Addendum to Cadmium Technical Report: Updated Tissue Objective

August 2021

Tsleil-Waututh Nation
səlilwətaɬ

BRITISH COLUMBIA

This Addendum forms part of a series of water quality parameter reports whose purpose is to inform updates to the 1990 Provincial Water Quality Objectives for Burrard Inlet. The reports in this series assess the current state and impacts of contamination in Burrard Inlet; incorporate new scientific research and monitoring of water quality; and reflect a broader understanding of goals and values, including those of First Nations, to improve the health of the marine waters of Burrard Inlet. Updating the 1990 Provincial Water Quality Objectives is a priority action identified in the Tsleil-Waututh Nation's Burrard Inlet Action Plan which has been an impetus for this work.

ISBN: 978-0-7726-8038-9

Citation:

Rao, A.S. 2021. Addendum to Cadmium Technical Report: Updated Tissue Objective. Prepared for Tsleil-Waututh Nation and the Province of B.C.

Authors' Affiliations:
Anuradha Rao, MSc, RPBio, Cert.RNS
On contract to Tsleil-Waututh Nation
3178 Alder Court, North Vancouver, BC

Cover Photograph:

Underwater monitoring equipment is installed from the Tsleil-Waututh Nation boat in Burrard Inlet.

Acknowledgements

Work to update the Burrard Inlet Water Quality Objectives is being led by the Tsleil-Waututh Nation (TWN), in collaboration with the BC Ministry of Environment and Climate Change Strategy (BC ENV). Progress on this work and production of this addendum have been supported by the following:

The project Coordination Team including: Anuradha Rao (project manager, contractor to TWN), Diane Sutherland (ENV), Patrick Lilley (Kerr Wood Leidal, consultant to TWN), Sarah Dal Santo (TWN).

Multi-agency advisory bodies: Burrard Inlet Water Quality Technical Working Group and Roundtable (representatives of First Nations; local, provincial and federal governments; health authorities; industry; academics and NGOs).

Staff, specialists and consultants including:

- Adrienne Hembree, Andrew George, Bridget Doyle, Carleen Thomas, Ernie George, Gabriel George, Graham Nicholas, John Konovsky and Stormy MacKay (TWN), Allison Hunt and Anne Sheridan (Inlailawatash)
- Kevin Rieberger, Heather Thompson and Melany Sanchez (ENV), and Dan Stein (MOH).
- Daniel Brown, Grace O'Connell, Jack Lau, Karin Björklund, Jessica LeNoble, Larissa Low (Kerr Wood Leidal)

We would also like to acknowledge financial support from: the Government of Canada, BC Ministry of Environment and Climate Change Strategy, Sitka Foundation and Vancity Credit Union, and in-kind contributions by Water Quality Roundtable member organizations.

CONTENTS

TABLES

ACRONYMS

AF	Allocation factor
BC	British Columbia OR Background concentration
BW	Body weight
IR	Ingestion rate
ENV	British Columbia Ministry of Environment and Climate Change Strategy
RAF	Relative absorption factor
SV	Screening value
TDI	Tolerable daily intake
TRV	Toxicological reference value
TWN	Tsleil-Waututh Nation
WQO	Water Quality Objective

1. PURPOSE OF THIS ADDENDUM

Since the publication of the Cadmium Technical Report for the Water Quality Assessment and Proposed Objectives for Burrard Inlet (LeNoble et al. 2019), a human health risk-based approach for deriving tissue screening values (SVs) was developed by representatives of the BC Ministry of Health, BC Ministry of Environment and Climate Change Strategy, and the Burrard Inlet Water Quality Objectives project coordination team using toxicology information from Health Canada (see section 2 for details). Human consumption of shellfish and finfish is an important value in Burrard Inlet, as identified in Rao et al. (2019); however, this value was not considered in the provisional Water Quality Objectives for Burrard Inlet originally adopted by the Province of BC in 1990 (Nijman and Swain 1990). Marine foods formed the majority of Tsleil-Waututh Nation's (TWN) traditional diet; it is an important goal of TWN to be able to safely eat healthy, wild foods harvested in their traditional waters. This Addendum is provided to update the objective for cadmium in tissue that had been proposed in the Cadmium Technical Report (LeNoble et al. 2019) in order to incorporate this human health risk-based approach.

2. UPDATED SCREENING BENCHMARKS FOR CADMIUM IN TISSUE

Human-health based SVs for fish and shellfish tissue were derived by Thompson and Stein (2021) from toxicological reference values and risk assessment methodologies published by Health Canada (Health Canada 2010a,b,c, 2012; Richardson 1997, Richardson and Stantec 2013). Benchmarks for future data analyses are provided in Table 1.

A risk-based approach was used to calculate human health-based SVs for cadmium in fish and shellfish tissue (Thompson and Stein, 2021). The approach considers: the contaminant *receptors* (people who are exposed to the contaminant, in this case subsistence/Indigenous, recreational, and general BC populations, with SVs calculated for the most sensitive life stage within each population), *exposure* to the contaminant (how much fish the receptors consume), and the contaminant *toxicity* (what is known about the contaminant and how it affects different receptors). Receptor characteristics were defined from Richardson and Stantec (2013), exposure was calculated through fish ingestion rates from Richardson (1997) and Health Canada (2010c), and toxicity was defined through toxicological reference values (TRVs) prescribed by Health Canada (2010a).

Tissue SVs are defined as conservative threshold values against which contaminant concentrations in fish tissue can be compared and assessed for potential risks to human health (Thompson and Stein, 2021). Fish and shellfish tissue in this report refer to "country foods", that is, foods produced in an agricultural (not for commercial sale) backyard setting or harvested through hunting, gathering or fishing activities (Health Canada 2010b). SVs provide general guidance to environmental managers and represent a suggested safe level of a contaminant in fish tissue based on a conservative estimate of a person's fish consumption per day; they do not provide advice regarding consumption limits or constitute a fishing advisory. Exceedances of a SV may indicate that further investigation to assess human health risk at a particular site is warranted; however, exceeding a SV does not imply an immediate risk to human health (Thompson and Stein, 2021).

Human health SVs were calculated by Thompson and Stein (2021) using the following equation from Health Canada (2012, see Thompson and Stein [2021] for details).

$$SV_n = \frac{TDI \times BW \times AF}{IR_{Food} \times RAF_{Oral}} + BC$$

Where:

- SV_n = screening value for a noncarcinogen (µg/g);
- *TDI* = tolerable daily intake (µg/kg BW/day); the contaminant dose deemed safe or acceptable;
- *BW* = body weight (kg);
- *AF* = allocation factor; the fraction of the contaminant allocated to come from country foods; an AF of 0.2 was applied;
- IR_{Food} = ingestion rate of fish by humans (g/day);
- RAF_{Oral} = relative absorption factor from the gastrointestinal tract for a contaminant; and
- *BC* = background concentration (µg/g); the naturally occurring background concentration in environmental media or tissue.

The TDI was obtained from the provisional oral tolerable daily intake of cadmium specified in Health Canada (2010a), with a health endpoint of renal tubular dysfunction. An allocation factor of 0.2 was used in the calculation to reflect the fraction of cadmium assumed to come from country foods (in this case, wild seafood).

Three screening values were calculated to capture a range of potential fishers (i.e. receptors), and are listed in Table 1. The most conservative value is protective of consumption by a toddler from a subsistence fisher population while the screening values for adult subsistence fishers and adult recreational fishers are less conservative.

Table 1: Human-health based tissue screening values for total cadmium (from Thompson and Stein 2021)

Receptor Population	Receptor Life Stage	Ingestion Rate (g/day)	Reference Dose (TDI) (µg/kg bw/day)	Standard Body Weight (kg)	Relative Absorption Factor (%)	Allocation Factor (unitless)	Screening Value[a] (µg/g, wet weight)
Subsistence fisher	Toddler	94	1.00	16.5	100%	0.2	0.03
	Adult	220	1.00	76.5	100%	0.2	0.07
Recreational fisher	Adult	111	1.00	76.5	100%	0.2	0.1

[a] Calculated screening value for which cadmium concentrations in tissue can be compared and assessed for potential risks to human health. This is a single benchmark for all tissue types.

3. PROPOSED OBJECTIVE FOR CADMIUM IN TISSUE AND RATIONALE

The proposed tissue objective for cadmium (Table 2) aims to manage human health risk from consumption of shellfish and finfish. This objective has been set to protect the most sensitive receptor, i.e. a toddler from a subsistence fishing population, in order to reflect TWN's goal of improving the health of Burrard Inlet so that Tsleil-Waututh people can once again safely eat healthy, wild foods harvested in their traditional waters.

As described above, this proposed objective is based on a very conservative SV. Research has shown that cadmium concentrations in bivalve shellfish in the Pacific Northwest, even in remote areas, can often exceed this proposed objective (Bendell 2009). Discussions with health authorities will be required

to interpret monitoring data for cadmium in tissue to understand implications on human consumption of seafood from Burrard Inlet.

Table 2: Proposed Water Quality Objectives for Total Cadmium

Sub-basin	Outer Harbour	False Creek	Inner Harbour	Central Harbour	Port Moody Arm	Indian Arm
Total Cadmium in Tissue	0.03 µg/g wet weight single-sample maximum (all tissue types)[1]					

[1] Applies to all tissue types. Based on at least 1 composite sample consisting of at least 5 fish or 25 bivalves. See Rao et al. (in prep) for additional details.

LITERATURE CITED

Bendell, L.I. 2009. Survey of levels of cadmium in oysters, mussels, clams and scallops from the Pacific Northwest coast of Canada, Food Additives & Contaminants: Part B, 2: 131-139.

British Columbia Ministry of Environment and Climate Change Strategy (ENV) and Tsleil-Waututh Nation (TWN). 2020. Water Quality Objectives for Burrard Inlet. Water Quality Objective Series, WQO-02. Prov. B.C., Victoria B.C.

Health Canada. 2010a. Part II: Health Canada toxicological reference values (TRVs) and chemical-specific factors, Version 2.0. Federal Contaminated Site Risk Assessment in Canada, 69 pp.

Health Canada. 2010b. Federal contaminated site risk assessment in Canada. Supplemental guidance on human health risk assessment for country foods (HHRA $_{Foods}$). Contaminated Sites Division. Safe Environments Directorate. Ottawa, ON (CA): Health Canada. http://publications.gc.ca/collections/collection_2012/sc-hc/H128-1-11-641-eng.pdf (Accessed July 2020)

Health Canada. 2010c. Federal contaminated site risk assessment in Canada. Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals. Contaminated Sites Division. Safe Environments Directorate. Ottawa, ON (CA): Health Canada. http://publications.gc.ca/collections/collection_2011/sc-hc/H128-1-11-639-eng.pdf (Accessed July 2020)

Health Canada. 2012. Federal contaminated site risk assessment in Canada. Part I: Guidance on human health preliminary quantitative risk assessment (PQRA), Version 2.0. Ottawa, ON (CA): Health Canada. http://publications.gc.ca/collections/collection_2018/sc-hc/H128-1-11-632-eng.pdf (Accessed July 2020)

LeNoble, J., Lilley, P. and A. Rao. 2019. Water Quality Assessment and Proposed Objectives for Burrard Inlet: Cadmium Technical Report. Prepared for Tsleil-Waututh Nation and the Province of B.C.

Nijman, R. and L.G. Swain. 1990. Coquitlam Pitt-River area Burrard Inlet water quality assessment and objectives. Technical appendix prepared for the BC Ministry of Environment.

Rao, A.S., Rieberger, K. and P. Lilley. In prep. Water quality sampling and monitoring recommendations for Burrard Inlet. Prepared for Tsleil-Waututh Nation and the Province of B.C.

Rao, A., Sanchez, M., Sutherland, D. and P. Lilley. 2019. Water Quality Assessment and Updated Objectives for Burrard Inlet: Overview Report. Prepared for Tsleil-Waututh Nation and the Province of B.C.

Richardson, G.M. 1997. Compendium of Canadian Human Exposure Factors for Risk Assessment. Ottawa: O'Connor Associates Environmental Inc.

Richardson, G.M and Stantec Consulting Ltd. 2013. 2013 Canadian Exposure Factors Handbook Life Expectancy, Body Dimensions, Inhalation, Time-Activity, and Soil Ingestion. University of Saskatchewan, Toxicology Centre: Saskatoon.

Thompson, H.C. and D. Stein. 2021. Tissue Quality Objectives Recommendations for Burrard Inlet. Prepared for Tsleil-Waututh Nation and the Province of B.C.