BRIEFING PAPER – WILDLIFE CONSUMPTION

This Briefing Paper describes the derivation of consumption levels of wild game containing mercury that may be harvested from the floodplain of the South River downstream of the former DuPont Waynesboro Plant, located in Waynesboro, Virginia. Game species are potentially consumed by individuals who harvest these animals.

Wild game tissue samples (muscle) were collected during sampling events conducted by the South River Science Team (SRST) between 2008 and 2011. Consumption levels were calculated using a range of exposure assumptions including meals size, concentration of mercury in tissue, and meal preparation methods for consumers of the following species:

- Water fowl
  - Canada goose (*Branta canadensis*)
  - Mallard (*Anas platyrhynchos*)
  - Wood Duck (*Aix sponsa*)
- Small Mammals
  - Muskrat (*Ondatra zibethicus*)
  - Squirrel (*Sciurus niger and Sciurus carolinensis*)
- Large Mammals
  - White-Tailed Deer (*Odocoileus virginianus*)
- Reptiles
  - Snapping Turtle (*Chelydra serpentine*)

A descriptive summary of the calculations for all cases is provided below.

The results of the calculations for a conservative case (i.e., an 8 ounce meal size, high estimate of mercury concentration in the tissue, and no adjustment for cooking and preparation losses) show that consumption levels could range from 4 meals per year for snapping turtles to unrestricted meals for white-tailed deer.

A Factsheet is being prepared using the results of this conservative case.

Consumption Calculations

Risk-based consumption levels for chronic exposure health effects were developed for adults using United States Environmental Protection Agency (USEPA) methodology for fish consumption limits (USEPA, 2000). The USEPA risk-based fish consumption limits derived in the guidance document relate the number of meals that can be eaten to tissue concentrations of a particular contaminant. For this evaluation, the equations in this guidance document (Equations 3-3 and 3-4) were modified to calculate a consumption level over a given time period (month or year)

as a function of meal size and mercury tissue concentration for each wild game species.

The equations used are as follows:

$$C = \frac{(RfD \; x \; BW \; x \; T)}{(MS \; x \; NM)}$$

Solving for

$$NM = \frac{RfD \; x \; BW \; x \; T}{(MS \; x \; C)}$$

Where:

C = Concentration in edible portions of wildlife, mg/kg ww

RfD = Oral Reference Dose, mg/kg-day

BW = Body weight, kg

T = Time period, days/month or year

MS = Meal size - consumed in one meal, kg

NM = Number of allowable meals per month or year

The following sections describe the toxicity value used for mercury and exposure assumptions used in the derivation of the risk-based consumption levels.

Toxicity Factors

The oral reference dose (RfD) of 0.0001 milligrams per kilogram per day (mg/kg-day) for methylmercury (MeHg) was used in the consumption limit calculation. The RfD, which was obtained from USEPA's Integrated Risk Information System (IRIS) online database, conservatively assumes that all total mercury is present as MeHg in each wild game species.

The RfD is based on developmental neuropsychological impairment observed in human epidemiological studies (EPA, 2013). The nervous system is considered to be the most sensitive target organ for which there are data suitable for derivation of an RfD.

Exposure Assumptions

A range of consumption levels were calculations for each of the seven (7) species evaluated using conservative (likely to overestimate actual exposure) assumptions but are reasonable for developing the consumption limits. Exposure assumptions

were based on a combination of USEPA-recommended values and professional judgment considering site-specific information. Rationale for selection of these assumptions is detailed below.

- **Time Period** – Consumption limits were calculated for two time periods: meals per month (30.44 days/year) and meals per year (365 days/year). Input variables were consistent with those recommended by USEPA (USEPA, 2000).

- **Body Weight** – A consumer body weight of 80 kilograms (kg) (176 pounds [lbs]), the average body weight of male and female adults in the U.S. population (USEPA, 2011), was assumed.

- **Meal Size** – Meal size is defined as the amount of game (in kilograms) consumed at one meal. To provide a range of estimates, three meal sizes were assumed in the calculations: 4 ounces (oz) (0.11 kg), 6 oz (0.17 kg) and 8 oz (0.23 kg). The values are consistent with the range of intake values reported by USEPA (USEPA, 2000 and USEPA, 2011) and in the literature (Burger, 2002).

- **Losses from Food Preparation** - Three meal preparation scenarios were considered: 1) no adjustment to meal size for cooking or preparation losses; 2) adjustment for cooking or preparation losses, which includes dripping and volatile losses; and, 3) adjustment for cooking/preparation losses and post-cooking losses, which involves losses from cutting, bones, excess fat, scraps and juices. The adjustment factors used were consistent with recommendations by USEPA (Table 13-69 in USEPA, 2011) to reflect what is actually consumed during a meal.

- **Tissue Concentration** – Tissue mercury data from species collected in the South River floodplain were used in the calculations. However, data collected from reference locations in the Middle River and South River were excluded from the data set. The tissue concentration determined from the data set was the 95% upper confidence limit (UCL) on the mean or the maximum detected concentration, whichever was lower (USEPA 1989). The 95% UCL was calculated using parametric methods (for a normal or lognormal distribution) or nonparametric methods if the data were neither normally nor lognormally distributed (USEPA 1992, 2002). Statistical calculations were performed using USEPA's ProUCL software. Statistical treatment was not conducted for constituents having less than 8 samples in a data set. In these cases, the maximum detected concentration was used. For the snapping turtle data set, statistical treatment was conducted for both the entire floodplain as well as for individual property where turtles were caught.

Results

The results of the calculations for a conservative case (i.e., an 8 ounce meal size, high estimate of mercury concentration in the tissue, and no adjustment for cooking and preparation losses) show that consumption levels could range from 4 meals per year for snapping turtles to unrestricted meals for white-tailed deer. The results are provided in the attached table.

These results are being used to develop a Factsheet on wildlife consumption.

References

Burger, J. (2002). *Daily consumption of wild fish and game: exposures of high end recreationists*. Int. J. Environ. Hlth. Research 12: 343-354. .

United States Environmental Protection Agency (USEPA). 1989. *Risk Assessment Guidance for Superfund (RAGS) Interim Final. (Volume 1 Part A Human Health Evaluation Manual).* USEPA /540/1-89/002. December 1989.

USEPA. 1992. *Supplemental Guidance to RAGS: Calculating the Concentration Term.* United States Environmental Protection Agency, Publ. 9285.7-081, May 1992.

USEPA. 2000. *Guidance for Assessing Chemical Contaminant Data For Use in Fish Advisories: Volume 2 Risk Assessment and Fish Consumption Limits*. USEPA 823-B-00-008

USEPA. 2002. *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*, United States Environmental Protection Agency, OSWER 9285.6-10, December 2002.

USEPA. 2011. *Exposure Factors Handbook*, 2011 Edition. USEPA/600/R-09/052F.

Calculation of Consumption Levels - Meals Per Year
(No Adjustment For Cooking or Preparation Losses)
South River Floodplain

$$C = \frac{RfD \times BW \times T}{MS \times NM}$$

Equations 3-3 and 3-4 in USEPA, 2000 (as modified)

Solving for

$$NM = \frac{RfD \times BW \times T}{MS \times C}$$

Parameter	Definition	Value	Source
C	Concentration in edible portions of wildlife, mg/kg ww	Species-Specific	95% UCL for total mercury (THg), except MAX used for deer species (<8 data points)
RfD	Oral Reference Dose, mg/kg-day	1.00E-04	RfD from EPA's IRIS. Assume that all THg is present as methyl mercury (MeHg)
BW	Body weight, kg	80	Table ES-1; USEPA, 2011
T	Time period, days/year	365	Default
MS	Meal size - consumed in one meal, kg	4 oz (0.11 kg), 6 oz (0.17 kg) or 8 oz (0.23 kg) - Uncooked meal size, no adjustment for cooking or preparation losses	
NM	Number of allowable meals per month	Calculated	

Species		C (mg/kg ww)	MS (kg)	NM (meals/year)	MS (kg)	NM (meals/year)	MS (kg)	NM (meals/year)
Waterfowl								
CANADA GOOSE	Muscle	4.47E-02	0.11	576	0.17	384	0.23	288
MALLARD	Muscle	7.91E-01	0.11	33	0.17	22	0.23	16
WOOD DUCK	Muscle	1.38E-01	0.11	187	0.17	124	0.23	93
Small Mammals								
MUSKRAT	Muscle	3.13E-01	0.11	82	0.17	55	0.23	41
SQUIRREL	Muscle	9.11E-02	0.11	283	0.17	188	0.23	141
Large Mammals								
WHITE-TAILED DEER	Muscle	1.39E-03	0.11	18525	0.17	12350	0.23	9263
Reptiles								
SNAPPING TURTLE[1]	Muscle	3.12E+00	0.11	8	0.17	5	0.23	4

Notes:

1 - Snapping turtle data is a summary of all South River and South Fork Shenandoah River locations (reference locations excluded)

References:

USEPA, 2000. Guidance for Assessing Chemical Contaminant Data For Use in Fish Advisories: Volume 2 Risk Assessment and Fish Consumption Limits. EPA 823-B-00-008
USEPA, 2011. Exposure Factors Handbook, 2011 Edition. EPA/600/R-09/052F.