Letter Health Consultation

Greater Elliott Bay Sediment and English sole
Seattle, King County, Washington

August 6, 2009

Prepared by

The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

DOH 334-213 August 2009

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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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STATE OF WASHINGTON
DEPARTMENT OF HEALTH
Division of Environmental Health
Office of Environmental Health Assessments
234 Israel Road S.E. ☐Town Center 3 ☐PO Box 47846 ☐Olympia, Washington 98504-7846
Tel: 360.236.3184 ☐Toll Free: 1.877.485.7316 ☐FAX: 360.236.2251
☐TDD Relay Service: 1.800.833.6388

Health Consultation Memorandum

May 1, 2009

TO:	Janice Sloan and Tom Gries Washington State Department of Ecology (Ecology)
FROM:	Lenford O'Garro Washington State Department of Health (DOH)
SUBJECT:	Greater Elliott Bay (Seattle) surface sediment and English sole contamination

Summary

Introduction:
In the greater Elliott Bay community, DOH's top priority is to ensure that the community has the best information possible to safeguard its health. Ecology asked DOH to conduct this health consultation. The purpose of this Letter Health Consultation (LHC) is to evaluate whether contaminants found in surface sediment (sediment throughout this LHC applies to surface sediment) and English sole fish in greater Elliott Bay, Seattle, Washington pose a health hazard to humans.

Conclusion:
DOH concludes that touching, breathing or accidentally eating sediment from the greater Elliott Bay is not expected to harm people's health. Also, the current fish advisory for Elliott Bay under the Puget Sound Fish Consumption Advisory Recreational Marine Area 10 is protective even when considering dioxin contamination.

Basis for conclusion:
The sediment samples were taken at depth in about four to six feet of water and this area is also an active shipping lane; therefore, it is unlikely there is a completed route of exposure to people. The advisory states "Eat no more than two meals per month of flatfish/bottom fish from Elliott Bay".

For More Information:
Please feel free to contact Lenford O'Garro (360) 236-3376 or 1-877-485-7316 if you have any questions about this memo.

Statement of Issues:

The Washington State Department of Health prepared this letter health consultation at the request of Ecology. The purpose of this letter health consultation is to evaluate whether contaminants found in surface sediment and English sole fish in greater Elliott Bay, Seattle, Washington pose a health hazard to humans. DOH prepares letter health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background:

Elliott Bay is located at the mouth of the Lower Duwamish Waterway (LDW) in Seattle, Washington. Greater Elliott Bay is defined by a line drawn between Alki Point and Four Mile Rock (Magnolia Bluff, Seattle) extending to approximately river mile 4.0 in the LDW [1]. The shoreline land use is primarily urban and industrial with some mixed and residential uses. Previous studies have identified polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and some trace metals as contaminants of concern in this area. Historically, discharges from heavy and light industries, maritime trade, municipal wastewater treatment plants, stormwater and surface runoff, combustion, and aerial deposition were the main sources of these contaminants.

In 2007, Ecology collected English sole (*Parophrys vetulus*) fish tissue (whole body and skinless fillet) and surface sediment samples from greater Elliott Bay to fill data gaps. A total of 15 English sole fish tissue samples were tested for dioxins/furans. Surface sediments from 0-2 and 0-10 cm depth intervals were collected from 30 locations. The maximum levels of contaminants in sediments are shown in Table 1 and the average level of dioxin in fish in Table 2.

In 2006, DOH evaluated contaminants in Puget Sound fish. Elliott Bay falls under the Puget Sound Fish Consumption Advisory Recreational Marine Area 10, with a fish advisory that states people should eat no more than two meals per month of flatfish/bottom fish from Elliott Bay (English sole and Starry Flounder) [2]. Additionally, the LDW including Harbor Island, East and West Waterways has a no consumption advisory for flatfish/bottom fish [2].

Discussion:

Contaminants of concern (COC) in sediment were determined by employing a screening process. Maximum sediment contaminant levels were screened against health-based soil comparison values. Several types of health-based comparison or screening values were used during this process. Comparison values such as ATSDR's Cancer Risk Evaluation Guide (CREG) and Environmental Media Evaluation Guide (EMEG) offer a high degree of protection and assurance that people are unlikely to be harmed by contaminants in the environment. For chemicals that cause cancer, the comparison values represent levels that are calculated to increase theoretical risk of cancer by about one in a million. In general, if a contaminant's maximum concentration is greater than its comparison value, then the contaminant is evaluated further.

Comparisons may also be made with legal standards such as the cleanup levels specified in the Washington State toxic waste cleanup law, the Model Toxics Control Act (MTCA). Legal standards may be strictly health-based or they may incorporate non-health considerations such as the cost or the practicality of attainment or natural background levels. These types of comparison values often form the basis for cleanup. Contaminants of concern in sediments were carcinogenic polycyclic aromatic hydrocarbons (cPAHs) (ranged from 0.01 to 2.3 ppm) and dioxin (ranged from 0.00000067 to 0.0000976 ppm).

Table 1. Maximum concentrations of contaminants detected in sediment within Elliott Bay in Seattle, Washington.

Compounds	Maximum Concentration (ppm)	Comparison Value (ppm)	EPA Cancer Class	Comparison Value Reference	Contaminant of Concern (COC)
2-Methylnaphthalene	0.38	200		RMEG	No
Acenaphthene	0.447	3000		RMEG	No
Acenaphthylene	0.708	2000*	D		No
Anthracene	1.42	20000	D	RMEG	No
Benzo(ghi)perylene	0.947	2000*	D		No
Dibenzofuran	0.829	290	D	Region 9	No
Fluoranthene	2.24	2000	D	RMEG	No
Fluorene	0.515	2000	D	RMEG	No
Naphthalene	0.961	30000	C	IM EMEG	No
Phenanthrene	1.74	2000*	D		No
Pyrene	3.6	2000	D	RMEG	No
Benzo(a)anthracene	1.0	0.62	B2	Region 9	cPAH
Benzo(a)pyrene	1.89	0.1	B2	CREG	cPAH
Benzo(b)fluoranthene	2.34	0.62	B2	Region 9	cPAH
Benzo(k)fluoranthene	0.815	6.2	B2	Region 9	cPAH
Chrysene	1.92	62	B2	Region 9	cPAH
Dibenz(a,h)anthracene	0.211	0.1**		CREG	cPAH
Indeno(1,2,3-cd)pyrene	1.3	0.62	B2	Region 9	cPAH
Total cPAH TEQ	2.3	0.1	B2	CREG	**Yes**
Total Dioxins TEQ	0.0000976	0.00005	B2	EMEG	**Yes**
Total PCB	0.317	1		EMEG	No
Arsenic	13.7	20	A	EMEG	No
Cadmium	0.71	10	B1	EMEG	No
Chromium	69.4	200***	A	RMEG	No
Copper	94.6	2,000	D	IM EMEG	No

Lead	86	250	B2	MTCA	No
Nickel	64	1000		RMEG	No
Selenium	1.3	300	D	EMEG	No
Silver	1.34	300	D	RMEG	No
Tin	132	20000		IM EMEG	No
Zinc	136	20000	D	EMEG	No

* Fluoranthene RMEG value was used as a surrogate
* * Benzo(a)pyrene CREG value was used as a surrogate
* ** Assume hexavalent chromium
CREG - ATSDR's Cancer Risk Evaluation Guide (child)
RMEG - ATSDR's Reference Dose Media Evaluation Guide (child)
EMEG - ATSDR's Environmental Media Evaluation Guide (child)
IM EMEG - ATSDR's Intermediate Environmental Media Evaluation Guide (child)
A - EPA: Human carcinogen
B1 - EPA: Probable human carcinogen (limited human, sufficient animal studies)
B2 - EPA: Probable human carcinogen (inadequate human, sufficient animal studies)
C - EPA: Possible human carcinogen (no human, limited animal studies)
D - EPA: Not classifiable as to health carcinogenicity
Region 9 – EPA: Preliminary Remediation Goals
MTCA - Model Toxics Control Act Method A - Soil Cleanup Level for Unrestricted Land Use
Total Dioxin TEQ – sum of dioxin/furans toxic equivalent (TEQ)
Total cPAH TEQ – sum of all carcinogenic polycyclic aromatic hydrocarbons (cPAH) toxic equivalent (TEQ); all cPAH in COC are added using the TEQ approach to obtain Total cPAH TEQ.
PPM – parts per million

Table 2. Dioxin concentrations detected in English sole from the greater Elliott Bay in Seattle, Washington.

Species	Contaminant	Average Concentration (ppt)	EPA Cancer Class
English sole (whole)	Total Dioxin TEQ	1.35	B2
English sole (fillet)		0.397	

B2 - EPA: Probable human carcinogen (inadequate human, sufficient animal studies)
Total Dioxin TEQ – sum of dioxin/furans toxic equivalent (TEQ)
PPT – parts per trillion

Chemical Specific Toxicity

Below are general summaries of COC health effects. The public health implications of exposure to these COCs from sediments and tissues are discussed later.

Dioxins and Furans, and cPAHs TEQ concentrations

Although several dioxin and furan congeners were analyzed in tissue, only a single value called a dioxin toxic equivalent (TEQ) is presented in this health consultation. Each dioxin/furan or dioxin-like PCB congener is multiplied by a Toxic Equivalency Factor (TEF) to produce the dioxin TEQ. The TEQs for each chemical are then summed to give the overall 2,3,7,8-tetrachlorodibenzo-p-dioxin TEQ. The TEQ approach is based on the premise that many dioxins/furans and dioxin-like PCB congeners are structurally and toxicologically similar to 2,3,7,8-tetrachlorodibenzo-p-dioxin. TEFs are used to account for the different potencies of dioxins and furans relative to 2,3,7,8-tetrachlorodibenzo-p-dioxin and are available for ten chlorinated dibenzofurans and seven chlorinated dibenzodioxins using the World Health Organization (WHO) methodology [3]. A similar TEQ approach is developed for each cPAH based on the relative potency to benzo(a)pyrene.

Dioxins and furans

Dioxins and furans (dioxins) consist of about 210 structural variations of dioxin congeners which differ by the number and location of chlorine atoms on the chemical structure. The primary sources of dioxin releases to the environment are the combustion of fossil fuels and wood; the incineration of municipal, medical and hazardous waste; and certain pulp and paper processes. Dioxins also occur at very low levels from naturally occurring sources and can be found in food, water, air, and cigarette smoke.

The most toxic of the dioxin congeners, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) can cause chloracne (a condition of acne like lesions on the face and neck). Exposure to high levels of dioxins can cause liver damage, developmental effects, and impaired immune function [4]. Long-term exposure to dioxins could increase the likelihood of developing cancer. Studies in rats and mice exposed to TCDD resulted in thyroid and liver cancer [5]. EPA considers TCDD to be a probable human carcinogen and developed a cancer slope factor of $1.5\text{x } 10^{5}$ mg/kg/day [6, 7].

Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are generated by the incomplete combustion of organic matter including oil, wood, and coal. They are found in materials such as creosote, coal, coal tar, and used motor oil. Based on structural similarities, metabolism, and toxicity, PAHs are often grouped together when one is evaluating their potential for adverse health effects. EPA has classified some PAHs – called cPAHs – as probable human carcinogens (Cancer Class B2) as a result of *sufficient* evidence of carcinogenicity in animals and *inadequate* evidence in humans [8].

Benzo(a)pyrene is the only cPAH for which EPA has derived a cancer slope factor. The benzo(a)pyrene cancer slope factor was used as a surrogate to estimate the total cancer risk of cPAHs in sediment. It should be noted, benzo(a)pyrene is considered the most carcinogenic of the cPAHs. The use of its cancer slope factor as a surrogate for total cPAH carcinogenicity may overestimate risk. To address this issue, DOH made an adjustment for each cPAH based on the relative potency to benzo(a)pyrene or TEQ [8].

Dietary sources make up a large percentage of PAH exposure in the U.S. population. Smoked or barbecued meats and fish contain relatively high levels of PAHs. However, the majority of dietary exposure to PAHs for the average person comes from ingestion of vegetables and grains (cereals) [9].

Beach Play Scenario

Although contact with sediments at the beaches may be an infrequent or seasonal exposure pathway, there is concern because areas along the greater Elliott Bay have elevated levels of contaminants (see Table 1). Exposure to contaminants in sediment can occur by swallowing it (ingestion exposure), breathing it (inhalation exposure) or getting it on the skin (dermal exposure). During recreational activities at the beaches, people are likely to be exposed to contaminants in sediments. In order for any contaminant to be a health concern, the contaminant must be present at a high enough concentration to cause potential harm, and there must be a completed route of exposure to people. These sediment samples were taken at depth in about four to six feet of water and this area is also an active shipping lane; therefore, it is unlikely that there is a completed route of exposure to people. However, in the event there is a completed route of exposure to people, dioxins and cPAHs are evaluated below since they exceed their health comparison values in sediments. Standard human health assessment for cancer and non-cancer risk was carried out using the formulas in Appendix A and results are shown in Tables A2 and A3. Theoretical cancer risk estimates for sediment exposure falls in the very low range and non-cancer risk is less than a hazard quotient of one.

Fish Meal Limits

ATSDR's Interaction Profile for persistent chemicals found in fish evaluates the possibility of interactive effects from exposure to a mixture of contaminants including mercury, PCBs and dioxins [10]. Mercury, dioxins and PCBs influence childhood development following *in utero* exposure. Therefore, meal limits were calculated assuming the toxicity of mercury, PCBs and dioxin are additive by summing individual hazard quotients yielding a *hazard index* of one.

Meal limits were calculated based on non-cancer endpoints of mercury, dioxin and PCBs. Meal limits based on the carcinogenic endpoint for dioxin and PCBs were not calculated because current weight-of-evidence is stronger for non-cancer versus cancer endpoints. Mercury, dioxin and PCBs have similar toxic non-cancer endpoints (i.e., immune and developmental endpoints). Meal limits were calculated that are considered protective of both the developing fetus and the general population.

In DOH's 2006 evaluation of Puget Sound fish, average mercury and PCB were 80 and 69 ppb respectively. Based on the average mercury and PCB levels in English sole from Elliott Bay, a fish advisory was set at two meals per month for flatfish/bottom fish from Elliott Bay.

The meal limits in Table B2 were derived from average dioxin, mercury and PCB levels in English sole from Elliott Bay. Exposure parameters are provided in Appendix B, Table B1. Average mercury and PCB data were taken from the data set used in the 2006 document [2]. The calculated additive meal limits are 2.15 meals per month for the immunologic endpoint and 2.3 meals per month for the developmental endpoint. The current fish advisory for Elliott Bay that states to eat no more than two meals per month of flatfish/bottom fish is protective of people who consume English sole fish from the greater Elliott Bay.

Conclusions

DOH concludes that touching, breathing or accidentally eating sediment from the greater Elliott Bay is not expected to harm people's health. These sediment samples were taken at depth in about four to six feet of water and this area is also an active shipping lane; therefore, it is unlikely that there is a completed route of exposure to people. Also, children or adults exposed to dioxin and cPAHs in sediments in a one-day-per-week or 52-days-per-year exposure scenario are within the acceptable theoretical cancer and non-cancer risk range.

The current fish advisory for Elliott Bay under the Puget Sound Fish Consumption Advisory Recreational Marine Area 10 is protective even with the addition of dioxin. The advisory states "Eat no more than two meals per month of flatfish/bottom fish from Elliott Bay".

Recommendations

- The current fish advisory for Elliott Bay under the Puget Sound Fish Consumption Advisory Recreational Marine Area 10 should remain in place.
- There are no additional recommendations at this time.

Please feel free to contact Lenford O'Garro (360) 236-3376 or 1-877-485-7316 if you have any questions about this memo.

References

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8. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs), (update) PB/95/264370. Atlanta: U.S. Department of Health and Human Services; August 1995.

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10. Agency for Toxic Substances and Disease Registry (ATSDR). Interaction Profile for Persistent Chemicals found in Fish (Chlorinated Dibenzo-p-Dioxins, Hexachlorobenzene,

p,p'-DDE, Methylmercury, Polychlorinated Biphenyls). Atlanta: U.S. Department of Health and Human Services; May 2004.

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Appendix A

This section provides calculated exposure doses and assumptions used for exposure to chemicals in sediments at Elliott Bay in Seattle, Washington. Three different exposure scenarios were developed to model exposures that might occur. These scenarios were devised to represent exposures to a child (0-5 yrs), an older child, and an adult. The following exposure parameters and dose equations were used to estimate exposure doses from direct contact with chemicals in sediment.

Exposure to chemicals in sediment via ingestion, inhalation, and dermal absorption.

Total dose $_{\text{(non-cancer)}}$ = Ingested dose + inhaled dose + dermally absorbed dose

Ingestion Route

$$\text{Dose}_{\text{(non-cancer (mg/kg-day)}} = \frac{\text{C x CF x IR x EF x ED}}{\text{BW x AT}_{\text{non-cancer}}}$$

$$\text{Cancer Risk} = \frac{\text{C x CF x IR x EF x CPF x ED}}{\text{BW x AT}_{\text{cancer}}}$$

Dermal Route

$$\text{Dermal Transfer (DT)} = \frac{\text{C x AF x ABS x AD x CF}}{\text{ORAF}}$$

$$\text{Dose}_{\text{(non-cancer (mg/kg-day)}} = \frac{\text{DT x SA x EF x ED}}{\text{BW x AT}_{\text{non-cancer}}}$$

$$\text{Cancer Risk} = \frac{\text{DT x SA x EF x CPF x ED}}{\text{BW x AT}_{\text{cancer}}}$$

Inhalation Route

$$\text{Dose}_{\text{non-cancer (mg/kg-day)}} = \frac{\text{C x SMF x IHR x EF x ED x 1/PEF}}{\text{BW x AT}_{\text{non-cancer}}}$$

$$\text{Cancer Risk} = \frac{\text{C x SMF x IHR x EF x ED x CPF x 1/PEF}}{\text{BW x AT}_{\text{cancer}}}$$

Table A1. Exposure assumptions used for exposure to cPAHs in sediment from Elliott Bay in Seattle, Washington.

Parameter	Value	Unit	Comments
Concentration (C)	Variable	mg/kg	Maximum detected value
Conversion Factor (CF)	0.000001	kg/mg	Converts contaminant concentration from milligrams (mg) to kilograms (kg)
Ingestion Rate (IR) – adult	100	mg/day	Exposure Factors Handbook [11]
Ingestion Rate (IR) – older child	100		
Ingestion Rate (IR) - child	200		
Exposure Frequency (EF)	52	Days/year	One days a week
Exposure Duration (ED)	30 (5,10,15)	years	Number of years at one residence (child, older child, adult yrs).
Body Weight (BW) - adult	72	kg	Adult mean body weight
Body Weight (BW) – older child	41		Older child mean body weight
Body Weight (BW) - child	15		0-5 year-old child average body weight
Surface area (SA) - adult	5700	cm^2	Exposure Factors Handbook
Surface area (SA) – older child	2900		
Surface area (SA) - child	2900		
Averaging Time$_{non\text{-}cancer}$ (AT)	1825	days	5 years
Averaging Time$_{cancer}$ (AT)	27375	days	75 years
Cancer Potency Factor (CPF)	7.3	$mg/kg\text{-}day^{-1}$	Source: EPA
24 hr. absorption factor (ABS)	0.13 0.14	unitless	Source: EPA (Chemical Specific) PAH PCBs
Oral route adjustment factor (ORAF)	1	unitless	Non-cancer (nc) / cancer (c) - default
Adherence duration (AD)	1	days	Source: EPA
Adherence factor (AF)	0.2	mg/cm^2	Child, older child
	0.07		Adult
Inhalation rate (IHR) - adult	15.2	m^3/day	Exposure Factors Handbook [11]
Inhalation rate (IHR) – older child	14		
Inhalation rate (IHR) - child	8.3		
Soil matrix factor (SMF)	1	unitless	Non-cancer (nc) / cancer (c) - default
Particulate emission factor (PEF)	1.45E+7	m^3/kg	Model Parameters

Table A2. Non-cancer hazard calculations resulting from exposure to cPAHs and dioxin in sediments from Elliott Bay in Seattle, Washington.

Contaminant	TEQ Concentration (ppm)	Scenarios	Estimated Dose (mg/kg/day)			Total Dose	RfD/ MRL/ LOAEL (mg/kg/day)	Total Dose/ (RfD/ MRL/ LOAEL)
			Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates			
cPAH	2.58	Child	4.90E-6	1.42E-6	3.39E-10	6.32E-6	1.0E+1	0.0000006
		Older Child	8.96E-7	5.20E-7	2.09E-10	1.42E-7		0.00000001
		Adult	5.11E-7	2.04E-7	1.29E-10	7.14E-7		0.00000007
Dioxin	0.0000976	Child	1.85E-10	5.38E-11	1.28E-14	2.39E-10	1.0E-9	0.24
		Older Child	3.39E-11	1.97E-11	7.92E-15	5.36E-11		0.054
		Adult	1.93E-11	7.718E-12	4.90E-15	2.70E-11		0.027

Theoretical Cancer Risk

Theoretical Cancer risk estimates do not reach zero no matter how low the level of exposure to a carcinogen. Terms used to describe this risk are defined below as the number of excess cancers expected in a lifetime:

Term		# of Excess Cancers
moderate	is approximately equal to	1 in 1,000
low	is approximately equal to	1 in 10,000
very low	is approximately equal to	1 in 100,000
slight	is approximately equal to	1 in 1,000,000
insignificant	is less than	1 in 1,000,000

Table A3. Cancer hazard calculations resulting from exposure to cPAHs and dioxin in sediments from Elliott Bay in Seattle, Washington.

Contaminant	Concentration (ppm)	EPA Cancer Class	Cancer Potency Factor (mg/kg-day^{-1})	Scenarios	Increased Cancer Risk			Total Cancer Risk
					Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates	
Total cPAH TEQ	2.58	B2	7.3	Child	2.39E-6	6.92E-7	1.65E-10	3.08E-6
				Older Child	8.73E-7	5.06E-7	2.09E-10	1.38E-6
				Adult	7.45E-7	2.97E-7	1.29E-10	1.04E-6
Total Dioxin TEQ	0.0000976	B2	1.5E+5	Child	1.85E-6	5.38E-7	1.28E-10	2.39E-6
				Older Child	6.78E-7	3.93E-7	1.58E-10	1.07E-6
				Adult	5.79E-7	2.31E-7	1.47E-10	8.11E-7

Lifetime cancer risk: 3.08E-6 + 1.38E-6 +1.04E-6 + 2.39E-6 + 1.07E-6 + 8.11E-7 = 9.77E-6

Appendix B

Meal Limit Calculations for dioxin Non-Carcinogenic Health Effects:

Meal limits were calculated based on developmental and immunologic endpoints for dioxin, mercury, and PCBs. Meal limits were calculated using the equation below in conjunction with the MRL or RfD as the target risk value and the exposure parameters provided in the Table B1 below. The developmental and immunologic endpoints are based on the additive effects of PCBs, and mercury as recommended in the ATSDR interaction profile for toxic contaminants found in fish. Table B2 provides fish meal limits that would be protective of women and children who eat fish English sole from Elliott Bay based on dioxin, mercury, and PCB.

ML = [(RfD or MRL)*BW* DM]/C * MS
ML = recommended fish meal limit per month (meal/month)
RfD = reference dose (EPA)
MRL = minimal risk level (ATSDR)

Many factors must be considered when one is recommending limits on the consumption of fish, including the very real health benefits of eating fish, the quality and comprehensiveness of environmental data, and the availability of alternate sources of nutrition. In addition, these limits do not consider that multiple species are consumed, a consideration that would require weighting of the percent of each species consumed. These allowable ingestion rates also do not consider the fact that cooking reduces exposure to some contaminants in fish. Therefore, allowable consumption limits for prepared fish would be greater than those shown in table B2.

Table B1. Exposure parameters used to calculate recommended fish consumption limits for greater English sole from Elliott Bay, Seattle, Washington.

Exposure Parameter	Endpoint		Units
	Developmental	Immunological	
Average Concentration (C)	variable		ug/kg
PCBs (RfD or MRL)	0.03	0.02	ug/kg/day
Mercury (RfD or MRL)	0.1	0.3	
Dioxin (RfD or MRL)	0.000001	0.00002	
Days per month (DM)	30.4	30.4	days/month
Mean Body Weight (BW)	60	60	kg
Meal size (MS)	0.227	0.227	kg

Table B2. Calculated meal limits per month for English sole from Elliott Bay in Seattle, Washington.

Average* Mercury concentration (ppb)	Average* PCB concentration (ppb)	Average Dioxin TEQ concentration (ppt) (fillet)	Developmental additive endpoint	Immune additive endpoint
80.0	69.0	0.397	2.3	2.15

* English sole based on data from current fish advisory for Elliott Bay, Puget Sound Recreational Marine Area 10.
PPB – parts per billion
PPT – parts per trillion

Certification

The Washington State Department of Health prepared this Letter Health Consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was completed 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.

Audra Henry
Technical Project Officer, CAPEB, DHAC
Agency for Toxic Substances & Disease Registry

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Gregg V. Ulirsch for (AY)

Alan W. Yarbrough
Team Lead, CAPEB, DHAC
Agency for Toxic Substances & Disease Registry