Health Hazards of Industrial Wood Waste

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Howard County Task Force Meeting, October 7, 2014

Health Hazards

Industrial mulch processing results in increased health risks

- Infectious agents – fungi and bacteria
- Wood dust – allergic and mucosal effects
- Wood dust – cancer
- Exposure and risk

Microorganisms and Dispersion Distance

- High levels of molds, fungi, thermophilic fungi, bacteria and other microorganisms (concentrations of $>10^4$ colony forming units) could be measured >300 m (>1000 feet) in residential air neighboring outdoor organic waste (Am. J. Ind. Med. 46:381–385, 2004)
- Examples of infectious agents have been shown to be dispersed at distances >5 km (J Infect Dis. 2006 Jan 1;193(1):102-11)

Example of Health Effects on Nearby Residents

- Health effects to a residential area from environmental outdoor pollution hundreds of meters from a composting site (Occup Environ Med 2003;60:336–342)

		Bioaerosol pollution in residential air‡ up to $>10^3$ CFU m^{-3} air		Duration of present residency >5 years	
Reported health complaints§	SS¶	OR**	95% CI††	OR	95% CI
Respiratory tract					
Frequency of colds >5×/year	209	1.94	0.65 to 6.78	4.72	1.19 to 31.83
Bronchitis	210	3.02	1.35 to 7.06	2.91	1.29 to 7.03
Waking up due to coughing	202	2.70	1.23 to 6.10	2.51	1.19 to 5.53
Wheezing	207	1.96	0.84 to 4.82	2.95	1.22 to 7.99
Shortness of breath at rest	203	3.99	1.31 to 15.19	1.50	0.56 to 4.49
Coughing on rising or during the day‡‡	210	2.67	1.17 to 6.10	1.51	0.69 to 3.29
Shortness of breath after exertion	205	4.23	1.74 to 11.34	2.03	0.90 to 4.91
Eyes and general health					
Itching eyes >10×/year	206	1.35	0.61 to 3.05	2.85	1.31 to 6.50
Smarting eyes >10×/year	205	2.44	1.02 to 6.22	2.42	1.06 to 5.86
Nausea or vomiting >5×/year	204	2.65	0.87 to 9.97	4.10	1.28 to 18.44
Excessive tiredness >5×/year	200	2.80	1.22 to 6.72	1.83	0.84 to 4.11
Shivering	210	4.63	1.44 to 20.85	3.67	1.32 to 12.20
Joint trouble >10×/year	207	1.27	0.54 to 3.07	1.52	0.65 to 3.71
Muscular complaints >10×/year	201	1.17	0.47 to 2.99	1.39	0.55 to 3.86

Summary

- Mulch processing can pose risks for human health due to increased exposure of infectious and hazardous agents. These include
  - infections due to fungal spores
  - Increased risk of dermatitis, allergic respiratory effects, and mucosal and nonallergic respiratory effects
  - Increased risk of cancer, including nasal, lung, and Hodgkin lymphoma
- Exposure risks can occur at significant distances from waste processing area

Woodbine Case Study: Possible Effects of Exposure to Manufacture of Mulch

October 7, 2014

Presentation to the Task Force
to Study Mulching, Composting, and Wood Processing

James Nickel
4904 Green Bridge Rd.,
Dayton, MD 21036

Background of Woodbine Case Study

- Unapproved facility had operated for several years
- Residents submitted at least 17 requests for zoning inspection
- Complaints identified possible health and quality of life issues
- Self-initiated an informal study
  - Researched known health issues of wood and mulch
  - Mapped the location of residents who submitted complaints
  - Attempted to get Howard County Health Department involved
- Oak Ridge Farms was temporarily shut down, but not due to health or quality of life issues.
  - They were shut down because mulch manufacturing was not allowed on RC zoned property
  - They had two refuse/recycling/shipping containers not allowed on RC zoned property

Known Health Issues

Respiratory and Cancer

Mulch, Fungi and Wood Dust
Peer Reviewed Studies

- While mulch is generally considered "safe", the context is typically residential application, not acres of mulch shredded and turned multiple times.

  Five studies that begin to touch on the potential consequences.

  - Fulminant Mulch Pneumonitis: An Emergency Presentation of Chronic Granulomatous Disease
    - Infectious Diseases Society of America
  - Pulmonary responses after wood chip mulch exposure.
    - US National Library of Medicine, NIH
  - Binding of Aspergillus fumigatus spores to lung epithelial cells and basement membrane proteins: relevance to the asthmatic lung.
    - I.M. Bromley and K. Donaldson
  - Fungal spores: hazardous to health
    - US National Library of Medicine, NIH
  - Adverse Human Health Effects Associated with Molds in the Indoor Environment
    - American College of Occupational and Environmental Medicine

Wood Dust: Hazardous to Health

- "Cancers have been associated with wood dust exposure. The National Institute for Occupational Safety and Health (NIOSH) considers both hardwood and softwood dust to be potentially carcinogenic to humans. *The three types of cancers associated with wood dust exposure are nasal and sinus cavity cancer, lung and other cancers, and Hodgkin's disease.* The wood and cancer relationship was studied by Milham (1974), who conducted a mortality study involving the AFL-CIO United Brotherhood of Carpenters and Joiners of America. This study supports the hypothesis that wood contains carcinogenic agents. The cancer mortality patterns found were:
  - Excess leukemia lymphoma group cancers in millwrights, mill workers, and lumber and sawmill workers
  - Excess gastrointestinal cancer in pile drivers.
  - Excess lung cancer in acoustical tile applicators and insulators. Excess lung and stomach cancer in construction workers with the greater excesses found in workers in major urban areas.
- Hodgkin's disease has also been associated with wood dust."

Wood Dust Exposure Hazards AEX-595.1-2006
Thomas L. Bean, in collaboration with Timothy W. Butcher and Timothy Lawrence
Ohio State University

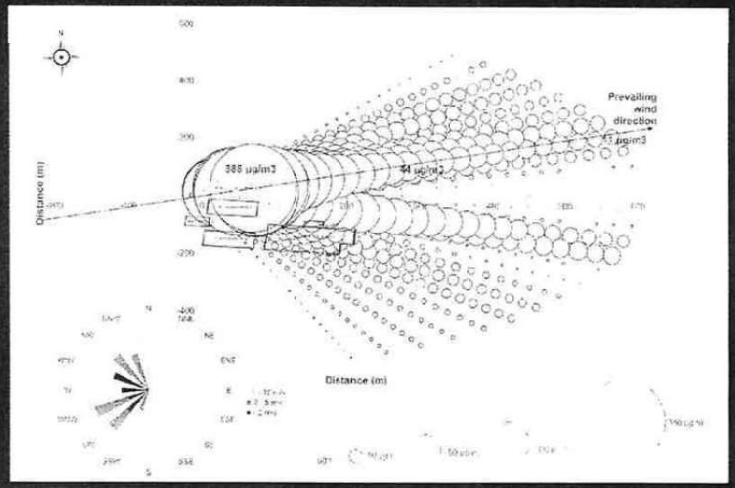
Mapping the Data

Significant Medical Literature of Effects of Emissions from Waste Facilities

- Chalvatzaki E, Aleksandropoulou V, Glytsos T, Lazaridis M. The effect of dust emissions from open storage piles to particle ambient concentration and human exposure. Waste Manag. 2012 Dec;32(12):2456-68
- Nadal M, Inza I, Schuhmacher M, Figueras MJ, Domingo JL. Health risks of the occupational exposure to microbiological and chemical pollutants in a municipal waste organic fraction treatment plant. Int J Hyg Environ Health. 2009 Nov;212(6):661-9.
- Domingo JL, Nadal M. Domestic waste composting facilities: a review of human health risks. Environ Int. 2009 Feb;35(2):382-9.
- Herr CE, Nieden Az Az, Stilianakis NI, Eikmann TF. Health effects associated with exposure to residential organic dust. Am J Ind Med. 2004 Oct;46(4):381-5.
- Herr CE, zur Nieden A, Stilianakis NI, Gieler U, Eikmann TF. Health effects associated with indoor storage of organic waste. Int Arch Occup Environ Health.
- Herr CE, Zur Nieden A, Jankofsky M, Stilianakis NI, Boedeker RH, Eikmann TF. Effects of bioaerosol polluted outdoor air on airways of residents: a cross sectional study. Occup Environ Med. 2003 May;60(5):336-42.

Dust Emissions and Distance

- Dust emissions from open piles of mulch / organic waste can be measured at distances >500 m (>1500 feet) (Waste Management 32 (2012) 2456–2468)



Studies of mulch related infections in medical literature

1: Ameratunga R, Woon ST, Vyas J, Roberts S. Fulminant mulch pneumonitis in undiagnosed chronic granulomatous disease: a medical emergency. Clin Pediatr (Phila). 2010 Dec;49(12):1143-6. doi: 10.1177/0009922810370057. Epub 2010 Aug 19.

2: Siddiqui S, Anderson VL, Hilligoss DM, Abinun M, Kuijpers TW, Masur H, Witebsky FG, Shea YR, Gallin JI, Malech HL, Holland SM. Fulminant mulch pneumonitis: an emergency presentation of chronic granulomatous disease. Clin Infect Dis. 2007 Sep 15;45(6):673-81. Epub 2007 Aug 8.

3: Veillette M, Cormier Y, Israël-Assayaq E, Meriaux A, Duchaine C. Hypersensitivity pneumonitis in a hardwood processing plant related to heavy mold exposure. J Occup Environ Hyg. 2006 Jun;3(6):301-7.

4: Nagai K, Sukoh N, Yamamoto H, Suzuki A, Inoue M, Watanabe N, Kuroda R, Yamaguchi E. [Pulmonary disease after massive inhalation of Aspergillus niger]. Nihon Kokyuki Gakkai Zasshi. 1998 Jun;36(6):551-5. Japanese.

5: Weber S, Kullman G, Petsonk E, Jones WG, Olenchock S, Sorenson W, Parker, Marcelo-Baciu R, Frazer D, Castranova V. Organic dust exposures from compost handling: case presentation and respiratory exposure assessment. Am J Ind Med. 1993 Oct;24(4):365-74.

6: Johnson CL, Bernstein IL, Gallagher JS, Bonventre PF, Brooks SM. Familial hypersensitivity pneumonitis induced by Bacillus subtilis. Am Rev Respir Dis. 1980 Aug;122(2):339-48. PubMed PMID: 6774642.

Dozens of examples of scientific articles from throughout the world related to infectious agents in mulch.

Particularly important and dangerous for immune compromised individuals.

Recent study found that of patients with fulminant mulch pneumonitis, half of those died of due to infection and underlying kidney disease.

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Health Effects of Wood Dust

From Centers for Disease Control and Prevention:

"Exposure to wood dust has long been associated with a variety of adverse health effects, including dermatitis, allergic respiratory effects, mucosal and nonallergic respiratory effects, and cancer. The toxicity data in animals are limited, particularly with regard to exposure to wood dust alone; there are, however, a large number of studies in humans."

1988 CDC OSHA PEL Documentation

Health Effects of Wood Dust

From *Ann Agric Environ Med* 2010, **17**, 29–44.

- **Abstract:** This paper reviews the literature on associations between dry wood dust exposure and non-malignant respiratory diseases … The results support an association between dry wood dust exposure and asthma, asthma symptoms, coughing, bronchitis, and acute and chronic impairment of lung function. In addition, an association between wood dust exposure and rhino-conjunctivitis is seen across the studies."

Dermatitis

- "Dermatitis. There are a large number of case reports, epidemiological studies, and other data on the health effects of wood dust exposure in humans. Dermatitis caused by exposure to wood dusts is common, and can be caused either by chemical irritation, sensitization (allergic reaction), or both of these together. As many as 300 species of trees have been implicated in wood-caused dermatitis."

1988 CDC OSHA PEL Documentation

Asthma

- "Allergic respiratory effects. Allergic respiratory responses are mediated by the immune system, as is also the case with allergic dermatitis. Many authors have reported cases of allergic reactions in workers exposed to wood dust … Asthma is the most common response to wood dust exposure"

1988 CDC OSHA PEL Documentation

Other Lung Effects

- "Mucosal and nonallergic respiratory effects (changes in the structure and function of the nasal mucosa and respiratory tract that are caused by exposure to wood dust). These changes include nasal dryness, irritation, bleeding, and obstruction; coughing, wheezing, and sneezing; sinusitis; and prolonged colds."

1988 CDC OSHA PEL Documentation

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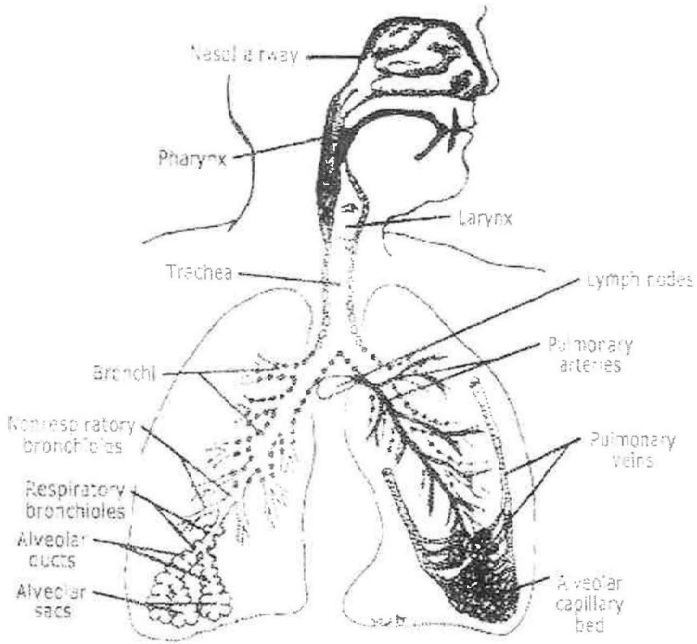
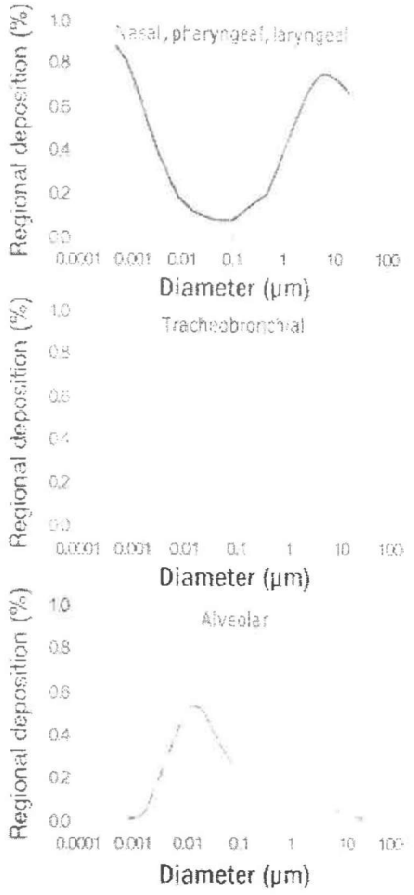
Cancer

- "The association between occupational exposure to wood dust and various forms of cancer has been explored in many studies and in many countries." (CDC)
- "There is *sufficient evidence* in humans for the carcinogenicity of wood dust. Wood dust causes cancer of the nasal cavity and paranasal sinuses and of the nasopharynx. Wood dust is *carcinogenic to humans (Group 1).*" (WHO, IARC)

Fig. 4.1 Deposition of inhaled particles in the human respiratory tract during nasal breathing





From ... Drawing courtesy of J. Harkema. Reproduced with permission from Environmental Health Perspectives

Nasal Cancer

- "Summary of evidence for nasal and sinus cavity cancers. The literature clearly demonstrates an association between wood dust exposure and nasal cancer. "
- English studies first identified this link by showing a 10- to 100 times-greater incidence of nasal adenocarcinoma among those exposed to wood dust than in the general population.
- "In the United States, three studies have reported a fourfold risk of nasal cancer or adenocarcinoma … and wood dust exposure."

1988 CDC OSHA PEL Documentation

Lung Cancer

- "Pulmonary cancer. A number of studies investigating the association between wood dust exposure and the development of lung cancer have been conducted."
- Milham (1974/Ex. 1-943) found a significant excess of malignant tumors of the bronchus and lung in workers who exposed to wood dust.

1988 CDC OSHA PEL Documentation

Hodgkin Lymphoma

- "Hodgkin's disease. Milham and Hesser concluded, on the basis of a case-cohort study of 1,549 white males dying of this disease … that there was an association between Hodgkin's disease and exposure to wood dust."
- Other studies concluded that men working in the wood industries in the eastern United States as well as Washington state were at special risk for Hodgkin's disease.

1988 CDC OSHA PEL Documentation

Other Cancers

- "Other cancers. NIOSH (1987a/Ex. 1-1005) concluded that the data on the relationship between occupational exposure to wood dust and the development of cancers other than nasal, Hodgkin's disease, or lung cancers are insufficient and inconclusive."
- Emerging evidence that risks of oral cancer increase with exposure to wood dust.

1988 CDC OSHA PEL Documentation

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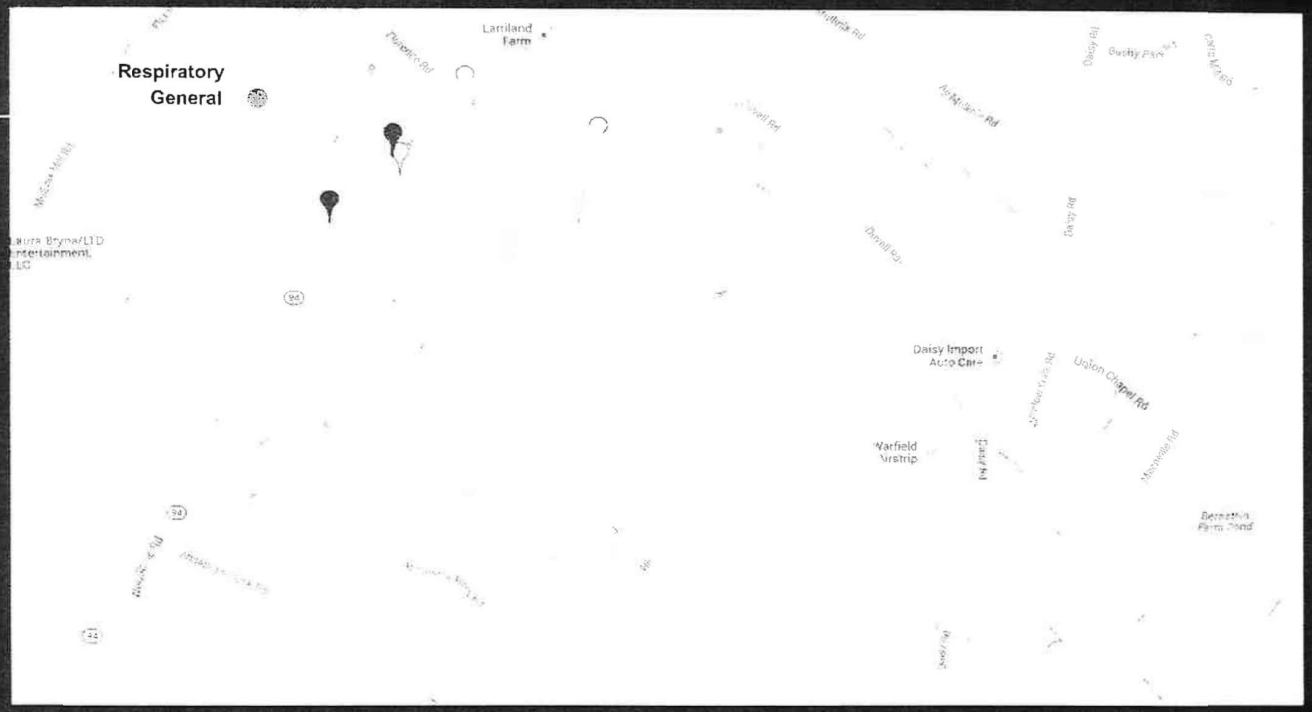
Requests to DPZ for Zoning Inspections Oak Ridge Farms

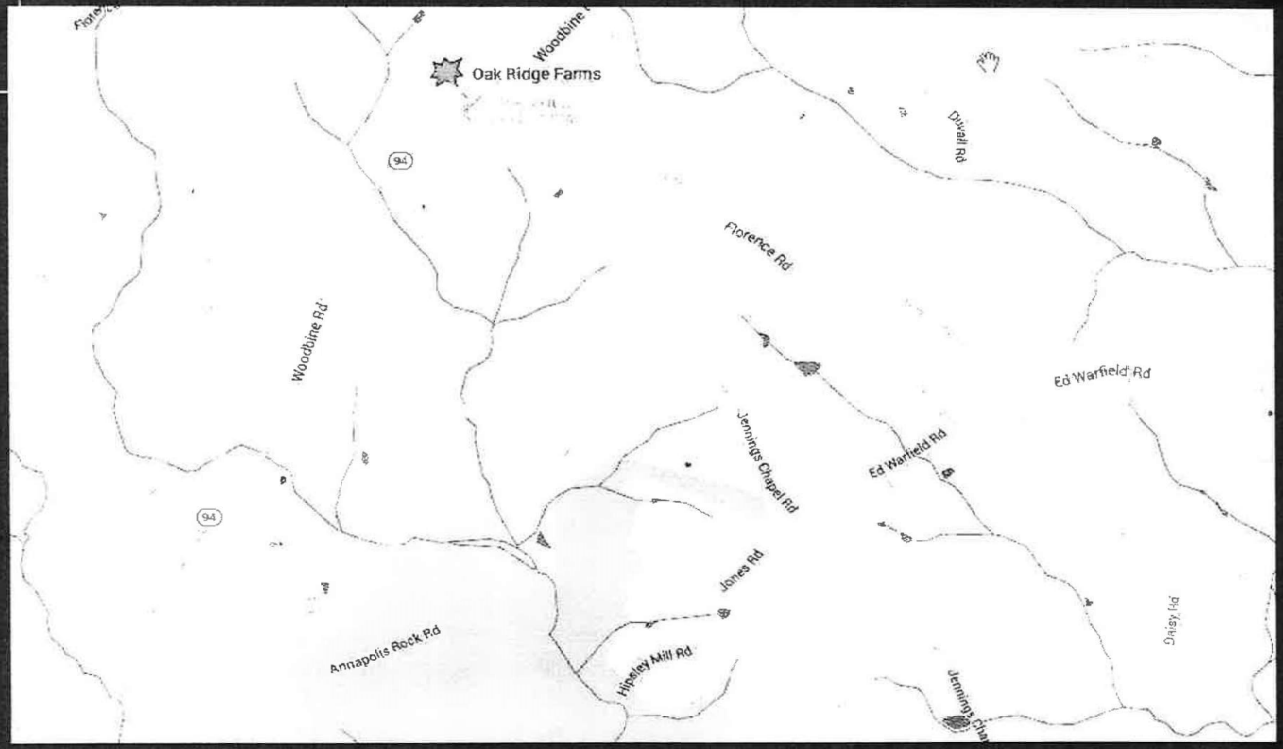
- Residents of Woodbine made 17 requests to DPZ [Nov-Dec 2013]
- 9 Requests explicitly stated respiratory related issues
  - All with health issues were age 51 and older
  - 2 residents under care at Johns Hopkins were tested and found to have wood particulate matter in their respiratory system
  - Distance between the Oak Ridge facility and most distant health issue was over 3 miles [airborne fungi spores can travel longer distances than wood dust]
- 8 Requests were of a general nature
  - Traffic
  - Pollution & contaminants
  - Decline in air quality
  - Odor
  - Noise, e.g., "louder than a combine"
  - Residents can feel the vibrations of the grinding equipment
  - Occurring 6 or 7 days a week

Inspection Requests - Clustering



Prevailing North West Winds Affecting Residents to over 3 miles
Florence and Jennings Chapel Roads may provide "corridors" for wind

Oak Ridge Farms Mulch to Woodbine Road



A Glimpse into Large Scale Mulch Production

"Typical" vs. Reality

- "Typical" Distribution of Wood Dust
  - Usually dissipates in 300-400 ft
  - Setbacks of 500 ft. would usually be enough
- Why is Woodbine different?
  - Oak Ridge Farms sits approximately 100 ft above the area downwind
  - Oak Ridge Farms processes a LOT of wood mulch. We don't know how much
    - Operated out of MD and Howard County regulations
    - Operated a large majority of the year
    - The 17 inspection requests were submitted in Nov-Dec 2013
    - Never reported accepted/recycled/marketed waste

Preliminary CY-2013 Data
Five Largest NWWRFs

Facility Name	Waste Marketed* Tons	Yards Marketed (4 yards/ton)	Yards Shredded (x5)	Yards Turned (x2)	Yards Sold (x1)	Yards Cumulative
Grant County Mulch Facility	116,598	466,392	2,331,960	932,784	466,392	2,731,136
[illegible] Recyclery	43,609	174,436	872,180	348,872	174,436	1,305,468
Recycled Green Industries, LLC	40,844	163,376	816,880	326,752	163,376	1,307,008
Wirtz & Daughters, Inc.	36,665	146,660	733,300	293,320	146,660	1,173,280
Garrett County Mulch	36,131	144,524	722,620	289,048	144,524	1,156,192
TOTAL	273,847					

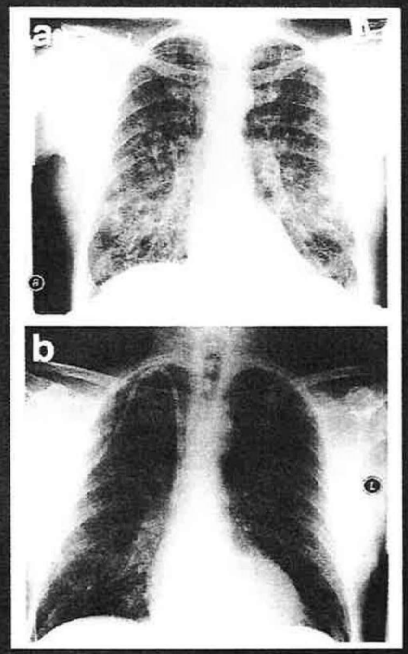
- There are 37 NWWRFs in Maryland
- All 37 marketed 427,470 tons in CY-2013
- These 5 facilities account for 64% of all production

Note: Exposure to hardwood dust should be limited to 1 mg per cubic yard

Infectious agents example: acute fungal pneumonia

At presentation

2 months later



A 69 year old retired man with no significant medical history. Developed acute pneumonia after spreading tree bark mulch.

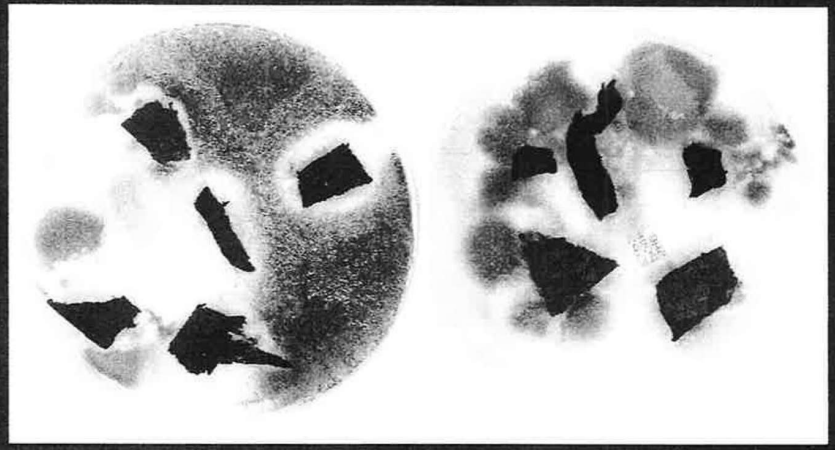
Hospitalized, developed kidney injury and failure. Remained dialysis dependent and housebound.

Died of sepsis 10 months later.

Inhalation of fungal spores from mulch was determined be the likely route of infection.

Medical MycologyCaseReports2(2013)125–127

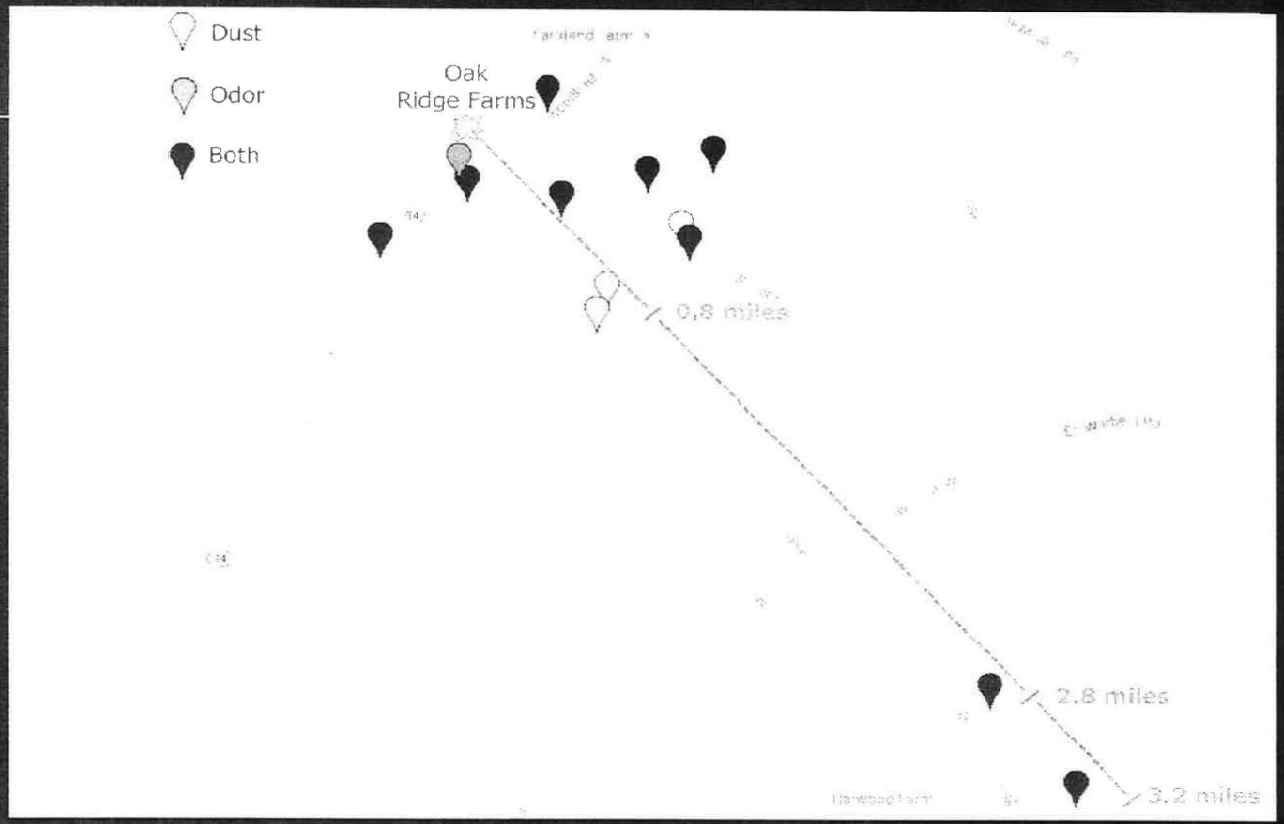
Infectious agents example: acute fungal pneumonia



Mulch culture showing growth of microogranisms (Aspergillus fumigatus, Rhizopus spp., Sporobolomyces spp. and bacteria)

Medical MycologyCaseReports2(2013)125–127

Dust and Odor Distribution



Woodbine Case Study Summary

- Woodbine Residents have been unwitting participants in a "test" resulting from operations by Oak Ridge Farms, LLC
- Indications are that Oak Ridge Farms was a large scale operation
- In a relatively short period of time, residents and livestock were showing symptoms commonly associated with fungal spore contamination and wood dust inhalation
- The clustering of those affected in line with the path of prevailing winds
- Residents experienced wood dust and odors at distances greater than three miles