

Letter Health Consultation

Evaluation of Chemical Contaminants in Varnish and Manila Clams

Tulalip Reservation, Snohomish County, Washington

December 23, 2015

Prepared by

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



DOH 334-386 December 2015

Foreword

The Washington State Department of Health (DOH) prepared this health consultation in accordance with the Agency for Toxic Substances and Disease Registry (ATSDR) methodologies and guidelines. Health consultations are initiated in response to health concerns raised by community members or agencies about exposure to hazardous substances released into the environment. The health consultation summarizes our health findings and if needed, provides steps or actions to protect public health.

The findings in this report are relevant to conditions at the site during the time the report was written. It should not be relied upon if site conditions or land use changes in the future.

This report was supported by funds provided through a cooperative agreement with the ATSDR, U.S. Department of Health and Human Services. The findings and conclusions in these reports are those of the author(s) and do not necessarily represent the views of the ATSDR or the U.S. Department of Health and Human Services. This document has not been revised or edited to conform to agency standards.

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December 23, 2015

Michael E. McHugh
Tulalip Tribes of Washington
Shellfish Program Manager
6404 Marine Drive
Tulalip, WA 98271

Re: Evaluation of Chemical Contaminant Data from Varnish and Manila Clams at the Tulalip Tribes 95th Percentile Shellfish Consumption Rate
Tulalip Reservation, Snohomish County, Washington

Dear Mr. McHugh:

At the request of the Tulalip Tribes, the Washington State Department of Health (Health) evaluated chemical contaminant data from varnish and Manila clam tissue from Tulalip Reservation tidelands at the Tulalip 95th percentile shellfish consumption rate.

This letter health consultation provides a tribal exposure scenario limited to the evaluation of two species of clams collected from areas classified as approved and unclassified for commercial harvest, as well as areas that are closed to butter and varnish clams due to pollution.

Each of the clam species were evaluated separately at the Tulalip 95th percentile shellfish consumption rate. The species of shellfish used in developing the Tulalip shellfish consumption rate include the following: Manila/littleneck clams, horse clam, butter clam, cockles, mussels, oysters, shrimp, crabs (Dungeness and Red Rock), moon snail, scallops, squid, sea urchin, sea cucumber, geoduck, limpets, lobster, razor clam, chiton, octopus, abalone, barnacles, crayfish, and others.⁽¹⁾

This consult only addresses chemical contaminants; no microbial contaminants were evaluated. Based on the evaluation of these data, consuming Manila clams at the Tulalip 95th percentile shellfish consumption rate may significantly increase the risk of cancer over a lifetime. Consuming varnish clams at the Tulalip 95th percentile shellfish consumption rate is not expected to contribute to significant cancer risk.

Background and Statement of Issues

Fish and shellfish consumption rates for tribes/subsistence consumers are, in general, significantly higher than consumption rates established for other populations. A shellfish consumption rate typically used in health risk assessment for recreational harvesters is 1.7 grams of shellfish per day, which is about 10% of the EPA-established general population fish and shellfish consumption rate.⁽²⁾ In contrast, a high-end 95th percentile Tulalip consumer is reported to eat about 148 grams of shellfish each day.⁽¹⁾

This letter health consultation was completed for the Tulalip Tribes as a follow-up to a previous letter health consultation that examined eastern softshell clam contaminant data from Warm Beach at the Tulalip 95th percentile consumption rate. In order to better assess health risk for tribal members, we recommended in a previous letter health consultation that the Tulalip Tribes conduct sampling and analysis on species consumed from actual harvest locations used by the tribes.⁽³⁾

Discussion

Clam Study Dataset and Limitations

The Tulalip Reservation tidelands are located south of Warm Beach, along the shores of Puget Sound in Snohomish County, Washington. These tidelands support tribal shellfish harvesting. The Tulalip Tribes sampled clams from 14 stations located along reservation tidelands. Figure 1 shows the clam sampling stations selected by the tribe.

In February 2015, Manila clams were sampled at the southernmost four stations and varnish clams were collected at the ten northern stations. Each sample station contained a minimum of 60 individual clams to create one single composite sample representative of the sample location. The clam samples were frozen whole, in shells at the Tulalip Stock Assessment Lab (7615 Totem Beach Road, Tulalip) for pending preparation and analysis. In June 2015, clams from each of the representative stations were shipped to AmTest Incorporated in Kirkland, WA. Laboratory clam sample preparation includes removing the clam body from the shell then combining and homogenizing all the clams for later analysis. Each sample was analyzed for several chemicals including heavy metals, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs).

All chemical concentrations were reported in dry weight for the clam tissue data.⁽⁴⁾ These data were converted to wet weight concentrations to better reflect the typical consistency of clams consumed. For details on the dry weight conversion calculations, see Attachment A – Screening Value and Dry Weight Conversion Calculations. The focus of this letter consult examines only the above chemical contaminants. It does not address the potential health concerns associated with biological hazards in shellfish.

The Department of Health's Shellfish Safety program evaluates biological hazards (such as biotoxins) and is responsible for classifying commercial and recreational shellfish growing areas. Commercial shellfish growing areas can be classified as Approved, Conditionally Approved, Restricted, or Prohibited. Figure 1 includes the Shellfish Safety program's current classification

of commercial growing areas on the Tulalip Reservation tidelands. For the most recent updates on biological hazards in shellfish, visit the Shellfish Safety program's website at www.doh.wa.gov/shellfishsafety.

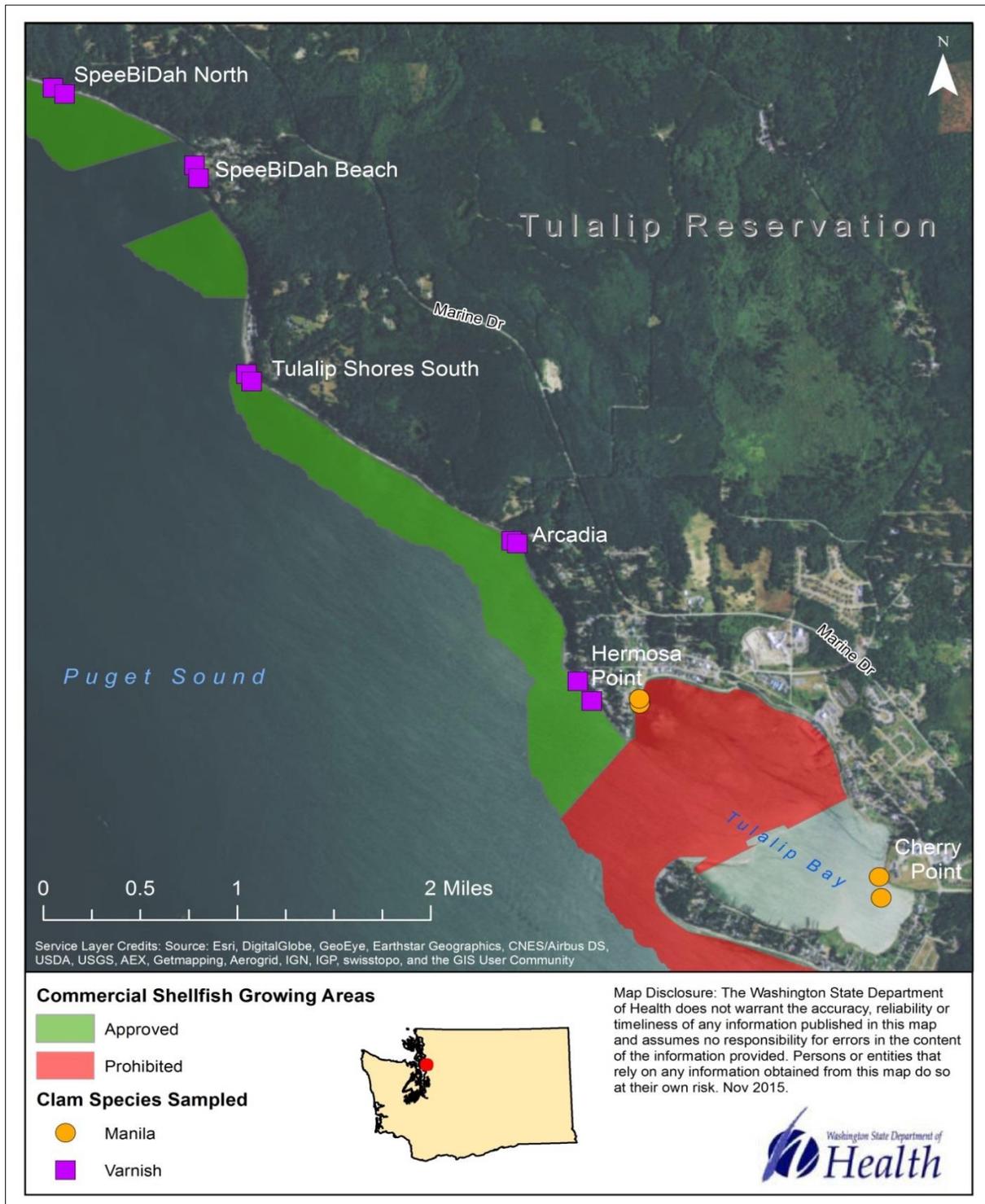


Figure 1: Varnish and Manila Clam Sampling Stations, Tulalip Reservation, Snohomish County, Washington

Exposure Pathways

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.⁽⁵⁾ An exposure pathway has five parts:

- Source of contamination (e.g. creosote pilings);
- Environmental Media and Transport Mechanism (e.g. biota);
- Point of Exposure (e.g. tidelands);
- Route of Exposure (eating, drinking, breathing, or touching); and
- Receptor Population (consumers).

When all five parts are present, it is considered a completed exposure pathway. When one or more parts are missing, only a potential exposure pathway exists. The Tulalip Tribes are harvesting both Manila and varnish clams from reservation tidelands, so they are considered to have a complete exposure pathway through consumption of these clams.

Health Screening Evaluation

Health generates screening values for each chemical analyzed using the Environmental Protection Agency's (EPA) guidance method for developing fish advisories.⁽⁶⁾ These risk-based screening values are a basis for assessing whether chemical contaminant concentrations present in clam tissue are a concern to human health when consumed. For details on the screening value calculations, see Attachment A – Screening Value and Dry Weight Conversion Calculations.

For preliminary screening, Health assumed that all shellfish consumed are clams with the highest concentrations of contaminants found in the February 2015 Tulalip Reservation clam samples. Both varnish and Manila clams were evaluated separately. The highest chemical level for each species of clam was compared to the appropriate screening value to see if it had the potential to pose health problems. Both non-cancer and cancer health effects (when applicable to a chemical) were part of this screening process. If the highest concentration of a chemical exceeds the screening value, Health considers it a "chemical of concern" and conducts further analysis. For details on the screening of chemicals, see Attachment B – Screening of Chemicals.

Exposure Assessment

There are many factors that determine whether an exposure will cause adverse health effects. Factors include the concentration of chemicals a person is exposed to, duration of exposure, how chemicals enter the person (through touching, eating, and/or breathing), other chemicals a person is exposed to, and an individual's age, health and nutritional status. An exposure assessment uses environmental data to estimate doses of chemicals people are exposed to and predicts the risk of non-cancer and cancer health effects, when applicable, for each chemical. Health risk assessment summaries are provided below.

Non-cancer Health Effects

Antimony and thallium were initially categorized as contaminants of concern in varnish clams. Hazard quotients were calculated for each chemical to assess the risk of developing non-cancer health effects. After comparison with documented health effect levels, there are no adverse health effects expected from varnish clams (see Table C1 for details).

Cancer Risk

Cancer is a common illness that increases in susceptibility with age. About 1 in 3 people living in the United States will develop cancer at some point in their lives.⁽⁹⁾ On top of this background risk of cancer, there can be a “lifetime excess cancer risk” from exposure to contaminants over a lifetime. The Department of Health considers all lifetime excess cancer risks exceeding 1 in 10,000 as a significant risk to health.

Consuming Manila clams at the 95th percentile Tulalip shellfish consumption rate could significantly increase the risk of cancer over a lifetime. Lifetime excess cancer risk from consuming Manila clams is about 2 in 10,000 from exposure to arsenic. Eating foods contaminated with arsenic over a lifetime may contribute to an increased risk for skin, liver, bladder, and/or lung cancers.⁽¹⁰⁾

The lifetime excess cancer risk from consuming varnish clams at the 95th percentile Tulalip shellfish consumption rate does not exceed 1 in 10,000, so it is not considered a significant cancer risk by the Department of Health.

Due to the analytical detection limits in the PCBs and PAHs data, there is too much uncertainty for us to assess cancer risk (for details see Table B6). However, due to the adequate number of samples and no single detection of PCBs or PAHs, we do not believe there is a reason to be concerned about levels of PCBs or PAHs in clams from these tidelands.

Conclusions

1. Consuming Manila clams at the Tulalip 95th percentile shellfish consumption rate could significantly increase the risk of cancer over a lifetime. Lifetime excess cancer risk from consuming Manila clams is about 2 in 10,000 from exposure to arsenic. However, this is a hypothetical risk because it assumes that all tribal shellfish consumption is only from Manila clams with the highest arsenic concentration found in the sampled area and they are consumed at a 95th percentile rate.
2. Consuming varnish clams at the Tulalip 95th percentile shellfish consumption rate is not expected to result in non-cancer health effects or contribute to significant cancer risk.

Recommendations

Health recommends visiting the Shellfish Safety program's website at www.doh.wa.gov/shellfishsafety for up-to-date coverage on biological hazards before harvesting shellfish from any area. This evaluation is limited to chemical contaminants in varnish and Manila clams from Tulalip Reservation tidelands. Although the scenario evaluated in this letter examined the consumption of clams at the 95th percentile Tulalip shellfish consumption rate, it may be unlikely that a tribal member's shellfish diet consists entirely of Manila or varnish clams. Below is some general advice to consumers:

General Advice

Health encourages people to eat at least two seafood meals per week as part of a heart-healthy diet in accordance with American Heart Association recommendations. People may eat seafood more than two times per week, but such frequent consumers should take the following advice to reduce exposure to contaminants in seafood:

- Consider eating a variety of fish and shellfish low in contaminants according to guidance provided on our website at www.doh.wa.gov/fish.
- Collect and eat seafood from a variety of locations away from urban areas.
- Consider eating an average serving size (about 8 oz. meat per meal for adults).
- Prepare proportionally smaller meals for young children.

We appreciate the opportunity to review and assist in the evaluation of the clam sampling data for the Tulalip Tribes. A copy of this letter will be placed on the Department of Health Site Assessments webpage at www.doh.wa.gov/consults. If you have any questions regarding this letter please contact me at 360-236-3357 or by email at Amy.Leang@doh.wa.gov.

Sincerely,

Amy Leang
Health Assessor, Toxicologist
Site Assessments and Toxicology Section

cc: Joanne Snarski, Department of Health

Attachment A – Screening Value and Dry Weight Conversion Calculations

Calculations are based on Environmental Protection Agency (EPA) methodology⁽⁶⁾

Equations used in Health Risk Assessment

Non-cancer Health Effects	Cancer Health Effects
$SV = \frac{[(MRL \text{ or } RfD) \times BW]}{CR}$	$SV = \frac{\left[\left(\frac{RL}{CSF}\right) \times BW\right]}{CR}$
$Dose = (C \times CR)/BW$	$Risk = Dose \times CSF$
$HQ = Dose/MRL$	

SV = Screening value (mg/kg or ppm)

Dose (mg/kg/day)

Risk (unitless)

HQ = Hazard Quotient (unitless)

C = Concentration (mg/kg or ppm)

MRL = Minimal risk level (mg/kg/day)

RfD = Reference dose (mg/kg/day)

BW = Mean body weight (kg) = 81 kg, Average Tulalip Adult

RL = Risk level (life time cancer risk) = 1×10^{-5}

CSF = Oral cancer slope factor (mg/kg/day)⁻¹, contaminant-specific

CR = consumption rate (kg/day) = 0.1479 kg/day, 95th Percentile Tulalip Shellfish CR⁽¹⁾

Conversion from Dry Weight to Wet Weight Concentrations

$$\begin{aligned} \text{Wet Weight} &= \text{Dry Weight} \times [100 - \% \text{ Water Content}] / 100 \\ &= \text{Dry Weight} \times [\% \text{ Total Solids}^*] / 100 \end{aligned}$$

*Total Solids in samples ranged from 10.5% - 17.3%.

Attachment B – Screening of Chemicals

Table B1. Non-Cancer Health Effects Screening of Metal Concentrations in Clams from Tulalip Reservation at Tulalip 95th Percentile Shellfish Consumption Rate, Snohomish County, WA

Metal	EPA Cancer Class	Maximum Concentration - Manila (ppm)	Maximum Concentration - Varnish (ppm)	MRL or RfD (mg/kg/day)	Screening Value (ppm)	Reference for Screening Values	Contaminant of Concern
Antimony		0.082	0.344	0.0004	0.22	EPA Oral RfD	Yes
Arsenic (inorganic)	A	0.022	0.012	0.0003	0.16	ATSDR Chronic Oral MRL	No
Barium	D	0.314	1.845	0.2	109.53	ATSDR Chronic Oral MRL	No
Beryllium	CN	<0.045	0.048972 U	0.002	1.10	ATSDR Chronic Oral MRL	No
Cadmium	B1	0.282	0.064	0.001	0.548	ATSDR Chronic Oral MRL	No
Chromium	CN	0.419	2.106	1.5	821.5	EPA Oral RfD, trivalent	No
Copper	D	2.006	3.893	0.01	5.5	ATSDR Intermediate Oral MRL	No
Lead	B2	0.169	0.297	NA	NA	NA	No (Table B2)
Nickel	B2	0.963	1.190	0.02	10.95	EPA Oral RfD	No
Selenium	D	0.786	0.906	0.005	2.74	ATSDR Chronic Oral MRL	No
Silver	D	0.404	0.490	0.005	2.74	EPA Oral RfD	No
Thallium		<0.0045	0.026	1.00E-05	0.0055	EPA Regional Screening Level	Yes
Vanadium		0.223	2.262	0.01	5.48	ATSDR Intermediate Oral MRL	No
Zinc	IN	10.706	38.144	0.3	164.30	ATSDR Chronic Oral MRL	No
Aluminum		70.566	296.400	1	547.67	ATSDR Chronic Oral MRL	No
Cobalt	B2	0.655	1.401	0.01	5.48	ATSDR Intermediate Oral MRL	No
Manganese	D	1.975	20.904	0.05	27.38	EPA Oral RfD	No
Molybdenum		<0.045	0.249	0.005	2.74	EPA Oral RfD	No
Mercury	C	0.054	0.031	0.0003	0.16	ATSDR Chronic Oral MRL, methyl	No

MRL: Minimal Risk Level from Agency for Toxic Substances & Disease Registry; RfD: Reference Dose from Environmental Protection Agency (EPA)

ppm: parts per million

mg/kg/day: milligrams per kilogram per day

NA: Not Applicable (no screening value established)

EPA Cancer Class -

A: Human Carcinogen

B1: Probable Human carcinogen based on limited evidence in humans and sufficient evidence in animals

B2: Probable human carcinogen based on sufficient evidence in animal

C: Possible human carcinogen

D: Not classifiable as to its carcinogenicity to humans

IN: Inadequate information to assess carcinogenic potential

Table B2: Integrated Exposure Uptake Biokinetic (IEUBK) Model to Predict Lead Poisoning at Tulalip Child Consumption Rates, Assuming all Shellfish are Clams from Tulalip Reservation, Snohomish County, WA

Maximum Lead Concentration (ppm)	Proportion of Meat Intake as Shellfish (%)	Children with Blood Lead Levels $\geq 5 \mu\text{g/dL}$ (%)	Public Health Concern
0.297	10.2%	0.033	No

Maximum concentration from varnish clam sample (see Table B1).

Results are based on the IEUBK Model Version 1.1 Build 11; input parameters from Environmental Protection Agency.

ppm: parts per million, $\mu\text{g/dL}$: micrograms per deciliter of blood; %: percent, \geq : greater than or equal to

The IEUBK model for lead exposure assumes that a child's total meat intake is 93.5 g/day on average. EPA's target cleanup goal is no more than 5% of the community with blood lead levels above 10 $\mu\text{g/dL}$.

Parameters used in model:

- Consumption rate: Tulalip Tribes child – 90th percentile shellfish (.597 g/kg/day)⁽¹⁾
Average child body weight = 16 kg
 $16 \text{ kg} \times 0.597 \text{ g/kg/day} = 9.55 \text{ g/day}$; this is 10.2% of the IEUBK model's total meat intake of 93.5.
Therefore, 10.2% was inputted as the proportion of meat intake as shellfish.
- Maximum Lead Concentration: 0.297 ppm

There would be no health concerns for lead poisoning at Tulalip consumption rates assuming all shellfish consumed were either varnish or Manila clams from Tulalip Reservation tidelands.

Table B3. Non-Cancer Health Effects Screening of Polycyclic Aromatic Hydrocarbons (PAHs) Concentrations in Clams from Tulalip Reservation at Tulalip 95th Percentile Shellfish Consumption Rate, Snohomish County, WA

PAHs	EPA Cancer Class	Manila Concentration (ppb)	Varnish Concentration (ppb)	MRL or Reference Dose (mg/kg/day)	Screening Value (ppb)	Reference for Screening Values	Contaminant of Concern
2-Methylnaphthalene		<3.5	<2.0	0.6	328600	Naphthalene, MRL Int-Oral	No
acenaphthylene		<3.5	<2.0	0.03	16430	Pyrene RfD surrogate	No
acenaphthene		<3.5	<2.0	0.6	328600	MRL, Intermediate-Oral	No
fluorene	D	<3.5	<2.0	0.04	21907	RfD, Chronic Oral	No
phenanthrene	D	<3.5	<2.0	0.3	164300	Anthracene RfD surrogate	No
anthracene	D	<3.5	<2.0	0.3	164300	RfD, Chronic Oral	No
fluoranthene	D	<3.5	<2.0	0.04	21907	RfD, Chronic Oral	No
pyrene	D	<3.5	<2.0	0.03	16430	RfD, Chronic Oral	No
benz(a)anthracene	B2	<3.5	<2.0	0.03	16430	Pyrene RfD surrogate	No
chrysene	B2	<3.5	<2.0	0.03	16430	Pyrene RfD surrogate	No
benzo(b)fluoranthene	B2	<3.5	<2.0	0.04	21907	Fluoranthene RfD surrogate	No
benzo(k)fluoranthene	B2	<3.5	<2.0	0.04	21907	Fluoranthene RfD surrogate	No
benzo(a)pyrene	B2	<3.5	<2.0	0.03	16430	Pyrene RfD surrogate	No
indeno(1,2,3-c,d)pyrene	B2	<3.5	<2.0	0.04	21907	Fluoranthene RfD surrogate	No
dibenz(a,h)anthracene	B2	<3.5	<2.0	0.03	16430	Pyrene RfD surrogate	No
benzo(g,h,i)perylene	D	<3.5	<2.0	0.03	16430	Pyrene RfD surrogate	No

MRL: Minimal Risk Level from Agency for Toxic Substances & Disease Registry

RfD: Reference Dose from EPA

ppb: parts per billion

mg/kg/day: milligrams per kilogram per day

EPA (Environmental Protection Agency) Cancer Class -

B2: Probable human carcinogen based on sufficient evidence in animals

D: Not classifiable as to its carcinogenicity to humans

Table B4. Non-Cancer Health Effects Screening of Polychlorinated Biphenyls (PCBs) Concentrations in Clams from Tulalip Reservation at Tulalip 95th Percentile Shellfish Consumption Rate, Snohomish County, WA

PCBs	EPA Cancer Class	Manila Concentration (ppb)	Varnish Concentration (ppb)	MRL or RfD (mg/kg/day)	Screening Value (ppb)	Reference for Screening Values	Contaminant of Concern
PCBs (Aroclor 1254)	B2	<4.19	<4.23	0.00002	11	ATSDR Chronic Oral MRL	No
PCBs (Aroclor 1016)	B2	<4.19	<4.23	0.00007	38	EPA Oral RfD	No

No PCBs were detected; reported concentrations are the highest Practical Quantitation Limits (PQLs). No MRLs or RfDs have been established for other PCB aroclors.

EPA: Environmental Protection Agency

MRL: Minimal Risk Level from Agency for Toxic Substances & Disease Registry

RfD: Reference Dose from EPA

B2: Probable human carcinogen based on sufficient evidence in animals

ppb: parts per billion; mg/kg/day: milligrams per kilogram per day

Table B4 ends the preliminary non-cancer health effects screening. Antimony and thallium were non-cancer contaminants of concern in varnish clams. These will be further evaluated in an exposure assessment (Table C1).

For screening cancer health effects, analytes with probable or likely cancer class categorization were analyzed further. Cadmium is known to be carcinogenic, but only when inhaled. Therefore, arsenic was the only metal to be screened for cancer (Table B5), and will be further evaluated in cancer risk assessment (Table C2).

Table B5: Cancer Health Effects Screening of Arsenic in Clams from Tulalip Reservation at Tulalip 95th Percentile Shellfish Consumption Rate, Snohomish County, WA

Metal	Manila Concentration (ppm)	Varnish Concentration (ppm)	Screening Value (ppm)	EPA Cancer Class	Oral Cancer Slope Factor (mg/kg/day) ⁻¹	Carcinogenic Contaminant of Concern
Arsenic (Inorganic)	0.022	0.012	0.00096	A	5.7	Yes

EPA (Environmental Protection Agency) Cancer Class A: Human Carcinogen

ppm: parts per million; mg/kg/day⁻¹: inverse of milligrams per kilograms body weight per day

Table B6: Indeterminate Cancer Screening of Clams for Chemicals and Comparison of Practical Quantitation Limits with Tulalip 95th Percentile Shellfish Screening Value, Tulalip Reservation, Snohomish County, WA

Chemical	Manila Practical Quantitation Limit (ppb)	Varnish Practical Quantitation Limit (ppb)	Screening Value (ppb)	Carcinogenic Contaminant of Concern
PCBs	<4.19	<4.23	2.7	Indeterminate
Total cPAHs TEQ	<5.3	<3.0	0.75	

ppb: parts per billion

Note: Cancer screening was indeterminate for PCBs and cPAHs. Screening levels based on the Tulalip 95th percentile shellfish consumption rate were lower than the Practical Quantitation Limits (PQLs) of PCBs and cPAHs (Table B6). A lower limit of detection or PCB congener analysis (as opposed to Aroclor analysis) is suggested for future studies. However, due to the adequate number of samples in the sampling effort and no single detection of PCBs or PAHs, we do not believe there is a reason to be concerned about levels of PCBs or PAHs in clams from these tidelands.

Attachment C – Non-Cancer Exposure Assessment and Cancer Risk

Table C1: Non-Cancer Hazard Quotients of Chemical Contaminants of Concern Identified from Tulalip Reservation Varnish Clams at the 95th Percentile Tulalip Consumption Rate, Snohomish County, WA

Metal	Maximum Concentration (ppm)	Estimated Dose	MRL or RfD (mg/kg/day)	Hazard Quotient (Dose/MRL)	Comparison Dose (mg/kg/day)	Reference Value
Antimony	0.344	6.3E-04	4.0E-04	1.6	0.35	LOAEL
Thallium	0.026	4.8E-05	1.0E-05	4.8	0.40	NOAEL

MRL: Minimal Risk Level from Agency for Toxic Substances & Disease Registry

ppm: parts per million; mg/kg/day: milligrams per kilogram per day

LOAEL: Lowest-observed-adverse-effect-level (EPA)

NOAEL: No-observed-adverse-effect level (ATSDR)

After comparison of estimated doses to documented health effect levels (comparison doses), no health effects are expected from either antimony or thallium.

Table C2: Cancer Risk of Chemical Contaminant of Concern Identified from Tulalip Reservation Clams at the 95th Percentile Tulalip Consumption Rate, Snohomish County, WA

Chemical	EPA Cancer Class	Oral Cancer Slope Factor (mg/kg/day) ⁻¹	Manila Concentration (ppm)	Varnish Concentration (ppm)	Manila Dose (mg/kg/day)	Varnish Dose (mg/kg/day)	Manila Cancer Risk	Varnish Cancer Risk
Inorganic Arsenic	A	5.7	0.022	0.0012	4.0E-05	2.2E-06	2.3E-04	1.2E-05

ppm: parts per million; mg/kg/day⁻¹: milligrams per kilograms body weight-day

Bold: Significant cancer risk (above 1E-04)

Cancer risk for arsenic in Manila clams is expected to be “low to moderate”, assuming the 95th percentile Tulalip shellfish consumer’s entire shellfish diet was comprised of Manila clams from Tulalip Reservation. Lifetime excess cancer risk is approximately 2 additional cases per 10,000 people. Ingesting arsenic over time may contribute to a particular increased risk for skin, liver, bladder, and/or lung cancer.⁽¹⁰⁾ The cancer risk from arsenic in varnish clams is not considered significant in this evaluation because lifetime excess cancer risk was calculated to be less than 1 in 10,000.

References

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