RESEARCH ABSTRACT
ENVIRONMENT

Title: Effectiveness of vegetative environmental buffers to reduce swine facility emissions – **NPB #13-084** revised

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Scientific Abstract:
The vegetative environmental buffers (VEBs) has been proposed as a potentially cost effective strategy for reducing multiple air pollutants from livestock facilities. However, effectiveness of VEBs is highly variable and usually depends on site specific design. Lack of information on performance and technical guidelines are barriers to adoption of VEBs. The objective of this study was to investigate the effectiveness of VEBs under various design parameters (such as height and depth of VEBs) for mitigating emissions of multiple air pollutants including NH_3, H_2S, N_2O, CH_4, VOC, odor and PM_{10}, from a research swine barn in northeast Kansas. The long term goal of the study is to establish the overall performance, identify the key design parameters and contribute to the development of guidelines of VEBs for its application in mitigating air emissions from swine production facilities. Four scenarios of VEBs of Red Cedars were established: no VEB as the background, one row of trees at 8 feet height, one row of trees at 12 feet height, and paralleled three rows of trees at 8 feet height. The line of the VEBs was 150 feet long and was 120-150 feet away from the ventilation fans of the swine barn. Six air sampling locations were set up, at 10 feet, 110 feet, 160 feet, 210 feet, 260 feet, and 310 feet away from the ventilation fans of the swine facility respectively. Gas concentrations were measured continuously using an INNOVA1412 photoacoustic multi-gas analyzer and a pulsed fluorescence H_2S analyzer in a sequential manner from sampling points 1 to 6 through a multi-point auto sampling system. For each VEB scenario, at least 10 days of continuous measurements were taken. The PM_{10} concentrations were measured continuously at sampling points 2, 3 and 6 using tapered element oscillating microbalances (TEOM). VOC concentrations were measured using a handheld VOC meter and odors were measured using a nasal ranger at all of the 6 sampling locations. The gas concentration data points at the 6 sampling locations were screened first by precipitation and then by wind direction using hourly local weather data. The data points were included in data analysis only when the sampling locations were at downwind and under influence of the swine facilities. The concentrations at various downwind distances were analyzed to demonstrate the patterns of transport and diffusion of air pollutants from the swine barns and the effect of the VEBs. The results showed that the VEBs were effective in reducing downwind concentrations of H_2S, NH_3, N_2O, and CH_4. And the 3-row-8' VEB was most effective as comparing with the other two designs. When wind speeds were lower than 1.5m/s, the 3-row-8' VEB was able to reduce downwind concentrations by up to 60%, 33%, 26%, and 51%, for H_2S, NH_3, N_2O, and CH_4, respectively. No reduction on VOCs and odor was observed possibly due to the limitation of the measuring instrumentations and approaches. As expected, how much air pollutants can be reduced depends on the thickness of the VEBs, while the downwind distance from the VEBs within which the reduction is effective depends on the height of the VEBs (the barrier height). For H_2S,

the reduction was no longer effective when the downwind distance was beyond 160 feet or 20 times the barrier height from the 3-row-8' VEB. Moreover, the reduction effectiveness for H_2S was sensitive to wind speed. As wind speed increased, the reduction effectiveness decreased. When wind speeds were larger than 3.5 m/s, higher downwind H_2S concentrations were observed with VEBs (especially, for the single-row VEBs) as compared with the control scenario (no VEB), which could be due to unwanted turbulence or downwash effect caused by the VEBs at high wind speeds. The effect of VEBs on downwind PM_{10} concentrations was more complex than expected. On the one hand, 23% PM_{10} reduction across the 3-row-8' VEB was observed; on the other hand, higher downwind PM_{10} concentrations were observed with VEBs as compared with the control scenario (no VEB), which could be due to reduced air movement associated with the VEBs. Further investigation is needed to confirm this observation. It is anticipated that further increasing the thickness of the VEBs could result in further reduced downwind PM_{10} concentrations, and thus could secure the reduction of downwind PM_{10} concentrations as compared with the control scenario (no VEB).