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Ms. Jennifer Borski
Wisconsin Department of Natural Resources
625 E. County Road Y, Suite 700
Oshkosh, WI 54901-9731

RE: Hydrogen sulfide issues in the manholes at Mauthe

Dear Jennifer:

As you know, hydrogen sulfide has been a problem in the manholes at the Mauthe site. Odors have reached the surface, and corrosion is occurring within the manholes.

Hydrogen sulfide production in manholes:

It is important to understand how hydrogen sulfide is produced in manholes, in order to plan maintenance activities, which might alleviate or minimize the problem, and to aid in personal protection.

The production of hydrogen sulfide in sewers starts with sulfate ions dissolved in water. In areas where there is little velocity in the water, a slime layer can build up, consisting of bacteria and inert solids. When the layer gets thick enough, it can prevent oxygen from penetrating through, turning conditions under the slime layer anaerobic. It takes approximately two weeks for a fully functional slime layer to develop.

Certain anaerobic bacteria in the slime layer then begin to strip oxygen from sulfate ions, and the remaining sulfide ions combine with hydrogen from the water, forming hydrogen sulfide.

The warmer the water temperature, the faster the production of hydrogen sulfide.

The hydrogen sulfide escapes from the water as a vapor, giving off a rotten egg odor. Turbulence within the water increases the rate of escape by orders of magnitude.

In aerobic areas within the manhole above the water line, bacteria of the genus *Thiobacillus* thrive. These bacteria have the unique ability of converting hydrogen sulfide into sulfuric acid. Sulfuric acid corrodes concrete and metal surfaces.

Discussion and Recommendations:

Contaminant transport and fate modeling has been performed at the site. The continued operation of the groundwater collection system will not be a cost-effective way of achieving cleanup goals at the site. Remedial options need to be reviewed and cleanup goals re-evaluated.

The groundwater collection system should continue to operate during the re-evaluation process, since it is providing a level of protection to the parcels immediately downgradient of the chromium contaminant source. However, since continued operation of the groundwater collection system may not be a component of the revised remediation plan, expensive retrofitting

of the manholes to minimize continued degradation is premature. OMMNI therefore did not address the issue of retrofitting the manhole.

In order to determine whether any less costly maintenance activities could be performed to minimize the rate of manhole deterioration and the degree of nuisance odors, OMNNI is recommending that a study be performed to better understand the nature of hydrogen sulfide levels within the manhole. If certain discrete events, such as groundwater pumping in the manholes, or certain chronic circumstances, such as solids or slime layer build-up in the collection piping, are found to correlate heavily with hydrogen sulfide formation and release into the air, the study might identify such correlations.

As part of this effort, OMNNI researched hydrogen sulfide monitors. We were looking for a monitor that could be placed entirely within the manhole, that continuously monitors and logs vapor concentrations, that requires minimal maintenance, that is downloadable into a laptop computer, and that is relatively inexpensive. We also looked for multi-port functionality, so that multiple depths within the manhole could be monitored at the same time.

A large number of hydrogen sulfide monitors are designed for personal protection. They operate continuously, but do not log concentrations, providing only an alarm when certain pre-set levels are reached. They are also not designed to hang in the particularly caustic environment of manholes.

OMNNI recommends using Arizona Instrument's Jerome Model 860 hydrogen sulfide monitor. It is designed for sewer monitoring, and can be hung at any depth within the manhole. Its sensor is attached to the unit, so the unit must be hung at the level being investigated. It has only one sensor, so cannot capture information from various depths simultaneously.

The Jerome 860 must be retrieved every 5 – 7 days, downloaded, "rested" for 48 hours, recalibrated, and then re-employed. It costs $1,310.00, or $2,060.00 for a pair. (See attached quote.) OMNNI recommends purchasing a pair, to allow simultaneous monitoring of two different levels within the manhole, and alternatively, to allow continuous monitoring (without the two-day rest period and associated labor).

Certain maintenance activities are helpful in sewers experiencing hydrogen sulfide production:

- Since hydrogen sulfide is not produced in the first place without the existence of a slime layer, making life harsh on slime layers is helpful. Slime layer buildup requires low water velocity, and inert material upon which to grow. Speeding up flow velocities and keeping pipes clean, at least every two weeks, will discourage the creation of a fully functional slime layer. In our situation, since the groundwater collection system uses corrugated piping, it is unlikely that jetting the system will produce favorable results.
- The bacteria in the slime layer will only strip oxygen from the dissolved sulfate ions in the absence of another oxygen source. If aerobic conditions are maintained below the slime layer, at least every two weeks, hydrogen sulfide will not be produced. In our situation, since hydrogen sulfide production is probably taking place along a good distance within the horizontal corrugated piping, it will be difficult to introduce air below the slime layers formed on the solids deposited between the corrugations in the piping.
- The rate of release of hydrogen sulfide from the water into the vapor phase is highly dependent on turbulence in the water. If maintenance activities are unsuccessful in preventing the production of hydrogen sulfide in the first place, lowering the turbulence in the water will at least minimize the rate of release of the hydrogen sulfide into the atmosphere. This could be accomplished by maintaining a couple feet of head above the pump at all times, as well as above the outfall of the collection piping into the manholes.

- Shock chlorination is commonly performed in water supply wells to kill bacteria. Its efficacy is a function of the severity of the problem, and its cost is determined by the volume of impacted water.

Hydrogen sulfide has an extremely low odor threshold, and can be detected by some people at vapor concentrations as low as 5 parts per billion. To completely eliminate the potential of producing concentrations above that level at the surface is a difficult proposition. As long as active pumping is taking place, new sulfate ions and inert solids are being continuously introduced into the system, and turbulence caused during pumping events is accelerating the rate of release of hydrogen sulfide into the air.

Odor masking or removal compounds are available for hydrogen sulfide. Their usefulness depends on the rate of hydrogen sulfide production. OMNNI recommends performing the hydrogen sulfide study, to better understand what's going on. With that information, we can decide whether increased manhole maintenance, masking or odor removal activities, or indeed complete shutdown of the groundwater extraction system is in order.

Sincerely,

Don Brittnacher

Don Brittnacher

Attachment