Health Consultation

NEPONSET RIVER AND RUCKADUCK POND SEDIMENT
CONTAMINATION IN RELATION TO BIRD MACHINE COMPANY
WALPOLE, NORFOLK COUNTY, MASSACHUSETTS

Prepared by the
Massachusetts Department of Public Health

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Under a Cooperative Agreement with:
United States Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

BACKGROUND

In Spring 2008, the Walpole Board of Health requested that the Massachusetts Department of Public Health (MDPH) Bureau of Environmental Health (BEH) review sediment data collected from sections of the Neponset River and Ruckaduck Pond to determine the potential for health concerns. The sediment data were collected by Weston Solutions, Inc., an environmental consulting firm, as part of an environmental investigation into a property known as the Bird Machine Company at 100 Neponset Street, Walpole. The property is located adjacent to the Neponset River and Ruckaduck Pond, an impoundment of the river (see Figure 1). During the initial site assessment, dioxin and furans were detected in soil samples collected in two locations, including one location that was at one time hydrologically connected with the river. As part of a follow-up assessment of potential impacts to the river, surficial sediment samples were collected from a section of the river upstream and downstream of the property and from Ruckaduck Pond. These samples were analyzed for dioxins and furans. MDPH/BEH agreed to review the sampling data for their possible public health consequence, including the potential for dioxins and furans to bioaccumulate in species of fish that then may be consumed by residents. MDPH prepared this health consultation as part of its cooperative agreement with the U.S. Agency for Toxic Substances and Disease Registry (ATSDR).

REVIEW OF ENVIRONMENTAL SAMPLING RESULTS

The term "dioxin" stands for a class of 210 organic compounds called chlorinated dibenzo-p-dioxins (CDDs) and dibenzofurans that exhibit a similar chemical structure. Seventeen of these compounds are considered to have dioxin-like toxicity by the U.S. Environmental Protection Agency (EPA) (EPA 1989). One of the most toxic of these is 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). A toxicity equivalency factor (TEQ) is assigned to each of the 17 dioxin-like compounds that depicts the relative toxicity of the compound compared to 2,3,7,8-TCDD. The concentration of each compound detected is multiplied by its respective Toxic Equivalency Factor (TEF). All the products are then summed and expressed as a 2,3,7,8-TCDD TEQ concentrate. A

TEQ can be derived if data for all 17 compounds are not available by combining the toxicity for those that were tested. Because it is based on the relative estimated toxicity of each compound with respect to 2,3,7,8-TCDD, the 2,3,7,8-TCDD TEQ can be compared with health-based screening levels established for 2,3,7,8-TCDD (ATSDR 1998, Van de Berg et. al 2006). The data from Weston Solutions were converted into 2,3,7,8-TCDD TEQ for evaluation. For individual dioxins and furans that were not detected, to be conservative, a value of one-half the detection limit was used when calculating the 2,3,7,8-TCDD TEQ for that sample.

On May 30, 2007, three sediment samples were collected from the Neponset River downstream of the property and on September 26, 2007, eight sediment samples were collected from the Neponset River upstream of the property. The samples were collected at a depth of 0-6 inches and were analyzed for dioxins and furans. The samples collected upstream of the property had 2,3,7,8-TCDD TEQ concentrations ranging from 1.2 to 14.6 nanogram per kilogram of sediment (ng/kg), with an average concentration of 7.3 ng/kg. The samples collected downstream of the property had 2,3,7,8-TCDD TEQ concentrations ranging from 1.0 to 15.4 ng/kg, with an average concentration of 9.6 ng/kg (see Table 1).

On June 14, 2007, five sediment samples were collected at a depth of 0-12 inches from Ruckaduck Pond and analyzed for dioxins and furans, with 2,3,7,8-TCDD TEQ concentrations ranging from 1.2 to 20.6 ng/kg, with an average concentration of 2,3,7,8-TCDD TEQ of 5.7 ng/kg (see Table 1).

DISCUSSION

Health assessors use a variety of health-based screening values, called comparison values, to help decide whether compounds detected at a site might need further evaluation. Comparison values include environmental media evaluation guides (EMEGs), reference dose media evaluation guides (RMEGs), and cancer risk evaluation guides (CREGs). The comparison values have been scientifically peer reviewed or were

derived from scientifically peer-reviewed values and published by ATSDR and/or EPA. EMEG and RMEG values are used to evaluate the potential for noncancer health effects. CREG values assess the potential for carcinogenic effects.

ATSDR has developed a Minimal Risk Level (MRL) for 2,3,7,8-TCDD of $1x10^{-9}$ milligram per kilogram per day (mg/kg/day), or 1 nanogram per kilogram per day (ng/kg/day) (ATSDR 1998). This was based on a lowest-observed adverse effect level (LOAEL) of 120 ng/kg/day for developmental effects in rhesus monkeys. ATSDR notes that the primary route of exposure to dioxin compounds for the general population is diet (e.g., fish), which is the main contributor to the background exposure. EPA has estimated that more than 90% of human body burdens of dioxins are derived from foods (EPA 2003). Considering exposure to all CDD and chlorinated dibenzofuran congeners, the background exposure level is as much as approximately 3 ng/kg/day (ATSDR 1998).

The average concentrations of 2,3,7,8-TCDD TEQ detected in the surface sediment samples from the Neponset River and Ruckaduck Pond did not exceed health-based screening values for soil (see Table 1). Screening values for sediment have not been developed, therefore soil screening values were used. This is a conservative comparison because exposure to sediments is expected to be much less than exposure to soils. That is, soil screening values are derived assuming daily exposure via incidental ingestion over a lifetime.

In addition, the sediment concentrations in the Neponset River and in Ruckaduck Pond were similar to non-urban background levels. EPA conducted a study evaluating dioxin concentrations in sediment cores collected from 11 non-source-impacted water bodies in six states (Arkansas, Georgia, New York, North Carolina, Utah, and Washington) and found concentrations of 2,3,7,8-TCDD TEQ in the uppermost section of the sediment core ranging from 0.012 to 16.3 ng/kg, with an average concentration of 5.3 ng/kg. EPA considers 5.3 ng/kg to be the "typical" background concentration in sediment (EPA 2003). The average sediment concentration found in the Ruckaduck Pond (5.7 ng/kg) was similar to the typical level found by EPA. The Neponset River average

concentrations (7.3 and 9.6 ng/kg) were within the range of concentrations reported by EPA and similar to the typical background concentration, but higher than EPA's average level. It is important to note, however, that the river concentration did not exceed the ATSDR screening value and all concentrations detected in the river were within non-urban background, as described in the EPA study above.

Dioxins are compounds that bioaccumulate in fish. Bioaccumulation is a process where concentrations of contaminants can increase in fish as a result of exposure in the water, sediment, and lower trophic level species. Dioxins may then accumulate in individuals who eat fish contaminated with dioxins.

No dioxin data are available for fish in this area of the Neponset River or Ruckaduck Pond. In order to assess any public health concerns for fish consumption, studies examining biota-sediment accumulation factors (BSAFs) for dioxin and fish were reviewed. BSAFs are the ratio of the chemical concentration in an organism to the chemical concentration in sediment. They can be used to estimate the potential concentration of a contaminant, such as dioxin, in an organism like fish when only sediment data are available. They are derived from studies that measure the chemical concentrations in both (Weisbrod et al. 2007).

BSAFs for various dioxin compounds have been reported for three freshwater fish that are likely to exist in the Neponset River and are consumed by humans: carp, channel catfish, and eel. BSAFs were reported for seven dioxin compounds in carp, 12 in channel catfish, and 11 in American eel (Van der Oost et al. 2002). Carp and channel catfish are generalist feeders that consume plant and animal material throughout the water column. Eels are bottom-dwelling carnivores (Hartel et al. 2002). For each surface sediment sample, the BSAF for each dioxin compound was multiplied by the corresponding TEF and combined into a 2,3,7,8-TCDD TEQ. In instances where a range of BSAFs for a compound were reported, the highest value was used (see Table 2). This result is an estimate of the concentrations in each species of fish based on the concentration of dioxin in each sediment sample. See Table 3 for an example of this derivation. The estimated

concentrations in carp, channel catfish, and American eel ranged from 0.22-0.38 ng/kg, 0.91-2.7 ng/kg, and 0.16-0.28 ng/kg, respectively (see Table 4).

Adults who eat carp, channel catfish, or eel from these three locations at the average rate of daily fish consumption for the U.S. (17.5 grams of fish per day, g/d, or 4.4 ounces per week) (EPA 2000) would receive an exposure dose ranging from 0.04-0.7 ng/kg/day. Because of their lower body weight, exposures relative to body weight would be higher for children than for adults. The estimated dioxin exposures for children consuming fish from these locations at the average rate would be 0.08-1.0 ng/kg/day. None of these exposure doses exceed ATSDR's chronic MRL for dioxin of 1 ng/kg/day.

CONCLUSIONS

Given that the average sediment concentrations from the three locations are similar, that the sediment concentrations of 2,3,7,8-TCDD TEQs from two locations were within the range of background (EPA 2003) and from the third location is slightly above the range of background estimates of exposure to 2,3,7,8-TCDD TEQ through fish consumption by using BSAFs do not exceed the ATSDR chronic MRL. Therefore, opportunities for exposure to dioxins in fish or sediment do not present health concerns.

ATSDR requires that one of five conclusion categories be used to summarize findings of a health consultation. These categories are as follows: (1) Urgent Public Health Hazard; (2) Public Health Hazard; (3) Indeterminate Public Health Hazard; (4) No Apparent Public Health Hazard; (5) No Public Health Hazard. A category is selected on the basis of site-specific conditions, such as the degree of public health hazard based on the presence and duration of human exposure, contaminant concentration, the nature of toxic effects associated with site-related contaminants, the presence of physical hazards, and community health concerns. Based on the evaluation of potential exposure to dioxins in sediment and fish described above, ATSDR would conclude that exposures pose “no apparent public health hazard”.

RECOMMENDATIONS

MDPH, upon request, will review any future environmental data associated with the Bird Machine Company site.

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PREPARER

This document was prepared by the Bureau of Environmental Health of the Massachusetts Department of Public Health. If you have any questions about this document, please contact Suzanne K. Condon, Director of BEH/MDPH at 250 Washington Street, 7th Floor, Boston, MA 02108.

CERTIFICATION

The Health Consultation, *Neponset River and Ruckaduck Pond Sediment, Walpole, Norfolk County, Massachusetts*, was prepared by the Massachusetts Department of Public Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the Health Consultation was initiated. Editorial review was completed by the cooperative agreement partner.

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Technical Project Officer, CAT, SPAB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this Health Consultation and concurs with its findings.

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Team Lead, CAT, SPAB, DHAC

Table 1: Sediment Data

Sample Location	Detects/Samples	Average 2,3,7,8-TCDD TEQ (ng/kg)	Comparison Value (ng/kg)
Ruckaduck Pond	5/5	5.7	Child Chronic EMEG- 50 Adult Chronic EMEG- 700
Neponset River-Upstream	8/8	7.3	
Neponset River-Downstream	3/3	9.6	

Table 2: BSAFs for Dioxin Compounds in Select Fish Species

Fish Species	2,3,7,8-TCDD	1,2,3,7,8-PcDD	1,2,3,6,7,8-HxCDD	1,2,3,4,6,7,8-HpCDD	OCDD	Sum PCDD	2,3,7,8-TCDF	1,2,3,7,8-PCDF	1,2,3,6,7,8-HxCDF	1,2,3,4,6,7,8-HpCDF	OCDF	Sum PCDF
Carp	0.27	0.06	0.035	0.005	--	--	0.06	--	0.037	0.003	--	--
Channel Catfish	0.15-0.48	0.19-0.31	0.06-0.28	0.01-0.71	0.01-0.86	0.01-0.72	0.01-0.19	0.004-0.21	0.01-0.04	0.001-0.07	0.001-0.07	0.003-0.17
American Eel	0.22	0.002	0.02	0.001	0.001	0.001-0.13	0.02	0.001	--	0.005	0.002	0.001-0.13

From Van Der Oost et al. 2003

Table 3: Sample Calculation, BSAFs for Dioxin Compounds in Carp

Compound	Detected Concentration (ng/kg)	TEF	TEQ Concentration (ng/kg)	BSAF	Estimated Fish Concentration (ng/kg)
2,3,7,8-TCDD	0.65	1	0.65	0.27	0.18
1,2,3,6,7,8-HxCDD	ND	0.1	0.105	0.035	0.0037
1,2,3,4,6,7,8-HpCDD	14	0.01	0.14	0.005	0.0007
2,3,7,8-TCDF	3.6	0.1	0.36	0.06	0.022
1,2,3,6,7,8-HxCDF	7.7	0.1	0.77	0.037	0.028
1,2,3,4,6,7,8-HpCDF	57	0.01	0.57	0.003	0.0017
Total 2,3,7,8-TCDD TEQ					0.24

TEQ Concentration = Detected Concentration x TEF
Estimated Fish Concentration = TEQ Concentration x BSAF
Total 2,3,7,8-TCDD TEQ = Sum of Estimated Fish Concentrations
For the Non Detect (ND), to be conservative the detection limit of 2.1 ng/kg was divided in two and used in the calculation.

Table 4: Average Estimated Concentrations of 2,3,7,8-TCDD TEQ (ng/kg) in Fish

Sample Location	Carp	Channel Catfish	Eel
Ruckaduck Pond	0.22	0.91	0.16
Neponset River-Upstream	0.27	1.5	0.19
Neponset River-Downstream	0.38	2.7	0.28

Site Map
Figure 1