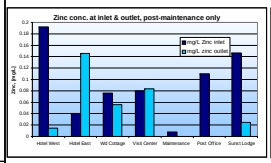


Figure 7. Zinc concentration at the inlet & outlet. The importance of zinc to the toxicity of cave-shrimp was brought to our attention & it was evaluated in the post-maintenance only. The filters did an excellent job removing zinc, except when sediments were not effectively removed (Figure 1).

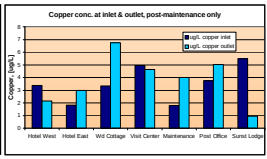


Figure 8. Copper concentration at the inlet & outlet. Copper was only measured in the post-maintenance filters. The filtration systems appear to be unable to remove copper.

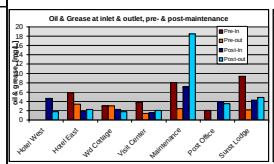


Figure 9. Oil & grease concentration at the inlet & outlet. The pre-service filters appear to attenuate oil & grease as good as –or better than- post-maintenance filters.

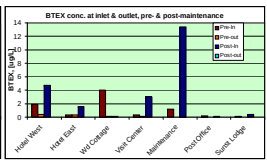


Figure 10. **B**enzene, **T**oluene, **E**thylebenzene & **X**ylene concentratons at the inlet & outlet. The filter systems appear to remove all traces of BTEX, especially after they were serviced.

SUMMARY & CONCLUSIONS

Prior to servicing - several filters had obstructions from debris carried in over the yrs, rendering them less effective. In heavy rains, stormwater was rapidly diverted to the overflow by-pass.

After servicing, they appear to be more effective at reducing bacteria, turbidity, Zn, sediments, & BTEX. But the refurbished filters did not improve attenuation of NH_3, COD, oils-grease & Cu. It is apparent the filters were less efficient prior to servicing & should be monitored to establish an optimum servicing schedule. Improvements are needed to reduce NH_3, COD, oils-grease & Cu.

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