LWG
LOWER WILLAMETTE GROUP

Chairperson: Bob Wyatt, NW Natural
Treasurer: Fred Wolf, Legacy Site Services for Arkema

Via Federal Express

September 21, 2012

Daniel Opalski
Director, Office of Environmental Cleanup (ECL)
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue, Mail Code: ECL-117
Seattle, WA 98101

Re: Lower Willamette Group Opening Submission
Formal Dispute on EPA Notice of Non-Compliance and Directed Revisions to the Portland Harbor Draft Final Baseline Human Health Risk Assessment and Request for Dispute Resolution
Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240

Dear Mr. Opalski:

In just a few months, the Portland Harbor Superfund Site will pass its twelfth anniversary on the National Priorities List.

During those twelve years, the fourteen members of the Lower Willamette Group have spent over $93 million to prepare the Remedial Investigation and Feasibility Study. We have collected nearly 8000 samples to generate more than a million points of data about the Portland Harbor site. Our scientific and mathematical evaluations of that data fill hundreds of thousands of pages; the draft Remedial Investigation alone fills 14 binders and 16 oversized map folios. We have had hundreds of meetings with EPA, and thousands of telephone conferences. And despite that extraordinary cost and effort, we have never before had a disagreement with EPA that could not be resolved. As recently as April and May of this year, EPA and the LWG jointly presented the LWG's draft Feasibility Study at a series of public meetings, taking the first steps together toward community acceptance of a future Portland Harbor cleanup.

The Baseline Human Health Risk Assessment (BHHRA) is an important part of the RI/FS process because it describes current baseline conditions and the current and potential future risks to human health posed by contamination at the site. The LWG has worked cooperatively with EPA since 2002 on planning for and preparing a BHHRA that will describe reasonable risks of exposure at the Site and provide a framework for risk management decisions necessary to select the cleanup action. The LWG's draft final BHHRA submitted in May 2011

was consistent with agreements reached with and directives received from EPA since 2002 and compliant with applicable EPA regulations and policy.[1]

EPA's decision in June to direct the LWG to accept its wholesale revision of the May 2011 Draft Final BHHRA in complete disregard of detailed agreements between EPA and the LWG on the contents of the BHHRA and to find the LWG in violation of the September 2001 Consent Order is a defining moment for the Portland Harbor site. The *Oregonian* newspaper wrote, "For the first time in 11 years, the Environmental Protection Agency has declared a key group of Portland Harbor property owners out of compliance with the harbor's cleanup consent order."[2] The *Willamette Week* headline was more succinct: "EPA smacks Lower Willamette Group."[3]

We strongly disagree with EPA's determination that the May 2011 draft final BHHRA is of inadequate quality and fails to comply with the Consent Order. Although we have resolved a number of our technical concerns about EPA's directed revisions to the May 2011 draft final BHHRA through informal negotiation with EPA following our July 23, 2012 initiation of dispute resolution, we continue to disagree with EPA's revisions on three important issues.[4]

But we are equally concerned that EPA's rejection, without warning or explanation, of negotiated agreements on technical issues for the BHHRA will have ramifications far beyond the document itself. According to guidance, "EPA prefers to achieve PRP-lead cleanups through settlements."[5] We do not have a wait list of PRPs anxious to write checks for Portland Harbor. To date, EPA has issued 144 general notice letters at this site. In twelve years, the combined efforts of EPA and the LWG have threatened or cajoled less than $5 million out of the 130 other GNL recipients.[6] The March 2012 draft Feasibility Study identifies remedial alternatives for Portland Harbor estimated to range in cost from about $200 million to almost $1.8 billion dollars. In the absence of a reliable, cooperative working relationship with the relatively small

---

[1] For your ease of reference, we have compiled significant documents, guidance and communications discussed in this letter on the enclosed CD. You will find the text of the LWG's May 2011 draft final BHHRA, redlined to show revisions from the September 2009 draft BHHRA, on this CD at Tab 15. Many of these documents were also discussed in and submitted with our July 23, 2012 letter initiating formal dispute resolution; to avoid confusion, we have retained the tab numbers assigned those documents by the July 23 letter.

[2] Oregonian article, July 31

[3] Willamette Week article, July 4

[4] For example, we understand that EPA decided sometime last year that the risk assessment needed to be revised to describe a reasonable maximum exposure (RME) scenario for fish ingestion. The fish ingestion scenario had been discussed by EPA and the LWG during development of the 2004 Programmatic Work Plan, which is attached at Tab 1. In 2003, the LWG recommended the use of RMEs for fish ingestion. EPA provided specific language to the LWG to use in section 3.4.3 of Appendix C of the Work Plan indicating that fish consumption rates will not be designated as representing either RME or Central Tendency exposures. All of the LWG drafts of the BHHRA since that date were consistent with the Programmatic Work Plan. Without notice to or discussion with the LWG, EPA changed its mind on RME in the June 2012 EPA directed redline of the BHHRA. In our subsequent discussions, EPA and the LWG have not reached agreement on how RME should be described for fish consumption. As explained in further detail below, the LWG strongly believes that EPA's description of RME for fish consumption in EPA's June 2012 directed redline is inconsistent with EPA guidance and arbitrary and capricious.

[5] EPA, "Enforcement First for Remedial Action at Superfund Sites" (OECA, OSWER September 20, 2002).

[6] At our request, the federal court has stayed our contribution litigation indefinitely in favor of the non-binding allocation process EPA asked us to pursue. *See* October 17, 2007 letter from Deb Yamamoto to General Notice Letter Recipients.

ED_000959_NSF_00054720-00002 06/25/2019 SEMS_0305969

group of parties performing the RI/FS, how will EPA persuade anyone else to fund a cleanup costing 3 times, or 10 times, or 18 times as much as the RI/FS?

It is not an overstatement to say that EPA's action in June 2012 with respect to the Draft Final Baseline Human Health Risk Assessment threatens to destroy over a decade of cooperative effort just as the parties are reaching the point of actual remediation. Indeed, EPA's action may have consequences for EPA/PRP relations well beyond the cleanup of the Portland Harbor NPL Site. That is not an outcome sought by the LWG. However, we must have confidence in the reliability of our agreements with EPA if we are voluntarily to go forward into remediation.

We understand that EPA needs flexibility to respond to changed circumstances. We acknowledge that EPA has broad authority to issue orders and directives. We are asking that EPA consider, as it exercises that discretion, that the cleanup of Portland Harbor will require a solid partnership between EPA and a much larger, and so far much less cooperative, collection of responsible parties.

Issues for Resolution between EPA and the LWG

For the reasons discussed below, we ask you to resolve this dispute by

1. Withdrawing the June 22, 2012 notice of noncompliance with the Consent Order and the June 29, 2012 threat to issue stipulated penalties;

2. Deciding three substantive issues concerning the content of the BHHRA, and adopting the attached September 17, 2012 redline BHHRA and tables reflecting issues resolved between the parties during the informal negotiations period; and

3. Committing to meet with the LWG senior management and to establish a mutually-agreed upon set of documented protocols to guide a better working relationship between the LWG and EPA such that EPA can successfully manage the RI/FS through to completion and facilitate a solid partnership with the responsible parties to clean up Portland Harbor.

Background

The LWG submitted its draft BHHRA in September 2009. In December 2009, EPA issued targeted comments so that the LWG had sufficient information to proceed with the scoping and development of the Feasibility Study. EPA stated that "Overall, most of the procedures followed in the BHHRA…are consistent with and followed the procedures agreed upon by EPA and the LWG for completing the baseline risk assessments."[7] In January and February 2010, EPA and the LWG reached agreements on how to resolve the targeted comments raised by EPA. These agreements were memorialized in writing and confirmed in a February 9, 2010 letter from EPA to the LWG. EPA noted that "[i]n general, EPA agrees with the LWG's understanding of how the directed comments have been resolved with the following

[7] December 23, 2009 EPA letter, attached at Tab 5, at p. 1.

clarification…." EPA then set forth three discrete clarifications, which the LWG and EPA subsequently discussed and resolved.

In July 2010, EPA provided its "complete set of comments…." on the September 2009 draft BHHRA, including both directed and non-directed comments.[8] The LWG and EPA met on August 20 and September 9, 2010 and reached agreement on how to address each of EPA's directed comments. These agreements were memorialized in a September 15th comment resolution table.[9] On September 22, 2010, EPA confirmed that "EPA has reviewed the September 15, 2010 letter and attachment and agrees, with clarifications, that EPA's directed comments on the…BHHRA would be revised in accordance with the general framework, and that the proposed resolution described in LWG's general responses matches our understanding of the meeting outcome."[10] EPA thanked the LWG "for its efforts in working to resolve the directed comments" and stated that it "looks forward to continued efforts on the LWG's part to resolve the non-directed comments."[11]

On October 15, 2010, the LWG met with EPA to resolve the non-directed comments. Based on the agreements reached, the LWG generated a resolution table for non-directed comments on November 18, 2010.[12] On December 8, 2010, EPA confirmed that "EPA has reviewed the LWG responses, as summarized in the tables, and has determined that the vast majority of issues associated with addressing EPA's comments have been resolved."[13] EPA further stated that it "believes that addressing all directed comments and non-directed comments consistent with previous direction and agreements, and the direction and clarifications in this letter and attachment, should resolve EPA's [BHHRA] comments." EPA reaffirmed that the finalization of the BHHRA should not delay progress on the draft FS Report, and thanked the LWG "for its efforts in working to resolve the [BHHRA] comments."[14]

On May 2, 2011, the LWG submitted the draft final BHHRA that addressed all EPA comments in accordance with the agreements reached between EPA and the LWG.[15]

On July 21, 2011, over ten weeks after submittal, EPA sent a letter to the LWG stating that it "appreciates the significant amount of work that the LWG has put into this document" and noting that "[f]rom our review to date, EPA agrees with the numerical calculations and technical findings of the document." However, EPA stated that the document did not satisfactorily address all of EPA's comments and lacked sufficient clarity, and therefore requested a Word version of the document so EPA could modify it.[16]

---

[8] July 16, 2010 EPA letter, attached at Tab 7, at p. 1. EPA's July 16, 2010 comments on the draft BHHRA are at Tab 8.
[9] *General Responses to Directed Comments on the BHHRA* (LWG, September 15, 2010), attached at Tab 9, at p. 3
[10] September 22, 2010 EPA letter, attached at Tab 10.
[11] *Id.*
[12] *General Responses to Non-Directive Comment Key Issues on the BHHRA* (LWG, November 18, 2010), attached at Tab 11.
[13] December 8, 2010 EPA letter, attached at Tab 12.
[14] *Id.*
[15] The redlined text of the May 2011 draft final BHHRA showing revisions from the September 2009 draft BHHRA is attached at Tab 15.
[16] July 21, 2011 EPA letter, attached at Tab 18.

The LWG was very concerned that EPA was taking over the document and asked for clarification as to the meaning of EPA's request. In conversations between EPA and the LWG, and in a follow up email from the EPA project manager, EPA assured the LWG that it did not intend to take over the document.[17] EPA reiterated that "EPA agrees with the numerical calculations and technical findings of the document" and stated that the LWG should proceed with drafting the FS based on the May 2011 draft final BHHRA. EPA explained that "EPA believes there are changes needed to some of the language and presentations in the document, and it will be most efficient for EPA to mark up the document with those specific changes rather than provide additional comments that would then lead to further back and forth…. The intent is to expedite the process by providing an approvable red-lined document that the LWG could then finalize."[18]

In transmitting the requested documents, the LWG confirmed its understanding that the parties would be "using the regular LWG/EPA process for resolving comments" and seeking "EPA's concurrence that any directives in EPA's July 21, 2011 letter, July 22 email and follow up conversations have been met."[19] The LWG asked EPA to "let us know if your understanding is any different."[20] EPA did not indicate any disagreement.

For the next 11 months, EPA provided no notice of any specific deficiencies in the document, did not indicate to the LWG that EPA was stepping back from any prior agreements, and did not engage the LWG in any substantive discussions about the BHHRA.

Then, on June 22, 2012, the EPA returned the BHHRA with an extraordinary number of redline changes, issued a notice of non-compliance, and threatened stipulated penalties if the LWG did not accept all of the EPA changes without discussion.[21]

Discussion

I. The May 2011 draft final BHHRA was consistent with agreed resolutions of EPA comments and did not violate the Consent Order.

On July 23, 2012, the LWG initiated formal dispute resolution concerning EPA's June 22, 2012 determination that the LWG "failed to produce a BHHRA of acceptable quality, or otherwise failed to perform in accordance with the requirements of the Order" and the directed revisions to the BHHRA's text, tables, and figures.[22] Our July 23 letter provided a specific response to each of the four "deficiencies" with the May 2011 draft final BHHRA identified by EPA in its June 22 letter as the basis for its conclusion that the LWG had "failed to perform in accordance with the requirements of the Order."

---

[17] *See* July 22, 2011 EPA email, attached at Tab 19.
[18] *Id.*
[19] July 29, 2011 LWG email, attached at Tab 20.
[20] *Id.*
[21] EPA's June 22, 2012 letter, with attachments, is enclosed at Tab 16. EPA's June 29 letter threatening the imposition of stipulated penalties is attached at Tab 17.
[22] The LWG's July 23, 2012 letter is attached at Tab 21.

ED_000959_NSF_00054720-00005 06/25/2019 SEMS_0305972

Following the initiation of formal dispute resolution, EPA advised the LWG that the four "deficiencies" identified in the June 22 letter were not the basis for EPA's June 22 determination that the LWG had failed to comply with the Consent Order and was subject to stipulated penalties; rather, EPA now bases that determination on 17 other EPA comments on the September 2009 draft BHHRA that EPA contends were not adequately addressed by the May 2011 draft final BHHRA. EPA provided a list of these 17 new items to the LWG on July 27, 2012.[23]

For the reasons discussed below, the July 27 list no more establishes a violation of the Consent Order than did the original "deficiencies" identified in the June 22 letter.[24] EPA should withdraw its June 22 notice of non-compliance and its June 29 letter threatening stipulated penalties immediately.

To begin with, EPA bears the burden of proving its position that the LWG has failed to comply with the Consent Order. *Cf.* 5 U.S.C. §556(d). *See 3M Company v. Browner*, 17 F.3d 1453, 1460 (D.C. Cir. 1994) ("In an action for a civil penalty, the government's burden is to prove the violation."); *see also Hazardous Waste Treatment Council v. EPA*, 886 F.2d 355, 366 (D.C. Cir. 1989) (discussing the burdens of production and persuasion in EPA administrative proceedings). Section IX.1 of the Consent Order reserves to EPA the right to "comment on, modify and direct changes for all deliverables in writing" and requires EPA to "meet with the Respondents in an effort to resolve disputes" about EPA comments and directives. If a revised submittal does not fully reflect EPA's "directions for changes," EPA may assess penalties or seek other appropriate relief. EPA must prove, then, that the LWG failed to make directed changes or to incorporate directed comments into the May 2011 draft final BHHRA.[25]

A. The LWG complied with agreed resolutions of EPA's directed comments on the September 2009 draft BHHRA.

EPA's comments on the September 2009 draft BHHRA were provided to the LWG in tables identifying each comment as "directed change," "note," "clarify," "issue," or "revise." Only three of the 17 "deficiencies" (items 1, 3 and 17) alleged by EPA's July 27 correspondence

---

[23] EPA's July 27, 2012 list, *Basis for Noncompliance*, is attached at Tab 22.

[24] To the extent EPA again asserts the four "deficiencies" identified in the June 22 letter as a basis for its finding that the LWG failed to comply with the consent order, please see our July 23 letter (Tab 21).

[25] Section 555(e) of the APA ("Ancillary Matters"), which applies to all agency processes and actions, requires that "[p]rompt notice shall be given of the denial in whole or in part of a written application, petition, or other request of an interested person made in connection with any agency proceeding. Except in affirming a prior denial or when the denial is self-explanatory, the notice shall be accompanied by a brief statement of the grounds for denial." (Emphasis added.) EPA's June 22 and July 27 communications were not accompanied by a sufficient statement of the reasons for rejecting the BHHRA. The purpose of Section 555(e) is "to ensure the overall fairness of agency proceedings and to provide a basis for judicial review," and to "keep the administrative agency within proper authority and discretion, avoid or prevent arbitrary, discriminatory, and irrational action by the agency, and inform the aggrieved person of the grounds of the administrative action so he can plan his course of action (including the seeking of judicial review)." *Administrative Law* (Second Edition) Aman and Mayton at 260 (2001) (internal citations omitted). Although the Consent Order does not contemplate pre-enforcement judicial review, that does not excuse EPA from complying with this provision of the APA.

relate to comments identified by EPA as "directed change" comments for the draft final BHHRA. As discussed above, the LWG met extensively with EPA about its July 2010 comments and documented the resolution of those comments in tables that were accepted by EPA. EPA must therefore prove that the May 2011 draft final BHHRA was inconsistent with the EPA/LWG agreed resolution of these three directed comments, not that it simply did not comply with the original EPA comments.

Item 1. Item 1 on EPA's July 27 list was identified by EPA in its July 2010 comments as an "issue." On December 8, 2010, however, EPA directed the LWG to "present the risks associated with PBDEs in bass, carp and clam tissue consistent with the fish consumption scenarios developed in the Portland Harbor baseline human health risk assessment." Accordingly, the LWG advised EPA that it would provide this information in an attachment to the BHHRA. On April 11, 2011, approximately three weeks before the due date for the draft final BHHRA, EPA advised the LWG that "estimated risks and hazard from PBDEs ultimately need to be incorporated into the tables presenting cumulative risks and hazard for the different exposure scenarios." EPA's letter states, "EPA's comments should be addressed in the next revision or the final version of [the] BHHRA as appropriate." Following a telephone conversation between the EPA and LWG risk assessors, EPA and the LWG agreed that "the intent of EPA's comment … was not to require inclusion of PBDE risks in each receptor-specific and location-specific table in the BHHRA, presentation of that information in an attachment is also acceptable"[26] and that "the Risk Characterization section in the Final BHHRA will include a discussion of the contribution of carcinogenic risk and noncarcinogenic hazard due to PBDE exposures."[27] The agreement (and indeed the original EPA April 11, 2011 comment) was that, given the late point in time at which EPA raised this issue, PBDE would be discussed in the risk characterization section of the <u>final</u> BHHRA, not in the May 2011 draft final BHHRA. In fact, the risk characterization section of EPA's June 2012 directed redline also does not discuss PBDE. As agreed, the LWG's cumulative risk table, Table 5-204, identifies PBDE as a contaminant potentially posing unacceptable risk.

Item 3. Item 3 on the July 27 list states that the LWG failed to comply with a directed comment by not revising a sentence about shellfish consumption uncertainties consistent with the comment. Comment S148 directed the LWG to revise the sentence as follows: "<u>Although fishers normally fish and/or collect those resources that are available in their area</u>, it is not known to what extent fishers would substitute alternative local types of shellfish ~~if the shellfish in the survey were not available~~." EPA and the LWG resolved Comment S148 by agreeing that "factual (i.e. objective) language can remain in the revised BHHRA. Judgmental language (both that in the draft BHHRA and that directed by EPA) will not be included in the revised BHHRA."[28] Accordingly, the LWG revised the sentence in the May 2011 draft final BHHRA to read, "It is not known to what extent fishers substitute alternative local types of shellfish."[29]

---

[26] EPA April 27, 2011 email, attached at Tab 23.
[27] LWG May 6, 2011 response to April 11, 2011 comments on BHHRA risk tables, attached at Tab 24.
[28] *General Responses to Directed Comments on the BHHRA* (LWG, September 15, 2010) at p. 3, attached at Tab 9. As noted above, EPA acknowledged and accepted the September 15, 2010 *General Responses to Directed Comments on the BHHRA* in a letter dated September 22, 2010, attached at Tab 10, with three unrelated clarifications.
[29] LWG Draft Final BHHRA (May 2, 2011) Section 6.2.5.3.

Notwithstanding the fact that EPA now relies on this revision as a basis for finding LWG in violation of the Consent Order, EPA finds LWG's revised text perfectly acceptable for the final BHHRA – EPA's June 2012 directed redline uses the LWG text it criticizes exactly: "It is not known to what extent fishers substitute alternative local types of shellfish."[30]

Item 17. Item 17 on the July 27 list states that the LWG failed to comply with July 16, 2010 directed Comment G1 by including the language "same rate every day of every year for 70 years" in four places in the May 2011 draft final BHHRA, as well as the language "…every month of the year exclusively of fish caught within the Study Area" in another place. Comment G1 directs the LWG to characterize numeric fish consumption rates as "low" (17.5 g/day), "moderate" (73 g/day) and "high" (142 g/day). Nothing in Comment G1 directs the LWG about how to discuss the duration over which the rates are averaged or touches on use of the phrases "every day," "every month" or "every year." EPA and the LWG resolved Comment G1 by agreeing that "ingestion rates will be presented in the revised BHHRA as the numeric rates (i.e., grams per day or meals per month)…. Characterization or descriptors of the ingestion rate (e.g. "low," "high") will not be included in the revised BHHRA."[31]

The July 16, 2010 comments did request deletion of the phrase "every day of every year" at several specific locations in the May 2011 draft final BHHRA. These comments comprised the first "deficiency" identified in EPA's June 22 letter, which EPA has since advised us is <u>not</u> a basis for EPA's determination that the LWG failed to comply with the Consent Order. As discussed in our July 23 letter, only two of EPA's five comments requesting these revisions were identified by EPA as "directed changes." The LWG revised the text in all five instances precisely as EPA requested, although as noted in Table 1 to the July 23 letter, we inadvertently missed this language at a sixth location in §6.2.5.3 where EPA did not provide a specific comment. Two of the sections EPA's July 27 list alleges contain the "every day of every year" text that fails to incorporate Comment G1 (which, as noted, addresses only fish ingestion rates) discuss sediment exposure (6.2.5.1) and exposure to groundwater seeps (6.2.5.2) and do not mention fish consumption at all. A third section (3.5.1.6.3) translates the gram-per-day fish consumption rates to equivalent meals per month, "every month of the year." Prior to July 27, 2012, EPA never provided a specific comment on this text in §3.5.1.6.3, or on the similar text EPA cites in §5.2.5.2.1.

Again, however, Comment G1 does not in any way instruct the LWG about how to discuss the duration over which fish ingestion rates should be averaged. EPA has conceded that the LWG complied with the Consent Order in the manner in which it addressed specific comments on this language; EPA can't get to a different outcome by relying on a general comment about a different issue.

B. The LWG also complied with agreed resolutions of EPA's non-directed comments on the September 2009 draft BHHRA.

---

[30] EPA June 2012 directed redline (behind Tab 16), Section 6.2.4.3.
[31] *General Responses to Directed Comments on the BHHRA* (LWG, September 15, 2010) at p. 5, attached at Tab 9.

ED_000959_NSF_00054720-00008 06/25/2019 SEMS_0305975

The remaining 14 items on EPA's July 27 list were not directed comments by EPA and therefore cannot support EPA's determination that the LWG has failed to comply with the Consent Order. The LWG did revise the BHHRA consistent with the agreed resolution for each of these comments. We discuss these items in detail in the attached Table 3. As Table 3 demonstrates, none of these items would constitute a violation of the Consent Order even had the comments been directed. We address some of these items more specifically below to illustrate that the alleged deficiencies are trivial make-weight.

Item 7, for example, alleges that the LWG should have revised a sentence in §3.3.5.2 to read, "The results of the survey show that tribal members have higher fish ingestion rates than the general public." The LWG's revised sentence (consistent with the agreement that the LWG would modify EPA's suggested language for clarity or consistency[32]) reads, "The results of the survey show that tribal members surveyed generally have higher fish ingestion rates than the general public."[33] EPA's June 2012 directed redline version of this sentence directs that the text read, "The results of the survey show that tribal members surveyed generally consume more fish than the general public."[34] Plainly, in June, EPA found the words "surveyed generally" an accurate description of the survey results.

Similarly, Item 6 states that the LWG failed to provide an explanation of why only one surface water sample from Swan Island Lagoon was used for COPC screening.[35] The May 2011 draft final BHHRA did provide this clarification:

> For transients and beach users, COPCs were selected from surface water samples taken from areas where direct contact with transient or beach users could occur, including both single point sampling stations where vertically integrated samples were collected and transect samples. This included one sample from Swan Island Lagoon.[36]

EPA's June 2012 directed redline of the BHHRA, rather than including any further explanation for the single sample, deletes all reference to there being only one such sample in Swan Island Lagoon. Similarly, Item 8 complains that the LWG should have discussed "the degree to which background concentrations [of arsenic] contribute to the EPC and risk" in a different way, while EPA's June 2012 directed redline deletes all discussion of background arsenic concentrations and risk. A non-directive EPA comment that was not important enough for EPA to carry into its own version of the BHHRA cannot be important enough to support EPA's determination that the LWG has violated the Consent Order.

An EPA determination of non-compliance should be reserved only for those instances where PRP(s) have clearly failed to comply with applicable requirements and official condemnation is warranted. The May 2011 draft final BHHRA is not that instance. EPA's desire to revise certain sections of the BHHRA, and to make sure the LWG agreed to those

---

[32] *General Responses to Non-Directive Comments on the BHHRA* (LWG, November 18, 2010), attached at Tab 11.
[33] May 2011 draft final BHHRA, §3.3.5.2, p. 60 (emphasis added).
[34] EPA June 22 redline §3.2.1.7 (emphasis added), attached at Tab 16.
[35] EPA July 16, 2010 Comment S38 (clarify), attached at Tab 8.
[36] May 2011 draft final BHHRA, Section 2.4.2

revisions, does not justify a finding of non-compliance. EPA's cavalier use of a non-compliance determination for the draft final BHHRA is a highly problematic precedent for how disagreements between EPA and the LWG will be resolved on the other important deliverables required to complete the RI/FS process and for implementation of the remedy itself.

In addition, EPA's letter of non-compliance could be interpreted by others as a rebuke of the LWG's efforts and the integrity of all its work over the last 11 years. The LWG has operated since its inception on the premise that public acceptance of the remedy for the Site will depend in large part on the credibility of the technical evaluations supporting the remedy. The LWG has retained highly-respected professional firms to assist in the preparation of its deliverables and they have consistently provided exceptional efforts on the LWG's behalf. It is extremely unfair that these unwarranted criticisms by EPA of the technical evaluations are impairing the reputations of the LWG and its consultants and providing opportunities for non-performing parties to take frivolous shots at the LWG in its efforts to recover reasonable costs from the dozens of other parties who chose not to step forward and perform the work.

For these reasons, and for the reasons discussed in detail in Table 3, EPA does not, and cannot, show that the LWG violated the Consent Order by failing to address a directed comment in a manner consistent with the agreed resolution of that comment, and EPA should retract the June 22, 2012 notice of non-compliance and the June 29, 2012 threat to issue stipulated penalties.

II. Certain of EPA's directed revisions to the May 2011 BHHRA are inconsistent with EPA Guidance.

The LWG's July 23, 2012 Dispute objected to EPA's June 22, 2012 "Directed Modifications and Additional Comments," as well as EPA's June 2012 directed redline of the BHHRA, on two grounds: (1) EPA's directives are contrary to prior direction and/or agreements with the LWG, and EPA's repudiation of prior direction and agreements with no rationale or explanation is arbitrary and capricious; and (2) the LWG objected to the substantive nature of the directed text revisions to the extent they are new, inconsistent or otherwise without technical or substantive merit. The LWG reserved the right to supplement the record regarding the second basis for dispute after it had time to review the EPA revisions in more detail.

On August 15, 2012, the LWG provided EPA with two tables that identified specific text revisions to which the LWG objects because they are inaccurate, inconsistent with guidance or otherwise without technical or substantive merit. These are attached as Table 1 and Table 2. EPA and LWG had several meetings to discuss the technical issues identified in those tables, and have been able to reach resolution on the majority of those issues. The results of the resolutions are documented in the attached September 17, 2012 EPA/LWG redline. There are three issues that remain unresolved, and the LWG requests that you decide as follows:

A. Retract EPA's directions on the reasonable maximum exposure (RME) case for fish consumption and direct staff to work with the LWG on development of an RME case that is consistent with guidance, as outlined below;

ED_000959_NSF_00054720-00010 06/25/2019 SEMS_0305977

B. Direct EPA staff to insert relevant factual information into the exposure assessment and risk characterization sections of the BHHRA regarding the drinking water scenario and clam consumption scenario; and

C. Reverse EPA's decision to remove a table of contents, executive summary, and conclusion section from the BHHRA.

In addition, we request that EPA confirm that the final BHHRA will reflect the progress made in the informal negotiations by accepting the agreed revisions in the attached September 17, 2012 Redline BHHRA.

A. EPA's direction on what constitutes a reasonable maximum exposure is inconsistent with guidance, inconsistent with national policy, and arbitrary and capricious.

One traditional component of preparation of a baseline human health risk assessment is the development of the RME, which refers to the level of exposure for people who are at the high end of the exposure distribution (above the 90th percentile). The RME scenario is intended to assess exposures that are higher than average, but are still within a realistic range of exposure that is likely to occur at the site.

The development of the fish consumption RME for Portland Harbor was the subject of extensive work and consideration by the LWG's risk assessors and Region 10 staff dating back to 2002. The LWG proposed to identify RME scenarios for two non-tribal populations of fish consumers in the BHHRA. EPA rejected this proposal and directed the LWG to use three fish consumption rates with a range of other exposure factors without identifying any RMEs. It was understood by the LWG that the May 2011 draft final BHHRA reflected a consensus between the LWG and EPA as to how the fish consumption scenarios would be handled, and that EPA had decided that they would not be handled through development of an RME.

It came as a shock to the LWG when EPA's June 22, 2012 "Directed Modifications and Additional Comments," as well as the June 2012 EPA directed redline, repudiated prior agreements and substantially changed the approach to the fish consumption scenarios by designating multiple RME scenarios. As detailed and discussed below, EPA's changes to the fish consumption scenarios are not only a departure from prior direction and agreements but are inconsistent with EPA guidance and policy, and are arbitrary and capricious.

The LWG requests that you resolve this dispute by retracting EPA's June 2012 revisions regarding RME designations on the fish consumption scenarios. If EPA would like to proceed with an RME designation for fish consumption in the BHHRA, the LWG requests that you direct EPA staff to work collaboratively with LWG's risk assessor to develop an RME case that is consistent with guidance, using the following parameters:

- Multi-species diet of resident fish (not a single species like bass or carp);
- Fillet with skin (not whole body);
- An exposure area that is appropriate for the fish consumption rate applied, with a preference to a site-wide exposure area; and

ED_000959_NSF_00054720-00011 06/25/2019 SEMS_0305978

- Fish consumption rates that, in the absence of site-specific data, are based on guidance and a thorough review of available studies from the Pacific Northwest and other freshwater sediment Superfund sites.

Although the LWG did not accept in its entirety the revised RME proposal that EPA provided on September 11, 2012, there are several key factors described in that proposal upon which it is likely that EPA and the LWG can reach agreement. The LWG would like the opportunity to continue the discussion with EPA staff to try to reach consensus on an appropriate RME for fish consumption at the Site.

1. Background.

a. EPA's prior direction and agreements with LWG on the fish consumption scenarios.

The following is a summary of the prior LWG proposals, EPA direction, and the resolutions reached between EPA and LWG regarding the fish consumption scenarios that are presented in the May 2011 draft final BHHRA.

- 2002 Scoping and Problem Formulation: The LWG submitted the *Draft Preliminary Planning, Scoping, and Problem Formulation Document* to EPA in 2002, which identified three angler populations for evaluation in the BHHRA: Recreational, Native American Consumption, and Non-Tribal Consumption. The LWG proposed a market-basket approach that would differentiate between the different angler populations in the amount of fish and the individual species consumed.[37]

- 2003 Fish Consumption Rates Technical Memorandum: The LWG submitted the *Fish Consumption Rates Technical Memorandum* to EPA in May 2003. The RME approach included a combination of ingestion rate, tissue type, and species type based on an evaluation of available information on consumption from the Pacific Northwest as well as national studies.[38] Using the Technical Memorandum, the LWG proposed fish consumption rates for the RME and central tendency (CT) exposure scenarios for each of the three populations (Recreational, Native American Consumer, and Non-Tribal Consumer).

- Programmatic Work Plan Development: In February 2004, EPA directed the LWG to evaluate fish consumption using four ingestion rates: three were identified as representing higher end consumption rates for the Recreational, Non-Tribal Consumer, and Tribal; one was identified as an average fish ingestion rate for recreational fishers. EPA did not designate the rates or scenarios as RME or CT. EPA also directed that these

[37] *Draft Preliminary Planning, Scoping, and Problem Formulation Document* (LWG, February 4, 2002), Section 5, p. 48-49, attached at Tab 25.
[38] *Technical Memorandum: Proposed Fish Consumption Rates for the Portland Harbor RI/FS Human Health Risk Assessment* (LWG, May 9, 2003), attached at Tab 26.

rates be used with exposure point concentrations (EPCs) for different species, tissue types, and exposure areas in calculating risks.[39]

- April 2004 Programmatic Work Plan Development: EPA and the LWG met several times to resolve the disagreement between the two positions, i.e., the LWG's proposal to designate an RME and CT for three populations based on a literature review of available studies using a market-basket approach, versus EPA's direction to use four rates for various species and tissue types without designating an RME or CT. The result of those discussions is captured in the language provided by EPA and included in the approved Programmatic Work Plan: "*The fish consumption evaluation will be based on a range of fish consumption rates. Because these consumption rates will not be designated as representing either RME or CT exposures, the EPCs for tissue will not be developed specifically for RME or CT scenarios.*"[40] "*Site-specific fish consumption information is not available for the recreational patterns that may exist for these receptors. Therefore, to evaluate the potential range in consumption patterns that may exist for these receptors, 3 ingestion rates will be used to calculate intakes for adults and 3 will be used for children. For adults, the fish ingestion rates that will be used in the HHRA are 17.5 grams per day (g/day), 73 g/day, and 142 g/day. The corresponding rates that will be used for children are 7 g/day, 31 g/day, and 60 g/day. These ingestion rates are anticipated to represent average to high end ranges of fish consumption for these receptors.*"[41]

- EPA's Approval of the Programmatic Work Plan: EPA approved the work plan in June 2004.[42] The approval letter refers to a March 15, 2004 conditional approval letter which provided EPA's direction on the fish consumption scenarios to be used in the Work Plan. EPA states: "*The fish consumption evaluation will be based on a range of fish consumption rates. Because these consumption rates will not be designated as representing either RME or CT exposures the EPCs for tissue will not be developed specifically for RME or CT scenarios.*"[43] This exact language was used by the LWG in the Programmatic Work Plan, per EPA direction.

- 2007 Round 2 Comprehensive Report: Fish consumption risks were presented for tribal and non-tribal fishers. The risks for the non-tribal fishers were based on the three ingestion rates from the Programmatic Work Plan (17.5 g/day, 73 g/day, and 142 g/day). The three ingestion rates were used in combination with EPCs for different species types, tissue types, and exposure areas. Consistent with EPA direction, these rates or scenarios were not designated as RME or CT. EPA commented that the three fisher names were confusing and they may need to think of some other names to distinguish the groups,

[39] Letter from EPA to LWG, February 11, 2004, attached at Tab 27.
[40] Programmatic Work Plan (LWG, April 2004) (Section 3.4.3), attached at Tab 1.
[41] Programmatic Work Plan (LWG, April 2004), Section 3.5.1.4, attached at Tab 1.
[42] Letter from EPA to LWG, June 29, 2004, attached at Tab 2.
[43] Letter from EPA to LWG, March 15, 2004, attached at Tab 47.

which was the only comment related to the description of the fish consumption scenarios.[44]

- 2009 Draft BHHRA: Fish consumption risks were presented for tribal fishers and fishers. Other than no longer using the term "non-tribal," the presentation of fish consumption risks was the same as in the Round 2 Comprehensive Report. EPA provided 10 comments in July 2010 on the September 2009 draft BHHRA that requested or directed changes to text describing the fish consumption risks, but none of EPA's comments referenced the need to characterize the consumption rates or scenarios as RME or CT.[45]

Based on this history, the LWG understood that the May 2011 draft final BHHRA represented EPA direction and a consensus approach to the fish consumption scenarios.

b. EPA's new position in the 2012 directed revisions to the BHHRA.

Although prior EPA direction and agreements dating back to 2004 clearly stated that fish consumption rates or scenarios would not be designated as RME or CT in the BHHRA, EPA's June 2012 directed redlines specifically designate the three non-tribal fish consumption rates used in the BHHRA as RME or CT rates.[46] For the non-tribal fishers, EPA has now split the receptor population, characterizing the two groups as either "recreational fishers" or "subsistence fishers."[47] For the subsistence fishers, EPA designated the consumption rate of 142 g/day for adults as the RME rate. EPA did not designate a CT rate for the subsistence fishers. For the recreational fishers, EPA designated the consumption rate of 73 g/day for adults as the RME rate and 17.5 g/day for adults as the CT rate.[48] EPA deleted the mean exposure point concentrations and did not designate any other factors in the consumption risk calculations as RME or CT.

---

[44] EPA Comments on Comprehensive Round 2 Site Summary and Data Gaps Report, January 15, 2008, attached at Tab 28.
[45] EPA Comments Portland Harbor RI Report – Baseline Human Health Risk Assessment, July 16, 2010, attached at Tab 8.
[46] *See* June 2012 EPA directed redline, Section 3.5.10.6, attached at Tab 16.
[47] EPA defines "recreational fisher" for purposes of Portland Harbor to "encompass a range of the population while focusing on those who may fish on a more-or-less regular basis." EPA defines "subsistence fisher" for purposes of Portland Harbor as "populations with high fish consumption rates, recognizing that fish are not an exclusive source of protein in their diet." June 2012 EPA directed redline, Section 3.5.10.6. In addition to the recreational and subsistence fisher, the BHHRA identifies a Tribal Fisher with a combined diet of resident and non-resident species at 175 g/day. EPA did not make significant revisions to the Tribal Fisher scenarios. However, the concept of a non-tribal "subsistence fisher" has never been discussed prior to June 2012. The LWG's understanding is that EPA is not using the term "subsistence" to imply there are non-tribal populations who rely on the fish in the Willamette River as a primary source of protein in their diet. For this reason, the LWG is not disputing use of that term; however, the LWG believes "Non-Tribal High Consumer" would be a more accurate term. If EPA nevertheless retains "subsistence," it should be described as "Non-Tribal Subsistence" to distinguish from the "Tribal Fisher" scenario.
[48] EPA designated corresponding fish consumption rates for children: 31 g/day for recreational and 60 g/day for subsistence. For simplicity, the discussion that follows refers to the adult rates with the understanding that the same issues apply to the corresponding rates for children.

EPA's directed revisions on the fish consumption rates lead to the designation of multiple RME cases for recreational and subsistence fishers as part of the Risk Characterization.[49] The May 2011 draft final BHHRA included calculation of risks from fish consumption using a range of ingestion rates, different tissue types, different species, and different exposure scales. EPA has identified all scenarios calculated with an ingestion rate of 73 g/day as the RME for the recreational fisher, and all scenarios calculated with an ingestion rate of 142 g/day as the RME for the subsistence fisher. This results in the following combination of RME exposure cases for the recreational fisher:

Exposure Endpoint	**Description of RME Cases**	**Total**
Combined Child/Adult, Cancer	• Four Bass scenarios using: Whole Body, one river mile; Whole Body, Study-Area Wide; Fillet, one river mile; and Fillet, Study-Area Wide. • Twelve additional single species (Carp, Brown Bullhead and Black Crappie) scenarios using: Whole Body, Fishing Zone; Whole Body, Study-Area Wide; Fillet, Fishing Zone; and Fillet, Study-Area Wide. • Two Multi-species scenarios using Whole-body, Study Area Wide; and Fillet, Study Area Wide.	18 RMEs
Child Non-Cancer	Same as above.	18 RMEs
Breastfeeding Infant	Same as above.	18 RMEs
Total		**54 RMEs**

A similar pattern exists for the subsistence fisher, using a different rate, resulting in 54 RME cases for the subsistence fisher. Basically, every exposure case calculated except scenarios using 17.5 g/day is now an RME.

There are several problems with this approach. First, it is inconsistent with guidance and national policy to designate a specific ingestion rate as the RME versus the overall exposure pathway (in this case, fish consumption). In other words, EPA's 54 recreational RME exposure cases should be reduced to a total of three RMEs: one for the adult/child cancer, one for child non-cancer, and one the breastfeeding infant. The same approach should be taken for the subsistence fisher.[50]

Second, even if it makes sense to designate multiple RMEs for each population and pathway, there are several scenarios that EPA inappropriately designates as the RME. Simply put, it is not reasonable to assume that a recreational fisher will eat 10 whole or fillet bass meals a month from the exact same river mile every year for 30 years, nor is it reasonable that a

[49] *See* June 2012 EPA directed redline, Section 5, attached at Tab 16.
[50] EPA also designates six RME scenarios for the Tribal Fisher. To be consistent with guidance, there should only be one RME for each pathway (child/adult cancer, child non-cancer, and infant), for a total of three RMEs. The LWG recommends that this RME scenario be based on fillet with skin, not whole body.

subsistence fisher will eat 19 whole or fillet bass meals a month from the exact same one-river mile every year for 30 years. RMEs are not supposed to reflect the worst possible case imaginable, but rather a conservative but realistic scenario.

Although the LWG preference is to honor the past EPA/LWG agreements that have guided the joint work on the Remedial Investigation and BHHRA for the past eight years, the LWG will not dispute EPA's desire to identify RME scenarios for fish consumption in the BHHRA at this late stage in the process. As noted above, the LWG originally proposed use of RME and CT in 2003. However, the specific approach EPA has taken and the scenarios EPA has directed as RMEs are not consistent with guidance or national policy, and are therefore arbitrary and capricious.

2. Definition and use of RME.

EPA's Risk Assessment Guidance for Superfund, Part A provides guidance on how to conduct baseline human health risk assessments. According to EPA guidance, "[a]ctions at Superfund sites should be based on an estimate of the reasonable maximum exposure (RME) expected to occur under both current and future land-use conditions. The reasonable maximum exposure is defined here as the highest exposure that is reasonably expected to occur at a site."[51]

The "intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures."[52] Although the goal of the Superfund program is to protect against the high-end, not average, exposures, "only potential exposures that are likely to occur" should be included in the exposure assessment.[53] The RME is, by definition, "within a realistic range of exposures, not a 'worst-case' estimate."[54]

An exposure scenario is made up of a combination of assumptions about exposure factors that are used to assess risk for a particular receptor population. The reasonable maximum exposure case is developed by combining "upper-bound and mid-range exposure factors . . . so that the result represents an exposure scenario that is both protective and reasonable; not the worst possible case."[55] The concept of mixing average and upper-bound values to calculate an RME is also discussed in the Preamble to the NCP: "The reasonable maximum exposure scenario is 'reasonable' because it is a product of factors, such as concentration and exposure frequency and duration, that are an appropriate mix of values that reflect averages and 95th percentile distributions."[56] Neither the guidance nor regulations discuss which values should be average or 95th percentile, or how to mix them. What is clear, however, is that it is the combination of all intake values, and not any one individual intake value, that creates the overall RME exposure case.

---

[51] *Risk Assessment Guidance for Superfund* (RAGS) (EPA, December 1989)Vol. I, Part A, § 6.1.2, attached at Tab 29.
[52] RAGS, Vol. I, Part A § 6.1.2, attached at Tab 29.
[53] 55 Fed. Reg. 8666, at 8710, attached at Tab 30.
[54] *Risk Assessment Principles & Practice* (EPA Office of the Science Advisor, March 2004), § 5.6, attached at Tab 31.
[55] RAGS, Vol. I, Supplemental Guidance, § 1.0, attached at Tab 29.
[56] 55 Fed. Reg. 8666, at 8710, attached at Tab 30.

3. EPA's directed revisions are inconsistent with guidance and national policy.

EPA has designated 108 RME scenarios for the fish consumption pathways – 54 for recreational fishers and 54 for subsistence fishers. These designations are based solely on one exposure factor as defining the RME – the fish consumption rate. As discussed above, the LWG is disputing this direction because: (a) It is inconsistent with guidance and national policy to designate a specific ingestion rate as the RME versus the overall exposure pathway; and (b) Even if it makes sense to designate multiple RMEs for each exposure pathway, EPA's specific designations are inconsistent with guidance and national policy.

a. It is inconsistent with guidance and national policy to designate one exposure factor as the RME rather than the overall exposure pathway.

EPA's approach is inappropriate because both guidance and EPA policy are clear that it is the combination of various exposure factors, not a single exposure factor, that defines an RME.[57] EPA's approach is also inappropriate because RME should be used to define a single overall exposure case for each exposure pathway. RME is not intended to be used to designate multiple RME exposure cases for each pathway to capture every possible circumstance and uncertainty, which is what EPA has done here. RAGS Part A notes:

> "In the past, exposures generally were estimated for an average and an upper-bound exposure case, instead of a single exposure case (for both current and future land use) as recommended here. The advantage of the two case approach is that the resulting range of exposures provides some measure of the uncertainty surrounding these estimates. The disadvantage of this approach is that the upper-bound estimate of exposure may be above the range of possible exposures, whereas the average estimate is lower than exposures potentially experienced by much of the population. The intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures. Uncertainty is still evaluated under this approach. However, instead of combining many sources of uncertainty into average and upper-bound exposure estimates, the variation in individual exposure variables is used to evaluate uncertainty."[58]

EPA is misusing the RME concept in a way that is entirely contrary to EPA guidance and practice. Using two populations of fishers (recreational and subsistence) and three endpoints (adult/child cancer, child non-cancer, and breastfeeding infant), the total number of RME cases presented in the BHHRA should be six, not 108.[59] This does not mean that the BHHRA cannot include and discuss variations on the exposure factors in

[57] RAGS, Vol. 1. Supplemental Guidance, § 1.0; 55 Fed. Reg. 8666, at 8710, attached at Tab 29.
[58] RAGS, Vol 1, Part A, § 6.1.2 (emphasis added), attached at Tab 29.
[59] As noted earlier, this same logic applies to the Tribal Fisher scenario. There should be one RME for adult/child, one for child and one for breastfeeding infant, for a total of three RMEs. EPA has identified six based on using both whole body and fillet on a Study-Area wide basis.

the context of uncertainty, such as smaller exposure scales if there are more popular fishing zones that exist at a site.

b. EPA's RME designations are inconsistent with guidance and national policy because they are not reasonably expected to occur at the Site.

The guidance is clear that RMEs are the reasonable maximum exposure "that is reasonably expected to occur at a site."[60] EPA's approach is inappropriate because EPA designates several exposure cases as the RME which are not reasonably likely to occur at the Site. The following are examples:

- Recreational Fisher: 73 g/day (10 meals/month), whole fish, unprepared (no loss of PCBs from cooking), and assuming the person fishes for one species (bass) in the same one-river mile section of the Superfund Site for a 30-year period.

- Recreational Fisher: 73 g/day (10 meals/month), whole fish, unprepared (no loss of PCBs from cooking), and assuming the person fishes for only one species (carp) in the same section of the Superfund Site for a 30-year period.

- Subsistence Fisher: 142 g/day (19 meals/month), whole fish, unprepared (no loss of PCBs from cooking), and assuming the person fishes for one species (bass) in the same one-river mile section of the Superfund Site for a 30-year period.

- Subsistence Fisher: 142 g/day (19 meals/month), whole fish, unprepared (no loss of PCBs from cooking), and assuming the person fishes for one species (carp) in the same section of the Superfund Site for a 30-year period.

In each case, the combination of the consumption rate, tissue type, species consumed, exposure area and duration results in an exposure case that is not reasonably likely to occur.

First, the fish consumption rate of 73 g/day is not technically supported. EPA selected 73 g/day as the RME value for recreational fishers based on a study completed in 1996 at the Columbia Slough.[61] A consumption rate of 73 g/day (10 meals per month) was derived from that survey based on the 95 percent upper confidence limit on the average for ingestion of fish where 75 percent of the mass of the total fish is consumed.

There are many issues with the basis of the 73 g/day consumption rate. The study used to derive the 73 g/day consumption rate was a creel survey conducted in the Columbia Slough, which is a small water body that drains into the Willamette River just downstream of the Study Area boundary for the Superfund Site. As stated in EPA's *Guidance for Conducting Fish and Wildlife Consumption Surveys*, one of the disadvantages to creel surveys is that they are conservative and potentially overestimate consumption:

---

[60] RAGS, Vol. 1, Part A, § 6.1.2, attached at Tab 29.
[61] June 2012 EPA directed redline, Section 3.5.10.6, attached at Tab 16.

> "Responses to questions about consumption are hypothetical because consumption of the catch has not yet occurred and it is unknown how many fish will be given away and consumed by the friends or family of the fisher. In addition, these responses measure only the *intent* to consume, which might not be an accurate representation of the true consumption rate. Follow-up studies might be needed to understand the relationship between the intent to consume and actual consumption. As preliminary estimates, the consumption estimates from creel surveys are conservative, potentially overestimating consumption for the fishing population."[62]

In addition, although EPA had previously told the LWG it could not rely on consumption studies that were not multi-year with a statistically significant number of participants,[63] the creel survey was only conducted over 20 days in a single one-month period in June 1995, which is not likely representative of the ongoing consumption evaluated in the BHHRA, and only included the responses of 21 people in deriving the consumption rate of 73 g/day. Finally, the actual consumption rate was derived using numerous assumptions, including extrapolation of interview responses to family members, extrapolation of a one-month survey period over an entire year, and the weight of the fish.[64]

In addition, the rate of 73 g/day was derived based on the assumption that an individual consumes 75 percent of the total weight of the fish. However, 30 percent of the total weight was cited as the amount considered edible in the survey.[65] Assuming that only 30 percent of the total weight of the fish is consumed, the consumption rate for the 95 percent upper confidence limit is 29 g/day. Given that recreational fishers are likely to consume fillet tissue, not whole body, if EPA were to rely on the Columbia Slough study to define the recreational scenario, the appropriate rate to use for recreational fishers based on the creel survey would be 29 g/day.

However, the fish consumption population evaluated in that survey appears more representative of a subsistence fisher than a recreational fisher. Many of the fishers that were interviewed represented diverse ethnic populations and often indicated they were fishing for whatever they could catch. The most common species caught was carp, followed by yellow perch and banded sculpin.[66] By contrast, other studies performed indicate that recreational

---

[62] *Guidance for Conducting Fish and Wildlife Consumption Surveys* (EPA 1998), attached at Tab 32, Section 4.9.2, p. 4-22.

[63] EPA Comments on Portland Harbor RI/FS Programmatic Work Plan (Revised March 31, 2003), July 25, 2003, attached at Tab 33: "EPA's position is that a well done fish consumption study that provides usable quantitative data, whether for the risk characterization or for comparison with existing studies, would require at least two to three years to complete and cost several hundred thousand dollars. This is based on our experience with several fish consumption studies in the Region, including those conducted for several tribes (Columbia River Tribes (CRITFC), Suquamish Tribe, and Tulalip/Squaxin Island Tribes) and Asian Pacific Islanders. We strongly discourage the Respondents from conducting any fish consumption studies or surveys that are less rigorous than these tribal and API studies. EPA will not accept the data from them for use in the risk assessment nor for comparison with existing well done studies."

[64] Adolfson Associates, 1996. Technical Memorandum on the Results of the 1995 Fish Consumption and Recreational Use Surveys – Amendment No. 1. The creel survey is attached at Tab 34.

[65] *Id.,* at p. 17 (citing ChemRisk, Methodology and Results of the Housatonic River Creel Survey Portland, ME. March 1994.)

[66] *Id.* at p. 10,

fishers typically prefer Chinook salmon, steelhead, Coho salmon, shad, crappie, bass and white sturgeon.[67] This is consistent with the ATDSR 2002 Public Health Assessment for Portland Harbor, which found that the resident species that are major sports fish are walleye, black crappie, white crappie and smallmouth bass.[68]

Finally, EPA's direction to use 73 g/day ingestion rate for recreational fishing of resident fish on the Lower Willamette River in Portland—a rate intended to exclude consumption of non-resident species like salmon, steelhead, and sturgeon—would be significantly higher than other sediment Superfund sites across the country. Based on a review of seven risk assessments from freshwater systems, the recreational fishing rate ranged from 25 g/day (Passaic River) to 59 g/day (Fox River), with an average ingestion rate of 38.4 g/day.[69]

Thus, a recreational exposure case using a 73 g/day ingestion rate (ten meals per month) of resident species is not reasonably likely to occur and not technically defensible. When these assumptions are further combined with an assumption that the person is eating ten whole bass or carp a month for 30 years from the same section of the Site, the exposure case is no longer within the range of possible exposures, let alone the RME. Similar logic applies to the subsistence fisher scenarios that assume someone is eating whole bass or carp 19 times a month from the same section of the Site over a 30 year period. Simply put, it fails the reasonableness test.

4. LWG and EPA should identify an RME that is consistent with guidance and national policy.

Consistent with previous direction from and agreements with EPA, the LWG calculated risks from fish consumption using a range of ingestion rates, different tissue types, different species, and different exposure scales. The combination of these different assumptions provided a range of estimates in the BHHRA from which RMEs may be selected as part of the Feasibility Study, Proposed Plan and Record of Decision. However, the LWG now understands that EPA is requesting a defined RME scenario for fish consumption in the BHHRA. Because the EPA-directed RMEs are inconsistent with guidance, the LWG proposes the following as a resolution to this disagreement:

<u>RME Exposure Cases</u>. EPA and the LWG should identify two non-tribal RME cases: a recreational fisher and a high consumer or subsistence fisher. Both the Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (AWQC Guidance) and the Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (Fish Advisory Guidance) recommend considering recreational and subsistence fishers separately.[70] While there is no evidence of a non-tribal "subsistence" fisher, there is

---

[67] *See* June 2012 EPA directed redline, Section 3.5.10.6, Tab 16, and related references: Hartman 2002, and Steele 2002, attached at Tab 48; DEQ Portland Harbor RI/FS Work Plan (draft, March 31, 2000), attached at Tab 49.
[68] *Public Health Assessment, Initial Release* (ATDSR January 15, 2002), attached at Tab 35.
[69] See Table 4, Summary of Risk Assessments From Other Freshwater Sediment Superfund Sites.
[70] *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (EPA 2000), attached at Tab 42, Section 4.3.3.1, p. 4-24; *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories* (EPA 2000), Volume 2: Risk Assessment and Fish Consumption Limits, attached at Tab 43, Section 1, p. 1-8.

evidence that immigrant populations and cultural sub-populations have different fishing trends than the traditional sport recreational fisher.[71] This provides justification for two separate scenarios in the BHHRA. However, the LWG believes the term "Non-Tribal High Consumer" is more accurate than "Subsistence." Regardless of the term used, the LWG does not dispute development of an RME scenario for two populations of non-tribal fishers: recreational and subsistence (high-consumer).

Fish Tissue Consumed. Both RME cases should be based on consumption of fillet with skin, not whole body. This approach is consistent with EPA guidance which states: "[t]he chemical concentration in fish or shellfish . . . should be the concentration in the edible tissues (when available)."[72] Using fillet rather than whole body is also consistent with other risk assessments surveyed.[73] While the subsistence fisher may consume more than the fillet for some meals, there is no evidence that he or she consumes 100 percent of the fish (whole body). Consumption of a higher percentage of the fish can be accounted for through uncertainty evaluations or use of more conservative assumptions for other factors, such as cooking loss.

Multi-Species. Both RME cases should be based on consumption of multiple resident species. Approximately 39 resident fish species have been found in the Lower Willamette River. All available information for the Study Area indicates that multiple species are preferred by both recreational and non-tribal consumers. In addition, the Columbia Slough study found that most respondents were fishing for whatever they could catch. Therefore in order to evaluate ongoing fish consumption, the LWG recommends using a multi-species diet for both the recreational and non-tribal consumers consisting of both bottom fish (carp and bullhead) and predator fish (crappie and smallmouth bass). The use of bottom feeders and predators as target species in freshwater systems is also recommended by the Fish Advisory Guidance.[74]

Exposure Area. A review of other risk assessments indicates a trend to evaluate risks based on site-wide exposure scales because people do not fish in just one location on a large river over long periods of time (30 years). The LWG recommends following this policy for the Lower Willamette River. This is consistent with the Tribal Fisher scenario in the BHHRA, which only presents a study-area wide exposure scale. The LWG also understands that EPA may be willing to use a study-area wide exposure scale for the subsistence fisher, rather than one-river mile. There is no justification to use a smaller scale for the recreational fisher if a high-end fish consumption rate is used. Use of a study-area wide exposure area would not preclude presentation of smaller scale evaluations (i.e. one river mile) for the recreational fisher in the risk assessment to assess uncertainties. Furthermore, the LWG would not dispute EPA's assumption that 100 percent of the fish consumed are caught within the Study Area even though fishers are likely to consume fish caught from other water bodies or even store-bought fish.

---

[71] Technical Memorandum: Proposed Fish Consumption Rates for the Portland Harbor RI/FS Human Health Risk Assessment (LWG May 9, 2003), attached at Tab 26; ATDSR 2002.
[72] RAGS, Vol. I, Part A, § 6.6.4, attached at Tab 29.
[73] See Table 4.
[74] *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories* (EPA 2000), Volume 1: Fish Sampling and Analysis, attached at Tab 36, Section 3.3, p. 3-3.

ED_000959_NSF_00054720-00021 06/25/2019 SEMS_0305988

Cooking Loss. EPA's directive includes an assumption that there is no loss of contaminants from cooking. This is consistent with prior EPA direction and the method used by the LWG in the BHHRA to date. While numerous studies demonstrate that loss of contaminants from cooking can be significant depending on the method of preparation and a cooking loss factor was used in other risk assessments surveyed, the LWG will accept that. Using a conservative assumption for this factor is an appropriate means of offsetting other uncertainties, such as the fact that some people may consume more than the fillet for a portion of their meals.

Recreational Fish Consumption Rate. This factor is the most difficult because, as EPA notes in its December 14, 2011 letter, EPA recommended that site-specific studies not be conducted for Portland Harbor.[75] Given that there is not site-specific data available, the following should be considered in setting a recreational fish consumption rate for Portland Harbor:

- In the absence of site-specific data, the recommended default value for recreational fishers in both the AWQC Guidance and Fish Advisory Guidance is 17.5 g/day. As discussed in the AWQC Guidance, the 17.5 g/day represents the 90th percentile consumption rate from the USDA CSFII Survey. The LWG understands that the 90th percentile includes both consumers and non-consumers, which underestimates the potential exposure for consumers only. In addition, the AWQC Guidance states that the 17.5 g/day is considered "to be indicative of the average consumption among sport fishers based on averages in the studies reviewed" in recommending its use as the default consumption rate for recreational fishers. However, the 90th percentile also includes both fish and shellfish. In the case of Portland Harbor, shellfish are evaluated separately, so the use of a consumption rate for fish that also includes shellfish overestimates the potential exposure. In addition, both the AWQC Guidance and Fish Advisory Guidance are applied to an entire water body (not the exposure scale for the fish).
- Recreational sport fishers at Portland Harbor consume both non-resident and resident species. The rate used in the risk assessment will only account for resident species and therefore should be appropriately reduced to the extent a high-end (95th percentile) fish consumption rate is used. Alternatively, EPA could apply an average fish consumption rate (like the USDA CSFII Survey 17.5 g/day) to account for the fact that only some of the fish consumed by the recreational fisher are resident fish.
- In any case, using 73 g/day from the Columbia Slough study would not be appropriate because the study assumed consumption of 75% of the fish weight, was a short-duration study with a small number of respondents, was based on numerous assumptions, and was not representative of the recreational fisher.
- Evaluating available fish consumption surveys in the Pacific Northwest and other freshwater sediment Superfund sites may be helpful in determining an appropriate rate. A literature review of available studies is the methodology LWG recommended in 2003.

[75] EPA Letter to The Honorable Earl Blumenauer, December 14, 2011, attached at Tab 37, at 3 ("EPA recommended that site-specific fish consumption studies not be conducted for the Portland Harbor risk assessment because such studies can often be very time-consuming and expensive. EPA's experience with other sediment sites indicated that readily available published studies and guidance would sufficiently describe the range of reasonably expected fish consumption rates relevant to the different populations known to occur in the Portland Harbor area.").

Subsistence Fish Consumption Rate. Similar to the recreational rate, there is no site-specific data that assesses the high consumption fisher or subsistence fisher, and EPA recommended that site-specific data not be collected.[76] The following should be considered in setting a rate for the subsistence fisher:

- The subsistence fisher at Portland Harbor is intended to represent higher consumption of resident fish by recent immigrants from Eastern Europe and Asia, as well as African-Americans and Hispanics. It is not intended to represent a traditional subsistence fisher; the tribal subsistence fisher is evaluated separately.
- As noted above, the LWG believes that the fish consumption population evaluated in the creel survey conducted in the Columbia Slough represents a subsistence fisher. The fishers interviewed represented diverse ethnicities including Eastern Europeans, Asians, African-Americans and Hispanics. They also indicated they were fishing for whatever they could catch. A consumption rate of 73 g/day (10 meals per month) was derived from that survey based on the 95 percent upper confidence limit on the average for ingestion of fish where 75 percent of the mass of the total fish is consumed. While the LWG believes that the consumption rate of 73 g/day is more representative of subsistence consumption, the LWG recognizes the limited scope of the survey and numerous assumptions in deriving the consumption rates.
- In the absence of site-specific information, the AWQC guidance recommends a default consumption rate of 142 g/day (19 meals per month) for subsistence fishers. As discussed in the AWQC Guidance, the 142 g/day represents the 99th percentile consumption rate from the USDA CSFII Survey. As with the 17.5 g/day consumption rate, the 99th percentile is based on consumers and non-consumers as well as consumption of both fish and shellfish. The AWQC Guidance also states "EPA believes that the assumption of 142.4 grams/day is within the range of average consumption estimates for subsistence fishers based on the studies reviewed" in recommending the use of 142 g/day as the default consumption rate for subsistence fishers. Both the AWQC Guidance and Fish Advisory Guidance are applied to an entire water body.
- In 2003, the LWG performed a review of surveys that were targeted at immigrant and cultural sub-populations in other regions to identify a 95th percentile fish ingestion rate. It may be helpful to update the literature review and compare to the Columbia Slough survey rate of 73 g/day and the AWQC default rate of 142.4 g/day to determine an appropriate rate for Portland Harbor.

Given that EPA's directive to define an RME for the recreational fisher and the subsistence fisher is new, you should provide time for the LWG and EPA to review available guidance, fish consumption surveys from other freshwater systems, and other Superfund sites to determine and a recommended fish consumption rate to use in combination with the other factors above to establish an RME. If EPA staff and the LWG cannot reach agreement within two months, you should determine the appropriate rate based on a review of briefing papers from each side upon expiration of the two-month period.

---

[76] *Id.*

5. Conclusion

You should retract EPA's June 2012 directed redline regarding the fish consumption scenarios because they are inconsistent with EPA guidance and policy, and therefore arbitrary and capricious. Please direct EPA staff and the LWG to work together to define an RME scenario for recreational and subsistence (or high consumers) based on the following parameters:

- Multi-species diet of resident fish (not a single species like bass or carp);
- Fillet with skin (not whole body);
- An exposure area that is appropriate for the fish consumption rate applied, with a preference to use a site-wide exposure area; and
- Fish consumption rates for recreational and subsistence (high-consumer) fishers that, in the absence of site-specific data, are based on guidance and a thorough review of available studies from the Pacific Northwest and other freshwater sediment Superfund sites. In any case, the recreational fisher RME should not use a recreational consumption rate of 73 g/day based on the Columbia Slough study.

As explained above, the LWG would like the opportunity to continue the discussion with EPA staff based on EPA's RME proposal dated September 11, 2012, and try to reach consensus on an appropriate RME for fish consumption at the Site. If EPA and the LWG cannot come to agreement within two months, you should decide the RME scenarios based on briefing papers submitted by both parties.

B. EPA's June 2012 directed redline fails to comply with EPA guidance stating that a BHHRA must provide an adequate description of the actual risks relating to exposure to contamination.

The purposes of a risk assessment are to (1) inform the lead agency's risk management decisions for the site and (2) communicate to the public the reasonable risks of exposure at the site and the underlying assumptions and limitations of the risk assessment. EPA explained in the preamble to the 1990 revision to the National Contingency Plan (NCP) that the risk assessment will "provide a framework for developing risk information necessary to assist decision-making at remedial sites."[77] To provide an accurate framework for risk management decisions, those reading the risk assessment must be "presented with all critical assumptions and uncertainties so that significant risks can be identified."[78] EPA also explains in its risk characterization guidance that "[w]ell balanced risk characterizations present risk conclusions and information regarding the strengths and limitations of the assessment for other risk assessors, EPA decision makers, and the public."[79]

The LWG disputes EPA's June 2012 directed redline that deleted relevant context information from the BHHRA. Through discussions with EPA since LWG filed its July 23, 2012 dispute, EPA has proposed revisions to the June 2012 BHHRA, which are reflected in the attached September 17, 2012 EPA/LWG redline. However, additional relevant context is

[77] 55 Fed. Reg. 8,665, 8,709 (1990). *See* Tab 30.
[78] *Id.*
[79] EPA, Guidance for Risk Characterization, II.3 (1995), attached at Tab 38.

missing from the September 17, 2012 EPA/LWG redline. Specifically, EPA continues to exclude from the Exposure Assessment discussion (Section 3) and the Risk Characterization discussion (Section 5), and in some cases from the BHHRA altogether, important context information relating to the domestic drinking water and clam consumption scenarios.

As an example, the September 17, 2012 EPA/LWG redline would direct the LWG to include the following in the description of the domestic drinking water exposure scenario in section 3.2.1.8:

> "Although there are currently no known uses of the Lower Willamette River as a source of drinking water, public and private use of the Willamette River as a domestic water source is a designated beneficial use by the State of Oregon. Hence, use of surface water as a source of household water was assessed as a potentially complete pathway."

As written, this statement is inaccurate by omission. A reader might reasonably infer from the description that Oregon has designated that Willamette River water from the Study Area will be supplied to households for use without any treatment. This inference would be incorrect. To make this description accurate and to accurately describe the results of the associated risk evaluation, Section 3 should (1) include the State of Oregon's complete statement of the designated beneficial use – "with adequate pretreatment and natural quality that meets drinking water standards;" and (2) indicate that the scenario evaluated in the assessment is the consumption of *untreated* surface water.

As another example, EPA's September 17 revised description of the clam consumption scenario in Section 3.3.6 provides:

> "The actual extent shellfish harvesting and consumption is presently occurring is not known. The Linnton Community Center project (Wagner 2004) reported that some transients reported eating clams and crayfish, although many of the individuals indicated that they were in the area temporarily, move from location to location frequently, or have variable diets based on what is easily available. While the degree to which consumption of clams currently occurs in Portland Harbor is unknown, the Linnton Community Center project suggests that it does not occur on an ongoing basis within the Study Area. The only clam species found in the Study Area during sampling events were Asian clams (Corbicula sp.)."

Again, this statement is inaccurate by omission. To accurately describe this scenario and the results of the associated risk evaluation, the risk assessment should include the relevant context information that the harvesting of non-native clams is currently illegal.[80]

Attached as Table 5 is a list of the specific sections of the BHHRA where EPA's proposed revisions fail to provide the context required by EPA guidance, along with the text that

[80] The LWG agrees this does not mean non-native clams are not consumed at all, but we contend this is an important context fact that impacts the likelihood and extent of consumption.

the LWG contends should be included in order to comply with EPA guidance, as discussed in the following sections.

1. The BHHRA should include information relevant to the likelihood of exposure actually occurring via each pathway.

To inform a "well balanced" risk characterization, the risk assessment must provide information relevant to the likelihood of the exposure scenarios evaluated in the risk assessment actually occurring. In the RAGS, EPA explains that a risk assessor should pay particular attention to the likelihood of exposure pathways and land uses actually occurring, because "[a] large part of the risk assessment is the estimation of cancer risks or hazard indices that are conditional on the existence of the exposure conditions analyzed. …It is important to provide the RPM or other risk manager with information related to the likelihood that the assumed conditions will occur to allow interpretation of a conditional risk estimate in the proper context."[81] The discussion in the risk assessment regarding the likelihood of exposure through a particular pathway actually occurring should be carried through EPA's risk characterization and into the development of appropriate exposure levels for the site.[82] EPA explains further that "the likelihood of the exposure actually occurring should be considered when deciding the appropriate level of remediation;" and, accordingly, EPA's risk assessment guidance "is designed to focus the assessment on more realistic exposures."[83] This focus on more realistic exposures informs EPA's well-balanced approach to risk characterization.

As set forth in Table 5, this guidance compels EPA to add back into Section 3 information that informs the likelihood of exposure scenarios occurring, specifically in Section 3.2.1.8 (with respect to the exact extent of the State of Oregon's beneficial use designation as a domestic water source, specifically that the designated use assumes pretreatment of the water and natural quality that meets drinking water standards) and Section 3.3.6 (with respect to Oregon law prohibiting harvesting non-native clams). EPA also needs to add text in Sections 3, 5 and 6 that clarifies that the exposure scenario assessed is the consumption of *untreated* surface water.

Including context information for the domestic drinking water scenario relating to the pretreatment expectation is consistent with risk assessments performed for other Superfund sites. In fact, at other sites, the risk assessment has excluded pathways altogether where there was no evidence that they were likely to occur based on current use. For example, the risk assessment for the Fox River site excludes the domestic drinking water scenario entirely, indicating that the Lower Fox River is not used as a primary drinking water source and is only used as a secondary drinking water source with pretreatment.[84] Including the pretreatment qualification as an important part of the designation itself is also consistent with how Oregon applies the designation. The *Snake River—Hells Canyon Total Maximum Daily Load*, Revised June 2004, describes at page 71 the application of the "adequate pretreatment" component of the designated beneficial use: "These waters, while not required to meet drinking water standards in-stream,

---

[81] RAGS Vol. 1, p. 8-18 (emphasis in original), attached at Tab 29.
[82] *See* 40 CFR 300.430(d)(4).
[83] *Id.*
[84] Wisconsin Department of Natural Resources, Final BHHRA and Ecological Risk Assessment for Lower Fox River and Green Bay, Wisconsin, attached at Tab 44, p. 5-7 (2002).

must be of sufficient quality that it is possible for them to meet drinking water standards with conventional treatment measures."[85]

2. EPA's revisions are inconsistent with guidance to the extent it has moved relevant context information back to the uncertainty section.

EPA has explained that, in several cases, it moved information from the Exposure Assessment section (Section 3) back to the Uncertainty section (Section 6) because it contends the information relates only to uncertainty and is not appropriately discussed in the exposure assessment. This is contrary to EPA guidance.

There are two different types of site-specific information that guide a well-balanced examination of the results of a risk assessment: (1) uncertainties and (2) context. Uncertainties describe the assumptions that go into the quantitative risk calculation. The LWG believes EPA's current version of the BHHRA appropriately explains in Section 6.0 what should be included in the uncertainty discussion: "EPA policy calls for numerical risk estimates to always be accompanied by descriptive information regarding the uncertainties of each step in the risk assessment to ensure an objective and balanced characterization of the true risks and hazards." This includes assumptions relating to the value of parameters, such as the consumption rate, and the applicability of modeling methods used in the assessment.[86] Uncertainties essentially explain the assessor's degree of confidence in the quantitative results of the risk calculations, and the LWG agrees that these uncertainties are appropriate for discussion in the Uncertainties Analysis (Section 6) of the BHHRA.

However, the other type of balancing information is context. This information includes the physical setting, the regulatory setting and other factors relating to the exposure scenarios evaluated in the risk assessment.[87] EPA indicates in the 1990 NCP preamble that:

> "EPA conducts an exposure assessment to identify the magnitude of actual or potential human or environmental exposures, the frequency and duration of these exposures, and the routes by which receptors are exposed. *This exposure assessment includes an evaluation of the likelihood of such exposures occurring and provides the basis for the development of acceptable exposure levels*." [88]

As set forth in Table 5, this EPA guidance compels EPA to add back into Section 3.3.6 context information that its directed revisions have removed and is now only addressed in Section 6.2.2.1, the Uncertainty section (with respect to the fact that the predominant species of clams found in the Portland Harbor is the invasive Asian clam which Oregon law prohibits harvesting). EPA also needs to add back into Section 3.2.1.8 the context information that the State of Oregon's beneficial use designation as a domestic water source assumes pretreatment of the water and natural quality that meets drinking water standards, which in the September 17, 2012 EPA/LWG redline is only addressed in Section 6.2.2.3.

---

[85] The *Snake River – Hells Canyon TMDL* is attached at Tab 39.
[86] *See* RAGS Vol. I , pp. 8-18-20 (1989) (Interim Final), attached at Tab 29.
[87] Guidelines for Exposure Assessment (EPA, May 1992), attached at Tab 40, pp. 72-73.
[88] 55 Fed. Reg. 8,666, 8,710, attached at Tab 30.

Including information relating to the harvesting ban on non-native clams is consistent with the kind of information included in risk assessments performed for other Superfund sites. EPA Region 10 noted in the Lower Duwamish Waterway BHHRA that there was limited suitable clam habitat at the site and that the ability of the site to support clam populations that would achieve the assumed consumption rates was unknown.[89] This is the same type of information that LWG here proposes to include in the discussions of the clam consumption scenario.

3. EPA Has Deleted Necessary Context Information Based on the Mistaken Assertion That All Regulatory Restrictions are Institutional Controls.

EPA has taken the position that certain regulatory information amounts to an institutional control and therefore should not be included in the description of the exposure scenarios.

- It takes this position with respect to just a portion of Oregon's designated beneficial use for the Willamette River. As described above, EPA's June 2012 directed redline in Section 3 refers to the Oregon rule that designates beneficial use as the justification for its direction to evaluate the domestic drinking water exposure scenario. EPA then, however, deletes references to the portion of that same rule that explains that the designation only applies assuming "adequate pretreatment" on the grounds that just this part of the Oregon rule is an "institutional control."

- Similarly, EPA's June 2012 directed redline takes the position that Section 3 should not include the factual statement that Oregon law generally (not just in Portland Harbor) prohibits the harvesting of the invasive Asian clams that are the subject of the clam consumption exposure assessment.

The LWG agrees that true institutional controls are not relevant to the BHHRA and will not be discussed in the final BHHRA. However, as properly understood, "institutional controls" are those controls instituted as part of a remedial action to limit exposure; "institutional controls" do not include existing laws and regulations such as those bulleted above, which are not associated with the release of contaminants at the site. Rather, these laws and regulations are a part of the baseline conditions at the site, essential considerations in the evaluation of the no-action alternative:

> "The role of the baseline risk assessment is to address the risk associated with a site in the absence of any remedial action or control, including institutional controls. The baseline assessment is essentially an evaluation of the no-action alternative. Institutional controls, while not actively cleaning up contamination at the site, can control exposure and, therefore, are considered to be limited action alternatives."[90]

[89] EPA Region 10/Washington Department of Ecology, Lower Duwamish Waterway BHHRA, p. 332 (2007), attached at Tab 45.
[90] 55 Fed. Reg. at 8,710-11, attached at Tab 30.

Both of the bullets above describe existing laws and regulations that exist currently as part of the "no action" baseline condition of the site and will continue to exist long after the remedy is implemented. Both are based on rules that have nothing to do with the site or its contamination. The condition in the Oregon rule that designates domestic water supply as a beneficial use of the Willamette River "with adequate pretreatment" is the same condition that exists on every similar designated beneficial use for surface water in the state of Oregon. It is not specific to the Study Area or related to any contamination in the Study Area. Similarly, the prohibition on the harvest of invasive clams exists throughout Oregon, not due to any issue regarding contamination. Rather than being institutional controls that are dependent on the selected remedy, these instead are part of the legal land use conditions that provide necessary context relating to the likelihood that scenarios evaluated in the risk assessment might actually occur.

As set forth in Table 5, this EPA guidance compels EPA to include in Section 3 an adequate description of the "no action" baseline condition as it affects both the domestic drinking water use scenario and the clam consumption scenario.

The LWG's proposal for including regulatory information affecting the baseline is also consistent with risk assessments performed for other sites. In another risk assessment, EPA excluded a pathway altogether based on current regulatory restrictions. The Housatonic River HHRA explains that the construction worker scenario was not evaluated because existing regulations precluded major construction in the floodplain.[91]

C. EPA's decision to not include a table of contents, executive summary or conclusion in the BHHRA is inconsistent with EPA policy and guidance and significantly impairs public review and input.

EPA's June 22 letter states that EPA "had to extensively modify the [BHHRA] to make it understandable to the general public." EPA's June 2012 directed redline deleted the executive summary, the table of contents and the conclusions of the risk assessment.

The BHHRA is a lengthy and complex document. A table of contents is necessary so that the reader can find his or her way around the document. In addition, many readers, especially the general public, either want a summary of what is found in the document or a summary that will give them guidance as to where specific topics of interest will be found. Taking these provisions out of the document automatically restricts its availability and use.

EPA guidance is replete with instructions to inform and involve the public. "Superfund has a long-standing commitment to community involvement (also known as public participation) … ." EPA Memorandum on Early and Meaningful Community Involvement. (OSWER 9230.0-99, October, 2001) . "EPA is committed to providing opportunities for citizens to participate meaningfully in the cleanup process." RAGS Volume 1, Community Involvement in Superfund Risk Assessments. "Clearly and concisely communicating the relevant results of the risk assessment can be one of the most important aspects of the entire RI/FS." Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A) (December

[91] EPA/Army Corps of Engineers, Housatonic River HHRA, attached at Tab 46, pp. 7-8, 7-30 (2005).

1989), Section 9.1.1. Having a BHHRA complete with a table of contents, executive summary and conclusion is essential to making the risk assessment as user friendly as possible. It is not reasonable to expect interested stakeholders and members of the general public to read every page of the risk assessment. It is also likely that certain parties will have a specific interest in the human health risk assessment, and not rely on, or even know to go to, the Remedial Investigation Report to find a summary of the key findings in the human health risk assessment.

RAGS, Volume 1, Human Health Evaluation Manual (Part A) also points out that "A consistent format for all Superfund risk assessments is strongly recommended … ." It appears that EPA risk assessments for most, if not all, of the large sediment Superfund sites have a table of contents, executive summary and conclusion. Examples include:

- Lower Duwamish Waterway Remedial Investigation. Appendix B. Baseline Human Health Risk Assessment. November 2007.
- Human Health Risk Assessment for the Coeur d'Alene Basin Extending from Harrison to Mullan on the Coeur d'Alene River and Tributaries. June 2001.
- Phase 2 Report, Further Site Characterization and Analysis, Volume 2F, Revised Human Health Risk Assessment, Hudson River PCBs Reassessment RI/FS. November 2000.
- Phase 1 Human Health Risk Assessment for Rest of the River. Housatonic River, Mass. November 2001.

EPA itself has previously stated that the Portland Harbor risk assessment reports "should each include a comprehensive executive summary."[92]

Removing these convenient summaries of the risk assessment from the document itself makes the BHHRA less, not more, "understandable to the general public." The table of contents, executive summary and conclusion sections should be returned to the BHHRA.

D. EPA should confirm the agreements made on the BHHRA during the informal negotiation period.

Following the LWG's initiation of dispute resolution proceedings on July 23, 2012, EPA and the LWG engaged in informal negotiations on the content of the BHHRA until September 14, 2012. Through these informal negotiations, EPA and the LWG were able to resolve the vast majority of EPA's June 22 directed revisions to the BHHRA. These agreements are reflected in the September 17, 2012 EPA/LWG redline attached as Exhibit 1 to this letter, and in Tables 1 and 2. The LWG requests that EPA confirm that the final BHHRA will reflect the progress made in the informal negotiations by accepting these agreed revisions. To the extent that EPA does not adopt these resolutions, the LWG reserves the right to provide supplemental information demonstrating that EPA's June 2012 directed revisions identified in the tables are either inaccurate, inconsistent with guidance, or otherwise inappropriate.

[92] EPA Comments on Comprehensive Round 2 Site Summary and Data Gaps Report, January 15, 2008, attached at Tab 28, comment 4.

III. EPA's unilateral June 2012 BHHRA revisions are neither consistent with the terms of the Consent Order nor with prior EPA-LWG practice and threaten a successful conclusion to both the Portland Harbor RI/FS and RD/RA process.

As is no doubt abundantly clear from the foregoing sections of this Notice, the LWG not only disputes the substance of a number of the changes that EPA made to the May 2011 draft final BHHRA and the notice of noncompliance, but also takes the position that the manner in which the changes took place, without prior warning or discussion and a virtual re-write of the document, are neither consistent with the terms of the Consent Order nor with the process which has developed since the Consent Order was signed in 2001.

One of the most important reasons that potentially responsible parties enter into consent orders with EPA to conduct remedial investigations and feasibility studies at Superfund sites is so that the PRPs can be in charge of drafting the documents upon which the remedial decision will be made. To be sure, the PRPs do not enter into the Consent Order thinking that they have a free hand. Both they and the consultants retained to conduct the work must be "qualified to perform properly and promptly the actions set forth in this Consent Order."[93] In addition, there are specific instructions that the activities and deliverables undertaken must be in accordance with CERCLA, the NCP and EPA guidance documents.[94] Finally, the Consent Order provides for EPA supervision of the process including the right to comment on, modify and direct changes to the documents.[95] Nevertheless, the thread that runs through the Consent Order and upon which the whole process is built is that as long as the PRPs follow the terms of the Consent Order, the SOW, CERCLA, the NCP, EPA guidance documents and apply sound science, EPA will not unilaterally substitute its own language into the deliverables. If this were not the case, PRPs would have no incentive to enter into these consent orders.

For nearly a dozen years, EPA and the LWG have successfully followed the same basic procedure to finalize work plans, reports and other deliverables. Under the Consent Order, the LWG prepares the first draft of the document. EPA reviews and provides comments on the document, typically identifying certain of those comments as directive. EPA and the LWG meet and attempt to agree on resolutions to EPA's comments, and agreements reached are memorialized in writing. If the LWG continues to disagree with any EPA comment, EPA, in its discretion, decides whether to issue the LWG a final direction to incorporate the comment in a revised deliverable. Then, the LWG either revises the document or may invoke the dispute resolution process of the Consent Order.[96]

---

[93] Consent Order §VII.1 and 2.
[94] Consent Order §VII.3.
[95] Consent Order §IX.1 and 4.
[96] Not coincidentally, this is exactly in line with the process envisioned by the Consent Order. The LWG "conduct(s) activities and submit(s) deliverables" as provided in the Scope of Work. Consent Order, §VII.3. EPA may "comment, modify, and direct changes for all deliverables in writing. Consent Order, §IX.1. EPA is to "meet with the Respondents in an effort to resolve disputes" on its comments. *Id.* Then, "[a]t EPA's discretion, Respondents must fully correct all deficiencies and incorporate and integrate all information and comments supplied by EPA either in subsequent or resubmitted deliverables within a time frame specified by EPA." *Id.*

EPA's decision, without warning, to completely rewrite the BHHRA is a dramatic departure from the collaborative working relationship the parties have cultivated. We could understand this, perhaps, if our May 2011 draft final BHHRA flagrantly defied important EPA directives, or if the contents of the draft final BHHRA somehow impeded the quality or timeliness of the Portland Harbor cleanup.[97] As discussed above, however, EPA has identified only three directive comments with which it alleges the LWG has not complied. In one case, EPA left the LWG's supposedly non-compliant revision in its June 2012 directed redline of the BHHRA; in the other two, although the LWG made the actual changes directed by the comment itself, EPA argues that the LWG should have been spurred by the comment to make additional revisions not actually discussed in the comment. And there was no impact on the quality and timeliness of the cleanup. EPA has acknowledged that the numerical calculations and technical findings of the document are accurate, and EPA directed the LWG to proceed with the draft feasibility study based on the May 2011 draft final BHHRA, so any final revisions were clearly not a critical path item. We note that EPA had the draft final BHHRA under review for nearly 14 months before providing its directed revisions.

We understand that EPA needs flexibility to respond to changed circumstances, and that EPA has the authority to correct perceived deficiencies even late in the process, but we do not understand why EPA believed it necessary or useful to make such sweeping unilateral revisions to the BHHRA without any advance warning or explanation to the LWG.

When EPA takes over a deliverable, the guidance directs clear communication to the PRPs: "All such responses should clearly tell the PRPs both what EPA is requiring of them pursuant to the enforcement instrument and the consequences of failing to comply. Clear communication with PRPs facilitates timely compliance, reduces the likelihood of disputes, and creates a record for any subsequent enforcement."[98] Here, EPA specifically assured us that it was <u>not</u> taking over the BHHRA. In a July 22, 2011 email, EPA noted that "there is some confusion about the intent of EPA's request" and stated "It is not EPA's intent to take over the risk assessment from the LWG." Rather, EPA believed it would be "most efficient" for EPA to put its final comments into the Word version of the document in red-line format. Based on this assurance, and the ensuing silence for the following 11 months, the LWG believed that there were no significant issues with the document.

As we stated in our July 23 letter, we believe that EPA's change of its prior negotiated and approved approach to developing the BHHRA is inconsistent with the terms of the Consent Order. In addition, its abandonment of existing agreements with the LWG constitutes arbitrary and capricious agency action in violation of the Administrative Procedure Act. "[A]n agency acts arbitrarily and capriciously when it abruptly departs from a position it previously held without satisfactorily explaining its reason for doing so." *Wisconsin Valley Improvement Company v.*

---

[97] *See, e.g.,* June 30, 2011 EPA Memorandum, Options for Responding to Deficient Deliverables from PRPs, attached at Tab 41. If a performing party submits a revised document that does not "fully reflect EPA's direction for changes," EPA can take the extreme step of taking over the document. *Id.* at pp. 1-2. EPA guidance sets forth the three factors that should be considered in evaluating whether to take this step: (1) "the past compliance history of the PRPs"; (2) "the degree of deficiency of the submitted deliverable"; and (3) "the impact of the deliverable on the quality and timeliness of the cleanup." *Id.* at p. 2.
[98] *Id.* at 2.

Federal Energy Regulatory Commission, 236 F. 3d 738, 748 (D.C. Cir. 2001). Through the informal negotiation period, we have heard some of the reasons EPA thought it necessary to entirely rewrite the BHRRA without regard for the parties' painstakingly detailed negotiation of the document. Without commenting on the adequacy of those explanations, EPA should have provided those explanations before it directed wholesale changes to the BHHRA, and certainly before it found the LWG in violation of the Consent Order for submitting the revised document we agreed to submit.

The Portland Harbor Superfund process has a long way to go. EPA and the LWG still have to finalize the baseline ecological risk assessment, the remedial investigation and the feasibility study. Once EPA makes the decision on the remedy, someone will have to do the remedial design and conduct the remedial action. We are extremely concerned that the collapse of the working relationship between EPA and the LWG signaled by EPA's directed revisions to the agreed content of the draft final BHHRA will significantly impact EPA's ability to build the much larger coalition of performing and funding parties that will be necessary to implement a Portland Harbor remedy. Especially in the current economic climate, we encourage EPA to think carefully before creating additional obstacles to cleanup. We also believe that EPA should honor its agreements with the LWG, or, if changed circumstances or other problems require it to change its position, EPA should explain its change of position and attempt to reach a new agreement with the LWG before taking over the document or directing wholesale revisions.

Given the many years of work that remain on this project, the LWG requests that the ECL Director commit to meet with the LWG Senior Management and to establish a mutually-agreed upon set of documented protocols to guide a better working relationship such that EPA can successfully manage the RI/FS through to completion and facilitate a solid partnership with the responsible parties to clean up Portland Harbor. These working protocols should respect EPA's role as the decision maker responsible for ensuring protection of human health and the environment, respect the expertise of the consultants working on the project, and also respect the significant time, money and good faith expended by the parties that volunteered to work with EPA on the RI/FS over the past 12 years.

Conclusion

For all of the reasons discussed in this letter, we believe that the LWG met its obligations under the Consent Order by submitting a draft final BHHRA consistent with the agreed resolution of over 200 EPA comments. We further believe that EPA's June 2012 directed redline regarding RME is inconsistent with EPA guidance and should be retracted, and that the final BHHRA should include factual information that provides context for the exposure scenarios and include an executive summary, table of contents and conclusions. Therefore, we ask that you:

1. Withdraw the June 22, 2012 notice of noncompliance with the Consent Order and the June 29, 2012 threat to issue stipulated penalties;

ED_000959_NSF_00054720-00033 06/25/2019 SEMS_0306000

2. Retract EPA's directions on the reasonable maximum exposure (RME) case for fish consumption and direct staff to work with the LWG on development of an RME case that is consistent with guidance, as outlined above;

3. Direct EPA staff to insert relevant factual information into the exposure assessment and risk characterization sections of the BHHRA regarding the drinking water scenario and clam consumption scenario;

4. Reverse EPA's decision to remove a table of contents, executive summary, and conclusion section from the BHHRA;

5. Approve the agreed revisions reflected in Exhibit 1 and Tables 1 and 2 to be incorporated into the BHHRA; and

6. Commit to meet with the LWG Senior Management and to establish a mutually-agreed upon set of documented protocols to guide a better working relationship between the LWG and EPA such that EPA can successfully manage the RI/FS through to completion and facilitate a solid partnership with the responsible parties to clean up Portland Harbor.

Sincerely,

The Lower Willamette Group

cc: Lori Cora, U.S. EPA Region 10, Office of Regional Counsel
Kristine Koch, U.S. EPA Region 10, Office of Environmental Cleanup
Chip Humphrey, U.S. EPA Region 10, Office of Environmental Cleanup
Elizabeth Allen, U.S. EPA Region 10, Office of Environmental Assessment

Enclosures:
Exhibit 1: September 17, 2002 EPA/LWG redline of BHHRA
Table 1: LWG Comments on EPA BHHRA Requiring Discussion with EPA - Status
Table 2: LWG Comments on EPA BHHRA Do Not Require Discussion - Status
Table 3: LWG Response to Basis For Notice of Noncompliance
Table 4: Summary of Risk Assessments At Other Freshwater Sediment Superfund Sites
Table 5: LWG Proposed BHHRA Revisions re: Exposure Scenario Context Information
Reference Material on CD

ED_000959_NSF_00054720-00034 06/25/2019 SEMS_0306001

PORTLAND HARBOR RI/FS

FINAL REMEDIAL INVESTIGATION REPORT

APPENDIX F

BASELINE HUMAN HEALTH RISK ASSESSMENT

FINAL

, 2012

TABLE OF CONTENTS

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00036 06/25/2019 SEMS_0306003

LIST OF ATTACHMENTS

Attachment F1 Decisions Involving the EPA Regarding the BHHRA Methods

Attachment F2 Summary of Data Management and Data Use Rules for BHHRA

Attachment F3 Risks From Exposures to PBDEs

Attachment F4 ProUCL Software Output From the Calculation of 95 percent UCLs

Attachment F5 Supporting Documentation for the Calculation of Blood Lead Concentrations for Relevant BHHRA Scenarios

Attachment F6 Supporting Documentation for the Uncertainty and Variability Analysis

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00037 06/25/2019 SEMS_0306004

LIST OF TABLES

Comment [KJ1]: The tribal fish consumption tables were deleted. EPA agreed to include the tables.

Table 2-1 BHHRA Data From Within Study Area, Summarized by Matrix
Table 2-2 BHHRA Data From Outside of Study Area, Summarized by Matrix
Table 2-3 Summary of BHHRA Sediment Data From Within Study Area
Table 2-4 Summary of BHHRA Sediment Data From Outside Of Study Area
Table 2-5 Summary of BHHRA Surface Water And Groundwater Seep Data From Within Study Area
Table 2-6 Summary of BHHRA Surface Water Data From Outside Of Study Area
Table 2-7 Summary of BHHRA Tissue Data From Within Study Area
Table 2-8 Summary of BHHRA Tissue Data From Outside Of Study Area
Table 2-9 Occurrence, Distribution, and Selection of Chemicals of Potential Concern - Industrial Use Beach Sediment
Table 2-10 Occurrence, Distribution, and Selection of Chemicals of Potential Concern - Sediment at Beaches Used for Recreation, by Transients, and/or by Fishers
Table 2-11 Occurrence, Distribution, and Selection of Chemicals of Potential Concern - In-water Sediment
Table 2-12 Summary of Samples Used in the Selection of Chemicals of Potential Concern for Surface Water Exposure Scenarios
Table 2-13 Occurrence, Distribution, and Selection of Chemicals of Potential Concern - Surface Water, Direct Contact With Divers
Table 2-14 Occurrence, Distribution, and Selection of Chemicals of Potential Concern - Surface Water, Direct Contact With Transients or Beach Users
Table 2-15 Occurrence, Distribution, and Selection of Chemicals of Potential Concern - Groundwater Seep
Table 2-16 Occurrence, Distribution, and Selection of Chemicals of Potential Concern - Untreated Surface Water as a Hypothetical Domestic Water Source
Table 3-1 Selection of Exposure Pathways
Table 3-2 Exposure Point Concentration Summary - Industrial Beach Sediment
Table 3-3 Exposure Point Concentration Summary - Transient, Recreational Users, and Bank Fishers Beach Sediment
Table 3-4 Exposure Point Concentration Summary - In-water Sediment
Table 3-5 Summary of Samples Used in the Calculation of Exposure Point Concentrations for Surface Water Scenarios
Table 3-6 Exposure Point Concentration Summary - Surface Water, Transient Use

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00038 06/25/2019 SEMS_0306005

Table 3-7 Exposure Point Concentration Summary - Surface Water, Recreational Use
Table 3-8 Exposure Point Concentration Summary - Surface Water, Diver Use
Table 3-9 Exposure Point Concentration Summary - Surface Water, Residential Use as a Domestic Water Source
Table 3-10 Exposure Point Concentration Summary - Groundwater Seep
Table 3-11 Exposure Point Concentration Summary - Smallmouth Bass, by River Mile
Table 3-12 Exposure Point Concentration Summary - Smallmouth Bass, Study Area-Wide
Table 3-13 Exposure Point Concentration Summary - Common Carp, by Fishing Zone
Table 3-14 Exposure Point Concentration Summary - Common Carp, Study Area-Wide
Table 3-15 Exposure Point Concentration Summary - Brown Bullhead, by Fishing Zone
Table 3-16 Exposure Point Concentration Summary - Brown Bullhead, Study Area-Wide
Table 3-17 Exposure Point Concentration Summary - Black Crappie, by Fishing Zone
Table 3-18 Exposure Point Concentration Summary - Black Crappie, Study Area-Wide
Table 3-19 Exposure Point Concentration Summary - Pacific Lamprey Tissue
Table 3-20 Exposure Point Concentration Summary - Sturgeon Tissue
Table 3-21 Exposure Point Concentration Summary - Adult Chinook Tissue
Table 3-22 Exposure Point Concentration Summary - Crayfish, by Station
Table 3-23 Exposure Point Concentration Summary - Crayfish, Study Area-Wide
Table 3-24 Exposure Point Concentration Summary - Clam, by River Mile
Table 3-25 Exposure Point Concentration Summary - Clam, Study Area-Wide
Table 3-26 Values for Daily Intake Calculations - Beach Sediment Exposures
Table 3-27 Values for Daily Intake Calculations - In-water Sediment Exposures
Table 3-28 Values for Daily Intake Calculations - Surface Water and Groundwater Seep Exposures
Table 3-29 Values for Daily Intake Calculations - Tissue Exposures
Table 3-30 Values for Daily Intake Calculations - Hypothetical Domestic Water Exposures

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00039 06/25/2019 SEMS_0306006

Table 3-31 Chemical-Specific Dermal Absorption Factors for Sediment Contact

Table 3-32 Chemical-Specific Parameters for Dermal Exposure to Surface Water and Groundwater Seeps

Table 3-33 Chemical-Specific Parameters for Dermal Exposure to Surface Water as a Hypothetical Domestic Water Source

Table 4-1 Cancer Toxicity Data - Oral/Dermal

Table 4-2 Noncancer Toxicity Data - Oral/Dermal

Table 4-3 Toxic Equivalency Factors

Table 5-1 Toxicity Endpoints for BHHRA COPCs

Table 5-2 Calculation of Cancer Risks and Noncancer Hazard Quotients - Dockside Worker, Beach Sediment Exposure, Reasonable Maximum Exposure

Table 5-3 Calculation of Cancer Risks and Noncancer Hazard Quotients - Dockside Worker, Beach Sediment Exposure, Central Tendency Exposure

Table 5-4 Calculation of Cancer Risks and Noncancer Hazard Quotients - Transient, Beach Sediment Exposure, Reasonable Maximum Exposure

Table 5-5 Calculation of Cancer Risks and Noncancer Hazard Quotients - Transient, Beach Sediment Exposure, Central Tendency Exposure

Table 5-6 Calculation of Cancer Risks and Noncancer Hazard Quotients - Adult Beach User, Beach Sediment Exposure, Reasonable Maximum Exposure

Table 5-7 Calculation of Cancer Risks and Noncancer Hazard Quotients - Adult Beach User, Beach Sediment Exposure, Central Tendency Exposure

Table 5-8 Calculation of Cancer Risks and Noncancer Hazard Quotients - Child Beach User, Beach Sediment Exposure, Reasonable Maximum Exposure

Table 5-9 Calculation of Cancer Risks and Noncancer Hazard Quotients - Child Beach User, Beach Sediment Exposure, Central Tendency Exposure

Table 5-10 Calculation of Cancer Risks – Combined Child and Adult Beach User, Beach Sediment Exposure, Reasonable Maximum Exposure

Table 5-11 Calculation of Cancer Risks – Combined Child and Adult Beach User, Beach Sediment Exposure, Central Tendency Exposure

Table 5-12 Calculation of Cancer Risks and Noncancer Hazard Quotients - Tribal Fisher, Beach Sediment Exposure, Reasonable Maximum Exposure

Table 5-13 Calculation of Cancer Risks and Noncancer Hazard Quotients - Tribal Fisher, Beach Sediment Exposure, Central Tendency Exposure

Table 5-14 Calculation of Cancer Risks and Noncancer Hazard Quotients - High-Frequency Fisher, Beach Sediment Exposure, Reasonable Maximum Exposure

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00040 06/25/2019 SEMS_0306007

Table 5-15 Calculation of Cancer Risks and Noncancer Hazard Quotients - High-Frequency Fisher, Beach Sediment Exposure, Central Tendency Exposure

Table 5-16 Calculation of Cancer Risks and Noncancer Hazard Quotients - Low-Frequency Fisher, Beach Sediment Exposure, Reasonable Maximum Exposure

Table 5-17 Calculation of Cancer Risks and Noncancer Hazard Quotients - Low-Frequency Fisher, Beach Sediment Exposure, Central Tendency Exposure

Table 5-18 Calculation of Cancer Risks and Noncancer Hazard Quotients – Breastfeeding Infant of Dockside Worker, Beach Sediment Exposure, Reasonable Maximum Exposure

Table 5-19 Calculation of Cancer Risks and Noncancer Hazard Quotients – Breastfeeding Infant of Dockside Worker, Beach Sediment Exposure, Central Tendency Exposure

Table 5-20 Summary of Risks From Exposures to Beach Sediment

Table 5-21 Calculation of Cancer Risks and Noncancer Hazard Quotients - In-water Worker, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-22 Calculation of Cancer Risks and Noncancer Hazard Quotients - In-water Worker, In-water Sediment Exposure, Central Tendency Exposure

Table 5-23 Calculation of Cancer Risks and Noncancer Hazard Quotients - Tribal Fisher, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-24 Calculation of Cancer Risks and Noncancer Hazard Quotients - Tribal Fisher, In-water Sediment Exposure, Central Tendency Exposure

Table 5-25 Calculation of Endpoint-Specific Hazard Indices - Tribal Fisher, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-26 Calculation of Cancer Risks and Noncancer Hazard Quotients - High-Frequency Fisher, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-27 Calculation of Cancer Risks and Noncancer Hazard Quotients - High-Frequency Fisher, In-water Sediment Exposure, Central Tendency Exposure

Table 5-28 Calculation of Endpoint-Specific Hazard Indices - High-Frequency Fisher, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-29 Calculation of Cancer Risks and Noncancer Hazard Quotients - Low-Frequency Fisher, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-30 Calculation of Cancer Risks and Noncancer Hazard Quotients - Low-Frequency Fisher, In-water Sediment Exposure, Central Tendency Exposure

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00041 06/25/2019 SEMS_0306008

Table 5-31 Calculation of Cancer Risks and Noncancer Hazard Quotients - Commercial Diver in Wet Suit, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-32 Calculation of Cancer Risks and Noncancer Hazard Quotients - Commercial Diver in Wet Suit, In-water Sediment Exposure, Central Tendency Exposure

Table 5-33 Calculation of Cancer Risks and Noncancer Hazard Quotients - Commercial Diver in Dry Suit, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-34 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of In-water Worker, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-35 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of In-water Worker, In-water Sediment Exposure, Central Tendency Exposure

Table 5-36 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Tribal Fisher, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-37 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Tribal Fisher, In-water Sediment Exposure, Central Tendency Exposure

Table 5-38 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of High-Frequency Fisher, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-39 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of High-Frequency Fisher, In-water Sediment Exposure, Central Tendency Exposure

Table 5-40 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Low-Frequency Fisher, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-41 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Low-Frequency Fisher, In-water Sediment Exposure, Central Tendency Exposure

Table 5-42 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Commercial Diver in Wet Suit, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-43 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Commercial Diver in Wet Suit, In-water Sediment Exposure, Central Tendency Exposure

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00042 06/25/2019 SEMS_0306009

Table 5-44 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Commercial Diver in Dry Suit, In-water Sediment Exposure, Reasonable Maximum Exposure

Table 5-45 Summary of Risks From Exposures to In-water Sediment

Table 5-46 Calculation of Cancer Risks and Noncancer Hazard Quotients - Transient, Surface Water Exposure, Reasonable Maximum Exposure

Table 5-47 Calculation of Cancer Risks and Noncancer Hazard Quotients - Transient, Surface Water Exposure, Central Tendency Exposure

Table 5-48 Calculation of Cancer Risks and Noncancer Hazard Quotients - Adult Recreational Beach User, Surface Water Exposure, Reasonable Maximum Exposure

Table 5-49 Calculation of Cancer Risks and Noncancer Hazard Quotients - Adult Recreational Beach User, Surface Water Exposure, Central Tendency Exposure

Table 5-50 Calculation of Cancer Risks and Noncancer Hazard Quotients - Child Recreational Beach User, Surface Water Exposure, Reasonable Maximum Exposure

Table 5-51 Calculation of Cancer Risks and Noncancer Hazard Quotients - Child Recreational Beach User, Surface Water Exposure, Central Tendency Exposure.

Table 5-52 Calculation of Cancer Risks – Combined Child and Adult Recreational Beach User, Surface Water Exposure, Reasonable Maximum Exposure

Table 5-53 Calculation of Cancer Risks – Combined Child and Adult Recreational Beach User, Surface Water Exposure, Central Tendency Exposure.

Table 5-54 Calculation of Cancer Risks and Noncancer Hazard Quotients - Commercial Diver in Wet Suit, Surface Water Exposure, Reasonable Maximum Exposure

Table 5-55 Calculation of Cancer Risks and Noncancer Hazard Quotients - Commercial Diver in Wet Suit, Surface Water Exposure, Central Tendency Exposure

Table 5-56 Calculation of Cancer Risks and Noncancer Hazard Quotients - Commercial Diver in Dry Suit, Surface Water Exposure, Reasonable Maximum Exposure

Table 5-57 Calculation of Cancer Risks and Noncancer Hazard Quotients - Adult Resident, Potential Future Domestic Water Use, Reasonable Maximum Exposure

Table 5-58 Calculation of Cancer Risks and Noncancer Hazard Quotients - Adult Resident, Potential Future Domestic Water Use, Central Tendency Exposure

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00043 06/25/2019 SEMS_0306010

Table 5-59 Calculation of Cancer Risks and Noncancer Hazard Quotients - Child Resident, Potential Future Domestic Water Use, Reasonable Maximum Exposure

Table 5-60 Calculation of Cancer Risks and Noncancer Hazard Quotients - Child Resident, Potential Future Domestic Water Use, Central Tendency Exposure

Table 5-61 Calculation of Cancer Risks – Combined Child and Adult Resident, Potential Future Domestic Water Use, Reasonable Maximum Exposure

Table 5-62 Calculation of Cancer Risks– Combined Child and Adult Resident, Potential Future Domestic Water Use, Central Tendency Exposure

Table 5-63 Summary of Risks From Exposures to Surface Water

Table 5-64 Calculation of Cancer Risks and Noncancer Hazard Quotients - Transient, Groundwater Seep Exposure, Reasonable Maximum Exposure

Table 5-65 Calculation of Cancer Risks and Noncancer Hazard Quotients - Transient, Groundwater Seep Exposure, Central Tendency Exposure

Table 5-66 Summary of Risks From Exposures to a Groundwater Seep

Table 5-74 Calculation of Cancer Risks and Noncancer Hazard Quotients – Adult Recreational Fishers, Single Species Diet Fish Consumption, Smallmouth Bass - Reasonable Maximum Exposure

Table 5-75 Calculation of Endpoint-Specific Hazard Indices – Adult Recreational Fishers, Single Species Diet Fish Consumption, Smallmouth Bass - Central Tendency Exposure

Table 5-76 Calculation of Endpoint-Specific Hazard Indices – Adult Recreational Fishers, Single Species Diet Fish Consumption, Smallmouth Bass, Reasonable Maximum Exposure

Table 5-77 Calculation of Endpoint-Specific Hazard Indices – Adult Subsistence Fishers, Single Species Diet Fish Consumption, Smallmouth Bass - Reasonable Maximum Exposure

Table 5-78 Calculation of Cancer Risks and Noncancer Hazard Quotients - Adult, Fish Consumption, Single Species Diet, Common Carp

Table 5-79 Calculation of Endpoint–Specific Hazard Indices – Adult Recreational Fishers, Single Species Diet Fish Consumption, Common Carp – Central Tendency Exposure

Table 5-80 Calculation of Endpoint-Specific Hazard Indices – Adult Recreational Fishers, Single Species Diet Fish Consumption, Common - Reasonable Maximum Exposure

Comment [KJ2]: The term "Potential Future" should be used.

In addition the title of the scenario, there are additional issues related to the discussion of the scenario that are unresolved.

Table 5-81 Calculation of Endpoint-Specific Hazard Indices – Adult Subsistence Fishers, Single Species Diet Fish Consumption, Common - Reasonable Maximum Exposure

Table 5-82 Calculation of Cancer Risks and Noncancer Hazard Quotients - Adult, Fish Consumption, Single Species Diet, Brown Bullhead

Table 5-83 Calculation of Endpoint-Specific Hazard Indices – Adult Recreational Fishers, Fish Single Species Diet Consumption, Brown Bullhead - Central Tendency Exposure

Table 5-84 Calculation of Endpoint-Specific Hazard Indices – Adult Recreational Fishers, Single Species Diet Fish Consumption, Brown Bullhead – Reasonable Maximum Exposure

Table 5-85 Calculation of Endpoint-Specific Hazard Indices – Adult Subsistence Fishers, Single Species Diet Fish Consumption, Brown Bullhead – Reasonable Maximum Exposure

Table 5-86 Calculation of Cancer Risks and Noncancer Hazard Quotients - Adult, Fish Consumption, Single Species Diet, Black Crappie

Table 5-87 Calculation of Endpoint-Specific Hazard Indices – Adult Recreational Fishers, Single Species Diet Fish Consumption, Black Crappie - Central Tendency Exposure

Table 5-88 Calculation of Endpoint-Specific Hazard Indices – Adult Recreational Fishers, Single Species Diet Fish Consumption, Black Crappie - Reasonable Maximum Exposure

Table 5-89 Calculation of Endpoint-Specific Hazard Indices – Adult Subsistence Fishers, Single Species Diet Fish Consumption, Black Crappie - Reasonable Maximum Exposure

Table 5-90 Calculation of Cancer Risks and Noncancer Hazard Quotients - Adult, Fish Consumption, Multi-Species Diet

Table 5-91 Calculation of Endpoint-Specific Hazard Indices – Adult Recreational Fishers, Multi-Species Diet Fish Consumption. - Central Tendency Exposure

Table 5-92 Calculation of Endpoint-Specific Hazard Indices – Adult Recreational Fishers, Multi-Species Diet Fish Consumption – Reasonable Maximum Exposure

Table 5-93 Calculation of Endpoint-Specific Hazard Indices – Adult Subsistence Fishers, Multi-Species Diet Fish Consumption – Reasonable Maximum Exposure

Table 5-94 Calculation of Cancer Risks and Noncancer Hazard Quotients - Child, Fish Consumption, Single Species Diet, Smallmouth Bass

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00045 06/25/2019 SEMS_0306012

Table 5-95 Calculation of Endpoint-Specific Hazard Indices – Child Recreational Fishers, Single Species Diet Fish Consumption, Smallmouth Bass – Central Tendency Exposure

Table 5-96 Calculation of Endpoint-Specific Hazard Indices – Child Recreational Fishers, Single Species Diet Fish Consumption, Smallmouth – Reasonable Maximum Exposure

Table 5-97 Calculation of Endpoint-Specific Hazard Indices – Child Subsistence Fishers, Single Species Diet Fish Consumption, Smallmouth - Reasonable Maximum Exposure

Table 5-98 Calculation of Cancer Risks and Noncancer Hazard Quotients - Child, Fish Consumption, Single Species Diet, Common Carp

Table 5-99 Calculation of Endpoint-Specific Hazard Indices – Child Recreational Fishers, Single Species Diet Fish Consumption, Common Carp – Central Tendency Exposure

Table 5-100 Calculation of Endpoint-Specific Hazard Indices – Child Recreational Fishers, Single Species Diet Fish Consumption, Common Carp – Reasonable Maximum Exposure

Table 5-101 Calculation of Endpoint-Specific Hazard Indices – Child Subsistence Fishers, Single Species Diet Fish Consumption, Common Carp – Reasonable Maximum Exposure

Table 5-102 Calculation of Cancer Risks and Noncancer Hazard Quotients - Child, Fish Consumption, Single Species Diet, Brown Bullhead

Table 5-103 Calculation of Endpoint-Specific Hazard Indices – Child Recreational Fishers, Single Species Diet Fish Consumption, Brown Bullhead – Central Tendency Exposure

Table 5-104 Calculation of Endpoint-Specific Hazard Indices – Child Recreational Fishers, Single Species Diet Fish Consumption, Brown Bullhead, Reasonable Maximum Exposure

Table 5-105 Calculation of Endpoint-Specific Hazard Indices – Child Subsistence Fishers, Single Species Diet Fish Consumption, Brown Bullhead – Reasonable Maximum Exposure

Table 5-106 Calculation of Cancer Risks and Noncancer Hazard Quotients - Child, Fish Consumption, Single Species Diet, Black Crappie

Table 5-107 Calculation of Endpoint-Specific Hazard Indices – Child, Fish Consumption, Single Species Diet, Black Crappie – Central Tendency Exposure

Table 5-108 Calculation of Endpoint-Specific Hazard Indices – Child Recreational Fishers, Single Species Diet Fish Consumption, Black Crappie – Reasonable Maximum Exposure

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00046 06/25/2019 SEMS_0306013

Table 5-109 Calculation of Endpoint-Specific Hazard Indices – Child Subsistence Fishers, Single Species Diet Fish Consumption, Black Crappie – Reasonable Maximum Exposure

Table 5-110 Calculation of Cancer Risks and Noncancer Hazard Quotients - Child, Fish Consumption, Multi-Species Diet

Table 5-111 Calculation of Endpoint-Specific Hazard Indices – Child Recreational Fishers, Multi-Species Diet Fish Consumption – Central Tendency Exposure

Table 5-112 Calculation of Endpoint-Specific Hazard Indices – Child Recreational Fishers, Multi-Species Diet Fish Consumption – Reasonable Maximum Exposure

Table 5-113 Calculation of Endpoint-Specific Hazard Indices – Child Subsistence Fishers, Multi-Species Diet Fish Consumption – Reasonable Maximum Exposure

Table 5-114 Calculation of Cancer Risks - Combined Child and Adult, Single Species Diet Fish Consumption, Smallmouth Bass

Table 5-115 Calculation of Cancer Risks - Combined Child and Adult, Single Species Diet Fish Consumption, Common Carp

Table 5-116 Calculation of Cancer Risks - Combined Child and Adult, Single Species Diet Fish Consumption, Brown Bullhead

Table 5-117 Calculation of Cancer Risks - Combined Child and Adult, Single Species Diet Fish Consumption, Black Crappie

Table 5-118 Calculation of Cancer Risks - Combined Child and Adult, Multi-Species Diet Fish Consumption

Table 5-119 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Adult Consuming Fish, Single Species Diet, Smallmouth Bass

Table 5-120 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Adult Consuming Fish, Single Species Diet, Common Carp

Table 5-121 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Adult Consuming Fish, Single Species Diet, Brown Bullhead

Table 5-122 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Adult Consuming Fish, Single Species Diet, Black Crappie

Table 5-123 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Adult Consuming Fish, Multi-Species Diet

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00047 06/25/2019 SEMS_0306014

Table 5-124 Summary of Risks Due to Consumption of Whole Body Fish Tissue – Recreational/Subsistence Fishers

Table 5-125 Summary of Risks Due to Consumption of Fillet Fish Tissue – Recreational/Subsistence Fishers

Table 5-126 Calculation of Cancer Risks and Noncancer Hazard Quotients - Clam Consumption

Table 5-127 Calculation of Endpoint-Specific Hazard Indices - Clam Consumption (3.3 g/day Consumption Rate)

Table 5-128 Calculation of Endpoint-Specific Hazard Indices - Clam Consumption (18 g/day Consumption Rate)

Table 5-129 Calculation of Cancer Risks and Noncancer Hazard Quotients - Adult Crayfish Consumption

Table 5-130 Calculation of Endpoint-Specific Hazard Indices - Crayfish Consumption (3.3 g/day Consumption Rate)

Table 5-131 Calculation of Endpoint-Specific Hazard Indices - Crayfish Consumption, (18 g/day Consumption Rate)

Table 5-132 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Adult Who Consumes Clams

Table 5-133 Calculation of Cancer Risks and Noncancer Hazard Quotients - Breastfeeding Infant of Adult Who Consumes Crayfish

Table 5-134 Summary of Risks From Consumption of Shellfish

Table 5-xxx Chemicals Potentially Posing Unacceptable Risks for Human Health

Table 6-1 Uncertainties Evaluated in the Baseline Human Health Risk Assessment

Table 6-2 Comparison of Concentrations in Chinook Tissue Samples

Table 6-3 Mercury Concentrations in Fillet Tissue With and Without Skin For Samples Collected Within the Study Area

Table 6-4 Comparison of Detection Limits of Undetected Analytes in Sediment to LWG Analytical Concentration Goals

Table 6-5 Comparison of Detection Limits of Undetected Analytes in Fish and Shellfish Tissue to LWG Analytical Concentration Goals

Table 6-6 Comparison of Detection Limits of Undetected Analytes in the Groundwater Seep to LWG Analytical Concentration Goals

Table 6-7 Comparison of Detection Limits of Undetected Analytes in Human Health Surface Water Samples to LWG Analytical Concentration Goals

Table 6-8 Clam Samples Missing Analytes

Table 7-1 Chemicals Potentially Posing Unacceptable Risks for Human Health

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00048 06/25/2019 SEMS_0306015

LIST OF FIGURES

Figure 3-1 Human Health Risk Assessment Conceptual Site Model
Figure 5-1 Risk Contribution by Analyte and Cumulative Risks by Beach, Dockside Worker Exposure to Beach Sediment
Figure 5-2 Risk Contribution by Analyte, Adult Recreational Beach User Exposure to Beach Sediment
Figure 5-3 Cumulative Risks by Beach, Adult Recreational Beach User Exposure to Beach Sediment
Figure 5-4 Risk Contribution by Analyte, Child Recreational Beach User Exposure to Beach Sediment
Figure 5-5 Cumulative Risks by Beach, Child Recreational Beach User Exposure to Beach Sediment
Figure 5-6 Risk Contribution by Analyte, Tribal Fisher Exposure to Beach Sediment
Figure 5-7 Cumulative Risks by Beach, Tribal Fisher Exposure to Beach Sediment
Figure 5-8 Risk Contribution by Analyte, Tribal Fisher Consumption of Fish Tissue
Figure 5-9 Cumulative Risks by Tissue Type, Tribal Fisher Consumption of Fish Tissue
Figure 5-10 Risk Contribution by Analyte, Adult Fisher Consumption of Smallmouth Bass Fish Tissue
Figure 5-11 Cumulative Risks by Tissue Type, Adult Fisher Consumption of Smallmouth Bass Fish Tissue
Figure 5-12 Risk Contribution by Analyte, Adult Fisher Consumption of Common Carp Fish Tissue
Figure 5-13 Cumulative Risks by Tissue Type, Adult Fisher Consumption of Common Carp Fish Tissue
Figure 5-14 Risk Contribution by Analyte, Adult Fisher Consumption of Black Crappie Fish Tissue
Figure 5-15 Cumulative Risks by Tissue Type, Adult Fisher Consumption of Black Crappie Fish Tissue
Figure 5-16 Risk Contribution by Analyte, Adult Fisher Consumption of Brown Bullhead Fish Tissue
Figure 5-17 Cumulative Risks by Tissue Type, Adult Fisher Consumption of Brown Bullhead Fish Tissue

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00049 06/25/2019 SEMS_0306016

Figure 5-18 Cumulative Risks by Tissue Type, Adult Fisher Consumption of Clam Tissue

Figure 5-19 Risk Contribution by Analyte, Adult Fisher Consumption of Clam Tissue

Figure 5-20 Cumulative Risks by Tissue Type, Adult Fisher Consumption of Crayfish Tissue

Figure 5-21 Risk Contribution by Analyte, Adult Fisher Consumption of Crayfish Tissue

Figure 6-1 Concentration Ratios For Smallmouth Bass Collected at East and West Sides of River

Figure 7-1 Ranges of Mean Exposure Cumulative Cancer Risk, by Medium

Figure 7-2 Ranges of Mean Exposure Toxicity Endpoint-Specific Hazard Indexes, by Medium

Figure 7-3 Ranges of 95 percent UCL or Maximum Exposure Cancer Risk, by Medium

Figure 7-4 Ranges of 95 percent UCL or Maximum Exposure Toxicity Endpoint-Specific Hazard Indexes, by Medium

Figure 7-5 Relative Contribution of Individual Analytes to Cumulative Site-Wide Risk for Adult Fish Consumption Scenario

Figure 7-6 Relative Contribution of Individual Analytes to Cumulative Site-Wide Risk for Adult Tribal Fisher Scenario

LIST OF MAPS

Map 1-1. Study Area Boundary for Baseline Human Health Risk Assessment

Map 2-1. Designated Potential Human Use Areas and Associated Beach Sediment Sample Locations

Map 2-2. Sample Locations for Assessment of Direct Contact With In-water Sediment

Map 2-3. Sample Locations for Assessment of Direct Contact With Surface Water by Transients and Recreational Beach Users

Map 2-4. Sample Location for Assessment of Direct Contact With Surface Water by Divers

Map 2-5. Sample Locations for Assessment of Direct Contact With Groundwater Seep

Map 2-6. Sample Locations for Assessment of Smallmouth Bass and Carp Tissue ~~Ingestion~~Consumption

Map 2-7. Sample Locations for Assessment of Shellfish Tissue ~~Ingestion~~Consumption

Map 2-8. Sample Locations for Assessment of Surface Water for Hypothetical Future Domestic Use ~~(Untreated)~~

Map 5-1-1. Risks from Direct Contact With Beach Sediment, RME Scenarios

Map 5-1-2. Risks from Direct Contact With Beach Sediment, CT Scenarios

Map 5-2-1. Risks from Direct Contact with Beach Sediment Excluding Risk from Background Arsenic, RME Scenarios

Map 5-2-2. Risks from Direct Contact with Beach Sediment Excluding Risk from Background Arsenic, CT Scenarios

Map 5-3-1. Risks from Direct Contact with In-water Sediment, RME Scenarios

Map 5-3-2. Risks from Direct Contact with In-water Sediment, CT Scenarios

Map 5-4-1. Risks from Smallmouth Bass Tissue ~~Ingestion~~Consumption Scenarios, 142 g/day Consumption Rate

Map 5-4-2. Risks from Smallmouth Bass Tissue ~~Ingestion~~Consumption Scenarios, 73 g/day Consumption Rate

Map 5-4-3. Risks from Smallmouth Bass Tissue ~~Ingestion~~Consumption Scenarios, 17.5 g/day Consumption Rate

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00051 06/25/2019 SEMS_0306018

Map 5-5-1. Risks from Common Carp Tissue ~~Ingestion~~Consumption Scenarios, 142 g/day Consumption Rate

Map 5-5-2. Risks from Common Carp Tissue ~~Ingestion~~Consumption Scenarios, 73 g/day Consumption Rate

Map 5-5-3. Risks from Common Carp Tissue ~~Ingestion~~Consumption Scenarios, 17.5 g/day Consumption Rate

Map 5-6-1. Risks from Black Crappie Tissue ~~Ingestion~~Consumption Scenarios, 142 g/day Consumption Rate

Map 5-6-2. Risks from Black Crappie Tissue ~~Ingestion~~Consumption Scenarios, 73 g/day Consumption Rate

Map 5-6-3. Risks from Black Crappie Tissue ~~Ingestion~~Consumption Scenarios, 17.5 g/day Consumption Rate

Map 5-7-1. Risks from Brown Bullhead Tissue ~~Ingestion~~Consumption Scenarios, 142 g/day Consumption Rate

Map 5-7-2. Risks from Brown Bullhead Tissue ~~Ingestion~~Consumption Scenarios, 73 g/day Consumption Rate

Map 5-7-3. Risks from Brown Bullhead Tissue ~~Ingestion~~Consumption Scenarios, 17.5 g/day Consumption Rate

Map 5-8-1. Risks from Crayfish ~~Ingestion~~Consumption Scenarios, 18 g/day Consumption Rate

Map 5-8-2. Risks from Clam ~~Ingestion~~Consumption Scenarios, 18 g/day Consumption Rate

Map 5-8-3. Risks from Crayfish ~~Ingestion~~Consumption Scenarios, 3.3 g/day Consumption Rate

Map 5-8-4. Risks from Clam ~~Ingestion~~Consumption Scenarios, 3.3 g/day Consumption Rate

Map 5-9-1 Assessment of Potential Future Domestic Water Use~~Assessment for Drinking Water~~, RME ~~Scenarios~~

Map 5-9-2 ~~Assessment for Drinking Water~~ Assessment of Potential Future Domestic Water Use, CT ~~Scenarios~~

Comment [KJ3]: Consistent with tables, these should be titled "Assessment for Potential Future Domestic Water Use"

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00053 06/25/2019 SEMS_0306020

LIST OF ACRONYMS

ACG	analytical concentration goal
ADAF	age-dependent adjustment factor
ALM	Adult Lead Methodology
AOPC	Area of Potential Concern
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criteria
BEHP	Bis 2-ethylhexyl phthalate
BERA	baseline ecological risk assessment
BHHRA	baseline human health risk assessment
Cal EPA	California Environmental Protection Agency
CDC	Centers for Disease Control
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
cm/hr	centimeters per hour
CNS	central nervous system
COI	contaminant[1] of interest
COPC	contaminant1 of potential concern
CRITFC	Columbia River Inter-tribal Fish Commission
CSM	conceptual site model
CT	central tendency
DA_{event}	absorbed dose per event
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
delta-HCH	delta-hexachlorocyclohexane
DEQ	Oregon Department of Environmental Quality
DL	detection limit
DQO	data quality objective
E	east
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
EPD	effective predictive domain
FS	feasibility study
g/day	grams per day
GI	gastrointestinal
GSI	Groundwater Solutions, Inc.
HEAST	Health Effects Assessment Summary Table
HHRA	human health risk assessment

[1] Prior deliverables and some of the tables and figures attached to this document may use the ~~teRM~~ term "Chemical of Interest" or "Chemical of Potential Concern", which as the same meaning as "Contaminant of Interest" or "Contaminant of Potential Concern", respectively, and refers to "contaminants" as defined in 42 USC 9601(33).

HI	hazard index
HQ	hazard quotient
IEUBK	Integrated Exposure Uptake Biokinetic model3
IRAF	Infant Risk Adjustment Factor
IRIS	Integrated Risk Information System
ISA	initial study area
K_p	dermal permeability coefficient
L/day	liters per day
LADI	lifetime average daily intake
LOAEL	lowest observed adverse effects level
LWG	Lower Willamette Group
LWR	Lower Willamette River
□g/dL	microgram per deciliter
□g/kg	microgram per kilogram
□g/L	microgram per liter
MCL	Maximum Contaminant Level
MCPP	2-(4-Chloro-2-methylphenoxy)propanoic acid
mg/kg	milligram per kilogram
ml/day	milliliters per day
ml/hr	milliliters per hour
MRL	method reporting limit
NHANES	National Health and Nutrition Evaluation Survey
NLM	National Library of Medicine
OAR	Oregon Administrative Rules
ODFW	Oregon Department of Fish and Wildlife
ODHS	Oregon Department of Human Services
pg/g	picograms per gram
PAH	polycyclic aromatic hydrocarbon
PBDE	polybrominated diphenyl ether
PCB	polychlorinated biphenyl
PEF	potency equivalency factor
PPRTV	Provisional Peer Reviewed Toxicity Value
PRG	preliminary remediation goal
RBC	risk-based concentration
RfD	reference dose
RG	remediation goal
RI/FS	remedial investigation/feasibility study
RM	river mile
RME	reasonable maximum exposure
RSL	Regional Screening Level
SCRA	site characterization and risk assessment
SF	slope factor
STSC	Superfund Health Risk Technical Support Center
SVOC	semi-volatile organic compound
TCDD	tetrachlorodibenzo-p-dioxin

TEF	toxic equivalency factor
TEQ	toxic equivalent
TZW	transition zone water
UCL	upper confidence limit
USDA	United States Department of Agriculture
VOC	volatile organic compound
W	west
WHO	World Health Organization
XAD	XAD-2 Infiltrex™ 300 system

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00056 06/25/2019 SEMS_0306023

GLOSSARY

Term	Definition
bioaccumulation	the accumulation of a substance in an organism
bioconcentration factor	the concentration of a chemical in the tissues of an organism divided by the concentration in water
central tendency	a measure of the middle or expected value of a dataset
contaminant of concern	the subset of contaminants[2] of potential concern with exposure concentrations that exceed EPA target risk levels
contaminant of interest	contaminant2 detected in the Study Area for all exposure media (i.e., surface water, transition zone water, sediment, and tissue)
contaminant of potential concern	the subset of contaminants2 of interest with maximum detected concentrations that are greater than screening levels
composite sample	an analytical sample created by mixing together two or more individual samples; tissue composite samples are composed of two or more individual organisms, and sediment composite samples are composed of two or more individual sediment grab samples
conceptual site model	a description of the links and relationships between chemical sources, routes of release or transport, exposure pathways, and the human receptors at a site
congener	a specific chemical within a group of structurally related chemicals (e.g., PCB congeners)
human health risk assessment	a process to evaluate the likelihood that adverse effects to human health might occur or are occurring as a result of exposure to one or more contaminants
dose	the quantity of a contaminant taken in or absorbed at any one time, expressed on a body weight-specific basis; units are generally expressed as mg/kg bw/day
empirical data	data quantified in a laboratory
exposure assessment	the part of a risk assessment that characterizes the chemical exposure of a receptor

[2] Prior deliverables and some of the tables and figures attached to this document may use the terms "chemical of concern", "chemical of interest", or "chemical of potential concern", which has the same meaning as "contaminant of concern", "contaminant of interest", or "contaminant of potential concern", respectively, and refers to "contaminants" as defined in 42 USC 9601(33).

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00057 06/25/2019 SEMS_0306024

Term	Definition
exposure pathway	physical route by which a contaminant moves from a source to a human receptor
exposure point	the location or circumstances in which a human receptor is assumed to contact a contaminant
exposure point concentration	the value that represents the estimated concentration of a contaminant at the exposure point
exposure area	size of the area through which a receptor might come in contact with a contaminant as determined by human uses
hazard quotient	the quotient of the exposure level of a chemical divided by the toxicity value based on noncarcinogenic effects (i.e., reference dose)
predicted data	data not quantified in a laboratory but estimated using a model
reasonable maximum exposure	the maximum exposure reasonably expected to occur in a population
receptor	The exposed individual relative to the exposure pathway considered
risk	the likelihood that a specific human receptor experiences a particular adverse effect from exposure to contaminants from a hazardous waste site; the severity of risk increases if the severity of the adverse effect increases or if the chance of the adverse effect occurring increases. Specifically for carcinogenic effects, risk is estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. Specifically for noncarcinogenic (systemic) effects, risk is not expressed as a probability but rather is evaluated by comparing an exposure level over a period of time to a reference dose derived for a similar exposure period.
risk characterization	a part of the risk assessment process in which exposure and effects data are integrated in order to evaluate the likelihood of associated adverse effects
slope factor	toxicity value for evaluating the probability of an individual developing cancer from exposure to contaminant levels over a lifetime
Study Area	the portion of the Lower Willamette River that extends from River Mile 1.9 to River Mile 11.8

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00058 06/25/2019 SEMS_0306025

Term	Definition
toxic equivalency factor	numerical values developed by the World Health Organization that quantify the toxicity of dioxin, furan, and dioxin-like PCB congeners relative to 2,3,7,8-tetrachlorodibenzodioxin
transition zone water	Pore water associated with the upper layer of the sediment column; may contain both groundwater and surface water
uncertainty	a component of risk resulting from imperfect knowledge of the degree of hazard or of its spatial and temporal distribution
upper confidence limit on the mean	a high-end statistical measure of central tendency
variability	a component of risk resulting from true heterogeneity in exposure variables or responses, such as dose-response differences within a population or differences in contaminant levels in the environment

1.0 INTRODUCTION

This Baseline Human Health Risk Assessment (BHHRA) presents an evaluation of risks to human health at the Portland Harbor Superfund Site (Site) in Portland, Oregon. This BHHRA is intended to provide an ~~assessment~~analysis of baseline risks and help determine the need for action at the Site, and to provide risk managers with an understanding of the actual and potential risks to human health posed by the site and any uncertainties associated with the assessment~~of potential exposures baseline human health risks due to contaminants at the Site and to support risk management decisions.~~

Comment [KJ4]: The revisions to this paragraph were not discussed previously with the LWG; however, they are acceptable to the LWG.

Portland Harbor encompasses the Lower Willamette River (LWR) in Portland, Oregon, from the confluence with the Columbia to about River Mile (RM) 12. It has been the focus of numerous environmental investigations completed by the LWG and various other governmental and private entities. Major LWG data collection efforts occurred during four sampling rounds in the ~~Remedial Investigation/Feasibility Study (RI/FS) Study Area~~LWR from ~~(~~RM 0.8 to 12.2~~)~~ to characterize the physical system of the river and to assess the nature and extent of contamination in sediment, surface water, transition zone water, storm water, and biota.

The LWG has worked with the United States Environmental Protection Agency (EPA) to develop the methods and assumptions used in this BHHRA. Consistent with EPA guidance (1989), this BHHRA incorporates assumptions to provide a health protective assessment of risks associated with contaminants present at the Site. The risk assessment for Portland Harbor is a baseline risk assessment in that it evaluates human health risks and hazards associated with contamination in the absence of remedial actions or institutional controls.

This BHHRA is being conducted as part of the Remedial Investigation Report (RI Report) to evaluate potential adverse health effects caused by hazardous substance releases at the Site, consistent with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The BHHRA will be used to support the development of contaminant thresholds to be used as preliminary remediation goals (PRGs) for sediment. The PRGs will provide preliminary estimates of the long-terms goals to be achieved by any cleanup actions in Portland Harbor. During the feasibility study (FS) process, the PRGs will be refined based on background sediment quality, technical feasibility, and other risk management considerations. EPA will identify the final remediation goals (RGs) for the site in the Record of Decision, following completion of the FS.

1.1 OBJECTIVES

The general objective of a human health risk assessment in the CERCLA process is to provide an analysis of potential baseline risks to human health from site-related contaminants and help determine the need for remedial actions, provide a basis for determining contaminant concentrations that can remain onsite and still be protective of public health, and provide a basis for comparing the effectiveness of various remedial alternatives. To achieve the overall objectives, the general process of BHHRA is:

- Identify contaminants of potential concern (COPCs)[3]
- Identify potentially exposed populations and pathways of exposure to COPCs
- Characterize potentially exposed populations and estimate the extent of their exposure to COPCs
- Quantitatively characterize the noncarcinogenic and carcinogenic risks to the populations resulting from potential exposure to COPCs and identify contaminants potentially posing unacceptable risks
- Characterize uncertainties associated with this risk assessment
- Identify the contaminants and pathways that contribute the majority of the risk.

1.2 APPROACH

This BHHRA generally follows the approach that was documented in the Programmatic Work Plan (Integral et al. 2004) and subsequent interim deliverables. It also reflects numerous discussions and agreements on appropriate risk assessment techniques for the Site among interested parties, including the EPA, Oregon Department of Environmental Quality (DEQ), Oregon Department of Human Services (ODHS), and Native American Tribes.

Potential exposure pathways, populations, and exposure assumptions were originally identified in the Programmatic Work Plan and in subsequent direction from EPA. Additional assumptions for estimating the extent of exposure were provided in the Exposure Point Concentration Calculation Approach and Summary of Exposure Factors Technical Memorandum (Kennedy/Jenks Consultants 2006) and the Human Health Toxicity Values Interim Deliverable (Kennedy/Jenks Consultants 2004a). Specific documents related to the approach for this BHHRA are presented in Attachment F1. The BHHRA is based on EPA (1989, 1991b, 2001a, 2004, 2005a) and EPA Region 10 (2000a) guidance, and is also consistent with DEQ guidance (DEQ 2000a, 2010).

Comment [KJ5]: As agreed, the LWG will identify specific direction from EPA at other locations in the document during finalization.

[3] Prior deliverables and some of the tables and figures attached to this document may use the term~~RM~~ "Chemicals of potential concern," which has the same meaning as "Contaminants of potential concern" and refers to "contaminants" as defined in 42 USC 9601(33).

1.3 SITE BACKGROUND

The LWR extends from the Willamette's convergence with the Columbia River at river mile (RM) 0 upstream to the Willamette Falls at RM 26. Portland Harbor generally refers to a heavily industrialized reach of the LWR between RM 0 and RM 12, the extent of the navigation channel. Additional information on the environmental setting of Portland Harbor, including historical and current land use, regional geology and hydrogeology, surface water hydrology, the in-water physical system, habitat, and human access and use is provided in Section 3 of the RI Report. The approximate ~~11~~10-mile portion of Portland Harbor from RM ~~0.8~~1.9 to ~~12.2~~11.8 is referred to as the Study Area (Map 1-1). Because the Site boundaries have not yet been defined[4], this BHHRA focused on the Study Area, while also including data collected within the portion of the LWR that encompasses RMs 0.8 to 12.2.

Comment [KJ6]: The revisions to this sentence were not discussed previously with the LWG; however, they are acceptable to the LWG.

Portland Harbor and the Willamette River have served as a major industrial water corridor for more than a century. Industrial use of the Study Area and adjacent areas has been extensive. The majority of the Study Area is currently zoned for industrial land use and is designated as an "Industrial Sanctuary" (City of Portland 2006a). Much of the shoreline in the Study Area includes steeply sloped banks covered with riprap or constructed bulkheads, with human-made structures such as piers and wharves over the water in various locations. A comprehensive update of Portland's Willamette Greenway Plan and related land use policies and zoning (The River Plan) is underway, addressing all of the Willamette riverfront in Portland (City of Portland 2006b). The Willamette Greenway Plan addresses the quality of the natural and human environment along the Willamette River and generally includes all land adjacent to the river, public lands near the river, and land necessary for conservation of significant riparian habitat. (The Willamette Greenway Plan, adopted by the City Council November 5, 1987, Ordinance 160237). The Greenway Plan is intended to "protect, conserve, enhance, and maintain the natural, scenic, historical, economic, and recreational qualities of lands along Portland's rivers." (Portland City Code Chapter 33.440). The Plan supports industrial uses within Portland Harbor while at the same time looks to increase public access to the river. As a result, recreational use within the Study Area may increase at certain locations in the future.

There are numerous potential human uses of Portland Harbor. Worker activities occur at the industrial and commercial facilities in the Study Area. However, due to the sparse beach areas and high docks associated with most of the facilities, worker exposure to the in-water portion of the Study Area may be limited in shoreline areas. Commercial diving activities also occur in the LWR. In addition, the LWR provides many natural areas and recreational opportunities, both within the river itself and along the riverbanks. Within the Study Area, Cathedral Park, located adjacent to the St. Johns Bridge, includes a sandy beach area and a public boat ramp and is used for water skiing, occasional swimming, and waterfront recreation. Recreational beach use also may occur within Willamette Cove, Swan Island Lagoon, and on the southern

[4] The Site boundaries will be defined by EPA in the Record of Decision for the Site.

end of Sauvie Island. Swan Island Lagoon includes a public boat ramp. Additional LWR recreational beach areas exist on the northern end of Sauvie Island and in Kelley Point Park, both of which are outside of the Study Area.

Fishing is conducted throughout the LWR basin and within the Study Area, both by boaters and from locations along the banks. The LWR also provides a ceremonial and subsistence fishery for Pacific lamprey (particularly at Willamette Falls) and spring Chinook salmon for Native American Tribes. Many areas in the LWR are also important currently for cultural and spiritual uses by local Native Americans.

Transients have been observed along the LWR, including some locations within the Study Area. The observation of tents and makeshift dwellings during RI sampling events confirms that transients were living along some riverbank areas. Transients are expected to continue to utilize this area in the future.

The RI/FS being completed for the Site is designed to be an iterative process that addresses the relationships among the factors that may affect chemical distribution, risk estimates, and remedy selection. Four rounds of field investigations have been completed as part of the RI/FS. A preliminary sampling effort was conducted in 2001 and 2002 prior to the RI/FS work plan. Round 1 was conducted in 2002 and focused primarily on chemical concentrations in fish and shellfish tissue and in beach sediment. Round 2 was conducted in 2004 and 2005 and focused on chemical concentrations in sediment cores, in-water surface sediment, surface water, transition zone water, and additional shellfish tissue and beach sediment. Round 3 was conducted in 2006 and 2007 and focused on chemical concentrations in additional surface water, sediment, and fish and shellfish tissue. These Round 1, Round 2, and Round 3 sampling efforts, while initially focused on RM 3.5 to 9.2, which is the Administrative Order on Consent-defined initial study area (ISA), extended well beyond the ISA to RM 0 downstream and to RM 28.4 upstream.

1.4 ORGANIZATION

In accordance with guidance from EPA (1989), which is consistent with DEQ guidance (2000a, 2010), the BHHRA incorporates the four steps of the baseline risk assessment process: data collection and evaluation, exposure assessment, toxicity assessment, risk characterization, as well as a discussion of overall uncertainties.

This BHHRA is organized as follows:

- Section 2, Data Evaluation – This section evaluates the available data for the Study Area and identifies the COPCs for further evaluation in the BHHRA.
- Section 3, Exposure Assessment – This section presents potentially complete routes of exposure and potentially exposed populations for further evaluation in the BHHRA, which are summarized in the conceptual site model (CSM).

- Section 4, Toxicity Assessment – This section evaluates the potential hazard and toxicity of the COPCs selected for quantitative evaluation in this BHHRA.
- Section 5, Risk Characterization – This section presents the cancer risks and noncancer hazards and identifies the contaminants potentially posing unacceptable risks to human health.
- Section 6, Uncertainty Analysis – This section discusses the uncertainties that are inherent in performing a HHRA, and the uncertainties specific to this BHHRA.
- Section 7, Summary – This section summarizes the findings of this BHHRA and identifies chemicals and pathways that contribute the majority of the risk within the Study Area.
- Section 8, Conclusions – This section provides the conclusions for this BHHRA.
- Section 9, References – This section lists the references used in this BHHRA.

2.0 DATA EVALUATION

This section presents the data that were used in this BHHRA and the results of the selection of COPCs in sediment, water, and tissue. The LWG and non-LWG sampling events included in the site characterization and risk assessment (SCRA) dataset are described in detail in Appendix A of the RI Report. The dataset used in this BHHRA represents a subset of data from the sampling events that comprised the SCRA dataset as of September 2008. Data needs for the BHHRA were identified through the data quality objective (DQO) process described in Section 7 of the Programmatic Work Plan (Integral et al. 2004). Only data that met Category 1/QA2 data quality objectives was used in the BHHRA. A risk evaluation of exposures to polybrominated diphenyl ethers (PBDEs) detected in in-water sediment, fish and shellfish tissue was conducted using a subset of data from the sampling events that comprised the SCRA dataset as of February 2011. The data for the PBDE analysis are discussed in Attachment F3, and the PBDE risk assessment used the general data evaluation methodology discussed in this section.

2.1 AVAILABLE DATA

The BHHRA dataset includes only those matrices relevant for direct human exposure pathways: surface sediment, clam and crayfish tissue, fish tissue, surface water and groundwater seeps. Other matrices included in the SCRA dataset (such as subsurface sediment) were not evaluated in the BHHRA because human exposure was considered unlikely. Data from RM 1.0, including Multnomah Channel, and upstream to RM 12.2, were included in the risk assessment. The BHHRA dataset is summarized by matrix in Table 2-1. The dataset is described briefly in the following subsections, and described in more detail in Section 2.0 of the RI Report.

2.1.1 Beach Sediment

Areas where potential exposure to beach sediment could occur were based only on current conditions, as identified in the Programmatic Work Plan. Because beaches are relatively dynamic environments, specific beach conditions may change in the future, and the evaluation presented in the BHHRA may no longer be appropriately descriptive of potential risks.

Composite sediment samples were collected during Round 1 from each beach that had been designated as a potential human use area within the Initial Study Area (ISA). Additional human use areas within the Study Area but downstream of the ISA were sampled during Round 2 as part of the sampling of shorebird habitat were also included in the BHHRA dataset. The designated potential human use areas and associated beach sediment samples are shown in Map 2-1, and Table 2-2 presents a summary of the composite sediment samples included in the BHHRA dataset.

2.1.2 In-Water Sediment

The in-water sediment BHHRA dataset includes samples collected outside of the navigation channel of the river and from less than 30.5 cm in depth. Beach sediment samples are excluded, as well as natural attenuation core samples, radioisotope samples, and samples collected from areas that were subsequently dredged. The in-water sediment dataset is comprised of samples collected within the study area includes samples from river mile (RM) 1 to RM 12.2, including Swan Island Lagoon, as well as samples from the mouth of Multnomah Channel. As described in Appendix A of the RI, samples collected from areas that have subsequently been capped or dredged were not included in the BHHRA dataset. Per an agreement with EPA, the screening of contaminants of potential concern (COPCs) used only the subset of data collected from RM 1.9 to RM 11.8 (and including Swan Island Lagoon and the mouth of Multnomah Channel), whereas the exposure assessment and risk characterization used both subsets of data containing samples from RM 1 to RM 12.2. A summary of in-water sediment samples included in the BHHRA dataset is presented in Table 2-3.

2.1.3 Surface Water

Surface water samples were collected by the LWG in seven separate events during Rounds 2 and 3 between 2004 and 2007, and are representative of various seasonal water flow conditions. Surface water samples were collected between RM 1.9 and RM 11.8 from 32 single point stations and 5 transect locations (at RM 2.0, Multnomah Channel, RM 3.9, RM 6.3, and RM 11). One additional surface water sample was collected from RM 16, outside the boundaries of the Study Area. Surface water samples were collected using either a peristaltic pump or an XAD-2 Infiltrex™ 300 system (XAD). Single point samples included near-bottom and near-surface samples, as well as vertically integrated water column samples. Transect samples included horizontally integrated near-bottom and near-surface samples, cross-sectional equal discharge increment samples horizontally integrated across the entire width of the river , and vertically integrated samples from the east, west, and middle sections of a transect on the river. Additional information on the surface water sampling methods is available in Section 5.3 of the RI Report. Tables 2-5 and 2-6 present a summary of the surface water samples included in the BHHRA dataset from within and outside of the Study Area, respectively.

2.1.4 Groundwater Seeps

A seep reconnaissance survey was conducted during Round 1 to document readily identifiable groundwater seeps along both sides of the river from RM 2 to 10.5 (GSI 2003). Twelve potential groundwater seeps were observed at or near potential human use beach areas. Of these, only three sites were identified in the survey where it was

considered likely for upland contaminants of interest (COIs)[5] to reach groundwater seeps or other surface expressions of groundwater discharging to human use beaches: the City of Portland storm sewer Outfall 22B, Willbridge, and McCormick and Baxter at Willamette Cove. Of these locations, only the Outfall 22B discharge was evaluated in the BHHRA. Groundwater infiltrates into the outfall pipe, which subsequently discharges to a beach that has been identified as a potential transient use area. The groundwater seep at Willbridge is at a beach restricted to industrial use, the seep at Willamette Cove, located downgradient of the McCormick and Baxter Superfund Site, was capped during remedial activities in 2004.

The stormwater pipeline that discharges at Outfall 22B provides a conduit for surface discharge of groundwater containing COIs that infiltrates into the pipe upland of the beach. The sampling events at Outfall 22B are described in Appendix A of the RI Report. Although samples have periodically been collected for analysis of the discharge at Outfall 22B both during and outside of stormwater events, samples taken during stormwater events were not included in the BHHRA dataset because they were not considered representative of typical exposures. Samples collected since 2002 were used in the BHHRA, and Table 2-5 presents a summary of the samples that were included in the BHHRA dataset.

2.1.5 Fish Tissue

The target fish species to be evaluated for human consumption were identified in the Programmatic Work Plan (Integral et al. 2004), and consisted of both resident and non-resident species. Samples of resident fish species were collected by the LWG during Rounds 1 and 3. Samples of non-resident fish species were collected in the summer of 2003 through a cooperative effort of the ODHS, Agency for Toxic Substances and Disease Registry (ATSDR), Oregon Department of Fish and Wildlife (ODFW), the City of Portland and EPA Region 10. Table 2-7 presents a summary of the fish tissue samples included in the BHHRA dataset.

2.1.5.1 Resident Fish Tissue

Resident fish species evaluated in the BHHRA are smallmouth bass (*Micropterus dolomieui*), black crappie (*Pomoxis nigromaculatus)*, common carp (*Cyprinus carpio carpio)*, and brown bullhead (*Ameiurus nebulosus*). The sampling protocol for each species differed based on the reported home ranges of species sampled. The tissue compositing scheme for the Round 1 data collection effort was reviewed and approved by EPA in November and December 2002. The Round 3 data collection, the tissue compositing scheme was approved by EPA in October 2007. Smallmouth bass and carp collected during Round 3 were analyzed separately as fillet and the remaining body-without-fillet tissue, and whole body concentrations were calculated

[5] Prior deliverables and some of the tables and figures attached to this document may use the term~~RM~~ "Chemicals of interest," which has the same meaning as "Contaminants of interest" and refers to "contaminants" as defined in 42 USC 9601(33).

using the individual fillet and body-without-fillet results. Thus, for the risk assessment, the Round 3 smallmouth bass samples were reported both as fillet and whole body results.

Smallmouth bass samples were collected in Round 1 from eight locations between RM 2 and 9, and corresponding to their small home range (ODFW 2005), and composited based on each river mile. Three whole body replicate composite samples were collected at three of the eight locations, one whole body composite sample and one fillet composite sample were collected at the 5 remaining sample locations. Round 3 samples were collected from 18 stations between RM 2 and 12, each corresponding to approximately one river mile, either the west or east side of the river, or both. One composite sample was collected from each station, typically consisting of five individual fish.

Black crappie, common carp, and brown bullhead samples were collected during Round 1 and composited from two three-mile long fishing zones, RM 3-6 and RM 6-9. Three common carp and brown bullhead whole body and fillet replicate composite samples were collected from each zone. Two black crappie whole body and fillet replicate composite samples were collected within each zone. All results from within the Study Area were included in the BHHRA dataset.

During Round 3, common carp samples were collected from three fishing zones, each approximately four river miles in length (RM 0-4, RM 4-8, and RM 8-12). Three common carp composite samples were collected from each fishing zone and analyzed separately as fillet tissue and body-without-fillet tissue. All Round 3 results were included in the BHHRA dataset.

Smallmouth bass, black crappie, and common carp fillet samples were analyzed as fillet with skin, except for the analysis of mercury, which was performed using fillet without skin. Brown bullhead fillet samples were analyzed as fillet without skin.

2.1.5.2 Salmon, Lamprey, and Sturgeon

Adult white sturgeon (*Acipenser transmontanus*), adult spring Chinook salmon (*Oncorhynchus tshawytscha*), and adult Pacific lamprey (*Lampetra tridentate*) were collected during ODHS Study. Although these data were not collected as part of the RI, the data met Category 1/QA2 data quality requirement s and were evaluated by the LWG and used in this BHHRA.

Adult Chinook salmon samples were collected at the Clackamas fish hatchery. Each composite sample consisted of three individual fish. Five whole-body (including one split), three fillet with skin, and three fillet without skin composite samples were analyzed. The fillet without skin composite samples were only analyzed for dioxin, furan, and polychlorinated biphenyl (PCB) congeners and mercury.

Adult Pacific lamprey samples were collected at the Willamette Falls. -Four whole body composite samples, each consisting of 30 individual fish, were analyzed.

Adult sturgeon samples were collected between RM 3.5 and 9.2. Six fillet samples were analyzed without skin (including one split), each sample consisting of a single fish.

2.1.6 Shellfish Tissue

Crayfish samples were collected from 24 stations during Round 1 based on habitat areas and from 9 stations during Round 3 based on habitat areas and data needs identified by the EPA. Commensurate with their limited home range, crayfish were collected and analyzed as whole body composite samples from each individual station. During Round 1, two replicate composite samples were collected at three of the 24 stations; a single composite sample was collected at the remaining stations. During Round 3, a single composite sample was collected at each station.

Clams (*Corbicula* sp.) were collected from three stations during Round 1, 33 stations during Round 2, and 10 stations during Round 3, sampling locations were based on habitat areas and biomass availability. A single composite sample was collected at each station in Rounds 1 and 2. In Round 3, two composite samples were collected from each of five stations, and a single composite sample was collected from each of the remaining five stations. Round 1 and Round 2 samples were analyzed undepurated. As previously noted, two samples were collected from ~~each~~ five of the sampling stations in Round 3, one sample from each station was depurated prior to analysis, the other was analyzed undepurated. At the remaining stations, only undepurated samples were analyzed. Depuration is a common method for cleansing shellfish~~,~~ that is often done prior to their consumption by humans to eliminate the sediment present in the gastrointestinal tract of the shellfish. Although data from laboratory bioaccumulation samples were also available from Round 2, these data were not used because field-collected tissue samples provide for a more direct evaluation of potential human exposure than laboratory bioaccumulation samples. Tables 2-7 and 2-8 present a summary of the shellfish tissue samples included in the BHHRA dataset, from both inside and outside the Study Area, respectively.

2.2 DATA EVALUATION

Prior to using the data in the BHHRA, the data were evaluated for inclusion in the BHHRA consistent with the Guidelines for Data Reporting, Data Averaging, and Treatment of Non-Detected Values for the Round 1 Database (Kennedy/Jenks Consultants et al. 2004), the Exposure Point Concentration Calculation Approach and Summary of Exposure Factors (Kennedy/Jenks Consultants 2006), and Proposed Data Use Rules and Data Integration for Baseline Human Health Risk

Assessment (BHHRA), submitted to EPA in a May 28, 2008 email. Data use rules applied to the combining of surface water data collected by different methods, the handling of non-detects, the summing of chemical groups, and the calculation of exposure point concentrations (EPCs).

2.2.1 Excluded Data

The data used BHHRA meet Category 1/QA2 data quality objectives, as described in Section 2.2 of the RI Report. Data that were not of this quality were removed from the BHHRA dataset. General reductions of the SCRA dataset to create the BHHRA dataset included removal of rejected analytical results ("R" qualified results), and removal of analytical results of samples collected from locations that have been capped, dredged, or remediated. This included all samples flagged as capped, dredged or remediated, including data from task WLCMBI02: the McCormick & Baxter September 2002 Sampling.

2.2.2 Field Replicates

Field replicates within the BHHRA dataset were handled per agreements with EPA. When calculating a mean or an upper confidence limit (UCL), and when reporting data in general, replicates were included in the dataset as discrete samples. Replicates with unique coordinates were included as separate samples when mapping or spatially weighing data. Where replicates have the same coordinates, data associated with the first sample were used and data from the second or third replicates were excluded.

2.2.3 Co-elution of PAHs

Benzo(b+k)fluoranthenes and benzo(k+j)fluoranthenes co-eluted in certain surface water and in-water sediment samples. For the purposes of the BHHRA, benzo(b+k)fluoranthenes results were assumed to be completely benzo(b)fluoranthene, and benzo(k+j)fluoranthenes results were assumed to be completely benzo(k)fluoranthene. Analytical results for these samples were not presented as co-elutions in the BHHRA, but rather, were presented as results for their assumed analyte.

2.2.4 Treatment of PCB Surface Water Data

Polychlorinated biphenyls (PCBs) were analyzed as Aroclors in samples collected using a peristaltic pump, and as congeners in high-volume samples collected using the XAD-2 sampling method. Because detection limits for the peristaltic pump samples were higher than those using high-volume samples, the results for PCBs from the high-volume samples were used. Aroclor concentrations in the high-volume samples were estimated from the PCB congener data by the

analytical laboratory. Therefore, Aroclor data were not used, and only PCB congener data were used to assess PCBs in the BHHRA surface water dataset.

2.2.5 Combining XAD Column and Filtered Surface Water Data

The XAD water quality samples consisted of two components: chemicals retained on the column that are representative of the dissolved concentration, and chemicals retained on the filter that are representative of the concentration of the suspended particulate fraction. In order to create a whole water sample from the XAD results, the analytical results for column and filter fractions for a given chemical were combined to give a total concentration. The following rules were used to calculate a whole water concentration for individual samples:

- If an analyte was detected in both the filter and the column, the detected concentrations were summed.
- If an analyte was detected in either the filter or the column but not in both portions of the sample, only the detected concentration was used.
- If an analyte was not detected in both the filter and the column, the highest detection limit reported for either the filter or the column was used.

Surface water samples collected using the high-volume XAD-2 sampling method are identified with the letters "XAD." The results of the combined XAD-2 column and filter data were renamed "WSXAD-Combo," and are presented as such in the BHHRA.

2.2.6 Combining Horizontal and Vertical Surface Water Data

The surface water data described in Section 2.1.3 were vertically integrated prior to use in the BHHRA. Transect samples are presented as a vertically and horizontally integrated transect. Non-integrated samples were collected from both near-bottom and near-surface (NB/NS) depths within the water column at single-point sampling locations. Vertically-integrated transect samples were collected from the east, west, and middle (E/W/M) sections of the river, horizontally integrated samples were collected from NB or NS water depths. NB/NS and/or E/W/M samples from the same location and date were combined to provide an integrated value for the water column or transect. In these cases, single-point data from NB and NS were vertically combined, vertically-integrated data from E/W/M were horizontally combined; and horizontally-integrated data from NB/NS were vertically combined using the following rules:

- If an analyte was detected in each sample, the detected concentrations were averaged.
- If an analyte was detected in at least one sample, the mean concentration was calculated using one-half the detection limit for non-detect results.

- If all results were non-detect, the mean of the detection limits was calculated and used as the non-detected concentration ("U" qualified).
- In some instances, a field replicate sample was collected from the middle of the river without corresponding replicate samples from the east or west side of the river, indicated by "M2" in the Sample ID. The results from these samples were included in the dataset at their reported concentrations, without combining them with other results.

Sample IDs for the results of the horizontally or vertically combined integrated data were renamed to include "-Int" at the end of the ID name, and are presented as such in the BHHRA.

2.2.7 Combining Fillet and Body-Without-Fillet Tissue Data

Smallmouth bass and carp samples collected during the LWG Round 3 sampling event were analyzed separately as fillet and body-without-fillet tissue. The results of these analyses were combined on a weighted-average basis to provide whole body results for use in the BHHRA. The steps used in combining the data were as follows:

- The whole-body tissue mass was calculated for each individual fish within each composite by summing its fillet and body-without-fillet tissue mass.
- The ratio of fillet to whole-body tissue mass was calculated for each individual fish within each composite. Likewise, the ratio of body-without-fillet to whole-body tissue mass was calculated for each individual fish within each composite.
- For each composite, the average of the fillet to whole-body tissue mass ratios was calculated, and the average of body-without-fillet to whole-body tissue mass ratios was calculated to provide an average of the percentage of fillet and body-without-fillet tissue mass for each composite.

The average percentages were then used to calculate a weighted average concentration for each composite sample according to the following rules:

- If the analyte was detected in both the fillet tissue and the body without fillet tissue, a weighted average was calculated using the detected values
- If the analyte was not detected in either of the tissue types, a weighted average was calculated using the full detection limits
- If the analyte was detected either the fillet or body-without-fillet sample, one-half the detection limit for the non-detect result was used to calculate the weighted average.

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00072 06/25/2019 SEMS_0306039

The combined fillet and body without fillet tissue data were considered whole body tissue results for carp and smallmouth bass and were used in the BHHRA as such.

2.2.8 Summation Rules for Analytes Evaluated as Summed Values

Certain contaminants were evaluated as the sum of similar individual congeners, isomers, and closely related degradation products of the parent compound rather than as individual chemicals. The chemicals evaluated as mixtures and for which analytes evaluated as sums in the BHHRA are as follows:

- Total PCBs were calculated as either the sum of nine Aroclor mixtures (1016, 1221,1232, 1242, 1248, 1254, 1260, 1262, 1268) or the sum of individual PCB congeners.
- Total endosulfan was calculated as the sum of α-endosulfan, β-endosulfan, and endosulfan sulfate.
- Total chlordane was calculated as the sum of *cis*- and *trans*-chlordane, oxychlordane, and *cis*- and *trans*-nonachlor.
- Total DDD was calculated as the sum of 2,4'-DDD and 4,4'-DDD.
- Total DDE was calculated as the sum of 2,4'-DDE and 4,4'-DDE
- Total DDT was calculated as the sum of 2,4'-DDT and 4,4'-DDT
- Total dioxin-like PCB congeners were calculated as the sum of PCBs 77, 81, 105, 114, 123, 126, 156, 157, 167, 169, and 189.
- Total PCBs-adjusted were calculated as the sum of total PCB congeners minus dioxin-like PCB congeners.
- Total xylenes were calculated as the sum of *m*-, *o*-, and *p*-xylene.

The individual components of each chemical mixture used in the BHHRA are presented in Table F2-2.

If an individual analyte of a chemical mixture was detected at least once within the study area in a given medium, it was considered present in that medium. The presence of an analyte in biota samples was assessed separately for each individual species and tissue. The presence of individual analytes in sediment, and surface water were also assessed separately based on the specific exposure scenario. Individual analytes that were a part of a chemical mixture but were determined not to be present are summarized in Table F2-3 by medium and species. Additionally, a minimum number of individual analytical results in the mixture was required for the summed analytical result to be calculated. For example, if a sample was only analyzed for a limited number of individual PCB congeners, or if a large number of individual congener results for a sample were rejected, a total PCB congener sum may not have been calculated. In addition,

chemical mixtures for samples meeting the criterion for the minimum number of individual analytical results required to calculate a sum, but with a limited number of individual analytical results, were qualified with an "A." Mixture sums that did not have a limited number of individual analytical results were qualified with a "T," indicating a calculated total. Table F2-4 shows the minimum number of individual analytical results required to calculate a sum for each mixture, and the maximum number of individual analytical results that would result in an "A" qualifier, indicating a limited number of individual analytical results were available for a sample. Table F2-4 also lists the number of samples for each medium for which a summed total was calculated, and the number of samples for which a summed total was not calculated because of lack of individual analytical results for the mixture. Sample IDs of samples for which a summed analytical result was not calculated are presented in Table F2-5.

Concentrations of the individual analytes that comprise a mixture were summed for each sample according to the following rules:

- If an analyte was detected in the sample, the detected concentration was used to calculate the sum
- If an analyte was not detected in a sample but was assumed to be present in the sample medium, one-half the detection limit was used to calculate the sum
- If all results were non-detect, the highest detection limit of the analytes assumed to be present in the medium was used as the detection limit for the sample, and the sample was flagged as a non-detect.

2.2.9 Total Dioxin/Furan and PCB TEQs

A toxicity equivalence procedure was used to assess the cumulative toxicity of complex mixtures of PCDD, PCDF, and PCB congeners. The procedure involves assigning individual toxicity equivalency factors (TEF's) to the PCDD, PCDF, and PCB congeners in terms of their relative toxicity to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD). The reported concentration of each congener in a sample is multiplied by its respective TEF to give the TEF-equivalent concentration. The resulting concentrations are then summed to give a TEQ. The World Health Organization (WHO) TEFs (Van den Berg et al. 2006), shown in Table 4-3, were used to calculate the total dioxin/furan and PCB TEQs. Dioxin/furan and PCB-TEQs were calculated according to the following rules

- Congeners reported as not detected in a given sample but determined to be present in the medium, one-half the detection limit multiplied by the TEF was used in the sum
- If all results in a sample were non-detect, the maximum toxicity-weighted detection limit was used for the TEQ, and the result was flagged as non-detect (U-qualified). The maximum toxicity-weighted detection limit was obtained by

multiplying each detection limit by its respective TEF and selecting the maximum value.

- Dioxin/furan TEQs were not calculated for those samples where analytical results for all 12 dioxin/furan congeners were not available.

Values were not presented for total TEQ in the BHHRA. Rather, risks from total TEQ were estimated by summing the risks from the total PCB TEQ and the total dioxin/furan TEQ.

2.3 CHEMICAL SCREENING CRITERIA AND SELECTION OF CONTAMINANTS OF POTENTIAL CONCERN

Because of the large number of chemicals detected in environmental media, a risk-based screening approach was used to focus the risk assessment on those contaminants most likely to significantly contribute to the overall risk. COPCs were selected for quantitative evaluation in the BHHRA by comparing the SCRA analytical data to risk-based screening values. The specific risk-based concentrations used to select COPCs are described below for the each media.

2.3.1 Sediment

EPA's Regional Screening Levels (RSLs) for soil (EPA 2010a) were used as the screening values for beach and in-water sediments. RSLs are risk-based concentrations in soil, air and water, and have been developed for both residential and industrial exposure scenarios. Using default exposure assumptions, RSLs represent concentrations that equate to a target cancer risk of 1×10^{6} or a hazard quotient of 1. As described in Region 10 guidance (2007a), RSLs based on a noncancer endpoint were divided by 10 to give a value equivalent to using a hazard quotient of 0.1. This was done to account for the additive nature of noncancer effects. RSLs based on noncancer endpoints were divided by 10 to account for potential cumulative effects from multiple chemicals, and these modified RSLs were used as the screening values. Consistent with the then current EPA Region 10 recommendations (EPA, 2008), a RSL of 7.7 mg/kg in soil for residential land use was calculated for trichloroethylene (TCE) using a cancer slope factor of 0.089 per mg/kg-day, which represents the geometric mid-point of the slope factor range from EPA 2001. EPA finalized its risk assessment for TCE in 2011 and the revised RSL is 0.9 mg/kg. Because TCE does not contribute substantially to the cumulative risk estimates for the in-water portion of Portland Harbor, the screening process was not re-evaluated. Chemicals for which no RSL was available were screened using RSLs for chemicals with a similar chemical structure.

Because uses of Portland Harbor include both recreational and industrial activities, COPCs were selected using both residential and industrial RSLs, consistent with the EPA comments on the Round 2 Comprehensive Report

(EPA 2008b). Residential RSLs were used to select COPCs in beach sediment for those areas where exposures could occur during recreational, transient, or fishing activities in those areas considered reasonably accessible from contiguous upland areas or by boat. In-water sediment data collected within the navigation channel were not used in the COPC screen. In areas where occupational exposures could occur, and for in-water sediment, COPCs were selected using industrial RSLs.

If the maximum detected concentration of a contaminant at a specific use area was greater than its respective screening level, that contaminant was selected as a COPC. The designated potential uses for beaches in the Study Area are presented in Map 2-1. COPCs for beach sediment and the rationale for selection are presented in Tables 2-9 and 2-10. COPCs for in-water sediment are presented in Table 2-11.

2.3.2 Surface Water

Surface water ~~Screening values for surface water and groundwater seeps EPA residential tapwater RSLs (EPA 2010a) and MCLs (EPA 2003a) were generally used as screening values for surface water and the groundwater seep to select COPCs for direct exposure scenarios. TCE was evaluated using the EPA Region 6 Human Health Medium-Specific Screening Level (EPA 2008a).~~

COPCs were selected ~~separately~~ for divers~~,~~ and transient/beach user exposures using EPA residential tapwater RSLs (EPA 2010a), COPCs for ~~, and~~ the potential use of surface water as a drinking water source were selected using the lower of either the tapwater RSLs or MCLs (EPA 2003a). TCE was evaluated using the EPA Region 6 Human Health Medium-Specific Screening Level (EPA 2008a). COPCs for evaluating exposure to divers and for drinking water were selected from the combined surface water data set described in Section 2.2.6. COPCs for transient and beach use scenarios were selected from surface water samples taken from areas where direct contact could occur. A summary of samples used for screening surface water for COPCs is provided in Table 2-12. Sample locations of surface water data evaluated and COPCs for diver exposures are shown on Map 2-3 and in Table 2-13; sample locations and COPCs for transient and recreational beach uses are shown on Map 2-4 and Table 2-14; sample locations and COPCs for the use of surface water as a drinking water source are shown on Map 2-8 and in Table 2-16.

Comment [KJ7]: The LWG reiterates that this is not an accurate statement. MCLs were only used as screening values for the potential future domestic water use scenarios. MCLs were not used as screening values for the other direct exposure scenarios for surface water or for the groundwater seep. To be accurate, the sentence should be revised to:
"EPA residential tapwater RSLs (EPA 2010a) were used as screening values to select COPCs for the groundwater seep and for surface water for transients, beach users, and divers. In addition, MCLs (EPA 2003a) were used as screening values for surface water for potential future domestic water use."

Comment [KJ8]: The LWG reiterates that this is not an accurate statement. MCLs were only used as screening values for the potential future domestic water use scenarios. MCLs were not used as screening values for the other direct exposure scenarios for surface water or for the groundwater seep. To be accurate, the sentence should be revised to:
"EPA residential tapwater RSLs (EPA 2010a) were used as screening values to select COPCs for the groundwater seep and for surface water for transients, beach users, and divers. In addition, MCLs (EPA 2003a) were used as screening values for surface water for potential future domestic water use."

2.3.3 Groundwater Seep

Chemicals concentrations detected in the groundwater seep at Outfall 22B were compared to the residential tapwater RSLs. As with the soil RSLs, the tapwater RSLs based on a noncancer endpoint were divided by 10 to give values equivalent to a HQ of 0.1. The location of Outfall 22B is shown on Map 2-5, and COPCs are presented in Table 2-15.

2.3.4 Fish and Shellfish Tissue

No appropriate risk-based screening values for fish tissue were available. Although EPA Region 3 has published fish tissue screening levels, the consumption rate of 54 g/day used to derive those values is not considered representative of the range of consumption rates relevant to Portland Harbor. Accordingly, all chemicals detected in fish and shellfish tissue in the BHHRA dataset were considered to be COPCs and evaluated further in the BHHRA. The general locations of fish in a particular composite of smallmouth bass and common carp are shown on Map 2-6. Brown bullhead and black crappie were composited over RM 3-6 and RM 6-9. Shellfish were composited over areas representing their assumed home range, and sample locations on Map 2-7 represent the general spatial distribution of composited samples.

3.0 EXPOSURE ASSESSMENT

Exposure assessment is the determination of the magnitude, frequency, duration, and route of exposure (EPA, 1989). Populations that currently, or may in the future, come into contact with site contaminants are identified along with potential routes of exposure that define the mechanism by which the exposure may occur. Magnitude is determined by estimating the amount, or concentration, of the chemical at the point of contact over an exposure duration, as well as the actual intake, or dose, of the chemical.

According to EPA (1989), an exposure assessment includes three primary tasks:

- Characterization of the exposure setting. This step includes identifying the characteristics of populations that can influence their potential for exposure, including their location and activity patterns, current and future land use considerations, and the possible presence of any sensitive subpopulations.
- Identification of exposure pathways. Exposure pathways are identified for each population by which they may be exposed to chemicals originating from the site.
- Quantification of exposure. The magnitude, frequency, and duration of exposure for each pathway is determined. This step consists of the estimating of exposure point concentrations and calculation of chemical intakes.

3.1.1 Conceptual Site Model

The conceptual site model (CSM) describes potential contaminant sources, transport mechanisms, potentially exposed populations, exposures pathways and routes of exposure. As discussed in Sections 4, 5, and 6 of the RI Report, contaminated media within the Study Area are sediment, water, and biota. Current and historical industrial activities and processes within the Study Area have led to chemical releases from either point or nonpoint sources, including discharges to the river from direct releases or via outfalls and groundwater within the Study Area. In addition, releases that occur upstream of the Study Area and atmospheric deposition from global, regional, and local emissions may also represent potential contaminant sources to the Study Area. Chemicals in sediment and water may be accumulated by organisms living in the water column or by benthic organisms in sediments. Fish and shellfish within the Study Area feeding on these organisms can accumulate chemicals in their tissues through dietary and direct exposure to sediment and water. Additional information on potential contaminant sources is provided in Section 4 of the RI Report, and a more detailed CSM is presented in Section 10. A graphical representation of the exposure CSM is presented on Figure 3-1.

3.2 IDENTIFICATION OF POTENTIALLY EXPOSED HUMAN POPULATIONS

Potentially exposed populations were identified based on consideration of current and potential future uses of the Study Area. An analysis of potential exposure pathways for the Study Area ~~is~~ was detailed in the Portland Harbor RI/FS Programmatic Work Plan (Integral 2004), including those directed by EPA. ~~e~~Consumption of shellfish by subsistence fishers, ~~and~~ in-water exposures by recreational and commercial divers, and potential future domestic water use were subsequently evaluated after ~~directed~~direction by EPA (see Attachment F1). The exposure scenarios identified below represent those populations that are anticipated to have the greatest potential for exposure to contaminants within the Study Area for both current and potential future conditions. For this reason, this risk assessment is likely to be protective of other potentially exposed populations that are not evaluated quantitatively in this BHHRA. The receptors evaluated for current and future uses of the Study Area are:

- Dockside workers
- In-water workers
- Transients
- Divers
- Recreational beach users
- Recreational/Subsistence Fishers
- Tribal fishers
- Potential Future Domestic water users

Comment [KJ9]: Consistent with the revisions to Section 3.2.1.8, this should include "Potential Future".

The above populations were identified based on human activities know to occur within the Study Area, with the exception the use of surface water as a domestic water source. However, public and private use of surface water is a beneficial use of the LWR, and as described in Section 1, this baseline risk assessment evaluates exposures assuming no institutional controls, such as obtaining a permit for use of surface water. Each of these receptors is described in greater detail in the following sections.

3.2.1.1 Dockside Workers

Portland Harbor supports a large number of water-dependent commercial uses, and many of the facilities adjacent to the LWR rely on ship and barge traffic. Dockside workers were evaluated to be representative of industrial and commercial workers at many of the facilities adjacent to the river. Specific activities are assumed to occur only within natural river beach areas, and include unloading ships or barges, or conducting occasional maintenance activities at specific locations near or at the water's edge. Exposures for dockside workers are evaluated as occurring only within defined areas considered to be industrial sites, rather than on a Study Area or harbor-wide basis. The specific areas evaluated are shown on Map 2-1.

3.2.1.2 In-Water Workers

In-water workers were evaluated as representative of individuals who conduct activities that typically occur in or over-water, rather than on shore as assumed for dockside workers. Specific activities may include the repair of in-water structures such as docks or pilings, maintenance dredging of private slips or berths, or maintenance and cleaning of equipment. While such activities would not necessarily be restricted to a given area, exposure would most likely be localized to specific facilities, and between the shore and the navigation channel.

3.2.1.3 Divers

Several different groups of people dive in the Portland Harbor area, including the public for recreation ~~and~~ (which may include gathering of biota for consumption), the sheriff's office for investigations and emergency activities, and commercial divers for a variety of purposes including marine construction, underwater inspections, routine operation and maintenance, and activities related to environmental work. The majority of divers are expected to be commercial divers who typically use either wet or dry suits, wet or dry gloves, and a full face mask or a regulator held in the mouth with the diver's teeth. Although dry suits provide greater protection, wetsuits are occasionally ~~often~~ used because of the higher cost of dry suits and higher water temperature (Sheldrake et. al, 2009). The Willamette River is 303d listed as a temperature impacted area, with the Lower Willamette reaching average temperatures of over 70 degrees F in the summer months. Based on communications with commercial diving companies in the Portland area (Hutton 2008, Johns 2008, and Burch 2008), the standard of practice for commercial divers is the use of dry suits and helmets when diving in the LWR. However, the use of wet suits by commercial divers ~~still~~may still occurs ~~is apparently still common among many commercial divers~~ (EPA 2008c). Accordingly, two different diver exposure scenarios are included in this BHHRA, and are differentiated by considering the use of either a wet suit or dry suit. Each scenario assumes that divers are exposed to sediment and surface water through inadvertent ingestion and dermal contact throughout the Study Area.

Comment [KJ10]: This is not a peer-reviewed document. If EPA wishes to include the information, EPA should cite personal communications with Sean Sheldrake.

Comment [KJ11]: Per the discussion on August 27, this statement should be linked to recreational divers (not commercial divers).

Comment [KJ12]: This sentence should be deleted to be consistent with the above discussion.

3.2.1.4 Transients

Transient encampments are known to exist within the Study Area along the Lower Willamette River. While tents and makeshift dwellings are typically observed above actual beach areas, transients are likely to have direct contact with beach sediment and surface water (including groundwater seeps) during swimming, bathing or other activities, such as washing of clothing or equipment, and may also use surface water as a drinking water source. Although individuals are anticipated to move within or outside the Study Area, some individuals may spend a majority of their time at relatively few areas. Thus, exposure was evaluated as occurring at individual beaches rather than averaged over a larger area. Specific locations where exposure by transients was evaluated in the risk assessment are shown on Map 2-1.

3.2.1.5 Recreational Beach Users

Adults and children participate in recreational activities at beaches within the Study Area, and the LWR is also used for boating, water skiing, swimming, and other activities. The areas currently used for recreational activities as well as other areas in the Study Area where sporadic beach use may occur were identified as recreational use areas. While certain individuals may frequent a specific area almost exclusively, others users may regularly use various areas throughout the Study Area. Recreational activities are likely to result in exposure to beach sediment and surface water.

3.2.1.6 Recreational/ and Subsistence Fishers

Comment [KJ13]: The description of scenarios and discussion in this section is unresolved, pending discussion of the RME scenario proposal.

A year-round recreational fishery exists within the Study Area. Current information indicates that spring Chinook salmon, steelhead, Coho salmon, shad, crappie, bass, and white sturgeon are the fish species preferred by local recreational fishers (DEQ 2000b, Hartman 2002, and Steele 2002). In addition to recreational fishing, an investigation by the Oregonian newspaper and limited surveys conducted on other portions of the Willamette River indicate that immigrants from Eastern Europe and Asia, African-Americans, and Hispanics are most likely to use fish from the lower Willamette either as a supplemental or primary dietary source (ATSDR 2002). These surveys also indicate that the most commonly consumed species are carp, bullhead catfish, and smallmouth bass, although other species may also be consumed. In conversations that were conducted as part of a project by the Linnton Community Center (Wagner 2004) about consumption of fish or shellfish from the Willamette River, transients reported consuming a large variety of fish, and several said they ate whatever they could catch themselves or obtain from other fishers.

Direct exposures to beach sediments by individuals engaged in recreational or subsistence fishing was evaluated at specific areas designated as transient and recreational use areas, exposures to in-water sediments were evaluated per half mile along each side of the river as well as on a Study Area-wide basis. Fish consumption was evaluated assuming a single-species diet comprised of each individual target resident fish species (smallmouth bass, black crappie, brown bullhead, and common carp), and based on whether only fillets or the whole fish is consumed. Exposure was evaluated over fishing zones, based on the relative size of the home range for each species, as well as averaged over the entire Study Area. In addition to the individual species diet, a multiple species diet was also evaluated on a harbor-wide basis, assuming each of the four target species comprised equal portions of the total fish consumption. In order to account for a range of cultural consumption practices, both fillet-only and whole body fish consumption were evaluated.

3.2.1.7 Tribal Fishers

The LWR provides a ceremonial and subsistence fishery for Native American tribes. Four Native American tribes (Yakama, Umatilla, Nez Perce, and Warm Springs) participated in a fish consumption survey that was conducted on the reservations of the participating tribes and completed in 1994 [Columbia River Inter-tribal Fish

Commission (CRITFC) 1994]. The results of the survey show that tribal members surveyed generally consume more fish than the general public. Certain species, especially salmon and Pacific lamprey, are an important food source as well as an integral part of the tribes' cultural, economic, and spiritual heritage.

3.2.1.8 Potential Future Domestic Water User

According to the City of Portland, the primary domestic water source for the city is the Bull Run watershed, which is supplemented by a groundwater supply from the Columbia South Shore Well Field (City of Portland 2008). In addition, the Willamette River was determined not to be a viable water source for future water demands through 2030 (City of Portland 2008). Although there are currently no known uses of the Lower Willamette River as a source of drinking water, ~~Both~~ public and private use of the Willamette River as a domestic water source is a designated beneficial use ~~of the LWR~~ by the State of Oregon. Hence, use of surface water as a source of household water was assessed as a potentially complete pathway. Exposure to surface water could occur via ingestion and dermal contact ~~throughout the Study Area~~, as well as volatilization of chemicals to indoor air through household use.

Comment [KJ14]: The title should include "PotentialFuture"

Comment [KJ15]: These revisions are not adequate to describe the likelihood of the exposure scenario. The description of the scenario is an unresolved issue.

Comment [KJ16]: The discussion of uncertainty and context for exposure scenarios is unresolved.

3.3 IDENTIFICATION OF EXPOSURE PATHWAYS

Exposure pathways are defined as the physical ways in which chemicals may enter the human body. A complete exposure pathway consists of the following four elements:

- A source of chemical release
- A release or transport mechanism (or media in cases involving media transfer)
- An exposure point (a point of potential human contact with the contaminated exposure medium)
- An exposure route (e.g., ingestion, dermal contact) at the exposure point.

If any of the above elements is missing, the pathway is considered incomplete and exposure does not occur. The potential exposure pathways to human populations at the Study Area include:

- Incidental ingestion of and dermal contact with beach sediment
- Incidental ingestion and dermal contact with in-water sediment
- Incidental ingestion and dermal contact with surface water
- Incidental ingestion and dermal contact with surface water from seeps
- Consumption of fish and shellfish
- Infant consumption of human milk.

A more detailed discussion of potential exposures for the Study Area under current and future conditions, and presents the rationale for including or eliminating pathways from quantitative evaluation. The identified receptors, exposure routes, and exposure pathways, and the rationale for selection are also summarized in Table 3-1.

Exposure pathways are designated in one of the following four ways:

Potentially Complete: There is a source or release from a source, an exposure point where contact can occur, and an exposure route by which contact can occur. Pathways considered potentially complete are quantitatively evaluated in this BHHRA.

Potentially Complete but Insignificant: There is a source or release from a source, an exposure point where contact can occur, and an exposure route by which contact can occur. However, exposure via the pathway is likely to be negligible relative to the overall risk. Pathways considered potentially complete but insignificant were not evaluated further in this BHHRA.

Incomplete: There is no source or release from a source, no exposure point where contact can occur, or no exposure route by which contact can occur for the given receptor. Pathways considered potentially incomplete were not evaluated further in this BHHRA.

Potentially complete pathway, but evaluated for a different receptor: These pathways may be complete for some individuals, but are not evaluated for the identified receptor because the pathways are not considered typical for that receptor. These pathways are evaluated for different receptors where the pathways are considered potentially complete and significant. Overlapping exposures that may occur for the different receptors are discussed further in Section 3.3.

The following sections provide a more detailed discussion of the exposure pathways that are quantitatively evaluated in this BHHRA.

3.3.1 Direct Exposure to Beach Sediment

Based on current and future uses within the Study Area, incidental ingestion and dermal contact with beach sediment could occur within natural river beach areas identified as human use areas in the Programmatic Work Plan. These areas were further classified with respect to the type of exposures that could occur, including recreational, ~~recreational/subsistence and tribal~~ fishing, transient, or dockside worker use areas. Human use areas in the Study Area and their associated classifications are shown in Map 2-1. Direct exposure to beach sediments is considered to be a potentially complete pathway for dockside workers, transients, recreational beach users, and ~~both recreational, /subsistence, and tribal~~ fishers.

Comment [KJ17]: EPA agreed to delete this language.

3.3.2 Direct Exposure to In-Water Sediment

Direct contact with in-water sediment could occur during activities conducted from a boat or other vessel that result in bringing sediment to the surface, during diving, or when fishing as a result of handling anchors, hooks, or crayfish pots. Hence, direct exposure to in-water sediment is considered to be a potentially complete pathway for in-water workers, divers, and ~~recreational, /subsistence, and tribal~~ fishers. Although recreational beach users may contact in-water sediment while swimming, such exposures are not expected to be significant and were not quantitatively evaluated in the risk assessment. Exposure to in-water sediment was evaluated throughout the Study Area by half-mile river segments ~~mile on~~for each side of the river rather than at specific areas as was done with exposure to beach sediments.

Comment [KJ18]: EPA agreed to delete this language.

3.3.3 Direct Exposure to Surface Water

Direct exposure to contaminants in surface water could occur during recreation or occupational activities that occur near or in the water, or from potential future use of the LWR as a domestic water source. Transients may also use surface water as a source of drinking water or for bathing. Accordingly, direct exposure via ingestion and dermal contact with surface water is considered to be a potentially complete pathway for transients, recreational beach users, ~~and~~ divers, and potential future domestic water users.

Comment [KJ19]: Should include "potential".

Comment [KJ20]: Should include "potential".

Exposure to contaminants in surface water via dermal absorption and ingestion were considered potentially complete but insignificant pathways for dockside workers, in-water workers, tribal fishers, and fishers. It is unlikely that dockside and in-water workers would have direct contact with surface water on a regular basis, and the potential for significant exposure is considered low ~~for recreational/subsistence and tribal fishers~~while fishing. Additionally, although contaminants may volatilize from ~~surface~~ water ~~to outdoor air~~, it is unlikely to result in a significant exposure considering the amount of mixing with ambient air and the relatively low concentrations of VOCs in ~~surface~~ water. Hence, inhalation of volatiles to ~~outdoor~~ ambient air was considered a potentially complete but insignificant exposure pathway for all receptors.

Comment [KJ21]: The revisions to this paragraph were not discussed previously with the LWG; however, they are acceptable to the LWG.

3.3.4 Direct Exposure to Groundwater from Seeps

Direct contact with groundwater is assumed to occur only at seeps where groundwater comes to the surface on a beach above the water line. Direct exposure to groundwater via seeps is considered a potentially complete exposure pathway for transients and recreational beach users. As described in Section 2.1.4, a seep reconnaissance survey identified only Outfall 22B, which is located at approximately RM 7W in an area designated as a potentially used by transients. Therefore, exposure to surface water from the groundwater seep at Outfall 22B was evaluated only for transients.

3.3.5 Consumption of Fish

Many of the contaminants found in Portland Harbor are persistent in the environment and accumulate in the food-chain. Local populations who consume fish caught in Portland Harbor may be exposed to COPCs that bioaccumulate in fish. While the populations evaluated in this BHHRA are described as "fishers," the fish consumption evaluation in this BHHRA includes people who consume fish caught within the Study Area, not just those who catch the fish. Consumption of locally-caught fish is evaluated as a potentially complete exposure pathway for dockside workers, in-water workers, recreational beach users, and divers. Consumption of fish by these populations is evaluated under the recreational and subsistence fisher receptor. By definition, ongoing long-term fish consumption by transients would not be expected to occur, and the evaluation of fish consumption for other receptors is considered to be protective of consumption of fish by transients.

3.3.6 Consumption of Shellfish

Certain contaminants can bioaccumulate in shellfish, and populations may be exposed to COPCs through consumption of shellfish that are collected within the Study Area. The actual extent shellfish harvesting and consumption is presently occurring is not known. The Linnton Community Center project (Wagner 2004) reported that some transients reported eating clams and crayfish, although many of the individuals indicated that they were in the area temporarily, move from location to location frequently, or have variable diets based on what is easily available. While the ~~extent~~degree to which consumption of clams ~~consumption~~ currently occurs in Portland Harbor is unknown, the Linnton Community Center project suggests that it does not occur on an ongoing basis within the Study Area. The only clam species found in the Study Area during sampling events were Asian clams (*Corbicula* sp.). The Superfund Health Investigation and Education (SHINE) program in the Oregon Department of Human Services (DHS) stated that is unknown whether or not crayfish are harvested commercially within Portland Harbor (ATSDR 2006). ODFW has records for crayfish collection in the Columbia and Willamette Rivers, but these records do not indicate whether the collection actually occurs within the Study Area. Based on ODFW's data for 2005 to 2007, no commercial crayfish landings were reported for the Willamette River in Multnomah County. DHS had previously received information from ODFW indicating that an average of 4,300 pounds of crayfish were harvested commercially from the portion of the Willamette River within Multnomah County each of the five years from 1997-2001. In addition, DHS occasionally receives calls from citizens who are interested in harvesting crayfish from local waters and are interested in fish advisory information. According to a member of the Oregon Bass and Panfish club, traps are placed in the Portland Harbor Superfund Site boundaries and crayfish collected for bait and possibly for consumption (ATSDR 2006). Although consumption of shellfish was considered a potentially complete pathway for dockside workers, in-water workers, recreational beach users, divers, and recreational fishers, it was quantitatively evaluated only for

subsistence fishers, as they were considered the most likely population to regularly harvest and consume shellfish.

3.3.7 Infant Consumption of Human Milk

Lipid-soluble chemicals can accumulate in body fat, including lipids found in breast-milk. As a result, breast-feeding represents a potentially complete exposure pathway for nursing infants. Accordingly, infant exposures to PCBs, dioxins/furans, DDx, and PDBEs were evaluated as a potentially complete exposure pathway wherever maternal exposure to those compounds was evaluated.~~Lipid-soluble chemicals accumulate in body fat, including lipids in breast milk. Breast-fed infants can then be exposed to these chemicals. Infant exposure to PCBs, dioxins, DDx compounds, and PDBEs via the consumption of human milk was evaluated as a complete exposure pathway for the children of all receptors~~.

3.3.8 Potentially Overlapping Exposure Scenarios

An estimate of reasonable maximum exposure should not only address exposure for individual pathways, but also exposures that may occur across multiple exposure routes. Examples of overlapping scenarios include in-water workers who fish recreationally, and may also be recreational beach users. Potentially overlapping scenarios are indicated on Figure 3-1, and risks from potentially overlapping scenarios are discussed in Section 5.

3.4 CALCULATION OF EXPOSURE POINT CONCENTRATIONS

The exposure point concentration (EPC) is defined as the average concentration contacted at the exposure point(s) over the duration of the exposure period (EPA, 1992a). EPA recommends using the average concentration to represent "a reasonable estimate of the concentration likely to be contacted over time" (EPA 1989). Use of the average concentration also coincides with EPA toxicity criteria, which are based on lifetime average exposures. Because of the uncertainty associated with estimating the true average concentration at a site, EPA guidance (EPA 1989, 1992) notes that the 95 percent upper confidence limit (UCL) of the arithmetic mean should ~~always~~ be used for this variable. The UCL is defined as a value that, when calculated repeatedly for randomly drawn subsets of data, equals or exceeds the true population mean 95 percent of the time. Use of the UCL can also help account for uncertainties that can result from limited sampling data, and more accurately accounts for the uneven spatial distribution of contaminant concentrations. The process to calculate EPCs for tissue and beach sediment was previously described in the Programmatic Work Plan, and Round 1 tissue EPCs were previously presented in *Round 1 Tissue Exposure Point Concentrations* (Kennedy/Jenks Consultants 2004b) and *Salmon, Lamprey, and Sturgeon Tissue Exposure Point Concentrations for Oregon Department of Human Services* (Kennedy/Jenks Consultants 2004c), both of which were approved by EPA. The process for deriving EPCs for in-water sediment, surface water, and groundwater seeps was previously described in *Exposure Point Concentration Calculation*

Approach and Summary of Exposure Factors (Kennedy/Jenks Consultants 2006), as approved by EPA.

EPCs for RME evaluations represent either the 95 percent UCL, or the maximum detected value when either there was insufficient data to calculate a UCL or the calculated UCL was greater than the maximum reported value. Although inconsistent with EPA guidance (EPA 1992), EPCs for sediment and surface water CT evaluations were calculated as the simple arithmetic mean, because such an evaluation is consistent with OAR 340-122-0084(1)(g) and the primary purpose of the CT evaluations is that they provide bounding information to evaluate uncertainties in the RME evaluation in this risk assessment. EPCs for fish/shellfish consumption scenarios are the lesser of the 95 percent UCL or the maximum detected concentration, central tendency evaluations were achieved by using mean or median consumption rates. For analytes with less than 5 detected concentrations, the maximum detected concentration for that exposure area was used as the EPC for the RME evaluation. The uncertainties associated with estimating EPCs from small datasets and with using the maximum detected concentration as the EPC are discussed in Section 6. The 95 percent UCLs were calculated for each dataset following EPA guidance (EPA 2002a and EPA 2007b). ProUCL version 4.00.02 (EPA 2007b) was used to test datasets for normal, lognormal, or gamma distributions and to calculate the 95 percent UCLs. If the data did not exhibit a discernable distribution, a non-parametric approach was used to generate a UCL. The 95 percent UCLs were calculated using the method recommended by ProUCL guidance (EPA 2007b).

Prior to calculating EPCs, the data were evaluated to address reporting of multiple results for the same analyte in the same sample and to reduce laboratory duplicates and field splits of samples to derive a single value for use. Data reductions performed within the SCRA database followed the rules described in *Guidelines for Data Reporting, Data Averaging, and Treatment of Non-Detected Values for the Round 1 Database Technical Memorandum* (Kennedy/Jenks Consultants et al. 2004). Sample results are reported as not detected when the concentration of the analyte in the sample is less than the detection limit. The actual concentration may be zero, or some value between zero and the detection limit. -The following rules were applied to the dataset for tissue, sediment, surface water, and groundwater seep samples:

1. A chemical was assumed to not be present if was not detected in any sample for a given medium within the Study Area, an EPC was not calculated for that chemical in that medium

2. A chemical was presumed to be present if it was detected at least once within the Study Area in samples for a given medium. When calculating the 95 percent UCL, non-detects were used in the calculation as recommended by the ProUCL software. ProUCL software output for the 95 percent UCLs calculated in this BHHRA are provided in Attachment F4. When calculating

the simple mean, non-detected values were replaced with one half their detection limit in the calculations.

3. Non-detects for which the detection limit was greater than the maximum detected concentration in an exposure area were removed from the dataset prior to calculating EPCs.

Certain toxicity values are based on exposure to chemical mixtures rather than to individual chemicals, as identified in *Human Health Toxicity Values Interim Deliverable* (Kennedy/Jenks Consultants 2004a). Concentrations of the individual isomers or congeners that comprise the mixtures were summed as described in Section 2.2.8 to calculate the EPCs for the mixtures, and the risks from these chemicals were evaluated on the basis of the combined mixture rather than for individual chemicals.

3.4.1 Beach Sediment

EPCs for beach sediment were calculated using data collected during Rounds 1 and 2 from locations designated as human use areas during Round 1 and 2, beach sediment data was not collected from human use areas during Round 3. One composite sample was collected from each beach area, and the results from each composite sample were was as the EPC for the RME and CT evaluations. When evaluating exposure for dockside workers at industrial sites, the same EPC was used to represent adjacent sites in instances where the beach area extended across individual site boundaries. Otherwise, each designated beach area was evaluated as a single exposure area for transients, recreational beach users, and recreational, subsistence and tribal fishers. Beach sediment exposure areas are presented on Map 2-1, EPCs for dockside workers are presented in Table 3-2, EPCs for transient, recreational, and fishing uses are presented in Table 3-3.

3.4.2 In-Water Sediment

Direct contact with in-water sediment is most likely to occur in the near-shore areas outside of the navigation channel. Thus, only surface sediment data collected less than 30.5 cm in depth and outside of the navigation channel were used to exposure to in-water sediments. In–water sediment EPCs are calculated in one-half mile segments along both sides of the river from RM 1.0 to RM 12.2, and for samples within Multnomah Channel. Study Area-wide EPCs were calculated using the sediment data collected between RM 1.9 and 11.8. In-water sediment EPCs for exposures by in-water workers, divers, and recreational/subsistence/tribal fishers are presented in Table 3-4.

3.4.3 Surface Water

Exposure concentrations in surface water were calculated using data collected within the Study Area, as well as the transect data collected from the mouth of Multnomah Channel. Both integrated and non-integrated water column samples were included in the data set, the specific samples used were dependent upon the anticipated exposures by the different receptors.

Surface water exposures by transients may occur throughout the year, EPCs were calculated using data from all seven seasonal sampling events. The data from each of the five transect locations were combined as described in Section 2.2.6. and EPCs were calculated for those five locations, at Willamette Cove using the discrete surface water samples, and on a Study Area-wide basis using the combined transect data from within the Study Area, excluding the transect location W027, which was collected at the mouth of Multnomah Channel. Surface water EPCs for exposures by transients are presented in Table 3-6.

Exposure to surface water by recreational beach users was assumed to occur primarily during summer months. Therefore, only data from the low-water sampling event conducted in July 2005 were used for calculating the surface water EPCs. These data were collected from recreational beaches in July 2005 included three transect locations and three single-point locations (Cathedral Park, Willamette Cove, and Swan Island Lagoon). Surface water EPCs for exposures by recreational beach users are presented in Table 3-7.

Exposures to surface water by divers were assumed to occur throughout the Study Area and were not considered seasonally dependent. EPCs were calculated in one-half mile intervals along each side of the river, and at each transect location. EPCs in surface water for exposures by divers are presented in Table 3-8.

Use of surface water as a domestic water source was assumed to have the potential to occur at any location through the Study Area on a year-round basis. Accordingly, data from all seven seasonal sampling events were used. EPCs were calculated for all individual transect stations and for single point stations with vertically integrated data. In addition, data from locations where co-located near-bottom and near-surface samples were collected were averaged and used in the domestic water dataset. Study Area-wide EPCs included all vertically integrated samples. EPCs for the use of surface water as a domestic water source are presented in Table 3-9.

3.4.4 Groundwater Seeps

As discussed Section 2.1.4, Outfall 22B, which is located on the west side of the river at RM 7, was the only seep identified where direct contact could occur within the Study Area. Data from two sampling events between 2002 and 2007 at times that did not involve stormwater influence were used to calculate the EPC, and the results are presented in Table 3-10.

3.4.5 Fish and Shellfish Tissue

EPCs for fish and shellfish tissue were calculated using data collected in the Round 1, Round 2, and Round 3 investigations, and the ODHS study. EPCs derived from Round 1 data were originally presented in *Round 1 Tissue Exposure Point Concentrations* (Kennedy/Jenks Consultants 2004b). EPCs derived using the results of the ODHS study were originally presented in *Salmon, Lamprey, and Sturgeon Tissue Exposure Point Concentrations for Oregon Department of Human Services* (Kennedy/Jenks Consultants 2004c).

Smallmouth bass were collected and composited over a per river mile. EPCs—whole body and fillet—were calculated for smallmouth bass at each river mile as well as for the entire Study Area consistent with their small home range. Common carp, black crappie, and brown bullhead were collected and composited within river segments designated as fishing zones, which are consistent with the home ranges identified in the Programmatic Work Plan. Fishing zones in Round 1 were designated three-mile segments at RM 3-6 and RM 6-9. Round 3 included additional samples of common carp (but not black crappie or brown bullhead) from three separate four mile long fishing zones that extended over four-mile segments at RM 0-4, RM 4-8, and RM 8-12. EPCs for common carp, black crappie, and brown bullhead were calculated as whole body and fillet for each fishing zone from which they were sampled, as well as for the Study Area.

Adult salmon were collected at the Clackamas fish hatchery, adult lamprey were collected at Willamette Falls, and sturgeon were collected throughout the Study Area. Salmon were analyzed as whole body, fillet with skin, and fillet without skin composite samples. Lamprey were analyzed only as whole body composite samples, sturgeon were analyzed only as fillet without skin composite samples. EPCs were calculated for each species accordingly as average concentrations representative of the entire Study Area.

Crayfish and clams were collected and composited at each sampling location. EPCs for crayfish were calculated for each individual location as well as for the entire Study Area. EPCs for clams were calculated for both depurated and undepurated samples per river mile on each side of the river, as well as for the entire Study Area. EPCs were also calculated for crayfish and clams collected between RM 1.0 and 1.9 and between RM 11.8 and 12.2, per an agreement with EPA.

EPCs for fish tissue are presented in Tables 3-11 through 3-21, and EPCs for shellfish tissue are presented in Tables 3-22 through 3-25.

3.5 ESTIMATION OF CHEMICAL INTAKES

The amount of each chemical incorporated into the body is defined as the dose and is expressed in units of milligrams per kilogram per day (mg/kg-day). The dose is

calculated differently when evaluating carcinogenic effects than when evaluating noncarcinogenic effects. Each is described below:

Non-cancer effects: The dose is averaged over the estimated exposure periodand is expressed as a chronic daily intake (CDI). Thus, the ~~ADD~~ CDI is used to represent the potential for adverse health effects over the period of exposure.

Carcinogenic effects: The dose is based on the estimated exposure duration, extrapolated over an estimated 70-year lifetime, representing the lifetime average daily intake (LADI)~~-~~. This is consistent with the cancer slope factors, which are based on lifetime exposures, and on the assumptions that the risk of carcinogenic effects is cumulative and continues even after exposure has ceased.

For non-occupational scenarios where exposures to children are considered likely, both adult and child receptors were evaluated. Children often exhibit behavior such as outdoor play activities and greater hand-to-mouth contact that can result in greater exposure than for a typical adult. In addition, children also have a lower overall body weight relative to the predicted intake. Because cancer risks are averaged over a lifetime, they are directly proportional to the exposure duration as well as the dose and the potency of the chemical. Accordingly, cancer risks were also assessed for a combined exposure from childhood through adult years, to account for the increased relative exposure and susceptibility associated with childhood exposures.

Superfund exposure assessments should be conducted such that the intake variables for an exposure pathway should result in an estimate of the reasonable maximum exposure (RME) expected to occur under both current and future land use conditions (EPA, 1989). The RME is defined as the highest exposure that is reasonably expected to occur at a site. The intent is to estimate an exposure that is substantially greater than the average, yet is still within the range of possible exposures. In general, this is accomplished by using a combination of 90th or 95th percentile values for contact rate, exposure frequency and duration, and 50th percentile values for other variables. This BHHRA also evaluated central tendency (CT) exposures, which is intended to represent an average exposure by the affected population. Rationale and/or references for each of the RME and CT values for exposure pathways that were quantitatively assessed for each exposure scenario for different populations are presented in exposure factor Tables 3-26 through 3-30 and discussed in the following sections.

3.5.1 Incidental Ingestion of Sediment

The following equation was used to calculate the intake (expressed as milligrams per kilogram per day [mg/kg-day]) associated with the incidental ingestion of contaminants in soil or sediment:

$$CDI / LADI = \frac{C_s \cdot IRS \cdot 10^{-6} kg/mg \cdot EF \cdot ED}{BW \cdot AT}$$

Age-weighted exposures for the combined child and adult receptors were calculated ~~using~~ consistent with the following equations:

$$CDI / LADI = \frac{C_s \times IFS_{adj} \times EF \times 10^{-6} kg/mg}{AT}$$

where:

$$IFS_{adj} = \frac{ED_c \times IRS_c}{BW_c} + \frac{ED_a \times IRS_a}{BW_a}$$

where:

C_s = chemical concentration in soil or sediment (mg/kg)
IFS_{adj} = age-adjusted soil/sediment ingestion factor [(mg-year)/(kg-day)]
IRS_a = adult soil/sediment ingestion rate (mg/day)
IRS_c = child soil/sediment ingestion rate (mg/day)
EF = exposure frequency (days/year)
ED_a = adult exposure duration (years)
ED_c = child exposure duration (years)
BW_a = adult body weight (kg)
BW_c = child body weight (kg)
AT = averaging time (days)

The exposure assumptions for estimating chemical intake from the ingestion of chemicals in sediment are provided in Tables 3-26 and 3-27.

3.5.2 Dermal Contact with Sediment

The following equation was used to calculate exposure resulting from dermal contact with contaminants in soil or sediment:

$$CDI / LADI = \frac{C_S \times ABS \times SA \times AF \times EF \times ED \times 10^{-6} kg/mg}{BW \times AT}$$

Combined child and adult age-weighted exposures resulting from dermal contact with contaminants in sediment for the recreational beach user exposure scenarios were calculated consistent with the following equations:

$$CDI / LADI = \frac{C_S \times SFS_{adj} \times ABS \times EF \times 10^{-6} kg/mg}{AT}$$

where:

$$SFS_{adj} = \frac{ED_c \times AF_c \times SA_c}{BW_c} + \frac{ED_a \times AF_a \times SA_a}{BW_a}$$

where:

C_s = chemical concentration in soil or sediment (mg/kg)
SFS_{adj} = age-adjusted dermal contact factor [(mg-year)/(kg-day)]
ABS = absorption efficiency
SA_a = adult exposed skin surface area (square centimeters [cm^2])
SA_c = child exposed skin surface area (cm^2)
AF_a = adult soil-to-skin adherence factor (mg/cm^2)
AF_c = child soil-to-skin adherence factor (mg/cm^2)
EF = exposure frequency (days/year)
ED_a = adult exposure duration (years)
ED_c = child exposure duration (years)
BW_a = adult body weight (kg)
BW_c = child body weight (kg)
AT = averaging time (days)

The exposure assumptions for estimating exposure from dermal contact with soil or sediment are provided in Tables 3-26 and 3-27.

Dermal absorption of chemicals from soil or sediment adhered to the skin is dependent on a variety of factors, including the condition of the skin, the nature of adhered soil/sediment, and the chemical concentration. Dermal absorption factors, representing the fraction of a chemical absorbed from soil or sediment adhered to the skin, are presented in Table 3-31. Only those compounds or classes of compounds for which dermal absorption factors are presented were evaluated quantitatively via dermal contact, although assuming less than complete absorption may not fully describe risks associated with dermally active compound such as carcinogenic PAHs. The uncertainties associated with the exposure and risk estimates via dermal exposures with soil and sediments are presented in Section 6.

3.5.2.1 Ingestion of Surface Water

Exposure resulting from ingestion of surface water was evaluated using the following equation:

$$CDI / LADI = \frac{C_w \times IR_w \times EF \times ED}{BW \times AT}$$

Combined child and adult age-weighted exposures due to ingestion of surface water were calculated ~~as~~ consistent with the ~~follows~~following equations. For inorganics:~~:~~

$$CDI / LADI = \frac{C_w \times IFW_{adj} \times EF}{AT}$$

where:

$$IFW_{adj} = \frac{ED_c \times IRW_c}{BW_c} + \frac{ED_a \times IRW_a}{BW_a}$$

where:

C_W = chemical concentration in water (mg/L)
IFW_{adj} = age-adjusted water ingestion factor [(L-year)/(kg-day)]
IRW_a = adult groundwater ingestion rate (L/day)
IRW_c = child groundwater ingestion rate (L/day)
EF = exposure frequency (days/year)
ED_a = adult exposure duration (years)
ED_c = child exposure duration (years)
BW_a = adult body weight (kg)
BW_c = child body weight (kg)
AT = averaging time (days)

The exposure assumptions for estimating chemical intake from the ingestion of groundwater or surface water are provided in Tables 3-28 and 3-30.

3.5.3 Dermal Contact with Surface Water

Dermal absorption of contaminants due to direct contact with surface water was evaluated using the following equation:

$$CDI / LADI = \frac{DA_{event} \times EV \times EF \times ED \times SA}{AT \times BW}$$

The combined child and adult age-weight absorption of contaminants due to direct contact with surface water was evaluated using the following equation:

$$CDI / LADI = \frac{DA_{event} \times EF \times DFW_{adj}}{AT}$$

The dermally-absorbed dose (DA_{event}) is calculated for organic analytes as a function of the length of exposure and the permeability of the skin to the chemical being absorbed. The rate a chemical enters the skin surface can be greater than the rate by which the chemical is leaving the skin and entering the bloodstream. If exposure is long enough, the chemical enters the skin at the same rate that it exits; this is a condition known as steady-state, designated as t^*. When the exposure duration is less the t^*, the DA_{event} is calculated as:

$$DA_{event} = 2 \times FA \times K_p \times C_w \times CF \sqrt{\frac{6 \times \tau \times ET_{adj}}{\pi}}$$

Formatted: Indent: Left: 0.5", First line: 0"

Formatted: Lowered by 15 pt

Formatted: Subscript

Formatted: Font: Italic

Formatted: Font: Italic

Formatted: Subscript

Formatted: Centered

When the exposure duration is greater than t^*, DA_{event} is calculated as: ~~The combined child and adult age-weighted exposure was calculated consistent with the following equations~~ as follows:

$$DA_{event} = K_p \cdot C_{water} \cdot CF \left[\frac{ET_{adj}}{1+B} + 2 \cdot \frac{1+3B+3B^2}{(1+B)^2} \right]$$

$$\cancel{CDI/LADI} = \frac{C_w \cdot SFW_{adj} \cdot K_p \cdot EF \cdot ET \cdot CF}{AT}$$

The age-adjusted exposure time is calculated as:

$$ET_{adj} = \frac{(ET_c \cdot ED_c) + (ET_a \cdot ED_a \cdot ED_c)}{ED_r}$$

and the age-adjusted dermal contact factor for water, DFW_{adj} is calculated using the following equation:

$$DFW_{adj} = \frac{EV_c \cdot ED_c \cdot SA_c}{BW_c} + \frac{EV_a \cdot ED_a \cdot SA_a}{BW_a}$$

~~where:~~

$$\cancel{SFW_{adj}} = \frac{ED_c \cdot SA_c}{BW_c} + \frac{ED_a \cdot SA_a}{BW_a}$$

Where:

C_w = chemical concentration in water (mg/L)
DA_{event} = dermally absorbed dose (mg/cm^2-event)
DFW_{adj} = age-adjusted dermal contact factor (cm^2-event-day/kg)
~~SFW_{adj} = age-adjusted water dermal contact factor [(cm^2-year)/kg]~~
K_p = dermal permeability coefficient (cm/hour)
τ = lag time (hours)
EV = events per day
EF = exposure frequency (days/year)
ET = exposure time (hours)
FA = fraction of chemical absorbed
CF = ~~Conversion~~ conversion ~~Factor~~ factor (~~0.001~~10^{-3} L/~~cubic centimeter~~cm^3)
ED_a = adult exposure duration (years)
ED_c = child exposure duration (years)
SA_a = adult exposed skin surface area (cm^2)
SA_c = child exposed skin surface area (cm^2)
BW_a = adult body weight (kg)
BW_c = child body weight (kg)

Formatted: Font: Italic
Formatted: Subscript
Comment [KJ22]: Equation needs to be corrected.
Formatted: Lowered by 17 pt
Formatted: Centered
Formatted: Subscript
Formatted: Lowered by 15 pt
Formatted: Centered
Formatted: Subscript
Formatted: Superscript
Formatted: Superscript
Formatted: Superscript

AT = averaging time (days)

~~The absorbed dose per event (CDA$_{event}$) for assessing direct contact with water was calculated using the c~~hemical-specific factors are presented in Tables 3-32 and 3-33. These values were obtained from Appendix B of EPA's Supplemental Guidance for Dermal Risk Assessment (2004). The uncertainties associated with calculating DA$_{event}$ for chemicals with factors outside of the ~~predictive~~ Effective Prediction D~~d~~omain are discussed in Section 6.

3.5.4 Consumption of Fish/Shellfish

The following equation was used to estimate exposure associated with the consumption of fish and shellfish:

$$CDI / LADI = \frac{C_t \times IR \times 10^{-3} kg/g \times EF \times ED}{BW \times AT}$$

Combined child and adult exposure was evaluated ~~using~~ consistent with the following equation:

$$CDI / LADI = \frac{C_t \times IR_{t\_adj} \times 10^{-3} kg/g \times EF}{AT}$$

where:

$$IR_{t\_adj} = \frac{ED_c \times IR_c}{BW_c} + \frac{ED_a \times IR_a}{BW_a}$$

where:

C_t = Contaminant concentration in fish tissue (mg/kg, wet-weight basis)
IR_c = Fish consumption rate - child (g/day, wet-weight basis)
IR_a = Fish consumption rate - adult (g/day, wet-weight basis)
EF = Exposure frequency (days/year)
ED_c = Exposure duration – child (years)
ED_a = Exposure duration – adult (years)
BW_c = Body weight – child (kg)
BW_a = Body weight – adult (kg)
AT = Averaging time (days)

The exposure assumptions used to estimate exposure from fish consumption are presented in Table 3-29.

3.5.5 Calculation of Intake due to Infant Consumption of Human Milk

Exposure to breastfeeding infants due to consumption of human milk was evaluated using a methodology developed by ODEQ, OHA, and EPA Region 10, adapted from EPA's Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions (EPA 1998a) and the Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities (EPA 2005a), and is described in detail in Appendix D of the DEQ Human Health Risk Assessment Guidance (DEQ 2010). The evaluation for this pathway focuses on PCBs, dioxins/furans, DDx, and PDBEs because of the propensity of these chemicals to bioaccumulate. Because the concentration of lipophilic chemicals in human milk is most directly correlated with the steady-state body burden, which itself is directly related to the long-term intake of the chemical, the daily maternal absorbed intake is calculated from the average daily dose to the mother (as calculated in the preceding sections) using the following equation:

$$DAI_{maternal} = ADD_{maternal} \times AE$$

where:

$DAI_{maternal}$ = daily absorbed intake of the mother (mg/kg-day)
$ADD_{maternal}$ = age-adjusted soil/sediment ingestion factor (mg/kg-day)
AE = absorption efficiency of the chemical

The steady-state chemical concentration in milk fat is then calculated as:

$$C_{milkfat} = \frac{DAI_{maternal} \times h \times f_f}{\ln(2) \times f_{fm}}$$

where:

$C_{milkfat}$ = chemical concentration in milk fat (mg/kg-lipid)
$DAI_{maternal}$ = daily absorbed intake of the mother (mg/kg-day)
h = half-life of chemical (days)
f_f = fraction of absorbed chemical stored in fat
f_{fm} = fraction of mother's weight that is fat

Intake for infants via breastfeeding is then calculated as:

$$Intake = \frac{C_{milkfat} \times f_{mbm} \times CR_{milk} \times ED_{inf}}{BW_{inf} \times AT}$$

where:

f_{mbm} = fraction of fat in breast milk
CR_{milk} = consumption rate of breast milk (kg/day)
ED_{inf} = exposure duration of breastfeeding infant (days)

BW_{inf} = average infant body weight (kg)
AT = averaging time (days)

Additional information regarding the evaluation of persistent, bioaccumulative COPCs is presented in Section 5.1.3.

3.5.6 Calculation of Intake for Mutagenic COPCs

Early-in-life susceptibility to carcinogens has long been recognized by the scientific community as a public health concern. In its revised Cancer Assessment Guidelines, EPA concluded that existing risk assessment approaches did not adequately address the possibility that exposures to a chemical in early life may can result in higher lifetime cancer risks than a comparable duration adult exposure (EPA 2005b). In order to address this increased risk, the agency recommends use of a potency adjustment to account for early-in-life exposures. When no chemical-specific data are available to assess directly cancer susceptibility from early-life exposure, the following default Age Dependent Adjustment Factors (ADAFs) are recommended to be used when evaluating a carcinogen known to cause cancer through a mutagenic mode of action.

- 10-fold adjustment for exposures during the first 2 years of life;
- 3-fold adjustment for exposures from ages 2 to <16 years of age; and
- No adjustment for exposures after turning 16 years of age.

Of the COPCs evaluated in this HHRA, EPA considers that there is sufficient weight-of-evidence to conclude the carcinogenic PAHs cause cancer through a mutagenic mode of action.

3.5.7 Incidental Ingestion of Sediment

The following equation was used to calculate the intake in mg/kg-day for mutagenic COPCs associated with incidental ingestion of soil or sediment:

$$CDI/LADI = \frac{C_s \left[\frac{(ED_{0\text{-}2} \times IRS_c) \times 10}{BW_c} + \frac{(ED_{2\text{-}6} \times IRS_c) \times 3}{BW_c} + \frac{(ED_{6\text{-}16} \times IRS_a) \times 3}{BW_a} + \frac{(ED_{16\text{-}30} \times IRS_a) \times 1}{BW_a} \right] \times EF}{AT}$$

where:

C_s = chemical concentration in soil or sediment (mg/kg)
IRS_a = adult soil/sediment ingestion rate (mg/day)
IRS_c = child soil/sediment ingestion rate (mg/day)

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00098 06/25/2019 SEMS_0306065

EF = exposure frequency (days/year)
$ED_{0\text{-}2}$ = exposure duration ages 0-2 (years)
$ED_{2\text{-}6}$ = exposure duration ages 2-6 (years)
$ED_{6\text{-}16}$ = exposure duration ages 6-16 (years)
$ED_{16\text{-}30}$ = exposure duration ages 16-30 (years)
BW_a = adult body weight (kg)
BW_c = child body weight (kg)
AT = averaging time (days)

3.5.8 Dermal Contact with Sediment

The following equation was used to calculate the intake from dermal contact with contaminants in soil or sediment:

$$CDI/LADI = \frac{C_S \left[\frac{ED_{0\text{-}2} \cdot AF_c \cdot SA_c \cdot 10}{BW_c} + \frac{ED_{2\text{-}6} \cdot AF_c \cdot SA_c \cdot 3}{BW_c} + \frac{ED_{6\text{-}16} \cdot AF_a \cdot SA_a \cdot 3}{BW_a} + \frac{(ED_{16\text{-}30} \cdot AF_a \cdot SA_a \cdot 1}{BW_a} \right] \cdot ABS \cdot EF \cdot 10^{-6} kg/mg}{AT}$$

where:

C_s = chemical concentration in soil or sediment (mg/kg)
ABS = absorption efficiency
SA_a = adult exposed skin surface area (square centimeters [cm^2])
SA_c = child exposed skin surface area (cm^2)
AF_a = adult soil-to-skin adherence factor (mg/cm^2)
AF_c = child soil-to-skin adherence factor (mg/cm^2)
EF= = exposure frequency (days/year)
$ED_{0\text{-}2}$ = exposure duration ages 0-2 (years)
$ED_{2\text{-}6}$ = exposure duration ages 2-6 (years)
$ED_{6\text{-}16}$ = exposure duration ages 6-16 (years)
$ED_{16\text{-}30}$ = exposure duration ages 16-30 (years)
BW_a = adult body weight (kg)
BW_c = child body weight (kg)
AT = averaging time (days)

3.5.9 Ingestion of Surface Water

The following equation was used to calculate intake of chemicals associated with ingestion of surface water:

$$CDI / LADI = \frac{C_w \left[\frac{(ED_{0\text{-}2} \times IRW_c) \times 10}{BW_c} + \frac{(ED_{2\text{-}6} \times IRW_c) \times 3}{BW_c} + \frac{(ED_{6\text{-}16} \times IRW_a) \times 3}{BW_a} + \frac{(ED_{16\text{-}30} \times IRW_a) \times 1}{BW_a} \right] \times EF}{AT}$$

where:

C_w	=	chemical concentration in water (mg/L)
IFW_{adj}	=	age-adjusted water ingestion factor [(L-year)/(kg-day)]
IRW_a	=	adult groundwater ingestion rate (L/day)
IRW_c	=	child groundwater ingestion rate (L/day)
EF	=	exposure frequency (days/year)
$ED_{0\text{-}2}$	=	exposure duration ages 0-2 (years)
$ED_{2\text{-}6}$	=	exposure duration ages 2-6 (years)
$ED_{6\text{-}16}$	=	exposure duration ages 6-16 (years)
$ED_{16\text{-}30}$	=	exposure duration ages 16-30 (years)
BW_a	=	adult body weight (kg)
BW_c	=	child body weight (kg)
AT	=	averaging time (days)

The exposure parameters are presented in Tables 3-26 to 3-30.

3.5.10 Population-Specific Exposure Assumptions

Assumptions about each receptor population evaluated in this BHHRA were used to select exposure parameters used to calculate the pathway-specific chemical intakes. Site-specific values are not available for all populations and pathways. Therefore, default values representative of the general U.S. population (EPA 1991b) or values representing best professional judgment based on known human uses of the Study Area were used. The majority of the exposure parameters used in this BHHRA were previously described in the *Exposure Point Concentration Calculation Approach and Summary of Exposure Factors* (Kennedy/Jenks Consultants 2006), which was approved by EPA. Exposure parameters for divers were provided by EPA in its comments on the Round 2 Report. The exposure parameters are discussed below and presented in Tables 3-26 to 3-30. These values represent potential exposures for application at appropriate areas and/or areas agreed upon with EPA and its partners within the Study Area.

3.5.10.1 Dockside Workers

Exposure frequency for dockside workers was assumed to be ~~200~~ 50 days/year for the RME evaluation, and ~~50~~ 44 days/year the CT evaluation. The RME value assumes a dockside worker is exposed to beach sediment one day per week for 50 weeks ~~each~~per year (50 weeks/year is based on the average number of days worked by an

outdoor worker as being 225 days/year, according to the U.S. Census Bureau's *1990 Earnings by Occupation and Education Survey,* and assuming a 5-day work week ~~The value of 200 days/year is slightly less than the EPA default exposure frequency of 225 days/year for outdoor workers, and represents the average number of days worked per year according to the U.S. Census Bureau's *1990 Earnings by Occupation and Education Survey*~~). An exposure duration of 25 years was used, representing an EPA default value for the RME estimate of job tenure. This value is consistent with data from the U.S. Bureau of Labor Statistics showing that the 95th percentile job tenure for men in the manufacturing sector is 25 years. The CT estimate assumed duration of 9 years, representing approximately the 50th percentile of residence time estimates from the U.S. Census Bureau data (EPA, 1997).

Comment [KJ23]: This revision is inconsistent with the LWG's understanding of the agreement. The agreed revision was:
"(the EPA default exposure frequency of 250 days/year assumes 50 weeks of exposure in a year)"

Note that 225 days/year does not equate to 50 weeks/year based on a 5-day work week.

A sediment ingestion rate of 200 mg/day was used for the RME evaluation, based on EPA Region 10 supplemental guidance on soil ingestion rates (EPA, 2000a), and is representative of approximately the midpoint between the recommended values of 100 mg/day for outdoor workers and 330 mg/day for construction workers. An ingestion rate of 50 mg/day was used to estimate CT exposure.

Dermal exposure was assessed assuming that the face, forearms and hands are exposed, representing an exposed skin surface area of 3,300 cm^2, which is representative of the median value (50th percentile) for adults. A body weight of 70 kg, representing the 50th percentile of mean body weights of men and women combined (EPA, 1997a) was used for all adult receptors. RME and CT exposure values for dockside workers are presented in Table 3-26.

3.5.10.2 In-Water Workers

According to the Army Corps of Engineers (Siipola 2004), the Port of Portland conducts the most frequent dredging within the Study Area, thus the exposure factors for workers at Terminal 4 are considered protective of in-water workers for potential in-water sediment exposures throughout the Study Area. Exposure factors for in-water workers were developed based on in-depth interviews with several workers at Terminal 4 who either conduct or oversee activities that could result in contact with in-water sediment. For the RME evaluation, in-water sediment exposures were assumed to occur for 10 of 25 years of employment at a given facility, with an exposure frequency of 10 days of sediment contact per year. For the CT evaluation, contact with in-water sediment is assumed for 4 of 9 years employment at a given facility, with an exposure frequency of 10 days of sediment contact per year. Intake rates for in-water sediment are the same as those used for the dockside worker, which are the default ingestion rate of soil for an industrial worker. RME and CT exposure values for the in-water worker are presented in Table 3-27.

3.5.10.3 Divers

Two different scenarios were evaluated, based on whether the divers wear wet or dry suits. Divers wearing wet suits are assumed to be working as commercial divers

without a full face mask, and wearing either wet gloves or no gloves. An exposure frequency of 5 days/year for the RME evaluation and 2 days/year for the CT evaluation are based on best professional judgment and discussions between EPA, LWG, and commercial divers, as well as the experience of EPA divers who work at the Portland Harbor Superfund site. Exposure durations of 25 years and 9 years were used for the RME and CT estimates, respectively, based on the labor statistics for job tenure described in Section 3.5.9.1.

Sediment ingestion rates were assumed to be 50 percent of the ingestion rate for dockside workers, corresponding to values of 50 mg/day and 25 mg/day, respectively for the RME and CT evaluations. Dermal exposure to sediment for divers wearing a wet suit was evaluated assuming the entire skin surface area was exposed. A value of 18,150 cm^2, representing the median skin surface area for men and women was used for both the RME and CT evaluations. Divers wearing a dry suit (with a neck dam) would likely have only their head, neck, and hands exposure, and a RME value of 2,510 cm^2 was used. Sediment dermal adherence factors for of 0.3 mg/cm^2-event and 0.07 mg/cm^2 event was used for the was used for the RME estimate and CT estimate, respectively. A CT evaluation was not done for divers wearing dry suits.

Incidental ingestion of surface water for both diver scenarios was assumed to be 50 mL/hour for both the RME and CT evaluations (EPA 1989). More recent data regarding estimates of the amount of water ingested by commercial divers indicates that on average, occupational divers ingested 6 mL/dive in freshwater and 10 mL/dive in marine water, with the maximum estimated ingestion ranging between 25 and 100/mL/dive (EPA 2011). Exposure via ingestion and dermal contact was assumed to occur for 4 hours/event for the RME estimate and 2 hours/event for the CT estimate.

Tables 3-27 and 3-28 summarize exposure assumptions for the wet suit and dry suit divers for in-water sediment and surface water, respectively.

3.5.10.4 Transients

Little information is available regarding how long individuals may remain at specific locations or within the Study Area itself. Based on professional judgment, an exposure duration of 2 years was assumed for the RME and 1 year for CT evaluations, exposure frequency was assumed to be daily (365 days/year). Incidental ingestion of sediment was evaluated at the same rates used for the dockside workers (200 mg/day). Dermal exposure was assessed assuming that the face, forearms and hands, and lower legs are exposed, representing an exposed skin surface area of 5,700 cm^2, which represents the median value for adults. A soil adherence factor of 0.3 mg/cm^2 was used based on the expectation that beach sediment would have a greater moisture content than dry soil. An ingestion rate of 2 L/day was used for consumption of surface water, which represents the default value for domestic water use. Tables 3-26 and 3-28 summarize RME and CT exposure values for the transient scenario for beach sediment and surface water, and the reference and rationale for each value.

3.5.10.5 Recreational Beach User

In the absence of specific information regarding the frequency of recreational activities in Portland Harbor, potential exposures are based on best professional judgment, assuming that beach use is most frequent in the summer, with less frequent use in the spring/fall, and only intermittent use in the winter. An exposure frequency of 94 days/year (5 days/week during summer, 1 day/week during spring/fall, and 1 day/month during winter) was used for the RME estimate and 38 days/year (2 days/week during summer, 2 days/month during spring/fall) was used for the CT estimate. Exposure duration for recreational activities is based on the assumption that individuals are largely permanent residents of the Portland area. Accordingly, an exposure duration of 30 years, which represents approximately the 95th percentile of the length of continuous residence in a single location in the U.S. population (EPA 1997) was used for the RME estimate. More recent studies described in the 2011 edition of EPA's Exposure Factors Handbook show the 95th percentile value is closer to 33 years, data from the U.S. Census Bureau indicate that 32 years represents the best estimate of residence time at the 90th percentile. However, the value of 30 years is consistent with other Superfund risk assessments nationwide, and represents a reasonably conservative estimate of total residence time in the area. An exposure duration of 9 years was used for the CT estimate.

Sediment ingestion rates of 100 mg/day for adults and 200 mg/day for children were used, approximating the 95th percentile soil ingestion rates. CT estimates assumed sediment ingestion rates of 100 mg/day for children and 50 mg/day for adults. Dermal exposures were evaluated assuming that the face, forearms and hands, and lower legs are exposed. Median values of 5,700 cm^2 and 2,800 cm^2 were used for adults and children, respectively. A soil-skin adherence of 3.3 mg/cm^2-day was used for children to account for the greater moisture content of beach sediment.

Water temperatures in the Lower Willamette River would typically limit swimming to the summer months, thus the RME estimates for swimming were~~as~~ assumed to occur at a rate of 26 days per year for adults and 65 days per year for children. As discussed in Section 3.5.10.3, incidental ingestion of river water was assumed to occur at a rate of 50 mL/hour while swimming. Based on current recommendations, 50 mL/hr represents mean value, assuming 21mL/hr for adults and 49 mL/hr for children, upper-percentile recommended values are 71 mL/hr for adults and 121 mL/hr for children (EPA 2011). Tables 3-26 and 3-28 summarize RME and CT exposure values for beach sediment and surface water, respectively, for adult and child recreational beach users.

3.5.10.6 Recreational~~/~~ and Subsistence Fishers

Comment [KJ24]: The description of scenarios and discussion in this section is unresolved.

Because there is limited information regarding the frequency of fishing activities within the Study Area, a range of possible exposures was evaluated for people who engage in recreational or subsistence fishing activities by considering both a high- and a low-frequency rate of fishing. RME estimates for high-frequency (subsistence) fishers assumed a fishing frequency of 156 days/year, approximating a rate of

3 days/week. Low-frequency (recreational) fishers were assumed to fish 104 days/year, approximating a rate of 2 days/week. CT estimates assumed a frequency of 52 days/year and 26 days/year for high- and low-frequency fishers, respectively, and are representative of assumed fishing frequencies of 1 day/week and 2 days/month. People engaged in recreational or subsistence fishing were also assumed to be residents of the greater Portland area, therefore exposure durations of 30 years and 9 years, were used for the RME and CT evaluations, respectively, based on the population statistics for residency discussed in Section 3.5.~~9~~10.5.

Incidental ingestion of beach sediment was evaluated assuming 100 mg/day for the RME estimate and 50 mg/day for the CT estimate, representative of soil ingestion rates in a typical residential setting. Rates of 50 mg/day for the RME estimate and 25 mg/day for the CT estimate were used for incidental ingestion of in-water sediment, representing 50 percent of the rates used for beach sediment. An exposed surface area of 5,700 cm^2, representing the face, hands, forearms and lower legs was used to assess dermal exposure to beach sediments, exposures to in-water sediment was assumed to be limited to the hands and forearms, corresponding to a surface area of 1,980 cm^2. Sediment adherence to skin was evaluated using a weighted adherence factor based on exposure to the hands, forearms, and lower legs (EPA 2004). A factor of 25 percent was used to account for the time spent fishing in a single area within the Study Area. Exposure assumptions for beach and in-water sediment contact for recreational/subsistence fishers are presented in Tables 3-26 and 3-27

Information currently available indicates that spring Chinook salmon, steelhead, Coho salmon, shad, crappie, bass, and white sturgeon are the fish species preferred by local recreational fishers (DEQ 2000b, Hartman 2002, and Steele 2002). In addition to recreational fishing, an investigation by the Oregonian newspaper and limited surveys conducted on other portions of the Willamette River indicate that immigrants from Eastern Europe and Asia, African-Americans, and Hispanics are most likely to be catching and eating fish from the lower Willamette either as a supplemental or primary dietary source (ATSDR 2002). These surveys also indicate that the most commonly consumed species are carp, bullhead, catfish, and smallmouth bass, although other species may also be consumed. In conversations that were conducted as part of a project by the Linnton Community Center (Wagner 2004) about consumption of fish or shellfish from the Willamette River, transients reported consuming a large variety of fish, and several said they ate whatever they could catch themselves or obtain from other fishers.

No studies were located that document specific consumption rates of recreational or subsistence anglers in Portland Harbor prior to its listing as a Superfund site. Surveys conducted subsequent to the listing would not be representative of historical, baseline consumption patterns due to subsequent fish advisories and efforts to limit consumption of fish caught from the harbor. Therefore, fish consumption rates from published studies were used to describe the range of reasonably expected exposures relevant to the different populations known to occur in the Portland Harbor area.

Three different rates were evaluated: 17.5 grams per day (approximately 2 eight ounce meals per month), 73 g/ day (10 eight ounce meals per month), and 142 g/day per day (19 eight ounce meals per month). The term "recreational fishers" is intended to encompass a range of the population while focusing on those who may fish on a more-or-less regular basis, and "subsistence fishers" to represent populations with high fish consumption rates, recognizing that fish are not an exclusive source of protein in their diet. Accordingly, 17.5 g/day is considered representative of a CT value for recreational fishers, and 73 g/day was selected as the RME value representing the higher-end consumption practices of recreational fishers. The consumption rate of 142 g/day represents a RME value for high fish consuming, or subsistence, fishers. No CT value was selected because the evaluations based on 17.5 g/day and 73 g/day inform the risks associated with lower consumption rates. Consumption rates for children aged 6 years and younger were calculated by assuming that their rate of fish consumption is approximately 42 percent of an adult, based on the ratio of child-to-adult consumption rates presented in the CRITFC Fish Consumption Survey (CRITFC 1994). The corresponding rates that were used for children are 7 g/day, 31 g/day, and 60 g/day.

The rates of 17.5 g/day and 142 g/day represent the 90th and 99th percentiles, respectively, of per capita consumption of uncooked freshwater/estuarine finfish and shellfish by individuals (consumers and non-consumers) 18 or older, as reported in the Continuing Survey of Food Intakes by Individuals (CSFII) and described in EPA's Estimated Per Capita Fish Consumption in the United States (EPA 2002b). While the values are presented in terms of "uncooked weight," it should not be construed to imply that the fish are consumed raw, as the consumption rates represent adjusted values to account for the amount of fish needed to prepare specific meals. No adjustments were made to contaminant concentrations in raw fish tissue because of the uncertainties associated with accounting for specific preparation and cooking practices.

The CSFII surveys recorded food consumption for two non-consecutive days. "Consumers only" were defined as individuals who ate fish at least once during the 2-day reporting period, individuals who reported not consuming any fish during the reporting period were designated as "non-consumers." For comparison, the 90th and 99th percentile consumption rates for consumers-only are 200 g/day and 506 g/day, respectively (EPA 2002b). Because of the short time period over which the survey is conducted, the results characterize the empirical distribution of average daily per capita consumption rather than describe true long-term average daily intakes. Although 17.5 g/day represents a 90th percentile value, it is considered an average consumption rate for sport fishers (EPA 2000d). Similarly, 142 g/day is considered to be representative of average consumption estimates for subsistence fishers when compared to upper percentile values for consumers only. However, the use of values representative of both non-consumers and consumers is appropriate as it accounts for the fact that some portion of the total diet of fish consumed may come from sources other than Portland Harbor. The consumption rate of 73 g/day is from a creel study

conducted in the Columbia Slough, and represents the 95 percent upper confidence limit on the mean, where 75 percent of the mass of the total fish is consumed (Adolfson 1996).

Consumption of shellfish was evaluated considering only consumption by adults, and assuming that consumption of shellfish is primarily a component of a subsistence diet. Site-specific information regarding consumption of shellfish is not available, thus a range of consumption rates were evaluated. Consumption rates of 3.3 g/day and 18 g/day were selected as representative of CT and RME estimates. These values represent the 50th and 95th percentile consumption rates of shellfish from freshwater and estuarine systems for individuals of age 18 and older in the United States (EPA 2002b). Exposure assumptions for recreational/subsistence fish consumption are presented in Table 3-29, and the uncertainties associated with these consumption rates are discussed in Section 6.

3.5.10.7 Tribal Fishers

Specific information regarding population mobility on Native American populations is less readily available than for the general U.S. population. The evaluation of exposures to Native Americans was based on the premise that they spend their entire lives in the area (EPA 2005c), and a typical lifetime was evaluated as 70 years. Fishing frequency was assumed to be 260 days/yr (5 days/week) for the RME estimate and 104 days/year (2 days/week) for the CT estimate.

Incidental ingestion of beach sediment was evaluated assuming 100 mg/day for the RME estimate and 50 mg/day for the CT estimate. Rates of 50 mg/day for the RME estimate and 25 mg/day for the CT estimate were used for incidental ingestion of in-water sediment, representing 50 percent of the rates used for incidental soil ingestion in a typical residential setting. An exposed surface area of 5,700 cm^2, representing the face, hands, forearms and lower legs was used to assess dermal exposure to beach sediments, exposures to in-water sediment was assumed to be limited to the hands and forearms, corresponding to a surface area of 1,980 cm^2. Sediment adherence to skin was evaluated using a weighted adherence factor based on exposure to the hands, forearms, and lower legs (EPA 2004). A factor of 25 percent was used to account for the time spent fishing in a single area within the Study Area. Exposure assumptions for beach and in-water sediment contact for tribal fishers are presented in Tables 3-26 and 3-27.

Fish consumption by tribal members was evaluated assuming a multi-species diet that includes both resident and anadromous fish (salmon, lamprey, and sturgeon). An overall rate of 175 g/day (approximately 23 eight oz meals per month), representing the 95th percentile of consumption rates for consumers and non-consumers in the CRITFC Survey was used for adult tribal fish consumers. A consumption rate of 73 g/day, representing the 95th percentile of consumption for children from the CRITFC Survey was used for child tribal fish consumers. The CRITFC survey reported that none of the respondents fished the Willamette River for resident fish, and

approximately 4 percent fished for anadromous fish. Overall fish consumption information from the CRITFC survey was used to determine the ingestion rate for each fish species, as shown ~~below~~in the following table:

Species	Grams per day[(a)]	Percent of diet
Salmon	67	38.4
Lamprey	12.3	7.0
Sturgeon	8.6	4.9
Smelt	12.5	7.2
Whitefish	23.2	13.3
Trout	25.1	14.3
Walleye	9.9	5.7
Northern Pikeminnow	3.7	2.1
Sucker	7.3	4.2
Shad	5.2	3.0
Total Consumption Rate	175	100

(a) Rates are based on the weighted mean data in Table 18 of CRITFC 1994.

As shown, consumption rates of anadromous species account for approximately 50 percent of total intake. C~~Thus, c~~onsumption of salmon, lamprey and sturgeon were ~~equally apportioned at a combined consumption rate of 88 g/day~~evaluated at rates of 67 g/day, 12.3 g/day, and 8.6 g/day, respectively. T~~, and t~~he remaining portion of the diet was evaluated assuming equal portions of the four resident fish (smallmouth bass, brown bullhead, common carp, and black crappie) for which tissue data were available. Consumption rates for children were calculated using the same dietary percentages as the adult tribal fish consumers and a total intake of 73 g/day. Exposure assumptions for tribal fish consumption are presented in Table 3-29. Adult salmon, adult lamprey, and sturgeon have life histories such that significant contaminant loading can occur outside of the Study Area, making it problematic to associate tissue concentrations with site contamination. However, including consumption of anadromous fish in conjunction with resident fish provides useful information regarding risks to tribal members who may fish the Lower Willamette River.

3.5.10.8 Domestic/Household Water User

Use of surface water as a household water source was evaluated assuming exposure occurs in a residential setting. Exposure frequency is assumed as 350 days per year (7 days/week for 50 weeks) for both the RME and CT evaluations. As discussed in Section 3.5.9.5, overall exposure duration for residential exposure was assessed as 30 years for the RME estimate and 9 years for the CT estimate. Water ingestion by adults was evaluated at a rate of 2 L/day for the RME estimate, representing the average of the 90th percentiles of two national studies (EPA 1997a). A value of 1.4 L/day was used for the CT estimate, representing the population-weighted means of the same studies. These values are representative of water consumed directly from the tap or used in the preparation of food and beverages for adults. Ingestion rates representing 50th percentile values of 1.4 L/day for RME and 0.9 L/day for CT were used for children aged 6 years and younger.

Dermal exposures during showering or bathing were evaluated assuming a rate of one event per day, with an event duration of 35 minutes (0.58 hr) for the RME and 15 minutes (0.15 hr) for the CT, representing the 95th and 50th percentile values from EPA 1997a. A total skin surface area of 18,000 cm^2, representing estimates of the 50th percentile of mean surface area for adult men and women (EPA 1997a), was used for both the RME and CT estimates. A corresponding mean surface area of 6,600 cm^2 was used for children aged 6 years and younger.

Table 3-30 summarizes the exposure assumptions used to evaluate domestic use of surface water.

3.5.11 Chemical-Specific Exposure Factors and Assumptions

In calculating chemical intakes, certain assumptions were made that were specific to a given chemical or class of chemicals. These chemical-specific assumptions had an effect on both EPCs and intake calculations, and are described below.

3.5.11.1 Arsenic

Although arsenic was analyzed as total arsenic, the toxicity values represent inorganic arsenic. In previous fish tissue studies in the lower Columbia and Willamette Rivers, the percent of inorganic arsenic relative to total arsenic ranged from 0.1 percent to 26.6 percent with an average of 5.3 percent inorganic arsenic in resident fish samples from the Willamette River (Tetra Tech 1995, EVS 2000). Shellfish may have a higher percentage of inorganic arsenic, as measured in studies on the Lower Duwamish River. The Columbia River Basin Fish Contaminant Survey (EPA 2002c) concluded that a "value of 10 percent is expected to result in a health protective estimate of the potential health effects from arsenic in fish." Therefore, 10 percent of total arsenic in tissue was assumed to be inorganic arsenic when calculating. Uncertainties associated with the assumption that 10 percent of the total arsenic is in the inorganic form in fish and shellfish are discussed further in Section 6.

3.5.11.2 PCBs

PCBs were analyzed as Aroclors and congeners in tissue. Where PCBs were analyzed as Aroclors, the summed concentration of individual Aroclors was used in calculating the EPCs. Where PCBs were analyzed as congeners, EPCs were calculated using both the total PCB value (sum of individual congeners) and an adjusted total PCB value. The adjusted total PCB value was calculated by subtracting the concentration of the coplanar PCB congeners from the total PCB concentration. This was done because the coplanar PCB congeners were evaluated separately (as TCDD toxic equivalents [TEQs]) for cancer risks. Further explanation of how PCB congeners were summed is provided in as described in Section 2.2.8.

3.5.11.3 Oral Bioavailability Factors for Sediment

Consistent with EPA guidance (1989), the chemical intake equations calculate the amount of chemical at the human exchange boundaries, not the amount of chemical available for absorption. Therefore, the estimated intakes calculated in this BHHRA are not the same as the absorbed dose of a chemical. However, the toxicity of an ingested chemical depends on the degree to which the chemical is absorbed from the gastrointestinal tract into the body. Per EPA guidance (1989, 2007c), if the exposure medium in the risk assessment differs from the exposure medium assumed by the toxicity value, an adjustment for bioavailability may be appropriate. For purposes of this BHHRA, oral bioavailability factors were not used to adjust the estimated exposures from COPCs in sediment. The uncertainties associated with not considering bioavailability in this BHHRA are discussed in Section 6.

4.0 TOXICITY ASSESSMENT

The toxicity assessment is composed of two steps: (1) hazard identification and (2) dose-response assessment. Hazard identification is the process of determining whether exposure to a chemical may result in a deleterious health effect in humans. It consists of characterizing the nature of the effect and the strength of the evidence that the chemical will cause the observed effect. Dose-response assessment characterizes the relationship between the dose and the incidence and/or severity of the adverse health effect in the exposed population. For risk assessment purposes, chemicals are generally separated into categories based on their toxicological endpoints. The primary basis of this categorization is whether a chemical exhibits potentially carcinogenic or noncarcinogenic health effects. Because chemicals that are suspected carcinogens may also give rise to noncarcinogenic effects, they must be evaluated separately for both effects.

4.1 TOXICITY VALUES FOR EVALUATING CARCINOGENIC EFFECTS

Cancer slope factors are used to estimate the risk of cancer associated with exposure to a chemical known or suspected to be carcinogenic. The slope factor is derived from either human epidemiological or animal studies, and represents an upper bound, generally approximating a 95 percent confidence limit, on the increased cancer risk from a lifetime exposure by ingestion. Slope factors are generally expressed in units of proportion (of a population) affected per mg of substance/kg body weight-day ([(mg/kg-day)$^{-1}$].

In addition to the numerical estimates of carcinogenic potential, a cancer weight-of-evidence (WOE) descriptor is used to describe a substance's potential to cause cancer in humans and the conditions under which the carcinogenic effects may be expressed. This judgment is independent of consideration of the agent's carcinogenic potency. Under EPA's 1986 guidelines for carcinogen risk assessment, the WOE was described by categories "A through E"—Group A for known human carcinogens through Group E for agents with evidence of noncarcinogenicity. Under EPA's 2005 guidelines for carcinogen risk assessment, a narrative approach rather than the alphanumeric categories is used to characterize carcinogenicity. Five standard weight-of-evidence descriptors are used: *Carcinogenic to Humans, Likely to Be Carcinogenic to Humans, Suggestive Evidence of Carcinogenic Potential, Inadequate Information to Assess Carcinogenic Potential, and Not Likely to Be Carcinogenic to Humans).* Slope factors for assessing dermal exposure were derived as described in Section 4.7, and oral and dermal slope factors are presented in Table 4-1.

4.2 TOXICITY VALUES FOR EVALUATING NONCARCINOGENIC EFFECTS

The reference dose (RfD) provides quantitative information for use in risk assessments for health effects known or assumed to be produced through a nonlinear

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00112 06/25/2019 SEMS_0306079

(possibly threshold) mode of action. The RfD, expressed in units of mg of substance/kg body weight-day (mg/kg-day) is defined as an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The use of RfDs is based on the concept that there is range of exposures that exist up to a finite value, or threshold, that can be tolerated without producing a toxic effect. Reference doses are presented in Table 4-2.

4.3 SOURCES OF TOXICITY VALUES

The following hierarchy of sources of toxicity values is currently recommended for use at Superfund sites (EPA 2003b):

- Tier 1 – EPA's Integrated Risk Information System (IRIS) database (EPA 2010b) is the preferred source of information because it normally represents the official EPA scientific position regarding the toxicity of the chemicals based on the data available at the time of the review. IRIS contains RfDs and cancer slope factor (SFs) that have gone through a peer review and EPA consensus review.
- Tier 2 - EPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) are toxicity values derived for use in the Superfund Program when such values are not available in IRIS. PPRTVs are derived after a review of the relevant scientific literature using the methods, sources of data and guidance for value derivation used by the EPA IRIS Program. The PPRTV database includes RfDs and SFs that have undergone internal and external peer review. The Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center (STSC) develops PPRTVs on a chemical-specific basis when requested by EPA's Superfund program.
- Tier 3 - Tier 3 includes additional EPA and non-EPA sources of toxicity information. Priority is given to those sources of information that are the most current, the basis for which is transparent and publicly available, and which have been peer reviewed. Tier 3 sources may include, but need not be limited to, the following sources:
    - The California Environmental Protection Agency (Cal EPA) Toxicity Criteria Database (Cal EPA 2008) includes toxicity values that have been peer reviewed.
    - The ATSDR Minimal Risk Levels are similar to RfDs and are peer reviewed.
    - Health Effects Assessment Summary Table (HEAST) toxicity values are currently under review by the STSC to derive PPRTVs. The toxicity values remaining in HEAST are considered Tier 3 values.

Trichloroethylene cancer potency was evaluated using the geometric mid-point of the slope factor range from EPA 2001b as recommended by EPA Region 10 (EPA 2007b). Recommendations were not provided for evaluating oral exposures for noncancer endpoints for trichloroethylene.

4.4 CHEMICALS WITH SURROGATE TOXICITY VALUES

If a toxicity value was not available from the above hierarchy for a specific chemical, a structurally similar chemical was identified as a surrogate. The reference dose or slope factor for the surrogate chemical was selected as the toxicity value and the surrogate chemical was indicated in Tables 4-1 and 4-2. The following chemicals were evaluated using surrogate toxicity criteria:

- Butyltin. The toxicity of organotin compounds is somewhat determined by the nature and number of groups bound to tin. In general, toxicity decreases as the number of linear carbons increases and as the number of substitutions decrease. As a health protective approach, RfD for dibutyltin compounds was selected as a surrogate for butyltin.

- Acenaphthylene is classified as category D (not classifiable as to human carcinogenicity). The RfD for acenaphthene, which is the most structurally similar PAH, was selected as a surrogate for acenaphthylene.

- Benzo(e)pyrene. As a health protective approach, the RfD for pyrene was used as a surrogate for benzo(e)pyrene.

- Benzo(g,h,i)perylene is classified as category D (not classifiable as to human carcinogenicity). As with benzo(e)pyrene, the RfD for pyrene was used as a surrogate for benzo(g,h,i)perylene.

- Dibenzothiophene. Fluorene the most structurally similar PAH with available toxicity values. Hence, the RfD for fluorene was used as a surrogate for dibenzothiophene.

- Dibenzofuran. The RfD for flourene, which represents the most structurally similar compound for which an RfD was available was selected as a surrogate for dibenzofuran.

- Di-n-octyl phthalate. The RfD for dibutyl phthalate was selected as a surrogate for di-n-octyl phthalate.

- Perylene. The RfD for pyrene was selected as a surrogate for perylene.

- Phenanthrene. The RfD for pyrene was selected as a surrogate for phenanthrene.

- Retene. The RfD for pyrene was selected as a surrogate for retene.
- Endrin aldehyde. Endrin aldehyde can occur as an impurity of endrin or as a degradation product (ATSDR 1996). The RfD for endrin was used as a surrogate for endrin aldehyde.
- Endrin ketone. Endrin ketone can occur as an impurity of endrin or as a degradation product (ATSDR 1996). The RfD for endrin was used as a surrogate for endrin ketone.
- 4-Nitrophenol. The RfD for 4-methylphenol was used as a surrogate for 4-nitrophenol.

4.5 CHEMICALS WITHOUT TOXICITY VALUES

No SF and RfD or other suitable surrogate values were obtained for titanium and delta-hexachlorocyclohexane (delta-HCH). Titanium is a naturally occurring element and has been characterized as having extremely low toxicity (Friberg et al. 1986). An STSC review concluded that the other hexachlorocyclohexane isomers could not be used as surrogates for delta-HCH due to differences in toxicity (EPA 2002d). Accordingly, the potential risks from titanium and delta-HCH are discussed qualitatively in the uncertainty assessment in Section 6.

SFs and RfDs were not identified for lead because lead was evaluated through comparison with benchmark concentrations that are based on blood lead levels. Benchmark concentrations for child exposure scenarios were predicted by the Integrated Exposure Uptake Biokinetic (IEUBK) model. Benchmark concentrations for adult exposure scenarios were predicted by the Adult Lead Methodology (ALM). Uncertainties associated with using these benchmark concentrations are discussed in Section 6.4.4.

4.6 TOXICITY VALUES FOR CHEMICAL CLASSES

Certain toxicity values are based on exposure to more than one isomer and not to individual chemicals. As a result, the risks were evaluated for the combined exposure rather than on an individual chemical basis. COPCs that were evaluated for toxicity as classes are indicated in Tables 4-1 and 4-2, and are discussed below.

- Chlordane: The chlordane toxicity values were derived for technical chlordane, which is composed of a mixture of chlordane isomers. The chlordane isomers analyzed in Round 1, Round 2, and Round 3 samples were alpha-chlordane, *trans*-chlordane, *cis*-nonachlor, *trans*-nonachlor, and oxychlordane. These isomers were summed in a total chlordane concentration. The SF and RfD for technical chlordane were used to evaluate total chlordane.

- DDD, DDE, and DDT: Technical DDT includes 2,4'-DDT and 4,4'-DDT, as well as 2,4'-DDE, 4,4'-DDE, 2,4'-DDD, and 4,4'-DDD. Although individual slope factors are available for DDD, DDE, and DDT based on studies conducted using the 4,4' isomers, the potency of the 2,4' isomers was assumed to be equal to that of the 4,4' isomers, and cancer risks assessed as the sum of the 2,4' and 4,4' isomers. Additionally, the RfD for DDT was used as a surrogate to evaluate the noncancer effects of DDD and DDE.

- Endosulfan: The RfD for endosulfan was derived from studies using technical endosulfan, which includes alpha-endosulfan, beta-endosulfan, and endosulfan sulfate. The individual endosulfan results were summed to give a total endosulfan concentration, and the RfD for technical endosulfan was used to evaluate total endosulfan.

- PCBs: The cancer slope factor for PCBs is based on administered doses of Aroclors (Aroclor 1016, 1242, 1254, or 1260), and was used to assess the cancer risks for total PCBs measured either as congeners or Aroclors. As discussed in Section 2.2.8, total PCB concentrations were calculated as either the sum of Aroclors or individual congeners. Where PCBs were reported as individual congeners, an adjusted PCB concentration was calculated by subtracting the sum of total dioxin-like PCB congener concentrations from the sum of all congeners. Dioxin-like PCB congeners were evaluated separately using the slope factor for 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) as described below. This approach may double-count a portion of the toxicity of the dioxin-like PCBs, as discussed in Section 6.3.6. The RfD for Aroclor 1254 was used to evaluate the noncancer endpoint for total PCBs, measured either as total unadjusted congeners or as Aroclors.

- Dioxins and furans: Toxic Equivalency Factors (TEFs) from the World Health Organization (WHO) (Van den Berg 2006) were used to evaluate carcinogenic effects of dioxin and furan congeners and for dioxin-like PCB congeners (see Table 4-3). Concentrations of individual congeners are multiplied by their respective TEF to provide a 2,3,7,8-TCDD-equivalant concentration (TEQ), the resulting TEQs are then summed into a total 2,3,7,8-TCDD TEQ. Cancer risk were assessed using the slope factor for 2,3,7,8-TCDD was used to evaluate the cancer endpoint of the TEQ for dioxin and furan congeners, as well as for dioxin-like PCB congeners. The ATSDR MRL for 2,3,7,8-TCDD was used in conjunction with the TEQ approach for dioxin and furan congeners, and for dioxin-like PCB congeners.

- Carcinogenic PAHs: Individual carcinogenic PAHs were evaluated for toxicity based on their potency equivalency factor (PEF), which estimates cancer potency relative to benzo(a)pyrene (EPA 1993). The toxicity values for individual PAHs shown in Table 4-1 incorporate their respective PEFs. Risk

from both individual and total carcinogenic PAHs was assessed in this BHHRA.

4.7 DERMAL ASSESSMENT

Toxicity is a function of contaminant concentration at critical sites-of-action. However, most oral reference doses and slope factors are expressed as an administered dose, whereas exposure estimates for dermal exposures are based on the absorbed dose. Anatomical differences between the gastrointestinal tract and the skin can affect rate as well as the extent of absorption. Thus, the route of exposure may significantly affect the critical dose at the site-of-action. A further complication is that an orally administered dose experiences "hepatic first-pass" metabolism, which may significantly alter the toxicity of the administered chemical. Additionally, some chemicals can cause cancer or other effects through direct action at the point of application. For such locally active compounds, it may be inappropriate to evaluate risks based on oral response data.

As recommended by EPA guidance (EPA 2004), an adjustment to the oral toxicity factor to account for the estimated absorbed dose was applied when the toxicity value derived from the critical study was based on an oral dose and GI absorption of the chemical is less than 50 percent from a medium similar to the one used in the critical study.

Dermal RfDs for assessing dermal exposure were calculated using the following equation:

$$RfD_{dermal} = RfD_o \times ABS_{GI}$$

RfD_{dermal} = dermal reference dose (mg/kg-day)
RfD_o = ~~child exposure duration~~oral reference dose (~~years~~mg/kg-day)
ABS_{GI} = fraction of contaminant absorbed in gastrointestinal tract

Cancer slope factors for assessing dermal exposure were calculated as follows:

$$SF_{dermal} = \frac{SF_o}{ABS_{GI}}$$

SF_{dermal} = dermal cancer slope factor $(mg/kg\text{-}day)^{-1}$
SF_o = oral cancer slope factor $(mg/kg\text{-}day)^{-1}$
ABS_{GI} = fraction of contaminant absorbed in gastrointestinal tract

5.0 RISK CHARACTERIZATION

Risk characterization integrates the information from the exposure assessment and toxicity assessment, using a combination of qualitative and quantitative information to provide numerical estimates of potential adverse health effects. Risk characterization is performed separately for carcinogenic and noncarcinogenic effects. Carcinogenic risk is expressed as the probability that an individual will develop cancer over a lifetime as a result of exposure to a potential carcinogen. Noncarcinogenic hazards are evaluated by comparing an estimated exposure level or dose with a reference dose that is without appreciable risk of adverse health effects.

5.1 RISK CHARACTERIZATION METHODOLOGY

This section describes how noncancer hazards and cancer risks were estimated in this BHHRA.

5.1.1 Noncancer Hazard Estimates

The potential for adverse noncancer health effects is generally addressed by comparing the CDI to the corresponding RfD to yield a hazard quotient (HQ; EPA 1989):

$$HQ = \frac{CDI}{RfD}$$

The calculation of a HQ assumes that exposures less than the RfD are unlikely to result in adverse health effects, even for sensitive populations. By definition, when the HQ is less than 1, the estimated exposure is less than the RfD and adverse health effects are unlikely. Unlike cancer risks, the HQ does not represent a statistical probability, and the likelihood of adverse effects does not increase in a linear fashion relative to a HQ of 1. Rather, exposures greater than the RfD may result in adverse health effects, but all RfDs do not have equal precision and are not based on the same severity of effects. HQs for individual chemicals were summed to yield a cumulative hazard index (HI). Although a HI provides an overall indication of the potential for noncancer hazards, dose additivity is most appropriately applied to chemicals that induce the same effect via the same mechanism of action. When the HI is greater than 1 due the sum of several HQs of similar value, it is appropriate to segregate the chemical-specific HQs by effect and mechanism of action. In this BHHRA, when the calculated HI was greater than 1, HQs based on the same target organ system were calculated. The target organs or systems on which the RfDs are based are presented in Table 5-1.

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00118 06/25/2019 SEMS_0306085

5.1.2 Cancer Risk Estimates

The cancer slope factor converts the estimated daily intakes averaged over a lifetime directly to an incremental cancer risk. Cancer risks are calculated by multiplying the estimated LADI of a carcinogen by the SF (EPA 1989):

$$Risk = LADI \times SF$$

The dose-response relationship is generally assumed to be linear through the low-dose portion of the dose-response curve. That is, the risk of developing cancer is assumed to be directly associated with the amount of exposure. However, this linear relationship is valid only when the estimated risk is less than 0.01 (1×10^{-2}). Where contaminant concentrations result in an estimated risk greater than 1×10^{-2}, the following equation was used (EPA, 1989):

$$Risk = 1 - e^{-LADI \times SF}$$

Because the slope factor typically represents an upper confidence limit, carcinogenic risk estimates generally represent an upper-bound estimate, and EPA is confident that the true risk will not be greater than risk estimates obtained using this model, and they may be less than that predicted. Cancer risk estimates for individual chemicals and different exposure pathways were summed where exposure was assumed to be concurrent to obtain the cumulative excess lifetime cancer risk for each receptor and/or exposure scenario.

5.1.3 Infant Consumption of Human Milk

As discussed in Section 3.3.7, infant exposure to persistent, lipophilic contaminants via breastfeed was quantitatively evaluated in the BHHRA. Using the methodology presented in Section 3.5.5, DEQ determined that the magnitude of the difference in the risk and hazard estimates between the infant and the mother remain constant regardless of the maternal exposure pathway or dose, and can be expressed as infant risk adjustment factors (IRAFs, DEQ 2010):

$$Risk_{infant} = Risk_{mother} \times IRAF_{ca}$$

$$HQ_{infant} = HQ_{mother} \times IRAF_{nc}$$

where:

HQ_{infant} = hazard quotient for breast-fed infant
HI_{mother} = hazard quotient for the mother
$Risk_{infant}$ = cancer risks to breast-fed infant
$Risk_{mother}$ = cancer risks to the mother
$IRAF_{ca}$ = infant risk adjustment factor for carcinogenic effects
$IRAF_{nc}$ = infant risk adjustment factor for noncancer effects

Where combined child and adult exposures were evaluated, the combined child/adult risks were used as the maternal cancer risk for assessing risks to infants. The chemical-specific IRAFs are presented in the following table:

Chemical	$IRAF_{ca}$	$IRAF_{nc}$
PCBs	1	25
Dioxins/Furans	1	2
DDx	0.007	2
PBDEs	1	2

5.1.4 Risk Characterization for Lead

Health effects associated with exposure to inorganic lead and compounds are well documented and include neurotoxicity, developmental delays, hypertension, impaired hearing acuity, impaired hemoglobin synthesis, and male reproductive impairment. Importantly, many of lead's health effects may occur without other overt signs of toxicity. Lead has particularly significant effects in children, and it appears that some of these effects, particularly changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold. Because of the difficulty in accounting for pre-existing body burdens of lead and the apparent lack of threshold, EPA determined that it was inappropriate to develop a RfD. The Centers for Disease Control (CDC) has identified a blood lead concentration of 10 micrograms per deciliter (□g/dL) as the level of concern above which significant health effects may occur (CDC 1991), and the concentration of lead in the blood is used as an index of the total dose of lead regardless of the route of exposure (EPA 1994). An acceptable risk is generally defined as a less than 5 percent probability of exceeding a blood lead concentration of 10 □g/dL (EPA 1998).

Using the ALM (EPA 2003c), acceptable lead concentrations in fish tissue that are unlikely to result in fetal blood lead concentrations greater than 10 □g/dL were calculated using the following equation:

$$PbF = \frac{PbB_f / R \cdot GSD^{1.645} - PbB_o - AT}{BKSF \cdot IR_F \cdot AF_F \cdot EF_F}$$

Where:

PbB_a	=	Central tendency of adult blood lead level
PbB_o	=	Adult baseline blood lead level
PbB_f	=	Fetal blood lead level
R	=	Fetal/maternal blood lead ratio
GSD	=	Geometric standard deviation PbB
BKSF	=	Biokinetic slope factor

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00120 06/25/2019 SEMS_0306087

PbF	=	Lead fish tissue concentration
IR_F	=	Consumption rate of fish
AF_F	=	Gastrointestinal absorption of lead from fish
EF_F	=	Exposure frequency for fish consumption
AT	=	Averaging time

The values used in this analysis are presented in Attachment F5. Because the lead models calculate a central tendency or geometric mean blood lead concentration, median values are typically used as inputs. The mean estimate of national per capita fish consumption of 7.5 g/day (EPA 2000b) was used as the consumption rate for recreational fishers, the median consumption rate of 39.2 g/day from the CRITFC study was used for tribal fishers. Using the equation presented above, the target lead concentrations in fish are 5.2 mg/kg for recreational fishers and 1 mg/kg for tribal fishers.

EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model was used to calculate tissue lead concentrations unlikely to result in blood lead concentrations greater than 10 □g/dL in children. Because site-specific values for concentration of lead in soil, house dust, air and drinking water were not readily available, default values were used for those inputs. The ratio of child-to-adult consumption of 0.42 was applied to the median adult consumption rate of 7.5 g/day to obtain a childhood rate of 3.2 g/day for children of recreational fishers. The corresponding lead concentration~~s~~ in fish is 2.6 mg/kg. Assuming a consumption rate of 16.2 g/day for tribal children, representing the 65th percentile consumption rate from the CRITFC survey, the calculated lead concentration in fish is 0.5 mg/kg. Uncertainties associated with the evaluation of lead are discussed further in Section 6.

5.1.5 Cumulative Risk Estimates for Contaminants Analyzed by More Than One Method

In some instances specific contaminants were analyzed by more than one method, and thus more than one EPC calculated for that contaminant. Cumulative risks are presented using the EPC from only one method to avoid double-counting the risks from a given contaminant. When assessing risks associated with sediment exposures, Aroclor data was used because the data set was larger than for congeners. However, because the congener analysis provided lower detection limits, it was preferentially used when available for assessing risks associated with consumption of fish and shellfish. Where metals were analyzed as both total and dissolved fractions in surface water and groundwater seep samples, the EPCs based on total metals were used in the cumulative risk estimates because unfiltered data is generally more representative of typical human exposure.

5.2 RISK CHARACTERIZATION RESULTS

Comment [KJ25]: The discussions of the fish consumption risks and the primary contributors to risk are unresolved issues.

This section presents a summary of the risk characterization results the scenarios described in Section 3. EPA policy (EPA 1991a) states that CERCLA actions are generally warranted when where the baseline risk assessment indicates that a cumulative site risk to an individual using RME assumptions for either current or future land use is greater than the 1 x 10^{-4} lifetime excess cancer risk end of the cancer risk range of 1 x 10^{-4} to 1 x~~x~~ 10^{-6}, or the HI is greater than 1. Accordingly, risk and hazard estimates are generally presented in terms of whether they are greater than the upper end of the cancer risk range of 1 x 10^{-4} or the HI is greater than 1. Uncertainties associated with the assumptions in each exposure scenario are discussed in detail in Section 6. Risks from exposures to PBDEs in in-water sediment and tissue were assessed separately, and are presented in Attachment F3.

5.2.1 Dockside Workers

Risks to dockside workers were estimated separately for each of the eight beaches designated as a potential dockside worker use areas, shown in Map 2-1.

The estimated CT and RME cancer risks are less than 1 x 10^{-4} at all beach areas, and the HI is less than 1 for adults and infants.

5.2.2 In-Water Workers

As discussed in Section 3.2.1.2, in-water workers are described as typically working around in-water structures such as docks, and primarily exposed to in-water sediments. In-water sediment exposure by in-water workers was evaluated in half-mile increments along each side of the river. The estimated CT and RME cancer risks are less than 1 x 10^{-4} at all RM segments, and the RME HIs for adults are less than 1 at any location. The HI for infants at RM 7W is 2 ~~at RM 7W, and~~ due to dioxins and furans ~~are the primary contributors to the estimate~~. These results are presented in Tables 5-21, 5-22, 5-34 and 5-35.

5.2.3 Transients

Risks to transients were estimated separately for each beach designated as a potential transient use area, as well as the use of surface water as a source of drinking water and for bathing. Beaches where sediment exposure was evaluated are shown on Map 2-1. Year-round exposure to surface water for four individual transect stations, Willamette Cove, Multnomah Channel, and for the four transects grouped together to represent Study Area-wide exposure are shown on Map 2-3. The CT and RME risk estimates for beach sediment are less than 1 x 10^{-4} for all locations, and the HI is less than 1. The results of the RME and CT evaluations for exposure to beach sediments are presented in Tables 5-4 and 5-5, respectively.

Estimated CT and RME cancer risks associated with surface water exposures are less than 1 x 10^{-4} at all individual and transect locations, and the HI is less than 1. The results of the RME and CT evaluations are -presented in Tables 5-46 and 5-47, respectively.

As noted in Section 3.3.4, exposure to surface water by transients was also evaluated at the groundwater seep at Outfall 22B. All risk and hazard estimates are less than 1 x 10^{-4} and 1, respectively, and the results are presented in Tables 5-64 and 5-65.

5.2.4 Divers

Commercial divers were evaluated for exposure to surface water and in-water sediment, and assuming the diver was wearing either a wet or a dry suit. As described in Section 3.4.2, in-water sediment exposure by divers is evaluated in half-mile exposure areas for each side of the river, and on a Study Area wide basis. Risks associated with exposure to surface water were evaluated for four individual transect stations, and at single-point sampling stations grouped together in one-half mile increments per side of river.

5.2.4.1 Diver in Wet Suit

The estimated CT and RME cancer risk associated with exposure to in-water sediments is less than 1 x 10^{-4} at all half-mile river segments and for Study Area-wide exposure, and the HI is also less than 1 for adults. The HI for infants is 2 at RM 8.5W for the RME evaluation~~, and PCBs are the primary contributor to the hazard estimate~~ due to PCBs. The RME and CT estimates for adults are presented in Tables 5-31 and 5-32, respectively. RME and CT risk and hazard estimates for infant exposures are presented in Tables 5-42 and 5-43, respectively.

The estimated CT and RME cancer risk associated with exposure to surface water is less than 1 x 10^{-4} for all half-mile river segments, and the HI is less than 1. These results are presented in Tables 5-54 and 5-55, respectively, for the RME and CT evaluations. Indirect exposure to contaminants in surface water by infants via breastfeeding was not evaluated.

5.2.4.2 Diver in Dry Suit

The estimated RME cancer risk is less than 1 x 10^{-4} at all half-mile river segments and for Study Area-wide exposure, and the HI is also less than 1 for adults and infants. The results of the adult RME risk and hazard estimates are presented in Table 5-33, a CT evaluation was not done for a commercial diver in a dry suit.

The estimated RME cancer risk associated with exposure to surface water is less than 1 x 10^{-4} for all half-mile river segments, and the HI is less than 1. These results are presented in Tables 5-56. Indirect exposure to contaminants in surface water by infants via breastfeeding was not evaluated.

5.2.5 Recreational Beach Users

Risks associated with exposure to beach sediment were evaluated separately for each beach designated as a potential recreational use area, shown on Map 2-1. Exposure to surface water was evaluated using data collected from three transect locations and three single-point locations (Cathedral Park, Willamette Cove, and Swan Island Lagoon) shown on Map 2-3.

The estimated CT and RME cancer risks associated with exposure to beach sediments are less than 1 x 10^{-4} at all recreational beach areas, and the HI is also less than 1. These results are presented in Tables 5-6 through 5-11. Indirect exposure to contaminants in beach sediment to infants via breastfeeding was not evaluated.

The results of the risk evaluation for exposure to surface water by recreational beach user are presented in Tables 5-48 through 5-53. The estimated CT and RME cancer risks associated with exposure to surface water are less than 1 x 10^{-4} at all recreational beach areas, and the HI is also less than 1. These results are presented in Tables 5-50 through 5-53.

5.2.6 Recreational/Subsistence Fishers

Recreational and subsistence fishers were evaluated assuming direct exposure to contaminants in sediment and via consumption of fish and shellfish. As discussed in Section 3.2.1.6, exposures associated with beach sediment were assessed at individual beaches designated as potential transient or recreational use areas, in-water sediment exposures were evaluated on a one-half river mile basis per side of the river and as an averaged, Study Area-wide evaluation. Sediment exposures were further assessed as CT and RME evaluations and assuming either a low- or a high-frequency rate of fishing.

5.2.6.1 Sediment-Direct Contact

The estimated CT and RME cancer risks associated with low-frequency fishing exposures to either beach or in-water sediments are less than 1 x 10^{-4} at all areas evaluated. Noncancer hazards associated with adult exposures to beach or in-water sediment are less than 1 at all locations evaluated, the noncancer hazard associated with indirect exposures to infants via breastfeeding is greater than 1 at two locations for in-water sediment: RM 7W (2)~~, where~~ due to dioxin/furans ~~TEQ concentrations are the primary contributor,~~ and RM 8.5W (2)~~, where~~ primarily due to PCBs ~~are the primary contributor~~, with a HQ of 1. These results are presented in Tables 5-16 and 5-17 for beach sediment exposures, and Tables 5-29 and 5-30 for in-water sediment exposures.

The estimated CT and RME cancer risks associated with high-frequency fishing exposures to either beach or in-water sediments are less than 1 x 10^{-4} at all areas

evaluated. For beach sediment, noncancer hazards associated with adult exposure are less than 1 at all locations evaluated. Noncancer hazards associated with adult exposures to in-water sediment are greater than 1 at RM 7W (2)~~, with~~ primarily due to dioxin/furans, with a HQ of 1~~ TEQ concentrations as the primary contributor the noncancer hazard~~. The noncancer hazard associated with indirect exposures to infants via breastfeeding is also greater than 1 at RM 7W (3)~~, where~~ due to dioxin/furans ~~TEQ concentrations are the primary contributor,~~ and RM 8.5W (2)~~, where~~ due to PCBs~~ are the primary contributor with a HQ of 2~~. These results are presented in Tables 5-14 and 5-15 for beach sediment exposures, and Tables 5-26 through 5-28 for in-water sediment exposures.

5.2.6.2 Consumption of Smallmouth Bass

Consumption of both whole body and fillet-only smallmouth bass was evaluated on a river mile basis to account for their relatively small home range. An additional analysis averaging consumption over the entire Study Area was also conducted. The estimated CT and RME cancer risks associated with combined child and adult consumption of whole body smallmouth bass are greater than 1×10^{-4} for all river miles evaluated, and RME cancer risk estimates are greater than 1×10^{3} for each river mile. CT cancer risk estimates are greater than 1×10^{3} at RM 7, RM 11, and at Swan Island Lagoon. Study Area-wide RME risks for recreational and subsistence fishers are 7×10^{-3} and 4×10^{-3}, the CT estimate for recreational fishers is 9×10^{-4}. Values for river miles having the highest estimated RME risks are as follows (for recreational and subsistence fishers, respectively): RM 7 (6×10^{-3} and 1×10^{-2}), Swan Island Lagoon (6×10^{-3} and 1×10^{-2}), and RM 11 (1×10^{-2} and 2×10^{-2}). Dioxins/furans, PCBs and DDx ~~are the primary contributors to the overall risk~~have risk estimates greater than 1- x- 10^{-4} at RM 7; PCBs~~,~~ and ~~to a lesser degree~~ dioxins/furans~~, are the primary contributors~~ have risk estimates greater than 1-x- 10^{-4} in Swan Island Lagoon and at RM 11.

RME risk estimates for fillet-only consumption are all greater than 1×10^{-4}, the CT estimate is greater than 1×10^{-4} at RM 7 and RM 11. Study Area-wide RME risks for recreational and subsistence fishers are 9×10^{-4} and 2×10^{-3}, the CT estimate for recreational fishers is 2×10^{-4}. River miles having the highest estimated risks are (for recreational and subsistence fishers, respectively): RM 7 (9×10^{-4} and 2×10^{-3}) and RM 11 (2×10^{-3} and 3×10^{-3}), fillet-only data were not collected in Swan Island Lagoon. Dioxins/furans and PCBs ~~are the primary contributors to the overall risk as~~have risk estimates greater than 1- x- 10^{-4} at RM 7, PCBs~~, and to a lesser degree dioxins/furans, are the primary contributors in Swan Island Lagoon and~~ have risk estimates greater than 1- x- 10^{-4} at RM 11. These results are presented in Table 5-114.

RME noncancer hazards associated with childhood consumption of whole body smallmouth bass are greater than 1 at all river miles evaluated. Areas with the highest estimated hazard display~~s~~ a pattern similar to those with highest cancer risks. Values for river miles having the highest estimated hazard are as follows (for recreational and subsistence fishers, respectively): RM 7 (300 and 600), Swan Island Lagoon (500

Formatted: Superscript
Formatted: Superscript
Formatted: Superscript
Formatted: Superscript
Formatted: Superscript
Formatted: Superscript
Formatted: Superscript
Formatted: Superscript

and 1,000), and RM 11 (700 and 1,000). The highest values for the CT noncancer hazard estimates for recreational fishers are 70 (RM 7), 200 (RM 11), and 100 (Swan Island Lagoon). Study Area-wide RME hazards for recreational and subsistence fishers are 200 and 500, respectively, the CT estimate for recreational fishers is 60. Dioxins/furans and PCBs ~~are the primary contributors~~result in the highest hazard estimates at RM 7, while PCBs ~~are predominantly the contributor~~result in the highest hazard estimates in Swan Island Lagoon and at RM 11.

RME hazard estimates for fillet-only consumption are also greater than 1 at all river miles. Values for river miles having the highest estimated RME hazard for fillet-only consumption are as follows (for recreational and subsistence fishers, respectively): RM 7 (50 and 90), and RM 11 (100 and 300); fillet-only data were not collected in Swan Island Lagoon. Study Area-wide RME hazards for recreational and subsistence fishers are 70 and 100, respectively, the CT estimate for recreational fishers is 20. PCBs and dioxin/furans ~~are the primary contributors to~~result in the highest ~~the~~ hazard estimates at RM 7 while PCBs ~~are the primary contributor to the~~result in the highest hazard estimates at RM 11. These results are presented in Table 5-94.

RME and CT noncancer hazard associated with indirect exposure to infants via breastfeeding was also assessed. Values for river miles having the highest estimated RME hazard due to consumption of whole body smallmouth bass are as follows (for infant children of recreational and subsistence fishers, respectively): RM 7 (3,000 and 5,000), Swan Island Lagoon (6,000 and 10,000), and RM 11 (8,000 and 20,000). The associated CT estimates for recreation fishers are 600 at RM 7, 1,000 at Swan Island Lagoon, and 2,000 at RM 11. The RME hazard estimates associated with fillet-only consumption are: RM 7 (300 and 600), and RM 11 (2,000 and 4,000), fillet-only data were not collected in Swan Island Lagoon. The comparable CT estimates for recreational fishers are 70 at RM 7, and 500 at RM 11. PCBs ~~are the primary contributors to the estimated~~result in the highest noncancer hazard estimates. These results are presented in Table 5-119.

5.2.6.3 Consumption of Common Carp

Consumption of ~~C~~common carp was evaluated assuming fish were caught from one of five overlapping fishing zones described in Section 3.4.5, as well as on a Harbor-wide basis. The estimated RME cancer risks associated with combined child and adult consumption of whole body common carp are greater than 1×10^{-4} in each fishing zone evaluated~~, and RME cancer risk estimates are greater than 1×10^{-4}~~. Values for fishing zones having the highest estimated risks are as follows (RME estimates for recreational and subsistence fishers, respectively): FZ 3-6 (1×10^{-2} and 2×10^{-2}), FZ 4-8 (3×10^{-2} and 7×10^{-2}, and FZ 8-12 (2×10^{-3} and 5×10^{-3}). The Study Area-wide risk estimates are 4×10^{-2} and 2×10^{-2}. CT estimates for recreational fishers are greater than 1×10^{-4} in all fishing zones, and is 5×10^{-3} when evaluated Study Area-wide. Risk estimates for PCBs, dioxins/furans, and DDx are ~~the primary contributors in FZ 4-8 and PCBs are the primary contributors in FZ 3-6 (dioxins/furans were not analyzed in this FZ)to the estimated risks~~greater than 1- x

10^{-4} assuming whole body consumption~~.~~ ~~dioxins/furans were not analyzed in fillet samples collected from FZs 3-6 and 6-9~~.

The RME risk estimates for fillet-only consumption (for recreational and subsistence fishers, respectively) are: FZ 3-6 (1×10^{-3} and 2×10^{-3}), FZ 4-8 (2×10^{-2} and 4×10^{-2}, and FZ 8-12 (1×10^{-3} and 2×10^{-3}). The Study Area-wide RME risk estimates are 4×10^{-2} and 2×10^{-2}. The CT estimate for recreational fishers is 1×10^{-4} in FZ 0-4, all other CT estimates are greater than 1×10^{-4}. Risk estimates for PCBs, dioxins/furans, and DDx are ~~the primary contributors to the estimated risks~~greater than 1- x- 10^{-4}; ~~dioxins/furans were not analyzed in fillet samples collected from FZs 3-6 and 6-9~~. These results are presented in Table 5-115.

RME noncancer hazards associated with childhood consumption of whole body common carp are greater than 1 in each fishing zone evaluated. Values for fishing zones having the highest estimated hazard are as follows (RME estimates for recreational and subsistence fishers, respectively): FZ 3-6 (900 and 2,000) and FZ 4-8 (3,000 and 5,000). The Study Area-wide estimates are 2,000 and 4,000. The associated CT estimates for recreational fishers is 200 at FZ 3-6, 600 in FZ 4-8, and 500 Study Area-wide. The comparable hazard estimates for fillet-only consumption are: FZ 3-6 (200 and 100), FZ 4-8 (4,000 and 2,000), and 500 Study Area-wide. CT estimates for recreational fishers are 30 in FZ 3-6, 500 in FZ 4-8, and 500 Study Area-wide. PCBs ~~are the primary contributors to~~result in the highest ~~the~~ hazard estimates. These results are presented in Table 5-98

RME noncancer hazards associated with indirect exposure to infants via breastfeeding are greater than 100 in each fishing zone evaluated. Values for fishing zones having the highest estimated hazard are as follows (infant children of recreational and subsistence fishers, respectively): FZ 3-6 (10,000 and 20,000) and FZ 4-8 (30,000 and 60,000); Study Area-wide estimates are 30,000 and 50,000, respectively. The comparable CT estimates for infants of recreational fishers are 3,000 in FZ 3-6, 8,000 in FZ 4-8, and 6,000 Study Area-wide.

RME hazard estimates associated with fillet-only consumption are (for infants of recreational and subsistence fishers, respectively): FZ 3-6 (1,000 and 3,000), FZ 4-8 (30,000 and 50,000); the Study Area-wide estimates are 30,000 and 50,000. CT estimates for infants of recreational fishers are 400 in FZ 3-6, 6,000 at FZ 4-8, and 6,000 Study Area-wide. PCBs ~~are the primary contributors to the~~result in the highest hazard estimates. These results are presented in Table 5-120.

5.2.6.4 Consumption of Brown Bullhead

Data from brown bullhead was combined across two fishing zones, encompassing RMs 3-6 and 6-9, was well as combining these data to provide a Study Area wide assessment. The RME estimates assuming whole body consumption are (for recreational and subsistence fishers, respectively) are 6×10^{-4} and 1×10^{-3} in FZ 3-6, 6×10^{-4} and 4×10^{-3} in FZ 6-9, and 2×10^{-3} and 4×10^{-3} Study Area-wide. The

Formatted: Superscript

Formatted: Superscript

Comment [KJ26]: Recommend that this sentence be moved to the following paragraph where fillet risks are discussed.

Formatted: Superscript

Formatted: Superscript

Comment [KJ27]: Recommend that this sentence be moved to the following paragraph where fillet risks are discussed.

associated CT estimates for recreational fishers are 2 x 10^{-4} in FZ 3-6, 6 x 10^{-4} in FZ 6-9, and 5 x 10^{-4} Study Area wide.

RME risk estimates for recreational and subsistence fishers, respectively, assuming fillet-only consumption are 7 x 10^{-5} and 1 x 10^{-4} in FZ 3-6, and 1 x 10^{-3} and 2 x 10^{-3} in FZ 6-9. The Study Area-wide risk estimates are 1 x 10^{-3} and 2 x 10^{-3}. The associated CT estimates for recreational fishers are 2 x 10^{-5} in FZ 3-6, 3 x 10^{-4} in FZ 6-9, and 3 x 10^{-4} Study Area wide. These results are presented in Table 5-116.

RME noncancer hazards associated with childhood consumption of whole body brown bullhead are greater than 1 in all instances. The RME estimates for recreational and subsistence fishers, respectively, are 40 and 70 in FZ 3-6, 200 and 400 in FZ 6-9, and 200 and 300 Study Area-wide. CT estimates for recreational fishers are 8 in FZ 3-6, 50 in FZ 6-9, and 40 Study Area-wide.

RME hazard estimates assuming fillet-only consumption are 7 and 10 in FZ 3-6, 100 and 300 in FZ 6-9, and 100 and 300 Study Area-wide. CT estimates for recreational fishers assuming fillet-only consumption are 2 at FZ 3-6, 30 at FZ 6-9, and 30 Study Area-wide. These results are presented in Table 5-102.

Assuming whole body consumption of brown bullhead, the RME noncancer hazards associated with indirect exposure to infant children of recreational and subsistence fishers, respectively, via breastfeeding are 300 and 600 in FZ 3-6, 2,000 and 5,000 in FZ 6-9, and 2,000 and 4,000 Study Area-wide. CT estimates for infants of recreational fishers are 70 at FZ 3-6, 600 at FZ 6-9, and 500 Study Area-wide. The RME hazard estimates assuming parental fillet-only consumption are 70 and 100 in FZ 3-6, 2,000 and 3,000 in FZ 6-9, and 2,000 and 3,000 Study Area-wide. CT estimates for infants of recreational fishers are 20 at FZ 3-6, 400 at FZ 6-9, and 400 Study Area-wide. These results are presented in Table 5-121.

5.2.6.5 Consumption of Black Crappie

Data from black crappie was also combined across two fishing zones, encompassing RMs 3-6 and 6-9, was well as combining these data to provide a Study Area wide assessment. RME estimates assuming whole body consumption for recreational and subsistence fishers, respectively, are 3 x 10^{-4} and 6 x 10^{-4} in FZ 3-6, 6 x 10^{-4} and 1 x 10^{-3} in FZ 6-9, and 6 x 10^{4} and 1 x 10^{-3} Study Area-wide. The comparable CT estimates for recreational fishers are 9 x 10^{-5} in FZ 3-6, 2 x 10^{-4} in FZ 6-9, and 2 x 10^{4} Study Area-wide.

RME risk estimates assuming fillet-only consumption are 3 x 10^{-5} and 6 x 10^{-5} at FZ 3-6, 4 x 10^{-5} and 8 x 10^{-5} in FZ 6-9, and 4 x 10^{-5} and 8 x 10^{-5}. CT estimates for recreational fishers are 9 x 10^{-6} in FZ 3-6, 1 x 10^{-5} in FZ 6-9, and 1 x 10^{-5} Study Area-wide These results are presented in Table 5-117.

RME noncancer hazards associated with childhood consumption of whole body black crappie are greater than 1 in all instances. The RME estimates for recreational and subsistence fishers, respectively, are 20 and 40 in FZ 3-6, 40 and 80 in FZ 6-9, and 40 and 80 Study Area-wide. CT estimates for recreational fishers are 8 in FZ 3-6, 50 in FZ 6-9, and 40 Study Area-wide.

RME hazard estimates assuming childhood fillet-only consumption for recreational and subsistence fishers, respectively, are 4 and 8 at FZ 3-6, and 6 and 10 at FZ-6-9. The associated Study Area-wide risk estimates assuming fillet-only consumption are 6 and 10. CT estimates for recreational fishers assuming fillet-only consumption are 2 in FZ 3-6, 30 in FZ 6-9, and 30 Study Area-wide. These results are presented in Table 5-102.

Assuming adult whole body consumption of black crappie, the RME noncancer hazards associated with indirect exposure infants to infant children of recreational and subsistence fishers, respectively, via breastfeeding are 100 and 300 at FZ 3-6, 400 and 700 at FZ 6-9, and 400 and 700 Study Area-wide. CT estimates for infants of recreational fishers assuming fillet-only consumption are 70 in FZ 3-6, 600 in FZ 6-9, and 500 Study Area-wide.

RME hazard estimates for infants of recreational and subsistence fishers, respectively, assuming parental fillet-only consumption are 30 and 60 at FZ 3-6, and 40 and 80 at FZ 6-9. The associated Study Area-wide risk estimates assuming fillet-only consumption are 40 and 80. These results are presented in Table 5-121.

5.2.6.6 Multi-Species Diet

A multi-species diet, comprised of equal proportions of each of smallmouth bass, common carp, brown bullhead, and black crappie was evaluated on a harbor-wide basis. The estimated recreational fisher CT and RME cancer risk estimates for combined child and adult consumption of whole body fish are 2×10^{-3} and 7×10^{-3}, respectively, and the estimated risk for subsistence fishers is 1×10^{-2}. The corresponding CT and RME risk estimates for recreational fishers based on fillet-only consumption are 1×10^{-3} and 6×10^{-3}, respectively. The estimated risk for subsistence fishers is 1×10^{-2}. Risk estimates for PCBs ~~,~~and dioxins/furans~~, and DDx~~ are ~~the primary contributor to the risk estimates~~greater than 1×10^{-4}. These results are presented in Table 5-118.

Formatted: Superscript

Formatted: Superscript

The RME noncancer hazard estimates for childhood consumption of whole body fish for recreational and subsistence fishers are 600 and 1,000, respectively. The associated RME estimates for fillet-only consumption are 500 and 1,000, respectively. PCBs ~~are the primary contributors to the~~result in the highest hazard estimates. These results are presented in Table 5-110.

The RME noncancer hazard estimates for indirect exposure by infants via breastfeeding assuming maternal consumption of whole body fish are 8,000 for

recreational fishing and 10,000 for subsistence fishing.- The associated RME estimates associated with maternal fillet-only consumption are 7,000 for recreational fishing and 1,000 for subsistence.– PCBs ~~are the primary contributors to the~~result in the highest hazard estimates. These results are presented in Table 5-123

5.2.6.7 Consumption of Clams

The estimated RME cancer risks associated consumption of undepurated clams by subsistence fishers are greater than 1 x 10^{-4} at 10 of the 22 river mile sections evaluated. Values for river miles having the highest estimated risks are as follows: RM 5W (6 x 10^{-4}), RM 6E (7 x 10^{-4}), and RM 6W (7 x 10^{-4}). Other areas where the estimated risk is equal to or greater than 1 x 10^{-4} are RM 2E, 3E, 4E, 4W, 7W, 8W, Swan Island Lagoon, 9W, and 11E. The estimated risk Study Area-wide is 4 x 10^{-4}. Carcinogenic PAHs and PCBs ~~are generally the primary contributors to the overall risk,~~pose the highest risks on a Study Area-wide basis. Risk estimates for cPAHs are ~~the primary contributors to the risk estimates~~greater than 1- x- 10^{-4} at RMs 5W and 6W. ~~a~~At RM 7, dioxins/furans result in the highest risk estimates. PCBs ~~and dioxins/furans are the primary contributors~~result in the highest risk estimates in Swan Island Lagoon and at RM 11. No estimated CT cancer risks associated with consumption of undepurated clams are greater than 1 x 10^{-4}. Risks were also evaluated based on consumption of depurated clams at RM 1E, RM 2W, RM 10, RM 11E, and RM 12E. None of the estimated CT or RME cancer risks are greater than 1 x 10^{-4}. These results are presented in Table 5-126.

The estimated RME noncancer hazards associated consumption of undepurated clams by subsistence fishers are greater than 1 at 20 of the 22 river mile sections evaluated. Values for river miles having the highest noncancer hazard are as follows: RM 3E (8), RM 6E (40), RM 9W (8), and RM 11E (10). The estimated noncancer hazard Study Area-wide is 9. ~~Although cPAHs and PCBs are generally the primary contributors to the overall hazard, cPAHs are the primary contributors to the hazard estimates at RMs 5W and 6W.~~ PCBs ~~and dioxins/furans are the primary contributors~~result in the highest hazard estimates at RM 2E, RM- 3E, RM- 6E, RM 8W, Swan Island Lagoon, RM- 9W, and RM- 11E~~in Swan Island Lagoon at, RM 5W, 6W RM 7 and at RM 11~~. The estimated CT hazards associated with consumption of undepurated clams is greater than 1 at RM 6E, where the HI is 7, and PCBs~~are the primary contributor to the~~result in the highest hazard estimate. The estimated hazard associated with consumption of depurated clams is greater than 1 for the RME estimate at RM 11E, where the HI is 7. PCBs ~~are the primary contributor to the~~result in the highest estimated hazard. These results are presented in Table 5-126.

RME noncancer hazard associated with indirect exposure to infants via breastfeeding was also assessed, and the estimated hazard is greater than 1 at each river mile evaluated. Values for river miles having the highest estimated hazard due to parental consumption of clams are as follows (for infant children of subsistence fishers): RM 2E (20), RM 6E (200), and RM 11E (50). These results are presented in Table 5-132.

Formatted: Superscript

Formatted: Superscript

5.2.6.8 Consumption of Crayfish

The estimated RME cancer risks associated consumption of crayfish by subsistence fishers are greater than 1 x 10^{-4} at two of the 32 individual stations evaluated: 07R006 (3 x 10^{-4}) located at RM 7W, and CR11E (3 x 10^{-4}) located at RM 11E. When evaluated -Study Area-wide, the estimated risk is 3 x 10^{-4}. Risk estimates for ~~D~~dioxins/furans are ~~the primary contributors to the estimated risk~~greater than 1- x- 10^{-4} at -07R006~~,~~ and risk estimates for PCBs are ~~the primary contributors~~greater than 1 x- 10^{-4} at CR11E. No estimated CT cancer risks associated with consumption of crayfish are greater than 1 x 10^{-4}. These results are presented in Table 5-129.

The estimated RME noncancer hazards associated consumption of crayfish by subsistence fishers are greater than 1 at six of the 32 individual stations. Stations having the highest estimated hazard are 03R005 (4) located at the end of the International Slip, 07R006 (6), and CR11E (20). The estimated noncancer hazard Study Area-wide is 10. PCBs ~~are generally the primary contributors to the~~result in the highest noncancer hazard at 03R005 and CR11E, dioxins/furans ~~are the primary contributors~~result in the highest noncancer hazard at 07R006. These results are presented in Table 5-129.

RME noncancer hazard associated with indirect exposure to infants via breastfeeding is greater than 1 at 17 of the 32 stations evaluated. Values at locations having the highest estimated hazard due to parental consumption of clams are as follows (for infant children of subsistence fishers): 02R001 (20) at RM 2E, 03R003 (20) at RM 3E, 03R005 (60) at RM 3E, 07R006 (20) at RM 7W~~,~~, 09R002 (30) at RM 9W, and CR11E (400) at RM 11E. The hazard is 200 when evaluated Study Area-wide. These results are presented in Table 5-133.

5.2.7 Tribal Fishers

Tribal fishers were evaluated assuming direct exposure to contaminants in sediment and via consumption of fish. Exposures associated with beach sediment were assessed at individual beaches, in-water sediment exposures were evaluated on a one-half river mile basis per side of the river and as an averaged, Study Area-wide evaluation. Fish consumption was evaluated assuming a multi-species diet consisting of anadromous and resident fish species, and fishing was evaluated on a Study Area-wide basis.

5.2.7.1 Sediment – Direct Contact

The estimated CT and RME cancer risks associated with direct contact to beach sediment is less than 1 x 10^{-4} at all beaches evaluated. The estimated RME cancer risk associated with exposure to in-water sediment is greater than 1 x 10^{-4} at two locations: RM 6W (2 x 10^{-4}) and RM 7W (3 x 10^{-4}). Risk estimates for cPAHs are ~~the primary contributors to the risk estimate~~greater than 1- x- 10^{-4} at RM 6W, risk estimates for dioxins/furans are ~~the primary contributors~~greater than 1- x- 10^{-4} at RM 7W. These results are presented in Table 5-12 and 5-13.

Comment [KJ28]: Consistent with Section 5.2.6.7, risks and hazards for the 3.3 g/day ingestion rate should be discussed.

Formatted: Superscript
Formatted: Superscript
Formatted: Superscript
Formatted: Superscript
Formatted: Superscript
Formatted: Superscript
Formatted: Superscript
Formatted: Superscript

With the exception of in-water sediment exposure at RM 7W, the estimated non-cancer hazard is less than one at all beach and in-water locations evaluated. The estimated hazard is 3 at RM 7W, ~~and~~ primarily due to dioxins/furans ~~are the primary contributors to the estimate~~, with a HQ of 2. These results are presented in Tables 5-12 and 5-13.

Noncancer RME hazard estimates associated with indirect exposure to infants via breastfeeding was evaluated assuming maternal exposure to in-water sediment. The estimated hazard is greater than 1 at 3 locations, RM 7W (5), RM 8.5 (4), and RM 11E (2). These results are presented in Table 5-40.

5.2.7.2 Fish Consumption

The estimated RME cancer risks for the combined child and adult exposure is 2 x 10^{-2} assuming whole body consumption, and 1 x 10^{-2} assuming consumption of fillets only. Risk estimates for PCBs, ~~and to a lesser extent~~ dioxins/furans, and arsenic ~~are the primary contributors to the overall risk estimates~~are greater than 1- x- 10^{-4}. These results are presented in Table 5-71.

Formatted: Superscript

Formatted: Superscript

The RME noncancer hazard associated with childhood consumption of whole body fish is 800, and is 600 assuming consumption of fillets only. PCBs, and to a lesser extent dioxins/furans, ~~and arsenic, and DDx are the primary contributors to the overall risk~~result in the highest noncancer hazard estimates. These results are presented in Table 5-69.

The RME noncancer hazard associated with indirect exposure of tribal infants via breastfeeding assuming maternal consumption of whole body fish is 9,000, and is 8,000 assuming maternal fillet-only consumption. PCBs ~~are the primary contributors to the~~result in the highest hazard estimates. These results are presented Table 5-72.

5.2.8 Domestic Water Use

Use of surface water as a source of household water for drinking and other domestic uses was evaluated using data from five transect and 15 single point sampling locations, as well as averaged over a Study Area-wide basis. The estimated cancer risk for combined child and adult exposures is greater than 1 x 10^{-4} at W031 (3 x 10^{-4}), located at RM 6W. PAHs are the primary contributor to the estimated cancer risk. However, dermal exposure is the primary pathway contributing to the risk estimate, and as described in EPA 2004, the physical-chemical properties of several PAHs, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene), place them outside of the Effective Prediction Domain used to estimate the absorbed dermal dose from water. Although PAHs are direct-acting carcinogens, the risk estimates associated with estimating dermal absorption from water have a greater degree of uncertainty than the other risk estimates presented in this BHHRA. These results are presented in Table 5-62.

The estimated noncancer hazard based on childhood exposure is equal to or greater than 1 at several sampling locations: W005 (1) at RM 4~~E~~, W023 (1) at RM 11, W027 (2) near the mouth of Multnomah Channel, and W035 (2) in Swan Island Lagoon. In all instances, MCPP is the primary contributor to the estimated hazard. These results are presented in Table 5-59.

5.3 CUMULATIVE RISK ESTIMATES

Cumulative risk and hazard estimates were calculated for those populations where concurrent exposure to more than one media was assumed to be plausible. Recreational/subsistence and tribal fishers were further evaluated on the basis of whether they were assumed to fish predominately from the shore or from a boat. Populations for which concurrent exposure to more than one media was considered for are as follows:

- Transients: Beach sediment, ~~in-water sediment,~~ surface water
- Divers: In-water sediment, surface water
- Recreational beach users: Beach sediment, surface water
- Recreational fishers (beach): Beach sediment, fish tissue (fillet or whole body)
- Recreational fishers (boat): In-water sediment, fish tissue (fillet or whole body)
- Subsistence fishers (beach): Beach sediment, fish tissue (fillet or whole body), shellfish tissue
- Subsistence fishers (boat): In-water sediment, fish tissue (fillet or whole body), shellfish tissue
- Tribal fishers (beach): Beach sediment, fish tissue (fillet and whole body)
- Tribal fishers (boat): In-water sediment, fish tissue (fillet and whole body)

Cumulative risk estimates are generally presented for each one-half river mile per side of the river, and the risk estimates for specific media appropriate to each one-half mile segment were used to calculate the total risk or hazard. For example, cumulative risks for subsistence fishers who fish from a boat and consume smallmouth bass would include the risks associated with exposure to in-water sediment at the specific half-mile, shellfish collected within same half-mile and side-of-river specific segment, and smallmouth bass from the larger river mile assessment. The results of the cumulative risk estimates are presented in Table 5-xxx through 5-xxx. Chemicals that resulted in a cancer risk greater than 1 x 10^{-6} or an HQ greater than 1 under any

of the exposure scenarios for any of the exposure point concentrations evaluated in this BHHRA are presented in Table 5-xxx.

5.4 SUMMARY OF RISK CHARACTERIZATION

Cancer risk and noncancer hazard from site-related contamination was characterized based on current and potential future uses at Portland Harbor, and a large number of different exposures scenarios were evaluated. Exposure to bioaccumulative contaminants (PCBs, dioxins/furans, and organochlorine pesticides, primarily DDx compounds, via consumption of resident fish consistently poses the greatest potential for human exposure to in-water contamination. In general, the risks associated with consumption of resident fish are greater by an order of magnitude or more than risks associated with exposure to sediment or surface water. The greatest non-cancer hazard estimates are associated with bioaccumulation through the food chain and exposure to infants via breastfeeding. Because the smallest scale over which fish consumption was evaluated was per river mile, the resolution of cumulative risks on a smaller scale is not informative. The highest relative cumulative risk or hazard estimates are at RM 2, RM 4, RM 7, Swan Island Lagoon, and RM 11. However, assuming exposure to sediment alone, ~~there are no areas posing the greatest risk are RM 6W, RM 7W, RM 8.5W, and RM 11E~~the risk estimates are greater than 1 x 10^{-4}~~,~~ at RM 6W and 7W for the tribal fisher; the risk estimates for all other locations and scenarios are less than 1 x 10^{-4}. ~~shellfish~~ Assuming shellfish consumption alone, ~~poses~~ the ~~greatest~~ highest relative risk estimates are ~~risks~~ at RM 43E, RM 5W, RM 6W, ~~and~~ RM 6E, RM- 7W and RM- 11E.

~~The results of the BHHRA will be used to derive risk-based PRGs and AOPCs for the FS, as well as to develop risk management recommendations for the Site. In addition, the BHHRA may be consulted by risk managers as they deliberate practical risk management objectives during the course of the FS.~~

Formatted: Superscript

Comment [KJ29]: The agreement was to discuss the risks relative to 1 x 10-4 and not use the term "greatest risk". Also, the agreement was to discuss hazards relative to a HI of 1.

6.0 UNCERTAINTY ANALYSIS

The presence of uncertainty is inherent in the risk assessment process, from the sampling and analysis of chemicals in environmental media to the assessment of exposure and toxicity, and risk characterization. EPA policy calls for numerical risk estimates to always be accompanied by descriptive information regarding the uncertainties of each step in the risk assessment to ensure an objective and balanced characterization of the true risks and hazards.

The term "uncertainty" is often used in risk assessment to describe what are, in reality, two conceptually different terms: uncertainty and variability. Uncertainty can be described as the lack of a precise knowledge resulting in a fundamental data gap. Variability describes the natural heterogeneity of a population. Uncertainty can sometimes be reduced or eliminated through further measurements or study. By contrast, variability is inherent in what is being observed. Although variability can be better understood, it cannot be reduced through further measurement or study, although it may be more precisely defined. However, the additional cost of further data collection may become disproportional to the reduction in uncertainty.

The risks and hazards presented are consistent with EPA's stated ~~risk management~~ goal of ~~being protective of 90 to 95 percent of the potentially exposed population~~RME representing the high end of the possible risk distribution, which is generally considered to be greater than the 90th percentile. However, these estimates are based on numerous and often conservative assumptions and, in the absence of definitive information, assumptions are used to ensure that actual sites risks are not underestimated. The cumulative effect of these assumptions can result in an analysis having an overall conservativeness greater than the individual components. Accordingly, it is important to note that the risks presented here are based on numerous conservative assumptions in order to be protective of human health and to ensure that the risks presented here are more likely to be overestimated rather than underestimated

6.1 DATA EVALUATION

As discussed in Section 2, sediment, surface water, groundwater seep, and biota data were collected during the RI. Data of confirmed quality that meet the DQOs for risk assessment were used in this BHHRA to estimate exposures. Although uncertainty is inherent in environmental sampling, the use of the EPA's DQO planning process (EPA 2000e) minimized the uncertainty associated with the data collected during the RI. A discussion of key data evaluation uncertainties is presented in the following sections.

6.1.1 Use of Target Species to Represent All Types of Biota Consumed

Because it is not practical to collect samples of every resident fish and shellfish species consumed by humans within the Study Area, as recommended by EPA guidance (2000a), target resident species were selected to represent the diet of all types likely consumed by humans. Four target species were collected to represent a diet consisting of resident fish: smallmouth bass, black crappie, common carp, and brown bullhead. Crayfish and clam tissue samples were collected to represent a diet containing locally-harvested shellfish. Factors considered in selecting the target species included likely consumption by humans, home range, the potential for bioaccumulation of COPCs, the trophic level of species, and their abundance.

PCBs generally represent the greatest contributors to the estimated risks, and detected concentrations are highest in smallmouth bass and common carp. Therefore, the use of target resident species as representative of all biota consumed is unlikely to underestimate potential risks. If non-resident species are consumed, the risks may be less, commensurate with the amount of non-resident species present in the diet.

6.1.2 Source of Chemicals for Anadromous and Wide-Ranging Fish Species

Salmon, lamprey, and sturgeon have traditionally represented a substantial portion of the fish diet of tribal members. These species likely spend a substantial portion of their lives outside of the Study Area, and thus contaminant concentrations in these species may bear little relationship to sediment concentrations in the Study Area.

The Washington Department of Ecology analyzed returning fall Chinook salmon, as fillet tissue with skin, collected from three coastal rivers (the Queets, Quinault, and Chehalis Rivers) in 2004 (Ecology 2007). PCBs as Aroclors were detected at concentrations ranging from 5.0 µg/kg to 6.3 µg/kg in the Ecology study, relative to the maximum detected concentration of 20 µg/kg for salmon fillet tissue with skin collected from the Lower Willamette. The dioxin TEQ concentrations ranged from 0.09 picograms per gram (pg/g) to 0.23 pg/g in the Washington coastal rivers relative to the maximum detected concentration of 2 pg/g for salmon fillet tissue with skin collected from the Lower Willamette. A comparison of the tissue concentrations from the Ecology study and the Lower Willamette indicates that the concentration of PCBs measured as Aroclors and congeners are noticeably greater in salmon collected from the Clackamas fish hatchery relative to concentrations detected in the Ecology study. The reported concentrations of total DDT and dioxins as TEQs are generally consistent between the Ecology study and results from Portland Harbor. These results are summarized in Table 6-2. While the Chehalis River passes through some developed areas and therefore may have localized sources, both the Queets and Quinault Rivers are located almost entirely within Olympic National Forest and wilderness areas, so the potential for contribution from localized sources should be minimal. The degree to which contaminant concentrations in anadromous fish are due to exposures that occur within the Study Area is unknown. However, approximately

95 percent of the cumulative tribal fish consumption risk is due to contaminants detected in resident species, even though they only account for 50 percent of the estimated diet. As a result, while sources of bioaccumulative chemicals other than Portland Harbor may contribute to tissue concentrations in anadromous fish species, the uncertainty associated with the source of chemicals to non-resident fish species should not affect the conclusions of this BHHRA for tribal fish consumption.

6.1.3 Use of Either Whole Body or Fillet Samples to Represent Fish Consumption

Different contaminants are preferentially accumulated in different parts of an organism. Organic compounds tend to accumulate to a greater degree in tissues with a higher fat content, while heavy metals accumulate more in muscle tissues. Thus, diets consisting of different parts of the fish would result in varying levels of exposure to the consumer. The COPCs with the greatest contribution to the cumulative risk and hazard are persistent chlorinated organic compounds (PCBs, DDx, and various PCDD/PCDF congeners) that preferentially accumulate in fatty tissue. As discussed in Attachment F6, the difference in measured concentrations between fillet and whole body can be as great as a factor of 10 or more.

Based on information presented in the Columbia Slough consumption survey (Adolfson 1996), the majority of fishers surveyed consume only the fillet, which may not include skin. According to the CRITFC Survey (CRITFC 1994), tribal fish consumers are also most likely to consume the fillet. However, some individuals or groups consume other portions of the fish. Assuming a diet of whole body or fillet tissue with skin represents a conservative assumption and provides a range of risks associated with different dietary habits. Because it is unlikely that a diet consists entirely of whole body tissue, the evaluation of risks associated with consumption of only whole body tissue provides a health protective approach.

6.1.4 Use of Undepurated Tissue to Represent Clam Consumption

Only a limited number clam tissue samples (five of 22) collected in the Study Area were ~~not~~ depurated prior to analysis. Depuration is a common practice in the preparation of clams for human consumption, although they may also be consumed undepurated. With the exception of certain metals, average chemical concentrations detected in clam tissue in the Study Area were higher in undepurated than in depurated samples. However, depurated clam tissue samples were collected from edges of the site at the northern and southern stretches, and the concentrations are shown in Tables 3-24 and 3-25. Using the concentrations from undepurated samples provides a health-protective approach to assessing risk from consumption of clams.

6.1.5 Use of Different Tissue Sample Preparation to Assess the Same Chemical

Samples of resident fish tissue from Round 1 were analyzed for mercury in fillet tissue without skin, while during Round 3, smallmouth bass and common carp samples were analyzed in fillet tissue with skin. The Round 1 and Round 3 datasets were combined for Study Area analysis. For the reasons presented in Section 6.1.3, the comparability of analytical data from fillet tissue with skin and fillet tissue without skin creates uncertainty in the BHHRA. Because mercury preferentially accumulates in muscle tissue, concentrations would be expected to be higher in the fillet tissue samples without skin. However, for smallmouth bass, mercury concentrations were generally higher in fillet tissue with skin, while in common carp mercury concentrations were generally higher in fillet tissue without skin. A comparison of mercury tissue concentrations is provided in Table 6-3. The uncertainty associated with the use of different tissue types to assess risks from mercury should not affect the conclusions of this BHHRA.

6.1.6 Exclusion of Non-Detected ~~Results~~ Chemicals Where Detection Limits Exceeded Analytical Concentration Goals

Although site-specific Analytical Concentration Goals (ACGs) were established for each media, ACGs for some chemicals were not attainable in some instances with present laboratory methods. DLs for chemicals that were analyzed but never detected were compared to the appropriate ACG for each media, and the results of that analysis are presented in Tables 6-5 through 6-7.

Chemicals that were not detected were not quantitatively evaluated in the BHHRA. If chemicals were present at concentrations above the ACGs but below the DLs, those chemicals would contribute to the estimated risk and hazard. However, given the number of chemicals that were detected at concentrations above their respective ACGs and the magnitude of difference between detected concentrations and ACGs, it is unlikely that exclusion of chemicals that were not detected would affect the conclusions of this BHHRA.

6.1.7 Removal of Non-Detected Results Greater Than the Maximum Detected Concentration for a Given Exposure Area

As discussed in Section 3.4, if the DL for non-detected result was greater than the maximum detected concentration for an exposure area, that result not included when calculating the EPC. These results are presented in tables F2-7 through F2-13. Inclusion of non-detected data greater than the maximum detected concentrations would likely have resulted in higher risk estimates in the risk characterization of the BHHRA.

6.1.8 Using N-Qualified Data

As discussed in Section 2.2.3 of the RI, data were qualified using the "N" qualifier, when the identity of the analyte is not definitive, generally a result of the presence of an analytical interference in the sample. Examples include samples analyzed for chlorinated pesticide by EPA Method 8081A, which were most commonly N-qualified as a result of analytical interference due to the presence of PCBs in the samples. These N-qualified data were used in the BHHRA for calculating EPCs in fish and/or clam tissue. The following COPCs were included based solely using N-qualified data, and had estimated cancer risks greater than 1 x 10^{-6} or HQs greater than 1:

- alpha-Hexachlorocyclohexane (fish tissue)
- beta-hexachlorocyclohexane (fish tissue)
- gamma-hexachlorocyclohexane (fish tissue)
- Heptachlor epoxide (clam tissue)

Both the identity and concentration of these contaminants in fish/clam tissue is uncertain, and they were not detected in abiotic media at levels posing risk to human health. A discussion of how EPCs and risk estimates would change for adult consumption of whole body fish tissue and shellfish tissue if N-qualified data were not included in the BHHRA dataset is presented in Attachment F6.

6.1.9 Using One-Half The Detection Limit for Non-Detect Results in Summed Analytes

When data are presented as summed values (e.g., total PCB congeners), one-half the detection limit was used as a surrogate concentration when calculating the summed value for those specific analytes reported as non-detect. Use of one-half the detection limit assumes that there is equal probability that the actual concentration in the sample may be greater or less than the surrogate value. In general, the detection limits for non-detect results were low relative to detected concentrations. In addition, by only including those contaminants that were determined to be present in a given medium, the uncertainty associated with the use of non-detect results was minimized.

6.1.10 Contaminants That Were Not Analyzed in Certain Samples

Not all fish tissue samples were analyzed for the same suite of analytes. For example, fillet samples collected in Round 1 were analyzed for PCB as Aroclors, but no analysis was done for dioxins and furans. Fillet samples of smallmouth bass and common carp collected in Round 3B were analyzed for PCB, dioxin, and furan congeners. In samples where congeners were analyzed, the risks from the total dioxin TEQ, which is not otherwise measured, comprise approximately 1 to 70 percent of the cumulative risks. Therefore, the risks from consumption of black crappie and brown bullhead fillet tissue, which were only analyzed in Round 1, likely

underestimate the actual risks particularly in those areas where PCBs and dioxin/furans are the predominant contaminants.

In addition, not all clam samples were analyzed for the same number of contaminants due to limited tissue mass of some composites collected during Round 2. Table 6-8 presents a listing of analyses not completed for specific samples. Additional samples were collected in Round 3B and analyzed for a greater number of specific contaminants. The Round 2 and Round 3B clam tissue data were combined and evaluated on a river-mile basis in the BHHRA. Therefore, EPCs were available for almost all COPCs in each exposure area.

6.1.11 Chemicals That Were Not Included as Analytes

As it is not practical to analyze for every chemical, specific chemicals and chemical groups were chosen for analysis based on an investigation of known or probable sources at in the LWR. However, the chemicals expected to have the potential for significant contributions to risk are included in the risk assessment. The list of chemicals for analysis was determined in collaboration with EPA and its partners and presented in the approved sampling and analysis plan. Subsequently, there has been interest in two additional groups of chemicals: polybrominated diphenyl ethers (PBDEs) and volatile organic compounds (VOCs) in tissue. Risks have subsequently been assessed for exposures to PBDEs in in-water sediment and resident fish tissue, as presented in Attachment F3.

VOCs were not analyzed in tissue or surface water samples. Because of their nature, VOCs are not expected to accumulate in tissue to a sufficient degree to pose significant risk via consumption relative to the other chemicals detected in tissue. Given the magnitude of concentrations and toxicities of other chemicals that were detected in surface water and tissue, VOCs are unlikely to contribute significantly to the overall risks. Therefore, the lack of analysis for VOCs is unlikely to alter the conclusions of the BHHRA.

6.1.12 Chemicals That Were Analyzed But Not Included in BHHRA

Not all detected chemicals were included in the BHHRA. The following analytes were excluded from assessment are either because there are no suspected sources, or the analyte typically only present adverse health risks at high concentrations:

- Ammonia
- Calcium
- Calcium carbonate
- Carbon dioxide
- Chloride
- Ethane
- Ethylene
- Magnesium
- Methane
- Nitrate
- Nitrite
- Oxygen
- Phosphate
- Phosphorus
- Potassium
- Silica
- Sodium
- Sulfate
- Sulfide

6.1.13 Data Not Included in BHHRA due to Collection Date

Data collected after June 2008 were not included in the BHHRA due to the completion schedule of the RI/FS. These data sets are discussed in the Portland Harbor RI Report, and include a number of in-water sediment samples. However, due to the large spatial coverage of the existing in-water sediment BHHRA dataset, this uncertainty is not expected to affect the overall conclusions of the BHHRA.

6.1.14 Compositing Methods for Biota and Beach Sediment Sampling

Compositing schemes were developed to be representative of the medium sampled and to be representative of each exposure unit. Fish were composited based on an estimate of the average home range for each species (ODFW 2005). The home ranges for common carp and brown bullhead may be as large or larger than the Study Area, the home range for bass may be larger or smaller than the one mile assumed in the BHHRA. For example, bass may only reside on one side of a river mile reach instead of throughout the one mile reach on both sides of the river. Smallmouth bass were composited on a river mile basis, while black crappie, brown bullhead, and carp were composited on a fishing zone basis. Fishing zones for brown bullhead and black crappie were from RM 3-6 and RM 6-9; fishing zones for common carp were from RM 0-4, RM 4-8 and RM 8-12. However, the compositing scheme represents only an approximation of the home ranges of the fish collected, and typically consisted of five individual fish. Replicate composite samples were collected, and risks were evaluated using both the composite samples as well as on a Study Area-wide basis. Where contaminants are evaluated on a harbor-wide basis and/or specific species are wide-ranging, this process is not likely to have an appreciable effect on the conclusions of the BHHRA. However, where samples are composited over an area larger than the actual home range of specific fish species, the result may either over- or underestimate risks, depending on the distribution of contaminant concentrations in the area over which samples are composited. For example, the highest DDx concentrations are located on the west side of the river at RM 7.5, while the EPC for smallmouth bass at that river mile combined data collected from both sides of the river.

Beach sediment was composited on a beach by beach basis, resulting in a single sample result for each exposure area. Uncertainty stems from this compositing scheme because the results of the risk evaluation are dependent on a single sample. Composite samples are generally assumed to represent the area from which the individual samples of the composite were taken, but an unrepresentative individual sample (e.g., one representing extremely localized or ephemeral contamination) used in the composite could significantly bias the composite results. The compositing scheme for beaches results in risk evaluation based on a single sample at a single point in time. If a beach was found to pose an unacceptable risk, additional samples at that beach might be warranted. However, all of the beach sediment exposure

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00141 06/25/2019 SEMS_0306108

scenarios ranged from 8 x 10^{-9} to 9 x 10^{-5}, which are below or within the target risk range of 1 x 10^{-4} to1 x 10^{-6}.

6.1.15 Mislabeling of Smallmouth Bass Fish Sample

One smallmouth bass sample collected from the west side of RM 11 (LW3-SB11W-11) during the Round 3 sampling event was incorrectly recorded as LW3-SB11E-01 (RM 11 east) at the field lab. This fish became part of the final LW3-SB11E-C00B and LW3-SB11E-C00F composite samples, which are the body and fillet composites from RM 11 east. Fish SB11E-01 (actually from SB11W) accounted for 15 percent of both sample types on a mass basis. However, since smallmouth bass exposure areas were assessed on a river mile basis, the data from RM 11E and RM 11W were included in the same EPC calculations, and the effects of this uncertainty are not expected to affect the conclusions of this BHHRA.

6.2 EXPOSURE ASSESSMENT

Uncertainties that arise during the exposure assessment can typically have some of the greatest effect on risk estimates. The following subsections address uncertainties associated with exposure models, exposure scenarios, exposure factors, and EPCs used in the risk estimates.

6.2.1 Subsurface Sediment Exposure

A complete exposure pathway requires the presence of a retention or transport medium, an exposure point, and an exposure route. Subsurface sediment was not considered an exposure medium in the BHHRA because it was assumed that potential human contact with river sediment below 30 cm in depth was unlikely, or that if it does occur, the frequency and extent would be minimal. Situations which may result in human exposure to subsurface include: potential scouring, natural hydraulic events that are not well understood, future development of near-shore and upland properties, maintenance of the navigation channel, ports, and docks, placement and maintenance of cable and pipe crossings, pilings and dolphins, anchoring and spudding of vessels, and exposure to propeller wash from vessels. Due to the low potential of exposure to subsurface sediment, the estimates presented in the BHHRA are considered sufficiently representative of baseline exposures.

6.2.2 Potential Exposure Scenarios

Some of the key uncertainties associated with the exposure scenarios evaluated in the BHHRA are discussed in the following subsections.

6.2.2.1 Shellfish Consumption

A commercial crayfish fishery exists in the LWR, and crayfish landings must be reported to ODFW by water body and county. Per ODFW, the crayfish fishery in the

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00142 06/25/2019 SEMS_0306109

LWR is not considered a large fishery (Grooms 2008), and no commercial crayfish landings were reported for the Willamette River in Multnomah County from 2005 to 2007. DHS had previously received information from ODFW indicating that an average of 4,300 pounds of crayfish were harvested commercially from the portion of the Willamette River within Multnomah County each of the five years from 1997-2001. In addition to this historical commercial crayfish harvesting, DHS occasionally receives calls from citizens who are interested in harvesting crayfish from local waters who are interested in fish advisory information. According to a member of the Oregon Bass and Panfish club, crayfish traps are placed in the Portland Harbor Superfund Site boundaries and collected for bait and possibly consumption (ATSDR 2006). It is not known to what extent non-commercial harvesting of crayfish occurs within the Study Area, if at all, or whether those crayfish are consumed and/or used for bait.

Evidence of current consumption of freshwater clams from Portland Harbor is limited. According to a project conducted by the Linnton Community Center (Wagner 2004), transients reportedly consume clams from the river on a limited and infrequent basis. As part of the project, conversations were conducted with transients about their consumption of fish or shellfish from the Willamette River. These conversations were not conducted by a trained individual and were not documented. Transients reported consuming various fish species, as well as crayfish and clams, and many indicated that they were in the area temporarily, move from location to location frequently, or have variable diets based on what is easily available. Assuming that clam consumption occurs, the Linnton Community Center project suggests that it does not occur on an ongoing basis within the Study Area. DEQ and EPA staff have occasionally received calls from individuals who claim to have harvested clams and are inquiring whether consumption is safe, and individuals ~~of apparent southeast Asian descent~~ have been observed harvesting clams from the shore in Portland. However, the predominant species found in the LWR during sampling events were Asian clams (*Corbicula*), which are an invasive, non-native species. Oregon law (OAR 635–056–0050) prohibits the possession, transportation, and sale of non-native wildlife, and the actual extent to which freshwater clams or other shellfish are currently harvested from Portland Harbor and consumed is not known.

6.2.2.2 Wet Suit Divers

Commercial diving companies in the Portland area were contacted to develop a better understanding of potential diver exposures within the Study Area. All of the diving companies that were contacted indicated that the standard of practice for commercial divers is the use of dry suits and helmets when diving in the LWR (Hutton 2008, Johns 2008, and Burch 2008). EPA Region 10 reported observing divers in wet suits and with regulators that are held with the diver's teeth within the Study Area. An evaluation was also performed of helmet diving with use of a neck dam, which allows can allow water to leak into the diving helmet. Commercial divers as recently as 2009 have been observed using techniques to don a diving helmet which increase exposure

(Sheldrake personal communication with RSS, 2009, DEQ, 2008). The observed wet suit divers were performing environmental investigation and remedial activities, which are not activities evaluated as part of a commercial diver scenario. Also, it is not known whether the individuals who were observed diving in wet suits on specific occasions are diving within the Study Area on a regular basis, as they do not work for the commercial diving companies in the Portland area. Recreational diving also takes place in Portland Harbor (Oregon Public Broadcasting Think Out Loud, "Are you going to swim in that?" August 22, 2008). Therefore, including a wet suit diver scenario with associated ingestion from use of a recreational type regulator, rather than a full face mask or diving helmet, and full body dermal exposure in this BHHRA (in addition to a dry suit diver scenario) is a conservative approach.

6.2.2.3 Potential Future Domestic Water Use

The evaluation of surface water as a domestic water source is based on the assumption that surface water is drawn from the Study Area. Within the Study Area, the LWR is not currently used as a domestic water source. According to the City of Portland, the primary domestic water source for Portland is the Bull Run watershed, which is supplemented by a groundwater supply from the Columbia South Shore Well Field (City of Portland 2008). In addition, the Willamette River was determined not to be a viable water source for future water demands through 2030 (City of Portland 2008). Additionally, although domestic water supply is a designated beneficial use of the Willamette River, OAR 340-041-0340 Table 340A defines the beneficial use only with adequate pretreatment and natural quality that meets drinking water standards. Thus, it is unlikely that individuals at households receiving water from the city would be exposed to contaminants at concentrations greater than the MCL. As presented in Section 5.2.8, cPAHs and MCPP are the only COPCs that posed an estimated cancer risk greater than 1 x 10^{-4} (cPAHs) or a noncancer hazard greater than 1 (MCPP). The uncertainties associated with assessing dermal exposures to dissolved PAHs are discussed further in Section 6.2.4.2. Although there is no MCL established for MCPP, the associated HQ is greater than 1 at only one of the locations evaluated, W035, located at RM 8.5, where the estimated hazard is 2. ~~Therefore, the evaluation of surface water as a domestic water source is a conservative approach and is not based on current knowledge of future planned uses of the Willamette River within the Study Area as a domestic water.~~

Comment [KJ30]: Should include "and natural quality that meets drinking water standards"

6.2.3 Potentially Complete and Insignificant Exposure Pathways

Exposure pathways that have been determined to be potentially complete and insignificant were not evaluated further in this BHHRA. As described in Section 3.2, these exposure pathways have a "source or release from a source, an exposure point where contact can occur, and an exposure route by which contact can occur; however, the pathway is considered a negligible contributor to the overall risk." The exposure pathways identified as potentially complete and insignificant were related to Willamette River surface water exposures to populations evaluated in this BHHRA. Ingestion and dermal absorption of chemicals from surface water were quantitatively

evaluated for the populations that are expected to have the most frequent contact with surface water. Surface water exposures were not evaluated were for dockside workers, in-water workers, tribal fishers, and fishers.

The BHHRA identified and evaluated the exposure pathways that were expected to result in the most significant exposure to COPCs in the Study Area. The magnitude of exposures experienced by populations for these exposure pathways are typically expected to be much greater than that expected for the exposure pathways identified as "insignificant." Thus, the assessment of risk to populations from exposure pathways that were quantitatively evaluated in this BHHRA would be adequately protective of exposed populations in the Study Area. However, the uncertainty associated with not directly evaluating exposure pathways considered insignificant could underestimate risks for the Study Area. Due to the low potential of exposure for these pathways, this uncertainty is not expected to impact the conclusions of this BHHRA.

6.2.4 Exposure Factors

Assumptions about exposure factors typically result in uncertainty in any risk assessment. As discussed previously, the scenarios evaluated are representative of exposures that could occur in the Study Area under either current or future conditions. RME and CT values were used for the exposure scenarios to help assess the overall effect that variability in each of the exposure assumptions has on the risk estimates. The range of risk estimates between these two exposure scenarios provides a measure of the uncertainty surrounding these estimates.

A range of ingestion rates for fish consumption were used to evaluate variability on the risk estimates, thus the resulting risks in this BHHRA represent a range of possible outcomes, including estimates that may be representative of the upper range of plausible exposures.

The following exposure factor uncertainties have been identified and analyzed further to determine the potential effects on the risk estimates:

6.2.4.1 Exposure Parameters for Sediment Exposure Scenarios

The parameters used in the BHHRA to evaluate beach and in-water sediment exposure used were intended to provide conservative estimates based on potential uses in the Study Area.

Beach areas that are accessible to the general public were identified as potential human use areas, even though it is not known whether recreational beach use actually occurs at these locations, and the extent to which the beach may be used and the nature of the contact with sediments is unknown. Future changes in land use may make some beach areas more- or less-accessible to the general public, which increases uncertainty about future exposure. When evaluating in-water sediment, each on-half mile river mile segment on each side of the navigation channel was

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00145 06/25/2019 SEMS_0306112

considered a potential exposure area for all in-water sediment exposure scenarios, regardless of the feasibility or practicality of use of the area. Information from this approach can be used to inform the public about relative risks throughout the river and can help focus the feasibility study.

There are uncertainties associated in the selection of the exposure duration, frequency, and intake parameters used to evaluate both beach and in-water sediment exposures. These scenarios assume long-term repeated use of the same beach or one-half mile river mile segment, which may not accurately reflect actual use practices. The exposure frequencies evaluated range from 94 days/year up to 250 days/year. Default intake parameters for soil exposure were generally used; however, to account for an assumed greater moisture content of beach sediments, the dermal adherence factor used to evaluate child recreational beach exposure was 10-fold greater than the default for soil. Consistent with EPA guidance (2004), only those compounds or classes of compounds for which dermal absorption factors are available were quantitatively evaluated via dermal contact exposure. COPCs for which dermal absorption factors were not available were not quantitatively evaluated, as dermal absorption was essentially assumed to be zero. However, as the majority of COPCs were quantitatively evaluated, this uncertainty does not substantially change the conclusions of this BHHRA. Most of the uncertainties associated with the sediment exposure parameters are likely to overestimate the risks associated with direct exposure to sediment.

6.2.4.2 Exposure Parameters for Surface Water and Groundwater Seep Exposure Scenarios

Although dermal absorption of PAHs from water was quantitatively evaluated in the BHHRA, the dermal permeability coefficient (K_p) falls outside of the effective predictive domain (EPD) for a number of the PAHs, including the following:

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Indeno(1,2,3-cd)pyrene
- Dibenzo(a,h)anthracene

EPA dermal assessment guidance (EPA 2004) states that "although the methodology [for predicting the absorbed dose per event] can be used to predict dermal exposures and risk to contaminants in water outside the EPD, there appears to be greater uncertainty for these contaminants." The range of uncertainty associated with the Kp value can be several orders of magnitude. For instance, the predicted Kp value recommended by EPA (2004) for benzo(a)pyrene is 0.7 centimeters per hour (cm/hr), while the range of predicted Kp values presented by EPA (2004) is 0.024 cm/hr (95 percent lower confidence level) to 20 cm/hr (95 percent upper confidence level). This

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00146 06/25/2019 SEMS_0306113

uncertainty could result in over-estimation or under-estimation of risk from exposure to surface water. With the exception of arsenic, the only exceedances of 1 x 10^{-6} risk from surface water scenarios are the result of dermal exposure to PAHs in surface water. However, all of the surface water exposure scenarios were below or within the target risk range of 1 x 10^{-4} to 1 x 10^{-6}.

6.2.4.3 Exposure Parameters for Fish/Shellfish Consumption Scenarios

Site-specific information regarding fish consumption is not available for Portland Harbor. In the absence of specific data, fish consumption data representative from several sources was considered and selected as being representative of the general population of the greater Portland area, as well as that portion of the population that actively fishes the Lower Willamette and utilizes fish from the river as a partial source of food. However, the rates presented in the CSFII study represent per capita consumption rates rather than true long-term averaged consumption rates. Further, the large range between the percentile values is indicative of substantial variability in the underlying data. For example, consumption rates consumers are 200 g/day at the 90th percentile and 506 g/day at the 99th percentile. The consumption rate for consumers and non-consumers is approximately 18 g/day at the 90th percentile and 142 g/day at the 99th percentile. As discussed in Section 3.5.9.6, the RME consumption rate selected for recreational fishers of 73 g/day is based on data from the Columbia Slough study. That study was a creel survey, and the representativeness of the rate is dependent on several factors, including but not limited to:

- Willingness of anglers to participate
- Communication. If a substantial number of anglers consist of 1st or 2nd generation ethnic minorities, then language may be a barrier.
- Discrepancy between individuals who catch fish and those who prepare meals. Men generally fish but women generally prepare seafood and are much more familiar with the mass of seafood consumed.
- Difficulty in translating from the items inspected in an angler's basket to portion sizes and amounts consumed, since this requires assumptions about edible portions and cleaning factors.
- Lack of a random or representative sample. Interviewers can only speak with who they encounter.
- Timing and seasonality of interviews.
- Weather conditions may bias the results of any day's interviews.

In addition to the consumption rates, uncertainty also exists with respect to the relative percentage of the diet of obtained from the Study Area or within individual exposure areas versus other nearby sources of fish, and the degree to which different methods of preparation and cooking may reduce concentrations of persistent lipophilic contaminants.

Uncertainties associated with tribal consumption rates largely relate to limitations inherent in the CRTFIC consumption survey on which the consumption rates used in the BHHRA are based. These consumption rates may be biased low for tribal members because:

- Tribal members who have a traditional lifestyle (and likely a higher consumption rate) would have been unlikely to travel to the tribal offices that were used for administering the CRITFC fish consumption interviews.
- The fish consumption rates for some tribal members that were perceived as being outliers (consumption rates were too high) were dropped from the CRITFC data before the consumption rates were calculated.
- Current fish consumption rates may be suppressed and, therefore, do not reflect the potential of the higher consumption rates if fishery resources improved or if contaminant concentrations in the water body decrease.

Conversely, conservative assumptions were used with respect to exposure frequency and duration, as well as the relative contribution of fish from the Lower Willamette to the overall tribal diet. According to the CRITFC survey, none of the respondents fished the Willamette River for resident fish and at most, approximately 4 percent fished the Willamette for anadromous fish. However, future use of the site by tribal members may change if fishery resources improved.

Information regarding consumption of shellfish from the Study Area relies in part from information obtained from a community project sponsored by the Linnton Community Center, as discussed in Section 3.3.6. However, it is not known to what extent shellfish consumption actually occurs. Because site-specific shellfish consumption rates are not available, nationwide CSFII (USDA 1998) shellfish consumption data were used. As with the rates for fish consumption, these are based on per capita consumption rates from the general population. In the nationwide survey, shrimp accounted for more than 80 percent of the shellfish consumed, crayfish accounted for less than one percent of diet, and freshwater clams were not included in the nationwide survey. It is not known to what extent fishers substitute alternative local types of shellfish. However, the mean nationwide shellfish consumption rate from freshwater sources is 0.01 g/day; upper percentiles for freshwater shellfish consumption rates are not available (EPA 2002b).

The upper and lower bounds of uncertainty relating to fish ~~the~~ and shellfish consumption is discussed in Attachment F6.

6.2.4.4 Assumptions about a Multi-Species Diet

Uncertainties exist in the assumptions about the relative composition of a multi-species diet. The non-tribal multi-species diet assumes equal proportions of all four resident fish species, the tribal multi-species diet assumed equal proportions of the four resident fish species, as well as dietary percentages of salmon, lamprey, and sturgeon derived from the CRITFC survey. Variations of these dietary assumptions would result in different risk estimates. Because the risks from consumption of the

individual species that make up the multi-species diet were evaluated separately, the range of risks from fish consumption scenarios encompasses the potential variations in the multi-species diet. The range of the magnitude of these risks generally less than an order of magnitude, and is discussed further in Attachment F6. The magnitude in the difference of risk estimates based on diet composition shows that this uncertainty could result in over or under-estimation of actual risks from a multi-species diet.

6.2.5 Exposure Point Concentrations

The following uncertainties related to calculation of EPCs for this risk assessment were analyzed further to determine the potential effects on the risk estimates.

6.2.5.1 Using 5-10 Samples to Calculate the 95 percent UCL on the Mean

Data sets with fewer than 10 samples ~~per exposure area~~ generally provide poor estimates of the mean concentration, defined as a large difference between the sample mean and the 95 percent UCL. In general, the UCL approaches the true mean as more samples are included in the calculation of the EPC. ~~The~~ Study Area-wide fish tissue EPCs that were calculated as the 95 percent UCL on the mean using less than 10 samples~~,~~ included EPCs for whole body brown bullhead and ~~fillet~~ common carp fillet~~(see Appendix F2)~~.- The 95% UCLs calculated using less than 10 samples are presented in Appendix F2.~~The~~ EPCs for the individual exposure ~~points~~ areas for whole body brown bullhead and ~~fillet~~ common carp fillet were up to two times ~~higher~~ greater than the Study Area-wide EPCs, as discussed in Attachment F6.

Comment [KJ31]: This revision is not consistent with the agreement. The following sentence should be added here per agreement from EPA:
"The 95% UCLs calculated using less than 10 samples are presented in Appendix F2."

Note, these 95% UCLs are not limited to fish tissue as is indicated the existing text.

6.2.5.2 Nondetects Greater than Maximum Detected Concentrations

Consistent with EPA guidance, analytical results reported as non-detect for which the detection limit was greater than the maximum detected concentration in a given exposure area were removed from the dataset prior to calculation of the 95 percent UCL. These sample identifications, detection limits, and associated maximum concentrations are listed by media and exposure area in the tables in Attachment F2. If the actual concentrations were closer to the detection limit for surface water and in-water sediment, the risk estimates would still be less than 1×10^{-6}.

6.2.5.3 Using the Maximum Concentration to Represent Exposure

The maximum concentration was used in instances where there were either less than five detected results or fives samples for a given analyte and exposure area, including EPCs calculated to represent Study Area-wide exposure. Use of the maximum concentration to represent exposure occurred for all media, and occurred most frequently for the fish and shellfish consumption scenarios. Contaminants and exposure points for which the maximum detected concentration was used instead of a 95 percent UCL on the mean are presented in the exposure point concentration tables in Section 3. In some cases, the maximum concentration for a contaminant was anomalously high, and may not be representative of tissue concentrations resulting from exposure to CERCLA-related contamination within the Study Area.

Generally, the ratios between the maximum and minimum detected concentrations are less than 3. For in-water sediments, the ratios are less than 4. When comparisons are made within an exposure area for biota, the majority of the ratios of the 95 percent UCL/maximum EPCs to the mean are equal to or less than 2, and the remaining ratios are less than 4. A more in-depth analysis of scenarios for which using the maximum concentration to represent exposure significantly affected the result of the risk estimate, and consequently which chemicals were designated as contaminants potentially posing unacceptable risks for a scenario, is provided in Attachment F6.

EPA's UCL guidance (EPA 2002) notes that that defaulting to the maximum observed concentration may not be protective when sample sizes are very small because the observed maximum may be smaller than the population mean.

6.2.5.4 Possible Effects of Preparation and Cooking Methods

Cooking and preparation methods of fish tissue can change the concentration of lipophilic contaminants in fish tissues; EPA (1997b) states that "cleaning and cooking techniques may reduce the levels of some chemical pollutants in the fish." PCBs tend to concentrate in fatty tissues. Trimming away fatty tissues, including the skin, may reduce the exposure to PCBs. Removing the skin can reduce PCB concentrations in raw fillet by 50 percent by (EPA 2000c). Cooking can also reduce the concentrations as much as 87 percent, depending on the method (Wilson et al. 1998). However, one study showed a net gain in PCB concentrations after cooking (EPA 2000c). The potential for reduction in PCB concentrations due to cooking is subject to a substantial degree of variability, and some consumption practices make use of whole fish, reductions in PCB concentrations were not considered quantitatively in the risk assessment.

6.2.5.5 Assumptions about Arsenic Speciation

~~The toxicity of arsenic is dependent on the chemical species, inorganic arsenic Is generally more toxic than organic forms.~~ Tissue concentrations of arsenic were reported as total arsenic, ~~which is consistent with~~ while EPA toxicity criteria~~, which are~~ are based on ~~total~~ inorganic arsenic. A study conducted on the middle Willamette River (EVS 2000) measured composites of resident fish (largescale sucker, carp, smallmouth bass, and northern pikeminnow) from a 45-mile section of the river extending from the Willamette (River Mile 26.5) to Wheatland Ferry (River Mile 72). Total arsenic and inorganic arsenic concentrations were determined in composites of whole body, fillet with skin, and composites of that portion of the fish remaining after removing fillets. Percent inorganic arsenic ranged from 2 percent (carp) to 13.3 percent (sucker). The average percent of inorganic arsenic was 4.2 percent for the carp and 3.8 percent for the smallmouth bass. Consistent with the recommendation in the Columbia River Basin Fish Contaminant Survey (EPA 2002e), the EPC for inorganic arsenic was estimated as 10 percent of the total arsenic detected in tissue.

Comment [KJ32]: Should include a parenthetical: "(organic and inorganic)"

Inorganic arsenic in clams was found to range as high as 50 percent of total arsenic in data collected in the Lower Duwamish River. However, the Lower Duwamish is an estuarine system, while the Lower Willamette in Portland Harbor is freshwater system. Since the actual percent of arsenic that is inorganic in clam tissue from the Study Area is unknown, this results in uncertainty in the estimate of inorganic arsenic EPCs in shellfish. The clam tissue data collected from the Study Area was evaluated to determine whether a higher percentage of inorganic arsenic might have a significant effect on overall risk from the consumption of clam tissue:

- All of the arsenic concentrations in clam tissue are within a factor of 2. In addition, the arsenic concentrations in clams are normally distributed.
- Due to the narrow range of arsenic concentrations, the risks from consumption of clams are within a factor of 2 throughout the Study Area.
- If inorganic arsenic is assumed to be 50 percent of the total arsenic rather than the assumption of 10 percent used in the BHHRA, the cumulative risks from consumption of clams increase by a factor of 1.1 to 1.3. Arsenic is not the primary contributor to risks from consumption of clams.

Given all of the other uncertainties associated with risks from clam consumption, the inorganic arsenic assumption is a minor uncertainty with minimal effect on the overall risk estimates.

Although arsenic resulted in risks greater than 1×10^{-6} for some of the fish consumption scenarios, the contribution of arsenic to the cumulative risk was substantially less than that from PCBs. Therefore, the assumptions about inorganic arsenic are not likely to affect the overall conclusions of the BHHRA.

6.2.5.6 Polychlorinated Biphenyls

PCBs were analyzed as Aroclors in some media and as individual PCB congeners in others. This introduces some uncertainty when comparing cumulative risk across media. Congener analysis may provide a more accurate measure of PCBs in environmental samples than does the Aroclor analysis. Although most PCBs may have originally entered the environment as technical Aroclor mixtures, environmental processes, such as weathering and bioaccumulation, may have led to changes in the congener distributions in environmental media such that they no longer closely match the technical Aroclor mixtures used as standards in the laboratory analysis, leading to inaccuracies in quantitation.

The results for PCBs in whole body tissue samples analyzed for both PCBs as Aroclors and as individual PCB congeners were qualitatively compared to evaluate correlations associated with the use of Aroclor data. -Windward (2005) analyzed fish tissue from the Lower Duwamish Waterway as PCB Aroclors and as individual PCB congeners. The PCB Aroclor data and PCB congener data were significantly correlated for both fillet and whole body tissue. It should be noted that the Lower Duwamish Waterway is not freshwater, and different species were assessed in the

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00151 06/25/2019 SEMS_0306118

Lower Duwamish study compared to Portland Harbor. These correlations suggest that PCB Aroclor data may be used in the place of congener data if congener data are not available.

When available, PCB congener data were included in cumulative risk sums for tissue because differences in bioaccumulation in addition to weathering results in greater uncertainty in the PCB Aroclor analysis for tissue. However, fillet tissue collected in Round 1 was analyzed for PCB Aroclors only, Round 3 smallmouth bass and common carp samples were analyzed for PCB congeners only. Because PCB congener data are available for smallmouth bass and common carp fillet tissue, cumulative risks for exposure to fillet tissue from ingestion include only the most recent tissue data for these two species. This introduces uncertainty to the cumulative risk estimates for exposure to fillet tissue when comparing risks across all four resident species.

PCB Aroclor data were included in cumulative risk sums for sediment because the PCB Aroclor dataset is larger than the congener dataset.

PCB congener data were included in the risk evaluation for surface water because the PCB Aroclor data was derived from the results of the congener analysis for the samples used in the risk characterization of this BHHRA. Total PCB congeners did not screen in as COPCs for any surface water scenarios. If PCB Aroclor data from the surface water dataset were used in the COPC screening, PCBs would still not be considered a COPC for any surface water scenarios.

When PCB congener data were used, the total PCB concentration was adjusted by subtracting the concentrations of coplanar PCBs from the total PCB concentration. This was done for purposes of estimating cancer risks because the coplanar PCBs were evaluated separately for the cancer endpoint.

6.2.5.7 Bioavailability of Chemicals

The toxicity values used in the risk assessment are often based on laboratory studies in which the chemical is administered in a controlled setting via food or water. Absorption from environmental media may be lower than that observed in the laboratory. Studies have shown that conditions in environmental media (e.g., pH, organic carbon content) can affect the bioavailability of a chemical (Ruby et al. 1999, Pu et al. 2003, Saghir et al. 2007). If the bioavailability of a chemical in a given environmental medium is less than that in the laboratory study used to derive the toxicity value, the risk assessment will overestimate the exposure to that chemical in that medium. The National Research Council has recommended that consideration of bioavailability be incorporated in decision-making at sites (National Academy of Sciences 2003). While site-specific information on the bioavailability of chemicals in sediment is not available, it is important to recognize that there is uncertainty associated with not incorporating bioavailability into the risk estimates, especially related to sediment-associated chemicals.

6.2.5.8 Exposure Areas for Consumption of Smallmouth Bass

Exposure via consumption of smallmouth bass was evaluated on a river mile basis. Uncertainties associated with the home range of smallmouth bass are discussed in Section 6.1.13. In Round 1, samples were composited on a per river mile basis, Round 3, samples were composited on a per river mile basis for each side of river. The Round 1 and Round 3 results were combined, and the EPC thus represents an exposure area of one river mile. A study by ODFW (ODFW 2005) that included tracking the movement of smallmouth bass in the Lower Willamette indicated that their home range is typically between 0.1 and 1.2 km, and they are most frequently found in near-shore areas.

Figure 6-1 displays the ratios of concentrations of DDT, DDE, DDD, cPAH, dioxin/furan TEQ, and PCB congeners detected in composite smallmouth bass samples collected at the east side of the river mile compared to concentrations for those detected in composite samples collected at the west side of the river mile. At RM 8, 9, and 10, the ratios are all less than 1, indicating concentrations on the east side of the river are generally less than concentrations on the west side of the river. For the remaining river miles, some ratios exceed one. East to west side concentration ratios for PCBs at river mile 11 are highest of any river mile evaluated. As previously discussed in Section 6.1.14, that a fish from RM 11W was included in the composite for RM 11E due to a mislabeling of the sample. Due to the low number of samples for each exposure area, the maximum detected concentration from either side of the river was typically used as the RME EPC for the river mile exposure areas. In addition, the area over which fishing occurs should also be considered. Given an exposure duration of 30 to 70 years, it is possible that fish would be collected over an area greater than a single river mile. Therefore, use of an exposure area consisting of a single river mile for evaluating consumption of smallmouth bass is generally health protective and unlikely to underestimate risks.

6.2.5.9 EPCs in Surface Water for Recreational Beach Users

Only data collected from the low water sampling event was used to assess recreational exposures to surface water, in order to represent surface water conditions during the time of year when most frequent recreational use occurs. There is some uncertainty in the representativeness of this dataset for surface water conditions for recreational users.

Because exposure to surface water by transients can occur throughout the year, data from sampling events during three seasons of the year were used for this scenario and can be used to assess the representativeness of the single low water sampling event. Arsenic was the only surface water COPC detected in recreational exposure areas. The Study Area-wide average total arsenic concentration for transient exposure to surface water, using year-round data, is 0.48 µg/l. The Study Area-wide average total arsenic concentration for recreational beach user exposure to surface water, using low flow data, is 0.51 µg/l. Given the similarity of these results, the uncertainty associated

with the recreational beach user surface water dataset should not affect the conclusions of this BHHRA.

6.3 TOXICITY ASSESSMENT

The results of animal studies are often used to predict the potential human health effects of a chemical. Extrapolation of toxicological data from animal studies to humans is one of the largest sources of uncertainty in evaluating toxicity. Much of the toxicity information used in this BHHRA comes from EPA's Integrated Risk Information System (IRIS), which states the following on its website:

> In general IRIS values cannot be validly used to accurately predict the incidence of human disease or the type of effects that chemical exposures have on humans. This is due to the numerous uncertainties involved in risk assessment, including those associated with extrapolations from animal data to humans and from high experimental doses to lower environmental exposures. The organs affected and the type of adverse effect resulting from chemical exposure may differ between study animals and humans. In addition, many factors besides exposure to a chemical influence the occurrence and extent of human disease (EPA 2010b, http://www.epa.gov/iris/limits.htm).

EPA typically applies uncertainty factors, typically a factor 10, when deriving reference doses, to account for limitations in the data. These limitations include variation in susceptibility among the members of the human population, uncertainty in extrapolating animal data to humans, uncertainty in extrapolating from data obtained in a study with less-than-lifetime exposure, uncertainty in extrapolating from a LOAEL rather than from a NOAEL, and uncertainty associated with extrapolation when the database is incomplete. As a result, actual risks within the Study Area are likely to be lower than the estimates calculated in this BHHRA.

In addition, the following specific uncertainties have been identified.

6.3.1 Early Life Exposure to Carcinogens

As discussed in Section 3.5.6, early-in-life susceptibility to carcinogens has long been recognized as a public health concern. EPA's Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens (EPA 2005b) provides a process to evaluate risks from early-life exposure to carcinogens known to act via a mutagenic mode of action. The only exposure scenarios for which early-life exposures are considered are recreational beach use, fish consumption, and household use of surface water. Of the COPCs identified in the risk assessment, only cPAHs have been identified as mutagenic. The BHHRA did not specifically address early-life exposures in the separate child and adult scenarios. However, increased early-life susceptibility was used to assess risks associated with exposure to PAHs in the combined adult/child scenarios. Therefore, the combined adult/child scenario accounts for the additional potency associated with early life exposures.

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00154 06/25/2019 SEMS_0306121

6.3.2 Lack of Toxicity Values for Delta-hexachlorocyclohexane, Thallium, and Titanium

Delta-HCH was detected in tissue and in-water sediment. An SF or RfD toxicity value could not be identified for delta-HCH according to the hierarchy of sources of toxicity values recommended for use at Superfund sites (EPA 2003b). Also, an STSC review concluded that the other hexachlorocyclohexane isomers could not be used as surrogates for delta-HCH due to differences in toxicity (EPA 2002d). Potential risk from delta-HCH was not quantitatively evaluated because of the lack of availability of toxicity data.

Thallium was detected in in-water sediment and surface water, and titanium was detected in in-water sediment. Thallium and titanium are naturally occurring elements, and although thallium may have a wide spectrum of effects on humans and animals (EPA 2009a), titanium has been characterized as having extremely low toxicity (Friberg et al 1986). An SF or RfD toxicity value could not be identified for titanium according to the hierarchy of sources of toxicity values recommended for use at Superfund sites (EPA 2003b), and consultation with EPA indicated no surrogate toxicity value was available. Therefore potential risk from exposure to titanium was not quantitatively evaluated in this BHHRA.

6.3.3 Use of Toxicity Values From Surrogate Chemicals for Some Chemicals that Lack Toxicity Values

For some chemicals, if a RfD or SF toxicity value was not available from the recommended hierarchy, a structurally similar chemical was identified as a surrogate. The RfD or SF for the surrogate was selected as the toxicity value and the surrogate chemical was indicated in Section 4. Uncertainty exists in using surrogate chemicals to represent the toxicity of chemicals for which toxicity values are not available. Using surrogate toxicity values could over- or under-estimate risk for a specific chemical.

Based on the results of the BHHRA, the chemicals that exceeded the minimum target cancer risks of 1×10^{-6} or hazard quotient of 1 did not rely on surrogate toxicity values. Therefore, the use of surrogate toxicity values should not affect the conclusions of this BHHRA.

6.3.4 Toxicity Values for Chromium

Chromium was analyzed as total chromium in all media. Although toxicity values exist for both trivalent and hexavalent chromium, hexavalent chromium exhibits greater toxicity that the trivalent form. The reference dose for hexavalent chromium is 0.003 mg/kg-day, versus 1.5 mg/kg-day for trivalent chromium. Hexavalent chromium can be reduced to trivalent chromium in an aqueous environmental medium if an appropriate reducing agent is available, and thus trivalent chromium is more prevalent in the environment (ATSDR 2008). Screening values for trivalent

chromium were used in the selection of total chromium as a COPC for in-water sediment, beach sediment, the groundwater seep, and surface water. This is an uncertainty because the trivalent chromium screening level is for insoluble salts.

The highest HQ for chromium from fish consumption was 0.004.- Even if a portion of the chromium were present as hexavalent chromium, the HQ would likely still be less than 1. Additionally, EPA currently considers the carcinogenic potential of hexavalent chromium via oral exposure as "cannot be determined." Toxicity criteria derived by the New Jersey Dept. of Environmental Protection was used as a Tier 3 source for evaluating the cancer risks associated with oral exposures to hexavalent chromium.

6.3.5 Toxicity Values for Polychlorinated Biphenyls and Applicability to Environmental Data

The toxicity values for PCBs were applied to both PCB congeners (not including coplanar congeners) and Aroclors. The RfD for PCBs is based on an immunotoxicity endpoint for Aroclor 1254 (EPA 2010b). Several other Aroclors have been detected in media within the Study Area, indicating the mixture of PCBs differs from that used in the study to develop the RfD. The cancer SF for PCBs was derived for PCB mixtures based on administered doses of Aroclors to rats. The PCB mixtures used in the studies included the coplanar PCB congeners (dioxin-like PCBs), and -coplanar PCBs may have contributed to the carcinogenicity observed in the study. Because the cancer risk from coplanar PCB congeners was evaluated separately, including both the total PCB and coplanar PCB congener risks in the cumulative cancer risk may result in an overestimate of the cancer risks. Although the potential double counting of PCB mass was corrected for by using the PCB adjusted values, there was no correction for the potential double counting of toxicity of dioxin-like PCBs in the PCB TEQ cancer risk estimate.

PCBs are classified as probable human carcinogens based on adequate dose-response data from studies in rats. However, the human carcinogenicity data are inadequate. Several cohort studies have been conducted that analyzed cancer mortality in workers exposed to PCBs. These studies did not find a conclusive association between PCB exposure and cancer; however they were limited by small sample sizes, brief follow-up periods, and confounding exposures to other potential carcinogens. Therefore, using a cancer SF based on the dose-response observed in rats adds further uncertainties to the cancer risk estimates from PCBs as a dose-response has not been observed in humans.

In addition to the uncertainties with toxicity values for total PCBs, there are uncertainties with the toxicity values for the PCB TEQ, which is evaluated using toxicity values for dioxin and dioxin-like compounds. In its 2001 evaluation of the dioxin reassessment, members of the EPA's Science Advisory Board (SAB) did not reach consensus on the classification of 2,3,7,8-TCDD as a carcinogen (EPA 2001d).

The National Academy of Sciences (NAS 2006) discussed the primary uncertainties with the toxicity values for dioxin and dioxin-like compounds as follows:

- The estimation of risks at doses below the range of existing reliable data may result in an overestimate of risk. An estimate of risk for typical human exposures to dioxin and dioxin like compounds would be lower in a sub-linear extrapolation model than in the linear model that was used to derive the 2,3,7,8-TCDD SF.

- The issue of appropriately assessing the toxicity of various mixtures of these compounds in the environment. The relative concentrations may change over an exposure period, even though the potency of the individual congeners remains constant. The estimated risk in a given sample depends on both potency and concentration.

The above uncertainties apply to risks from dioxins and furans, as well as risks from dioxin-like PCBs.

6.3.6 Adjustment of Oral Toxicity Values for Dermal Absorption

As discussed in Section 4.7, an adjustment was applied to the oral toxicity factor to account for the estimated absorbed dose when evaluating dermal exposures when the following conditions were met:

- The toxicity value derived from the critical study is based on an administered dose (e.g., through diet or by gavage)

- A scientifically defensible database demonstrates the GI absorption of the chemical is less than 50 percent in a medium similar to the one used in the critical study.

EPA (2004) recommends the adjustment of oral toxicity values to reflect dermal absorption only when GI absorption was less than 50 percent, eliminating the need for small adjustments in the oral toxicity value that are not supported by the level of accuracy in the critical studies that are the source of the toxicity values. Organic chemicals are generally well absorbed across the GI tract, absorption of inorganic chemicals is dependent on a number of factors, but is generally less than for organic chemicals. However, in the absence of a specific value for GI absorption, a default of 100 percent was used. EPA 2004 states that assuming 100 percent absorption may underestimate dermal risk for those chemicals that are poorly absorbed because it overestimates the dose at the site of action. The extent of underestimation is proportional to the actual GI absorption. Inorganic COPCs for which the default value of 100 percent GI absorption was used are aluminum, arsenic, boron, cobalt, copper, iron, molybdenum, selenium, thallium, and zinc.

6.4 RISK CHARACTERIZATION

Uncertainties arise during risk characterization due to the methods used in calculating, summing, and presenting risks. The following subsections address uncertainties associated with the risk characterization of this BHHRA.

6.4.1 Endpoint-specific Hazard Indices

In deriving endpoint-specific HIs, only one health endpoint is used for each chemical, even though some chemicals may have a myriad of health effects as exposures increase. As an example, a majority of the non-cancer affect from the site ~~are~~ is from PCBs and total TEQ. The endpoint used for deriving the RfD for PCBs is immunotoxicity, while the endpoint used for deriving the RfD for dioxin/furan TEQ and PCB TEQs is reproductive effects. If the reproductive endpoint for PCBs based upon the lowest observed adverse effects level (LOAEL) of 0.02 mg/kg/day is used with the same Uncertainty Factor as the immunological endpoint to derive an RfD for a reproduction endpoint for PCBs, the RfD for reproductive effects would be a factor of 4 greater than the RfD for immunological effects. Using this ratio, the endpoint-specific HI for reproduction for this exposure scenario for PCBs would be 5,000/4 = 1,250. The total HI for reproduction effects, combining HIs for total TEQ (500) and non-dioxin-like PCBs (1,250), would increase from 500 to 1,750. For the chemicals that have the largest non-cancer contribution in the HHRA, there is a possibility of under-predicting non-cancer health effects by using only one endpoint per chemical.

6.4.2 Risks from Cumulative or Overlapping Scenarios

Where multiple exposure scenarios exist for a given population, the risks for each of the exposure scenarios that are considered potentially complete and significant for a given population were summed to estimate the cumulative risks for that population (see Tables 5-199 and 5-200). In calculating the cumulative risks, the maximum cancer risk for each RME scenario was used. This provides a conservative approach, as the same individual may not experience the maximum exposure under more than one exposure scenario. However, due to the fact that risks from one scenario are usually orders of magnitude higher than any other scenario for a given receptor, risks from potential cumulative scenarios should not affect the conclusions of this BHHRA. However, the possible magnitude of uncertainty associated with risks from cumulative or overlapping scenarios is discussed further in Attachment F6.

In addition to cumulative exposure scenarios for a given population, an individual may be a member of multiple exposure populations, and thus overlapping exposure scenarios. Because there are numerous possible combinations of overlapping scenarios due to variations in exposure points and exposure assumptions, a model was not developed to quantitatively evaluate overlapping scenarios in this BHHRA. However, because the risk from fish and shellfish consumption is typically at least 10-fold greater than other exposure pathways, if an individual consumes fish, the relative contribution from other exposure scenarios is not likely to contribute

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00158 06/25/2019 SEMS_0306125

significantly to the overall risks for that individual. This BHHRA presents the risks for all of the exposure scenarios, so the risks for a given overlapping scenario could be calculated simply by summing the risks for each of the exposure scenarios that make up the overlapping scenario.

This BHHRA assessed potential risks from exposure to media within the Study Area. Upland sites were not included in this BHHRA. If exposure to upland sites were incorporated with exposures to media within the study, the overall estimate of cumulative risk would likely be higher than the risk estimates in this BHHRA.

6.4.3 Risks from Background

Metals are naturally occurring and the concentrations ~~may be~~ present in tissue, water, or sediment may not be directly related to contamination. Reported concentrations of arsenic and mercury in samples collected within the Study Area result in estimated risks greater than 1 x 10^{-6} or an HQ of 1 for one or more of the exposure scenarios evaluated in the BHHRA. Exposure concentrations of arsenic in beach sediment ranged from 0.7 mg/kg to 9.9 mg/kg, within the general range of 7 mg/kg used as a background concentration of arsenic by DEQ (DEQ 2007). ~~Risks from background concentrations of arsenic in beach sediment and surface water are discussed in Section 5 of the BHHRA.~~ At the background concentration of 7 mg/kg, the calculated risk from arsenic would exceed 1 x 10^{-6} for several of the beach sediment and in-water sediment exposure scenarios evaluated in this BHHRA.

Neither background nor anthropogenic tissue concentrations of COPCs were established for the Study Area. Regional tissue concentrations were measured as part of the Columbia River Basin Fish Contaminant Survey in five anadromous species (Pacific lamprey, smelt, coho salmon, fall and spring Chinook salmon, steelhead) and six resident species (largescale sucker, bridgelip sucker, mountain whitefish, rainbow trout, white sturgeon, walleye). All samples were composites; the size of the individual fish varied with species. Concentrations of certain contaminants are higher in tissue collected within the Study Area than observed in the Columbia River study, and the sources of the regional tissue concentrations are unknown. Consistent with EPA policy, risk estimates were presented in this BHHRA without accounting for contributions from background. However, it is important to recognize that background concentrations may result in unacceptable risk and hazard estimates.

6.4.4 Risks from Lead Exposure

The maximum EPC calculated for lead are associated with a probability of exceeding protective blood lead levels in the fetus of a pregnant woman who consumes fish from the Study Area. This EPC may be attributable to lead in the gut of the fish rather than tissue concentrations. Protective lead concentrations in tissue were estimated using the EPA Adult Lead Methodology (ALM) (EPA 2003c), based on agreements with the EPA to follow the same methodology used in the CRITFC (1994) survey to

assess tissue exposures from lead. The ALM as adapted for the Portland Harbor BHHRA focuses on potential affects to the fetus when considering fish consumption by pregnant women. However, the ALM was developed for evaluating exposure to lead in soil and may not be appropriate to use for fish consumption. Furthermore, the ALM is sensitive to the bioavailability of ingested lead. For purposes of calculating a tissue concentration of lead that is expected to be without adverse effects, the default bioavailability of lead in soil was used, and it is not known whether this is an appropriate assumption for lead in tissue.

6.4.5 Future Risks

This BHHRA estimated current and future risks for exposure within the Study Area, based on known and reasonably anticipated future uses of the Study Area. However, the LWR is a dynamic, industrialized waterway, and if the land uses in certain areas of the Study Area were to change in the future in a manner with the uses considered in the BHHRA, risk and hazard estimates presented here may not be representative of conditions in the future.

6.5 OVERALL ASSESSMENT OF UNCERTAINTY

A summary of the uncertainties and a qualitative classification of their magnitude, their impact on the health protectiveness of the assessment, and their significance to risk management decisions are presented in Table 6-1. For each of the uncertainties identified and discussed in this section, Table 6-1 provides a qualitative assessment (using High, Medium, and Low as descriptors) for each of these properties. In addition, the table presents whether an uncertainty is more likely to over-estimate or under-estimate actual risks from the Study Area. While there are numerous uncertainties identified for this BHHRA, and the cumulative effect of these uncertainties could be significant to the conclusions of the BHHRA, some of these uncertainties would be expected to have more of a significant effect on risk management decisions than other uncertainties. These are identified with a "High" descriptor under the "Significance to Risk Management" column in Table 6-1.

Risk assessments typically include conservative assumptions to minimize the chances of underestimating exposure and/or risks of adverse effects to human health, and therefore potentially underestimating the need for remedial actions. In this BHHRA, conservative assumptions were incorporated into the identification of exposure scenarios, the selection of exposure assumptions, the development of EPCs, and the use of toxicity values. Only a portion of the uncertainties in this BHHRA are quantifiable. Further analysis of the data and review of pertinent published literature provided a possible range of values for some of the uncertainties presented above. The magnitude of these ranges are provided in Attachment F6 and discussed in this Section.

While it is not probable that the maximum values of the uncertainties apply for every tissue consumption exposure scenario and contaminant , this magnitude of uncertainty indicates that risks may actually be less than 1 x 10^{4} or HI of 1 for certain scenarios.

While conservative, the results of the BHHRA are intended to show the relative risks associated with the exposure scenarios, and which contaminants are contributing the highest percentage of the calculated risks.

7.0 SUMMARY

The overall objective of this BHHRA is intended to provide an analysis of baseline risks and help determine the need for action at the Site, and to provide risk managers with an understanding of the actual and potential risks to human health posed by the site, and any uncertainties associated with the assessment~~is to provide an analysis of potential baseline risks to human health from site-related contaminants and help determine the need for remedial actions, provide a basis for determining contaminant concentrations that can remain onsite and still be protective of public health, and provide a basis for comparing the effectiveness of various remedial alternatives.~~

Comment [KJ33]: The revisions to this paragraph were not discussed previously with the LWG; however, they are acceptable to the LWG.

The populations evaluated in the BHHRA were identified based on human activities currently known to occur within the Study Area or that could occur in the future, as described in the Programmatic Work Plan or in subsequent direction from EPA. Populations and associated exposure scenarios that were quantitatively evaluated in this BHHRA include:

- Dockside Workers – Direct exposure to beach sediment
- In-water Workers – Direct exposure to in-water sediment
- Recreational Beach Users – Direct exposure to beach sediment and surface water
- Transients – Direct exposure to beach sediment, surface water, and groundwater seep
- Divers – Direct exposure to in-water sediment and surface water
- Recreational and Subsistence Fishers – Direct exposure to beach or in-water sediment, consumption fish and shellfish
- Tribal Fishers – Direct exposure to beach and in-water sediment, consumption of fish
- Potential Future Domestic Water Use – Direct exposure to surface water used as a domestic water source
- Infants - Indirect exposure to bioaccumulative contaminants (PCBs, dioxin/furans, DDx, and PDBEs) in environmental media via indirect exposures due to breastfeeding.

Comment [KJ34]: Should include "Potential Future"

7.1 SUMMARY OF RISKS

A comparison of the estimated risks by exposure media can help focus risk management decisions by identifying the media contributing most to the overall

human health risks at the Study Area. As discussed in Sections 5, the magnitude of risk varies greatly across the different scenarios. Figures 7-1 and 7-2 display the ranges of total cumulative cancer risk and endpoint-specific HIs, respectively, for each media type, based on CT exposure assumptions for each media evaluated in the BHHRA. Figures 7-3 and 7-4 display the ranges of total cumulative cancer risk and cumulative HIs, respectively, based on RME assumptions. The estimated risks associated with consumption of fish and shellfish are orders of magnitude higher than risks from other scenarios, and exceed a cumulative cancer risk of 1 x 10^{-4} and a HI of 1. Scenarios for which the cumulative estimated cancer risk is greater than 1 x 10^{-4} or the HI is greater than 1 are consumption of fish and shellfish, ~~scenarios~~ and direct contact with in-water sediment by tribal and high frequency fishers.

7.2 CONTAMINANTS POTENTIALLY POSING UNACCEPTABLE RISKS

Comment [KJ35]: These revisions to the remainder of the document are inconsistent with the LWG's proposal for the use of the term primary contributor. This remains an unresolved issue.

One role of the BHHRA is to identify those contaminants that pose the greatest risks to current and future receptors, along with the media and exposures routes associated with those risks. This information is used to inform response actions. This section presents the primary contributors to human health risk at the Site. The exposure scenarios and chemicals discussed here represent a subset of the scenarios and contaminants evaluated in this BHHRA.

Contaminants were identified as potentially posing unacceptable risks if the estimated cancer risk is greater than 1 x 10^{-6} or the HQ is greater than 1 for any of the exposure scenarios evaluated in this BHHRA, regardless of the uncertainties associated with the estimates. Given the uncertainties in the analytical data discussed in Section 6, the preliminary ~~COCs~~list ~~were~~was ~~assessed~~further refined to select the final ~~COCs~~listing of contaminants potentially posing unacceptable risks for this BHHRA. Th~~e focus on primary contributors to risk~~is can assist with the development of the FS by focusing on those scenarios and contaminants associated with the greatest overall risk in the Study Area. While these scenarios and contaminants may be the focus of the remedial analyses, other exposure scenarios and contaminants potentially posing unacceptable risks may still be considered in remedial decisions for the Site.

~~Contaminants were identified as potentially posing unacceptable risks if the estimated cancer risk is greater than 1 x 10^{-6} or the HQ is greater than 1 for any of the exposure scenarios evaluated in this BHHRA, regardless of the uncertainties associated with the estimates. Given the uncertainties in the analytical data discussed in Section 6, the preliminary COCs were assessed to select the final COCs for this BHHRA.~~

α-, β-, and □-Hexachlorocyclohexane and heptachlor were detected in fish tissue only as N-qualified data. Due to retention time issues in the analytical methods used for the Round 1 tissue samples, some of the pesticide tissue data were N-qualified, indicating that the identity of the chemical could not be confirmed. In the subsequent Rounds 2 and 3 sampling events, different analytical methods were used so that the identification of pesticides was not an issue in tissue. EPA guidance (1989)

recommends caution in the use of data where there are uncertainties in the identification of contaminants. Therefore, if a chemical was identified as potentially posing unacceptable risks based only on the use of N-qualified data, that chemical is not recommended for further evaluation for potential risks to human health.

The contaminants potentially posing unacceptable risks to human health based on the results of this BHHRA that are recommended for further evaluation for potential risks to human health are presented in Table 7-1.

~~7.3 PRIMARY CONTRIBUTORS TO RISK~~

~~One role of the BHHRA is to identify those contaminants that pose the greatest risks to current and future receptors, along with the media and exposures routes associated with those risks. This information is used to inform response actions. This section presents the primary contributors to human health risk at the Site. The exposure scenarios and chemicals discussed here represent a subset of the scenarios and contaminants evaluated in this BHHRA.~~

~~The focus on primary contributors to risk can assist with the development of the FS by focusing on those scenarios and contaminants associated with the greatest overall risk in the Study Area. While these scenarios and contaminants may be the focus of the remedial analyses, other exposure scenarios and contaminants potentially posing unacceptable risks may still be considered in remedial decisions for the Site.~~

~~Only those exposure scenarios and contaminants that resulted in an estimated cancer risk greater than 1 x 10^{-6} or an HQ greater than 1 were considered in identifying the primary contributors to risk.~~ Additional considerations in the ~~selection~~ evaluation of ~~contributors~~ contaminants potentially posing unacceptable risk included:

- The relative percentage of each contaminant's contribution to the total human health risk consistent with assumptions on exposure areas.
- Uncertainties associated with the exposure scenarios, such as the likelihood of future site use, number of assumptions made in estimating exposure, or level of uncertainty in estimates of exposure variables.
- Frequency of detection, both on a localized basis and Study Area-wide.
- Comparison of risks within the Study Area to risks based on measured regional contaminant concentrations for similar exposure scenarios, indicating background or other anthropogenic sources of chemicals in the region.
- Magnitude of risk greater than EPA's target range for managing cancer risk of 1 x 10^{-4} to 1 x 10^{-6} and noncancer hazard of 1.

~~The chemicals contaminants potentially posing unacceptable risks and the primary contributors to risk based on the above criteria are discussed below, and those~~

~~recommended for further evaluation for potential risks to human health are presented in Table 7-1.~~

~~7.3.1~~7.2.1 Fish Consumption Scenarios

Twenty six ~~COCs~~ contaminants (PCBs, dioxins, six metals, Bis-2-ethylhexyl phthalate (BEHP), PAHs, hexachlorobenzene, and seven pesticides) are identified as potentially posing unacceptable risks ~~due~~ associated with fish ~~to~~ consumption~~ of fish~~:

- PCBs (~~:~~PCBs and PCB TEQs): ~~B~~~~oth total PCBs and PCB TEQ b~~based on the magnitude of the estimated risks greater than 1 x 10^{-4}, the overall spatial scale, and the relative contribution to cumulative risk estimates.

- Dioxins/furans: ~~Total dioxin/furan TEQ a~~Based on~~ssociated with both~~ localized and Study Area-wide exposures, the magnitude of the risk estimates greater than 1 x 10^{-4}, the overall spatial scale, and the relative contribution to cumulative risk estimates.

- Metals: Antimony, arsenic, mercury, selenium, and zinc were associated with one or more fish consumption exposure scenarios that resulted in a risk estimate that exceeded a cancer risk of 1 x 10^{-6} or HQ of 1.
  - The overall estimated risk estimates for arsenic are greater than 1 x 10^{-4} based on Study Area-wide exposures.
  - The HQ associated with antimony is greater than 1 at RM 10 based on consumption of whole body smallmouth bass tissue.
  - Lead, based on a measured tissue concentration greater than the protective tissue concentrations derived using blood lead models. However, this is due to only a single result of smallmouth bass whole body tissue collected at RM 10 with anomalously high result, as discussed in Section 6.1.14
  - Mercury, -based on an HQ of 1 for both localized and Study Area-wide exposures.
  - Selenium, based on an HQ of 1 at RM 11 for consumption of smallmouth bass fillet tissue, in a single sample.
  - Zinc, based on an HQ of 2 in a single sample of whole body common carp collected from RM 4 to RM 8.

- BEHP, based on cancer risk estimates greater than 1 x 10^{-6} on both a localized and Study Area-wide basis, and RME cancer risk estimates greater than 1 x 10^{-4} and a HQ greater than 1 at RM 4 based on consumption of smallmouth bass for recreational and subsistence fishers.

- PAHs: Benzo(a)anthracene, benzo(a)pyrene, dibenzo(a)anthracene, and total cPAHs, based on cancer risk estimates greater than 1 x 10^{-6}. Cancer risk estimates for total carcinogenic PAH are greater than 1 x 10^{-6} at five river mile

segments and Study Area-wide based on consumption of smallmouth bass and for two fishing zones and Study Area-wide based on consumption of common carp.

- Organochlorine Pesticides: Aldrin, dieldrin, heptachlor epoxide, total chlordane, total DDD, total DDE, and total DDT are identified based on estimated cancer risks greater than 1 x 10^{-6} or an HQ of 1.
  - Aldrin, based on cancer risk estimates greater than 1 x 10^{-6} for subsistence fishers for single-species diet of common carp at localized areas and Study Area-wide.
  - Dieldrin, based on estimated cancer risks greater than 1 x 10^{-6} for consumption of all fish species on a localized and Study Area-wide basis.
  - Heptachlor epoxide, based on estimated cancer risk estimates greater than 1 x 10^{-6} for single-species diet of common carp by subsistence fishers at RM 0 to RM 4.
  - Total chlordane, based on estimated cancer risks greater than 1 x 10^{-6} for consumption of all fish species on a localized and Study Area-wide basis.
  - DDD, based on estimated cancer risks greater than 1 x 10^{-6} for consumption of all fish species on a localized and Study Area-wide basis.
  - DDE, based on estimated cancer risks greater than 1 x 10^{-6} for consumption of all fish species on a localized and Study Area-wide basis, and an HQ greater than 1 at RM 7, based on consumption of smallmouth bass.
  - DDT, based on an estimated cancer risk greater than 1 x 10^{-6} based on consumption of all fish species on a localized and Study Area-wide basis.

- PDBEs: based on an HQ greater than 1 for consumption of smallmouth bass and carp on a localized basis.

Formatted: Indent: Left: 1.5", No bullets or numbering

Formatted: Underline

Formatted

Comment [KJ36]: PBDEs should be a separate bullet and not a sub-bullet under organochlorine pesticides.

Considering the magnitude and relative contribution to the overall risk estimates, as well as their frequency of detection, PCBs and dioxins/furans are the most significant contributors to risk for fish consumption scenarios. Estimated risks from PCBs and dioxins/furans are greater than 1 x 10^{-4} or an HQ of 1 for both the CT and RME evaluations at both localized and Study Area-wide exposures. Figure 7-5 illustrates the relative contribution of individual contaminants to cumulative risk estimates based on the Study Area-wide multi-species fish consumption by adult subsistence fishers. PCBs are the most significant contributor to the overall risk estimate, and taken together with dioxins/furans expressed as a TEQ, account for the majority of the estimated risk on a Study Area-wide basis. On a river mile basis, PCBs pose the highest risks at all locations except RM- 7, where dioxins/furans pose the highest risks. Figure 7-6

shows the relative contributions to the overall risk estimate based on Tribal fish consumption.

PCBs and dioxins/furans have been detected in fish tissue collected outside of the Study Area in both the Willamette and Columbia Rivers. In a risk assessment for the mid-Willamette (EVS 2000), PCB concentrations were found to result in a HQ greater than 1 assuming both a 142 g/day and a 17.5 g/day consumption rate, and an estimated cancer risk greater than 1 x 10^{-4} for the 142 g/day consumption rate. Dioxins and furans were also found to result in an estimated cancer risk greater than 1 x 10^{-4} using a 142 g/day consumption rate (non-cancer endpoints were not evaluated for dioxins and furans). In the Columbia River Basin Fish Contaminant Survey (EPA 2002c), the estimated cancer risks associated with PCBs and dioxins/furans were greater than 1 x 10^{-4} assuming a consumption rate of 142 g/day, and the estimated risk due to PCBs was greater than 1 x 10^{-4} assuming a consumption rate of 7.5 g/day. While ambient concentrations have not been established for fish tissue, as discussed in Section 6.4.2, regional tissue concentrations may be associated with unacceptable risks from fish consumption, especially at higher consumption rates. While the concentrations in the Study Area are higher than the regional tissue concentrations, the sources of PCBs and dioxins and furans in regional tissue data are unknown, and efforts are underway to reduce regional tissue concentrations.

~~7.3.2~~7.2.2 Shellfish Consumption Scenarios

Seventeen contaminants (PCBs, dioxins, arsenic, PAHs, pentachlorophenol, and five pesticides) were identified as potentially posing unacceptable risks due to consumption of shellfish, based on estimated cancer risks greater than 1 x 10^{-6} or a HQ of 1:

- PCBs~~:~~ (Total PCBs and PCB TEQs):~~,~~ ~~b~~Based on cancer risk estimates greater than 1 x 10^{-4} and/or HQs greater than 1 for shellfish consumption in localized and Study Area-wide exposures~~. PCBs are considered a primary contributor to risk for the shellfish consumption pathway because~~, ~~of~~ the magnitude and spatial scale of the risk estimates greater than 1 x 10^{-4}, their relative contribution to cumulative risk estimates, and their frequency of detection.

- Dioxins/furans~~:~~ (Total dioxin/furan TEQs):~~,~~ ~~b~~Based on cancer risk estimates greater than 1 x 10^{-4} and/or HQs greater than 1 for shellfish consumption in localized and Study Area-wide exposures~~. Dioxins are considered a primary contributor to risk for the shellfish consumption pathway because of~~, the magnitude and spatial scale of the risk estimates greater than 1 x 10^{-4}, their relative contribution to cumulative risk estimates, and their frequency of detection.

- Arsenic: Based on cancer risk estimates that greater than 1 x 10^{-6} from clams and crayfish at both consumption rates and on a localized and Study Area-wide scale. No cancer risk estimates exceeded 1 x 10^{-4}. Though arsenic is identified as a contaminant potentially posing unacceptable risk on both a localized and Study Area-wide spatial scale, concentrations in shellfish tissue are ~~likely~~ due in part to the contribution of background concentrations.

- cPAHs: Based on cancer risk estimates greater than 1 x 10^{-6} from both clams and crayfish at both ingestion rates and on a localized and Study Area-wide scale. Cancer risk estimates greater than 1 x 10^{-4} from clams collected at locations RM 5W and RM 6W and assuming a consumption rate of 18 g/day. cPAHs are considered a primary contributor to risk for the shellfish consumption pathway at those locations because of the magnitude of the risk estimates and their relative contribution to the cumulative risk.

- Pentachlorophenol: Pentachlorophenol was detected only in a single crayfish composite sample collected near RM 8. It was not detected in the remaining 40 shellfish samples. This single detection of pentachlorophenol resulted in a cancer risk estimate within the range of 1 x 10^{-6} to 1 x 10^{-4}.

- Organochlorine pesticides~~:~~ (Aldrin, dieldrin, total DDD, total DDE, and total DDT):~~,~~ ~~ba~~~~B~~Based on an estimated cancer risk greater than 1 x 10^{-6} or a HQ of 1.
  - Aldrin, based on an estimated cancer risk greater than 1 x 10^{-6} for consumption of clams at RM 8W and on a Study Area-wide basis, assuming a consumption rate of 18 g/day.
  - Dieldrin, based on an estimated cancer risk greater than 1 x 10^{-6} for consumption of clams near RM 8W and Study Area-wide, assuming a consumption rate of 18 g/day.
  - Total DDD, based on an estimated cancer risk greater than 1 x 10^{-6} for consumption of clams near RM 8W and Study Area-wide, assuming a consumption rate of 18 g/day.
  - Total DDE, based on an estimated cancer risk greater than 1 x 10^{-6} for consumption of clams near RM 6W, RM 7W, RM 8W and Study Area-wide, assuming a consumption rate of 18 g/day.
  - Total DDT, based on an estimated cancer risk greater than 1 x 10^{-6} for consumption of clams near RM 6W and RM 7W, assuming a consumption rate of 18 g/day.

~~Based on~~Considering the magnitude and relative contribution to the total risk estimates~~,~~ and their frequency of detection, PCBs, dioxins/furans, and cPAHs are ~~considered the primary~~ the most~~i~~ significant contributors to ~~risk~~ the risk estimates ~~for~~ associated with consumption of shellfish ~~consumption~~. PCBs and dioxins/furans combined contribute approximately 58 percent and 91 percent, respectively, of the cumulative cancer risk from consumption of clams and crayfish,~~.~~ cPAHs contribute

approximately 35 percent and 5 percent, respectively, of the cumulative cancer risk from consumption of clams (undepurated samples) and crayfish. ~~For clam consumption,~~ PCBs ~~and dioxins/furans are considered primary contributors to risk~~contribute are the most significant contributors to the risk estimates on a Study Area-wide basis, and ~~while~~ cPAHs are considered primary contributors~~contribute significantly to the~~ to risk estimates on a localized basis (at RM 5W and RM 6W) pose the highest risks from consumption of clams at all locations except RM- 4W, RM 5W, and RM 6W, where cPAHs pose the highest risks, and RM- 4E and RM 7W, where dioxins/furans pose the highest risks.

~~7.3.3~~7.2.3 In-Water Sediment Scenarios

PAHs (primarily benzo[a]pyrene), arsenic, PCBs, and dioxins are identified as contaminants potentially posing unacceptable risk for in-water sediment. PAHs and dioxins are identified for all of the in-water sediment scenarios, arsenic and PCBs were identified for the tribal fisher and high frequency fisher scenarios only. The relative contribution of each contaminant to cumulative cancer risk estimates varied by river mile. ~~Throughout the~~On a Study Area-wide basis, estimated risks from cPAHs and dioxins/furans each contributed approximately 50 percent of the cumulative cancer risk estimate. As previously discussed, cumulative cancer risks associated with arsenic ~~may be~~are due in part to naturally occurring concentrations in sediment. Cumulative cancer risks from PCBs ~~is~~ are greater than 1 x 10^{-6} at four one-half mile river segments, and from dioxins at two one-half mile segments. Cumulative cancer risks from cPAHs are greater than 1 x 10^{-6} for at 22 one-half mile river segments. Carcinogenic PAHs ~~are considered the primary~~ contribute significantly~~ors~~ to risks ~~for~~ associated with in-water sediment exposures ~~on a Study Area-wide basis due to~~based on ~~the relative magnitude and spatial scale of estimated risks greater than 1 x10^{-4}~~at many locations throughout the Study Area. PCBs and dioxins/furans ~~are considered primary~~contribute significantly to the ~~contributors to~~ risk estimates ~~on a localized basis~~ at RM 2E, RM 3.5E, RM 6.5E, RM 8.5W, RM 9W, RM 11E, and Swan Island Lagoon ~~for~~ (PCBs) and RM 7W (~~for~~ dioxins/furans).

~~7.3.4~~7.2.4 Beach Sediment Scenarios

PAHs (primarily benzo[a]pyrene) and arsenic were identified as potentially posing unacceptable risk in beach sediment. Risks greater than 1 x 10^{-6} associated with exposure to arsenic in beach sediment are ~~likely~~ due in part to naturally occurring concentrations of arsenic. Risks greater than 1 x 10^{-6} associated with exposure to benzo(a)pyrene was limited to a few locations, with the maximum cumulative cancer risk at beach location 06B025.

~~7.3.5~~7.2.5 Surface Water Scenarios

PAHs ~~are the primary contributor~~contribute significantly to ~~risks associated with direct contact to surface water. E~~estimated cancer risks that are greater than 1 x 10^{-4} assuming use of river water as a domestic water source~~,~~ and greater than 1 x 10^{-6} for

divers at RM 6W. However, as noted in Section 5.2.8, the estimated risks associated with dermal exposure to PAHs in water should be used with caution, as PAHs are not within the Effective Prediction Domain of the model used to estimate the dermally-absorbed dose. Additional risk management considerations during remedy selection should consider the limited spatial scale and degree of uncertainty associated with the diver exposure assumptions. HIs greater than 1 at Multnomah Channel and RM 8.5 were due to MCPP and associated with use of river water as a potential drinking water source.

~~7.3.6 Summary of Primary Contributors to Risk~~

~~The identification of the primary contributors to human health risks can help provide focus to the FS by identifying a smaller number of chemicals and exposure scenarios that have the largest contribution to overall risk. To provide context for the significance of the remedial actions to the protection of human health, the uncertainties associated with the exposure assumptions and potential contribution of background sources of contaminants to the Study Area should be considered when evaluating primary contributors to human health risks in the FS.~~

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00171 06/25/2019 SEMS_0306138

8.0 REFERENCES

Adolfson Associates, Inc. (Adolfson). 1996. Technical Memorandum on the Results of the 1995 Fish Consumption and Recreational Use Surveys, Amendment Number 1. April 19, 1996.

ATSDR. 1996. Toxicological Profile for Endrin. Accessed online October 2008 at http://www.atsdr.cdc.gov/toxprofiles/tp89.html.

ATSDR. 2002. Public Health Assessment, Initial Release: Portland Harbor, Portland, Multnomah County, Oregon. January 15, 2002.

ATSDR. 2006. Final Release: Public Health Assessment, Portland Harbor, Portland, Multnomah County, Oregon, EPA Facility ID: OR0001297969. March 22, 2006.

ATSDR. 2008. Toxicological Profile for Chromium. Accessed online November 2008 at http://www.atsdr.cdc.gov/toxprofiles/tp7.html.

Burch, Dee (President of Advanced American). 2008. Personal communication, telephone call, with Don Larson, Business Development Coordinator, Kennedy/Jenks Consultants, Portland, OR. July 14, 2008.

Cal EPA. 2008. Toxicity Criteria Database, September 2008. Office of Environmental Health Hazard Assessment. Accessed October 2008 at http://www.oehha.org/risk/pdf/TCDBalpha100108.pdf.

Centers for Disease Control (CDC). 1991. Preventing lead poisoning in young children: a statement by the Centers for Disease Control. Atlanta, Georgia: US Department of Health and Human Services, Public Health Service.

City of Portland. 2006a. Comprehensive Plan Goals and Policies. City of Portland Bureau of Planning, Portland, OR. July 2006.

City of Portland. 2006b. River Concept. City of Portland Bureau of Planning, Portland, OR. April 26, 2006.

City of Portland. 2008. Water Management and Conservation Plan, Final Draft Report. Portland Water Bureau. Portland, OR, March 2008.

Columbia River Inter-Tribal Fish Commission (CRITFC). 1994. A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin, Technical Report 94-3. Columbia River Inter-Tribal Fish Commission, Portland, OR. October 1994.

DEQ. 2000a. Guidance for Conduct of Deterministic Human Health Risk Assessments. Oregon Department of Environmental Quality. May 2000.

DEQ. 2000b. Portland Harbor RI/FS Work Plan, DRAFT. Oregon Department of Environmental Quality. 31 March 2000.

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00172 06/25/2019 SEMS_0306139

DEQ. 2003. Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites. Land Quality Division, Environmental Tanks and Cleanup Program. Portland, OR. September 22, 2003.

DEQ. 2007. Guidance for Assessing Bioaccumulative Chemicals of Concern in Sediment. DEQ Environmental Cleanup Program. Portland, OR. April 2007.

DEQ. 2010. Human Health Risk Assessment Guidance. DEQ Environmental Cleanup Program. Portland, OR. October 2010.

EPA. 1989. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A), Interim Final. Office of Solid Waste and Emergency Response, EPA/540/1-89/002. December 1989.

EPA. 1991a. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. Office of Solid Waste and Emergency Response. OSWER Directive 9355.0-30. April 1991.

EPA. 1991b. Risk Assessment Guidance for Superfund, Volume I. Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors, Interim Final. Office of Emergency and Remedial Response: OSWER Directive: 9285.6-03.

EPA. 1992. Supplemental Guidance to RAGS: Calculating the Concentration Term. OSWER Publication 9285.7-081.

EPA. 1993. Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. Office of Health and Environmental Assessment, EPA/600/R-93/089. July 1993.

EPA. 1994. Memorandum: OSWER Directive: Revised Interim Soil Lead Guidance For CERCLA Sites and RCRA Corrective Action Facilities. Office of Solid Waste and Emergency Response. Washington, D.C.

EPA. 1997a. *Exposure Factors Handbook*. Office of Research and Development, Volumes I-III, EPA/600/P-95/002Fa-c, Office of Research and Development, Washington, DC 20460.

EPA. 1997b. Should I Eat the Fish I Catch? A guide to healthy eating of the fish you catch. EPA 823-B-97-009. Office of Science and Technology. September 1997.

EPA. 1998. Memorandum: OSWER Directive: Clarification to the 1994 Revised Interim Soil Lead (Pb) Guidance for CERCLA Sites and RCRA Corrective Action Facilities (August 1998). Office of Solid Waste and Emergency Response. EPA/540/F-98/030.

EPA. 1999. A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents. EPA Office of Solid Waste and Emergency Response. EPA 540-R-98-031. July 1999.

EPA. 2000a. EPA Region 10 Supplemental Human Health Risk Assessment Guidance, Office of Environmental Assessment, Soil Ingestion Rates. January 25, 2000.

EPA. 2000b. Estimated Per Capita Fish Consumption in the United States. EPA-821-R-00-025.

EPA. 2000c. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1, Fish Sampling and Analysis, Third Edition. Office of Water. EPA 823-B-00-007. November 2000.

EPA. 2000d. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health. EPA-822-B-00-004. October 2000.

EPA. 2000e. Data Quality Objectives Process for Hazardous Waste Site Investigations. EPA QA/G-4HW. Final. EPA Office of Environmental Information. EPA/600/R-00/007. January 2000.

EPA. 2001a. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments), Final. Office of Emergency and Remedial Response, Publication 9285.7-47. December 2001.

EPA. 2001b. Trichloroethylene Health Risk Assessment: Synthesis and Characterization, August 2001, EPA/600/P-01/0002A – External Review Draft.

EPA. 2001c. Risk Assessment Guidance for Superfund, Volume 3, Part A: Process for Conducting Probabilistic Risk Assessment. Office of Emergency and Remedial Response. EPA 540-R-02-002. December 2001.

EPA. 2001d. Dioxin Reassessment-An SAB Review of the Office of Research and Development's Reassessment of Dioxin. Review of the Revised Sections (Dose Response Modeling, Integrated Summary, Risk Characterization, and Toxicity Equivalency Factors) of the EPA's Reassessment of Dioxin by the Dioxin Reassessment Review Subcommittee of the EPA Science Advisory Board (SAB). EPA-SAB-EC-01-006. Science Advisory Board, Washington, DC. May 2001.

EPA. 2002a. Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. Office of Emergency and Remedial Response. OSWER 9285.6-10. December 2002.

EPA. 2002b. Estimated Per Capita Fish Consumption in the United States. EPA 821-C-02-003. August 2002.

EPA. 2002c. Columbia River Basin Fish Contaminant Survey, 1996-1998. EPA 910-R-02-006. August 12, 2002.

EPA. 2002d. Feasibility for Derivation of Provisional Toxicity Values for delta-Hexachlorocyclohexane (CASRN 319-86-8). SRC SF 01-019a-c/10-17-02.

EPA. 2002e. Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III). EPA OSWER #9285.7-52 March 2002.

EPA. 2003a. National Primary Drinking Water Standards. Office of Water (4606M). Maximum Contaminant Levels. EPA 816-F-03-016. June 2003.

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00174 06/25/2019 SEMS_0306141

EPA. 2003b. OSWER Directive 9285.7-53. Human Health Toxicity Values in Superfund Risk Assessments. December 5, 2003.

EPA. 2003c. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001. January 2003.

EPA. 2004. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final. Office of Emergency and Remedial Response. EPA/540/R/99/005. July 2004.

EPA, 2005a. Guidelines for Carcinogen Risk Assessment. Risk Assessment Forum. Washington, D.C. EPA/630/P-03/001F. March 2005.

EPA. 2005b. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. Risk Assessment Forum. Washington, D.C. EPA/630/R-03/003F. March 2005.

EPA, 2005c. Application of the draft framework for selecting and using tribal fish and shellfish consumption rates for risk-based decision making at CERCLA and RCRA cleanup sites in Puget Sound and the Strait of Georgia to the Lower Duwamish Waterway sediment cleanup action - June 16, 2005. US Environmental Protection Agency, Region 10, Seattle, WA.

EPA, Region 10. 2007a. Internal Memorandum from Michael Cox regarding Recommendations for Human Health Risk-based Chemical Screening and Related Issues at EPA Region 10 CERCLA and RCRA Sites. April 17, 2007.

EPA. 2007b. ProUCL Version 4.00.02 User Guide. EPA/600/R-07/038. April 2007.

EPA 2007c. Guidance for Evaluating the Oral Bioavailability of Metals in Soil for Use in Human Health Risk Assessment. OSWER 9285.7-80. May 2007.

EPA. 2007d. User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK), Windows version 1.1. EPA 9285.7-42. May 2007.

EPA. 2008a. Region 6 Human Health Medium-Specific Screening Levels. http://www.epa.gov/region6/6pd/rcra_c/pd-n/screen.htm. Screening Levels last updated on March 8, 2008.

EPA 2008b. Region 10 Memorandum regarding Portland Harbor Superfund Site; Administrative Order on Consent for Remedial Investigation and Feasibility Study; Docket No. CERCLA-10-2001-0240. Comprehensive Round 2 Site Characterization and Data Gaps Analysis Report. Dated January 15, 2008.

EPA. 2008c. Region 10 Memorandum regarding Proposed Commercial Diver Exposure Scenario for the Portland Harbor Risk Assessment. September 15, 2008.

EPA 2009a. Toxicological Review of Thallium and Compounds (CAS No. 7440-28-0) In Support of Summary Information on the Integrated Risk Information System (IRIS). EPA/635/R-08/001F.

EPA 2010a. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Dated May 2010. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm. Screening Levels last updated on April 19, 2009.

EPA. 2010b. Integrated Risk Information System (IRIS). Accessed November 2010 at http://www.epa.gov/iris/.

EPA. 2011. *Exposure Factors Handbook: 2011 Edition*. National Center for Environmental Assessment, Office of Research and Development, EPA/600/R-09/052F.

EVS Environment Consultants, Inc. (EVS). 2000. Human health risk assessment of chemical contaminants in four fish species from the Middle Willamette River, November 21, 2000. Salem, OR: Oregon Department of Environmental Quality. (Willamette River Basin Studies: Human Health Technical Study; EVS Project No. 2/839-01).

Friberg, L., Nordberg, G.F., Kessler, E. and Vouk, V.B. (eds). Handbook of the Toxicology of Metals. 2nd ed. Vols I, II.: Amsterdam: Elsevier Science Publishers B.V., 1986.

Grooms, M. 2008. Personal communication (email of February 12, 2008 to T. Pinit, Kennedy/Jenks Consultants, Portland, OR, regarding crayfish catch reports). Oregon Department of Fish and Wildlife, Portland, OR.

Groundwater Solutions, Inc. (GSI) 2003. Technical Memorandum: Results of Seep Reconnaissance Survey River Mile 2 – 10.5, Lower Willamette River. USEPA Docket No: CERCLA-10-2001-0240.

Hartman, Bud (President of Pan Fish Association, Portland, OR). 2002. Personal communications, telephone call with Bill Williams, Senior Scientist, Kennedy/Jenks Consultants, Portland, OR. March 19, 2002.

Hope, B. 2008. A Model for the Presence of Polychlorinated Biphenyls (PCBs) in the Willamette River Basin (Oregon). Environ. Sci. Technol. 2008, 42, 5998-6006.

Hutton, Jesse (President of Northwest Underwater Construction, LLC). 2008. Personal communication, telephone call with Taku Fuji, Senior Scientist, and Levi Fernandes, Engineer, Kennedy/Jenks Consultants, Portland, OR. July 11, 2008.

Integral Consulting, Inc. 2004. Round 2 Quality Assurance Project Plan Addendum 1: Surface Water. Prepared for The Lower Willamette Group. Portland, OR.

Integral Consulting, Inc., Kennedy/Jenks Consultants. 2004. Round 2 Quality Assurance Project Plan Addendum 3: Groundwater Pathway Assessment Pilot Study. Prepared for The Lower Willamette Group. Portland, OR.

Integral Consulting, Inc., Windward Environmental, LLC. 2004. Round 2 Quality Assurance Project Plan. Prepared for The Lower Willamette Group. Portland, OR.

EXHIBIT 1
September 21, 2012
LWG Opening Submission - Formal Dispute
ED_000959_NSF_00054720-00176 06/25/2019 SEMS_0306143

Integral Consulting, Inc., Windward Environmental, LLC, Kennedy/Jenks Consultants, Anchor Environmental, LLC, Groundwater Solutions, Inc. 2004. Portland Harbor RI/FS Programmatic Work Plan. Prepared for The Lower Willamette Group. Portland, OR.

Integral Consulting, Inc. 2007. Round 2 Quality Assurance Project Plan Addendum 9: Fish and Invertebrate Tissue and Collocated Sediment Sampling for Round 3B. Prepared for The Lower Willamette Group. Integral Consulting, Inc., Portland, OR.

Integral Consulting, Inc., Windward Environmental, LLC, Kennedy/Jenks Consultants, Anchor Environmental, LLC. 2007. Portland Harbor RI/FS Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report. Prepared for The Lower Willamette Group. Portland, OR. February 22, 2007.

Integral Consulting, Inc., 2008. Round 3B Fish and Invertebrate Tissue And Collocated Sediment Data Report Addendum 1: Lead and Antimony Results For Smallmouth Bass Sample LW3-SB010E-C00B. Prepared for the Lower Willamette Group. Portland, OR. September 26, 2008.

Johns, Mike (Vice President of Operations for Advanced American Construction). 2008. Personal communication, telephone call, with Don Larson, Business Development Coordinator, Kennedy/Jenks Consultants, Portland, OR. July 16, 2008.

Kennedy/Jenks Consultants, Integral Consulting, Inc., Windward Environmental, LLC. 2004. Portland Harbor RI/FS Technical Memorandum Guidelines for Data Reporting, Data Averaging, and Treatment of Non-detected Values for the Round I Database. Prepared for The Lower Willamette Group. Kennedy/Jenks Consultants, Portland, OR; Integral Consulting, Inc., Mercer Island, WA; Windward Environmental, LLC, Seattle, WA.

Kennedy/Jenks Consultants. 2004a. Human Health Toxicity Values. Interim Deliverable. Prepared for The Lower Willamette Group. Kennedy/Jenks Consultants, Portland, OR.

Kennedy/Jenks Consultants. 2004b. Round I Tissue Exposure Point Concentrations. Interim Deliverable. Prepared for The Lower Willamette Group. Kennedy/Jenks Consultants, Portland, OR.

Kennedy/Jenks Consultants. 2004c. Salmon, Lamprey, and Sturgeon Tissue Exposure Point Concentrations for Oregon Department of Human Services. Prepared for The Lower Willamette Group. Kennedy/Jenks Consultants, Portland, OR.

Kennedy/Jenks Consultants. 2006. Portland Harbor RI/FS Technical Memorandum Human Health Risk Assessment: Exposure Point Concentration Calculation Approach and Summary of Exposure Factors. Prepared for The Lower Willamette Group. Kennedy/Jenks Consultants, Portland, OR.

National Academy of Sciences (NAS). 2003. Bioavailability of Contaminants in Soils and Sediments: Processes, Tools, and Applications. National Academies Press. Washington D.C.

National Academy of Sciences (NAS). 2006. Health Risks from Dioxin and Related Compounds, Evaluation of the EPA Reassessment. National Academies Press. Washington D.C.

National Library of Medicine (NLM). 2004. Hazardous Substances Data Bank (HSDB).

Oregon Department of Human Services (ODHS). 2007. Environmental Toxicology Program. Fish Advisories: Consumption Guidelines. Accessed January, 2007. http://oregon.gov/DHS/ph/envtox/fishconsumption.shtml#table

Oregon Fish and Wildlife Department (ODFW). 2005. Biology, Behavior, and Resources of Resident and Anadromous Fish in the Lower Willamette River. Final Report of Research, 2000-2004 . Thomas A. Friesen, editor. March 2005.

Pu X; Carlson G; Lee L. 2003. Oral bioavailability of pentachlorophenol from soils of varying characteristics using a rat model. Journal of Toxicology and Environmental Health, Part A. 2003, Nov 14; 1966(21):2001-13.

Ruby, MV; R Schoof; W Brattin; M Goldade; G Post; M Harnois; DE Mosby; SW Casteel; W Berti; M Carpenter; D Edwards; D Cragin; W Chappell. 1999. Advances in evaluating the oral bioavailability of inorganics in soil for use in human health risk assessment. Environmental Science and Technology; 33 (21). 1999. 3697-3705.

Saghir SA; Bartels MJ; Budinsky RA; Harris EE; Clark AJ; Staley JL; Chai Y; Davis JW. 2007. Effect of organic carbon content, clay type, and aging on the oral bioavailability of hexachlorobenzene in rats. Environmental Toxicology and Chemistry. 2007, Nov; 26(11):2420--9.

Sheldrake S., D. Davoli, M. Poulsen, P. B. Duncan, E. R. Pedersen, 2009, Diver Exposure Scenario for the Portland Harbor Risk Assessment. Proceeding of the American Academy of Underwater Sciences 28th Symposium. pp. 7-13.

Siipola, M. Personal communication (telephone conversation on November 9, 2004 with Laura Kennedy, Kennedy/Jenks Consultants). U.S. Army Corps of Engineers, Portland, OR.

Steele, Ralph (Owner of Lure-em Tackle Shop, Portland, OR). 2002. Personal communication, telephone call with Bill Williams, Senior Scientist, Kennedy/Jenks Consultants, Portland, OR. April 8, 2002.

Striplin Environmental Associates, Inc. 2002. Round 1 Quality Assurance Project Plan Final Report. Prepared for The Lower Willamette Group. Striplin Environmental Associates, Inc., Olympia, WA.

Tetra Tech. 1995. Willamette River Basin Water Quality Study. Summary and Synthesis of Study Findings. Final Report 97-094. Prepared for Oregon Department of Environmental Quality, Portland, OR. Tetra Tech, Inc., Redmond, WA. 119 pp.

United States Department of Agriculture (USDA). 1998. Continuing Survey of Food Intake by Individuals, CSFII 1994-1996. Agricultural Research Service.

Van den Berg, M., et al. 2006. The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds. Toxicol Sci. 2006 Jul 7, 16829543. World Health Organization Collaborating Centre for Research on Environmental Health Risk Assessment and Institute for Risk Assessment Sciences, Faculties of Veterinary Medicine, Science and University Medical Center, Universiteit Utrecht, PO Box 80177, 3508 TD Utrecht, The Netherlands.

Wagner, P. 2004. Personal Communication: letter dated June 6, 2004 to Amanda Guay, Oregon Department of Human Services. Linnton Community Center.

Wallner-Kersanach, S. E. Lobo, E. M. da Silva. 1994. Depuration Effects on Trace Metals in *Anomalocardia brasiliana* (Gmelin, 1791). Bull. Environ. Contam. Toxicol. (1994) 52:840-847.

Washington Department of Ecology (Ecology). 2007. Washington State Toxics Monitoring Program: Contaminants in Fish Tissue from Freshwater Environments in 2004 and 2005. Publication No. 07-03-024. June 2007.

Washington Department of Health (WDOH). 2005. Analysis of Chemical Contaminant Levels in Store-Bought Fish from Washington State. *Proceedings of the 2005 National Forum on Contaminants in Fish.* Baltimore, MD. Powerpoint presentation accessed online at http://www.epa.gov/fishadvisories/forum/2005/index.htm.

Wilson et al. 1998. The effect of cooking practices on the concentration of DDT and PCB compounds in the edible tissue of fish. J. Expo. Anal. Environ. Epidemiol. Jul-Sep;8(3):423-40.

Windward. 2005. Lower Duwamish Waterway Remedial Investigation, Fish and Crab Data Report Addendum: PCB Congener Data, MS/MSD Analyses, and DDT Confirmation Final. Prepared for Lower Duwamish Waterway Group, Windward Environmental LLC, Seattle, WA. October 2005.

Windward. 2009. Portland Harbor RI/FS bioaccumulation modeling report. Draft. WW09-0003. Prepared for Lower Willamette Group. May 29, 2009. Windward Environmental LLC, Seattle, WA.

Table 1: LWG List of Priority Issues on EPA's June 22, 2012 Version of BHHRA that Require Discussion with EPA

LWG Assigned No.	Section(s) and Page(s) Number Examples[1]	LWG's Comments on EPA's Modification to the Draft Final BHHRA	Context for Comments	Status
Issues Related to Study Area Boundary			The Study Area was defined as RM 1.9 to 11.8 in the RI. Changes to the Study Area boundary affects the RI, FS, and BHHRA risk calculations.	
1a	List of Tables	EPA requested that Tables 2-1 and 2-2 be merged and that Tables 2-3 and 2-4 be merged. Does this apply to Tables 2-5 and 2-6 and Tables 2-7 and 2-8 as well? If the tables are combined, there needs to be a column or row that distinguishes between samples collected within the Study Area and samples collected outside the Study Area.	2, 3	Resolved
1b	1.3, p. 27	The second to last sentence should be revised as follows: "The approximate 10~~1~~-mile portion of Portland Harbor from RM 1.9 to 11.8 ~~0.8 to 12.2~~ is referred to as the Study Area (Map 1-1)."	1, 2	Resolved
1c	3.4.2, p. 54	The following sentence should be added prior to the last sentence: "Study Area-wide EPCs were calculated using the sediment data collected between RM 1.9 and 11.8."	1, 2	Resolved
Issues Related to Fish Consumption Scenarios: - **Use of the terms "Recreational" and "Subsistence"** - **Use of the terms "RME" and "CT"**			EPA's changes to the characterization of the fish consumption scenarios are inconsistent with prior agreements. The designation of the 17.5 g/day consumption rate as a CT value is inconsistent with EPA guidance and would impact the PRGs for the FS. Due to the lack of site-specific information on fish consumption, it was previously agreed to use a range of ingestion rates, in combination with other exposure assumptions, to characterize the potential consumption that might occur in Portland Harbor.	
2a	List of Tables	EPA and the LWG agreed the fish consumption risk scenarios should not refer to Reasonable Maximum Exposure or Central Tendency. The numeric consumption rates should be used in the risk tables to describe the fish consumption scenarios, per prior agreements.	2	Unresolved
2b	3.2, p. 45	"Non-tribal" should be used instead of "Recreational/Subsistence" to describe the fisher in the bullet list.	2	Unresolved
2c	3.2.1.6, p. 47	The title should be changed to "Non-Tribal Fishers".	2	Unresolved
2d	3.3.1, p. 49	The second sentence should be revised as follows: "These areas were further classified with respect to the type of exposures that could occur, including recreational, ~~recreational/subsistence and tribal~~ fishing, transient, or dockside worker use areas."	2	Resolved
2e	3.3.1, p. 49	The last sentence should be revised as follows:	2	Resolved

[1] Additional modifications similar to those identified in the LWG comments may occur elsewhere in EPA's June 22, 2012 version of the BHHRA. The LWG comments apply to those modifications throughout the document.

Comment Categories:
1 - Technical inaccuracy
2 - Comment is result of inconsistency with prior agreements or comments
3 - Clarification needed

Settlement Confidential Pursuant to FRE 408. Do not quote or cite. This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or part.

LWG Assigned No.	Section(s) and Page(s) Number Examples[1]	LWG's Comments on EPA's Modification to the Draft Final BHHRA	Context for Comments	Status
		"Direct exposure to beach sediments is considered to be a potentially complete pathway for dockside workers, transients, recreational beach users, and ~~both recreational/subsistence and tribal~~ fishers."		
2f	3.3.2, p. 49	The second sentence should be revised as follows: "Hence, direct exposure to in-water sediment is considered to be a potentially complete pathway for in-water workers, divers, and ~~recreational/subsistence and tribal~~ fishers."	2	Resolved
2g	3.3.3, p. 50	The second sentence of the second paragraph should be revised as follows: "It is unlikely that dockside and in-water workers would have direct contact with surface water on a regular basis, and the potential for significant exposure is considered low for ~~recreational/subsistence and tribal~~ fishers."	2	Resolved
2h	3.3.5, p. 50	The third and fourth sentences should be revised as follows: "Consumption of locally-caught fish is evaluated as a potentially complete exposure pathway for dockside workers, in-water workers, recreational beach users, and divers. Consumption of fish by these populations is evaluated under the non-tribal fisher ~~recreational/subsistence~~ receptor."	2	Unresolved
2i	3.4, p.52	The LWG disagrees that the arithmetic average concentrations should not be used for the fish/shellfish consumption scenarios and proposes the following language for the third sentence of the second paragraph: "EPCs for fish/shellfish consumption scenarios are the lesser of the 95 percent UCL or the maximum detected concentration as well as the arithmetic mean~~, central tendency evaluations were achieved by using mean or median consumption rates~~." However, if EPA requires that the arithmetic average concentrations not be used, the third sentence of the second paragraph should be revised as follows: "EPCs for fish/shellfish consumption scenarios are the lesser of the 95 percent UCL or the maximum detected concentration; arithmetic mean EPCs were not used for fish/shellfish consumption scenarios~~, central tendency evaluations were achieved by using mean or median consumption rates~~."	2	Unresolved
2j	3.4.1, p. 54	The fourth sentence should be revised as follows: "Otherwise, each designated beach area was evaluated as a single exposure area for transients, recreational beach users, and ~~recreational/subsistence and tribal~~ fishers."	2	Unresolved
2k	3.5.10.6, p. 68	The title should be changed to "Non-Tribal Fishers".	2	Unresolved

Comment Categories:
1 - Technical inaccuracy
2 - Comment is result of inconsistency with prior agreements or comments
3 - Clarification needed

Settlement Confidential Pursuant to FRE 408. Do not quote or cite. This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or part.

LWG Assigned No.	Section(s) and Page(s) Number Examples[1]	LWG's Comments on EPA's Modification to the Draft Final BHHRA	Context for Comments	Status
		Throughout this section, references to recreational and subsistence should be deleted. There is no site-specific data on fishing practices that allows the distinction of different fisher populations within Portland Harbor. Furthermore, the LWG disagrees that there is adequate documentation of "subsistence" fishing in Portland Harbor.		
2l	3.5.10.6, pp. 68 - 70	The following sentence should be deleted: "Accordingly, 17.5 g/day is considered representative of a CT value for recreational fishers, and 73 g/day was selected as the RME value representing the higher-end consumption practices of recreational fishers. The consumption rate of 142 g/day represents a RME value for high fish consuming, or subsistence, fishers."	1, 2	Unresolved
2m	5.2.6, p. 87	The title should be changed to "Non-Tribal Fishers".	2	Unresolved
2n	5.2.6.2, p. 88	The LWG disagrees with the use of the terms CT and RME for fish consumption scenarios.	2	Unresolved
Issues Related to Drinking Water Scenario			EPA removed factual information regarding the drinking water scenario that is important in understanding the uncertainty associated with potential exposures and associated risks from drinking water.	
3a	3.2, p. 45	The second sentence of the paragraph following the bullet list should be re-worded as follows: "However, public and private use of surface water is a beneficial use of the LWR following adequate pretreatment, and as described in Section 1, this baseline risk assessment evaluates exposures assuming no institutional controls, such as pretreatment or obtaining a permit for use of surface water."	2	Unresolved
3b	3.2.1.8, p. 45	The paragraph should be revised as follows: "Both public and private use of the Willamette River as a domestic water source following adequate pretreatment is a designated beneficial use of the LWR by the State of Oregon. Hence, use of surface water as a source of household water was assessed as a potentially complete pathway. Because this baseline risk assessment evaluates exposures assuming no institutional controls, such as pretreatment, the term hypothetical is used to describe the domestic use of the LWR. Exposure to surface water could occur via ingestion and dermal contact throughout the Study Area, as well as volatilization of chemicals to indoor air through household use."	2	Partially resolved – EPA agreed to add language regarding the potential future use of the Willamette River as a domestic water source.
3c	6.2.2.3, p. 106	The following paragraph should be added: "Under OAR 340-041-0340 Table 340A, domestic water supply is a designated beneficial use of the Willamette River, but only with adequate pretreatment and natural quality that	2	Resolved

Comment Categories:
1 - Technical inaccuracy
2 - Comment is result of inconsistency with prior agreements or comments
3 - Clarification needed

Settlement Confidential Pursuant to FRE 408. Do not quote or cite. This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or part.

LWG Assigned No.	Section(s) and Page(s) Number Examples[1]	LWG's Comments on EPA's Modification to the Draft Final BHHRA	Context for Comments	Status
		meets drinking water standards. The use of the Willamette River as a domestic water source would only occur after adequate pretreatment to meet Safe Drinking Water Act standards and Oregon rules. As a result, the term hypothetical was used to describe the scenario, which was based on the use of untreated surface water."		
Issues Related to Clam Consumption Scenario			EPA removed factual information regarding the clam consumption scenario that is important in understanding the uncertainty associated with potential exposures and associated risks from clam consumption.	
4a	3.3.6, p. 51	The following sentences should be added to this paragraph: "The ongoing consumption of clams at the rates used in the BHHRA is uncertain for a variety of reasons, including that Asian clams (*Corbicula sp.*), which is the clam species that was found in the LWR during sampling events, are on the prohibited species list of the ODFW rules regarding the importation, possession, confinement, transportation and sale of nonnative wildlife (OAR 635–056–0050)."	2	Partially resolved – EPA agreed that language regarding the likelihood of clam consumption could be added.
4b	5.2.6.7, pp. 92 - 93	Risks from consumption of depurated clams should also be discussed.	2	Resolved
4c	5.2.6.7, pp. 92 - 93	Risks from both consumption rates (18 g/day and 3.3 g/day) should be discussed.	2	Resolved
4d	5.2.6.8, p. 93	Risks from both consumption rates (18 g/day and 3.3 g/day) should be discussed.	2	Resolved
4e	6.2.2.1, p. 105	The following sentences should be added to the paragraph on clam consumption: "Asian clams (*Corbicula sp.*) is the clam species that was found in the LWR during sampling events. Asian clams are on the prohibited species list of the ODFW rules regarding the importation, possession, confinement, transportation and sale of nonnative wildlife (OAR 635–056–0050)."	2	Resolved
Issue Related to Summary of Risks			EPA removed factual information regarding the chemicals potentially posing unacceptable risks.	
5a	7.2.1, p. 126	Factual information regarding the risks from organochlorine pesticides via fish consumption should be included. For example, aldrin results in cancer risks greater than 1 x 10^{-6} for carp only.	1, 2	Resolved

Comment Categories:
1 - Technical inaccuracy
2 - Comment is result of inconsistency with prior agreements or comments
3 - Clarification needed

Settlement Confidential Pursuant to FRE 408. Do not quote or cite. This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or part.

Table 2: LWG Comments on EPA's June 22, 2012 Version of BHHRA that Do Not Require Discussion with EPA Unless Requested by EPA

LWG Assigned No.	Section(s) and Page(s) Number Examples[1]	LWG's Comment on EPA's Modification to the Draft Final BHHRA	Context for Comment	LWG Proposed Resolution on August 15, 2012[2]	Status
1	General	Throughout document, the numbering of sections and references to sections needs to be corrected.	1	Section numbers and references will be corrected.	Resolution pending (revisions will be made to final document)
2	General	Throughout document, there are incomplete sentences that need to be corrected.	1	Incomplete sentences will be corrected.	Resolution pending (revisions will be made to final document)
3	General	Throughout document, typos and grammatical errors need to be corrected.	1	Typos and grammatical errors will be corrected.	Resolution pending (revisions will be made to final document)
4	General	Several references to EPA approvals, discussions, and directions were removed from text; these are factual statements and should be included.	2	Where specific assumptions were used or analyses done based on EPA direction, a reference to that direction will be included.	Resolved
5	List of Tables	The term "hypothetical" should be included in the Tables 5-57 thru 5-62 for future drinking water use.	2	The term "hypothetical" will be added to the drinking water scenario.	Resolved
6	List of Tables	Was it intentional to delete the tribal fisher risk tables? (formerly Tables 5-67 thru 5-79).	3	The tribal fisher risk tables will be included.	Resolved
7	List of Tables	The fish and shellfish consumption risk tables should include both the 95% UCL/maximum and mean exposure point concentrations, per prior agreements.	2	Both the 95% UCL/max and mean exposure point concentration tables will be included.	Unresolved
8	1.0, p.25	"*potential exposures baseline human health risks*" meaning of new phrase not clear	3	The sentence will be revised to: "potential baseline human health risks"	Resolved
9	1.1, p.25-26	"*The general objective of a human health risk assessment in the CERCLA process is to provide an analysis of potential baseline risks to human health from site-related contaminants and help determine the need for remedial actions, provide a basis for determining contaminant concentrations that can remain onsite and still be protective of public health, and provide a basis for comparing the effectiveness of various remedial alternatives.* " Some of these objectives are related to risk management. It was agreed that the BHHRA would not discuss risk management.	2	The sentence will be revised to: "The general objective of a human health risk assessment in the CERCLA process is to provide an analysis of potential baseline risks to human health from site-related contaminants."	Resolved
10	1.2, p. 26	The following statement is inaccurate: "*Potential exposure pathways, populations, and exposure assumptions were originally identified in the Programmatic Work Plan.*" Several scenarios were not included in the Programmatic Work Plan and were subsequently added per direction from EPA.	1	The sentence will be revised to: "Potential exposure pathways, populations, and exposure assumptions were originally identified in the Programmatic Work Plan and in subsequent directions from EPA."	Resolved
11	2.1.6, p. 35	The following sentence should be modified as indicated: "As previously noted, two samples were collected from ~~each~~ five of the sampling stations in Round 3, one sample from each station was depurated prior to analysis, the other was analyzed undepurated. At the remaining stations, only undepurated samples were analyzed."	1	The sentence will be revised per the comment.	Resolved
12	2.1.6, p. 35	The following sentence should be added:	2	The sentence will be added per the comment.	Resolved

[1] Additional modifications similar to those identified in the LWG comments may occur elsewhere in EPA's June 22, 2012 version of the BHHRA. The LWG comments apply to those modifications throughout the document.
[2] The proposed resolutions were discussed during the informal negotiations between the LWG and EPA. Final resolutions are reflected in the September 17, 2012 Redline BHHRA.

Comment Categories:
1 - Technical inaccuracy
2 - Comment is result of inconsistency with prior agreements or comments
3 - Clarification needed

Settlement Confidential Pursuant to FRE 408. Do not quote or cite. This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or part.

LWG Assigned No.	Section(s) and Page(s) Number Examples[1]	LWG's Comment on EPA's Modification to the Draft Final BHHRA	Context for Comment	LWG Proposed Resolution on August 15, 2012[2]	Status
		"Depuration is a common method for cleansing shellfish that is often done prior to human consumption to eliminate the sediment present in the gastrointestinal (GI) tract of the shellfish."			
13	2.3.2, p.42	The first sentence should be modified as follows: "~~Screening values for surface water and groundwater seeps~~ EPA residential tapwater RSLs (EPA 2010a) ~~and MCLs (EPA 2003a)~~ were generally used as screening values for surface water and the groundwater seep to select COPCs for direct exposure scenarios. In addition, MCLs (EPA 2003a) were used as screening values for hypothetical domestic water use."	1,2	The sentence will be revised per the comment.	Resolved
14	3.2, p. 45	"Hypothetical" should be inserted before "Domestic water user" in the bullet list.	2	"Hypothetical" will be inserted.	Resolved
15	3.2.1.3, p. 46	Unless EPA can provide supporting documentation, the following should be deleted from the first sentence: "Several different groups of people dive in the Portland Harbor area, including the public for recreation ~~and gathering of biota for consumption~~,....."	2	The sentence will be revised per the comment.	Resolved
16	3.2.1.3, p. 46	Unless EPA can provide supporting documentation, the third sentence should be deleted: "~~Although dry suits provide greater protection, wetsuits are often used because of the higher cost of dry suits and water temperature.~~"	2	The sentence will be deleted.	Resolved
17	3.2.1.8, p. 48	"Hypothetical" should be added to the title.	2	"Hypothetical" will be added to the title.	Resolved
18	3.3.2, p. 50	The last sentence should be revised as follows: "Exposure to in-water sediment was evaluated throughout the Study Area by half river mile segments on either side of the river rather than at specific areas as was done with exposure to beach sediments."	1	The sentence will be revised per the comment.	Resolved
19	3.3.3, p. 50	The following sentence should be added to the first paragraph: "Surface water was also evaluated as a potential future domestic water source due to the designated beneficial use of the LWR for domestic consumption following adequate pretreatment." The last sentence of the first paragraph should be revised as follows: "Accordingly, direct exposure via ingestion and dermal contact with surface water is considered to be a potentially complete pathway for transients, recreational beach users, ~~and~~ divers, and future domestic water users."	1, 2	The sentence will be added, and the last sentence will be revised per the comment.	Resolved.
20	3.3.7, p. 51	The last sentence should be revised as follows: "Infant exposure to PCBs, dioxins, DDx compounds, and PDBEs via the consumption of human milk was evaluated as a potentially complete exposure pathway for the children of all receptors for which those bioaccumulative compounds were COPCs."	1	The sentence will be revised per the comment.	Resolved
21	3.4, p.52	The fourth sentence of the first paragraph should be revised as follows:	1	The sentence will be revised per the comment.	Resolved

Comment Categories:
1 - Technical inaccuracy
2 - Comment is result of inconsistency with prior agreements or comments
3 - Clarification needed

Settlement Confidential Pursuant to FRE 408. Do not quote or cite. This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or part.

LWG Assigned No.	Section(s) and Page(s) Number Examples[1]	LWG's Comment on EPA's Modification to the Draft Final BHHRA	Context for Comment	LWG Proposed Resolution on August 15, 2012[2]	Status
		"Because of the uncertainty associated with estimating the true average concentration at a site, EPA guidance (EPA 1989, 1992) notes that the 95 percent upper confidence limit (UCL) of the arithmetic mean should ~~always~~ be used for this variable."			
22	3.4, p.52	The second sentence of the second paragraph should be revised as follows: "Although inconsistent with EPA guidance (EPA 1992), EPCs for sediment and surface water CT evaluations were calculated as the simple arithmetic mean because the evaluation is required under Oregon rules (OAR 340-122-0084(1)(g))."	2	The sentence will be revised per the comment.	Resolved
23	3.4.5, p. 55	The second sentence of the second paragraph should be revised as follows: "Common carp, black crappie, and brown bullhead were collected and composited within river segments designated as fishing zones, which are generally consistent with the home ranges identified in the Programmatic Work Plan ~~which are largely based on the home range of the fish as determined in a study of anadromous fish in the LWR by the Oregon Department of Fish and Wildlife (ODFW 2005)~~." (note: the ODFW 2005 study did not address migration of carp, bullhead, or crappie)	1	The sentence will be revised per the comment.	Resolved
24	3.5, p. 56	The term "ADD" needs to be defined. Also, subsequent equations need to be revised to use "ADD" instead of "CDI".	1	"ADD" will be defined as "Average Daily Dose" and all subsequent references to CDI will be changed to ADD.	Resolved
25	3.5, pp. 57 - 64	The age-adjusted equations were not used in the BHHRA, with the exception of the mutagenic COPCs. Rather than present all of the age-adjusted equations, it would be simpler to state that adult risks were adjusted for a 24-year period and added to the child risks to calculate the combined child/adult risks for non-mutagenic COPCs. For the mutagenic COPCs, equations are also needed for dermal contact with surface water and fish consumption.	1	The age-adjusted equations will be deleted, with the exception of the mutagenic COPCs. Text will be added to explain how the combined child/adult risks were calculated.	Resolved
26	3.5.2.1, p. 59	The age-adjusted equation should include a conversion factor.	1	A conversion factor will be added.	Resolved
27	3.5.3, p. 60	The term "EV" needs to be defined.	1	"EV" will be changed to "ET"	Resolved
28	3.5.3, p. 60	The age-adjusted dermal equation is incorrect.	1	The age-adjusted dermal equation will be deleted.	Resolved
29	3.5.5, p. 61	The infant intake equations were not used in the risk calculations. Risks to infants through breastmilk consumption were calculated using infant risk adjustment factors (as described in Section 5.1.4 of the May 2, 2011 version of the BHHRA).	1	The infant intake equations will be deleted.	Resolved
30	3.5.10, p. 65	The following sentence should be added to the first paragraph prior to the last two sentences: "Exposure parameters for domestic water users are from EPA guidance (1989, 2004a)."	1	The sentence will be added per the comment.	Resolved
31	3.5.10.1, p. 65	The first and second sentences should be revised as follows: "Exposure frequency for dockside workers was assumed to be ~~205~~0 days/year for the RME evaluation, and ~~50~~44 days/year the CT evaluation. The RME value assumes a dockside	1	The sentences will be revised per the comment.	Resolved

Comment Categories:
1 - Technical inaccuracy
2 - Comment is result of inconsistency with prior agreements or comments
3 - Clarification needed

Settlement Confidential Pursuant to FRE 408. Do not quote or cite. This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or part.

LWG Assigned No.	Section(s) and Page(s) Number Examples[1]	LWG's Comment on EPA's Modification to the Draft Final BHHRA	Context for Comment	LWG Proposed Resolution on August 15, 2012[2]	Status
		worker is exposed to beach sediment one day per week for 50 weeks (the EPA default exposure frequency of 250 days/year for a worker assumes 50 weeks of exposure in a year) ~~The value of 200 days/year is slightly less than the EPA default exposure frequency of 225 days/year for outdoor workers, and represents the average number of days worked per year according to the U.S. Census Bureau's *1990 Earnings by Occupation and Education Survey*~~."			
32	3.5.10.3, p. 66	The second sentence of the second paragraph should be revised as follows: "Dermal exposure to sediment was evaluated assuming the entire skin surface area was exposed for divers wearing a wet suit and not a dry suit."	1	The sentence will be revised per the comment.	Resolved
33	3.5.10.5, p. 67	The first sentence of the last paragraph should be revised as follows: "Water temperatures in the Lower Willamette River would typically limit swimming to the summer months, thus swimming was assumed to occur at a rate of 26 days per year for adults and 65 days per year for children for RME estimates."	1	The sentence will be revised per the comment.	Resolved
34	3.5.10.7, p. 71	The second sentence of the paragraph at the bottom of the page should be revised as follows: "Thus, the species-specific consumption rates for ~~of~~ salmon, lamprey and sturgeon in the above table were ~~equally apportioned at a combined consumption rate of 88 g/day, and~~ were used in combination with a consumption rate of 86.9 g/day that was equally proportioned for ~~the remaining portion of the diet was evaluated assuming equal portions of~~ the four resident fish (smallmouth bass, brown bullhead, common carp, and black crappie) for which tissue data were available."	1	The sentence will be revised per the comment.	Resolved
35	4.7, p. 80	RfDo is defined incorrectly.	1	RfDo will be defined as the oral reference dose.	Resolved
36	5.1.1, p. 81	This section uses the term "CDI". Section 3 used the term "ADD". Need to be consistent.	1	CDI will be replaced with ADD.	Resolved
37	5.2, pp. 85 - 95	The cancer risks and HIs/HQs discussed in the text need to be consistent with the values in the tables.	1	The cancer risks/HIs will be updated in the text.	Resolution pending (revisions will be made to final document)
38	5.2.6.1, p. 87	The discussion should clarify that the HIs greater than one are for in-water sediment only.	1	The following sentence will be added after the first sentence in each paragraph: "For beach sediment, noncancer hazards are less than 1." The following clause will be added at the beginning of the next sentence: "For in-water sediment,..."	Resolved
39	5.2.6.2, p. 88	The LWG disagrees that DDx is a "primary contributor" to the overall risk at RM 7.	1	DDx will be deleted as a primary contributor to risk.	Resolution pending (LWG provided proposed language to EPA)
40	5.2.6.2, p. 88	The statement that "RME risk estimates for fillet-only consumption are all greater than 1×10^{-4}" is incorrect (see RM 3 and RM 5 as examples).	1	The sentence will be revised to indicate where risks are greater than 1 x 10-4.	Resolution pending (RME issue resolution required first)

Comment Categories:
1 - Technical inaccuracy
2 - Comment is result of inconsistency with prior agreements or comments
3 - Clarification needed

Settlement Confidential Pursuant to FRE 408. Do not quote or cite. This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or part.

LWG Assigned No.	Section(s) and Page(s) Number Examples[1]	LWG's Comment on EPA's Modification to the Draft Final BHHRA	Context for Comment	LWG Proposed Resolution on August 15, 2012[2]	Status
				Note, depending on the resolution of the RME/CT issue, additional revisions will be required.	
41	5.2.6.3, p. 89	The LWG disagrees that DDx is a "primary contributor" to the overall risk in FZ 4-8.	1	DDx will be deleted as a primary contributor to risk.	Resolution pending (LWG provided proposed language to EPA)
42	5.2.6.3, p. 89	The statement that "dioxins/furans were not analyzed in this FZ" (referring to FZ 3-6) is incorrect.	1	The parenthetical regarding dioxins/furans will be deleted.	Resolved
43	5.2.6.6, p. 92	The LWG disagrees that DDx is a "primary contributor" to the overall risk for the multi-species diet.	1	DDx will be deleted as a primary contributor to risk.	Resolved
44	5.2.6.7, p. 93	The statement that "cPAHs are the primary contributors to the hazard estimates at RMs 5W and 6W" is incorrect.	1	The sentence will be deleted.	Resolution pending (LWG provided proposed language to EPA)
45	5.2.7.2, p. 94	The LWG disagrees that arsenic and DDx are "primary contributors" to the noncancer hazard.	1	DDx will be deleted as a primary contributor to risk.	Resolved
46	5.3, p. 95	Exposure to in-water sediment was not evaluated for transients.	1	"in-water sediment" will be deleted from the transient bullet.	Resolved
47	5.3, p. 95	The following summary of risks by location is inconsistent with prior discussions and the risk tables: "The highest relative cumulative risk or hazard estimates are at RM 2, RM 4, RM 7, Swan Island Lagoon, and RM 11. However, assuming exposure to sediment alone, areas posing the greatest risk are RM 6W, RM 7W, RM 8.5W, and RM 11E, shellfish consumption alone poses the greatest risks at RM 4E, RM 5W, RM 6W, and RM 6E"	1	These sentences will be deleted.	Resolution pending (LWG provided proposed language to EPA)
48	6.0, p. 97	The first sentence of the third paragraph should be revised as follows (per RAGS Vol 3, Part A): "The risks and hazards presented are consistent with EPA's stated risk management goal of being protective of 90 to 9~~5~~9.9 percent of the potentially exposed population"	1	The sentence will be revised per the comment.	Resolved
49	6.1.2, p. 98	The following sentence should be added to the second paragraph: "These results indicate that sources of chemicals outside of the Study Area may contribute to bioaccumulation of chemicals in anadromous fish species."	2	The sentence will be added per the comment.	Resolved
50	6.1.4, p. 99	The first sentence should be revised as follows: "Only a limited number clam tissue samples (five of 22) collected in the Study Area were ~~not~~ depurated prior to analysis."	1	The sentence will be revised per the comment.	Resolved
51	6.1.6, p. 100	The title of this section is not consistent with the discussion that follows. The LWG recommends changing the title to "Exclusion of Chemicals that Were Not Detected".	1	The title will be changed per the comment.	Resolved
52	6.1.10, p. 115	The second sentence should be revised as follows: "For example, fillet samples collected in Round 1 were analyzed for PCB as Aroclors, but no	1	The sentences will be revised per the comment.	Resolved

Comment Categories:
1 - Technical inaccuracy
2 - Comment is result of inconsistency with prior agreements or comments
3 - Clarification needed

Settlement Confidential Pursuant to FRE 408. Do not quote or cite. This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or part.

LWG Assigned No.	Section(s) and Page(s) Number Examples[1]	LWG's Comment on EPA's Modification to the Draft Final BHHRA	Context for Comment	LWG Proposed Resolution on August 15, 2012[2]	Status
		analysis was done for dioxins and furans." The last sentence of the same paragraph should be revised as follows: "Therefore, the risks from consumption of black crappie and brown bullhead fillet tissue, which were only analyzed in Round 1, likely underestimate the actual risks particularly in those areas where ~~PCBs and~~ dioxin/furans are the predominant contaminants."			
53	6.2.2, p. 104	The introductory paragraph should acknowledge that the exposure scenarios discussed in the following sub-sections have greater uncertainty and/or are less likely to occur than other exposure scenarios.	2	The introductory paragraph will be revised as follows: "Some of the exposure scenarios evaluated in this BHHRA have greater uncertainty than other scenarios. The uncertainties associated with those scenarios are discussed in the following subsections."	Resolved
54	6.2.2.1, p. 105	The second to last sentence should be revised as follows: "and individuals of apparent southeast Asian descent have been observed harvesting clams from the shore in Portland although not within the Study Area."	1	The sentence will be revised per the comment.	Resolved
55	6.2.5.3, p. 109	The sentence following the first bullet list should be modified as follows: "In addition to the consumption rates, uncertainty also exists with respect to the relative percentage of the diet of obtained from the Study Area or within individual exposure areas versus other nearby sources of fish"	1	The sentence will be revised per the comment.	Resolved
56	6.2.5.1, p. 110	This paragraph should refer to the EPCs in the Appendix F2 tables (not just the brown bullhead and carp EPCs).	1	The following sentence will be added: "The 95% UCLs calculated using less than 10 samples are presented in Appendix F2."	Resolved
57	6.2.5.5, p.112	The second sentence is incorrect (toxicity criteria are not based on total arsenic).	1	The sentence will be revised as follows: "Tissue concentrations of arsenic were reported as total arsenic, ~~which is consistent with~~ while the EPA toxicity criteria~~, which~~ are based on total arsenic."	Resolved
58	6.4.3, p. 121	The last sentence of the first paragraph states "Risks from background concentrations of arsenic in beach sediment and surface water are discussed in Section 5 of the BHHRA." However, EPA's modifications removed the discussion of background concentrations of arsenic from Section 5. Either the discussion should be added to Section 5 or moved to this section.	2	A discussion of the risks from background concentrations of arsenic will be added to Section 5.	Resolved
59	7.0, p. 123	The first sentence of the second paragraph should be modified as follows: "The populations evaluated in the BHHRA were identified based on human activities currently known to occur	1	The sentence will be revised per the comment.	Resolved

Comment Categories:
1 - Technical inaccuracy
2 - Comment is result of inconsistency with prior agreements or comments
3 - Clarification needed

Settlement Confidential Pursuant to FRE 408. Do not quote or cite. This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or part.

LWG Assigned No.	Section(s) and Page(s) Number Examples[1]	LWG's Comment on EPA's Modification to the Draft Final BHHRA	Context for Comment	LWG Proposed Resolution on August 15, 2012[2]	Status
		within the Study Area or could occur in the future, as described in the Programmatic Work Plan or in subsequent direction from EPA."			
60	7.2.1, p. 127	The primary contributors to risk discussed in this section are inconsistent with the primary contributors to risk identified in Section 5.	1	This section will not be revised.	Resolution pending (LWG provided proposed language to EPA)
61	7.2.3, p. 129	The fourth sentence should be modified as follows: "~~Throughout the~~ On a Study Area-wide basis, estimated risks from cPAHs and dioxins/furans each contributed approximately 50 percent of the cumulative cancer risk estimate."	1	The sentence will be revised per the comment.	Resolved
62	Executive Summary and Conclusions	The LWG believes a document of this size and complexity warrants an Executive Summary and Conclusions section.	2	Language to be negotiated after resolution of the technical issues.	Unresolved

Comment Categories:
1 - Technical inaccuracy
2 - Comment is result of inconsistency with prior agreements or comments
3 - Clarification needed

Settlement Confidential Pursuant to FRE 408. Do not quote or cite. This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or part.

Table 3: LWG Response to Basis for Notice of Noncompliance

	EPA July 27 Basis for Noncompliance	EPA Comment on 2009 Draft RI	LWG/EPA Comment Resolution	May 2, 2011 Draft Final BHHRA (redline)	EPA June 22, 2012 Redline of BHHRA
1	PBDE was not adequately addressed in BHHRA PBDEs were not included in Table 5 calculations of cumulative risk and hazard, nor were they discussed in the risk assessment document in this regard. The draft BHHRA only discusses PBDEs as being assessed separately in Attachment F3.	July 16, 2010 Comment S117 (Issue): Delete the last sentence of the second paragraph. The first full paragraph on page 111 discusses the results of PBDE analysis for sturgeon, salmon and lamprey done as a part of the ODHS study, and then performs a conservative risk calculation using maximum detected values for PBDEs. Although this is useful information for salmon, sturgeon and lamprey, it is not directly applicable to resident fish species (e.g., carp and bass) that tend to have higher levels of bioaccumulative compounds (like DDX, PCBs and dioxins/furans) than salmon, lamprey and sturgeon. Without resident fish data on PBDEs, the conclusion that PBDEs are unlikely to contribute to the overall risks is not defensible. The EPA Region 10 lab has recently completed analyses of PBDEs in selected samples of resident biota from the PH Round 3 sampling (20 carp samples (10 fillet and 10 rest of body), 38 bass samples (19 fillets and 19 rest of body), and 6 clam samples). This data was recently made available to the LWG. December 8, 2010 directed comment: BHHRA Comment - Inclusion of the PBDE Fish Tissue Data in the BHHRA: This comment was provided to the LWG as part of our data lockdown comment with respect to the RI Report (see above). EPA disagrees that the PBDE analysis was solely for the purpose of method development. EPA has determined that the PBDE data is sufficient to assess risk within Portland Harbor, support regional watershed efforts and monitor the effectiveness of the site remedy with respect to PBDEs. As a result, EPA directs the LWG to present the risks associated with PBDEs in bass, carp and clam tissue consistent with the fish consumption scenarios developed in the Portland Harbor baseline human health risk assessment. This comment shall not change the agreed upon PRGs to be used in the draft FS. EPA reserves the right to require the development of PRGs for PBDEs in the future (e.g., proposed plan and/or final FS) if deemed necessary. EPA April 11, 2011 cover letter on March 17, 2011 tables:	May 6, 2011 response to April 11, 2011 comments on tables: "As clarified in EPA's email on April 27, 2011, PBDEs do not need to be incorporated in the tables presenting cumulative risks and hazards. Consistent with EPA's email, the Risk Characterization section in the Final BHHRA will include a discussion of the contribution of carcinogenic risk and noncarcinogenic hazard due to PBDE exposures. PBDEs are identified in the tables of contaminants posing cancer risks greater than 1 x 10-6 or hazard quotients greater than 1 in the Draft Final BHHRA." (emphasis added) The agreement between EPA and the LWG was to add the discussion of PDBE in the risk characterization section of the Final BHHRA, not the draft Final BHHRA due three weeks after EPA's directed comment to include it. EPA's April 27 email states that PBDEs should be identified in Table 5-189 as appropriate. This must refer to table 5-187 of the first draft BHHRA (there was no table 5-189), which is now table 5-204 and includes PBDE.	PBDEs are listed on Table 5-204 "Chemicals Potentially Posing Unacceptable Risk." PBDEs are identified in Executive Summary as contaminant potentially posing unacceptable risk (§ES.6, p. 26).	EPA redline does not include PBDEs in the Risk Characterization section.

Table 3: LWG Response to Basis for Notice of Noncompliance

		"EPA's comments should be addressed in the next revision or the final version of BHHRA as appropriate." EPA April 27, 2011 email: Elizabeth Allen and Laura Kennedy recently discussed possible ways to meet the intent of Comment 4 of EPA's April 11, 2011 comments on LWG's March 17, 2011 submittal of the revised risk calculations for the PH BHHRA. Their recommendation is that a discussion of the contribution of carcinogenic risks and noncarcinogenic hazard due to PBDE exposures be presented in the risk characterization section of the BHHRA. As appropriate, PBDEs will be identified in Table 5-189 for further evaluation. EPA concurs with the recommended approach. The intent of EPA's comment 4 was not to require inclusion of PBDE risks in each receptor-specific and location-specific table in the BHHRA, and presentation of that information in an attachment is also acceptable.			
2	RME and CTE identifiers were not incorporated into BHHRA tables. EPA July 16, 2010 comment #52 and #20 was not adequately incorporated The LWG did not clearly and factually define which EPCs were used to evaluate the RME and CT in this risk assessment in the tables. Thus, Section 3 Tables were not changed to reflect this comment nor were Section 5 Tables for fish consumption.	July 16, 2010 Comment S52 (clarify): In this section and subsequently throughout the risk assessment, replace the term "95% UCL/max EPC" with "RME EPC." The repeated references to a "mean" EPC relative to one based on a 95 percent UCL or maximum concentration is misleading. The text in the second paragraph incorrectly states that exposure point concentrations would be calculated differently for central tendency (CTE) and reasonable maximum (RME) exposures. Consistent with EPA guidance (1992, 2000), the EPC should represent an estimate of the arithmetic average concentration for a contaminant based on a set of site sampling data. Because of the uncertainty associated with estimating the true average concentration at a site, the 95 percent UCL of the arithmetic mean should be used for this variable. The 95 percent UCL provides reasonable confidence that the true site average will not be underestimated. The average concentration, defined as the 95 percent UCL, should be used for both CTE and RME evaluations. The RME evaluation should be distinguished from CTE by accounting for variability in such variables as exposure frequency and intake rates.	LWG November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the BHHRA: The EPCs will be described in a factual manner in the BHHRA (i.e., the EPC will be identified as the mean, 95% UCL, or maximum). The terms RME and CT will not be used in reference to the EPCs. EPA December 8, 2010: "EPA has reviewed the LWG responses, as summarized in the [November 18, 2010] tables, and has determined that the vast majority of the issues associated with addressing EPA's comments have been resolved." (Letter then notes three other unrelated issues on which EPA is providing additional direction and certain further clarification on the BERA.) May 6, 2011 LWG response April 11, 2011 Comment 1: For sediment and water exposure scenarios, the tables in the Draft Final Baseline Human Health Risk Assessment (BHHRA) have been revised to note whether a central tendency or reasonable maximum exposure scenario is presented. As discussed during the October 15, 2010 meeting, the fish and shellfish ingestion scenarios involve a range of ingestion rates, so the tables do not present a RME or CTE scenario. For those scenarios, the table titles in the Draft Final BHHRA	Tables submitted as described in May 6, 2011 response to comment #1.	

		July 16, 2010 Comment S20 (revise, clarify): Throughout the text, figures, tables and maps, the phrase "RME Exposure…" should be used in place of "95% Upper confidence limit (UCL) or Maximum." April 11, 2011 Comment 1: Per EPA Specific Comment 52 on the draft Portland Harbor BHHRA, the tables should be revised to note whether a Central Tendency Exposure (CTE) or a Reasonable Maximum Exposure (RME) exposure scenario is presented. Accordingly, in all instances "95% UCL/Maximum Exposure Scenario" should be changed to "RME" in the title. EPA agreed that actual exposure point concentrations could be referred to specifically on the basis of the value they represented (arithmetic mean, 95 percent upper confidence limit on the arithmetic mean, or the maximum detected concentration), but that the exposure scenarios would be referred to as either CTE or RME as consistent with EPA risk assessment guidance and policy.	have been revised to reference the exposure point concentrations and do not refer to the 95% UCL/maximum or mean as exposure scenarios. May 6, 2011 LWG cover letter to comment responses: It is the LWG's understanding based upon our discussions and EPA's email clarifications that the proposed modifications to the BHHRA set forth in these responses will satisfy EPA's directive comments, and therefore there is no need for the LWG to dispute any of the comments. If, however, you disagree with the LWG's understanding of the agreed resolution, the LWG requests that you extend the deadline for the LWG to invoke dispute to 14 days following your written notice of such disagreement.		
3	EPA directed comment #148 was not adequately incorporated. This was a directed comment that specified that the text be modified to read "Although fishers normally fish and/or collect those resources that are available in their area, it is not known to what extent fishers would substitute alternative local types of shellfish." The first part of the sentence was not included as per the direction.	July 16, 2010 Comment S148 (directed change) Revise the following sentence in the first paragraph as shown: *Although fishers normally fish and/or collect those resources that are available in their area, it is not known to what extent fishers would substitute alternative local types of shellfish. ~~if the shellfish in the survey were not available~~"*	Text to be revised in accordance with September 15, 2010 General Responses to Directed Comments on BHHRA (emphasis added): The LWG disagrees with EPA's directed changes requiring the removal of factual information from the draft BHHRA. The LWG believes that the addition of statements asserting a need for remediation or goals of remediation in the BHHRA is not consistent with guidance. As discussed at the August 20th and September 9th meetings, factual (i.e., objective) language can remain in the revised BHHRA. Judgmental language (both that in the draft BHHRA and that directed by EPA) will not be included in the revised BHHRA. The need for remediation or goals of remediation will not be discussed in the revised BHHRA. Discussion of remedial goals will be included in the FS consistent with the RAOs. EPA September 22, 2010 EPA General Responses to EPA Directed BHHRA and BERA Comments: "EPA has reviewed the September 15, 2010 letter and attachments and agrees, with clarifications, that EPA's directed comments on the BERA and BHHRA should be	Section 6.2.5.3, p. 156: "It is not known to what extent fishers substitute alternative local types of shellfish."	EPA redline retains the LWG text exactly.

Table 3: LWG Response to Basis for Notice of Noncompliance

			revised in accordance with the general framework, and that the proposed resolution described in LWG's general responses matches our understanding of the meeting outcome." Includes three unrelated clarifications.		
4	EPA July 26, 2011 comment #17 was not adequate incorporated. The revised text fails to clarify that modifying factors aren't used in the derivation of slope factors. Since these represent probabilities, the uncertainty is expressed by using a UCL on the slope of the line. The original risk assessment text used the term "uncertainty or variability factors, and referred to a typical range of 100 to 1,000. Those specific numbers cited appear to represent the "uncertainty factors" used in the derivation of noncancer toxicity criteria (reference doses or reference concentrations), which tend to be factors of 10, for things like accounting for interspecies differences in metabolism, or that there may be particularly sensitive individuals in a heterogeneous human population and we may have tested a group of genetically homogenous animals. Sometimes the uncertainty factors were also combined with modifying factors, intended to reflect scientific uncertainties of the study and database not explicitly treated with standard uncertainty factors. So "uncertainty factor" and "modifying factor" are specific, discrete terms with different definitions and neither is used in the derivation of cancer slope factors, which are really the output of various statistical regression models. As such, there is no uncertainty factors used for cancer risk assessments, as the values are already expressed as some confidence interval. The comment was in part an attempt to point out this distinction, the LWG response was to go from uncertainty factors to modifying factors, which is technically incorrect. In addition, although the comment did not provide specific, word-for-word direction, the LWG was willing to change the definition of uncertainty factors, but failed to address the part of the comment that said they should also note that it is possible that hazard may be underestimated if certain endpoints were not the focus of the toxicological studies. However,	July 16, 2011 Comment S16 (revise): Delete the last sentence in the last paragraph in ES.3: ~~"Because many of the exposure scenarios that were evaluated in the BHHRA are highly variable and do not have standard default exposure factors, uncertainties associated with the exposure factors are anticipated to have significant impacts on the risk estimates."~~ The phrase "highly variable" represents a subjective judgment, and will have different meanings to different readers of the assessment. The analysis of uncertainties should avoid unsupported claims about the relative variability of different exposure scenarios. An objective discussion of uncertainties for each scenario and their relationship to the quantitative risk estimates is adequate. July 16, 2011 Comment S17 (revise): Delete the following 2 sentences from the end of the first paragraph: ~~*"Uncertainty or variability factors, which typically range from two to three orders of magnitude (100 to 1,000 times), are often used by EPA in deriving toxicity values for human health given the uncertainties in the toxicological data. As a result, actual risks within the Study Area could be lower than the potential risk estimates calculated in the BHHRA."*~~ "Uncertainty or variability factors" are not used for the derivation of cancer slope factors. Rather, their use is limited to the development of non-cancer toxicity criteria. In addition, the text fails to note uncertainties in toxicity factors that may result in underestimates of risk (e.g., lack of test data on reproductive, developmental and/or immunological endpoints).	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: This issue was addressed in the responses to EPA's Directive Comments. Text to be revised in accordance with EPA September 22, 2010 EPA General Responses to EPA Directed BHHRA and BERA Comments: "EPA has reviewed the September 15, 2010 letter and attachments and agrees, with clarifications, that EPA's directed comments on the BERA and BHHRA should be revised in accordance with the general framework, and that the proposed resolution described in LWG's general responses matches our understanding of the meeting outcome." Includes three unrelated clarifications. EPA December 8, 2010: "EPA has reviewed the LWG responses, as summarized in the [November 18, 2010] tables, and has determined that the vast majority of the issues associated with addressing EPA's comments have been resolved." (Letter then notes three other unrelated issues on which EPA is providing additional direction and certain further clarification on the BERA.)	The specific comment quoted by EPA is identified as S17 but the text of the comment quoted in EPA's July 27 Basis for Noncompliance is S16. EPA's discussion, however, relates to our changes in response to S17. S17, which was not a directed comment, merely requests that the LWG delete two sentences. The LWG modified the first sentence consistent with the agreed resolution and deleted the second sentence as requested. Nothing in the July 16, 2010 comment itself can be read as pointing out a distinction between the means of deriving of non-cancer toxicity values and the derivation of cancer slope factors. The comment does not say that "they should also note that it is possible that hazard may be underestimated if certain endpoints were not the focus of the toxicological studies," it simply requests deletion of the last sentence, which the LWG deleted. S16: Sentence was deleted and replaced with: Uncertainties that are inherent in exposure assessment are attributed to both variability in the population assessed and also the degree of knowledge associated with exposure assumptions. These uncertainties associated with the exposure assessment impact the risk estimates.	

Table 3: LWG Response to Basis for Notice of Noncompliance

	the LWG has steadfastly refused to discuss uncertainties when they may indicate the risk could possibly be underestimated.			S17: ~~Uncertainty or variability~~ Modifying factors, which typically range from two to three orders of magnitude (100 to 1,000 times), are often used by EPA in deriving toxicity values for human health given the level of confidence ~~uncertainties~~ in the toxicological data, the intra-species differences (i.e., animal to human), and the inter-species differences to account for sensitive human subpopulations. ~~As a result, actual risks within the Study Area could be lower than the potential risk estimates calculated in the BHHRA.~~ Note: EPA's July 27 memo also states: "However, the LWG has steadfastly refused to discuss uncertainties when they may indicate the risk could possibly be underestimated." This is not true. See, e.g., section 6.4.1: "For the chemicals that have the largest non-cancer contribution in the HHRA, there is a possibility of underpredicting non-cancer health effects by using only one endpoint per chemical."	
5	EPA July 16, 2010 comment #28 was not adequately incorporated. The statement is still not accurate. The assessment of human health risks is to be made on a reasonable maximum exposure, which is defined in EPA guidance (RAGS Part A, EPA 1989) as the highest exposure that is reasonably expected to occur at a site. For this reason, the intake variable values for Superfund exposure assessments are selected so that the combination of all intake variables results in an estimate of the reasonable maximum exposure for that pathway. The selection of these values has nothing to do with the lack of site-specific values.	EPA July 16, 2010 Comment S28 (revise): The document suggests that this report is somehow different from other risk assessments because EPA directed the use of conservative assumptions. In fact, risk assessments performed under guidance from other federal agencies, states, and even other countries, assess risks and inform risk management decisions based on assumptions that report risks in the upper range of those possible. The risk assessment for PH is thus typical in this regard. Accordingly, with the exception of the first sentence, the text in the third paragraph should be deleted.	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: This issue was addressed in the responses to EPA's Directive Comments. Text to be revised in accordance with EPA September 22, 2010 EPA General Responses to EPA Directed BHHRA and BERA Comments: "EPA has reviewed the September 15, 2010 letter and attachments and agrees, with clarifications, that EPA's directed comments on the BERA and BHHRA should be revised in accordance with the general framework, and that the proposed resolution described in LWG's general responses matches our understanding of the meeting outcome." Includes three unrelated clarifications.	Section 1.0, 3rd paragraph: The LWG has worked with the United States Environmental Protection Agency (EPA) to develop the methods and assumptions used in this BHHRA. At the direction of EPA, this BHHRA incorporates ~~conservative~~ assumptions to provide a health protective assessment of risks associated with contaminants present at the Site, which is consistent with EPA	

Table 3: LWG Response to Basis for Notice of Noncompliance

			EPA December 8, 2010: "EPA has reviewed the LWG responses, as summarized in the [November 18, 2010] tables, and has determined that the vast majority of the issues associated with addressing EPA's comments have been resolved." (Letter then notes three other unrelated issues on which EPA is providing additional direction and certain further clarification on the BERA.)	guidance on risk assessment (1989). For many of the exposure scenarios evaluated in this BHHRA, upper-bound literature values are used to quantify exposure due to the lack of site-specific exposure information. In some cases, the maximum detected concentrations are used to quantify long-term exposures~~. While the use of maximum detected concentrations provides a health protective approach, it~~ which may not be representative of ~~conditions~~ ongoing exposures in the Study Area. Therefore, the results of the BHHRA have a margin of conservatism built into the risk conclusions consistent with EPA guidance (1989). ~~The conservative assumptions about exposure and toxicity also affect the preliminary remediation goals (PRGs) and early activities in the Feasibility Study (FS).~~ Note: Text was revised to address EPA comment that paragraph suggested the risk assessment was not consistent with EPA guidance. EPA's comment did not request that the text be revised to state a specific hierarchy of information sources from which exposure assumptions should be derived. It is a factual statement that if site-specific values were available, they would have been used: The interaction between site-specific rates and estimated rates is discussed in EPA guidance: "Exposure frequency and duration are used to estimate the total time of exposure. **These terms are determined on a site-specific basis.** If statistical data are available, use the 95th percentile	

Table 3: LWG Response to Basis for Notice of Noncompliance

				value for exposure time. **In the absence of statistical data (which is usually the case), use reasonable conservative estimates of exposure time**." (RAGs A, emphasis added) Per EPA's Fish Consumption Guidance (2000), the following is the hierarchy of data sources for fish consumption rates: 1. Local fish consumption surveys 2. Local fish consumption survey with limited scope 3. Regional or state survey data from other areas having matching characteristics 4. National fish or food consumption data	
6	EPA July 26, 2010 comment #38 was not adequately incorporated. Since the agreement was that the data set would not change, an explanation in the BHHRA Section 2.4.2 was to be provided per the comment. However, Section 2.4.2 does not provide any explanation for why only one of the surface water samples (W020) from Swan Island Lagoon was used for COPC screening for transients and recreational beach exposures and for the domestic water source as requested in the comment.	July 16, 2010 Comment S38 (clarify): It is not clear why only one of the surface water samples (W020) from Swan Island Lagoon was used for COPC screening for transients and recreational beach exposures and for the domestic water source. Please add an explanation, or use all of the data in the COPC screen.	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: The data sets used in the draft BHHRA were based on prior discussions and agreements with EPA, as documented in the Issue Resolution table for the Round 2 Comprehensive Report and the Meeting Summary Memo dated June 9, 2008. EPA is now requesting changes to those data sets. To include additional data and/or modify the data evaluated in the BHHRA would be a significant effort. The following changes are being requested in EPA's comments: - Inclusion of data outside of the Study Area in identifying COPCs - Additional surface water data for transient and recreational beach user exposures EPA will not require the changes to the data sets used in the BHHRA that were requested in the identified non-directive comments. EPA December 8, 2010: "EPA has reviewed the LWG responses, as summarized in the [November 18, 2010] tables, and has determined that the vast majority of the issues associated with addressing EPA's comments have been resolved." (Letter then notes three other unrelated issues on which EPA is providing additional	New text does explain that only vertically integrated single point samples and transect samples were used and that there was one such sample from Swan Island Lagoon: §2.4.2: "For transients and beach users, COPCs were selected from surface water samples taken from areas where direct contact with transient or beach users could occur, including both single point sampling stations where vertically integrated samples were collected and transect samples. This included one sample from Swan Island Lagoon."	EPA removed the explanation about the surface water datasets used for COPC screening, including the statement about there being only one sample from Swan Island Lagoon used.

Table 3: LWG Response to Basis for Notice of Noncompliance

			direction and certain further clarification on the BERA.)		
7	EPA July 16, 2010 comment #50 was not adequately incorporated. The proposed language inappropriately qualifies the survey results inconsistent with EPA's provided language.	July 16, 2010 Comment S50 (revise): In the second sentence, change the word "suggest" to "show" in the following sentence: *"The results of the survey <u>show</u> ~~suggest~~ that tribal members have higher fish ingestion rates than the general public."*	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: EPA provided suggested revisions to the text of the BHHRA. The LWG proposes modifications to the suggested language for purposes of clarity and/or consistency. EPA agrees with the response. EPA December 8, 2010: "EPA has reviewed the LWG responses, as summarized in the [November 18, 2010] tables, and has determined that the vast majority of the issues associated with addressing EPA's comments have been resolved." (Letter then notes three other unrelated issues on which EPA is providing additional direction and certain further clarification on the BERA.)	§3.3.5.2: The results of the survey ~~suggest~~ show that tribal members surveyed generally have higher fish ingestion rates than the general public.	EPA's June 22 uses the LWG language, not the language of EPA's July 2010 comments: §3.2.1.7: "The results of the survey show that tribal members surveyed generally consume more fish than the general public."
8	EPA July 16, 2010 comment #76c was not adequately incorporated. Neither the LWG's response nor the revised BHHRA address part c of EPA's comment. Further, the LWG simply subtracted out background from the EPC values and presented this in maps, which is different than discussing the degree to which background concentrations contribute to the EPC and risk (per the comment) and inconsistent with	June 16, 2010 Comment S76.c. (revise, clarify) A summary discussion should be presented at the end of this section that references a summary table showing all of the beaches that are above risk levels of 10-6, 10-5, and 10-4 for each receptor, with contaminants included. This presentation should also include graphs for tribal adult exposure to beach sediments, for total cancer risk by beach, and for cancer risk for arsenic, dioxin/furan TEQ, B(a)P, and	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: EPA requested that a summary discussion be included at the end of the risk characterization section for each exposure medium evaluated in the BHHRA. The LWG proposes that the summary discussion should identify those chemicals with cancer risks greater than 10-6, 10-5, and 10-4 and hazard quotients greater than 1.	Text was revised consistent with the comment to state that arsenic occurs naturally and to identify beaches at which arsenic concentrations are greater than background levels: Section 5.2.1.3.1: Arsenic is a naturally occurring metal. The concentration for arsenic in soil	EPA deleted all discussion of potential risk related to background concentrations of arsenic in sediment and water.

Table 3: LWG Response to Basis for Notice of Noncompliance

	EPA's Risk Characterization Handbook and The Role of Background in the CERCLA Cleanup Program guidance. We made a comment and their response went the wrong direction.	total cPAH by beach. Other beach scenarios (e.g., recreational users, transients, and dockside workers) should also be shown. The graph should be organized by river mile (east and west) with corresponding sample numbers for each river mile shown. c) The discussions of arsenic are vague throughout this section and elsewhere in the risk characterization section. The discussions provided do not allow the reader to evaluate arsenic contribution to risks or at which beaches arsenic concentrations are greater than background levels. The points that need to be made are 1) arsenic occurs both naturally and as a result of environmental releases, and 2) assuming an estimated background of 7 mg/kg, the degree to which background concentration contribute to the EPC and risk should be described.	EPA agrees with the response. EPA December 8, 2010: "EPA has reviewed the LWG responses, as summarized in the [November 18, 2010] tables, and has determined that the vast majority of the issues associated with addressing EPA's comments have been resolved." (Letter then notes three other unrelated issues on which EPA is providing additional direction and certain further clarification on the BERA.)	recognized by DEQ to represent background levels in Oregon is 7 milligrams per kilogram (mg/kg) (DEQ 2007). At this background concentration, the calculated risk from arsenic would exceed 1 x 10-6 for the adult recreational beach user RME scenario. When a background concentration of 7 mg/kg is subtracted from detected concentrations of arsenic in beach sediment, resulting cumulative risks for the adult recreational beach user RME scenario exceed 10-6 at beaches 04B024 and B003. Beaches with risk exceedances of 1 x 10-6 excluding risks from background arsenic are shown for all exposure scenarios for beach sediment in Maps 5-32-1 and 5-2-2. Note: The comment does not direct or suggest a methodology for depicting background arsenic levels. Because the data does not suggest significant source of non-natural arsenic, the LWG's methodology was designed to identify those beaches where other chemicals not attributable to background (i.e. BaP) result in risks greater than 1 x 10-6.	
9	EPA July 16, 2010 comment #99 was not adequately incorporated. While the revised text (p. 102) notes that the depurated samples were collected at the edges of the study area, there is still is an inappropriate comparison of risk between the depurated and undepurated clams collected at the Site. The distribution of risk relative to the distribution of sediment contaminant concentrations and the appropriate comparison of depurated and undepurated clams gathered from the same location show that there is very little difference in the risk and hazard. Consequently, it is not	July 16, 2010 EPA Comment S99 (issue): The document concludes that Study Area-wide cancer risks from consumption of undepurated clams are 2 to 3 times higher than those from Study Area-wide cancer risks from depurated clams, and that corresponding non-cancer hazards are 1 to 2 times higher. The database for COPCs in depurated clam tissue is limited to 5 of the 22 clam samples, and these 5 samples are from the northern stretch of the river (1E and 2W) and the southern stretch of the river (10W, 11E, and 12E). It is not appropriate to compare risks from these 5 depurated samples from the edges of the site to the 22 non-depurated clam	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: The BHHRA will be revised consistent with the comment.	§5.2.6 was revised to clarify that depurated clam tissue was collected from the edges of the Study Area: Estimated risks from shellfish consumption within the Study Area ranged from a high cumulative cancer risk of 7 x 10-4, which was for the 95% UCL/max EPCs, ~~high~~ (18 g/day) ingestion rate undepurated clam tissue scenario, to a cumulative cancer risk of 9 x 10-7, which was for the mean	§5.2.7.6 deletes any reference to or discussion of depurated clams.

Table 3: LWG Response to Basis for Notice of Noncompliance

	consistent with our comment to compare depurated samples on a site-wide basis since they are not representative of site-wide risk and hazard.	samples from the entire length of the site from RM 1 to RM 12, or to compare non-depurated clams to depurated clams from only the edges of the site (1E and 2W; 10W, 11E, and 12E) and assume that the results are representative of the entire site. As no supporting calculations are presented in the draft BHHRA, it is not clear what samples were used for these calculations, and EPA cannot determine if the calculations are correct. These supporting calculations should be included in Attachment F5. In drawing conclusions from this analysis, the discussion should be clear that these data only provide information on 5 sampling locations, all of which are on the edges of the site rather than in areas with particularly high cPAH concentrations.		EPC, ~~medium~~ (3.3 g/day) ingestion rate crayfish tissue scenario. Estimated risks from shellfish consumption in areas assessed outside of the Study Area ranged from 2 x 10-6 to 8 x 10-5. Clam samples were not all analyzed for the same chemicals, and the uncertainties associated with the resulting risks are discussed in ~~Section~~ Section 6. Study Area-wide risks from ingestion of undepurated clam tissue are two to three times higher than Study Area-wide risks from ingestion of depurated clam tissue, as shown in Table 5-182 and Table 5-183. Depurated clam tissue samples were collected from five locations at the northern and southern edges of the Study Area, while undepurated clam tissue samples were collected from 22 locations throughout the Study Area. For all high ingestion rate scenarios, risks are above a 1 x 10-6 cumulative cancer risk and are primarily due to PCBs. Note: The LWG added a reference to the tables showing the Study Area- wide risks for both depurated and undepurated clams, where the risks are 2 – 3 times higher for the undepurated clams. We also added a table in Attachment F6 (formerly F5) that provides the concentrations of COPCs in depurated and undepurated samples collected at the same location.	
10.	EPA July 16, 2010 comment #106 was not adequately incorporated. The LWG's draft BHHRA did not address EPA's comment nor was it consistent with the agreement documented. EPA's comment clearly	July 16, 2010 EPA Comment S106 (revise) Revise the first paragraph to delete the following sentence: *In a deterministic risk assessment multiple conservative assumptions compound to result in an estimate of risk that can be many times (or*	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: This issue was addressed in the responses to EPA's Directive Comments. September 15, 2010 General Responses to Directed Comments on BHHRA:	The sentence in question was revised to state: "In a deterministic risk assessment, ~~multiple~~ conservative assumptions can compound to result in an estimate of risk that ~~can be many times (or~~	EPA's text in §7.0 makes the same point, but uses the word "cumulative" instead of "compound" and makes a judgment on an overestimate of risk:

Table 3: LWG Response to Basis for Notice of Noncompliance

	indicated that the LWG had not supplied any information in support of their compounding statement and the draft BHHRA also did not. Therefore, the statement too is a judgment or opinion which the LWG agreed to eliminate from the BHHRA.	*orders of magnitude) greater than the likely actual risk posed by a particular site."* There is no information presented in this section or anywhere else in the risk assessment to support such a claim.	As discussed at the September 9th meeting, language regarding the compounding of conservative assumptions will not be included in the revised BHHRA. Factual information about the range of the exposure assumptions and how the combination of those assumptions may fall within the RME range of 90th to 99.9th percentiles can be included in the revised BHHRA.	~~orders of magnitude) greater than the likely actual risk posed by a particular site~~is at the upper end of the probable risk range." Note: This is consistent with RAGS Volume 3 Part A: "In general, if the terms in the denominator of the exposure or risk equation have low variability and do not approach zero, then the CTE point estimate is likely to agree quite well with the arithmetic mean from the PRA simulation, and the RME point estimate is likely to correspond to the high-end of the risk distribution (see discussion of RME range in Section 1.2.5)." (emphasis added) The LWG deleted text regarding multiplying conservative assumptions to magnify the overall conservatism in at least 10 places (see ES.5, 5.2.1, 5.2.2, 5.2.3, 5.2.4.1, 5.2.5, 5.2.6.1, 5.3, 6.5, and 7.1). It was an inadvertent error not to delete the words "compound to" from this sentence; however, the revised sentence is consistent with EPA guidance and with the thrust of this non-directive comment, which we understood to take issue with the statement that estimates of risk can be many times greater than the likely actual risk posed by a site."	"However, these estimates are based on numerous and often conservative assumptions and, in the absence of definitive information, assumptions are used to ensure that actual sites risks are not underestimated. The cumulative effect of these assumptions can result in an analysis having an overall conservativeness greater than the individual components. . Accordingly, it is important to note that the risks presented here are based on numerous conservative assumptions in order to be protective of human health and to ensure that the risks presented here are more likely to be overestimated rather than underestimated."
11.	EPA July 16, 2010 comment #111 was not adequately incorporated. No information is presented in Attachment F6 to support the statement made here which was what EPA agreed had to be included for the statement to stay. The sentence needs to be deleted as directed.	EPA July 16, 2010 comment S111 (revise, clarify) The following statement occurs in the first paragraph: "Depending on the species and chemical, the difference in concentrations between fillet and whole body tissue can be minimal or more than a factor of 10, as discussed in Attachment F5." As discussed in our comments on Attachment F5, a table should be provided that shows data used and results that supports the conclusion (e.g., "factor of 10") presented here. Analyses not reported in the	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: The BHHRA will be revised consistent with the comment.	The info is discussed in Attachment F6, Section 2.1 and on Table F6-1. The LWG believes the information in Table F6-1 supports the statement in section 6.1.3: "*Depending on the species and chemical, the difference in concentrations between fillet and whole body tissue can be minimal or more than a factor of 10*"	§6.1.3: As discussed in Attachment F6, the difference in measured concentrations between fillet and whole body can be as great as a factor of 10 or more

Table 3: LWG Response to Basis for Notice of Noncompliance

		risk assessment cannot be evaluated or approved by EPA. Please note that comment S11 was not identified as a "directed change" as stated in EPA's July 27, 2012 Basis for Noncompliance document.		Note: Table F6-1 includes ratios of whole body to fillet for PCBs and mercury in smallmouth bass and carp. The ranges are 4 – 17 for PCB TEQ in smallmouth bass, 4 – 10 for PCB congeners in smallmouth bass, 0.5 – 1 for mercury in smallmouth bass, 1 – 7 for PCB TEQ in carp, 1 – 2 for PCB congeners in carp, and 0.7 – 0.9 for mercury in carp.	
12.	EPA July 16, 2010 comment #112 was not adequately incorporated. The Table F6-13 is very difficult to read, but seems to show no discernible pattern. The LWG did not statistically prove their point therefore they did not address the comment and the statement should have been deleted as directed.	EPA July 16, 2010 Comment S112 (issue) This section concludes that, *"With the exception of a few metals, average chemical concentrations were higher in undepurated clam tissue collected at the Study Area than in depurated clam tissue*. The database for COPCs in depurated clam tissue is limited to 5 of the 22 clam samples, and these five samples are from the northern stretch of the river (1E and 2W) and the southern stretch of the river (10 W, 11E, and 12 E). Hence, it is not evident that the results from these samples are representative of conditions from the entire length of the site from RM 1 to RM 12. At a minimum, the risk assessment should discuss the uncertainty associated with such a limited data set for depurated clam tissue, and present a balanced discussion of the appropriateness of extrapolating these limited results to represent tissue concentrations in more contaminated areas of the site.	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: The BHHRA will be revised consistent with the comment.	The LWG did not present statistical data, because we conclude that "Using…undepurated tissue to represent tissue consumption throughout most of the Study Area provides a health protective approach…" We agree that no statistically valid conclusion can be drawn from five samples, and we did not attempt to do so. The EPA comment says, "at a minimum," the uncertainty associated with the data set needs to be discussed. The LWG revised the text consistent with the comment by discussing the uncertainty of this comparison in the text: Clam tissue throughout most of the Study Area was analyzed as undepurated samples, and a limited number of clam samples were depurated before analysis. A common practice in the preparation of clam tissue for consumption includes depuration, although undepurated clam may also be consumed. The amount of COPC-containing particles within the gut of bivalves can vary widely; however, studies have demonstrated that the sediment content in the gut of bivalves could represent up to 39% of the total body load of	EPA text is virtually identical: §6.1.4: "With the exception of certain metals, average chemical concentrations detected in clam tissue in the Study Area were higher in undepurated than in depurated samples."

Table 3: LWG Response to Basis for Notice of Noncompliance

				metals (Wallner-Kersanach et al. 1994). With the exception of a few metals, average chemical concentrations were higher in undepurated clam tissue collected at the Study Area than in depurated clam tissue collected at the Study Area. However, depurated clam tissue accounted for only five of the 22 clam samples collected for the BHHRA dataset, and the depurated samples were collected from edges of the site (northern and southern stretches). Therefore, there are uncertainties associated with comparing depurated and undepurated tissue in the BHHRA dataset. These concentrations are shown in the EPC tables in Section 3 (Tables 3-24 and 3-25). Using analytical concentrations of undepurated tissue to represent tissue consumption throughout most of the Study Area provides a health protective approach to assessing risk from clam tissue consumption.	
13.	EPA July 16, 2010 comment #155 was not adequately incorporated. There is no rationale provided to adequately substantiate these findings, therefore, they are judgment and/or opinions which were agreed to be eliminated from the BHHRA. [highlighted text: "In some cases, the maximum concentration for a contaminant was anomalously high, and may not be representative of tissue concentrations resulting from exposure to CERCLA-related contamination within the Study Area." And "The conservatism of using the maximum detected concentrations as the EPC for exposure	EPA July 16, 2010 Comment S155 (clarify) According to the information presented in Attachment F5, the ratios between the maximum and minimum concentration values shown are less than 3. For in-water sediments, the ratios are less than 4. When comparisons are made within an exposure area for biota (which is the appropriate comparison, rather than Study Area-wide, given the heterogeneity in sources in PH), the vast majority of the ratios of the maximum EPCs to the mean are equal to or less than 2, and the remaining ratios are less than 4. EPA believes it is important that this information be presented in the main body of the risk characterization, as it shows that there are not major differences between risks calculated using the mean of the concentration data and those calculated using the maximum for individual exposure areas.	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: The BHHRA will be revised consistent with the comment.	As the comment requests, §6.2.6.3 was revised to state: Generally, the ratios between the maximum and minimum detected concentrations are less than 3. For in-water sediments, the ratios are less than 4. When comparisons are made within an exposure area for biota, the majority of the ratios of the 95% UCL/maximum EPCs to the mean are equal to or less than 2, and the remaining ratios are less than 4. Note: The highlighted text in EPA's July 27 Basis for Noncompliance document was not the subject of comment S155 and (with the	§6.2.5.3: First highlighted sentence retained without revision, second sentence deleted.

Table 3: LWG Response to Basis for Notice of Noncompliance

	areas with less than 5 detected results impacts the conclusions of this BHHRA."]			exception of the substitution of "contaminant" for "chemical" in response to an unrelated EPA comment) was unchanged from the first draft BHHRA.	
14.	EPA July 16, 2010 comment #187 was not adequately incorporated. The comment was directed towards the misquoting of EPA guidance, which was not fixed in the revised BHHRA, and asked for further analysis before eliminating the data, which doesn't seem to have been conducted in the revised BHHRA.	EPA July 16, 2010 Comment S187 (issue) The statement here that EPA does not recommend the use of data such as the N-qualified results overstates the actual recommendations presented in the guidance. In fact, EPA guidance recommends that when the identity of a chemical is uncertain, site history and other information should be used to establish whether there is reason to believe that the chemical may be present. As discussed in comments on page 112, Section 7.1.11, the list of chemicals presumptively identified in the Round 1 tissue samples should be compared to analytical results from sediment samples collected within the exposure areas related to the tissue samples (e.g., 1 mile for bass, 1 mile on either side of the river for clams) as a means to determine whether there is reason to presume that chemicals for which the results are N-qualified are likely to be present in the tissue samples. If these analytes are not present in the sediment at concentrations that present a risk to human health, they may be excluded as PRGs.	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: Prior to eliminating a chemical as a COC based on N-qualified data, the sediment data for the tissue COCs should be evaluated. If the N-qualified chemicals in tissue of small home range species (i.e., smallmouth bass, clams, and crayfish) result in a risk greater than 10-6 and are positively identified in sediment within the same exposure area, the chemical should be identified as a chemical potentially posing unacceptable risk.	§7.1.3 was revised to clarify that no data was eliminated from the identification of whether a chemical potentially poses unacceptable risk on the basis of N-qualified data. Rather, the LWG is simply recommending that a chemical identified as potentially posing unacceptable risk solely on the basis of N-qualified data not be carried forward into further evaluations. Due to retention time issues in the analytical methods used for the Round 1 tissue samples, some of the pesticide tissue data were N-qualified, indicating that the identity of the chemical could not be confirmed. In subsequent sampling events, different analytical methods were used so that the identification of pesticides was not an issue in tissue samples collected in Rounds 2 and 3. EPA guidance (1989) does not recommend the use of data where there are uncertainties in the identification of contaminants~~chemicals~~, as is the case in the N-qualified data. Therefore, if a chemical was identified as ~~a preliminary COC~~potentially posing unacceptable risks based only on the use of N-qualified data, that chemical ~~was not selected as a final COC~~is not recommended for further evaluation for potential risks to human health. RAGS A says, "In general, include data with qualifiers that indicate uncertainties in concentrations but	§7.1.1 slightly modifies the LWG's discussion of guidance but does not alter the LWG's conclusion: "EPA guidance (1989) recommends caution in the use of data where there are uncertainties in the identification of contaminants. Therefore, if a chemical was identified as potentially posing unacceptable risks based only on the use of N-qualified data, that chemical is not recommended for further evaluation for potential risks to human health".

Table 3: LWG Response to Basis for Notice of Noncompliance

				not in identification." The text in the draft final BHHRA is consistent with that guidance.	
15.	EPA July 16, 2010 comment #195 was not adequately incorporated. Attachment F2, Section 3.2, pages 11-14 The draft BHHRA states that the data were excluded because of insufficient number of congeners, but does not state the rule nor does it address the last part of the comment, which asked for a discussion of the overall effect.	EPA July 16, 2010 Comment S195 (issue) Additional discussion and analysis are needed regarding the exclusion of the PCB congener data from the in-water sediment samples collected by the City of Portland for its outfall sediment investigation. These samples were excluded because of insufficient congener data (<100 PCB congeners for total PCBs, and <12 congeners for PCB TEQ) to calculate a summed total PCB congeners and total PCB TEQ. It is not clear if the 85 in-water sediment samples were excluded because the no congener analysis was conducted or because the detection limits were too high. Consistent with EPA guidance, non-detect data where the detection limit is greater than the maximum detected value should only be excluded when their inclusion results in the calculated EPC to be greater than the maximum detected concentration. In either instance, the overall effect on the in-water sediment COPC selection process and EPC calculations should be discussed.	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: The LWG accepts the comment and will include additional language, information, and/or analyses in the revised BHHRA in addressing the comment.	The rules for not using the ND data are provided in Section 3.2 of Attachment F2. As requested, additional explanation was provided: "This table shows 85 in-water samples for which TotalPCB congeners were not calculated because of limited number of analytical results from the City of Portland outfall sediment investigation. These samples were analyzed for a limited number of congeners that did not meet the minimum number of PCB congeners required to compute a sum." Note: Because total PCBs were not calculated consistent with the rules, the effect on the EPC calculations is unknown and cannot be discussed further.	All text concerning this data deleted from Attachment F2 (and not included in Section 2 discussion)
16.	EPA's July 16, 2010 comment #209 was not adequately incorporated. Attachment F5, Section 2.9, page 7 EPA Rationale for Deficiency: The point of comment 209 was that a) the exposure pathways evaluated in the risk assessment were those for which use of the "high risk and persistence" SF was appropriate. Therefore, the alleged "uncertainty" discussed was in no way relevant to the Portland Harbor risk assessment. Rather than present any specific information justifying any specific instances where the lowest risk and persistence slope factor may have been appropriate, the LWG simply added the text from the comment describing why the whole analysis was inappropriate in the first place, without deleting the offending analysis. The language, being unsubstantiated, was judgmental	EPA July 16, 2010 Comment S209 (issue) This section is misleading and should be modified. The EPA document titled Cancer Dose-Response Assessment and Application to Environmental Mixtures (EPA/600/P–96/001F, September 1996) presents the rationale for the use of 3 different cancer slope factors for PCBs. Three slope factors are provided: 2 per mg/kg-day for high risk and persistence PCBs, such as Aroclor 1260 and 1254; 0.4 per mg/kg- day for low risk and persistence PCBs, such as Aroclor 1242; and 0.07 per mg/kg-day for lowest risk and persistence PCBs, such as Aroclor 1016. The high risk and persistence value should be used for those exposure pathways associated with environmental processes that tend to increase risk, including: food chain exposure; sediment or soil ingestion; dust or aerosol inhalation; dermal exposure (if an absorption factor has been applied); the presence of dioxin-like, tumor-promoting, or persistent congeners in other media; and early-life exposure (all pathways and mixtures). The low risk and persistence value should be used for those	November 18, 2010 General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment: The BHHRA will be revised consistent with the comment.	The comment requested modification of Section 2.9 of Attachment F6. The LWG modified the section using the exact language EPA provided in the comment. The comment does not request or instruct deletion of any text.	EPA made no revisions to §2.9 of Attachment F6.

	or opinionated which was to be deleted from the BHHRA.	exposure pathways that tend to decrease risk, including: ingestion of water-soluble congeners, inhalation of evaporated congeners, and dermal exposure if no absorption factor has been applied. The lowest risk and persistence value should be used where congener or isomer analyses verify that congeners with more than four chlorines comprise less than one-half percent of total PCBs, suggesting that potency is best represented by the least potent tested mixture. All of the pathways assessed in the HHRA are included under the criteria for use of the high risk and persistence cancer slope factor of 2 per mg/kg-day. Even for scenarios where adults only (not children) ingest water, the lower cancer slope factor (0.4 per mg/kg-day) should not be used, as risks are calculated using surface water data that would contain both water soluble congeners and those found in water-borne colloidal material and particulate matter.			
17	EPA December 23, 2009 and July 16, 2010 general comment #1 were not adequately incorporated. Basis for EPA determination: The Superfund Human Health Risk Assessment guidance (RAGS part A, Chapter 6) defines the Chronic Daily Intake (CDI) as *exposure expressed as mass of a substance contacted per unit body weight per unit time, averaged over a long period of time (as a Superfund program guideline, seven years to a lifetime)* and the Lifetime Average Daily Intake as *exposure expressed as a mass of a substance contacted per unit body weight per unit time, averaged over a lifetime.* LWG agreed to not present these risks in a judgmental or opinionated fashion. While the LWG stated that these are meals per month which was agreed to, the LWG kept opinionated language, such as "Same rate every day of every year for 70 years." [sic Section 3.5.1.6.3, page 66, Section 6.2.5.1, page 124, Section 6.2.5.2, page 125, and Section 6.2.5.3, page 128 as well as the statement made in Section 5.2.5.2.1, page 98 "…every month of the year exclusively of fish caught within the Study Area."	December 23, 2009 Comment: Inappropriate Statements Regarding Fish Ingestion Rates The BHHRA makes numerous statements throughout the document that question the fish consumption rates used to evaluate the risks to human health. For example, the three main rates are referred to as high (17.5 g/day), higher (73 g/day), and highest (142 g/day). EPA disagrees with this characterization. The EPA rate of 17.5 g/day (two 8-oz meals per month) is based on the 90th percentile of the general population, which includes non-consumers of fish. The 90th percentile for fish consumers is much higher (200 g/day). EPA uses the 17.5 g/day rate to approximate a fish-consuming population that does not include tribal or subsistence fishers. It is not an unreasonable rate, and should not be referred to as a "high" ingestion rate, but rather as a "low" ingestion rate. The rate of 142 g/day used as the highest rate for non-tribal fishers in this risk assessment is the 99th percentile for consumers and non-consumers from the same USDA study; the consumption rate for consumers only from this study is 506 g/day. The ingestion rate of 142 g/day was used by EPA in developing its Ambient Water Quality Criteria for consumers who obtain much of their daily protein from fish; therefore, it is appropriate to use this	September 15, 2010 General Responses to Directed Comments on BHHRA (emphasis added): The LWG recognizes that the ingestion rates from the USDA CSFII Study are for both consumers and non-consumers; however, the rates used in the draft BHHRA are equal to the 90th and 99th percentiles, which are considered upper-bound exposures per RAGS A: "If statistical data are available for a contact rate, use the 95th percentile value for this variable. (In this case and throughout this chapter, the 90th percentile value can be used if the 95th percentile value is not available.)" Furthermore, the draft BHHRA did not consider the fraction of fish consumed from the site, did not account for reductions due to preparation and/or cooking methods, and assumed consumption of resident fish only (i.e., no anadromous fish such as salmon). Therefore, applying the 90th and 99th percentile ingestion rates for all fish and shellfish consumption combined in a national diet study to consumption of resident fish only exclusively from Portland Harbor is an uncertainty, as discussed in the draft BHHRA. As discussed at the September 9th meeting, ingestion rates will be presented in the revised BHHRA as the numeric rates (i.e., grams per day or meals per month) and the source of the rates will be presented, consistent with the text in the Programmatic Work Plan.	Text of the draft final BHHRA was revised to describe ingestion rates numerically rather than characterizing the rates as "high" or "low." For example, §3.5.1.5.3 was revised as follows: "~~For all three of the ingestion rates evaluated, the ingestion rates represent high-end fish consumption relative to the average ingestion rates from these respective studies.~~ These ~~high-end~~ ingestion rates were used for both the mean and 95% UCL/max risk calculations~~, and for the purposes of this BHHRA, they are referred to as the high(17.5 g/day), higher (73 g/day), and highest (142 g/day) ingestion rates~~." Note: Nothing in Comment G1 directs the LWG about how to discuss the duration over which the rates are averaged or touches on use of the phrases "every day," "every month" or "every year."	

		value as a "high" ingestion rate for this risk assessment. It should be kept in mind that the rate of 142 g/day does not truly describe subsistence consumption as a "subsistence" fish consumer would obtain almost all of their protein from fish. The more appropriate rate for subsistence fishers may be closer to the 506 g/day value which is the 99th percentile value for consumers only in the USDA study. This is supported by the fish consumption study of the Suquamish Tribe in Puget Sound whose 90% biota consumption rate is over 500 g/day. The consumption rate of 142 g/person/day was used to represent high frequency non-tribal fishers in this risk assessment. For subsistence fish consumers, who could represent an important population in PH, using 506 g/day as an approximate subsistence value, only about 28% (142 g/day divided by 506 g/day) of total fish consumption would have to come from the LWR in order for a consumption rate of 142 g/person/day and the upper range risks estimated in the HHRA to apply. For the third non-tribal adult fish consumption rate used in this risk assessment, 73 g/day, data from the Columbia Slough Study was used. The possible uncertainties in this study and in the consumption rates derived from it rate are appropriately discussed in the BHHRA. The BHHRA discussion and the data from the USDA study support use of a fish consumption value of 74 g/day as "medium" consumption rate, not a "higher" consumption rate. The arguments concerning uncertainties in fish ingestion rates provided in the HHRA are not compelling. Further, EPA believes that the body of information available regarding fish consumption rates both nationally and locally makes it clear that the fish ingestion rates used in the BHHRA appropriately address a range of exposures that might occur for consumers of locally caught fish. Text throughout the document should be revised to indicate the nature of these risk estimates, as indicated above, and appropriate text substituted to acknowledge the need to protect high consuming fish populations and discuss fish ingestion rates in that context. July 16, 2010 general comment #1 (directed change): The draft Portland Harbor Baseline Human Health	Characterization or descriptors of the ingestion rate (e.g., "low", "high") will not be included in the revised BHHRA.	EPA did provide other comments that requested deletion of the phrase "every day of every year" at several specific locations in the draft final BHHRA. These comments comprised the first "deficiency" identified in EPA's June 22 letter, which EPA has since identified us is not a basis for EPA's determination that the LWG failed to comply with the Consent Order. As discussed in our July 23 letter, only two of EPA's five comments requesting these revisions were identified by EPA as "directed changes." The LWG revised the text in all five instances precisely as EPA requested, although as noted in Table 1 to the July 23 letter, we inadvertently missed this language at one location in §6.2.5.3 where EPA did not provide a specific comment. Two of the sections EPA now cites as containing the "every day of every year" text that fails to incorporate this directive comment about fish ingestion rates discuss sediment exposure (6.2.5.1) and exposure to groundwater seeps (6.2.5.2) and do not touch on fish consumption at all. A third section (3.5.1.6.3) translates the gram-per-day fish consumption rates to equivalent meals per month, "every month of the year." EPA provided no specific comment on this text in §3.5.1.6.3, or on the similar text EPA cites in §5.2.5.2.1. The one place the "every day of every year" text remains in the draft final BHHRA is in §6.2.5.3, which, as we identified in our letter of July 23, was inadvertently missed during editing, although EPA made no specific request that this text be deleted.	

Table 3: LWG Response to Basis for Notice of Noncompliance

		Risk Assessment (BHHRA) includes numerous statements regarding the fish consumption rates used to evaluate the risks to human health. The three primary non-tribal fish ingestion rates used in the draft BHHRA are characterized as high (17.5 grams per day [g/day]), higher (73 g/day), and highest (142 g/day). EPA disagrees with this characterization, believes them to be misleading, and believes that significantly higher ingestion rates may be appropriate to represent different local and ethnic populations that rely on fishing as part of their culture and/or as a substantial food source. As such, the three ingestion rates presented in the BHHRA should be characterized as low, moderate, and high. The rate of 17.5 g/day (equivalent to two 8-ounce meals per month) is based on the 90th percentile rate for uncooked freshwater and estuarine finfish and shellfish for individuals (consumers and non-consumers) of age 18 and over in the United States (EPA 2002b, data from USDA CSFII Study). The 90th percentile for fish consumers only from this USDA study is much higher, at 200 g/day. EPA uses the 17.5 g/day rate to approximate a fish-consuming population that does not include tribal or subsistence fishers. It is not an unreasonable rate, and should not be referred to as a high ingestion rate, but rather as a low ingestion rate. A non-tribal adult fish consumption rate of 73 g/day was used in this risk assessment based on data from the Columbia Slough. The possible uncertainties associated with the consumption rates derived from this study are appropriately discussed in the BHHRA. The BHHRA discussion and the data from the USDA study support use of a fish consumption value of 73 g/day as moderate consumption rate, not a higher consumption rate. The rate of 142 g/day used as the highest rate for non-tribal fishers in the draft BHHRA is the 99th percentile for consumers and non- consumers from the same USDA study; the consumption rate for consumers only from this study is 506 g/day. The ingestion rate of 142 g/day is used by EPA in developing Ambient Water Quality Criteria (AWQC) for consumers who obtain much of their daily protein from fish. The consumption rate of 142 g/person/day was selected in the BHHRA to represent high-frequency, non-tribal fishers, and represents an appropriate "high" ingestion rate for			

Table 3: LWG Response to Basis for Notice of Noncompliance

		the Portland Harbor (PH) risk assessment. Overall, the arguments concerning uncertainties in fish ingestion rates provided in the HHRA are not compelling. Further, EPA believes that the body of information available regarding fish consumption rates, both nationally and locally, makes it clear that the fish ingestion rates used in the BHHRA appropriately address a range of exposures that might occur for consumers of locally caught fish. Please revise text throughout the document to indicate the nature of these risk estimates, as indicated above, and substitute appropriate text to acknowledge the need to protect high consuming fish populations and discuss fish ingestion rates in that context.			

Table 4: Summary of Risk Assessments from Other Freshwater Sediment Superfund Sites

Site Name	Location, EPA Region	Fish Consumption Receptors		Ingestion Rate for Fish from Site (g/day)		Cooking Reduction Factor (unitless)		Exposure Duration (Years)		Exposure Area	Species Consumed	Fish Tissue Type	Site-Specific Fish Consumption Surveys	Additional Fish Consumption Notes	Primary Reference(s)
		Receptor	Age Group	RME	CT	RME	CT	RME	CT						
Bunker Hill	ID, Region 10	Public Recreation Scenario	Child/Adult	46	25	0	0	30	9	One exposure area: Lower Coeur d'Alene River.	Separate EPCs were calculated for each species after pooling the data from the three lateral lakes. **Species included:** Perch, bullhead, pike.	Fish fillets (report does not mention skins)	ATSDR completed a fish consumption survey for the Coeur d'Alene basin (ATSDR 1989). Survey assessed three populations: Coeur d'Alene tribe, fishing license holders, and volunteers.	RME rate of 46 grams/day based on national fish portions sizes (EPA 1997) and information from the ATSDR Coeur d' Alene fish consumption study. CT rate of 25 grams/day based EPA (1997) recommended rate for freshwater anglers. Traditional subsistence rate of 540 grams per day based on Umatilla Tribe information. Modern subsistence rate of 170 grams per day was derived from a study of four Columbia River tribes and assumed to represent 95th percentile (EPA 1997).	Final Human Health Risk Assessment for the Coeur d'Alene Basin Extending from Harrison to Mullan on the Coeur d'Alene River and Tributaries RI/FS Study Report, June 2001.
		Traditional Subsistence	Child/Adult	540	Not assessed	0	0	70	Not assessed						
		Modern Subsistence	Child/Adult	170	Not assessed	0	0	70	Not assessed						
Fox River	WI, Region 5	Recreational Angler	Adult	59	15	Chemical specific; 0.5 (organics)		50	30	**Four Separate Exposure Areas,** River reaches: Little Lake Butte des Morts; Appleton to Little Rapids; Little Rapids to Depere; DePere to Greeb Bay; Green Bay Zone 3B.	Data for all edible fish species were combined and evaluated by sample type (fillet or whole body). **Species included**: bass (white, largemouth, smallmouth), bluegill, bowfin, bullhead (black, brown), burbot, carp, catfish (channel, flathead), chub (bloater), cisco (lake herring), crappie (black), drum (sheepshead), muskellunge (musky), perch (white, yellow), pike (northern), pumpkinseed, redhorse (shorthead, northern), rockbass, salmon (chinook, coho), sauger, smelt (rainbow), splake, sucker (white, longnose), sunfish (green), trout (lake, brown, brook, rainbow), walleye, whitefish.	Fillet with skin	Three different recreational angler surveys for area.	Average fish concentrations used in risk calculations. **Recreational angler:** RME based on average 95th percentile for West et al 1989, 1993. CT based on average mean percentile for West et al 1989, 1993. **Subsistence fisher:** 227 g/day based on average portion for Hmong (Hutchison and Kraft 1994). RME assumed 130 days/year; CT assumed 34 days per year.	Baseline Human Health and Ecological Risk Assessment, Lower Fox River Wisconsin. February 1999.
		High-intake Consumer	Adult	81	21			50	30						
Kalamazoo River	MI, Region 5	Sport Angler	Adult	39	15	0.5	0.5	30 (2-7 reproductive)	30 (2-7 reproductive)	Exposure areas based on Aquatic Biota Study Areas (ABSAs) (exposurea areas > 10 miles in river length).	EPCs evaluated as two separate scenarios: Smallmouth bass (100%) and smallmouth bass/carp (76%/24%)	Skin-on fillets (bass) and skin-off fillets (carp).	The subsistence scenario based on 95th percentile ingestion rates for minority, low income and the high end sport angler scenario based on nonminority low-income from West 1993 data. The central tendency sport angler rate was derived from a review of several regional studies in Michigan, (West 1989, 1993) Wisconsin (Fiore, et al. 1989), and New York (Connelly, et al. 1990).	The recreational RME fish ingestion rate reflects 50 percent fraction of fish consumed are from the site. EPCs based on both average and maximum fish concentrations. Fish consumption rates based on work previously conducted by EPA Region 5 on Manistique Harbor, Michigan; and the Lower Fox River Superfund sites. Fish ingestion rates for sport angler based on the Great Lakes Water Quality Initiative Technical Support Document for Human Health Criteria and Values (EPA 1995).	Final (Revised) Human Health Risk Assessment, Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. May 2003.
		Subsistence Angler	Adult	110	Not assessed	0.5	Not assessed	30 (2-7 reproductive)	Not assessed						
Grand Calumet	IN, Region 5	Active Angler	Adult	37.8	Not assessed	0	Not assessed	24	Not assessed	**Five Separate Exposure Areas:** Lake George Branch Canal (~ 2 miles length) Indiana Harbor Canal (~ 2 miles length) East Branch Grand Calumet River (~10 miles length) Grand Calumet River Lagoons - West Lagoon and Little West Pond (~37 acres) Grand Calumet River Lagoons - Middle and East Lagoons (~133 acres)	EPCs were calculated as all fish species combined. **Species included:** Primarily carp. Also included channel catfish, largemouth bass, whitesucker, steelhead, blue gill, Chinook, goldfish.	Only fish tissue for "skin on fillets" used in HHRA.	Site specific fish consumption survey not completed. HHRA discussion of fish consumption rates adapted from the Baseline Risk Assessment for the West Branch of the Grand Calumet River (TetraTech FW 2005). TetraTech report based on data from other studies within the Great lakes Region.	Maximum or UCL EPCs used in risk calculations. **Adult rate** of 37.8 grams/day corresponds to the 95th percentile for active consumers in northern Indiana. It also corresponds to the 80th percentile of active consumers very aware of consumption advisories. **Child rate** of 14 grams/day was scaled based on body weight. This rate is consistent with the 95th percentile consumption rate of freshwater fish by individuals 14 and under (13.9 g/day) cited in the Child-Specific Exposure Factors Handbook (EPA 2006).	Grand Calumet Feasibility Study, Baseline Human Health Risk Assessment. September 2007.
			Child (6 to 11 years)	14		0		6							
Housatonic	MA, Region 1	Current/Future Recreational Angler	Adult (> 18 years)	30.1	4.4	0.25	0.25	44	17	**Four Separate Exposure Areas:** 1. Primary Study Area (Reaches 5 and 6) approximately 11 miles from the confluence downstream to and including the Woods Pond impoundment. 2. Rising Pond (Reach 8) – An approximately 45-acre impoundment 3. West Cornwall and Bulls Bridge (Reaches 11 and 12) – A stretch of flowing water including a newly established (2003 season) bass management area and a trout management area . 4. Lake Lillinonah and Lake Zoar (Reaches 14 and 15)	Brown bullhead, largemouth bass, pumpkin seed (sunfish), and yellow perch. EPCs calculated for brown bullhead and largemouth bass (combined), sunfish and yellow perch (combined), and all fish species combined.	Skinned and trimmed fillet (brown bullhead, largemouth bass, pumpkin seed (sunfish), and yellow perch).	The following three studies detailing fish catch for the Housatonic River were evaluated as a basis for fish consumption rates: 1. The PCB Exposure Assessment Study conducted by the Massachusetts Department of Public Health in 1995/1996 (MDPH, 1997). 2. A creel survey conducted by ChemRisk/GE in 1992 (ChemRisk, 1994). 3. A creel survey conducted by the Connecticut Department of Environmental Protection from 1984 to 1986 (CTDEP, 1988). This study formed the basis for a paper on ingestion rates (Ebert et al., 1996). Fish consumption advisories were in place during all of these studies, which may lead to an underestimate of fish consumption rates in the absence of advisories. Because of this, the following study was cited as primary source in deriving the fish ingestion rate: Maine Angler Survey (Ebert et al., 1993; ChemRisk, 1992).	The RME fish ingestion rates reflect 97 percent fraction of fish consumed are from the site, and the CT fish ingestion rates reflect 50 percent fraction of fish consumed are from the site. Ingestion rates for combined fish (fillet) are 95th percentile and mean values from re-calculation of rates in the Maine Angler Study. RME rates based on consuming anglers only and assumes the angler does not share their catch. CT rates includes anglers that share their catch and those that do not share their catch. Ingestion rates shown are for fish species other than trout. Lower ingestion rates were used for trout in exposure areas for free-flowing waters only.	Human Health Risk Assessment GE/Housatonic River Site, Rest of River. Weston for USEPA Region 1. Vol IV, Appendix C, Consumption of Fish and Waterfowl Risk Assessment. February 2005.
			Child (1 to 6 years)	15.5	2.2	0.25	0.25	6	6						
Hudson River	NY, Region 2	Current/Future Recreational Angler	Adult (> 18 years)	31.9	4.0	0	0.2	22	6	Modeled predictions of future PCB concentrations in fish were averaged over the entire Upper Hudson River, a river length of	EPCs were calculated using species ingestion fractions multiplied by the PCB concentrations in each of the modeled fish species: Brown bullhead, largemouth bass, and yellow	Fillets (skin on)	Fish consumption rates was determined using data from the 1991 New York Angler survey (Connelly et al., 1992) to represent Upper		Phase 2 Report Further Site Characterization and Analysis. Volume 2F- Revised Human Health Risk Assessment, Hudson River PCBs
			Adolescent (7-18 years)	21.3	2.7	0	0.2	12	3						

Table 4: Summary of Risk Assessments from Other Freshwater Sediment Superfund Sites

Site Name	Location, EPA Region	Fish Consumption Receptors		Ingestion Rate for Fish from Site (g/day)		Cooking Reduction Factor (unitless)		Exposure Duration (Years)		Exposure Area	Species Consumed	Fish Tissue Type	Site-Specific Fish Consumption Surveys	Additional Fish Consumption Notes	Primary Reference(s)
		Receptor	Age Group	RME	CT	RME	CT	RME	CT						
			Child (1 to 6 years)	10.6	1.3	0	0.2	6	3	approximately 40 miles.	brown bullhead, largemouth bass, and yellow perch.		Hudson River anglers.		Reassessment RI/FS. November 2000.
Passaic River	NJ, Region 2	Angler/Sportsman	Adult (>18 years)	25	8	0	Chemical specific; 0.2 (PCBs)	24	9	One exposure area: 8-mile stretch of Lower Passaic River.	White perch and American eel (EPCs based on composite of tissue samples rather than single species).	EPCs based on historical data for whole organism, assumed to include skin, organs, and head. Specific data for fillets were not available. (Note: report states that "EPCs derived for COPCs in fish may be overestimated because whole organism were used rather than fillet samples".	No site-specific fish consumption survey completed. Ingestion rates based on EPA (1997) Exposure Factors Handbook.	EPCs for both RME and CT based on 95UCL. RME and CT adult fish consumption rates based on 95th percentile and mean from the Exposure Factors Handbook (EPA 1997), which was based on fish ingestion studies from several freshwater locations within the country. Ingestion rates for adolescent and young child scaled based on 2/3 adult rate for adolescent and 1/3 adult rate for young child.	Battelle. 2007. Lower Passaic River Restoration Project, Draft Focused Feasibility Study Risk Assessment. Submitted to United States Environmental Protection Agency, Region 2, and United States Army Corps of Engineers, Kansas City District. 1 June 2007.
			Adolescent (10-18 years)	17	5			9	6						
			Young Child (0 to 6 years)	8	3			6	3						

TABLE 5: LWG PROPOSED REVISIONS RE EXPOSURE SCENARIO CONTEXT INFORMATION

Section in 9/17/12 EPA Draft	Language in 9/17/12 EPA Draft	Reason for Objection	LWG-Proposed Revision
3.2.1.8	According to the City of Portland, the primary domestic water source for the city is the Bull Run watershed, which is supplemented by a groundwater supply from the Columbia South Shore Well Field (City of Portland 2008). In addition, the Willamette River was determined not to be a viable water source for future water demands through 2030 (City of Portland 2008). Although there are currently no known uses of the Lower Willamette River as a source of drinking water, public and private use of the Willamette River as a domestic water source is a designated beneficial use by the State of Oregon. Hence, use of surface water as a source of household water was assessed as a potentially complete pathway. Exposure to surface water could occur via ingestion and dermal contact, as well as volatilization of chemicals to indoor air through household use.	☐ Does not include all context information relating to the likelihood of exposure actually occurring under the scenario evaluated: "EPA conducts an exposure assessment to identify the magnitude of actual or potential human or environmental exposures, the frequency and duration of these exposures, and the routes by which receptors are exposed. This exposure assessment includes an evaluation of the likelihood of such exposures occurring and provides the basis for the development of acceptable exposure levels." 55 Fed. Reg. 8,665, 8,710 (1990). ☐ The information is relevant context information that should be addressed the Exposure Assessment section and not just the Uncertainty Analysis section. ☐ The full description of the beneficial use designation is not an "institutional control" but rather a part of the "no action" baseline condition.	According to the City of Portland, the primary domestic water source for the city is the Bull Run watershed, which is supplemented by a groundwater supply from the Columbia South Shore Well Field (City of Portland 2008). In addition, the Willamette River was determined not to be a viable water source for future water demands through 2030 (City of Portland 2008). Although there are currently no known uses of the Lower Willamette River as a source of drinking water, public and private use of the Willamette River as a domestic water source is a designated beneficial use by the State of Oregon with adequate pretreatment and natural quality that meets drinking water standards. ~~Hence, u~~However, use of untreated surface water as a source of household water was assessed as a potentially complete pathway.

Section in 9/17/12 EPA Draft	Language in 9/17/12 EPA Draft	Reason for Objection	LWG-Proposed Revision
3.3.6	The actual extent shellfish harvesting and consumption is presently occurring is not known. The Linnton Community Center project (Wagner 2004) reported that some transients reported eating clams and crayfish, although many of the individuals indicated that they were in the area temporarily, move from location to location frequently, or have variable diets based on what is easily available. While the degree to which consumption of clams currently occurs in Portland Harbor is unknown, the Linnton Community Center project suggests that it does not occur on an ongoing basis within the Study Area. The only clam species found in the Study Area during sampling events were Asian clams (*Corbicula* sp.).	Does not include all context information relating to the likelihood of exposure actually occurring under the scenario evaluated: "EPA conducts an exposure assessment to identify the magnitude of actual or potential human or environmental exposures, the frequency and duration of these exposures, and the routes by which receptors are exposed. This exposure assessment includes an evaluation of the likelihood of such exposures occurring and provides the basis for the development of acceptable exposure levels." 55 Fed. Reg. 8,665, 8,710 (1990). The information is relevant context information that should be addressed the Exposure Assessment section and not just the Uncertainty Analysis section. The description of the legal prohibition on harvesting is not an "institutional control" but rather a part of the "no action" baseline condition.	The actual extent shellfish harvesting and consumption is presently occurring is not known. The Linnton Community Center project (Wagner 2004) reported that some transients reported eating clams and crayfish, although many of the individuals indicated that they were in the area temporarily, move from location to location frequently, or have variable diets based on what is easily available. While the degree to which consumption of clams currently occurs in Portland Harbor is unknown, the Linnton Community Center project suggests that it does not occur on an ongoing basis within the Study Area. The only clam species found in the Study Area during sampling events were Asian clams (*Corbicula* sp.)~~.~~, which are an invasive, non-native species, and Oregon law (OAR 635–056–0050) prohibits the possession, transportation, and sale of non-native wildlife.

Section in 9/17/12 EPA Draft	Language in 9/17/12 EPA Draft	Reason for Objection	LWG-Proposed Revision
3.5.10.8	Use of surface water as a household water source was evaluated assuming exposure occurs in a residential setting.	Does not include a key assumption: "An exposure scenario generally includes facts, data, assumptions, inferences, and sometimes professional judgment about the following: …The physical setting where exposure takes place (exposure setting)[;] The exposure pathway(s) from source(s) to exposed individual(s) (exposure pathways)[;] Identification of the individual(s) or population(s) exposed, and the profile of contact with the chemical based on behavior, location as a function of time, characteristics of the individuals, etc. (characterization of the exposed population)[.]" EPA, Guidelines for Exposure Assessment, pp. 72-73 (1992).	Use of untreated surface water as a household water source was evaluated assuming exposure occurs in a residential setting.

Section in 9/17/12 EPA Draft	Language in 9/17/12 EPA Draft	Reason for Objection	LWG-Proposed Revision
5.2.8	Use of surface water as a source of household water for drinking and other domestic uses was evaluated using data from five transect and 15 single point sampling locations, as well as averaged over a Study Area-wide basis.	Does not include a key assumption: "It is essential that presenters not only communicate the results of the assessment by addressing each of the descriptors where appropriate, but that they also communicate their confidence that these results portray a reasonable picture of the actual or projected exposures. This task will usually be accomplished by frankly commenting on the key assumptions and parameters that have the greatest impact on the results, the basis or rationale for choosing these assumptions/parameters, and the consequences of choosing other assumptions." EPA, Guidance for Risk Characterization, III.A (1995).	Use of untreated surface water as a source of household water for drinking and other domestic uses was evaluated using data from five transect and 15 single point sampling locations, as well as averaged over a Study Area-wide basis.
6.2.2.3	The evaluation of surface water as a domestic water source is based on the assumption that surface water is drawn from the Study Area.	Does not fully describe assumption: *Id.*	The evaluation of surface water as a domestic water source is based on the assumption that untreated surface water is drawn from the Study Area.

Table of Contents: CD of Supporting Documentation for the September 21, 2012 Lower Willamette Group Opening Submission – Formal Dispute on EPA Notice of Non-Compliance and Directed Revisions to the Portland Harbor Draft Final Baseline Human Health Risk Assessment and Request for Dispute Resolution
Lower Willamette River, Portland Harbor Superfund Site
USEPA Docket No: CERCLA-10-2001-0240

TAB#	Date	Document Title
1	April 23, 2004	April 23, 2004 Programmatic Work Plan
2	June 29, 2004	EPA Letter: RI/FS Work Plan Approval
3	December 2, 2005	EPA Letter: Identification of Round 3 Data Gaps
4	April 15, 2009	Outstanding Portland Harbor RI/FS Issues, Status as of 4/15/2009
5	December 23, 2009	EPA Letter: Preliminary Comments on the Baseline Human Health and Ecological Risk Assessments
6	February 9, 2010	EPA Letter: LWG Response to EPA Preliminary Comments on Baseline Human Health and Ecological Risk Assessments
7	July 16, 2010	EPA Letter: EPA Comments on Portland Harbor Draft Remedial Investigation Report (enclosed 7/16/2010 EPA General Comments on the Portland Harbor Draft Remedial Investigation Report)
8	July 16, 2010	EPA Comments Portland Harbor RI Report - Baseline Human Health Risk Assessment
9	September 15, 2010	General Responses to EPA's Directive Comments on the Baseline Human Health Risk Assessment
10	September 22, 2010	EPA Letter: General Responses to EPA Directed BHHRA and BERA Comments
11	November 18, 2010	General Responses to EPA's Non-Directive Comment Key Issues on the Baseline Human Health Risk Assessment November 18, 2010
12	December 8, 2010	EPA Letter: General Responses to EPA Non-Directed RI, BHHRA and BERA Comments with Attachment 1, EPA Response to Non-Directed Comment Resolution Tables December 8, 2010
13	January 12, 2011	LWG Letter: December 21, 2010 EPA Letter on the Status of the Portland Harbor Feasibility Study;September 27, 2010 EPA Letter on the Benthic Risk Evaluation; and December 8, 2010 EPA Letter on General Responses to EPA Non-Directed RI, BHHRA and BERA Comments. Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240
14	February 25, 2011	EPA Letter: Schedule for Remedial Investigation (RI) and Feasibility Study (FS)
15	May 2, 2011	Redlined LWG Portland Harbor RI/FS Draft Final Remedial Investigation Report Appendix F Baseline Human Health Risk Assessment Draft Final
16	June 22, 2012	EPA Letter: Directed Modifications and Additional Comments on Baseline Human Health Risk Assessment dated May 2, 2011 with Attachments

17	June 29, 2012	EPA Letter: Response to Lower Willamette Group (LWG) June 29, 2012, letter regarding EPA Directed Modifications and Additional Comments on Baseline Human Health Risk Assessment dated May 2, 2011
18	July 21, 2011	Portland Harbor Superfund Site; Administrative Order on Consent for Remedial Investigation and Feasibility Study; Docket No. CERCLA-10-2001-0240 Portland Harbor Baseline Human Health Risk Assessment (BHHRA)
19	July 22, 2011	EPA Email to LWG, Subject: EPA request for human
20	July 29, 2011	LWG Email to EPA RE: Word Version of Text of Draft Baseline Human Health Risk Assessment (BHHRA)
21	July 23, 2012	Notice of Objection to EPA Notice of Non-Compliance and Directed Revisions to the Portland Harbor Draft Final Baseline Human Health Risk Assessment and Request for Dispute Resolution Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240
22	July 27, 2012	Basis for EPA's Determination the May 2, 2011 Draft BHHRA was Not In Compliance with AOC
23	April 27, 2011	EPA Email, Subject: EPA comments re:PBDE risk calculations
24	May 6, 2011	LWG Letter: EPA April 11, 2011 Comments on BHHRA Risk Tables and Calculations (Lower Willamette River, Portland Harbor Superfund Site, USEPA Docket No: CERCLA-10-2001-0240)
25	February 4, 2002	Portland Harbor Superfund Site, Preliminary Planning, Scoping, and Problem Formulation Document
26	May 9, 2003	Technical Memorandum: Proposed Fish Consumption Rates for the Portland Harbor RI/FS Human Health Risk Assessment
27	February 11, 2004	EPA Letter Re: Portland Harbor Superfund Site; Administrative Order on Consent for Remedial Investigation and Feasibility Study; Docket No. CERCLA-10-2001-0240 RI/FS Work Plan & Attachments - EPA Review Comments, Portland Harbor RI/FS Revised Draft Final Programmatic Work Plan; Portland Harbor RI/FS Summary of Fish Consumption Issues and Their Resolution; Attachment 1, EPA Fish Consumption Rates
28	January 15, 2008	EPA Letter Re: Comprehensive Round 2 Site Characterization and Data Gaps Analysis Report (with Table: EPA Comments on Comprehensive Round 2 Site Summary and Data Gaps Analysis Report)
29	December, 1989	Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A) Interim Final
30	March 8, 1990	National Oil and Hazardous Substances Pollution Contingency Plan, 55 FR 8666-01
31	March, 2004	EPA Office of the Science Advisor Staff Paper: Risk Assessment Principles & Practices
32	November, 1998	EPA Guidance for Conducting Fish and Wildlife Consumption Surveys

33	July 25, 2003	EPA Response and Comments on the Portland Harbor RI/FS Programmatic Work Plan, March 31, 2003
34	April 19, 1996	Technical Memorandum on the Results of the 1995 Fish Consumption and Recreational Use Surveys - Amendment No. 1
35	January 15, 2002	Public Health Assessment, Initial Release
36	November, 2000	Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1, Fish Sampling and Analysis, Third Edition
37	December 14, 2011	EPA Letter to The Honorable Earl Blumenauer
38	February, 1995	Guidance for Risk Characterization, U.S. Environmental Protection Agency, Science Policy Council, February, 1995
39	June, 2004	Snake River-Hells Canyon Total Maximum Daily Load (TMDL) Submitted July 2003, Revised June 2004; Attached Oregon TMDLs Approved by EPA – May 2000 through September 2012
40	May 29, 1992	Guidelines for Exposure Assessment
41	June 30, 2011	EPA Memorandum, Options for Responding to Deficient Deliverables from PRPs
42	October, 2000	EPA Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000)
43	November, 2000	Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 2, Risk Assessment and Fish Consumption Limits, Third Edition
44	December, 2002	Final Baseline Human Health and Ecological Risk Assessment: Lower Fox River and Green Bay, Wisconsin Remedial Investigation and Feasibility Study
45	November 12, 2007	Lower Duwamish Waterway Remedial Investigation Report Appendix B: Baseline Human Health Risk Assessment
46	February, 2005	Human Health Risk Assessment GE/Housatonic River Site Rest of River Volume I
47	March 15, 2004	Portland Harbor Superfund Site; Administrative Order on Consent for Remedial Investigation and Feasibility Study; Docket No. CERCLA-10-2001-0240 RI/FS Work Plan
48	March 19, 2002 and April 8, 2002	Attachment A (Conversation Logs) to Appendix C (Human Health Risk Assessment Approach) to the Programmatic Work Plan: Kennedy/Jenks Consultants Conversation Log with Mr. Bud Hartman, President of the Pan Fish Association, Portland, OR & Kennedy/Jenks Consultants Conversation Log with Mr. Ralph Steele, Owner of Lure-em Tackle Shop, Portland, OR
49	March 31, 2000	DEQ Portland Harbor Remedial Investigation/Feasibility Study Work Plan Draft