STATE OF WISCONSIN
Department of Health Services
Division of Public Health
Bureau of Environmental and Occupational Health

Memo

To: Ken Johnson, Regional Water Leader, WDNR SCR

From: Robert Thiboldeaux, PhD, Toxicologist, Wisconsin Division of Public Health

CC: Lloyd Eagan, Director, WDNR SCR
Mark Cain, Wastewater Engineer WDNR SCR
Andrew Craig, WDNR Bureau of Watershed Management

Date: February 17, 2011

Re: Public Health setbacks for manure spray irrigation

As part of the Environmental Assessment and permit review for the proposed Rock Prairie Dairy, you have asked the Bureau of Environmental and Occupational Health whether the proposed setbacks for the manure spray irrigation system are sufficient from a public health perspective. Wisconsin code allows for a 500 foot setback to inhabited dwellings unless aesthetic and public health impacts demand otherwise.[1] As the practical experience among state regulatory agencies with manure spray irrigation is limited, we have reviewed current literature and consulted with experts in other states.

The Rock Prairie Dairy proposes land application of liquid manure using center pivot sprinkler technology on quarter section areas. The sprinkler application areas are circular; injection has been proposed for the squared corners of each quarter section. The relevant public health question hinges on determining whether populations will be directly exposed to manure spray irrigation drift, and the risk corresponding to that exposure. Risk is dependent upon:

- The presence of harmful organisms in applied material, *i.e.* bacterial, viral, and parasitic fecal pathogens in untreated liquid manure.
- The presence and emission, to air, of Hazardous Air Pollutants from spray-applied material. Hydrogen sulfide and ammonia are the most commonly identified CAFO-related HAPs.
- Concentration of the applied material, *i.e.* dilution and fecal pathogen load.
- Exposure: drift radius, distance to source, and frequency of exposure.

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[1] Wisc. Admin. Code ch NR 214. LAND TREATMENT OF INDUSTRIAL LIQUID WASTES, BY–PRODUCT SOLIDS AND SLUDGES. http://legis.wisconsin.gov/rsb/code/nr/nr214.pdf

If center pivot irrigation is approved for the Rock Prairie Dairy, then engineering detail and best management practices should be followed to minimize risk to the public. Robert Dungan with the USDA has provided a detailed review of the fate and transport of manure bioaerosols, including those associated with manure spray irrigation.[2] Dungan, in his 2010 review, notes that while land application of untreated liquid manures increase the chances of aerosolizing microorganisms, few papers outside of municipal wastewater research have addressed the risk to humans associated with land application of fecal wastes. Mechanical similarities of manure spray irrigation to other types of waster land application are used in this assessment, and could be used to inform CAFO policy and permitting decisions.

The Idaho Department of Environmental Quality has published a *Microbial Risk Assessment and Fate and Transport Modeling of Aerosolized Microorganisms at Wastewater Land Application.*[3] The Idaho DEQ risk assessment makes the following conclusions:

- Fine droplets may contribute to microbial risk under high wind conditions.
- Droplets larger than 200 micrometers do not transport significantly beyond the application area and may be neglected when analyzing risk at typical buffer zone distances.
- Deposition of droplets and aerosol containing microbial pathogens on surfaces such as produce may be a significant pathway for exposure under windy conditions. Thus, if wastewater loadings are elevated, high-wind cut-off restrictions should be considered.
- Worst-case conditions that lead to the greatest exposure and risk of infection are nighttime low-wind stable conditions, which maximize the inhalation pathway, and high-wind conditions, which maximize the deposition and produce ingestion pathway.

Exposure to airborne or deposited pathogens. With regard to deposition of aerosols, the infective dosages of common fecal pathogens are normally thought of in terms of ingestion rather that inhalation. This makes accurate risk assessment via inhalation difficult even when the airborne concentration is known. Infective inhaled exposure, depending on the organism, could be directly to the lungs, or could be to the gut where inhaled pathogens are secondarily swallowed. Given adult inhalation rates of 25,000 L air/d,[4] the presence of bioaerosols implies a risk of significant inhalation exposure. Similarly, where airborne pathogens are deposited on ready-to-eat crops or on surfaces handled by adults or young children, accumulation could occur throughout the irrigation period, and risk of infection would be dependent upon the

[2] Dungan R. S. 2010. BOARD-INVITED REVIEW: Fate and transport of bioaerosols associated with livestock operations and manures. J. Anim Sci. 88:3693-3706.
[3] Hardy R, Schilling K, Fromm J, Dai X, Cook M. 2006. Technical Background Document: Microbial Risk Assessment and Fate and Transport Modeling of Aerosolized Microorganisms at Wastewater Land Application Facilities in Idaho. Idaho Department of Environmental Quality.
[4] Derelanko MJ, Hollinger MA (eds.). 2002. Handbook of Toxicology, 2nd ed. CRC Press.

concentration of viable pathogen on the food or handled surface. In the case of *E. coli* O157:H7, the infectious dose has been estimated to range from 1 to 100 colony-forming units.[5] For *Salmonella spp.*, an infective dose may be as low as 15-20 cells.[6]

The U.S. Centers for Disease Control has developed worker safety guidelines applicable to the range of land-applied municipal, industrial, and agricultural wastes.[7] In addition to waste worker hygiene practices, training, and equipment that minimize occupational safety risks, the CDC guidance recommends several *Environmental Practices to Prevent and Minimize Occupational Exposures.* These recommendations would apply equally to avoiding exposure to the public adjacent to a manure spray irrigation site:

- Where feasible, substitute Class A biosolids for Class B biosolids.[8]
- Monitor the source material to assure Class A or Class B standards prior to land application operations.
- Monitor stored biosolids prior to application to assure that the biosolids are properly stabilized and that unacceptable regrowth or cross-contamination from substandard material has not occurred.
- Where local conditions permit, inject or incorporate biosolids below the soil.
- On windy days, avoid spreading or disturbing dry biosolids that would create dust.
- On windy days, avoid spreading biosolids by high-pressure spray.
- Avoid unnecessary mechanical disturbance and contact with land-applied Class B biosolids during the period when public access is restricted.
- Equip heavy equipment used at storage and application facilities with sealed, positive-pressure, air-conditioned cabs that contain filtered air-recirculation units.
- Monitor worker exposures when adjusting precautions to address site-specific issues.

Division of Public Health conclusions and recommendations. Interrupting human exposure to feces, with its attendant risk of infection by bacterial, viral, and parasitic pathogens, is at the foundation of public health practice.

- Based on available literature, it appears that a 500 foot setback from irrigation nozzles to receptors for the land application of liquid manure will be adequate to avoid infection *if* the system is designed to (1) substantially

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[5] Paton, J.C. and Paton, A.W. 1998. Pathogenesis and diagnosis of shiga toxin-producing *Escherichia coli* infections. Clin. Microbiol. Reviews. 11(3):450-479.

[6] FDA. 2009. Foodborne Pathogenic Microorganisms and Natural Toxins Handbook. U.S. Food and Drug Administration. http://www.fda.gov/Food/FoodSafety/default.htm

[7] DEPARTMENT OF HEALTH AND HUMAN SERVICES. 2002. Guidance for Controlling Potential Risks to Workers Exposed to Class B Biosolids Centers for Disease Control and Prevention. National Institute for Occupational Safety and Health. Publication 2002.149

[8] See Wisc. Admin. Code ch NR 204.07. DOMESTIC SEWAGE SLUDGE MANAGEMENT http://legis.wisconsin.gov/rsb/code/nr/nr204.pdf

reduce the microbial load of the applied material,[9] using some form of treatment such as aerobic or anaerobic digestion, lime treatment, or composting; (2) deliver spray droplets greater that 200 μm mean diameter to minimize aerosolization and drift, and (3) that the irrigation schedule be optimally managed with regard to weather conditions and time of day. DHS recognizes that manure treatment may be outside of the scope of the current Rock Prairie Dairy proposal.

- In addition to steps to avoid infectious exposure to off-site receptors, land application of manure liquid must be managed to avoid unacceptable off-site levels of hazardous air pollutants, particularly hydrogen sulfide and ammonia. Since manure injection techniques are currently proposed for part of the project, it is noteworthy that injection techniques are among the most effective for the control of both odor and HAP emissions.[10]

- NR 214 allows for the regulation of land-applied wastes with regard to aesthetic impacts. If manure spray irrigation is permitted as part of the Rock Prairie Dairy project, DHS recommends that the land application of manure liquids be managed to minimize impacts, particularly nuisance odor, that might inhibit the full use and enjoyment of neighboring private residences. Nuisances, though qualitative, are important to those perceiving the nuisance, and raise the potential for land-use conflicts. Attention to both technical detail (treatment and storage of manure; application techniques)[11] and landowner relationships in avoiding nuisance conflicts will benefit the Rock Prairie Dairy project.

- If the center pivot sprinkler technology is approved for the Rock Prairie Dairy project, DHS recommends that the permit include regulatory means, such as the monitoring of both applied liquid manure and deposition in downwind areas, to *assure* that any permit conditions to avoid aerosolization, drift, and odor control are met.

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[9] Hardy *et al.* (referenced above) conclude that *E. coli* loadings less than 1000 to 10,000 colony-forming units/L in land-applied wastewater represent minimal risk beyond a typical 300 foot buffer zone.

[10] Burton, CH. 1997. Manure management - treatment strategies for sustainable agriculture. Silsoe Research Institute, Silsoe, Bedford, UK. *In* Casey KD, Bicudo JR, Schmidt DR, Singh A, Gay SW, Gates RS, Jacobson LD, Hoff SJ. 2006. Air quality and emissions from livestock and poultry production/waste management systems. Pp. 1–40. In J. M. Rice, D. F. Caldwell, and F. J. Humenik (eds). Animal Agriculture and the Environment. National Center for Manure and Animal Waste Management White Papers. ASABE, St. Joseph, Michigan.

[11] Kranz WL, Koelsch RK, Shapiro CA. 2007. Application of Liquid Animal Manures Using Center Pivot Irrigation Systems. Univ. Nebraska Extension. Publication EC778.