# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>PREFACE</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAPTER 1</td>
<td>SMS AND TRIBAL TREATY RIGHTS</td>
</tr>
<tr>
<td>SECTION 1.1</td>
<td>KEY TERMS, ABBREVIATIONS, AND CONCEPTS</td>
</tr>
<tr>
<td>SECTION 1.2</td>
<td>INTRODUCTION</td>
</tr>
<tr>
<td>SECTION 1.2</td>
<td>TRIBAL TREATY RIGHTS</td>
</tr>
<tr>
<td>SUBSECTION 1.2A</td>
<td>IMPLICATIONS OF BOLDT &amp; Rafeedie</td>
</tr>
<tr>
<td>SUBSECTION 1.2B</td>
<td>RIGHTS TO CONSULTATION &amp; SOVEREIGNTY</td>
</tr>
<tr>
<td>SUBSECTION 1.2C</td>
<td>CENTENNIAL ACCORD</td>
</tr>
<tr>
<td>SECTION 1.3</td>
<td>ENVIRONMENTAL JUSTICE</td>
</tr>
<tr>
<td>SECTION 1.4</td>
<td>UNDERSTANDING THE CLEANUP PROCESS</td>
</tr>
<tr>
<td>CHAPTER 2</td>
<td>SITE ID AND ASSESSMENT</td>
</tr>
<tr>
<td>SECTION 2.1</td>
<td>CONCEPTUAL SITE MODEL</td>
</tr>
<tr>
<td>SECTION 2.2</td>
<td>CLEANUP LEVELS FRAMEWORK</td>
</tr>
<tr>
<td>SECTION 2.3</td>
<td>DERIVING RISK-BASED CONCENTRATIONS</td>
</tr>
<tr>
<td>SUBSECTION 2.3A</td>
<td>HUMAN HEALTH RISK</td>
</tr>
<tr>
<td>SUBSECTION 2.3B</td>
<td>SELECTING HUMAN HEALTH EXPOSURE PARAMETERS</td>
</tr>
<tr>
<td>SUBSECTION 2.3C</td>
<td>BENTHIC CRITERIA</td>
</tr>
<tr>
<td>SUBSECTION 2.3D</td>
<td>HIGHER TROPHIC LEVEL RISK</td>
</tr>
<tr>
<td>SUBSECTION 2.3E</td>
<td>APPLICABLE LAWS</td>
</tr>
<tr>
<td>SECTION 2.4</td>
<td>USING BACKGROUND FOR ESTABLISHING CLEANUP LEVELS</td>
</tr>
<tr>
<td>SUBSECTION 2.4A</td>
<td>NATURAL BACKGROUND DETERMINATION</td>
</tr>
<tr>
<td>SUBSECTION 2.4B</td>
<td>REGIONAL BACKGROUND DETERMINATION</td>
</tr>
<tr>
<td>SECTION 2.5</td>
<td>PQL AS A CLEANUP STANDARD</td>
</tr>
<tr>
<td>CHAPTER 3</td>
<td>CLEANUP &amp; REMEDIATION</td>
</tr>
<tr>
<td>SECTION 3.1</td>
<td>SAMPLING</td>
</tr>
<tr>
<td>SUBSECTION 3.1A</td>
<td>TISSUE</td>
</tr>
<tr>
<td>SUBSECTION 3.2B</td>
<td>SEDIMENT</td>
</tr>
<tr>
<td>SECTION 3.2</td>
<td>REMEDIATION TECHNOLOGIES</td>
</tr>
<tr>
<td>SECTION 3.3</td>
<td>SEDIMENT RECOVERY ZONE</td>
</tr>
<tr>
<td>SECTION 3.4</td>
<td>CONCLUSION</td>
</tr>
</tbody>
</table>
ACKNOWLEDGEMENTS
The authors would like to thank the Northwest Indian Fisheries Commission’s Beyond GAP Program for funding the development of this document. The authors would also like to thank the following individuals for providing review to help improve the content of this document:

Dianne Barton, Columbia River Intertribal Fish Commission
Todd Bolster, Northwest Indian Fisheries Commission
Catherine O’Neill, Seattle University School of Law
Patricia Cirone, US Environmental Protection Agency (retired)
Bill Beckley, Ridolfi, Inc.
PREFACE
The intent of this document is to provide guidance to tribal technical staff on how to derive site-specific cleanup levels for contaminated sediment sites under Washington State jurisdiction within a tribe’s treaty-reserved usual and accustomed areas using the Sediment Cleanup Users Manual (SCUM) II. The SCUM II references overarching provisions of Model Toxics Control Act (MTCA) and Sediment Management Standards (SMS) that apply to cleanups at contaminated sediment sites in Washington. The targeted audience is technical staff who do not necessarily have experience specific to sediment remediation sites but still have some background in the environmental science and policy fields. This document is not intended to help tribes create their own sediment quality standards for on-reservation cleanups under tribal jurisdiction, but the information provided might be useful for those who wish to do so. Much of the information contained was developed from issues that have arisen in cleanups in which tribes were engaged.

The SCUM II was created by the Washington State Department of Ecology (Ecology) to serve as technical guidance for the revised (SMS), Chapter 173-204 Washington Administrative Code (WAC). The revised SMS became effective on September 1, 2013. The intent of the revisions was to better integrate some of the provisions of MTCA with some of the provisions in the older SMS.

The revisions focus on deriving site-specific criteria for cleanups instead of having a default standard that can be applied across all sites. Many tribes do not have the funding or staff knowledgeable about SMS, MTCA, or toxics cleanups to meaningfully participate in this resource-intensive process. Tribal staff are often pitted against industry consultants who have large budgets and experience across tens if not hundreds of sites. On such an uneven playing field, tribes may be pressured to accept site cleanup levels and goals that are not protective of tribal treaty rights and resources. These are also environmental justice issues, as tribal members are at a disproportionately higher risk of exposure to environmental contamination.

This guidance is intended to help tribal technical staff negotiate a protective standard with regulators and industry consultants. This guidance applies specifically to aquatic species found in western Washington (marine, estuarine, and freshwater), which may not occur in inland waters of eastern Washington. This document can have applications for eastern Washington tribes as well; however, these tribes depend on different resources than what is typically found in western Washington.

The content of this publication relates to guidance available at the time of its publication on December 31, 2014. In July and August 2014, Ecology held workshops in order to try to incorporate input from a variety of stakeholders and tribes. At the time of this publication, Ecology intends to revise some of SCUM II to incorporate these edits in February 2015. This guidance is based on the latest available version of the SCUM II from December 2013 (Publication no. 12-09-057).
Chapter 1   SMS and Tribal Treaty Rights

SECTION 1.1 KEY TERMS, ABBREVIATIONS, AND CONCEPTS
ATSDR- Agency of Toxic Substances and Disease Registry
CSL- Cleanup Screening Level
CSM- Conceptual Site Model
DMMP- Dredged Material Management Program
DOH- Washington State Department of Health
Ecology- Washington State Department of Ecology
EPA- United States Environmental Protection Agency
FCR- Fish Consumption Rate
FDF- Fish Diet Fraction
FS- Feasibility Study
HHRA- human health risk assessment
MTCA- Model Toxics Control Act
NOAA- National Oceanic and Atmospheric Administration
NWIFC- Northwest Indian Fisheries Commission
PSEP- Puget Sound Estuary Protocols
PQL- Practical Quantitation Limit
SAP- Sampling and Analysis Plan
SCO- Sediment Cleanup Objective
SCUM II- Sediment Cleanup Users’ Manual II
SMS- Sediment Management Standards
SRZ- Sediment Recovery Zone
SUF- Site Use Factor
TEF- toxicity equivalency factor
TEQ- toxicity equivalence quotient
U&A- Usual and accustomed areas
USACE- US Army Corps of Engineers
USEPA- United States Environmental Protection Agency
USFWS- United States Fish and Wildlife Service
UTL- Upper Threshold Limit
WAC- Washington Administrative Code
WDFW- Washington Division of Fish and Wildlife
WSDOT- Washington State Department of Transportation
Section 1.2 Introduction

Tribes can assert their sovereignty and protect their treaty resources from degradation by participating in the cleanup decision-making process regarding contaminated sediments. Contaminated sediments pose a risk to the health of fish and shellfish resources that tribal members depend on for cultural sustenance, as well as the health of the community. The well-being of tribal community health have shown to be associated with the health of natural resources.\(^1\) Chemical contamination in sediments has shown to contaminate fish and shellfish resources on which tribes depend.\(^2,3\) How sediment contamination is addressed during sediment cleanups can impact the tribe’s culture, and therefore tribes should be integrally involved in any decision regarding the current and future health of these resources.

Government-to-government consultation and natural resource co-management authority are two rights that allow tribes to have a dialogue with state and federal agencies that is more significant than being an ordinary stakeholder. Understanding the rights of consultation that is afforded by treaty can inform tribal technical staff as to the influence that tribes have to address community concerns. Meaningful participation in cleanup decisions allows tribes to mitigate potential impact to aquatic resources. Tribal technical staff will ultimately be able to better apprise decision makers and tribal community members who depend on these natural resources.

Section 1.3 Tribal Treaty Rights

Tribes are entitled by treaty to maintain an active role in decisions regarding toxic sediment cleanups and to have the treaty resource itself protected from degradation. Treaty rights are rights reserved by indigenous peoples through treaties with the federal government. These “contracts among nations” recognized and reserved unique sets of rights, benefits, and conditions for the treaty-making tribes who agreed to cede off millions of acres of their homelands to the United States and accept its protection.\(^4\)

Like other treaty obligations of the United States, Indian treaties are considered to be “the supreme law of the land,” and they are the foundation upon which federal Indian law and the federal Indian trust relationship is based. While tribal sovereignty is in some respects limited today by the United States under treaties, acts of Congress, Executive Orders, federal administrative agreements and court decisions, what remains is nevertheless protected and maintained by the federally recognized tribes against further encroachment.

---


\(^4\) Bureau of Indian Affair. www.bia.gov/FAQs
by other sovereigns, such as the states. Tribal sovereignty ensures, among other things, that any decisions about the tribes with regard to their property and citizens are made with their participation and consent.\footnote{5}

In Washington State, Territorial Governor Isaac Stevens negotiated all of the treaties in the 1854-1855 timeframe.\footnote{6} In western Washington, 20 tribes were signatories to these treaties. These treaties have an importance to natural resources management since the treaties reserved certain rights to fishing, shellfish harvesting, hunting, and gathering in exchange forceding ownership of the tribes’ lands. Each treaty outlines the area that was ceded by signatory tribes, and this is referred to as the usual and accustomed (U&A) areas. These reserved rights allow tribes to maintain important cultural, economic, spiritual, and ceremonial practices that provide sustenance, economic benefit, and well-being.

The value of these treaty rights is priceless since they allow tribal members to continue to practice their culture that they have maintained since time immemorial. The importance of fishing and shellfish harvesting is apparent to any casual observer during a cultural event. Indigenous Northwest cultures often depict fish and shellfish in their artwork. Weddings, funerals, and important events are often marked with a clam bake. The gossip around the reservation is centered on which beaches are open for clam digs and oyster picks. When the salmon runs return, many fishers go to set their gill nets. For the fishing peoples of the Pacific Northwest, fish and fishing are necessary for survival as a people – they are vital as a matter of cultural flourishing and self-determination.\footnote{7}

Subsection 1.3A Implications of Boldt & Rafeedie

After the Stevens Treaties were signed in the 1850s, the rights they reserved to the tribal signatories were nonetheless undermined as the state of Washington took control of salmon harvests and systematically denied the tribes the ability to exercise their treaty-reserved rights. The struggle to obtain recognition of those rights climaxed in the “Fish Wars” of the late 1960s and early 1970s, when tribal members were arrested and jailed for fishing in defiance of state law.

Various facets of the tribes’ treaty-secured rights have been affirmed over the years by the courts, notably in 1974, with \textit{U.S. v. Washington}, more popularly known as the Boldt Decision. The Boldt Decision recognized the tribes as co-managers of the treaty-reserved resources and affirmed that tribes are entitled to 50 percent of the harvestable number of salmon returning to Washington waters.

In 1994, a subsequent case in the \textit{U.S. v. Washington} litigation, called the Rafeedie Decision, recognized that the tribes’ reserved rights to take fish included shellfish. This ruling further cemented tribes as natural resource co-managers with the State.

\footnote{5}{Bureau of Indian Affair. www.bia.gov/FAQs}
\footnote{6}{Northwest Indian Fisheries Commission. http://nwifc.org/member-tribes/treaties/}
\footnote{7}{National Environmental Justice Advisory Council. 2002. Fish Consumption and Environmental Justice, 43-45.}
These precedents recognize tribes’ unique rights to the fish and shellfish resource and their unique status as co-managers of the treaty resource – all of which mean that tribes’ position in cleanups affecting fish and shellfish is quite different from that of an ordinary “stakeholder.” Therefore, tribes must be given the same distinction as that of other governmental entities such as sovereign nations.

Subsection 1.3B Rights to Consultation & Sovereignty
Tribes are sovereign nations, with inherent powers of self-government. Tribal governmental authority may be modified by Congress. This power, however, is wholly federal; states have no authority over tribes. The federal government, moreover, has a trust responsibility regarding tribes and tribal property/resources – a responsibility that includes protection from encroachments by states and their citizens.

Tribes’ powers of self-government include considerable authority to regulate activities on their lands. Tribal regulatory authority is independent of and not subordinate to state regulatory authority. Tribes can enact and enforce stricter or more lenient laws and regulations than those of the surrounding or neighboring state(s) wherein they are located. However, tribes frequently collaborate and cooperate with states through compacts or other agreements on matters of mutual concern.

In recognition of tribes’ sovereign status, both federal and state governments have committed to working with tribes on a government-to-government basis on matters affecting tribes’ rights, resources, and interests. The federal government has elaborated this commitment by means of Executive Order and other formal statements, through which it has pledged itself to meaningful and regular consultation and collaboration with tribal governments.

“Consultation” is different from, and goes beyond, mere “participation” to which an ordinary stakeholder might be entitled as a matter of public process surrounding toxic sediment cleanup decisions. The former is a form of dialogue reserved for government-to-government exchange.

While not an independent source of legal rights, the Executive Order nonetheless reflects a commitment that federal agencies, including those involved in cleanups, are directed to uphold. Although United States Environmental Protection Agency (EPA) is not the lead agency for toxics cleanups under the Sediment Management Standards (SMS), it still has a role in protecting human health and the environment by writing guidance, serving as a federal trustee, and approving both State and Tribal standards. Laws and decisions set by EPA may also apply as an applicable law (See Section 2.3E Other Applicable Laws for more details).

---

Similarly, the state of Washington has committed to government-to-government consultation with tribes by means of the Centennial Accord, discussed further in the next section.

Subsection 1.3C Centennial Accord
On August 4, 1989, the State of Washington signed the Centennial Accord with the 26 federally recognized tribes in the State at the time. The intent was to establish a more solid government-to-government relationship between each tribe and the State. Currently, Washington State has government-to-government relationships with 29 tribes located in the State itself, and five tribes with reservations outside the state that have traditional homelands/treaty-reserved rights within the State.

This relationship applies to state agencies that tribes usually work with on environmental issues. Regarding toxics cleanup of sediment sites, the Washington State Department of Ecology (Ecology) is the lead agency involved. However, there are sometimes interactions with other agencies such as Department of Health (DOH), Department of Fish and Wildlife (WDFW), and Department of Natural Resources (DNR). These additional agencies have some jurisdiction over human health and natural resources in Washington State, and therefore there might be interactions with these agencies during the cleanup process even though they do not have authority over the toxics cleanup itself.

After the Centennial Accord was executed, each state agency was required to draft a Centennial Accord Implementation Plan. For more detail on Ecology’s Centennial Accord Implementation Plan, please see the link included in the citation. Ecology’s Centennial Accord Implementation Plan specifically notes:

*Consultation means more than simply informing affected tribes about what the agency is planning to do. Consultation means respectful, effective communication that works toward a consensus before a decision is made or an action is taken. Ecology is committed to government-to-government consultation with tribes on all actions and issues of interest to tribes under Ecology’s statutory authority.*

**SECTION 1.4 ENVIRONMENTAL JUSTICE**
An important aspect of toxics cleanups is environmental justice. EPA defines environmental justice as “the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.” It is based upon the concepts that no one should be disproportionately burdened by environmental and health hazards and that all those affected by environmental agencies’

---

decisions should be able to participate in – or, in the case of tribes, be consulted regarding – the relevant decision-making process.

Environmental justice implicates a different constellation of issues where tribes and their members are among those affected by environmental decisions. Some of the differences stem from the fact that tribes, unlike other “environmental justice groups” or communities, are sovereign governments. This point has been recognized by the EPA, which in 2014 issued a policy devoted specifically to environmental justice for tribes and indigenous peoples.\(^{13}\)

Additionally, the adverse impacts of contamination that affects tribal members, resources, and rights are often different not only in degree but also in kind from those experienced by non-tribal individuals or groups. For example, tribal members who practice subsistence and ceremonial traditions often utilize the natural resources of an impacted area more frequently than other groups.

A difference between tribal consumers of fish and shellfish in Washington State compared to non-tribal consumers is their reliance on locally harvested seafood. About 67 to 68 percent of total fish and shellfish consumed by the Squaxin Island Tribe is locally harvested. That percent is even higher for other tribes: 88 percent for the Columbia River Tribes, 72 to 88 percent for the Tulalip Tribes, and 81 to 96 percent for the Suquamish Tribe.\(^{14}\) If these resources are collected from a polluted source, then tribal members will be disproportionately impacted. This also suggests that tribal members will be differently exposed since they will be exposed to the same contaminants repeatedly as opposed to the typical consumer who might be exposed to varying concentrations of different contaminants from different sites. Moreover, fishing, shellfish harvesting, and plant gathering are cultural practices of western Washington tribes. The harms from contamination of fish and shellfish, then, are not simply a matter of human physiological health for tribal people. The harms have multiple, interrelated dimensions for the well-being of tribal members and the tribe as a whole, with physical, social, economic, political, cultural, and spiritual facets. Fish and shellfish consumption are not merely habits or preferences that can be discarded in the face of fish consumption advisories or harvest restrictions issued once the resource has been allowed to become contaminated. Due to historic poverty and discrimination, tribes are more often impacted by the location of polluting facilities. These influences caused tribes to have less of a voice as to where the polluting facilities were located.

Both EPA and Ecology have committed to the pursuit of environmental justice. The federal government has underscored its commitment by means of an Executive Order.\(^{15}\)

---

Again, while this document does not create legal rights, the commitment it embraces, and similar commitments by the state of Washington, can be used as an avenue for urging meaningful policy decisions for tribal communities.

SECTION 1.5 UNDERSTANDING THE CLEANUP PROCESS

The SCUM II was created by the Ecology to serve as technical guidance for the revised SMS, Chapter 173-204 Washington Administrative Code (WAC).

The Model Toxics Control Act, Chapter 70.105D RCW, authorizes Ecology to regulate environmental cleanups and is the implementing authority for Part V of the SMS. The SMS provides Ecology with a uniform set of procedures and requirements for managing contaminated sediments.

The revised SMS became effective on September 1, 2013. The intent of the revisions was to better integrate some of the provisions of the Model Toxics Control Act (MTCA) with some of the provisions in the older SMS. The majority of the SMS rule revisions focused on Part V, Sediment Cleanup Standards of the SMS rule. The updates to the draft SCUM II reflect these new sediment cleanup provisions. The draft SCUM II is intended as guidance for Ecology site managers, potentially liable persons (PLPs), and technical consultants on how to conduct cleanup of contaminated sediment sites with a focus on how to implement the Part V provisions of the SMS rule.

The Washington State cleanup process generates a series of reports that describes site contamination, evaluates potential active remedies, and selects remedies that will address contamination at the site. This series is commonly followed at both MTCA and SMS cleanup sites. The pros and cons of the remedies commonly evaluated under the SMS are described in more detail in Section 3.2 Remediation Technologies.

The Remedial Investigation (RI) report details the sampling results from investigations and provides an overview of contamination at the site. The RI contains the human health risk assessment for the site, which will be explained in more detail in Subsection 2.3A Human Health Risk and Subsection 2.3B Selecting Human Health Exposure Parameters. The Feasibility Study (FS) report looks at cleanup alternatives and which ones can be practicable at the site being considered. The Cleanup Action Plan (CAP) takes the information presented in the FS, with more specifics on the expected schedule, and documents the final cleanup decisions.

After the CAP is completed, then the remedial design process begins. This is when Ecology will go over details of how the cleanup actions will occur. Pre-design investigation (PDI) sampling may be conducted to clarify the extent of contamination if it has been several years since the samples were collected for the RI. After the PDI sampling has been completed, and data gaps have been filled, then the engineering design report will go into detail as to how the cleanup will be completed. After the publication of each document, Ecology will hold a comment period when tribes can submit comments for each document. As part of government-to-government consultation, Ecology may open comment periods for tribes before the public comment period, or may receive tribal comments even though there is no public comment period.
**Figure 2: Washington State Cleanup Process**

### Key Public Comment Period
- Public notice posted on website and newspaper and mailed to residents
- Opportunity to comment (at least 30 days); may be combined with comment period on RI/FS
- Comments response letter

### Definitions:
- **Interim Action:** An action that only partially addresses the cleanup of the site.
- **Remedial Investigation:** Provides information on the extent and magnitude of contamination at a site.
- **Feasibility Study:** Provides identification and analysis of site cleanup alternatives.
- **Cleanup Action Plan:** A document that selects the cleanup action and specifies cleanup standards and other requirements for a particular site.

*Source: Ecology’s Scott Paper Mill Draft Public Participation Plan, August 2008*
Chapter 2  Site Identification and Assessment
Section 2.1  Conceptual Site Model
One of the most important aspects of understanding the fate and transport of contaminants related to a cleanup is the CSM. The CSM describes how the contaminants are being released into the environment in relation to their source, and what resources may be impacted. The CSM should link contaminant sources, release mechanisms, fate and transport pathways, exposure routes, and receptors. This information is essential for a cleanup design since it describes where the contaminants lie and will therefore inform development of a cleanup design that prevents hazardous exposures. The CSM should be developed before the RI since it will inform site managers what the data gaps are in order to prioritize investigation sampling. Section 2.3 of the SCUM II describes how to develop a conceptual site model (CSM).


When reviewing a CSM, it is important to consider all possible pathways of chemical pollutants from potential sources identified at a site. CSMs should consider fate and transport pathways from all potentially impacted sources, including sediment, air, soil, groundwater, surface water, and porewater. This will help determine whether there is
Concern from contaminants crossing from one medium to another. The CSM should identify likely exposure routes as well as potential receptors, such as humans and ecological receptors. For human receptors, it should consider multiple exposure routes such as ingestion of sediments, ingestion of fish and shellfish, dermal contact, and inhalation. Attention should be given to plants or aquatic vegetation used for cultural practices such as basket weaving or medicine.

Contamination that originates from a variety of upland sources can contaminate sediments. For example, upland contamination can leach through soil into groundwater. Groundwater can then transport the contamination to surface water or sediments, depending on the chemical’s solubility. Soil erosion can contribute to contamination in sediments. Aerial deposition can contribute to sediment contamination by depositing airborne particles into sediments or soil.

The purpose of a cleanup level is to establish a contaminant concentration that is determined to be protective of human health and aquatic life to which the PLPs are responsible for remediating to in order for Ecology to consider the site clean from contamination. The cleanup levels established in the SCUM II Guidance Document (above) create a lower bound, more protective Sediment Cleanup Objective (SCO) and an upper bound, less protective cleanup screening level (CSL) for each individual chemical of concern. The Ecology site manager can adjust the site-specific clean level somewhere between the upper and lower and bounds established by the SCO and CSL based on technical feasibility and expected environmental impacts. Both of the SCO and CSL are based on one of three options: background, risk-based concentration, or practical quantitation limit (PQL).

However, since the risk-based concentration is based on the lowest (i.e. most protective) of four different standards, and the final cleanup level is based on the highest (i.e. least protective) of three standards (background, risk-based, or PQL); risk-based concentrations are rarely the final SCO or CSL at a sediment cleanup site. When the SCOs and CSLs were derived for sediment cleanup sites in Port Angeles Harbor and Port Gamble Bay, for example, nearly all of them defaulted to either natural or regional background. This will most likely be replicated across most, if not all toxics sediment cleanup sites under the SMS simply due to Ecology’s decision framework, diagrammed
above, for selecting a cleanup standard. The risk-based concentrations will likely simply be too low (i.e., protective) to compete against natural/region background and PQL. Recognizing this reality may help technical staff determine where to focus their efforts in commenting on the development of cleanup standards.

Indeed, much effort in recent years has been focused on the fact that the default fish consumption rates in state standards significantly understate both contemporary quantities of fish intake and the amount of fish tribal members are entitled to consume, given their treaty-secured rights. Attention has also been focused (through both the SMS and water quality standard revision efforts) on the need to enlist other exposure parameters that reflect tribal members’ greater dependence on natural resources, lifetime residency in place, and other parameters of exposure. While these observations remain important to ensuring accurate and appropriate human health-based-based standards, the risk-based concentration tends not to be the driver for the derivation of the CSL and SCO. Rather, at present, CSL and SCO are more likely to be determined based on background or PQL. Under this method the same PQL can be used for both the CSL and CSO. However, in Subsection 2.3A Human Health Risk, it will be explained how these exposure parameters can be relevant to a health assessment that will be useful in informing tribal consumers about potential risks, as well as defining a level that is ultimately protective of human health according to best available science.

SECTION 2.3 DERIVING RISK-BASED CONCENTRATIONS

WAC 173-204-500(5)(c) presumes that sediment cleanup levels are protective of human health and the environment. The new structure of the SMS promotes the establishment of the SCO and CSL based on background and PQL. There can oftentimes be a gap between these cleanup goals and human health risk-based standards. Sediment cleanup levels cannot be presumed to be protective of human health and the environment until they are compared to levels established based on human health and ecological risk. By default then, if background or PQL are selected as the standard for the site, then there is a difference between that and human health risk-based levels that needs to be quantified for tribal members and decision makers.

SUBSECTION 2.3A HUMAN HEALTH RISK

Chapter 9 in the SCUM II discusses how to establish risk-based human health sediment cleanup standards based on regulations found in WAC 173-204-561.

For the SCO, human health risk is based on individual contaminants having a cancer risk of less than 1 in a million (10^-6) for carcinogens, or a hazard quotient (HQ) ≤ 1 for noncarcinogens. For the CSL, the human health risk-based standard is derived from individual or multiple contaminants having a cancer risk of less than 1 in 100,000 for carcinogens, or a HQ ≤ 1 for noncarcinogens. WAC 173-204-561(2)(a) is the basis for establishing a SCO based on human health risk of 10^-6 cancer risk for carcinogens and a hazard quotient of less than 1 for non-carcinogens. WAC 173-204-561(3)(b) is the basis for establishing the CSL based on human health risk of 10^-5 cancer risk for carcinogens and a hazard quotient of less than 1 for non-carcinogens.
A health evaluation can be a valuable tool for determining human health risk and potential effects of contaminants on tribal members who harvest from areas in proximity to a contaminated site. The SMS method for selecting the SCO and CSL (see Subsection 2.1A) makes it unlikely that the cleanup will achieve concentrations based on human health risk. Section 9.1.5 of the SCUM II states that if only sediment data exist for the site, then it is not possible to back-calculate risk-based sediment concentrations. The SCO and CSL then therefore automatically default to background or PQL. However, a risk-based concentration can establish an ultimate cleanup goal that might be achieved in the future through periodic reviews and technological advances. Also, it is important that tribal technical staff compare cleanup levels to human health risk-based values in order to inform tribal policymakers as well as inform tribal harvesters.

Therefore, the burden of proof may often fall on tribes to pay for and collect fish and shellfish tissue samples if tribes are interested in finding out health risks from harvesting in proximity to a sediment cleanup site.

However, there are other avenues that tribes can pursue to order to get a human health evaluation that is informative and useful for tribal members.

One way of evaluating the contamination at a site and the potential for human exposure is to request that Agency for Toxic Substances and Disease Registry (ATDSR) conduct a human health consultation for the site of interest. ATDSR has prepared human health consultations based on requests sent from tribes at sediment sites including Port Gamble Bay, Port Angeles Harbor, Port Gardner, Oakland Bay, and Eagle Harbor.16 Have the tribe’s chair write a letter to ATSDR’s regional representative (ATSDR Region 10) and the ATSDR director in Atlanta to petition a human health evaluation. The letter should be clear about what contaminants to evaluate and which exposure parameters to look for (more on this in Section 2.3B Selecting Human Health Exposure Parameters).

ATSDR has a cooperative agreement with Washington DOH, who will use their staff to conduct the human health consultation and produce the health assessment. One of the downsides of using the DOH/ATSDR approach is that the tribe is responsible for collecting its own fish and shellfish tissue samples for analysis if samples have not already been collected as part of the RI. Also, it can be several years waiting for the review and final approval from ATSDR of the health assessment.

Another option is utilizing the human health risk assessment (HHRA) in the RI report. The RI Report must include a human health risk assessment unless Ecology determines that is not appropriate for specific cleanup sites. Tribes can advocate to have this assessment included. The tribal technical staff should ensure that the exposure parameters selected are adequate for the tribe’s needs (Section 2.3B Selecting Human Health Exposure Parameters).

A HHRA should be conducted whether the site has its cleanup levels based on risk-based concentrations or not. The HHRA will help inform tribal government about risk management, and it will help tribal members get a better understanding of their relative health risks from the site. It will also establish an ultimate cleanup goal that has the potential to be achieved through periodic reviews and technological advances.

**SUBSECTION 2.3B SELECTING HUMAN HEALTH EXPOSURE PARAMETERS**

The effectiveness of the HHRA is based on the appropriateness of the selected exposure parameters. The SCUM II identifies a reasonable maximum exposure (RME) scenario as a “high-end (but not worst case) estimate of individual exposures” in Section 2.3.2. However, this estimate should be consistent with EPA’s Risk Assessment Guidance for Superfund definition of RME, which takes into account the highest exposure that is reasonably expected to occur at a site under current and future conditions. RME estimates typically fall between the 90th percentile and 99.9th percentile, depending on the availability of the data. The intent is to measure the subset that is getting exposed the most (well above average) in order to ensure that the vast majority of the population is safe. If a population is exposed via more than one pathway, the combination of exposures across pathways also must represent an RME.

The exposure parameters in Table 9-1 and 9-2 in SCUM II may be a good reference for non-tribal risk assessors who are looking to develop exposure factors specific to tribal use at sediment sites. The Traditional Tribal Subsistence Exposure Scenario and Risk Assessment Guidance Manual is another valuable resource for educating risk assessors on how to incorporate exposure routes in the HHRAs that are specific to tribal lifeways. The rest of this section details considerations for exposure parameters that may not be discussed in the SCUM II.

**Fish Consumption Rate**

For risk management cleanup decisions, consistent with EPA regulatory guidance, regional-specific technically defensible fish dietary data is preferred over national data. The SCUM II does not list information on the tribal fish consumption studies. The SCUM II references Ecology’s Fish Consumption Rate (FCR) Technical Support.

---


Document, Versions 1.0 and 2.0. These documents provide a greater level of detail into the tribal fish consumption studies conducted in Washington State.

The Technical Support Document profiles consumption studies from four tribes/tribal groups: Tulalip, Suquamish, Squaxin Island, and four Columbia River Treaty Tribes. Another consumption survey for the Lummi Nation was finalized in 2012, after the Technical Support Document was completed. Choosing an already existing consumption study as a proxy for the tribe’s own consumption data can be a challenge. However, it is also important to consider several factors when choosing a proxy, such as study design, timing, seasonal fluctuations in abundance, and method. For example, using a study that was conducted in a year with low salmon returns could measure an artificially suppressed rate. Further, consumption surveys only reflect current consumption patterns, which may be suppressed due to contamination or other factors, and may not represent a more traditional tribal consumption rate.

Ecology’s September 2011 Version 1.0 Technical Support Document made preliminary recommendations for a default fish consumption rate in the range of 157 to 267 grams/day, with 210 grams/day representing the 90th percentile of the exposure distribution. The 90th to 95th percentile fish consumption estimate range is between 210 and 267 grams/day of the exposure distribution; this corresponds to a Reasonable Maximum Exposure (RME) defined at or above the 90th percentile of the exposure distribution. A 210 grams/day fish consumption rate represents eating about six 8-ounce fish meals per week. The 95th percentile fish consumption estimate of 267 grams/day represents about eight 8-ounce fish meals per week; a 90th to 95th percentile range of six to eight 8-ounce fish meals/week. The figure below shows how Ecology’s recommended default fish consumption rate range was statistically derived.

Some tribes may wish to conduct their own fish consumption studies. However, these come with downsides. A good study can be resource intensive, and take years to complete. If conventional study designs are employed and only contemporary consumption practices are documented, there is a risk that even a well-conducted survey will document a suppressed FCR – perhaps a rate that is lower than those already available from other contemporary tribal studies. Also, a publicly available study containing sensitive tribal information is available for agencies and industry to preferentially select from among the data or cite the data out of legal, historical, or...
cultural context. There is the possibility that, once the survey is conducted, that Ecology may choose not incorporate it into a standard.

A suppression effect “occurs when a FCR for a given population, group, or tribe reflects a current level of consumption that is artificially diminished from an appropriate baseline level of consumption for that population, group, or tribe.”

There are two primary circumstances linked to suppressed FCRs. In the first, a suppression effect may arise when an aquatic environment and resources have become contaminated to the point that tribal members refrain from consuming fish. Were the fish not contaminated, they would be consumed at more robust levels. In the second, a suppression effect may arise when fish species are no longer available in historical quantities, such that tribal members are unable to catch and consume as much fish as they had or would.

However, when tribes are affected, there are two important differences. First, the “appropriate baseline level of consumption” is clear for tribes, whereas it may be subject to debate for other groups. Only tribes have legally protected rights to a certain historical, original, or heritage baseline level of consumption. Second, the causes of suppression have exerted pressure on tribes for a longer period, and in more numerous ways, than on the general population. Whereas those in the general population may have begun to reduce their intake of fish in response to consumption advisories once these became more prevalent in the 1970s and thereafter, tribal members historically have been excluded from their fisheries, and harassed and imprisoned for exercising their fishing rights.

Indeed, the forces of suppression, often perpetrated or permitted by federal and state governments, have included inundation of fishing places; depletion and contamination of the fishery resource; and years of prosecution, intimidation, and gear confiscation.

Even considering these potential downsides, a tribe may determine than a consumption survey specific to the tribe is valuable. Table 9-3 in the SCUM II discusses the evaluation criteria necessary for consideration of incorporating future surveys, including: timing of interviews, training of interviewers, consideration of all fish species, source identification, participant selection, sample size, statistical analysis, quality assurance and quality control, and accuracy and precision.

Consumption surveys should include both anadromous and resident species. For sites in Region 10, particularly PCB-contaminated sediment sites, salmon have typically been excluded from the fish consumption rate used to estimate site-related risks. There has been some controversy as whether to include anadromous fish in factoring in fish consumption studies since species like salmonids can spend considerable portions of their life cycle in

---

the open ocean. However, there is evidence to support that the toxic body burden of anadromous fish is greatly influenced by their origin and migration. For example, skinless muscle tissue from Puget Sound Chinook salmon had PCB concentrations three to five times higher than average concentrations report for adult Chinook salmon from six other populations on the West Coast.\textsuperscript{30}

\textit{Fish Diet Fraction}

The fish diet fraction is a exposure parameter unique to the MTCA and SMS. Fish diet fraction means the percentage of the total fish and/or shellfish in a person's diet that has the potential to be obtained from the site. However, the FDF, the way it is used under MTCA and SMS, is inappropriate for human health, and should always have a value of 1. A value of 1 assumes 100\% of the diet is derived from organisms obtained from the site. The tribal surveys that have been conducted in Washington already sort out which species are being consumed, and indicate that they are harvested from local waters (see Section 1.3 Environmental Justice for studies indicating tribes’ reliance on local fish/shellfish harvest).

The term FDF is not used in EPA HHRA guidance, however it is similar in concept to EPA’s term “fractional intake.” Fractional Intake (FI) refers to the proportion of a fisher’s or shellfish harvester’s diet of fish or shellfish that is derived from a particular site. Any fraction less than one in this value will create a less protective standard. Ecology justifies a FDF less than 1, by citing that “it is important to provide some flexibility to address future sites not located in U&A fishing areas.” However, this contradicts current state policy since all waters in Washington State are part of some Tribe’s U&A.\textsuperscript{31,32}

In Section 9.3.3.3 of the SCUM II, Ecology allows for adjusting the FDF less than one based on: the size of the site, the species being consumed, the home range and migrating patterns of the species being consumed, and whether the habitat at the site can, or has the potential to, support the species. However, a lot of these factors can be based on incomplete or inaccurate information, having the potential to adversely impact treaty rights. Also, as natural resource co-managers, Ecology cannot be the sole determiner of whether the habitat can support the species. This decision must be made in coordination with tribes, as well as the state’s other natural resource agencies, e.g. WDFW and DNR, and even federal agencies such as the US Army Corps of Engineers (USACE), US Fish and Wildlife Service, and National Oceanic and Atmospheric Administration. Therefore, it is essential that tribes participate and advocate in the setting of the FDF.


Site Use Factor
The site use factor is another human health risk factor not in EPA risk assessment guidance, MTCA, or the SMS, but is only in the SCUM II. It is defined as the percentage of time that a fish/shellfish is in contact with contaminants at the site, which takes into account the home range of anadromous species. The SUF does not model how tribal members or community residents use tidelands that could potentially be affected by cleanup activity or future use. In the SCUM II, it is unclear who or how it will be decided that “the habitat can, or has the potential to, support the species and the established FCR [fish consumption rate]” (p. 9-14).

The SUF should always be 1. Any fractional value in this input will reduce the estimated dose and therefore create a less protective risk-based standard. Use of site area to fish home range ratios and sustainability considerations are not appropriate for assessment of human health risks as they can substantially underestimate risk.35

SUBSECTION 2.3C Benthic Criteria
Risk-based levels for benthic invertebrates are addressed in the SMS Sediment Quality Standards (SQS). The SQS are based on both chemical and biological criteria that are derived from bioassays and toxicity studies. Although there is the presumption of protectiveness at the SCO, this cannot automatically assumed to be true until it is compared to the chemical and biological criteria.

WAC 173-204-562 addresses protection of benthic invertebrates in marine and low salinity environments. WAC 173-204-563 addresses protection of benthic invertebrates in freshwater environments. Table 8-1 lists the sediment chemical criteria for freshwater and marine sediments, as well as apparent effects thresholds.

Bivalve larval sediment bioassay test
The existing Puget Sound Estuary Protocols (PSEP) bivalve larval sediment bioassay provides a measurement of normal larval development in the presence of sediment. The protocol requires shaking 18 grams of sediment in 900 mL of water and allowing the suspended sediments to settle out over a four-hour period. The test is initiated with non-swimming 2-hour-old embryos that develop into swimming larvae with shells. The larvae are allowed to develop into D-shell-stage larvae. At the end of the test (~48 hours) the overlying water is gently stirred without disturbing the sediment at the bottom of the test chamber - then decanted. Aliquots of the decanted water are collected and numerated, with larvae scored as normal or abnormal. Developmentally-delayed larvae are counted as abnormal. Larvae that have died during testing decompose quickly and are generally not recovered.

In 2009, a modification to the standard PSEP protocol was proposed to address the larval entrapment issue. It involves conducting the standard PSEP larval test, but with a modified test-termination procedure. At approximately 42 hours from test initiation, the water, larvae and settled sediment are homogenized by gentle mixing using a perforated

35 Lon Kissinger to Ecology staff. E-mail. 29 October 2012.
plunger. The contents are then allowed to settle until the test is terminated at the test duration indicated in the standard PSEP test method (48 to 60 hours). At test termination, the overlying water is decanted, aliquots are collected, and larvae are enumerated as in the standard protocol. This adjustment allows for the recovery of any larvae trapped in fine sediments or flocculent materials.

This has method has been applied at sites for new bioassays without publication or replication by other labs. Currently, there is the only one lab using this protocol, and the results are being used to override the results using the existing method. There have been issues with extending the test beyond the 48-60 hours by adding time after the re-suspension, which brings into question whether the resulting increase in live larva is an artifact of the test. If the re-suspension is done and the test terminated immediately afterwards this may not be an issue. Further, this revised protocol should be more thoroughly vetted by other labs, and should go through a more formal and transparent adoption process if it is to become the standard protocol.

Protocol Comparison - SMS Program. Ecology has evaluated the development and application of the re-suspension protocol in recent testing of Port Gamble sediments. Outcomes were compared for 31 test sediments ranging from very fine-grained sediments with wood waste to sands with low organics. The greatest increase in the number of recovered normal survivors using the re-suspension protocol was generally associated with those samples with higher percent fines and organic matter. Comparing the outcome of the re-suspension protocol to the PSEP protocol, the following were observed:

• 15 of 31 treatments were unchanged
• 8 of 16 SQS exceedances changed to passes
• 5 of 6 CSL exceedances changed to passes
• 1 of 6 CSL exceedances changed to an SQS exceedance
• 2 passes changed to SQS exceedances as a result of improved reference performance

The improved recovery of normal larvae was seen in 29 of 31 test sediments and in 4 of 6 reference sediments. This supports the conclusion that the re-suspension protocol provides an improvement for the bivalve larval bioassay in sediments where entrapment occurs. This potential for entrapment can be partly determined by looking at the percent fines in sediment, but other factors such as the presence and nature of wood waste should also be considered. It is interesting to note that improved recovery in fine-grained reference sediments reduces the frequency of reference failures and may result in some test sediments failing that would otherwise have passed using the standard PSEP protocol. This occurred for 2 of the 31 test sediments from the Port Gamble case study.

The issue with this new protocol is the timeframe; the re-suspension needs to be done as directed in the protocol, before the end of the test.  

---

34 BIOASSAY ENDPOINT REFINEMENTS: BIVALVE LARVAL AND NEANTHES GROWTH BIOASSAYS. Prepared by David Kendall, (U.S. Army Corps of Engineers) and Russ McMillan, (Washington State Department of Ecology) for the DMMP agencies and SMS Program, and Bill Gardiner, Brian Hester, and Jack D Word (NewFields, LLC).
The standard sampling depth in the SMS for ecological risk is the biologically active zone of 10 cm but can be adjusted specific to the site. In Port Gamble, for example, the depth was set at a range between 45 centimeters (cm) and 3 feet due to the existence of geoduck clams in the site. Areas where human health exposure is considered likely, such as intertidal sediments, have a point of compliance at 45 cm. More detail on this is provided in Section 7.3.1 Point of compliance in the SCUM II.

SUBSECTION 2.3D  HIGHER TROPHIC LEVEL RISK
WAC 173-204-564 and Chapter 10 in the SCUM II detail how to derive a standard that is appropriately protective of higher trophic level species. This is of particular concern for sites impacted by persistent and bioaccumulative contaminants, especially those contaminants that have greater adverse impacts to ecological receptors than human health receptors. Examples of such chemicals are listed in Section 10.3.3 in the SCUM II, and include fluoranthene, lead, mercury, pentachlorophenol, pyrene, selenium, and tributyltin. Table 10-1 in the SCUM II lists several species of concern that might be considered in this assessment. Since the SCO and CSL will frequently default to natural background and PQL, some tribes may choose not to evaluate the risks to higher trophic level species. Tribes may choose to evaluate these risks in order to determine impact to higher trophic resources.

SUBSECTION 2.3E  OTHER APPLICABLE LAWS
Applicable laws can help determine a risk-based concentration that will be used for the CSL and SCO. “Applicable laws” include legally applicable requirements and requirements that Ecology determines are relevant and appropriate requirements. “Relevant and appropriate” requirements are those that might not be legally applicable but are still pertinent for consideration at the site. Once a requirement is determined by Ecology to be relevant and appropriate, it must be complied with as an applicable law. The commonly used term is “applicable or relevant and appropriate requirements” (ARARs).

Section 17.1.2 outlines federal and state laws that are considered ARARs. Of particular importance to tribes, the SMS explicitly recognize tribal standards as “relevant and appropriate.” Even if the CSL and SCO are not likely to be driven by “applicable laws” any more than by risk-based standards, this aspect of the SMS recognizes tribal sovereignty. If tribes are considering whether or not to issue regulations, their calculus might be affected by knowing that regulations would be potentially viewed as “applicable laws” for cleanup purposes. Where cleanups leave contaminants in place in excess of health-based levels/ARARs, there needs to be periodic review, which means that the human health risk assessment still matters as a touchstone for this review.

SECTION 2.4  USING BACKGROUND FOR ESTABLISHING CLEANUP LEVELS
SUBSECTION 2.4A  NATURAL BACKGROUND DETERMINATION
According to presentations conducted by Ecology staff, the SCO for some contaminants will almost always default to natural background, and the CSL will most likely default to
Therefore, it may make sense to focus the most energy towards accurately deriving this background standard.

Unfortunately, using natural or regional background does not create a standard that is necessarily protective of human health or the environment. It simply measures what is considered “background” at the site, and is based on the reliability of the data collected for what is considered representative of background conditions. Therefore, if the natural background data is collected from a set of water bodies that have been polluted by anthropogenic sources, then this can create a standard that erroneously results in high concentrations of a harmful pollutant. This will likely lead to scenarios where more areas of the sediment cleanup are in compliance with the standard, but should otherwise be remediated by the polluter if standards were not based on a polluted background level.

Natural background is defined as “the concentration of a hazardous substance consistently present in the environment that has not been influenced by localized human activities.” The standard for natural background is defined as the 90/90 upper threshold limit (UTL). Statistically, this means that with 90% confidence, the 90th percentile of the data set will fall below that value. The concept comes from the statistics theory about collecting a representative sample: you assume that there is always some difference between the sediment sample set you have collected and what the actual sediment concentrations are out in your water body of interest. The more sediment samples collected, and the more comparable they are to one another by characteristic (see Section 3.1B, Sediments), then the lower the standard deviation will be. The lower the standard deviation, the lower the upper confidence interval will be and therefore you will have a lower standard to base your value. However, having fewer samples, or even having a few samples that are much higher than the rest of your data, can cause a higher standard deviation. This will in effect create a higher and less protective standard, since the upper threshold limit is based on the standard deviation.

### Table 11-1: Derivation of Background Threshold Values (BTVs)

<table>
<thead>
<tr>
<th>CoP</th>
<th>Distribution</th>
<th>Method</th>
<th>Mean</th>
<th>SD</th>
<th>50th percentile</th>
<th>90th percentile</th>
<th>BTV (90/90 UTL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>cPAH TEQ (µg/kg)</td>
<td>Lognormal</td>
<td>MLE</td>
<td>1.3</td>
<td>0.77</td>
<td>3.6</td>
<td>9.6</td>
<td>16</td>
</tr>
<tr>
<td>Cadmium (mg/kg)</td>
<td>Lognormal</td>
<td>MLE</td>
<td>-1.2</td>
<td>1.2</td>
<td>0.39</td>
<td>0.99</td>
<td>3.0</td>
</tr>
<tr>
<td>Dioxin/furan TEG (ng/kg)</td>
<td>Lognormal</td>
<td>MLE</td>
<td>1.31</td>
<td>1.19</td>
<td>0.97</td>
<td>2.71</td>
<td>4.35</td>
</tr>
</tbody>
</table>

1 Method for estimating the population mean and standard deviation (SD): MLE = Maximum likelihood estimates.

2 Mean and standard deviation (SD) are shown on log scale for lognormal distributions; on concentration scale for normal distributions.

---


The table above is an excerpt from Port Gamble Bay’s Final RI Report. The lower the standard deviation is, the closer the 90/90 UTL is to the 50th and 90th percentile values. For cadmium, which has the highest standard deviation, the 90/90 UTL is about three times the 90th percentile value. For PAHs, which have the lowest standard deviation, the BTV is about 1.7 times higher than the 90th percentile. As you can see, the quality of the sediment data collected can be a major determinant as to what background standard is derived. Therefore, tribes may want to collect their own sediment samples or comment on which sites that are included as representative of background in order to reduce the uncertainty associated with the sediment data set. This will in turn lower the standard deviation, which will create a more protective background standard.

When selecting sample sites for natural background, you want to select areas that are free of anthropogenic sources of pollution, but also comparable both physically and geographically with the site in question. This can be quite a monumental task, since many areas are not completely free of anthropogenic influences. Also, sediment cleanup sites are often in water bodies that have been modified for industrial or navigational purposes, and do not have the same sediment transport characteristics as natural water bodies.

Both EPA and Ecology are committed to using the sediment chemistry data collected from US EPA’s Ocean Survey Vessel (OSV) Bold survey of Puget Sound as the basis for natural background. The Department of Ecology has made a policy decision to use natural background identified by the OSV Bold Survey to fill this lower bound SCO. In the summer of 2008, the OSV Bold sampled sediments in the Puget Sound. Due to point source pollution outfalls and legacy manufacturing sites, there are toxic sediment hot-spots in certain areas in the Sound. The goal of this 2008 survey, however, was to establish a sediment quality baseline for the Puget Sound that was focused on non-hot spot areas. This was the most extensive survey involving analysis of bioaccumulative contaminants such as dioxins/furans and polychlorinated biphenyls (PCBs) ever conducted in Puget Sound. Sediment samples were collected and analyzed at 70 locations throughout the Sound. The samples were analyzed for concentrations of dioxin/furan and PCB congeners, as well as the standard list of contaminants of concern, which includes semi-volatiles, polycyclic aromatic hydrocarbons, PCB Aroclors, pesticides and trace metals, and sediment conventionals (total organic carbon, grain size distribution, and percent solids).

The result was low levels of most contaminants being found, with the exception of three samples that represented much higher levels of dioxins/furans. These outliers were significant enough to skew the results and were therefore removed by EPA in their natural background determination. The Washington Department of Ecology, however, chose to use the data without removing these outliers, thus resulting in a standard that is twice as high as the standard EPA has established for dioxins/furans. Ecology’s controversial choice leaves this standard open to negotiation by a tribe during a cleanup.
SUBSECTION 2.4B  REGIONAL BACKGROUND DETERMINATION

Regional background is unique to the updated SMS rule (WAC 173-204-505(16)). "Regional background" means the concentration of a contaminant within a defined geographic area that is primarily attributable to diffuse sources, such as atmospheric deposition or storm water, not attributable to a specific source or release. The main difference between regional and natural background is that regional background may include diffuse, human-caused pollution that cannot be primarily attributed to a specific source (and will, in nearly every case, be higher than natural background). The key here is that regional background should not factor in areas with specific, localized sources, such as a stormwater outfall, but that it might include pollutants from nonpoint sources, such as runoff, vehicle exhaust, etc. However, liable parties have the opportunity to use this loose rule language to incorporate background sources that are questionable. Therefore, it may require some effort on part of the tribal technical staff to ensure that only truly diffuse nonpoint source pollution is incorporated into regional background.

The identified issue with regional background is that the choices and application of method are not clearly specified in the Ecology guidance and therefore are not applied consistently throughout Washington. Further as there has been no specific methodology to establish regional background, it is open to the discretion of the Department of Ecology. Therefore, PLPs can take advantage of this by attempting to set a less protective Regional Background standard. Therefore, tribes will have to review regional background standards. It is important to remember that the Regional Background will frequently be the applied CSL on sediment cleanups as in many situations it will be the highest value.

According to the SCUM II guidance (Chapter 16), Ecology may determine compliance with a background-based cleanup level by comparing it to an average site concentration. The Ecology application of the 90/90 UTL for the regional background and comparing this statistic to a site mean, leaves the scenario where conceivably a site could still be contaminated and listed as clean. What the method is doing is using the 90th percentile of the upper confidence limit of the 90th percentile value and comparing this number to the mean value of the site. This comparison being used as a determinant of compliance leaves many areas of the site unremediated above cleanup level, even though it is determined to be “clean” at a policy level. Determining compliance with background-based cleanup standards is an area where Tribe’s may wish to have significant input, since it will determine what potential risks will remain once a site has been deemed clean.

SECTION 2.5  PQL AS A CLEANUP STANDARD

The practical quantitation limit (PQL) is the “lowest concentration that can be reliably measured within specified limits of precision, accuracy, representativeness, completeness and comparability during routine laboratory operating conditions.”\(^{37}\) Anything measured below this value and measured about the method detection limit (MDL) usually receives a “J” value from the lab, indicating that it was measured, but that it could not be measured reliably. If a chemical cannot be measured above the MDL, then it is considered undetected and given a “U” value. A common misconception is that if a

\(^{37}\) WAC 173-340-200
chemical is not measured that it is not present. This just means that it might be present, it is just at a lower concentration than can be measured by the lab’s method.

PQL is not an acceptable standard based upon the Clean Water Act, which contains the following excerpt:

*Analytical detection limits have never been an acceptable basis for setting standards since they are not related to actual environmental impacts. The environmental impact of a pollutant is based on a scientific determination, not a measuring technique which is subject to change.*

According to the SMS, when the limit for an analytical method (the PQL) is higher than the concentrations based on protection of human health or the environment, Ecology “may require the use of another method to lower the practical quantitation limit.” Since the PQL would only be selected as a cleanup level if it were higher than a risk-based standard, Tribes should encourage Ecology to use its discretion to require analytical methods that obtain the lowest possible PQL. MTCA also provides Ecology the discretion to require the “use or development of specialized sample collection or analysis techniques to improve the method detection limit or practical quantitation limit for the hazardous substances at the site.”

Whenever a PQL is used as a cleanup level, Ecology must “provide for periodic review to determine the effectiveness and protectiveness of cleanup actions.” Tribes may wish to have input on the development of monitoring or other aspects of this “periodic review” to ensure that any improvements in analytical methods are taken into account.

---

38 National Toxics Rule Preamble 40 CFR Part 131
39 WAC 173-204-200
40 WAC 173-340-707
41 WAC 173-340-707
Chapter 3  Cleanup & Remediation

Section 3.1  Sampling

An important aspect of sampling, whether it is sediment or tissue, is developing a sampling and analysis plan (SAP). This is described in more detail in the Section 3.2.2 Sampling and analysis plan of the SCUM II. To successfully reliability and comparability, tribal technical staff should follow PSEP. This will also help ensure that samples that are collected can be entered into Ecology Environmental Information Management database and incorporated into the RI or other reports.

Subsection 3.1A  Tissue

Fish tissue sampling is the most valuable sampling for gauging impacts to tribal consumers. Tissue data shows contamination in foods, and represents the exposure pathway that is most likely to be a concern for tribal members.

When selecting species of concern to sample, the focus should be on shellfish and bottomfish due to their longer residence at the site and close proximity to sediments. Bivalves are filter feeders and spend their entire lifecycles in a relatively stationary position. Therefore, they are the most affected by site-specific sediment conditions. Bottomfish travel, but still remain relatively stationary, spending more time in close contact with contaminated sediments compared to more migratory fish. Crabs are a sampling priority due to being bottom feeders and therefore accumulating many lipophilic contaminants in the hepatopancreas.

Technical staff should consult tribal fisheries, shellfisheries managers, and tribal members in order to determine which species are most commonly harvested, as these should be a priority for sampling. These contacts will know which habitats are suitable for commonly harvested species. Some examples of commonly harvested species in western Washington include oysters, manila clams, butter clams, and cockles.

The biota sediment accumulation factor (BSAF)/biota accumulation factor (BAF) can be used to derive a sediment risk-based concentration from a known fish tissue risk-based concentration, and requires having both tissue and sediment data collected. The BSAF is the lipid normalized tissue concentration divided by the total organic carbon normalized sediment concentration. A BAF is not normalized for lipid content or organic carbon and is the tissue concentration divided by the sediment concentration. BSAF values are calculated for lipophilic compounds, while BAF values are calculated for lipophobic compounds. The BSAF predicts the bioaccumulation of lipophilic contaminants in aquatic biota from measured concentrations in sediment. Also, the sediment and tissue data must be specific to the site. Advantages of collecting this information for tribes is deriving the risk-based concentrations and understanding the bioaccumulation from sediments to shellfish. One of the disadvantages of this approach is that the CSL or SCO could still resort to background or PQL.

Subsection 3.1B  Sediment
Sediment data is useful for a variety of purposes. Sediment concentrations can be compared to tissue data to show bioaccumulation of contaminants. Sediment concentrations fill data gaps for human health exposures based on direct contact and ingestion of sediments. This information can also provide details on exposures to benthic organisms through their direct contact with sediments, which will in turn help reveal impacts to humans and higher trophic species than depend on these benthic invertebrates. Standard Operating Procedures for Obtaining Marine Sediment Samples\textsuperscript{42} and Quality Assurance Project Plan: The Puget Sound Assessment and Monitoring Program Sediment Monitoring Component\textsuperscript{43} are two useful resources for developing sediment SAPs that are consistent with PSEP. However, there are additional considerations that need to be taken into account in order to conduct sediment sampling that is useful towards creating a sediment dataset that can be used to influence a more effective cleanup.

The point of compliance for evaluating human health exposures is typically the top 45 cm in the SCUM II to account for health risks associated with direct contact from shellfish harvesting and beach play. The point of compliance can be established at a different depth depending on the exposure scenario and site-specific circumstances. For example, the point of compliance may be modified if the remediated site has the potential to be disturbed deeper than 45 cm (such as anchoring or propeller wash) or if the exposure pathway is deeper or shallower than 45 cm. For evaluating ecological risk, the point of compliance is typically the biologically active zone of the top 10 cm. For additional information, see Section 7.3.1 Point of compliance in the SCUM II.

Matching TOC & Grain Size
There is a significant correlation with fines content and the concentration of contaminants found in sediments. This is due to finer sediments having an exponentially increasing surface area with decreasing particle size and increased surface charge. Fines are usually found in depositional areas with lower wave energy, while coarser material is usually found in areas with higher wave energy. When choosing sample locations, technical staff should prioritize the areas with higher percent fines in order to capture the areas of highest concern. Also, areas with higher percent fines that undergo active remediation have the greatest potential for resuspension.

Total organic carbon (TOC) is another characteristic that is important to consider when evaluating concentrations of contaminants. TOC is the total load of organic compounds in sediment. It is a measure of both anthropogenic and natural sources. Information on TOC can help inform where to sample organic pollutants.


An important consideration is matching these characteristics when measuring sediments for regional and natural background data sets. For areas that are being measured as natural background and regional background, it is important to collect sediment samples that match grain size and TOC in areas undergoing remediation at the site.

Section 3.2 Remediation Technologies
WAC 173-240-570 discusses the selection of cleanup actions. This statute outlines several different remedies that are typically used for remediation of sediment sites. They are usually selected based on extent of contamination, site use, and cost. The technology chosen affects the quality of a cleanup. The technology for a cleanup site is usually chosen in the FS once the RI describes the full extent of contamination. Here are the remediation technologies as described in Section 14.3 Remedial Technologies and Cleanup Action Alternatives for Sediments in the SCUM II:

Source Control
Source control is a critical aspect of sediment cleanups since it eliminates ongoing sources of pollution. Eliminating these sources prevents recontamination once the cleanup is complete. This usually is the first action that is completed during a cleanup so that the more active remedies are not entirely discounted by continuing contamination. However, this action does not address historical contamination, which is why other active remedies are usually needed after the source control action is complete. Some examples of actions to address source control include: removing creosote pilings, removing outfalls, rerouting outfalls to higher energy areas, reducing air emissions, blocking flow of contaminated groundwater, and addressing erosion of contaminated soils from upland areas.

Source control may not be the preferred remedy at a site or part of the site if the method for addressing source control is more damaging than the source itself being present, if it restricts future access to treaty rights, or if it is destructive to habitat.

Dredging
Dredging is usually the most drastic and most permanent way to remove contaminated sediments from a site. This remedy is reserved for the most contaminated areas. It is also the most costly and comes with the risk of resuspension and turbidity. For example, some sites with high PCB contamination had higher concentrations of PCBs after dredging than before dredging (refer to Reynolds Aluminum site in Massena, New York).

There are two techniques that are commonly used for dredging: clamshell and hydraulic dredging. Clamshell is the most common and most cost-effective method, however it has the highest chance for resuspension and turbidity. There is also a subset of clamshell dredging called environmental clamshell dredging that uses closed buckets. These buckets have certain features that can be used to reduce turbidity and create a level cut

---

with less residual than an ordinary clamshell dredge bucket. This is helpful for areas with tribal harvest since this technology reduces the chance that there will be any residual layer of contaminants post-cleanup.

Hydraulic dredging has a reduced likelihood of resuspension, but poses obstacles when there is debris. Both hydraulic and clamshell dredging can leave a residual layer, however the environmental clamshell closed buckets are specifically designed to reduce this residual layer.

Turbidity is a measurement of water clarity that is frequently used to determine water quality. Measuring turbidity during cleanup activities can indicate the amount of sediment being disturbed. This disturbance can cause suspension of contaminants into the water column, thereby allowing them to be transported over a greater distance as well as impact additional aquatic species. Tribes can provide comment on turbidity criteria, which is an enforceable mechanism established through the cleanup permitting process that cleanup contractors must comply with in order to meet the permit requirements. WAC 173-201A-200(1)(e) establishes numeric turbidity criteria for freshwater sites while WAC 173-201A-210 establishes numeric turbidity criteria for marine sites. A site-specific turbidity criteria of 5 NTUs was established for the Lower Duwamish Waterway dredging.

Some tribes may prefer not to have dredging at the site or part of the site. Resuspension of contaminants contained in sediments, progress towards sediment recovery, vessel traffic, and construction are all factors that tribes must consider when analyzing the potential for dredging at a site.

**Dredging Disposal**

Although dredging and disposal are grouped together is Section 14.3, it needs its own section to clarify details on the different types of disposal. These include upland landfill, open water dispersal, and beneficial reuse.

Upland landfill may be the most favorable disposal option for tribes for several reasons. First, it has the least likelihood of contaminating other treaty resources by being transported to an upland facility. Second, these landfills are required to have protective measures in place in order to ensure that recontamination will not occur, such as a leachate liner than protects contaminants from entering groundwater. Tribes should make sure that these protective measures are in place when reviewing cleanup plans. Upland facilities may impact groundwater or other terrestrial resources of concern for tribes.

Open water disposal may be the least favorable option for dredging disposal. This option runs the highest risk of contaminating other treaty resources, or impacting the resources of other tribes. It needs to meet the requirements for open water disposal set by the Dredged Material Management Program (DMMP). The DMMP is an interagency

---

collaboration that manages and regulates the disposal of dredged material from dredging projects in Washington State. These agencies include the USACE; EPA, Region 10; Ecology; and DNR.

Beneficial reuse can be a positive outcome for recycling clean sediments, however at a contaminated site, it can often be difficult to find material clean enough for reuse.

In situ treatment
In situ treatment includes adding active amendments to the sediments in order to bind contaminants. This is different from enhanced monitored natural recovery since it involves contaminants binding to activated carbon or organoclay in order to sequester them and make them not bioavailable. Enhanced monitored natural recovery involves a sand layer than accelerates natural processes, but does not actively sequester contaminants.

Which amendments are used greatly vary depending on which contaminants are present at the site, since the sequestering agents have stronger affinities for certain contaminants based on their chemistry. For example, activated carbon and organoclay are more effective at removing organics (e.g. PCBs and PAHs), while apatite is more effective at removing metals.⁴⁶

Some tribes may prefer not to promote in situ treatment at a site or part of a site. This is due to uncertainties on how the amendments can impact benthic invertebrates. Also, predicted recovery timeframes for a site may indicate that amendments are not necessary for sediment to achieve cleanup goals.

Engineered containment (capping)
Capping can be an effective remedy for preventing exposure to contaminants at a site; however, this depends largely on the cap design and site-specific conditions. The depth of the cap at different sites depends on the species present and site conditions. For example, caps at sites in western Washington have been designed to accommodate the biologically active zone of geoduck at up to depths of four feet. If the caps are not sufficiently deep enough to protect species present at the site, or it is not deep enough to prevent exposure to contaminants from beneficial uses at the site, then it is an ineffective cap design.

Caps can also be effective at containing residuals post-dredging, as well as containing material beneath depths where dredging is not practicable.

Enhanced monitored natural recovery
Enhanced monitored natural recovery can be an effective technology for areas with relatively low contamination that are above cleanup levels. The sand layer placement helps to accelerate natural recovery by artificially accelerating sedimentation and allowing for benthic organisms to colonize the new layer. This may be the preferred

method over monitored natural recovery since it includes a sand layer or amendment that is not as dependent on the sedimentation rate. However, for areas of contamination that are well above cleanup standards, this remedy may be ineffective, and dredging, capping, and/or in situ treatment should be considered.

Monitored natural recovery
Monitored natural recovery (MNR) is one of the least protective methods for addressing contaminants in sediments. It is also one of the least costly remedies since it simply requires monitoring and time. Depending on the persistence and extent of the contamination as well as the sedimentation rate and source control measures, natural recovery can take decades. This is usually longer than acceptable for most tribes. EPA suggests that MNR “is not recommended for use where local cultures subsist on fish and shellfish because it is generally a slow process.” Also, EPA suggests that MNR is especially conducive when “natural recovery processes have a reasonable degree of certainty to continue at rates that will contain, destroy, or reduce the bioavailability or toxicity of contaminants within an acceptable time frame” and “expected human exposure is low and/or reasonably controlled by institutional controls.”

MNR may be the preferred option if the sedimentation rate is known through sampling and modeling, and sources of potential recontamination are adequately controlled. If the sedimentation rate and monitoring show that the area is making progress towards recovery, then a tribe may choose that MNR is the best option for a site or part of a site. The costs and delays associated with finding appropriate material to be used for capping or EMNR may prove to be less of a benefit than letting the area recover naturally over time. See Section 3.3 Sediment Recovery Zone for additional information on pathways that tribes can pursue in order to get more protections for areas designated MNR.

Institutional controls
Institutional controls are the least protective way to address contamination at a site. Institutional controls are legal requirements that restrict access and use of the site in order to prevent exposure to contamination. Restricting access can be ineffective due to trespassing. Also, institutional controls cannot block tribes from practicing treaty rights on tidelands, although agencies may issue consumption advisories.

Institutional controls can be effective after active remediation has been completed in order to preserve the integrity of the cap and thin-layer sand placement. However, it is the least favorable option as the sole remedy since it usually leaves contamination in place and restricts access. Both of these factors have the potential to greatly impact treaty rights.

SECTION 3.3 SEDIMENT RECOVERY ZONE

A SRZ is an area designated for monitored natural recovery when sediments are not expected to reach cleanup levels within a 10-year timeframe. It is an institutional control on monitored natural recovery. The SRZ is not a protective method for reducing exposure to sediment contamination, however it offers some clauses that allow additional involvement and input from tribes. WAC 173-204-590 is the statute that affects the requirements and criteria of a sediment recovery zone (SRZ).

A SRZ must be specifically authorized by Ecology as part of the cleanup action plan and consent decree under WAC 173-204-575. In addition, the approval and cleanup action decision must contain a legal description of the property proposed as a SRZ, the landowners of the property, and the time period over which the SRZ is authorized. The areal extent of the SRZ must be as small as practicable. WAC 173-204-590(5) provides for monitoring as part of the SRZ designation, and Section (7) describes the necessary avenues for public involvement, including tribes.

SRZs may not be necessary at every site where there is MNR or institutional controls, however it has the potential to provide additional protection for tribes that are unsatisfied with leaving large areas under MNR.

SECTION 3.4 CONCLUSION
Tribal involvement is critical to effective cleanup and remediation of contaminated sediment sites. Treaty law guarantees that tribes can provide input to any process that affects tribes’ rights, resources, and interests. Sediment contamination affects resources protected by treaty such as fish, shellfish, and plants that tribal members depend on for cultural practices. Meaningful consultation between tribes and state and federal agencies allows tribes to have their comments incorporated into the cleanup process and design. This allows tribes to participate in a decision that could have potential impacts to their lifeways.

In order to have meaningful consultation, it is necessary that tribal technical staff understand the advantages and disadvantages with each approach in order to better inform decision makers and protect tribal members. This document is meant to present common challenges encountered by tribal technical staff setting site-specific cleanup levels for contaminated sediment sites under the revised SMS. Each site has different characteristics, and each tribe may have a different decision as to which approach works best to protect its interests. Making informed cleanup decisions allows tribes to assert their sovereignty in a way that protects treaty resources from further degradation and therefore ensures the well-being of tribal communities.
APPENDIX A
NATURAL BACKGROUND CASE STUDY
PORT ANGELES HARBOR

Ecology reserves the sole authority on selecting the areas used to establish Regional Background and in the case of Port Angeles Harbor deviated from the definition in WAC 173-204-505(16). "Regional background" means the concentration of a contaminant within a defined geographic area that is primarily attributable to diffuse sources, such as atmospheric deposition or storm water, not attributable to a specific source or release. The main difference between regional and natural background is that regional background may include diffuse, human-caused pollution that cannot be primarily attributed to a specific source (and will, in nearly every case, be higher than natural background). The key here is that regional background should not factor in areas with specific, localized sources, such as a stormwater outfall, but that it might include pollutants from nonpoint sources, such as runoff, vehicle exhaust, etc. However, liable parties have the opportunity to use this loose rule language to incorporate background sources that are questionable. Therefore, it may require some effort on part of the tribal technical staff to ensure that only truly diffuse nonpoint source pollution is incorporated into regional background.

For the Port Angeles Regional Background, Ecology originally chose Sequim Bay, Dungeness Bay and Discovery Bay as the examples. After receiving significant push back from the Port district, city and industry representatives, Ecology chose to include Port Townsend Bay in the Regional Background. Port Townsend has several point sources, including an active paper mill, the U.S. Navy’s Indian Island ammunition depot, and outfalls within the bay. Ecology attempted chose to mitigate this choice by not sampling within 500 feet of a known source.

This approach became a contentious issue and ultimately based on the individual cleanup, tribal representatives successfully argued to have those samples that were considered outliers removed before the results were applied to Port Angeles. Once the outliers were removed, Ecology chose to remove Dungeness Bay from the data set because, it was decided that the values were too low and more like natural background. To supplement the data set, PLPs proposed using data points within Port Angeles Harbor. This was done in Port Gardner, which is a much larger open site. Issues beyond the use of part of a cleanup site for part of a background value (which is not supposed to be done under the SMS guidance) were brought up by the Lower Elwha Klallam Tribe to argue against the inclusion of site numbers.
APPENDIX B
DIOXIN PQL

Ecology bases their rationale on an unpublished paper, (USE OF PRACTICAL QUANTITATION LIMITS (PQLs) TO ESTABLISH CLEANUP STANDARDS FOR CONTAMINATED SEDIMENT SITES UNDER THE SEDIMENT MANAGEMENT STANDARDS (SMS)).

The Washington Department of Ecology chose to establish a “reasonable” PQL standard based upon EPA Methods 1613B and 8290 using a rounded median value of the mid-range PQL. This sets a precedent of average (reasonable) PQL standard that does not give testing labs any motivation to improve their technological standards and lower the PQL. It further allows less stringent standards to be applied at cleanup sites based upon average values instead of the best available values.

Based upon the application of the Ecology methodology on dioxins/furans for the Method 1613B, the exclusion of the four (4) high end PQLs of 11.4 ppt seems appropriate as it is clearly stated that even those labs indicated that it is feasible to reach lower a PQL, and have chosen not to. This supports the theory that without motivation many labs will only meet the minimum standard and not improve their technology and will result in stagnant cleanup standards. This indicates that use of analytical detection levels is inappropriate as a standard as it is highly variable among labs. Their exclusion of the three (3) lower values of 2.3 ppt penalizes those labs that lower their analytical detection levels, resulting in the omission of 41% of the lower detection limit values. This results in a median value of 5.2 ppt, which is less protective than the Dredged Material Management Program (DMMP) standard of 4 ppt. This incongruity between standards is an issue that can be addressed during consultation and in comments.

The PQL for dioxins/furans has further issues as described below:

Based on the information in the memorandum to file from Ecology staff, Joyce Mercuri and Teresa Michelsen dated April 12, 2012, referring to establishing practical quantitation limits (PQL) for dioxin mixtures, the proposal indicates that the 17 individual dioxin/furan congeners were multiplied by their respective toxicity equivalency factors (TEF) and added together to develop a toxicity equivalence quotient (TEQ) value for the PQLs and MDLs.

Referring the 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds:

*Where there was a concern expressed about the application of the TEF/TEQ approach to abiotic environmental matrices such as soil, sediment, etc. The present TEF scheme and TEQ methodology is primarily meant for estimating exposure via dietary intake situations because present TEFs are based largely on oral uptake studies often through diet. Application of these ‘intake or ingestion’ TEFs for calculating the TEQ in abiotic environmental matrices has limited toxicological relevance and use for risk assessment,*
unless the aspect of reduced bioavailability and environmental fate and transport of the various dioxin-like compounds are taken into account. If human risk assessment is done for abiotic matrices it is recommended that congener-specific equations be used throughout the whole model, instead of using a total TEQ-basis, because fate and transport properties differ widely between congeners.\textsuperscript{49}

This indicates that the attempted application of TEF modifiers to a PQL standard addressing sediments or any other media is not an appropriate use of the methodology and would lead to an inaccurate conclusion as to risk, they therefore recommend if abiotic matrices are attempted only congener specific equations be used instead of using the TEQ-basis. Congener-specific equations do not include the use of TEF modifiers.

Using the TEF values outside of the equation is unreliable because TEF estimates represent a low-confidence interim approach to characterizing the highly variable toxicities of dioxin compound mixtures. TEF values are not precise. Individual estimates may range over several factors of ten. Moreover, the research upon which they are based is of variable quality and quantity. The values are frequently set using single compound studies that result in ignoring important interactions that may add or subtract from their toxicities.\textsuperscript{50}

All TEF values are assumed to vary in uncertainty by at least one order of magnitude, depending on the congener and its relative effect potency (REP) distribution. Consequently, a TEF of 0.1 infers a degree of uncertainty bounded by 0.03 and 0.3. For a TEF value of 0.3, a degree of uncertainty bounded by 0.1 and 1 was used. Thus, the TEF is a central value with a degree of uncertainty assumed to be at least +/- half a log, which is one order of magnitude.\textsuperscript{51}


\textsuperscript{51} The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds Martin van den Berg, Linda S. Birnbaum, Michael Denison, Mike De Vito, William Farland,4 Mark Feeley,5Heidelore Fiedler,6 Helen Hakansson,7 Annika Hanberg,7 Laurie Haws,8 Martin Rose,9 Stephen Safe,10 Dieter Schrenk,11 Chiharu Tohyama,12
Furthermore many of the TEF values are not the result of studies but are based upon the location of the chlorine atoms in the molecular structure of the particular congener. This being the case there is no consensus of confidence in the individual values. The consensus is that though the knowledge of the individual potency of the congeners is limited and that their synergistic or antagonistic effects are not completely known the total TEQ when compared to an equal amount of 2,3,7,8-TCDD has equal predictive effects. The point being that the end result of the TEF/TEQ method is the 2,3,7,8-TCDD toxicity model.

Using the TEQ methodology for dioxins MTCA requires three steps 1) multiply each of 17 congeners by its assigned TEF, 2) add the resultant numbers together, 3) compare the resultant number to that of an equivalent amount of 2,3,7,8 TCDD. This last step was not followed in the PQL adaptation and thus nullified the value of the method. 2,3,7,8-TCDD being the equivalency standard the PQL would be logically be that for 2,3,7,8-TCDD which is .05 ppt not a new number resulting from the various congener TEF modified PQL values. Ecology’s own rules require a minimum of 2 labs that can meet their standard, which is the case with dioxins/furans; therefore the lowest PQL of 2.33 ppt could be used by their rules.

Angelika Tritscher, Jouko Tuomisto, Mats Tysklind, Nigel Walker and Richard E. Peterson


52 Dose-Additive Carcinogenicity of a Defined Mixture of “Dioxin-like Compounds” Nigel J. Walker, Patrick W. Crockett, Abraham Nyska, Amy E. Brix, Michael P. Jokinen, Donald M. Sells, James R. Hailey, Micheal Easterling, Joseph K. Haseman, Ming Yin, Michael E. Wyde, John R. Bucher, and Christopher J. Portier
