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Milking Center Wastewater Management - Bark Filter Mound

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All dairy farms, regardless of size, generate milking center wastewater from the milking parlor and the milk house. Such wastewater typically contains low concentrations of manure, milk residue, food grade cleansers, and other water contaminants. Unlike manure, which contains economically-usable levels of crop nutrients, milking center wastewater has little fertilizer or economic value. Dairy farms generate 2 to 11 gallons/day/cow of milking center wastewater. A previous MDR article (Safferman, S. I., Milking Facility Wash Water: Facts and Figures," Michigan Dairy Review, January 2008, pp. 1-2) contains a literature review concerning the quantification and characterization of milking center wastewater.

The challenge of managing milking center wastewater is compounded for farmers who manage their dairy manure as a solid. Without a liquid manure storage facility to contain manure and the milking center wastewater, few options for milkhouse wastewater management are available, other than frequent hauling to crop fields or through conventional septic systems. The vast majority of farms with fewer than 100 milk cows manage manure as a solid. Therefore, this challenge falls disproportionately on smaller dairy farms that do not have liquid storage systems. The 2002 Census of Agriculture shows that over 70% of all dairy operations in Michigan have fewer than 100 milk cows (2,172 out of 3,013), making this is a widespread concern. These dairy farms need environmentally protective management options that are affordable and easily operated and maintained.

In 2004, the USDA Natural Resources Conservation Service and the Michigan Department of Environmental Quality organized a multi-agency workgroup to examine milking center wastewater management alternatives for small-sized Michigan dairy farms. Workgroup participants are listed at the end of the article. After a nearly 3-year on-farm field trial, the workgroup concluded that one alternative, the bark filter mound, has good potential, but further experience at dairy farms of different sizes, soil types, and management practices is needed before broad application of the practice can be recommended.

Bark Filter Mound

The bark filter mound has been tested in other states but has not become a widespread practice due to technology limitations and operational problems. Although there are variations in features, they all incorporated similar principles. The milking center wastewater passes through a settling tank and fat trap to capture solids and milk fats, which are periodically land applied at agronomic rates. The wastewater is then dispersed into an infiltration area, sized according to water volume generated and soil type. The infiltration area is covered with organic matter, usually bark or wood chips, that serves the following functions:

- Permit oxygen penetration to promote aerobic microbial treatment.
- Insulate the infiltration area preventing freezing.
- Minimize offensive odor generation due to sorption by the organic matter.

Because the wastewater is dispersed above the top soil, natural filtration, sorption, and microbial degradation contribute to treatment as the water progresses downward. This is in contrast to the septic system and leach field approach, where the wastewater is distributed in the subsoil, bypassing the biologically active topsoil.
After studying the use of bark filter mounds in other states, the workgroup determined the need to implement the following modifications:

- Apply wastewater so it passes through the filter media in order to enhance treatment.
- Test a variety of filter media in order to determine which is most effective.
- Disperse the wastewater evenly within the filter mound using a pressurized system.

Design of Modified Filter Mound

A progressive small farm in central Michigan was found that welcomed the field demonstration. This farm has approximately 200 milk cows and produces approximately 5 gallons per cow per day of milking center wastewater when milking twice a day. The field trial filter mound system tested four filter media: bark, wood chips, marble-size Styrofoam chips, and pea stone.

Before entering the filter mound system, wastewater flows, by gravity, through a series of three settling tanks sized to provide a total capacity of at least three times the daily wastewater production to ensure adequate settling. After the settling tanks, a timer-controlled pump sent the wastewater to the pressurized pipe distribution network to dose the 3-foot deep mound of filter media. There were four sections of the filter mound, each with a different media. A sequencing valve was used to ensure the equal, sequential distribution of the wastewater to each section. The distribution system in each section consisted of four lines of 1.5-inch diameter PVC pipe. In three test sections, the distribution lines were covered with a half-round 8-inch, dual-wall corrugated plastic pipe. In the fourth section, 24-inch wide by 18-inch high polyethylene effluent chambers were installed over the distribution lines to provide a wider spreading area and to allow more air into the surface of the filter media. All lines were laid deep enough in the mound to protect against frost. Figure 1 is a photograph of the mound being constructed and Figure 2 shows the distribution line, spraying under the 8-inch half round pipe, in the bark section.

Figure 1: Filter mound under construction.

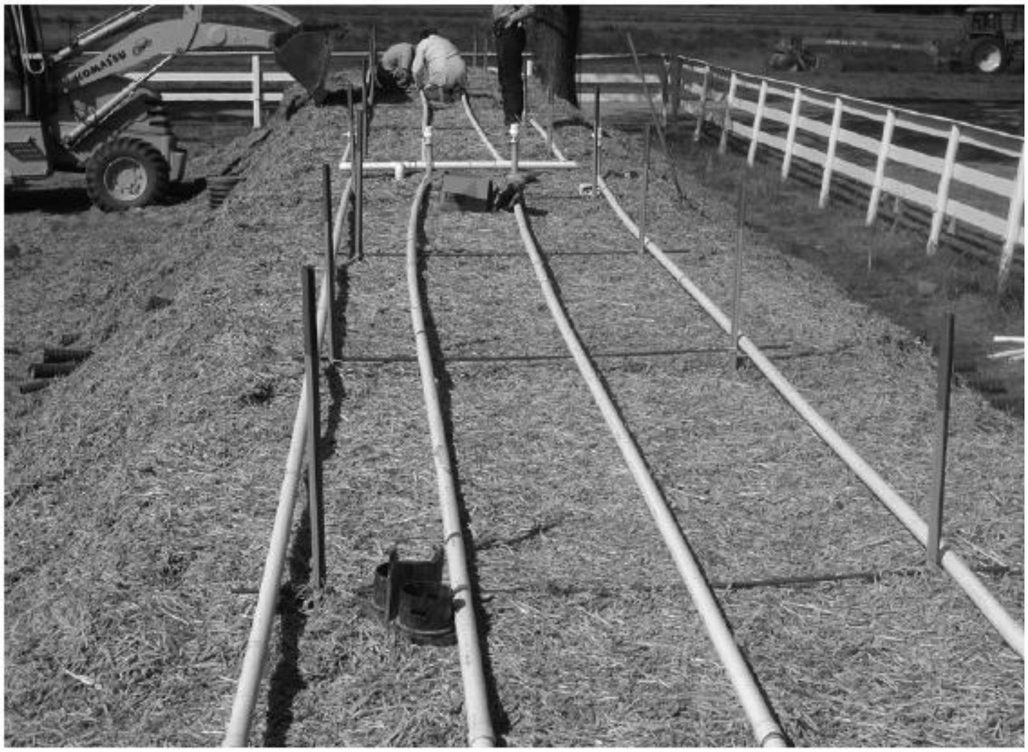

Figure 2: Distribution line spraying under round pipe.

The field trial filter mound was located on a Metamora sandy loam soil. These soils do not have a natural layer of lower permeability near the surface (siting is critical so that the topsoil becomes an integral part of the system and ponding at the base does not occur). The base of the filter mound was approximately 20 feet wide, but the area towards the top of the mound, receiving wastewater, was estimated to be approximately 15 feet. There were four sections of the filter mound, each 50 feet long, and each with a different media. Consequently, the total area receiving wastewater was approximately 3,000 square feet. At 1,000 gallons per day of production, the application rate was approximately 0.33 gallons per square foot per day. Figure 3 is a photograph of the completed bark section in the background and wood chip section in the foreground. Due to the complexity of the system and to maximize the chance of successful operation, it is essential that installation of the entire system is performed by a qualified contractor and in accordance to the developing standard.

Figure 3: Completed filter mound.

Wastewater Characteristics and Treatment Results

Starting in the fall of 2005, wastewater samples were routinely collected every 1 to 2 months from the following locations.

- Pumping chamber.
- In the filter mound, 1.5 feet below the distribution line.
- At the natural ground surface (approximately 3 feet below the distribution lines).
- Approximately 2 feet below natural ground surface.

Samples were analyzed for nitrogen (ammonia and nitrate), phosphorus, bacteria (measured as the surrogate E. coli), solids, oxygen demanding substances (chemical oxygen demand – COD), and two metals of interest to groundwater quality (manganese and iron).

The results show the bark is an effective treatment media for nitrogen, phosphorus, E. coli, and COD. Removals of all were routinely above 90%. The wood chip media provided only marginal treatment and little treatment occurred through the Styrofoam chips and pea stone. The remaining discussion is limited to the bark filter media because of its treatment effectiveness.

Field Trial Filter Mound System Operation

The field trial filter mound was operated for nearly 3 years. Approximately a year after installation the farm increased to 3 milkings per day. Shortly thereafter, suspended solids (primarily hair and undigested silage fibers) clogged the brush filter, pump screen, and distribution lines. To control the accumulation of solids in the wastewater, the following modifications were made and proved to be very effective.

- Installation of a pipe baffle at the exit of the first settling tank.
- Installation of slit-opening screen filter at the outlet of the second settling tank.
- Cleaning of the milking parlor sump (approximately 3-feet long, 2-feet wide, 18-inches deep) after every 9-12 milkings.

The bark filter mound section settled one foot during the first year of operation but thereafter, settling was insignificant. Digging into the bark below the distribution lines showed only minimal decomposition. Consequently, the usable life of the bark is expected to be at least four years.

In consideration of the experience with this field trial filter mound, the recommended maintenance schedule is presented in Table 1.

Table 1: Recommended maintenance schedule.

Procedure	Frequency	Estimated Time
Clean Filters	1/month	30 minutes
Replace Brush Filter	1/year	10 minutes
Clean out Sump in Milking Parlor	2/week	30 minutes
Visual Inspection of Mound	1/week	5 minutes
Pump Settling Tanks and Spread Liquid at Agronomic Rates	1/quarter	6 hours
Flush Distribution Lines	1/quarter	1 hour
Check of Pumps, Floats Hydrotek Valve, and Pump Controls (most likely by a contractor)	1/year	
Replenish/replace Bark	Once every 4-5 years	12 hours

Conclusions

The bark filter mound has the potential to be an effective alternative for managing milking center wastewater based on this proof-of-concept demonstration. Before broad application can be recommended, further research at dairy farms of different sizes, soil conditions, and management practices is needed to develop siting and design guidance and operation and maintenance procedures.

The workgroup has identified other potential demonstration sites and is actively seeking funding to install and monitor at least two more bark filter mound field trials in order to answer these questions.

Workgroup participants include: Thad Cleary, Geoff List, Joe Rathbun, and Angela Strong of Michigan Department of Environmental Quality; Stephen Davis, Suzanne Reamer of USDA Natural Resources Conservation Service; Ted Loudon, Del Mokma, Steven Safferman of Michigan State University; Dale Ledebuhr of Michigan Milk Producers Association; Ben Foster of Michigan Land Improvement Contractors of America; Gary Fritz of Clinton Conservation District; Dann Bolinger of Pioneer Seed Company (formerly Michigan State University Extension); Kristine Foight of USDA Agricultural Research Service (formerly Clinton Conservation District); Michelle Crook of Michigan Department of Agriculture; William Northcott of Michigan State University Extension.