Letter Health Consultation

WESTERN FUMIGATION SITE

4165 PRUDEN BOULEVARD

SUFFOLK, VIRGINIA

Prepared by
Virginia Department of Health

JULY 31, 2012

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

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In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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LETTER HEALTH CONSULTATION

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COMMONWEALTH of VIRGINIA
Department of Health
KAREN REMLEY, MD, MBA, FAAP
STATE HEALTH COMMISSIONER
P O BOX 2448
RICHMOND, VA 23218
TTY 7-1-1 OR
1-800-828-1120

Charles L. Turner
Director, Air Quality Monitoring
VA Department of Environmental Quality
629 East Main Street
PO Box 1105
Richmond, VA 23218

Dear Mr. Turner:

This letter is in response to your request for the Virginia Department of Health (VDH) to examine potential health risks associated with the fumigant, methyl bromide, at the Western Fumigation facility in Suffolk, Virginia. Thank you for providing VDH with air sampling information related to this facility. Through a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), we completed an evaluation of the air sampling information you provided to VDH on March 24, 2011 (Table 1). The purpose of this letter is to conduct a review of the air sampling information and evaluate the potential public health implications of methyl bromide used at this facility.

BACKGROUND

Western Fumigation, located at 4165 Pruden Boulevard in Suffolk, Virginia, uses methyl bromide to treat wood commodities (Figure 1) (1). The processing area is a large warehouse that is loaded on Tuesday with commodities to be treated with fumigants. The warehouse is then fumigated with methyl bromide on Wednesday and Thursday. On Friday the warehouse is aerated (mechanically ventilated) for a minimum of four hours until the concentration of methyl bromide is less than 98% of the initial concentration (2). Aeration vents extend out of the side of the warehouse on both the southern and eastern side. Western Fumigation is surrounded by an open field on the eastern edge, an industrial facility to the north, a technical center and a school yard to the northwest, a parking lot to the west, and apartments to the south. To the east is a residential area approximately 700 yards away and a farmhouse 160 yards away.

The Virginia State Air Pollution Control Board became aware of Western Fumigation after receiving a letter sent to the Board suggesting that fumigation facilities in Suffolk used control equipment that should be evaluated. The Air Pollution Control Board directed Virginia Department of Environmental Quality (DEQ) to perform an air quality study to determine if Virginia's Significant Ambient Air Concentration (SAAC) for one-hour average concentration of methyl bromide (950 micrograms/cubic meters ($\mu g/m^3$)) was being exceeded. The SAAC is the concentration of a toxic pollutant in the ambient air that, if exceeded, may have an adverse effect

to human health. VDH was asked to evaluate the air quality study and determine if methyl bromide use at this facility had any potential public health implications.

METHYL BROMIDE

Methyl bromide is a colorless, odorless nonflammable gas occurring naturally in the environment at low levels. Methyl bromide is manufactured to make other chemicals and is also used extensively as a fumigant. As a fumigant methyl bromide is used to control a number of pests including rodents, insects, and fungi in warehouses, agricultural fields, and shipping containers. Methyl bromide exposure occurs primarily through inhalation. Workers who fumigate homes, fields, and commodities may be exposed to higher than background levels of methyl bromide (3).

Inhalation of methyl bromide can cause headaches, dizziness, fainting, apathy, weakness, confusion, speech impairment, visual effects and numbness. Inhalation of higher concentrations of methyl bromide can cause paralysis, lung injury, kidney damage, and injury to the heart. There are no reports of reproductive or developmental effect of methyl bromide exposure. The U.S. Environmental Protection (EPA) has determined that methyl bromide is not classifiable as to its human carcinogenicity (3,4). Long-term inhalation carcinogenicity studies conducted by the National Toxicology Program found no evidence of carcinogenesis in male or female mice (5).

SAMPLING METHODOLOGY AND RESULTS

Sampling data collected at the property perimeter indicates the presence of methyl bromide in samples collected outside the facility prior to fumigating (background) and during aerating (venting). Background samples were collected when methyl bromide was not being used and were collected from six core sites located at the property line contiguous to the fumigation facility (Figure 2). Eight background samples were collected on Sunday August 8, 2010 and eight on Tuesday August 17, 2010. Of those 16 samples, one collected from the southwest and one from the western side of the facility on August 8th had measureable quantities of methyl bromide. The samples collected on the southwest and western sides of the facility were determined to be 28 and 38 µg/m^3, respectively (Table 1).

A total of 32 air (21 grab and 11 1-hour) samples were collected when methyl bromide was being aerated from the facility on four non-consecutive days, Friday August 20th, Friday August 27th, Friday October 22nd, and Friday November 19th 2010. Methyl bromide was not detected in any of the nine (seven grab and two 1-hour) samples collected from the northwest or western sides of the facility. Fourteen grab samples taken from all the other sides of the facility ranged from not detected up to 2,078 µg/m^3. Eight out of the 14 grab samples collected contained measurable amounts of methyl bromide, with a geometric mean equivalent to 43 µg/m^3 (Table 1).

A total of 11 1-hour samples were collected during aeration from all sides of the facility except the northwestern side. Methyl bromide was not detected in any of the 1-hour samples collected on the western side of the facility. For the 1-hour samples, the geometric mean air concentration of methyl bromide was 19 µg/m^3 with the highest (516 µg/m^3) and lowest (0.3 µg/m^3)

concentration being collected from the southwestern end of the facility on different days (Table 1).

A review of the air sampling results indicates that methyl bromide is primarily detected during aeration on the south and eastern sides of the facility, which is typically downwind and where the vents are located. We compared the geometric mean of the 1-hour (19µg/m^3) and grab samples (43µg/m^3) to ATSDR's Minimal Risk Level (MRL) and EPA's Reference Concentration (RfC) for methyl bromide.

- A MRL is defined as, "an estimate of daily exposure of a human being to a chemical that is likely to be without an appreciable risk of deleterious effects (non-carcinogenic) over a specified period of time." MRLs are based upon human and animal studies and are reported for acute exposure (less than 14 days), intermediate exposure (15 – 364 days), and chronic exposure (greater than 365 days).

- The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily inhalation exposure of the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It is not a direct estimator of risk but rather a reference point to gauge the potential effects.

Both the 1-hour and grab samples are representative of short-term exposure and their geometric means are below the acute MRL (200 µg/m^3) (3). MRLs are derived for substances by factoring the most relevant documented no-observed-adverse-effects level (NOAEL) or lowest-observed-adverse-effects level (LOAEL) and applying uncertainty factors. ATSDR's MRL for methyl bromide acute exposure was derived from an 8-hour rat inhalation exposure study. The most sensitive indicator (neurological effects) identified in the study was a significant decrease in the hypothalamic concentration of norepinephrine and a decrease in the activity of tyrosine hydroxylase in rats exposed to methyl bromide in air at 31 parts per million (ppm) and not at 16 ppm (6,7). A NOAEL was assigned to animals exposed to 16 ppm. The acute MRL, 0.05 ppm (200 µg/m^3), was derived by adjusting the NOAEL for less-than-continuous exposure (8 hours/24 hours), and dividing by an uncertainty factor of 100 (10 for extrapolating from animals to human, and 10 for human variability) (3). Therefore, acute health effects would not be expected in individuals exposed continuously to methyl bromide at mean (average) levels for short periods of time.

One of the 1-hour samples did contain methyl bromide above the acute MRL. This occurred in one out of 11 1-hour samples (9%). The concentration in this sample was 516 µg/m^3 and was collected on the same side of the warehouse as the vents. Elevated concentrations of methyl bromide would be expected in the vicinity of the vents during aeration.

The chronic MRL for methyl bromide is 20 µg/m^3 (0.005 ppm)(3). ATSDR's MRL for methyl bromide chronic exposure was derived from an eight year human study. The critical effect was an increased prevalence of muscle ache, fatigue, and ataxia. This critical effect was observed at a LOAEL equal to 8930 µg/m^3 in the study. This concentration was adjusted for intermittent exposure and applying an uncertainty factor of 100 (10 for using a LOAEL, and 10 for human variability) (3).

EPA's RfC for methyl bromide is 5 µg/m^3 (8). RfCs are doses derived from the NOAEL or LOAEL by application of uncertainty factors and an additional modifying factor, which is based on a professional judgment of the entire database of the chemical. In general, the RfC is an estimate of a daily inhalation exposure (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. EPA's RfC for methyl bromide was derived from a 29-month rat inhalation study (8,9). The study's critical effect was degenerative and proliferative lesions of the olfactory epithelium of the nasal cavity. This critical effect was detected at a LOAEL of 11,700 µg/m^3. The LOAEL was converted to a Human Equivalent Concentration and an uncertainty factor of 100 (10 for intraspecies uncertainty, and 10 because a LOAEL was used for a mild effect and to account for interspecies dosimetric adjustments) was applied (10).

DISCUSSION

VDH determines exposure to environmental contamination by identifying exposure pathways. A completed exposure pathway consists of: a source of contamination, an environmental medium (e.g., air, water and soil), a point of exposure, a route of exposure, and a receptor population (e.g., workers, community members and individual household members). A complete pathway exists when people are actually exposed to a contaminant through inhalation, ingestion, or by skin contact. VDH has determined that two exposure pathway exists at Western Fumigation.

- Completed exposure pathway - unprotected workers, visitors, and trespassers exposed to methyl bromide within the perimeter of Western Fumigation during aeration.

- Potential exposure pathway - members of the community outside of the perimeter may be exposed to methyl bromide downwind during aeration.

Both the 1-hour and grab samples' geometric mean are below ATSDR's acute MRL. Although the grab samples' geometric mean is above ATSDR's chronic MRL and EPA's RfC grab samples represent a snapshot of the contaminant level, and do not necessarily represent what an individual would be exposed to all day, every day. Two grab and one 1-hour samples measured higher than the acute MRL. It is possible that on-site visitors, workers, and trespassers exposed to these acute elevated levels could sustain lung, neurological, or renal damage. More samples are needed to characterize the frequency and duration of peak levels of methyl bromide during aeration.

Chronic inhalation MRLs and RfCs are derived for continuous, long-term 24-hour a day exposures. In most instances, inhalation exposures from a site will be for less than 24 hours per day. The 1-hour and grab samples collected represent short-term exposure and their geometric mean are below ATSDR's acute MRL (200 µg/m^3). Based on the sampling information received, VDH is not able to evaluate potential health risks posed to nearby businesses, schools, and homes without additional sampling information that extends beyond the Western Fumigation facility's perimeter.

EVALUATING HEALTH EFFECTS

A hazard quotient (HQ) is the ratio of the exposure dose to the reference dose (Equation 1). If the ratio is greater than one, than the potential for adverse health effects needs to be assessed further.

Equation 1

$$HQ = \frac{Exposure\ Dose}{Reference\ Dose}$$

The reference dose is typically derived from either an RfC, or a MRL. Derivation of the reference dose is shown in Appendix A. RfCs and MRLs are based on a continuous exposure which is different than what workers, trespassers, or visitors may actually be exposed to on site. Because workers are known to be present at the warehouse during aeration of methyl bromide, VDH calculated the exposure dose based on: an 8-hours work day, aeration once a week, and the daily inhalation rate is 15.2 cubic meters per day (m^3/day) for adults aged 19-65 years old. Equations and exposure parameters are shown in Appendix A. An exposure dose for trespassers and visitors was not calculated because the duration and frequency of these receptors is not known.

The ratio of the exposure dose to reference dose (chronic MRL) was less than one (HQ = 0.05) for workers exposed to methyl bromide on site using VDH's exposure parameters. Because the HQ is less than one, the potential for adverse health effects does not need to be assessed further for this receptor. Any additional worker exposure concern should be referred to the Virginia Department of Labor and Industry. Because trespassers and visitors are expected to be exposed less frequently and for shorter durations than workers, any HQ calculated for these receptors would also be less than one.

CONCLUSIONS

During warehouse aeration, the geometric mean of methyl bromide (19 µg/m^3) in 1-hour perimeter samples was below ATSDR's MRL (20 µg/m^3) for chronic exposure but higher than EPA's RfC (5 µg/m^3). Both the 1-hour and grab samples geometric mean were below ATSDR's MRL (200 µg/m^3) for acute exposure. The highest reported 1-hour sample level (516 µg/m^3) was above the acute MRL. Grab and 1-hour samples varied considerably based on sampling location. Two background grab samples were above ATSDR's chronic MRL. Based on this information VDH concludes:

- Chronic exposures to methyl bromide might have occurred in the past and are still occurring, but exposure to workers are not at levels likely to cause adverse health effects (HQ = 0.05).
- Unprotected workers, visitors, and trespassers may suffer from respiratory, neurological, and renal damage if exposed to the maximum grab samples' concentrations of methyl bromide detected during aeration. Additional sampling is needed to characterize the potential health risks that may occur during aeration.
- Assessing the risk to nearby residents, businesses, and schools, is not possible at this time without further sampling.

- Assessing the risk to visitors, workers, and trespassers from measureable amounts of methyl bromide in two background samples is not possible at this time without further sampling.

RECOMMENDATIONS

VDH recommends that DEQ collect 8-24 hr time weighted average ambient air samples during fumigation and aeration at adjacent businesses, schools, and residential homes to assess any public health impact to the community.

VDH recommends that the frequency of grab and 1-hour samples be increased during aeration on site to better assess the public health impact to visitors, workers, and trespassers during peak levels.

VDH recommends more background samples be collected on site during and after fumigation operations. This information will be used to better assess background levels of methyl bromide and its potential impact on public health.

Please feel free to contact me if you have any questions or concerns regarding this evaluation.

Dwight Flammia, Ph.D.
Public Health Toxicologist
Division of Environmental Epidemiology
Virginia Department of Health
(804) 864-8182
dwight.flammia@vdh.virginia.gov

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Appendix A.

Figure 1. Location of Western Fumigation Facility and surrounding area.

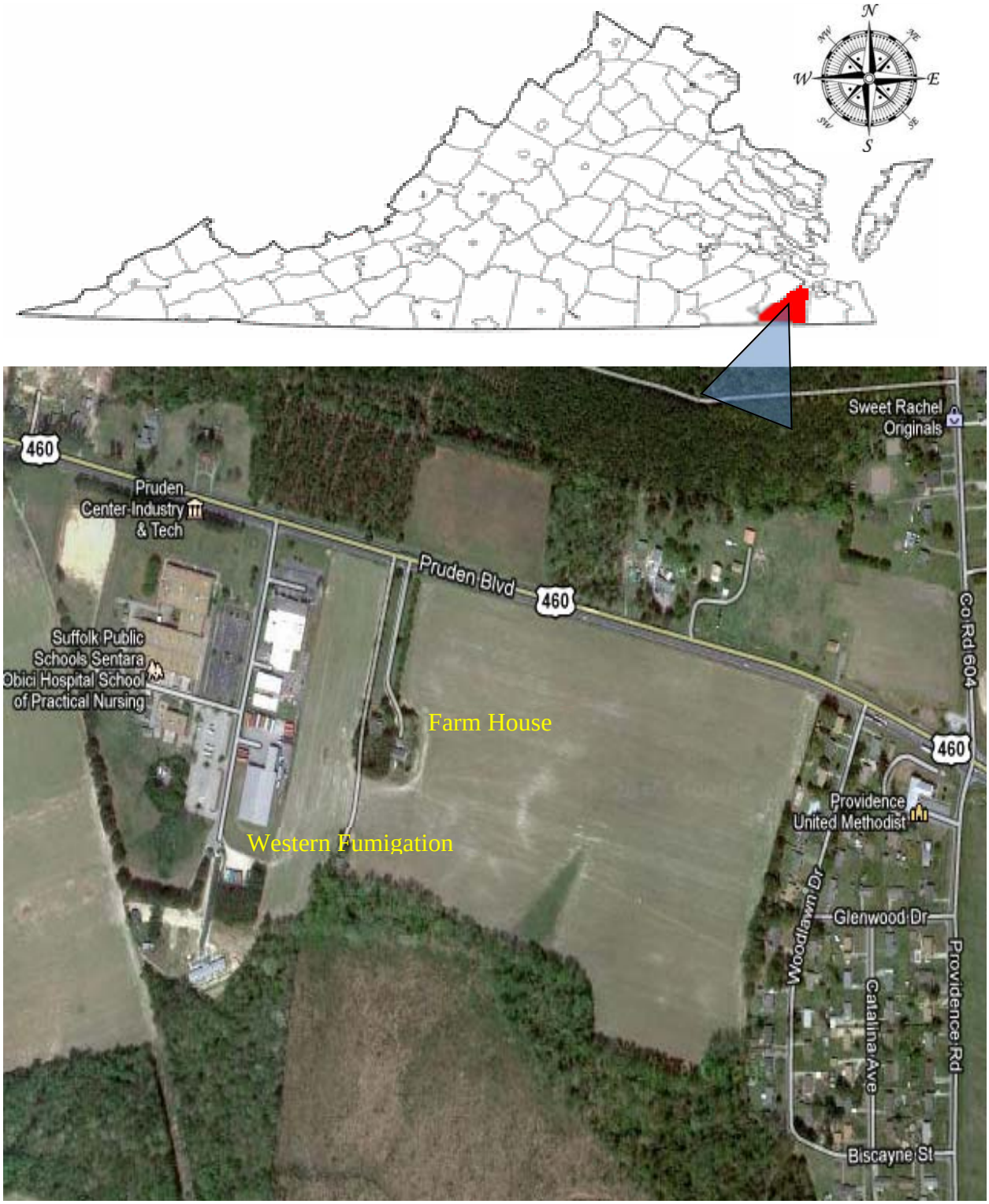

Figure 2. Location of sampling sites and wind direction.

= Sampling sites

Table 1. Methyl bromide summary of August-November 2010 air sample results

		Background µg/m^3		Venting µg/m^3		MRL* µg/m^3	
Location	*Sample type*	*Range*	*Detection frequency*	*Range*	*Detection frequency*	*Acute*	*Chronic*
Northwest	Grab	ND	0/2	ND	0/4	200	20
	1-Hour	NC		NC			
West	Grab	ND-38	1/2	ND	0/3		
	1-Hour	NC		NC	0/2		
Southwest	Grab	ND-29	1/2	ND - 1548	2/3		
	1-Hour	NC		0.3 - 516	5/5		
South	Grab	NC		NC			
	1-hour	NC		1	1/1		
Southeast	Grab	ND	0/2	ND-55	1/2		
	1-Hour	ND	0/4	5 - 59	3/3		
East	Grab	ND	0/2	ND - 41	2/4		
	1-Hour	NC		NC			
East/Northeast	Grab	NC		2078	1/1		
	1-Hour	NC		NC			
Northeast	Grab	ND	0/2	ND - 16	2/4		
	1-Hour	ND		NC			
Geometric Mean	Grab samples collected during venting			43			
	1-Hour samples collected during venting			19			

*MRL=Minimal Risk Level
ND=Not Detected
NC=Sample not collected
µg/m^3=microgram per cubic meters

Equations and exposure parameters used to determine Hazard Quotient

Equations

Chronic Average Daily Dose

$$ADD_{Chronic} = \frac{C * IR * EF * ET}{BW * CF_1 * CF_2}$$

Reference dose

$$RD = \frac{MRL * IR}{BW}$$

Hazard Quotient

$$HQ = \frac{ADD_{Chronic}}{RD}$$

Exposure Parameters

Abbreviations	Value	Comments and Definitions
$ADD_{Chronic}$	µg /kg/day	Chronic Average Daily Dose
BW	70 kg	Average weight of a human adult
C	19 µg/m^3	Geometric mean of methyl bromide measure during 5 different aeration days
CF_1	24 hours/day	Number of hours in a day
CF_2	7 days/week	Number of days in a week
EF	1 day/week	Number of days the warehouse is aerated in a week
ET	8 hours /day	Number of hours worked in a day
HQ	Unit less	Hazard Quotient
IR	15.2 m^3 / day	Volume of air an adult breaths in a day
MRL	20 µg/m^3	ATSDR chronic minimal risk level concentration
RD	µg/kg/day	Reference Dose

REPORT PREPARATION

This Letter Health Consultation for the Western Fumigation Site was prepared by the Virginia Department of Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented.

Author
Dwight Flammia, Ph.D.
Public Health Toxicologist
Division of Environmental Epidemiology
Virginia Department of Health
(804) 864-8182
dwight.flammia@vdh.virginia.gov

ATSDR Reviewer

Jennifer Freed
Technical Project Officer
ATSDR