Health Consultation

Evaluation of Contaminant Exposures from Human Consumption of Crabs and Oysters Near the

ATLANTIC WOOD INDUSTRIES SITE

PORTSMOUTH, VIRGINIA

EPA FACILITY ID: VAD990710410

JUNE 6, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

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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Prepared By:

U.S. Department of Health and Human Services
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Summary and Statement of Issues

The Environmental Protection Agency Region 3 has requested that the Agency for Toxic Substances and Disease Registry (ATSDR) evaluate the public health risk associated with consumption of crabs and oysters from the Southern Branch of the Elizabeth River (Portsmouth, Virginia) near the Atlantic Wood Industries (AWI) Superfund site. In addition to the AWI site, there are two other Superfund sites, other sources of contamination, and a number of active port and industrial facilities near this portion of the Southern Branch of the Elizabeth River.

The Atlantic Wood NPL site is located in the waterfront area of the Southern Branch of the Elizabeth River in Portsmouth, VA. Historic industrial operations, including wood-treating operations, at the facility have resulted in soil, groundwater, and sediment contamination. The predominant contaminants at the site are polynuclear aromatic hydrocarbons (PAHs) from creosote, pentachlorophenol and associated dioxins, and metals such as arsenic, cadmium, lead, copper and chromium. There is a ban on collecting oysters due to bacteria and metals, but oyster beds are being restored which will increase opportunities for harvesting. Also, there is a fin fish advisory for poly-chlorinated biphenyls (PCBs, and kepone) which recommends limiting fish consumption to two fish meals per month from this area for many species and recommends that some species not be eaten at all.

A Public Health Assessment (PHA) for this site was published in 1994, and considered the consumption of the area shellfish and fin fish as a potential exposure pathway (ATSDR, 1994). The 1994 PHA makes several recommendations concerning additional or continued site monitoring and characterization, worker safety, and public access restriction. The PHA also makes a specific recommendation to "Determine if the ban on collecting shellfish is effective and determine if the ban should include fin fish."

Current Fish Advisories, Shellfish Ban, and Angler Survey

The Virginia Department of Health (Division of Shellfish Sanitation) has condemned the taking of shellfish from "all of the Elizabeth and Lafayette Rivers and their tributaries....", which includes the area around the AWI site. As described below, this condemnation refers only to molluscan shellfish such as oysters and clams but does not include blue crabs. These areas are closed to shellfishing on the basis of biological and heavy metal contamination.

> ***If the waters are condemned for shellfishing, can I harvest crabs?***
> Yes, while shellfish is used as a term for defining both *molluscs* (oysters, clams, scallops, etc.) and *crustaceans* (crabs, lobsters and shrimp), the Division's Shellfish Closures for biological and metals refer ONLY to restrictions on the harvesting of molluscan shellfish.
>
> ***If the waters are condemned for shellfishing, can I eat the fish or crabs?***
> Yes, the condemnation for biological and metals only applies to bivalve molluscan shellfish since they may concentrate bacteria, viruses, and chemicals from the water, and since their intestinal tract is often eaten raw.
>
> From: http://www.vdh.state.va.us/EnvironmentalHealth/Shellfish/faq/index.htm

The Virginia Department of Health (VDH, 1997; Office of Epidemiology, Division of Public Health Toxicology) has also issued a fish consumption advisory for the James River (including the Elizabeth River and tributaries; see Attachment 1). This advisory is based on PCB (and kepone) concentrations in fish and advises against eating large (> 32 inches) catfish and carp and limiting intake of other sport/food fish (including striped bass, bluefish, croaker, spot, shad, small catfish [< 32 inches], and herring) to no more than 2 fish meals per month. The advisory also recommends that high risk individuals such as **women who are pregnant or may become pregnant, nursing mothers, and young children** not to eat any fish contaminated either with polychlorinated biphenyls (PCBs) or mercury from the respective advisory areas.

This advisory does not include blue crab. From:
http://www.vdh.virginia.gov/epidemiology/DEE/PublicHealthToxicology/Advisories/JamesRiver.htm

The Chesapeake Bay Program commissioned a survey of angler interviews to determine populations at risk for consuming contaminated fish (Gibson and McClafferty, 2005). Section V of this report presents results of angler surveys for the Elizabeth/James River region, which includes the AWI area (Southern Branch, Elizabeth River). The PCB fish advisory described above (for the Elizabeth River) was enacted during the period of angler interviews so that it was not possible to determine the effectiveness of that advisory in limiting fish consumption. However, the advisory based on kepone contamination had been in place for almost thirty years.

The angler surveys provide significant information about seafood consumption patterns. Based on these surveys, very few anglers consume more fish than recommended by the PCB/kepone advisory. For all species (fish and crab) less than three percent (25 of 962) of respondents eat more than 2 fish/crab meals per month. Of the 74 respondents that reported eating crabs, 86% (63 respondents) indicated that they never eat the crab hepatopancreas (crab mustard). Although crabbers who do regularly eat the mustard represent a small proportion of total consumers, this population should be included in potential exposure calculations.

Calculation of long term or annual doses for each of the contaminants detected in crabs and oysters has to consider consumption patterns over an entire year or multiple years. The angler surveys indicate that there is a distinct seasonal pattern for self caught seafood consumption with higher consumption rates for the May-September time period and lower consumption rates during the remainder of the year.

It is important to note that crabs are explicitly excluded from the current VDH fish advisory and shellfish ban. However, when estimating total exposures to PCBs and other contaminants, fish and crab meals should be collectively evaluated. Likewise, although consumption of whole crabs and crab mustard is relatively rare, such consumption patterns should be considered when evaluating potential exposures.

Contaminant Concentrations in Fish, Crabs and Oysters

As part of its ongoing risk assessment of the AWI site, the EPA has collected and analyzed crabs and oysters for a variety of contaminants. A summary of these analyses for crab meat, whole crabs, and oysters is included in Table 1 and Attachment 2. Attachment 3 lists the "Environmental Chemical Contaminant and Pesticide Tolerances, Action Levels, and Guidance

Levels" for fish and fishery products (FDA, 2001; **http://www.cfsan.fda.gov/~comm/haccp4.html**).

The guidance or tolerance levels in Attachment 3 are contaminant concentrations in seafood that are considered safe for human consumption by the U.S. Food and Drug Administration (FDA). Although none of the AWI site specific contaminants (Attachment 2) exceed the FDA tolerance levels, such levels have not been established for all contaminants measured in AWI seafood. Additionally, it should also be noted that the FDA levels are based on a multi-source seafood supply and consumption rates that may be exceeded by people that catch and eat a lot of seafood.

Table 1 lists the estimated exposure point concentrations of crab meat, whole crab, and oysters that were collected in the Southern Branch of the Elizabeth River near the AWI site. The listed concentrations are the 95th upper confidence limit (UCL) of the average measured concentrations or a similar estimate of average value for non-normally distributed concentrations. The specific parameter for each contaminant is listed in Attachment 1. These values are health protective estimates of the average concentrations. Note that contaminant concentrations for whole crabs are based on measured mass proportions of crab meat and hepatopancreas.[1] Crab meat comprises ~70% of whole crab edible mass and hepatopancreas the remaining ~30% of edible crab mass.

Table 1 also lists the relevant screening values for each contaminant used by the Virginia Department of Environmental Quality (VDEQ, 2008; as downloaded from the VDEQ website, **http://www.deq.virginia.gov/fishtissue/background.html**). Contaminants highlighted in gray have concentrations above their respective screening value. These screening values assume exposures based on a 70 kg body weight, a 6.5 g/day consumption rate, and a 1:100,000 risk level (or $1x10^{-5}$ theoretical excess lifetime risk) for cancer-causing contaminants and are based on the EPA reference dose for non-cancer effects. Note that the consumption of 6.5 g/day is approximately equal to eleven eight ounce fish or crab meals per year (e.g., two fish/crab meals per month equals 24 fish/crab meals per year).

From Table 1, dioxin, PCBs, dieldrin and several PAHs (benzo(a)anthracene, benzo(a)pyrene, and others) have estimated average concentrations (95th UCL) above their respective screening levels for whole crabs and oysters. The dieldrin concentrations in crab meat and oysters are below all screening values (Table 1). Although the 95th UCL for dieldrin in whole crab is essentially equal to the screening value (7 vs. 6.7 ppb, resp.) the average dieldrin concentration (5.8 ppb) as listed in Attachment 2 for whole crab is also below screening values. Consequently, dieldrin exposures will not be evaluated. Dieldrin and aldrin are typically discussed together for health evaluation purposes since aldrin readily breaks down to dieldrin in the body and environment. The dieldrin/aldrin combined concentrations are below screening levels for oysters while the aldrin levels were below detection for crab. As such, dieldrin/aldrin levels in crab and oysters are below levels of concern.

[1] Based on measured masses of crab meat and crab hepatopancreas in crab samples, there is about 19 grams of crab meat in each crab and about 10 grams per hepatopancreas (R. Sturgeon, pers. comm.) These values are similar to industry averages which assume that there is about 21 grams of meat in the average blue crab (http://www.bluecrab.info/buying_hards.htm).

Similarly, 95th UCL concentrations of PAHs (benzo(a)anthracene, benzo(a)pyrene, and others) are below screening values in crab meat and equal to or slightly above screening values in whole crab (Table 1; average PAH concentrations are less than or essentially equal to SVs; Attachment 1). Although PAH concentrations in oysters are well above screening values (Table 1), due to the shellfish ban, taking of oysters from this area is prohibited. Consequently, additional dose evaluation of PAHs will not be conducted for oysters or crabs. Concentrations of all contaminants in crab meat are below their respective VA and FDA screening values.

The list of contaminants in Table 1 and Attachment 2 include several forms of arsenic. Arsenic may be measured as total arsenic, inorganic arsenic, and several forms of organic arsenic. Each of the chemical arsenic species has a different relative toxicity and may require measurement and dose assessment for each form. In Table 1 and Attachment 2, the arsenite and arsenate species are summed to represent inorganic arsenic and of the various organic forms, only Dimethylarsinic acid (DMA) is present in significant and measurable concentrations. Additionally, studies report that DMA is a carcinogen in rodents but its cancer effects in humans is equivocal.

Table 1. Contaminant concentrations in crabs and oysters at the AWI site. Values are the 95th upper confidence limit or similar health protective estimate of the average concentrations.

Chemical of Concern	crab meat ppb	whole crab ppb	oyster ppb	VASV n-carc ppb	VASV carc. ppb	VA Source*
Dioxin TEQ(1989) (5)	0.0001	0.0072	0.0055		0.0062	6a
Dioxin TEQ(1998WHO)	0.0001	0.0081	0.0018		0.0062	6a
Mercury	62	49	27	500		6b (methyl)
Arsenic (total)	2900	3200	820			
Arsenic (inorganic)	41	59	42	3200	72	6b (inorg)
DMA (organic arsenic)	90	152	132			
Cadmium		500	770	11000		6b
Cobalt	13	92	150			
Copper	13000	41000	85000			
Iron		17000	74000			
Lead		120				
Selenium	760	1100	420	54000		6a/b
Thallium	270	240	220			
Vanadium		200	130			
Zinc		41000	1200000			
4,4'-DDE	8	24			320	6a
4-4'-DDT		20		5380	320	6a (total)
Aldrin			1	320	6.3	6a
PCB (Aroclor-1260)	23	250		220	50	6a/b (total)
alpha-BHC			2		20	6b
beta-BHC		2	3		60	6b
Dieldrin	1	7	1	540	6.7	6a
delta-BHC		1				
Heptachlor		1	6	5400	24	6a
Heptachlor Epoxide	<1	4	1	140	10	6b
Benzo(a)anthracene	10	35	170		15	6a
Benzo(a)pyrene	8	15	220		15	6a
Benzo(b)fluoranthene	17	33	450		15	6a
Dibenzo(a,h)anthracene	3	3	65		15	6a
Indeno(1,2,3-cd)pyrene	4	6	140		15	6a

*Virginia screening values (SV) are from "Fish Tissue and Sediment Toxics Evaluation" listed in the Virginia DEQ website: **http://www.deq.virginia.gov/fishtissue/background.html**

--VA Source refers to the tables 6a and 6b from the above report.

--n-carc. refers to non-carcinogenic screening values

--carc. refers to carcinogenic screening values.

--SV based on 70 kg body weight, 10^{-5} risk level, and 6.5 g/day consumption rate.

Estimated Doses from Crab and Oyster Consumption

Potential doses to contaminants detected in crab meat, whole crabs, and oysters are estimated using the measured concentrations of those contaminants and assumed rates of consumption and body weights. Contaminant concentrations used in the exposure calculations are the "Exposure Point Concentrations" listed in the tables of Attachment 1. These concentrations are the 95th Upper Confidence Limit of the means or a similar health protective estimate of the average value of the measured concentrations (CDM, 2006/2007).

The dose calculations required several assumptions related to crab and oyster consumption. These assumptions include:

- The amount of crab meat or number of crabs consumed for each meal—the calculated doses assume that each crab contains 19.1 grams of crab meat, whole crabs weighed 29.2 grams, and that each oyster weighed 12.7 grams (these weights are based on the average value of sampled crabs and oysters).
- A crab meal consisted of 12 crabs and on oyster meal of 18 oysters. The resulting meals represented about eight ounces of crab or oyster meat (whole crab meals are about 12 ounces). Larger or smaller portions can be estimated by simply adjusting the resulting doses (an 18 crab meal result in a dose that is 1.5 times larger than a 12 crab meal, etc.)
- Dose calculations assume an average adult body weight of 70 kg.
- PCB and dioxin dose calculations assume that there is a 25% reduction in contaminant concentrations due to preparation factors such as cooking and cleaning (Zabik, et.al., 1992). Note that the VDH assumes a 50% preparation reduction factor for assessing PCB and dioxin exposures (Wasti, 2004a/b).

The resulting doses are represented in units of milligrams [contaminant] per kilogram body weight per day (mg/kg/day).

The FDA guidance or tolerance levels from Attachment 3 have been adjusted for intake rates and body weights to produce tolerance levels in dose units (mg/kg/day; figures 1-3). These tolerance levels and other health endpoints such as ATSDR minimal risk levels (MRLs) or cancer risk levels along with estimated doses from different intake rates are shown in Figures 1 to 3.

Estimated inorganic arsenic doses for different consumption rates are shown in Figure 1 along with the doses that correspond to various risk or acceptable intake levels. Note that doses for all consumption rates up to 125 meals per year are below the FDA tolerable intake level, the VA non-cancer screening value and the ATSDR MRL. Only consumption of more than 90 whole crab meals per year (more than 7 meals per month) exceeds the 1:100,000 cancer risk screening value. Although possible, this rate of consumption of whole crabs from the AWI area is unlikely.

Estimated doses for organic arsenic (as DMA) are not shown in any of the Figures. However, the calculated DMA doses from eating whole crabs, crab meat, and oysters are all more than 1000 times lower than the DMA MRL (0.02 mg/kg/day) for consumption rates of up to 125 meals per year. There are no applicable cancer screening values for DMA.

It should also be noted that although doses for oyster consumption have been estimated, it is currently illegal to take oysters for any purpose from the waters of the Southern Branch of the Elizabeth River (VDH, 1997).

PCB doses from consumption of crab meat and whole crabs are shown in Figure 2. PCB concentrations, if detected, were not reported for oysters. Potential exposures to PCBs from crab meat are below the FDA tolerable intake level for up to 125 meals per year. Similarly, potential doses are below the VA non-cancer SV and the ATSDR MRL for ingestion rates up to 80 meals per year. However, potential PCB doses for crab meat consumption do exceed the VA cancer SV and theoretical 1:100,000 cancer risk level for more than 33 crab meat meals per year (or around 3 meals per month). PCB doses from eating whole crabs exceed the VA non-cancer SV and the ATSDR MRL for as few as 5 meals per year and the VA cancer SV for one meal per year.

Potential dioxin doses are shown in Figure 3. As with the PCB doses, dioxin doses from eating crab meat are below all applicable screening values for up to 125 meals per year. Dioxin doses from whole crab and oyster consumption exceed their respective screening values with as few as 5 meals per year.

Discussion

The estimated arsenic, PCB, and dioxin doses from eating crab meat are below the FDA tolerable intake levels for consumption rates of up to 125 (~8 ounce) meals per year and most other applicable health screening values for up to 80 meals per year. However, as shown in Figure 2 (using the 95th UCL concentration; 38 ppb), as few as 20 eight ounce crab meat meals per year results in a PCB dose that exceeds the VA cancer screening value. Using the mean PCB crab meat concentration (12 ppb; from Attachment 2), it takes ~65 crab meat meals per year to get a PCB dose that exceeds the VA cancer screening value.

It is important to note that PCB concentrations in crab meat and whole crabs are similar for crabs taken from Scuffletown Creek, the York River, and adjacent to the AWI site. Consequently, concern about PCB doses should not be considered an AWI site-specific issue.

Contaminant concentrations in whole crab, which includes the crab hepatopancreas are much higher than in crab meat. PCB concentrations in whole crabs are above VA screening value based on both mean and 95th UCL values (Table 1, Attachment 2). Ninety fifth percentile UCL values are also above VA SVs for dioxin, dieldrin, and several PAHs (although mean or average values are below SVs); PAH mean and 95th UCL values are also above SVs for oysters; Table 1).

Angler surveys indicate that relatively few anglers regularly consume whole crabs. Also, because there is a ban on taking oysters from waters near the AWI site, it is assumed that few people consume oysters from this area. However, the angler survey did not ask if people do eat oysters from this area and if they do, it is unlikely they would say so in a survey.

Based on consumption rates identified in a site specific angler survey, eating crab meat meals taken from waters adjacent to the AWI site is safe for the majority of people. However, as stated in the VDH web page on Virginia Fishing Advisories…"High risk individuals such as **women who are pregnant or may become pregnant, nursing mothers, and young children** are

advised not to eat any fish contaminated either with polychlorinated biphenyls (PCBs) or mercury from the respective advisory areas."
http://www.vdh.virginia.gov/epidemiology/DEE/PublicHealthToxicology/Advisories/index.htm

PCB concentrations in whole crabs are within the same range (50 to 500 ppb) that trigger a fish consumption advisory in Virginia (Wasti, 2004b). It should be noted that in derivation of their PCB doses and advisory concentrations, VDH assumes a 50% preparation factor (PCB concentrations are reduced by 50% due to cleaning and cooking). Based on data from Zabik, et al. (1992) for blue crab, this preparation factor may be overestimated and result in an underestimate of PCB doses (or an overestimate of the cancer screening value).[2] Additionally, some of the estimated whole crab exposure doses are within an order of magnitude of the LOAELs for non-cancer effects. Consequently, dioxin and PCB concentrations in whole crabs should be addressed in an updated VDH fish advisory for the Southern Branch of the Elizabeth River.

Consumption of PCBs in crab meat result in estimated doses that are below all relevant comparison values for up to ~33 crab meat meals per year (or about 3 meals per month; Figure 2). At about 33 crab meat meals per year, estimated doses exceed the VA cancer screening risk value). The non-cancer screening value and ATSDR MRL are not exceeded by up to 125 crab meat meals per year (Figure 2). The VDH estimates of PCB exposure differ from these estimated exposures in two significant ways. First, as mentioned above, VDH assumes that 50% of the PCBs in crab meat are not ingested as a result of losses during cooking and preparation. Secondly, VDH assumes PCB concentrations in crab meat to be average PCB concentrations rather than the 95th % UCL assumed in ATSDR calculations.

ATSDR agrees that the average PCB concentration in crab meat is the most appropriate value to use in estimating doses. However, the 95th % UCL is an upper bound estimate of the mean that reflects how well the sample data predict the "true" mean. Few samples with a great deal of scatter will result in a 95th %UCL that is much higher than the sample mean. Lots of samples with a small scatter of values will result in a 95th % UCL that is close to the sample mean. The AWI crab meat samples are based on only eight samples with considerable range of values (2.6 ppb to 52 ppb; mean 12 ppb). These concentrations are very similar to a five sample average measured by VDEQ (mean 11 ppb; Attachment 2). Due to the relatively small number of measured PCB concentrations in crab meat and the scatter of those values, ATSDR is using 23 ppb (95th % UCL; Table 1 and Attachment 2) as a health protective estimate of the average value for estimating doses.

2 It should also be noted that PCB preparation losses in crab meat are almost completely retained in the pot water from boiling or steaming and depend on whether the hepatopancreas is removed prior to cooking. Any use of the pot water in additional cooking for soups or stews will result in ingestion of the total PCBs (Zabik, et.al., 1992).

Regarding the original recommendation in the 1994 ATSDR Atlantic Wood Industries PHA to "Determine if the ban on collecting shellfish is effective and determine if the ban should include fin fish" the 2005 angler survey (Gibson and McClafferty, 2005) found that crab meat taken near the AWI site is regularly consumed, whole crabs are rarely consumed, and did not address the taking or consumption of oysters and other Molluscan shellfish. Also, a fin fish advisory for PCBs and kepone has been added for this area and remains in place (VDH web site, 2008).

Children's Health Considerations

ATSDR is committed to evaluating the special interests of children at sites such as Atlantic Wood. Children could have been exposed to PCBs in the womb during their mothers' pregnancies and while nursing if their mothers ate fish from the waterways near AWI. As they were weaned and began eating food from their parents' plates, they could have been exposed to PCBs in the fish their parents ate, but in smaller amounts. ATSDR estimated that the youngest, most vulnerable children could have eaten as much as one-third the amount of the adults. In addition, children living near the AWI could have been exposed to small amounts of PCBs if they played in the sediment and soil along AWI. From the exposure scenarios considered, however, the highest doses would have come from fish consumption—still, these doses are not expected to have caused them harm.

Nursing infants represent a subpopulation especially sensitive to PCB exposure. Breast milk has a high fat content, and PCBs are excreted in the milk. Breast-fed infants have an additional risk caused by a steroid that is excreted in human breast milk that inhibits the infants' ability to excrete PCBs. A study by Gladen et al. (1988) did not demonstrate any effect on infant psychomotor response associated with exposure through breastfeeding. Further, there are several advantages of breastfeeding, including improved nutrition, increased resistance to infection, protection against allergies, and better parent-child relationships. "With full regard for the uncertainty over the toxic effects of organochlorines in human milk, the known benefits of breastfeeding are extensive and serve as a strong rationale for advising mothers to continue to breast feed their newborns unless cautioned by their local health care worker to reduce or stop" (Van Oostdam et al. 1999).

We have not estimated specific child doses because resulting PCB and dioxin doses to a breast-feeding infant are based on intakes and body burdens of the mother. Although we have not calculated child-specific exposure doses for ingestion of crabs and oysters from the AWI area, we do recognize and support the VDH finding that ..."*High risk individuals such as* ***women who are pregnant or may become pregnant, nursing mothers, and young children*** *are advised not to eat any fish contaminated either with polychlorinated biphenyls (PCBs) or mercury from the respective advisory areas.*"

Conclusions and Recommendations

1) Based on measured concentrations of PCBs in crab meat and whole crabs and angler surveys of blue crab consumption rates, consumption of two crab meat meals per month is safe for most people.

2) The VDH should consider adding blue crab to the current PCB fishing advisory recommending limiting of crab meals to two times per month and no consumption for "high risk individuals." This would also cover exposures to "dioxins" in crabs.

3) Arsenic and dioxin doses from consumption of crab meat taken from the AWI area are below levels of public health concern for expected rates of consumption. Subsistence and recreational fishermen who eat more than two fish and crab meals per month should not take all of their catch from the AWI area.

4) Whole crabs and crab hepatopancreas (mustard) should not be consumed from the Southern Branch of the Elizabeth River. As such, it is recommended that proper signs be posted—especially in high access areas such as the fishing piers and boat ramps.

Based on the above conclusions, consumption of up to 2 crab meat meals per month taken adjacent to the AWI site is "no apparent public health hazard" for most people. This conclusion means that eating crab meat from this area will result in an increased intake of PCBs and dioxins but the doses are unlikely to produce any adverse health effects. More frequent consumption of crab meat, or any crab hepatopancreas (whole crab), or oysters from this area represents a public health hazard due to an increased risk of cancer and other potential health effects from PCBs, dioxins, and arsenic. Sensitive individuals such as pregnant or nursing women and young children should not consume fish, crabs, or other seafood from this area.

Public Health Action Plan

ATSDR will initiate discussions with the Virginia Sea Grant, the Chesapeake Bay Program, the Virginia Department of Health, and other appropriate programs to develop educational materials that inform anglers and seafood consumers of the above public health recommendations.

The VDH will develop and post appropriate language concerning consumption risks of crab hepatopancreas on their website devoted to fish consumption advisories and warnings.

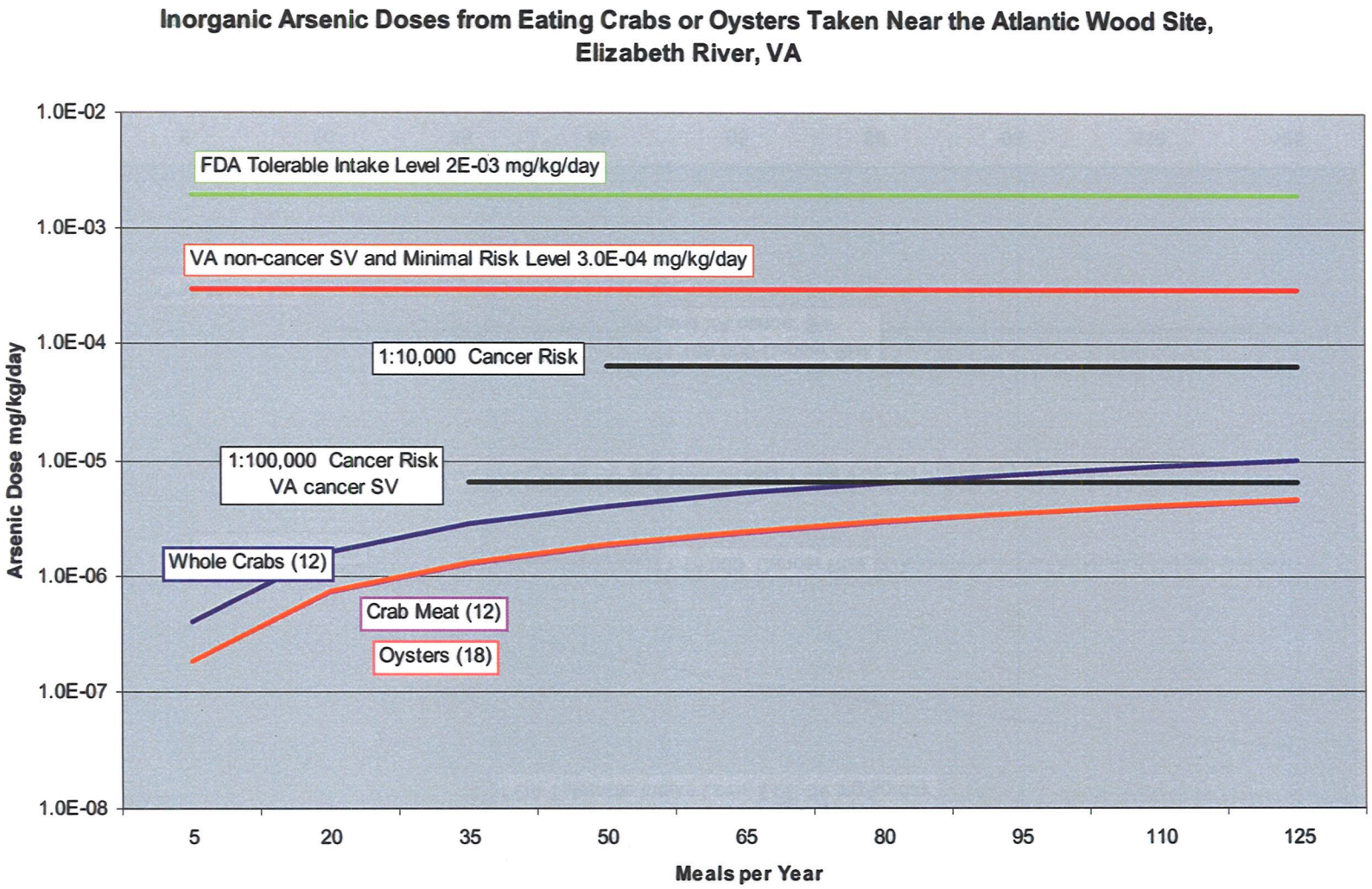

Figure 1. Estimated inorganic arsenic doses from eating crab meat, whole crab, and oysters.

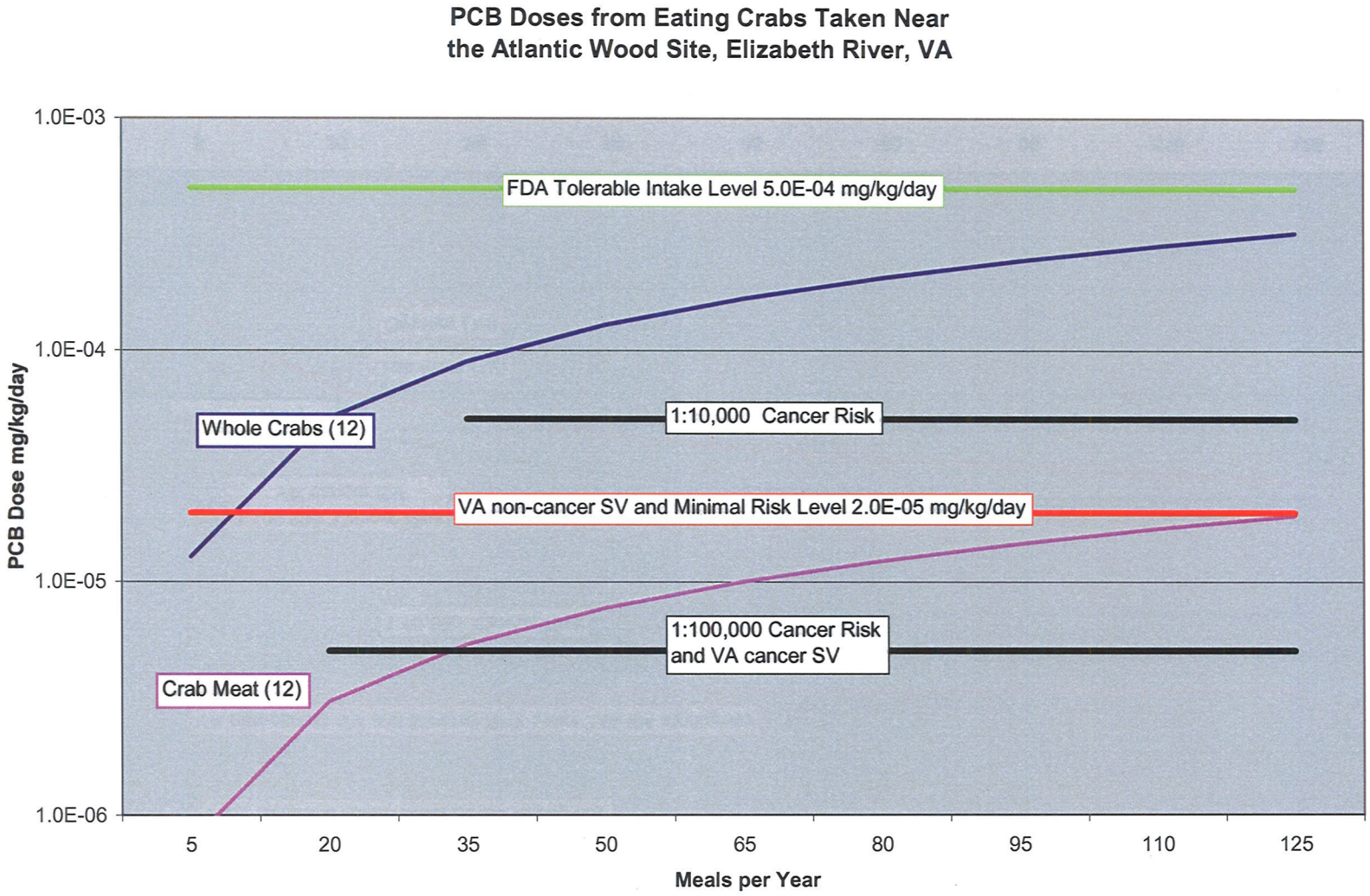

Figure 2. Estimated PCB doses from eating crab meat and whole crab.

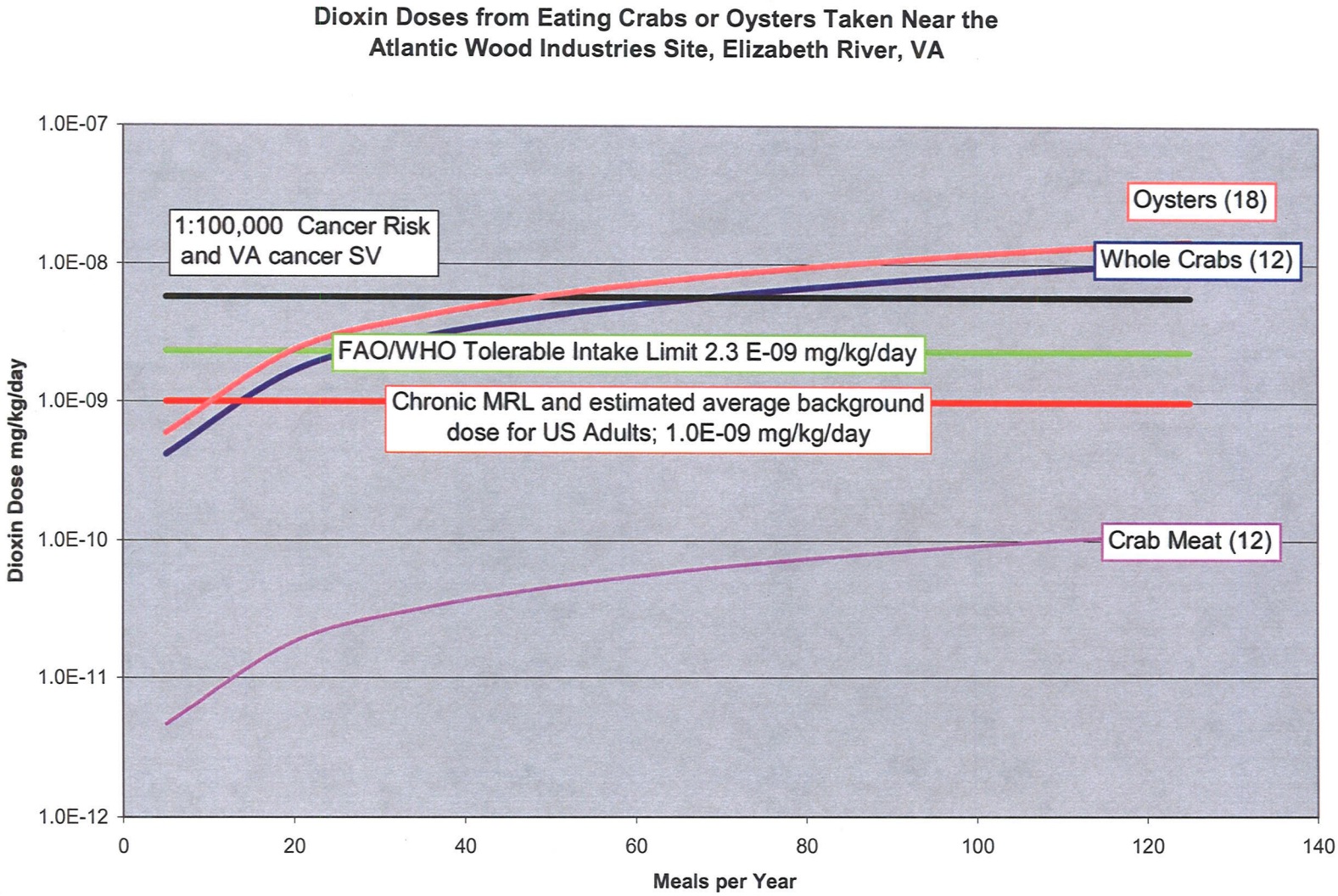

Figure 3. Dioxin doses from eating crab meat, whole crab, and oysters.

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Attachment 1

James River Fish Advisories, Virginia Department of Health, Division Environmental Epidemiology (downloaded January 15, 2008).
http://www.vdh.virginia.gov/epidemiology/DEE/PublicHealthToxicology/Advisories/JamesRiver.htm

James River from the I-95 James River bridge in Richmond downstream to the Hampton Roads Bridge Tunnel and the tidal portion of the following tributaries: Appomattox River up to Lake Chesdin Dam, Bailey Creek up to Rt. 630, Poythress Run, Bailey Bay, Chickahominy River up to Walkers Dam, Skiffes Creek up to Skiffes Creek Dam, Pagan River and its tributary Jones Creek, Chuckatuck Creek, Nansemond River and its tributaries Bennett Creek and Star Creek, Hampton River, Willoughby Bay and the Elizabeth River system (Western Br., Eastern Br., Southern Br., and Lafayette River) and tidal tributaries St. Julian Creek, Deep Creek, and Broad Creek. These river segments comprise ~325 miles. (PCBs, 7/1/02; modified 6/15/04;12/13/04; Kepone, 7/1/88; 10/10/06)	Richmond City, Henrico Co., Chesterfield Co., Charles City Co., Hopewell City, Colonial Heights City, Petersburg City, Dinwiddie Co., Prince George Co., Surry Co., James City., New Kent Co., Isle of Wight Co., Newport News City, Suffolk City, Portsmouth City, Hampton City, Norfolk City, Chesapeake City and Virginia Beach City	PCBs	Gizzard Shad	DO NOT EAT
		PCBs	Carp	DO NOT EAT
		PCBs	Blue Catfish ≥ 32 inches	DO NOT EAT
		PCBs	Flathead Catfish ≥ 32 inches	DO NOT EAT
		PCBs	Blue Catfish < 32 inches	No more than two meals/month
		PCBs	Flathead Catfish < 32 inches	
		PCBs	Channel Catfish	
		PCBs	White Catfish	
		PCBs	Largemouth Bass	
		PCBs	Bluegill Sunfish	
		PCBs	American Eel	
		PCBs	Quillback Carpsucker	
		PCBs	Smallmouth	

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			Bass	No more than two meals/month
		PCBs	Creek Chub	
		PCBs	Yellow Bullhead Catfish	
		PCBs	White Perch	
		PCBs	Anadromous (coastal) Striped Bass	
		PCBs	Bluefish	
		PCBs	Croaker	
		PCBs	Spot	
		PCBs	Blueback Herring	
		PCBs	Hickory Shad	
		Kepone	All Species	Limit consumption on a daily basis. However, PCBs advisory is more restrictive. Follow the PCBs advisory for the species listed.

Attachment 2.

Contaminant concentrations in fish, crab meat, whole crabs, and oysters taken near the Atlantic Wood Industries Site in the Southern Branch, Elizabeth River

The following data for crabs and oysters were collected and analyzed by Region 3 EPA and provided to ATSDR as electronic files (e-mail message from Ana Pomales to Mark Evans, August 7, 2007).

The fish PCB data were collected and analyzed by the Virginia Department of Environmental Quality and downloaded from the VADEQ website (http://www.deq.virginia.gov/fishtissue/fishtissue.html).

Note that the contaminant results are listed for fish, crab meat, whole crabs, and oysters in separate tables and that crab meat, whole crab, and oyster values are in parts per million (ppm) while the fish values are in parts per billion (ppb).

Chemical concentrations in whole crabs collected adjacent to the AWI Site				
Chemical of Potential Concern	Mean ppb	Maximum ppb	Exposure Point Value ppb	Exposure Point Statistic
Dioxin TEQ(1989) (5)	0.0047	0.012	0.0072	Approx. Gamma UCL
Dioxin TEQ(1998WHO)	0.0055	0.013	0.0081	Approx. Gamma UCL
Mercury	44	58	49	Student's-t UCL
Arsenic (total)	3000	3400	3200	Student's-t UCL
Arsenic (inorganic)	50	58	53	Student's-t UCL
Dimethylarsinic Acid (organic arsenic)	133	169	152	Student's-t UCL
Cadmium	430	620	500	Student's-t UCL
Cobalt	83	110	92	Student's-t UCL
Copper	36000	48000	41000	Student's-t UCL
Iron	16000	19000	17000	Student's-t UCL
Lead	89	200	120	Student's-t UCL
Selenium	1000	1200	1100	Student's-t UCL
Thallium	220	240	240	Max
Vanadium	140	200	200	Max
Zinc	40000	43000	41000	Student's-t UCL
4,4'-DDE	19	35	24	Student's-t UCL
4-4'-DDT	3.6	22	20	97.5% Chebyshev UCL
Aroclor-1260	180	390	250	95% H-UCL
alpha-BHC	0.36	0.53	0.44	Student's-t UCL
beta-BHC	0.95	2.3	1.7	Approx. Gamma UCL
Dieldrin	5.8	10	7.1	Approx. Gamma UCL
delta-BHC	0.85	2.2	1.3	Student's-t UCL
Heptachlor	0.38	0.89	0.76	95% Chebyshev UCL
Heptachlorepoxide	3.8	5.3	4.4	Student's-t UCL
Benzo(a)anthracene	13	36	35	95% Chebyshev UCL
Benzo(a)pyrene	10	25	15	Student's-t UCL
Benzo(b)fluoranthene	23	50	33	Student's-t UCL
Dibenzo(a,h)anthracene	2.6	4.1	3.3	Student's-t UCL
Indeno(1,2,3-cd)pyrene	4.3	10	6.1	Student's-t UCL

Notes:--Inorganic arsenic in whole crab assumes that crab meat comprises 70% of ingested mass and crab mustard comprises 30% of ingested crab mass.

--Contaminants highlighted in green have concentrations lower than FDA tolerances, action or guidance levels (previous table).

--Contaminants not highlighted do not have applicable FDA tolerances or action or guidance levels.

Chemical concentrations in oysters collected adjacent to the AWI Site

Chemical of Potential Concern	Mean ppb	Maximum ppb	Exposure Point Value ppb	Exposure Point Statistic
Dioxin TEQ(1989) (5)	0.00096	0.0082	0.0055	99% Chebyshev UCL
Dioxin TEQ(1998WHO) (5)	0.00097	0.0081	0.0018	Approx. Gamma UCL
Mercury	23	42	27	Mod-t UCL
Aluminum	24000	33000	26000	Student's-t UCL
Arsenic (total)	760	1100	820	Student's-t UCL
Arsenic (inorganic)	40	54	42	Student's-t UCL
Dimethylarsinic Acid (organic arsenic)	111	195	132	Student's-t UCL
Barium	260	580	310	Student's-t UCL
Cadmium	690	1000	770	Student's-t UCL
Cobalt	130	190	150	Student's-t UCL
Copper	77000	130000	85000	Student's-t UCL
Iron	66000	89000	74000	Approx. Gamma UCL
Selenium	370	760	420	Approx. Gamma UCL
Thallium	100	250	220	95% Chebyshev UCL
Vanadium	120	180	130	Student's-t UCL
Zinc	1100000	1600000	1200000	Student's-t UCL
Aldrin	0.41	1.4	0.71	95% Chebyshev UCL
alpha-BHC	1.3	3.7	2.2	95% H-UCL
beta-BHC	0.81	7.7	2.8	95% Chebyshev UCL
Dieldrin	0.59	2.4	0.82	Mod-t UCL
Heptachlor	2.2	6.8	5.7	97.5% Chebyshev UCL
Heptachlor Epoxide	0.63	1.4	0.98	95% Chebyshev UCL
Benzo(a)anthracene	170	540	540	Max
Benzo(a)pyrene	220	710	710	Max
Benzo(b)fluoranthene	450	1400	1400	Max
Benzo(k)fluoranthene	270	910	910	Max
Chrysene	240	790	790	Max
Dibenzo(a,h)anthracene	25	84	65	97.5% Chebyshev UCL
Indeno(1,2,3-cd)pyrene	53	160	140	97.5% Chebyshev UCL

--Contaminants highlighted in green have concentrations lower than FDA tolerances, action or guidance levels (previous table).

--Contaminants not highlighted do not have applicable FDA tolerances or action or guidance levels.

Crab Meat, Crabs Collected adjacent to the AWI Site				
Chemical of Potential Concern	Mean ppb	Maximum ppb	Exposure Point Value ppb	Exposure Point Statistic
Dioxin TEQ(1989) (5)	0.000087	0.00026	0.00014	Student's-t UCL
Dioxin TEQ(1998WHO)	0.00008	0.00025	0.00014	Student's-t UCL
Mercury	55	71	62	Student's-t UCL
Arsenic (total)	2700	3200	2900	Student's-t UCL
Arsenic (inorganic)	39	43	41	Student's-t UCL
Dimethylarsinic Acid (organic arsenic)	78	110	90	Student's-t UCL
Cobalt	11	17	13	Student's-t UCL
Copper	12000	14000	13000	Approx. Gamma UCL
DDE	6.4	13	8.4	Approx. Gamma UCL
Selenium	700	920	760	Approx. Gamma UCL
Thallium	220	250	270	Student's-t UCL
Arochlor 1260 (PCB)	12	52	23	Student's-t UCL
Dieldrin	0.58	1.4	0.79	Student's-t UCL
Heptachlor Epoxide	0.32	0.91	0.48	Student's-t UCL
Benzo(a)anthracene	6.5	18	10	Approx. Gamma UCL
Benzo(a)pyrene	5.7	12	8.3	Student's-t UCL
Benzo(b)fluoranthene	11	28	17	Student's-t UCL
Dibenzo(a,h)anthracene	2.4	4	3.3	Student's-t UCL
Indeno(1,2,3-cd)pyrene	2.8	5.3	3.9	Student's-t UCL

--Contaminants highlighted in green have concentrations lower than FDA tolerances, action or guidance levels (previous table).

--Contaminants not highlighted do not have applicable FDA tolerances or action or guidance levels.

2005 PCBs (http://www.deq.virginia.gov/fishtissue/documents/2005pcbsfish.xls)				
Station name/location/description	Sampling Date	Fish species name	ppb[1] (wet wt)	mg/kg
			Total PCB[2]	Total PCB[2]
Southern Branch Elizabeth River upstream Gilmerton bridge	6/22/2005	Mummichog !!!	92.91	0.09
	6/22/2005	Gizzard Shad - 1	640.49	0.64
	6/22/2005	Gizzard Shad - 2	339.64	0.34
	6/22/2005	Croaker	96.54	0.10
	6/22/2005	Menhaden	140.53	0.14
	6/22/2005	Blue Crab	11.40	0.011

Attachment 3

Environmental Chemical Contaminant and Pesticide Tolerances, Action Levels, and Guidance Levels (from FDA, 2001).

Deleterious Substance	*Level ppb*	*Food Commodity*	*Reference*
Aldrin/Dieldrin[a]	300	All fish	Compliance Policy Guide sec. 575.100
Benzene hexachloride	300	Frog legs	Compliance Policy Guide sec. 575.100
Chlordane	300	All fish	Compliance Policy Guide sec. 575.100
Chlordecone[b]	300	All fish Crabmeat	Compliance Policy Guide sec. 575.100
	400	Crabmeat	
DDT, TDE, DDE[c]	5,000	All fish	Compliance Policy Guide sec. 575.100
Diquat[d]	100	All fish	40 CFR 180.226
Fluridone[d]	500	Fin fish and crayfish	40 CFR 180.420
Glyphosate[d]	250	Fin fish	40 CFR 180.364
	300	Shellfish	
Toxic elements:			
Arsenic	76,000	Crustacea	FDA Guidance Document
	86,000	Molluscan bivalves	FDA Guidance Document
Cadmium	3,000	Crustacea	FDA Guidance Document
	4,000	Molluscan bivalves	FDA Guidance Document
Chromium	12,000	Crustacea	FDA Guidance Document
	13,000	Molluscan bivalves	FDA Guidance Document
Lead	1,500	Crustacea	FDA Guidance Document
	1,700	Molluscan bivalves	FDA Guidance Document
Nickel	70,000	Crustacea	FDA Guidance Document
	80,000	Molluscan bivalves	FDA Guidance Document
Methyl Mercury[f]	1,000	All fish	Compliance Policy Guide sec. 540.600
Heptachlor / Heptachlor Epoxide[e]	300	All fish	Compliance Policy Guide sec. 575.100

Attachment 3

Environmental Chemical Contaminant and Pesticide Tolerances, Action Levels, and Guidance Levels (from FDA, 2001).

Deleterious Substance	*Level ppb*	*Food Commodity*	*Reference*
Mirex	100	All fish	Compliance Policy Guide sec. 575.100
Polychlorinated Biphenyls (PCB's)[d]	2,000	All fish	21 CFR 109.30
Simazine[d]	12,000	Fin fish	40 CFR 180.213a
2,4-D[d]	1,000	All fish	40 CFR 180.142

[a] The action level for aldrin and dieldrin are for residues of the pesticides individually or in combination. However, in adding amounts of aldrin and dieldrin, do not count aldrin or dieldrin found at below 0.1 ppm.
[b] Previously listed as Kepone, the trade name of chlordecone.
[c] The action level for DDT, TDE, and DDE are for residues of the pesticides individually or in combination. However, in adding amounts of DDT, TDE, and DDE, do not count any of the three found below 0.2 ppm.
[d] The levels published in 21 CFR & 40 CFR represent tolerances, rather than guidance levels or action levels.
[e] The action level for heptachlor and heptachlor epoxide are for the pesticides individually or in combination. However, in adding amounts of heptachlor and heptachlor epoxide, do not count heptachlor or heptachlor epoxide found below 0.1 ppm.
[f] See Chapter 10 for additional information.
Note: the term "fish" refers to fresh or saltwater fin fish, crustaceans, other forms of aquatic animal life other than birds or mammals, and all mollusks, as defined in 21 CFR 123.3(d).