Comments on the
Pacific NorthWest LNG Project
Environmental Impact Statement (EIS)/Application

submitted by

UFAWU-UNIFOR

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Risk from the Resuspension of Contaminated Sediment

Luanne Roth (with excerpts by John Roelofs) May 1st, 2014

1) Dioxin and Furans Human Health Risk Background

A) Background

The PNW LNG project has many characteristics that make public involvement crucial for obtaining optimal decisions about mitigation and monitoring. The uniqueness of the effects of increased dioxin and furan intake on local people is one of them.

Dioxins and furans (PCDD/Fs) are sometimes called the most dangerous chemicals known to science. "Dioxin is one of the most toxic and environmentally stable tricyclic aromatic compounds of its structural class." (Environmental Protection Agency) (Prioritization of Toxic Air Contaminants, 2001)

(EPA fact sheet 1999). They are persistent, they bio-accumulate, they are toxic at extremely small amounts and, worse, there's already too much of them. Based on measurements of body loads of dioxins and furans it is estimated that the average lifetime daily intake is 2.0 to 4.2 pictogram 2,3,7,8-TCDD TEQs per kilogram of body weight per day. This is from a report by the Canadian Council of Ministers of the Environment which concludes, "However, no increases in this exposure should be allowed." (Dioxins and Furans The Canadian Perspective, CCME).

And that's for the average Canadian. Scientists, in peer reviewed studies, have expressed the opinion that at the upper end of our background human exposure level (i.e. people living near pulp mills, and of those people, those who eat a lot of seafood), there is only a very small margin, if any, of exposure left that might be tolerable.(based on animal studies) (Schecter et al, 2005).

Specifically, many of the cultures that live near this project eat more than the national average amount of seafood, much of it from the vicinity of the proposed dredge site. Canadians of Vietnamese, Norwegian, Chinese and other ancestry enjoy the variety of seafood from Chatham Sound. And importantly, "The Project will occur on Port lands within the claimed traditional territories of Tsimshian Nations. Five Tsimshian First Nation communities claim Aboriginal Rights and/or interests in the Prince Rupert Harbour area and/or up to Kitaelas Canyon: Metlakatla First Nation, Lax Kw'alaams First Nation, Gitxaala Nation, Kitselas Indian Band, and Kitsumkalum Band." (Summary of Environmental Impact Statement). The shores and ocean provide the staple food supply and livelihoods for these nations. And First Nation people certainly don't eat the mean amount of seafood. For Natives on Vancouver Island, "Total consumption of all seafood averages 60 kg per person per year or 165 grams per day. That equals two daily servings, nearly 15 times that of the average Canadian!" (Peter Ross and Tom Child, 2009). Here, in the north where options are fewer, this is probably an underestimate.

The release of contaminants into the environment will always be of concern, but the introduction of dioxins and furans here is particularly alarming. Not only is the project in an area of high seafood consumption, it is also an area that has high obesity and diabetes levels. Tsimshian Nation youth living in the Chatham Sound region have a high prevalence of central obesity and impaired glucose homeostasis (Zorzi et al, 2009) and generally the prevalence of diabetes among the Status Indian population is about 1.4 times higher than for other BC residents (Office of the Provincial Health Officer, 2007). Dose dependent incidence of diabetes and obesity has been demonstrated around the world among many groups of people exposed to various levels of dioxins and furans (David Carpenter, 2008). There is growing evidence that increased dioxin and furan intake will disproportionately affect those already susceptible (i.e. dose-response curve may be J-shaped or threshold type).

B) The Magnitude of the PNW Project Increases the Risk

"PNW- the largest Dredge Project in Canadian History"

The Main dredge, for the marine berthing terminal is proposed to be 7 million cubic meters:

"7 million m3 of material over an area of 84.6 hectares"- pg 676 /1203 Stantec/PNW

"W*e understand the Sydney project to be the largest dredging project in Canadian history...approximately 4.5 million cubic metres of material"* Jim Wooder, chair Sydney Marine Group 2012

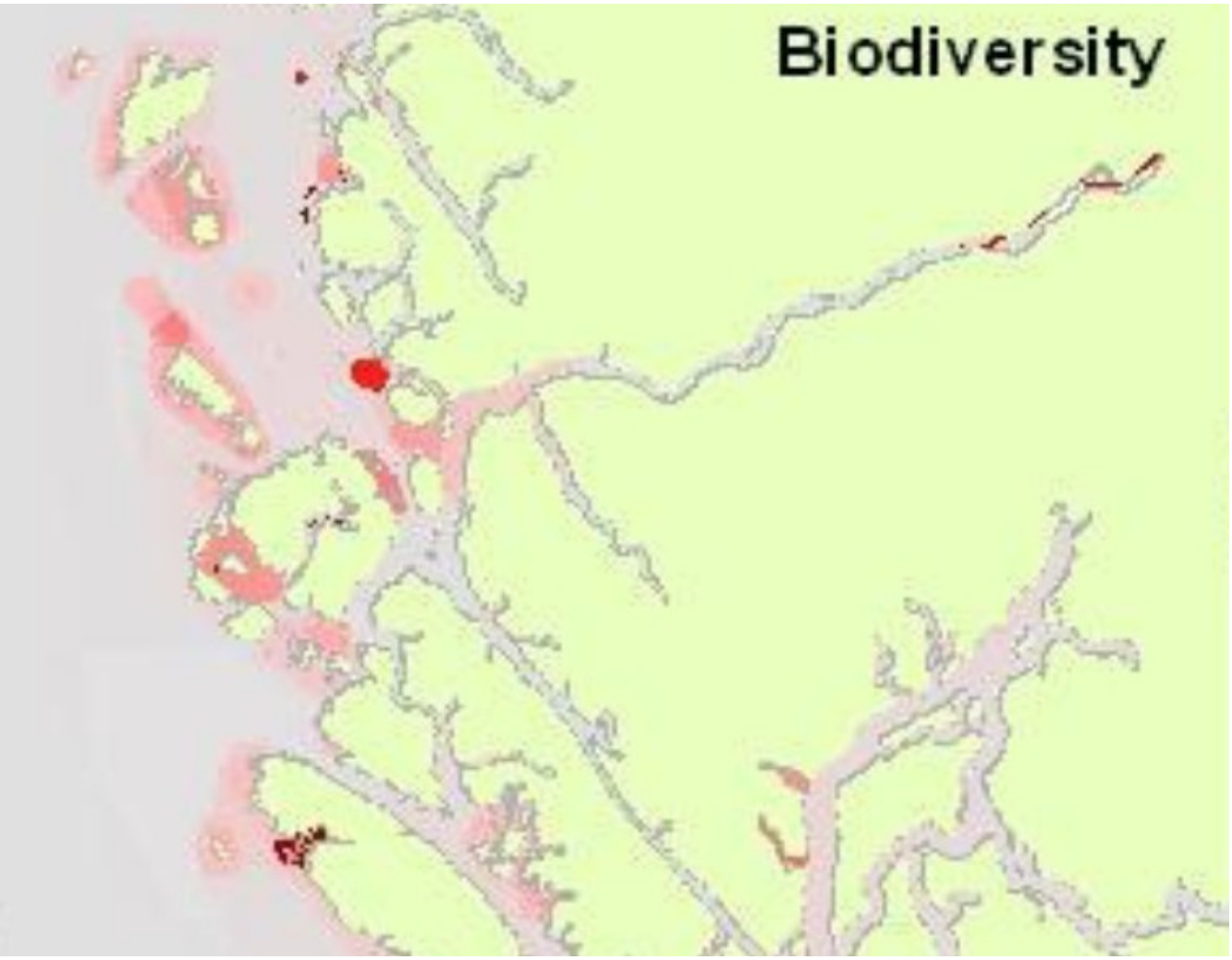
This project is not small. The area is about 80 hectares. We know the top 40 cm of a nearby and

similar site (Canpotex) is contaminated by 5.25 pg TEQ/g of PCDD/Fs (see discussion below). The PNW project will likely disturb about 1.6 TEQ grams. Although this doesn't seem like much, when it's a measure of toxic equivalents of TCDD-2,3,7,8 and it is compared to the maximum tolerable intake for humans (TDI = 2.3 pg/kg-bw/day UN report):
This dredge site contains enough PCDD/F to contaminate hundreds of millions of kilograms of seafood to a level that wouldn't be safe to consume at the level local natives and many other local citizens are accustomed to.

Now safely sequestered below the top sediment layer (see discussion below), this material, once resuspended will progress up the trophic ladder. At each rung there is the opportunity of bioconcentration. Factors for dioxins and furans range on the order of 30,000 to 128,000 (EPA Fact Sheet) (Technical Factsheet on: Dioxin (2,3,7,8-TCDD), and as it moves rung to rung bio-accumulation will occur. At each level it will do harm. Eventually some will make it into the human food supply. There, its effects will remain for a long time. It is estimated that the dioxins and furans will be passed through mother's milk for 6 generations (Michael Gismondi and Joan Sherman, 1996).

C) The Siting of the Project Increases the Risk

The diagram below is a compilation of local knowledge put in map form. It shows the value of what the PNW LNG Project puts at risk. Of 12 attributes, biodiversity was considered the most important.



The largest dredge project in Canadian history, is being proposed for the same spot, shown here in red, which was chosen by north coast people as the heart of biodiversity.
"The primary objective of this study was to develop, apply and critically assess a tool that draws on local knowledge expertise to identify locations in the marine environment considered 'important' based on a series of 12 value attributes." -Using Expert Informed GIS to Locate Important Marine Social-ecological Hotspots in Northern British Columbia Pacific Coastal Waterways -Pouyan Mahboubi, Margot Parkes, Craig Stephen, and Hing Man Chan 2014.

2) Evidence of Contamination- How Much and Where

A) Stantec/PNW failed to provide information characterizing the sediment in the main dredge area

-Stantec used samples from an area (PRGT) known to be outside the pulp mill contamination plume, to assure local residents that the PNW project risk was low.

We have provided a map below showing the location of the PRGT samples and exposing the inappropriateness of their use, and the misleading nature of these Stantec statements:

*"Marine Berth Dredge Area- Sediment contaminant levels from samples taken approximately 3 km south of the marine berth dredge area were generally below applicable guidelines, including total PAH (below detection limits in all samples), total PCB (below the detection limit in all samples except one, an isolated instance of a sample with PCB 20% higher than the 0.1 mg/kg disposal at sea screening criterion), mercury, cadmium, chromium, lead, and zinc (below the screening criteria in all samples), and dioxins and furans (below the CCME ISQG)."*Stantec/PNW- pg 525/1203

"*As part of a data-sharing agreement with the PRGT Project, surface and 1.0 meter core sediments were collected to the southwest of Lelu Island, within 5 km of the marine berth dredge area. PCDD/F concentrations in these samples had an average of 0.11 ng TEQ/kg dw."-pg 838 (ng/kg = pptr= pg/g)*

"Sediments near the marine berth contained PCDD/F concentrations that were only 5 to 23% of the amount in the MOF." pg 838/1203

-The existence of a pulp mill plume of toxic effluent is well known and documented. See the plume displayed in the map below or review the Skeena Cellulose Environmental Effects Monitoring Program (Hatfield Consultants Limited 1994). This information was available to Stantec and clearly refutes the value of the PRGT data in characterizing the sediment or predicting the potential effects of dredging at the marine terminal berth area and disposal of those sediments.

-It is well known that sediment in the pulp mill plume area is contaminated above the ISQG. Stantec itself did the report on the Canpotex sediment, the Port of Prince Rupert was a co-proponent, the Canpotex sediment report was being circulated to working groups in December 2013 and was publicly available on March 26th, 2014. Even before that, the public information for the Canpotex CEA in 2012 noted that the PCDD/F sediment levels were above the CCME ISQG.

-Likewise the samples from the MOF do not characterize the main dredge area. The MOF is in a fast running channel, with evidence of scouring and clearly inadequate and of little value for predicting the potential effects of dredging at the main marine terminal berth area; Stantec or anyone could recognize this was clearly different bottom and would have different sediment characteristics than the flat deep deposited sediment areas of the PNW main terminal dredge site or the Canpotex site.

-It is unacceptable that samples for the PNW Main dredge site were not provided by Stantec in the Application. It makes it impossible for the public to comment properly on the project, we cannot asses the risk to human health or aquatic life. Our only choice is to comment using the Canpotex sample data which is on public record and describes a nearby site within the sediment plume and with similar flat soft sedimentary bottom.

-The following statement used by Stantec to defend its use of PRGT samples shows they knew about the source of the plume. They also knew that the Canpotex site was further away from the MOF site than PNW main site is and they knew (it is in the public record and they did the report) that Canpotex levels were higher than the MOF. Any consulting firm reporting on sediment plumes in the area also knows the flow is to the north.

"Additional sediment quality will be collected for the marine berth, but the expectation is that sediments in the marine berth dredging area will be similar in quality to those collected for the PRGT Project due to the marine berth being in the open ocean and further away from the decommissioned pulp and paper mill compared to the MOF. "- Stantec pg 880

-It is disturbing that Stantec used clean samples from an area, uncharacteristic of the plume area where the main PNW dredge site is, to minimize the risk of the project to the public. Stantec knew or ought to have known, where the plume lay, knew that the Canpotex sediment was in the plume and above the ISQG, and knew or ought to have known that the PRGT sample site was well outside of the plume and so did not meet the requirement of characterizing the main dredge area sediment. In this excerpt, Stantec describes, possibly the largest dredge in Canadian history, within a known PCDD/F contaminated plume area, as "disturbance of small amounts of sediment...with associated low contaminant levels":

"Similar to comments made about the MOF dredge area, disturbance of small amounts of sediment during dredging at the marine berth dredge area (during construction), with associated low contaminant levels, would result in the same patterns of contaminant dispersal described for TSS from the dredge area, settling into areas with similar chemistry and contaminant levels. Similar dispersal is expected as a result of maintenance dredging, with a smaller range of dispersal due to a smaller volume of sediment. Sediment dispersal at Brown Passage as a result of disposal of marine berth area sediment at sea is expected to have similar dispersion patterns as MOF sediment, with lower levels of contaminants and therefore a lower risk of toxicological effects on marine biota"
-Stantec/PNW pg 525/1203 (note the MOF is a small dredge area in porpoise channel separate to the huge main dredge and the lower levels of contaminants comment is predicated on the PRGT samples)

Overall, the characterization of marine sediments within the PRPA are well enough understood as a result of the sampling that has been completed for a number of projects within their jurisdiction, and as a result of the modeling of the pulp mill plume, to make it clear that the sediment samples Stantec used in its Application, were not appropriate to characterize the sediment at the main PNW dredge site.

Stantec says it will do a follow-up program to characterize the chemical attributes of the marine sediment in the main dredge area:
"The purpose of the follow-up program for sediment quality is to characterize the physical and chemical attributes of marine sediment will be completed for the marine terminal dredge area."-30.2.2 Sediment Quality pg 1201
But this characterization of the sediment is necessary to meet the requirements of the Application and the needs of the public, it cannot be commented on and submitted to expert review with CEA funding if it is not included in this Application, but only in a follow-up program.

The sediment quality is a key issue, many people and First Nations have emphasized this. The local knowledge and special local considerations and values related to an assessment of risk, and possible mitigation, need to be included in the Environmental Assessment and can't be, without

information about the sediment contamination level, vertical distribution of contamination and other sediment characteristics.

B) Best Available Evidence

Horizontal Distribution of Contamination near PNW Main Dredge Site

The contamination in the plume area is not completely characterized, but from the Canpotex samples and others outside the plume area (see table below) we have a good indication that the PNW dredge area is about five to ten times above regional background levels; influenced by the nearby historic source of dioxin. Washington State guidelines as explained below, require that sediment levels be below the regional background, if they are to be disposed of at sea. The regional background level, away from the PNW contaminated dredge site, is roughly 0.4 pptr (see table below which includes some samples fairly near the plume). (The probable level at the PNW site is 3.14 pptr see detail in contamination at depth chart)

Table Comparing background dioxin levels from several locations in Chatham Sound and Rupert Harbour in pptr. These samples are chosen to be away from the pulp mill contamination.

Locations in Prince Rupert Harbour and Chatham Sound away from dredge site	Pg TEQ/g WHO 2005 humans (WHO 1998 fish)	notes
Fairview	0.84	not specified if WHO 2005 or WHO 1998
Brown Passage	0.43 (0.23)	
Proposed Canpotex disposal site	0.79 (.48)	
Near the proposed Canpotex disposal area	0.54 (0.29)	
Proposed Canpotex disposal site plume	1.33 (0.83)	
Reference	0.93 (0.50)	
Just south of Lelu Island	~0.2 (~0.1)	open house information from PNW LNG from pipe route samples (PRGT confirmed)
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Background levels away from pulp mill plume	0.72 (0.47)	This average is four times less than the dredge site: 3.14 (1.69)

Some of these readings are from pg 155/274 Table 4 Stantec-Canpotex

The table shows the Dredge Site contamination is more than four times the background! One can see the levels go up as they near the old pulp mill plume and they are below 0.5 in the background unaffected areas.

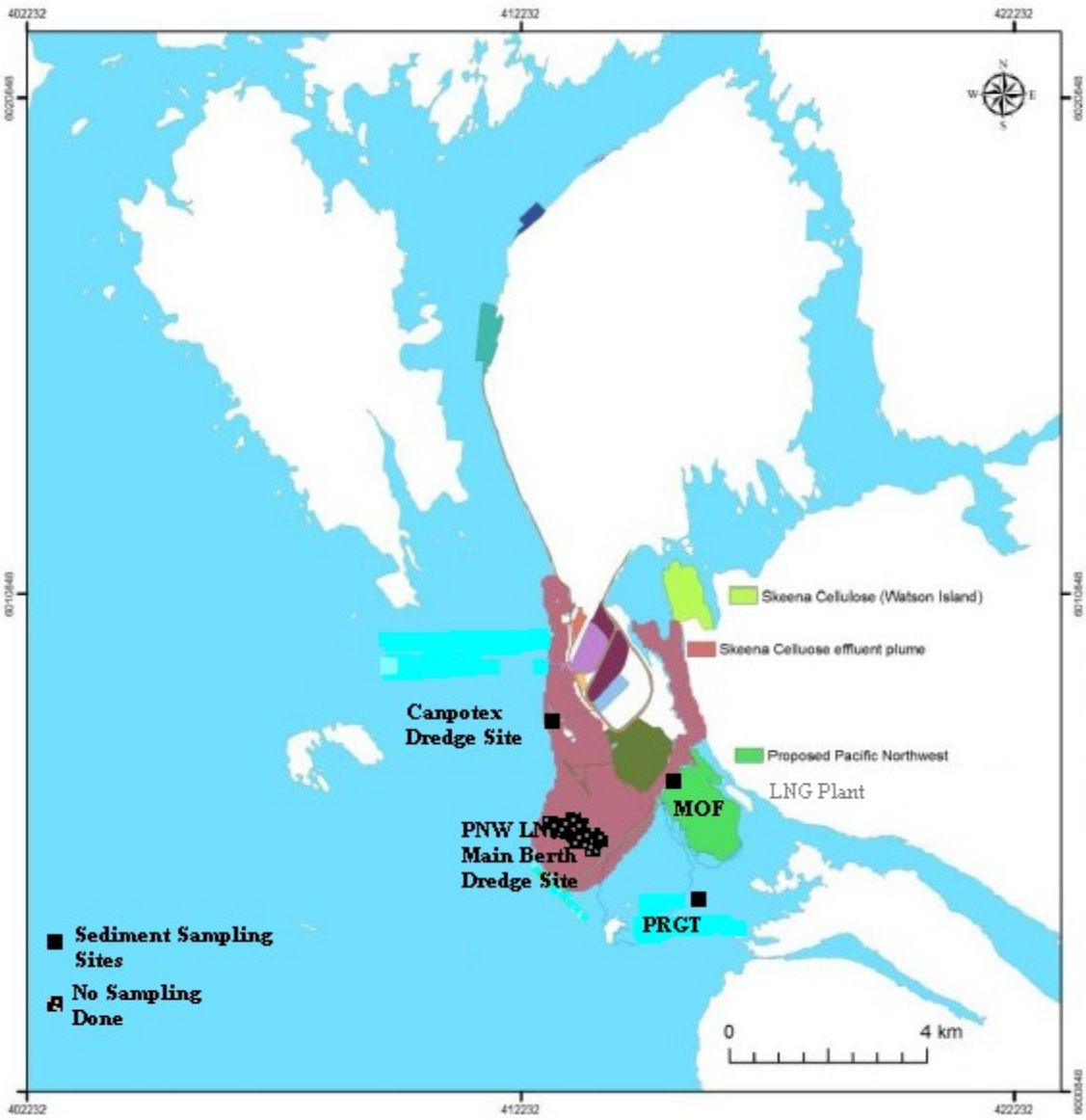
Pptr = pg/g = parts per trillion

Vertical Distribution of Contamination near the PNW Main Dredge Site

The characterization of the sediment in the Prince Rupert Port area is beginning to be understood with sampling. The Canpotex samples showed a highly contaminated layer of 14.5 pptr buried beneath 10 cm of less contaminated sediment (3.14 pptr – which exceeds ISQG) on the surface. It is important that PNW do further sampling because this vertical distribution is based on just three samples and it may be different at the PNW main dredge site. It is important to locate and confirm the "hotspots"; the dredge material is heterogenous; the contamination is most likely contained in the top 40 cm, which can be managed separately and represents only about 3% of the volume.

Background-based guidelines are designed for homogeneous sites where options are limited, a proper approach in this case, would consider the hot spots and consider separate management options, ie land based disposal of the high risk portion of the contaminated material, or if the underlying layer of contamination is too great -alternative siting may be the only recourse.

-The map and note below show that (given no sampling from the main PNW dredge area) the Canpotex samples are the best approximation.



Samples at PRGT (outside the plume) have very low levels of PCDD/F – Stantec used these levels to assure local residents that the project risk was low.
It is unacceptable that samples for the PNW Main dredge site were not provided in the Application. Our comment references Canpotex as the best approximation but we strongly protest the lack of samples.
The MOF site is in a scouring channel unlike the deep deposited sediment areas of Canpotex and PNW Main dredge.
Note the sampling locations and berth size are just rough estimations.
I would like to credit Skeena Cellulose Environmental Effects Monitoring Program (Hatfield Consultants Limited 1994) for the plume info but any errors presenting it in this format are mine.

-This comment references Canpotex sediment characteristics as the best approximation of the PNW main dredge site but we strongly protest the lack of samples.

We requested sampling information for the main dredge site and got the following reply from Stantec. As we have argued in this comment we do not agree that "the information provided meets the requirements for the environmental assessment."

Andrea Pomeroy forwarded me your email of April 28 requesting the sediment sample analysis for the marine terminal berth area to support your review of the Environmental Impact Statement/Environmental Assessment Certificate Application (EIS/Application) for the Pacific NorthWest LNG Project. I am responding to your request and hope to clarify information provided to you verbally at the open house.

The EIS/Application includes detailed sampling information to characterize the sediment size and concentrations of potential contaminants of concern (e.g., metals, PAHs [polycyclic aromatic hydrocarbons], and dioxans and furans) from data collected within the dredge footprint for the Materials Offloading Facility (MOF). The data collected at the MOF, along with other data collected nearby for the Prince Rupert Gas Transmission Project, was used to predict the potential effects of dredging at the marine terminal berth area and disposal of those sediments.

Overall, the characterization of marine sediments within the PRPA is well understood due to the sampling that has been completed for a number of projects within their jurisdiction. Based on the data collected for the project, our conclusion is that the project effects on sediment and water quality are not significant. However, as part of the environmental assessment, we recommend a follow-up program be completed to collect site specific data to characterize the sediments at the marine terminal berth area and confirm the predictions of the assessment.

...

Please note that the follow-up report is not required to support your review of the EIS/Application as the information provided meets the requirements for the environmental assessment.

-Brian Cox April 30th 2014

-The CCME Guideline of 0.85 pg TEQ/g is Exceeded

Stantec incorrectly suggestions that the PNW dredge area sediments are below the CCME guideline:

*"and dioxins and furans (below the CCME ISQG)."*Stantec/PNW- pg 525/1203

"Marine sediment quality around Lelu Island would also meet the disposal at sea criteria."-pg 839

However, if we use the best available evidence from Canpotex, see the Table and notes below, the surface contamination level (3.14 pptr TEQ) can be compared to the Canadian Council of Ministers of the Environment Interim Sediment Quality Guideline (CCME ISQG) for PCDD/F, which is 0.85 pg TEQ/g . The CCME guideline is exceeded by 370%.

-The Most Highly Contaminated Layer Lies 4" Below the Surface; 14.47 pptr TEQ

This section contains references for the sample levels, calculation notes and discussion of the significance of the finding that the highest contamination lies buried beneath the surface now.
The Canpotex site has average surface PCDD/F contamination of 3.14 pptr TEQ (using WHO 2005). The Canadian guideline is 0.85 pptr TEQ. The contamination just below the surface, from 10 cm deep to 20 cm, is 14.47 pptr TEQ.

Contamination at Depth Table from 2013 Canpotex site samples

Depth	pptr TEQ PCDD/F WHO 2005 Humans (WHO 1998)	

The top 10 cm (4")	3.14 (1.69)	Note 2
The next 10 cm (from 10 to 20 cm) (4"-8")	**14.47 (7.79)**	Note 3 & 4
These top 20 cm together(0-20)	8.81 (4.74)	Note 3
The next 20 cm (from 20-40 cm)	1.69 (0.91)	
From 40-80 cm	0.26 (0.14)	
The whole 0-80 taken together	2.20 (1.18)	
WHO 2005 TEFS for humans were used for calculation of TEQ (see section 3.A -3 for supporting references). All our PCDD/F levels are calculated or estimated based on WHO 2005 TEFs for Humans and any TEQs calculated using WHO 1998 TEFs for fish are shown in brackets. (pg/g = pptr)		

-Repeatedly, Stantec uses the incorrect assertion that the contamination is already on the surface to underplay the risk of resuspension resulting from the dredge.

The Table above, Contamination at Depth, shows the highest levels of dioxin and furan beneath the surface. This is in direct contradiction to Stantec's following claim that it is on the surface, and it brings into question their use of that incorrect fact to characterize the risk as minimal:

"Organisms that interact with newly deposited sediment will not be exposed to higher chemical concentrations because the surface sediments currently contain the highest detectable PCDD/F concentrations.....These multiple lines of evidence and supporting conditions suggest that the overall potential for PCDD/Fs in marine country foods to increase in concentrations is negligible to low." Stantec pg 856/1203

The following statement by Stantec seems misleading at best when we see (above) the levels which are nearby and which average 14.47 pptr TEQ in the 0.10- 0.20 m depth:

"For Pacific NorthWest LNG, disposal of sediment that has elevated PCDD/Fs in the surface layer only (maximum of 2.64 ng TEQ/kg dw at 0 to 0.2 m depth) at Brown Passage in water depths of 200 m, followed by disposal of sediment with no measurable concentrations is not expected to result in adverse environmental effects." pg 194/196 Stantec Appendix 5 (ng/kg = pptr = pg/g)

Notes to Section 2: Table 6 from the Stantec Canpotex Application

Table 6. Dioxin and Furan Concentrations (pg/g dw TEQ) in the Dredge Area

Sample Type	Depth (m)	n	Min	Max	Median	Mean	SD	n>ISQG	n>PEL
Surface	0-0.1	10	0.80	3.43	1.55	1.69	0.86	9	0
Dredge Unit Core	0-0.8	7	0.60	1.89	1.04	1.18	0.60	4	0
	0.8-1.6	7	0.08	0.17	0.13	0.12	0.04	0	0
Detailed Core	0-0.2	3	3.97	6.25	4.01	4.74	1.30	3	0
	0.2-0.4	3	0.48	1.45	0.81	0.91	0.49	1	0
	0.4-0.6	3	0.12	0.23	0.21	0.18	0.06	0	0
	0.6-0.8	3	0.10	0.12	0.10	0.10	0.01	0	0
	0.8-1.0	3	0.08	0.09	0.09	0.08	0.00	0	0
	1.0-1.2	3	0.06	0.11	0.07	0.08	0.02	0	0
	1.2-1.4	3	0.07	0.11	0.10	0.09	0.02	0	0
	1.4-1.6	3	0.07	0.11	0.08	0.08	0.02	0	0

NOTE:
TEQ calculated using WHO 1998 TEFs for fish

Notes to Section 2- References and Calculations

Note 1) In the Canpotex application, Stantec does not give the WHO 2005 TEFs for all samples but they do give both WHO 2005 and the WHO 1998 values for the ten surface samples -and that relationship is 3.14/(1.69) see note 2. Where Stantec has only given TEQs based on the old 1998 WHO TEFS, we estimated the WHO 2005 amounts from the 1998 WHO TEQ for fish using this 3.14/(1.69) relationship (Stantec pg 175 says the relationship is about 2 to 1). The Table 6 above is provided by Stantec and only shows levels using the old WHO 1998 TEFs for fish.
See section 3.A-3 below for supporting references regarding the use of WHO 2005, however, it is interesting to note that even when the sediment contamination levels are calculated using the old and lower WHO 1998 TEFs for fish, the levels still exceed the CCME ISQG!

Note 2) Surface Samples Provide Comparison for Calculation Method
The levels for the 10 surface samples are given by Stantec in Table B1, Appendix B Canpotex Application pg 159/274, showing both 2005 WHO TEFS for humans and 1998 WHO TEFs for fish and the means are 3.14 (1.69) respectively. The (1.69) mean is repeated above in Stantec's Table 6.

Note 3) Stantec only did a detailed depth profile of three Canpotex cores. We used those as the best guess of the vertical PCDD/F distribution. The mean of the 0-0.2 m segment was 8.81 (4.74) see Table 6 above. Stantec did not break those cores into 0-0.1m and 0.1-0.2 m so we have calculated an estimate using our knowledge of the many other surface samples in the 0-0.1m range- note 4.

Note 4) The mean of the ten Canpotex surface 0-0.1 m samples is 3.14 (1.69). If that holds true for the detailed cores then in order to have a mean of 8.81 (4.74) for the 0-0.2 m total depth, the 0.1-0.2 m section must have a mean of 14.47 (7.79). (3.14+14.47)/2=8.81 (1.69+7.79)/2=(4.74)

3) PNW Dredge area PCDD/F Levels Compared to Canadian and US Guidelines

A) Dredge area PCDD/F Exceeds CCME Guidelines and this indicates risk of adverse effects

1) Everyone is agreed, that the sediment contamination in the Canpotex proposed dredge area is above the Canadian Council of Ministers of the Environment Sediment Quality Guidelines for the Protection of Aquatic Life (CCME) and even the PNW readings for the MOF site included concentrations exceeding ISQG (range of 0.06 – 2.64 ng TEQ/kg dw).

The CCME Interim Sediment Quality Guideline (ISQG) is 0.85 pg TEQ/g. Below the ISQG there is less than 25% incidence of adverse effects on aquatic life. The PNW sediment likely lies in the range above this ISQG, but below the level, where there is a 50% incidence of adverse effects.

Stantec wants to use the PEL not the ISQG:

"The sediment baseline study indicated that PCDD/F concentrations are below the PEL that could indicate adverse effect to benthic and epibenthic fish."pg 856

Stantec's quote above is suggesting the PEL is the relevant guideline, not the ISQG. It ignores that the sediments from the MOF are above the ISQG and those from the nearby Canpotex site (14.5 pptr in the layer just beneath the surface) are well above the 0.85 ISQG; so the site likely lies somewhere

between the 25% incidence of adverse effects and 50% incidence (at the PEL); so it is not correct to lead people to believe the concentrations are below a level that could indicate adverse effect.

2) Whatever level is confirmed at the PNW site, the surface should be compared to the CCME and detailed cores should be done to make management decisions. Likely the surface will exceed the ISQG (the Canpotex dredge site has 3.14 pg TEQ/g for surface samples). CCME specifies that the 5 surficial cm is the appropriate measure to compare to the guideline. -CCME Introduction

"During dredging, sediment can be managed at the scale of the equipment used; for a clamshell dredge, this is approximately 0.5 m. In this situation, the concentration averaged through the 0.5 m depth is the most appropriate measure of PCDD/F levels in the dredge management unit (this reflects distribution of the higher concentration surface layer throughout 0.5 m).- Stantec

I hope that Stantec isn't suggesting here that its lack of detailed core analysis in the application is acceptable. Without contamination at depth information we can't locate the most highly contaminated portion and develop a management plan to deal with that portion safely.

3)Because our endpoint of concern is human health we used TEQs calculated with WHO 2005 TEFs for humans. The World Health Organization addressed this issue in a paper "The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds" -Martin van den Berg, et al 2006 While they acknowledge limitations to the use of WHO 2005 TEFs for humans for sediment analysis and they recommend more detailed analysis for human risk assessment, they don't recommend the use of WHO TEFs for fish.

"*As a result, application of these WHO TEFs for calculating the TEQ for e.g. OCDD and OCDF in abiotic environmental matrices has limited toxicological relevance and use for risk assessment unless the aspect of reduced bioavailability is taken into consideration. Nevertheless, the expert panel recognized that it is now common practice, to use the TEQ and associated TEFs directly to characterize and compare contamination by dioxin-like chemicals of abiotic environmental samples and is even codified in national and international legislation, e.g. the Stockholm Convention on Persistent Organic Pollutants (POPs).*
In relation to this use of the TEQ it should be emphasized that while these values by themselves do not have any toxicological implications or direct use in risk assessment, they can be a useful tool to compare concentrations within similar abiotic matrices and serve a prioritization function. Accordingly, it is recommended that when a human risk assessment is to be done from abiotic matrices, factors such as fate, transport, and bioavailibility from each matrix be specifically considered before a final estimate of the toxicological relevant TEQ is made. If a human risk assessment is done for abiotic matrices, the expert panel recognized that it would be preferable to use congener-specific equations throughout the whole model rather than base it on total TEQ in an abiotic matrix."-WHO 2006

For an indication of the current practice in the US and Canada concerning use of WHO 2005 vs WHO 1998 one can refer to The 2010 EPA memorandum, Compilation and Discussion of Sediment Quality Values for Dioxin" which notes that WHO 2005 TEFs for humans are used in eleven of twelve guidelines including CCME: "*All TEQs based on Van den Berg et al., (2006) except where noted.*" -EPA Memorandum Dioxin Klamath 2010

B) The CCME Guideline (ISQG) is applicable to open water disposal

The CCME Introduction specifically addresses this issue stating:

"*the variety of potential uses, sediment quality guidelines are likely to be routinely applied as screening tools in the site-specific assessment of the potential risk of exposure to chemicals in sediment and in formulating initial management decisions (e.g.,* ***acceptability for open-water disposal,*** *required remediation, further site investigation, and prioritization of sites)."- CCME*

Canadian Sediment Quality Guidelines for the Protection of Aquatic Life – Introduction pg 2 (emphasis added)

C) The CCME guideline should be used despite its Interim status

"*Although these sediment quality guidelines are considered interim at this time, they should not be used differently than if they were full sediment quality guidelines." –CCME Canadian Sediment Quality Guidelines for the Protection of Aquatic Life – Introduction pg 2*

D) Contrary to the position taken by Stantec the CCME ISQG Guideline is not too conservative in respect to Human Health Risk for Subsistence Human Consumers and in comparison to other risk based N.A. Guidelines

"...Canadian ISQGs and PELs for dioxins and furans are intentionally conservative since they combine toxicity test results and endpoints from a wide range of aquatic species and apply ten-fold safety factors." -Stantec 521/ 1203

"When elevated PCDD/F levels are associated with the surficial sediments, there will be a low risk of adverse effects (e.g., bioaccumulation in organisms such as fish, crabs and bivalves that are consumed by mammals and humans) in the range of 0.85 to 8.5 ng TEQ/kg dw, given the following considerations:
This is in the range identified in toxicity testing used to derive the ISQG, without the ten-fold safety factor, and is well below the PEL of 21.5 ng TEQ/kg dw." -Stantec 193/196 appendix 5

It is not appropriate for Stantec to recommend to local people that the tenfold safety factor which the CCME established to ensure low risk, can be ignored. The Stantec comment above also gives the impression that the ISQG takes into account bioaccumulation, but it does not. Bioaccumulation would serve to increase the risk

1) A Canadian Council made up of Ministers of the Environment (CCME) was competent; with their resources and knowledge they were well suited to set guidelines for Canada, and as elected officials and cabinet ministers in their respective governments, to balance environmental and economic risk in the Canadian context.

2) Of ten Risk/Effects based US/Can guidelines the CCME is in the middle. The CCME guideline is not the most conservative. A recent review of US and Canadian guidelines by the EPA shows the CCME in the middle of the risk/effects based guidelines; below is a listing pulled from it for comparison (see EPA Memorandum Dioxin Klamath 2010 appended for more detail):

Calculated using WHO 2005 TEFS for Humans	**Risk/Effects Based Guidelines from EPA 2010 Comparison**	**Excerpted for comparison with CCME ISQG see EPA memorandum referenced above for more detail**
0.0011 – 1.1pg/g	Oregon DEQ	Low value represents threshold for potential risk to subsistence human consumers; high value represents threshold for potential risk to the general population of human consumers. Screening level value to determine need for bioaccumulation testing/modeling (ref ODEQ 2007)

0.052 pg/g	Oregon DEQ	Protection of wildlife consumers: Mammals (ref ODEQ 2007)
0.56 pg/g	Oregon DEQ	Protection of fish (ref ODEQ 2007)
0.85 pg/g	adopted by State of WI	Interim Consensus-based SQGs (Dec 2003)
0.85 pg/g CCME	**CCME Environment Canada**	**Protection of benthos (Canadian SQGs not intended to address bioaccumulation.) (ref Environment Canada 2002)**
0.85 pg/g	adopted by EPA Region III BTAG	Screening Benchmarks for the evaluation of sampling data at Superfund sites.
2.5 pg/g	EPA (ORD-Duluth)	mammals (ref US EPA 1993)
11 pg/g	WA DOE	Residential Soil Clean-up level reflects 2007 rule amendments.(ref Chapter 173-340 WAC/Pers. Comm P. Kmet)
15 pg/g	PSDDA	Protection of recreational fishers; based on a 1991 (ref DMMP 2009)
72 pg/g	EPA (OSWER)	This is proposed draft interim PRGs in residential soil, current is 1000. US EPA (2009)

3) The Oregon guideline, the only one which specifically addresses subsistence human consumers, is three full magnitudes below the Oregon guideline for the general population of human consumers and three full magnitudes below the CCME guideline.
4) Of the four criteria above the CCME, two are over 20 years old and the other two are for residential soil.

4) Despite Stantec's assurances otherwise, there is a risk to human health if the CCME Dioxin guideline is exceeded

A) The CCME guideline is Risk/Effects Based, and is less conservative than the Oregon Risk based guideline for subsistence human consumers of seafood. When it is exceeded it is necessary to carry out a risk assessment in a manner that accounts for local conditions.

B) Cancer rate increase for extra consumption of PCDD/F is exponential, not linear, and the local population eats easily 15 times the Canadian average (two daily servings on WCVI according to Peter Ross and Tom Child, 2009). The Oregon guideline in the table above specifies a thousand fold difference in risk to subsistence human consumers, compared to the general population of human consumers.

-Appended graph shows exponential increase in cancer rate related to dioxins and furans in seafood consumed from the contaminated Puget Sound area. Tad Deshler, Windward Environmental LLC, Seattle, WA

- Dioxins/furans are highly toxic, so risk estimates are often higher than regulatory thresholds of concern, even for relatively low concentrations.
- Excess cancer risk estimates for dioxins/furans in Puget Sound seafood range from 3×10^{-7} for two meals per year (1.24 g/day on an annualized basis) to 3×10^{-5} for three meals per week (97 g/day on an annualized basis) (Figure 4).

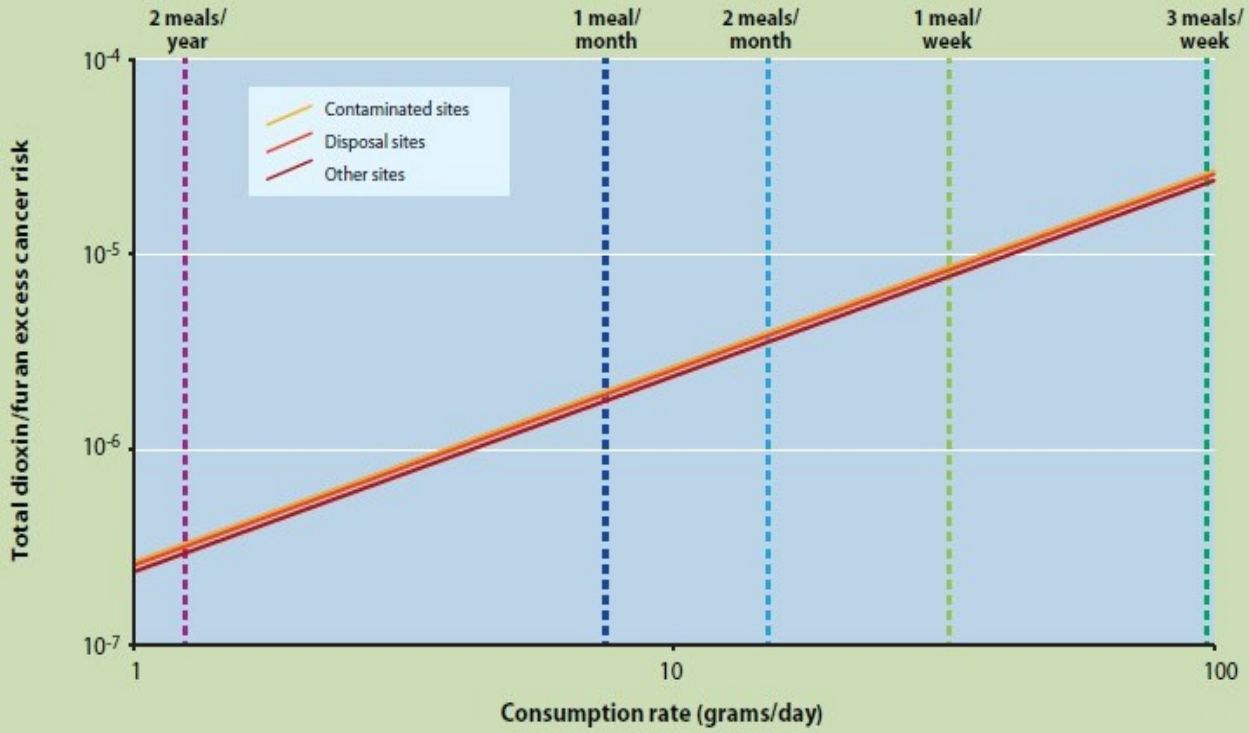


Figure 4. Hypothetical dioxin/furan excess cancer risk estimates associated with the consumption of Puget Sound seafood

Figure 4. This graph does not apply to seafood from the clean north coast.

Cautions to consider when evaluating Figure 4. It is hypothetical! The risk is hard to evaluate. Puget Sound levels are roughly ten times or more, higher than Chatham Sound (although similar to the PNW dredge site). The graph shows 3 extra cancers per 100,000 people at 3 meals per week, Ross estimated WCVI First Nations ate 14 servings per week. Cancer is not the only concern with dioxins and furans; they are immune suppressants, cause reduced fertility and birth defects, disproportionately affect children, are known endocrine disruptors and are associated with obesity, diabetes, and autism. It is not appropriate to assess local risk using this graph- it is only copied here to suggest that a risk to human health from resuspension of PCDD/F is a very real risk.

C) Bio-availability and bio-accumulation will increase as a result of re-suspension

The CCME Guideline warns that it does not take into account bio-accumulation. -CCME 2001-PCDD/Fs. It also advises that the PNW dredge sediments (if they are similar to Canpotex or even the

MOF) are above "*a chemical concentration below which adverse effects rarely occur.*" Bio-accumulation would be expected to exacerbate the risk to human health. Clearly, then, to understand the degree of risk to human health, it is necessary to consider increased bio-availability as a result of resuspension of now buried toxins. Stantec itself describes what would pose a risk:

"*An exposure pathway to affect ecological health could exist if chemical concentrations in deep sediment layers are higher than concentrations found in surface layers. Under this scenario, deep sediments containing higher concentrations of contaminants would settle over cleaner surface sediments. These concentrations must also be above ecological health-based criteria.*" Stantec pg 848

Yet even though the pulp mill has been closed for over twelve years and commonsense dictates that the worst contamination now lies buried under the surface, Stantec bases its argument that there will be no increased bioavailability on the premise that what contamination there is, lies in the surface.

But Stantec has not provided detailed cores from the PNW main dredge area to support that premise and it did not reference the Canpotex samples which clearly refute that premise and so they deny that the conditions are met for increased human exposure. Not only is the contamination highest beneath the surface but we have shown above from publicly available Canpotex data that the levels are high.

Stantec repeatedly denies the risk to human health based on the use of PRGT samples which were and are, clearly inappropriate:

"the sediment plume resulting from dredging activities will contain similar or lower concentrations of anthropogenic chemicals than the existing surface sediments." - Stantec pg 848

"Project activity interactions with sediment quality represent an incomplete exposure pathway to human health and no further analysis is warranted." - Stantec pg 848 (they did at least admit that benthic pathways needed more consideration)

"Organisms that interact with newly deposited sediment will not be exposed to higher chemical concentrations because the surface sediments currently contain the highest detectable PCDD/F concentrations." - Stantec pg 856

Bioaccumulation is increased because the contaminated sediment doesn't settle nearby, it drifts to cleaner areas. Contrary to Stantec: *"When sediment is disturbed during dredging, the contaminants settle nearby in an area of similar concentrations, where organisms are adapted to those levels."-Stantec*
The contamination is concentrated in the lightest fraction, which disperses over a wide area especially when there are extremely high tides and strong currents as in this area. So not only does Stantec deny the level and likely vertical distribution of the contamination, their comments above and below are indicative of their lack of consideration of and scanting of the risk posed by increased bioaccumulation as a result of resuspension of whatever levels are present:

"PCDD/Fs are hydrophobic compounds that bind strongly to the organic content in sediments and do not readily dissolve in water for gill uptake (Black and McCarthy 1988). PCDD/Fs bound to sediment particles do not permeate the gill membrane when exposed to fish gills (Loonen et al. 1994) resulting in minimum bioaccumulation through this process. Another way fish could be affected by the resuspension of sediment is by ingestion. However, this would only represent a small amount compared to benthic marine biota that are continuously in contact with sediment.....

These multiple lines of evidence and supporting conditions suggest that the overall potential for PCDD/Fs in marine country foods to increase in concentrations is negligible to low."Stantec pg 856/1203

Stantec only acknowledges the shorterm increase in bioavailability as a result of the sediment plume before settling: ***"Although the concentration of PCDD/F in the sediments would not increase from dredging activities, the resulting sediment plume may result in an increased exposure to some marine organisms. Suspended sediments in the water column***

from the plume could contain PCDD/Fs which are exposed to the gills of marine organisms (i.e., fish, prawns and crabs) or collected by filter feeders (i.e., shellfish) and could affect ecological health. Humans who consume these organisms could be exposed to increased PCDD/F concentrations."- pg 849

Species of marine country foods would only experience temporary exposures to PCDD/Fs in the plume.- pg 856

Stantec's position above is contradicted by the following references and graph which show that the proposed dredging and nearby disposal could greatly increase the bio-availability of toxins; through uptake and bio-accummulation by plankton in the water column and in the benthic food chain. We have to consider the role re-suspension plays, increasing bio-availability in the water column by winnowing out and dispersing now covered pollutants.

-The underlying sediment layer has much higher concentrations than the surface layer (see earlier discussion). Exposing that layer risks increased adverse effects: "*Currently, the degree to which dioxins and furans will be bio-available at particular sites cannot be predicted accurately from the physicochemical characteristics of sediments or the attributes of endemic organisms (Environment Canada 2000). Nonetheless, the incidence of adverse biological effects associated with exposure to dioxins and furans increases as their concentrations increase in a range of sediment types."*-CCME 2001 PCDD/Fs

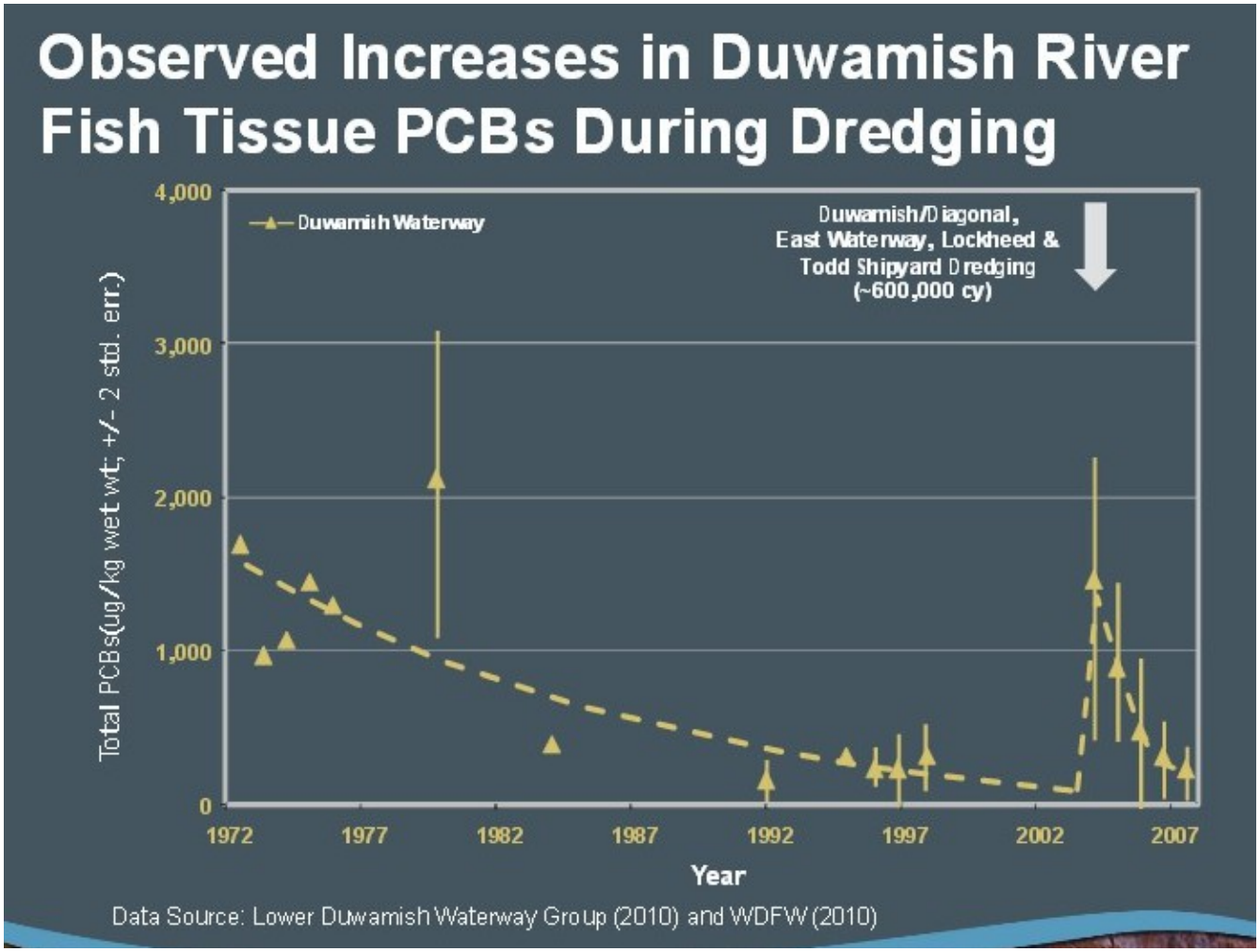
"For organic micropollutants, mixing of sedimentary matter with the water column may result in a substantial, lasting increase in water column concentration due to the transfer of pollutants bound to Dissolved Organic Matter to the water column and to the desorption of pollutants from particles."- Goossens and Zwolsman

"in less quiet conditions (rivers, tidal waters) the residence time in the water column can be much higher for "fine" particles, which generally carry the highest pollutant concentrations, than for "coarse" particles. For the fine particles the water residence time will be much longer and a substantial mobilization (and dispersion) of pollutants might be the result." - Goossens and Zwolsman, An Evaluation of the Behaviour of Pollutants During Dredging 1996

"These patterns suggest strongly that resuspension tends to enhance the transfer of organic pollutants in the benthic food chain." F. Charles et al 2005

-Exposing and resuspending PCDD/Fs will spread them and increase their bio-availability; PCDD/Fs tend to concentrate in the finest, lightest most easily lost fraction, which drifts furthest before settling and which also, is bio-available to plankton while suspended: *"The chemical transport of nutrients, metals, phosphorus, and organic and industrial compounds including chlorinated pesticides, polyaromatic hydrocarbons, polychlorinated biphenyls, dioxins and furans is mostly associated with the silt and clay (or cohesive) particle size fractions at <63 µm"* (Ongley, 1996).

-Graph showing the drastic and prolonged increase in PCB levels in fish as a result of dredging. This example of another hydrophobic chemical accumulating after dredging does not tally with Stantec's reassurances about hydrophobic compounds above.



D) Stantec underestimates the current PCDD/F level in country foods by sampling outside the plume and averaging, and also by comparing crab heptopancreas samples with crab muscle samples

"Overall, average concentrations of PCDD/F measured in crabs, prawns and clams were below concentrations that would adversely affect mammals and birds that consume aquatic biota. For mammalian consumers of aquatic biota (i.e., seals, otters), the average concentration of PCDD/Fs in the muscle tissues was 0.33 ng TEQ/kg wet weight (ww) compared to the tissue residue guideline of 0.71 ng TEQ/kg ww. When non-detects are assumed to be zero (lower-bound average), the concentration decreases to 0.04." - Stantec pg 840

If the food sampling was done to inform about the present food contamination in the main dredge area, it likely underestimates it. Looking at the food sampling locations, on the figure below, and comparing them to the contamination plume (back a few pages), it is clear that the only prawn sample site, one third of the clam sample sites and 40% of the crab sample sites lie outside the plume area, whereas the PNW main dredge area is completely within the plume.

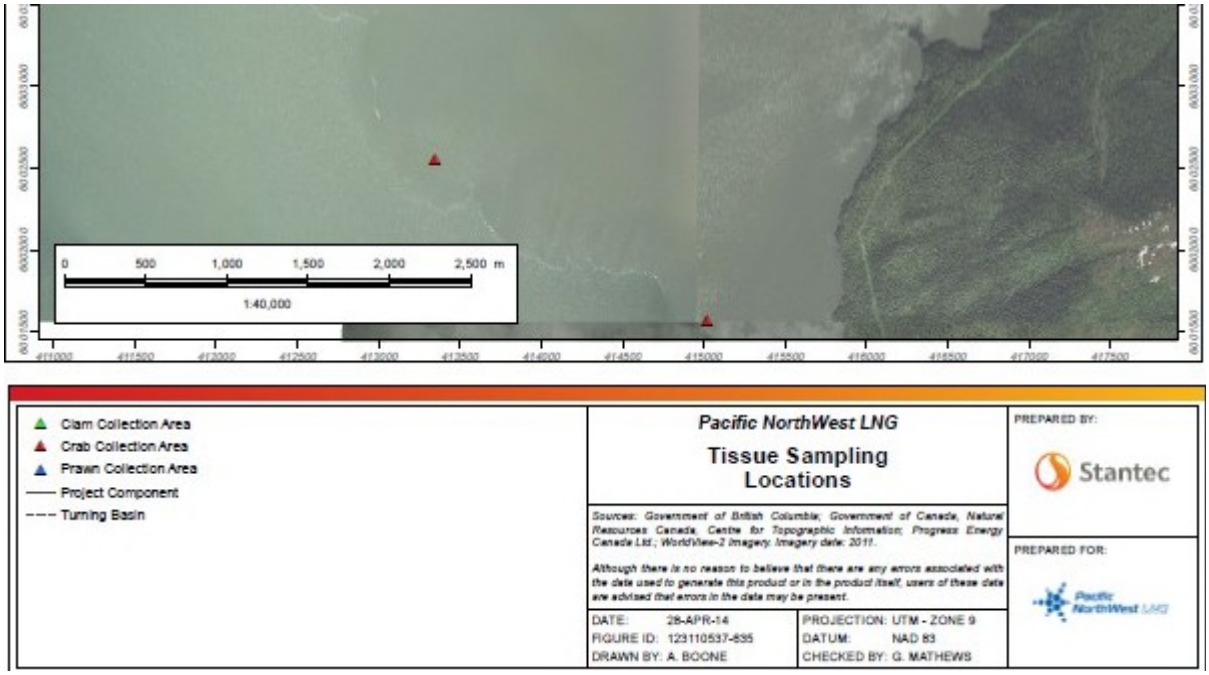
The following statement by Stantec is incorrect and gives false assurance in regard to human health risk by misrepresenting the level of contamination relative to a level which necessitated a ban:

"PCDD/F concentrations in crab hepatopancreas from Port Edward and Prince Rupert had measured concentrations of 1900 ng TEQ/kg ww in 1987, and steadily declined to 670 ng TEQ/kg ww in 1989, 260 ng TEQ/kg ww in 1990 and 53 ng TEQ/kg ww in 1993 (Yunker and Cretney 1995). In comparison, the baseline

marine food tissues collected around Lelu Island had an average concentration of 0.33 ng TEQ/kg ww, which may be an overestimation due to the influence on the detection limits described earlier. This data supports the body of evidence indicating that the concentrations of PCDD/Fs in marine traditional and country foods has continued to improve since the harvesting ban related to PCDD/Fs had been lifted in 1995.: -Stantec pg 840

The 0.33 pptr level in Stantec's collected marine food tissues cannot be compared to the 1990's level in crab hepatopancreas, because the hepatopancreas concentrates PCDD/F:

"*We have also provided 2,3,7,8-TCDD TEQ concentrations from a study conducted in 1995 (Skinner et al., 1997), conducted by the NY State Department of Environmental Conservation. This study of Newark Bay reports dioxin concentration in the muscle and the hepatopancreas of six blue claw crabs separately. The 290 pg/g is the maximum value for the concentration of dioxins in the hepatopancreas and 17 pg/g is the maximum concentration of dioxin in the muscle. The values 190 pg/g and 8 pg/g are the mean concentrations of the hepatopancreas and muscle respectively."*



5) Dredging changes the bio-availability of heavy metals and there is a risk to aquatic life and human health from re-suspension of heavy metals. There are other contaminants which need to be analyzed in the PNW main dredge site and considered for cumulative effects.

The following metals, were found throughout the dredge sediment at the Canpotex site, and they all exceeded guidelines, falling in the range where there is risk which may be increased by dredging and disposal a sea:

Copper is double the guideline.

Arsenic is 50% above the guideline.

Nickel is just at the guideline.

Vanadium is 40% above EPA guideline.

The following quotes describe a very real scenario, where the dredging acts to winnow out the very worst fraction, the finest particles with the highest concentration, which then drift the furthest settling in the shallow areas used for food gathering. This alone will increase their bioavailability but a subsequent change in pH, say on important eelgrass beds or clambeds, could produce a large longterm increase in bioacumulation.

"the toxicity of mixtures of metals has been shown to be more than additive" (Reeder et al., 1979) http://www.aadnc-aandc.gc.ca/DAM/DAM-INTER-NWT/STAGING/texte-text/ntr_pubs_SRE_1330715283115_eng.pdf

"Case-by-case considerations will include the following: (a) material placement sequencing; (b) consideration of the possible cumulative effects of other bioaccumulative compounds within the project sediments; and (c) the frequency of disposal site use." (DMMP 2010)

"*The chemical transport of nutrients, metals, phosphorus, and organic and industrial compounds*

including chlorinated pesticides, polyaromatic hydrocarbons, polychlorinated biphenyls, dioxins and furans is mostly associated with the silt and clay (or cohesive) particle size fractions at <63 µm" (Ongley, 1996).

"*In summary, the present amount of heavy metals will probably show a shift from precipitated mode to the adsorbed mode, during dredging. Both modes are particulate, but adsorbed heavy metals can be released very quickly following a pH decrease in the water. In the "after dredging" situation problems may arise when sedimentation yields a top layer polluted with heavy metals*."*-Goossens and Zwolsman, An Evaluation of the Behaviour of Pollutants During Dredging 1996*

"the control of dispersion of the most riskful fine material and of the water itself, may offer as yet unresolved technical problems" -Goossens and Zwolsman,

"*in less quiet conditions (rivers, tidal waters) the residence time in the water column can be much higher for "fine" particles, which generally carry the highest pollutant concentrations, than for "coarse" particles. For the fine particles the water residence time will be much longer and a substantial mobilization (and dispersion) of pollutants might be the result." - Goossens and Zwolsman*

Finally the sediment analysis when it is finally done, needs to include measurement of all the fire retardants used on coal coming into the area plus those used once the coal gets here.

Conclusions on PNW Application- Human Health Risk from Contaminated Sediment Re-suspension

This PNW Application and the whole public consulting process is called into question by the failure to provide sediment sampling information about the main dredge area. The sampling will almost certainly show that contamination greatly exceeds the CCME ISQG for PCDD/F and this should precipitate a thorough human health risk assessment.

The sampling results should be presented to the public in a new application and a process should be set up to allow interested groups and individuals to review the sampling reports and risk assessment (with the help of experts) and then comment. There is a reason that the public is allowed to comment on Applications. The whole EA process is called into question if absolutely vital information about one of the key issues (contaminated sediment) is not provided.

Considering: the extremely high consumption of local seafood, the almost certain high levels of PCDD/Fs beneath the surface in the main dredge area, the magnitude of the proposed dredging project and the serious siting flaw which will necessitate frequent dredging and daily sediment boat wash, the proponent should consider another site on purely human health considerations.

We have a pretty clean region except for the localized and improving plume area of the old pulp mill effluent, a goal for this environmental assessment and others in the area would be to keep it clean.