East Waterway OU

Anthropogenic Background Small Working Group Meeting #6

Invitees: EPA, East Waterway Group (Port of Seattle, City of Seattle, and King County) Muckleshoot Tribe, Suquamish Tribe

December 18, 2020; 9 – 10 am

Agenda

1. Review suspended sediments normalization approach

Attachments

Calculation spreadsheet updated during meeting

Attendees

EPA

- Ravi Sanga
- Elizabeth Allen

USACE (on behalf of EPA)

- Bill Gardiner

Suquamish Tribe

- Alison O'Sullivan

East Waterway Group (EWG)

- Brick Spangler (Port of Seattle)
- Jeff Stern (King County)
- Debra Williston (King County)
- Pete Rude (City of Seattle)
- Allison Crowley (City of Seattle)
- Merv Coover (ERM on behalf of the City)
- Dan Berlin (Anchor QEA on behalf of EWG)
- Greg Brunkhorst (Anchor QEA on behalf of EWG)
- Deb Chiavelli (Anchor QEA on behalf of EWG)

Meeting Notes

Dan: we'd like to use this meeting to clarify EPA's questions and provide additional information. What would EPA like to discuss?

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Ravi: EPA would like to understand what you have done for the normalization. It looks like what you're saying is that so little fine-grained sediment settles in the EW, meaning that natural recovery wouldn't help. We'd like to review the calculations and assumptions that no sand gets into the EW and not many fines settle.

Elizabeth: I made it through the spreadsheet, and I'm a bit confused about a few things. I subscribe to the theory that this should change the result, but this changed the result a lot. So, if that's the case, I'd like to understand it better. It would be great if you can explain it further.

Bill: I think I understand surface area is used in one place and mass is used in another. It would be helpful to walk through the intermediate steps. It's probably the one factor that makes the biggest difference in the values, but it's something we are talking about right at the end of this process, so we'd like to talk more about it. It's a little bit of a novel approach, so walking through the spreadsheet step by step would be helpful.

Ravi: Alison, do you have anything to add?

Alison: At this time I'm going to listen to the conversation to see if my concerns are addressed, and if not, I'll bring them up later.

Ravi: OK so please go ahead.

Greg: I'll pull up the spreadsheet. These 4 classes are specific grain sizes. These classes were selected because grain size data was available for the LDW, so we maintained those class sizes. We also grouped the sizes from our suspended sediment data and compared them to this grain size data, but we can go through that later.

Bill: are you using the output from the sediment transport model (STM) or the data that went into the STM?

Greg: we are using the calibrated STM values for how much is entering the LDW and also exiting the LDW. It's based on data, and the STM used available data to estimate these 30 year values.

Bill: for this distribution of particle sizes in suspended sediment, what do we see in bedded sediment as grain size distribution?

Jeff: as you can imagine, the range of grain size varies throughout the waterway substantially between the channel and sides. More coarse materials are present near outfalls. We calibrated the suspended solids grain size classes by running the model for 10 years to generate the sediment bed surface and picked the input that best matched the existing sediment grain size distribution.

Bill: So, the calibration is based on grain size in bedded sediment in LDW?

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Jeff: Yes, we compared the model pre- and post- for each model cell, and calibrated to input values that didn't change the grain size much, which was most similar to the grain size 10 years prior.

Greg: Looking at the calculations, this is a geometry problem. It's a surface area to volume problem. This was taken from an analysis that King County had performed. The fractional area per mass, which is surface area to mass ratio. As particle sizes are smaller, it's a greater surface area to mass ratio. In columns L through S, it's using the STM. We looked at what entered the LDW and what exited the LDW. What enters the LDW is a proxy for what is suspended in the Green. Columns L and N come directly from the STM, and M and O are percentages as the other columns are 30-year metric ton value. Then we use column I to get column P, which is surface area of particulate entering the LDW measured in km^2. We also estimate the surface area exiting the LDW, and calculated percentage in Column S, which we presented in the last presentation. *[see screen shot of spreadsheet on last page of these notes]*

Jeff: Column J is percent organic carbon. This is the same process for applying chemistry to organic carbon.

Elizabeth: Right, but that calculation stops there and is not used elsewhere right?

Greg: correct

Jeff: But it's the same rationale. The organics are attaching themselves to the organic carbon that's spread around the surface area. So, if there is more surface, there is more organic carbon attached to it. If you do partitioning, you would get the same result, and you could apply a partitioning approach.

Elizabeth: geometry tells you the ratio of surface area to volume and therefore mass is greater for smaller particles. So if you have fraction of organic carbon for each of these size classes, that's a calculation; that's not measured from actual data for each particle size.

Jeff: we do not have real data for the Duwamish or Green, but the graph on slide 8 of meeting 5 is real data and there are 3 to 5 different publications that follow this relationship. The one on slide 8 shows the best relationship, but they all come out in the same range, all based on actual data. The organic carbon applied to our particle sizes follows this relationship.

Elizabeth: I'm not questioning it. I just want to say this is another calculation. This may be relevant later on. But let's just go forward.

Bill: This spreadsheet is telling us that because of the differential settling of each particle, the heaver fractions that have lower concentrations are dropping out and settling in LDW. By the time it gets to the EW, there are more small particles that have higher concentrations. If we apply it to AB for EW, why am I expecting these particles to settle in EW? Will there be differential settling within the EW?

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We know there is relatively little settling in the EW. Does it force us to need to do more analysis of settling within the EW? We don't have much info from West Waterway.

Jeff: it's not like these particles aren't settling. Every one of these particles has lower mass leaving than entering. All materials settle, it's just a higher percentage of class 3 settle. There will be a portion of each class settling in the EW. To not account for it is problematic. We know it is settling, based on the geochronology cores in the EW that were undisturbed. They averaged about a centimeter a year.

Dan: I believe we settled on a net deposition rate of 1.2 cm/year in the SRI Report that was based on the geochron cores.

Bill: do we have grain size data for what is settling?

Dan: we have maps in the SRI showing surface sediment fines percentages, but there is no real pattern.

Debra: We have to remember there is ship traffic that mixes sediment.

Greg: We have to translate this to what is settling and staying. In the below table in the spreadsheet, we used the centrifuge and filtered solids samples. The basic concentrations here use the percentages in Column S from above. We're assuming the organic contamination is associated with surface area, and the overall mass of the sample (kg) would be consistent with the percent of mass, and the contaminant is calculated by taking the input concentration and dividing the sample by the percentages. This is the same relationship as fraction of organic carbon. Row 20 is for QC.

Bill: When we look at the different grain size fractions, a certain percentage of the surface area is Class 1a, 1b, 2, or 3. But then you're using mass in a different part of the calculation, which is confusing. Can you explain why we're using both mass and surface area?

Greg: if you use microgram (ug) of contaminant per kilogram (kg) of sample, 17 ug would be distributed according to the surface area. But then you can translate that distribution into a fraction of mass. So if you then divide the ug of contaminant by the kg of sample, you get ug/kg concentration.

Bill: so the surface area is to calculate total amount of contaminant, and mass is used for sediment mass to calculate concentration.

Greg: yes. You can split it into several steps.

Bill: Yeah that really helped me understand

Jeff: It probably would have been better for us to give you the equations in multiple steps.

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Greg: yeah that is a bit of a mind twister

Bill: is this the first time you've done this, or has it been done before?

Jeff: this is something the County's been working on for modeling the distribution of contaminants off of discharges. Our models track size distributions of solids in the outfall effluent, and we have distributions of particle sizes near outfalls, and we had to try to figure out how to turn that back into concentrations. We have tried different normalizations, absorption, and desorption when comparing chemistry data in effluent solids and nearby bedded sediment. Surface area weighting has been giving us more meaningful results. Effluent also has dissolved constituents, so we have also tried partitioning between dissolved and solids, and this is one way that has been effective in calculating concentrations and addressing kinetics issues.

Bill: ok thanks

Greg: So on with the calculations. Exiting the LDW, the assumption is that concentration vs particle size stays the same and then we are just running a mass weighted average based on new distribution of grain sizes from the STM. You are putting your fingers on where there are some uncertainties about some of these assumptions.

Ravi: Do we have this spreadsheet?

Elizabeth: we have it, but not the exercise Greg added in Columns P through R on the call today. The thing I want to point out is that concentration to mass is always directly proportional to concentration and volume. Carbon doesn't get used, but the calculated carbon content of Class 1a is much smaller than the next class (1b), which should change the density, and that doesn't get accounted for. That may not change it much, but it does change it. The other larger problem in my mind is that it makes sense in theory, but it remains theory without some empirical data backing it up. So, it's more of a consideration that these are the things that could affect it and much less of a factor as something we should use it for a calculation. Any dataset is always subject to uncertainties. We agreed that the suspended sediment dataset is most representative of what could get into the EW, but what this is saying is concentration to volume equals mass, which results in a pretty big difference. This difference supports use of this as an error bar rather than something we would use to derive AB. We have not discussed it internally. This is just my opinion at this point.

Debra: So, you're thinking more of a sensitivity analysis to show that the number of AB could be biased low as an acknowledgement in the sensitivity analysis. Is that right?

Elizabeth: Yes. I expect you would use this as part of the sensitivity analysis anyway. I would like a discussion of the theory of concentration with surface area to mass. That surface area relationship is independent of organic carbon. As the fraction of OC on the particle increases, that will have a wider

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mass. This is a good theory, and it's an interesting exercise, but we don't have anything that's actually resembling this concentration differential in actuality, and that's what troubles me.

Greg: this could provide some context to some of the other sensitivity analysis concentrations that we've actually done. The other fines normalized values we've done look a little bit more reasonable to the analysis we've done.

Debra: I would say this analysis lends support to the importance that our dataset has larger amounts of sand and less fines. It helps support some sort of metric for fines normalization. The simple way is not perfect either, but this analysis helps support looking at a more simplistic fines normalization method.

Elizabeth: I don't want to leave an impression that I think the calculation is unreasonable. I expected from the data that we would see higher concentrations in AB than we are seeing so there is probably a lot of merit to what we've done here and like I've always said, if you get to the same answer using a simple method, simple is better, but this is higher than expected, so there needs to be some empirical data to support this number. If there is data existing that shows that on this site, that would be helpful as well.

Jeff: Is it the Ecology data that looked at fine grained material, and their concentrations were higher?

Elizabeth: There has been data presented throughout this process that supports that assumption.

Jeff: You could theoretically apply this distribution to those actual samples and see how it matches up.

Greg: Do we want to circle into next steps?

Pete: yes it would be great to get next steps.

Dan: We have talked about the merits of this analysis and it appears EPA is leaning toward fines normalization as a sensitivity rather than as an actual measurement for AB. The larger group meeting is January 13. So, we have a couple of options – we could consider additional analysis and regroup one more time, we could agree to just put it in a sensitivity analysis, or third, we know there is some uncertainty, but we could consider the other fines normalization method we looked at that was not perfect, but simpler and fell in between the base case and this particle size analysis. Maybe we can take a moment to hear from EPA about whether that option is possible.

Ravi: I think we need to take time to discuss this internally. I would like notes from this meeting.

Elizabeth: Dan, what you said made sense. The thing with the other fines normalization is it wasn't a different answer, relatively speaking (from the base case). A little bit more data with the surface area

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method could change. The theory itself holds water, but more empirical analysis could help. The answer we're getting with the other fines normalization is so close to the non-normalized method.

Jeff: we look at it a bit different. We see the upstream dataset as biased low, and this analysis is saying it can be quite substantial, but there are uncertainties.

Elisabeth: sure

Jeff: this line of evidence is saying the non-normalized data is biased low by some magnitude and you can't put your finger on it right now so the question is what do you do about it?. Do you do something to address the low bias in some way acknowledging that you don't have the right answer? So we're feeling like doing some normalization might better than none.

Elizabeth: We are all on the same page. It seems likely there is a low bias for a lot of reasons we have discussed in these meetings. The question is, as you say, there is a bias but we can't quantify that bias with a degree of accuracy that I can make an argument I would need to convince my management. I would need more justification for that fudge factor. We all agree we should adjust it, but it's a tough thing to include a calculation for a cleanup goal in a ROD.

Bill: as you think about next steps and whether you want to do further analysis on this, maybe you could look back at the data we've talked about to see if the model is somewhat predictive, but I'm not sure we're able to do enough in a short amount of time that this model would be sufficient to use as a cleanup number. So, if you want to do more analysis, you can, but we may not get to where we are considering all of the factors. So to me, this works as a sensitivity analysis, and suggests we are probably biased low, but more analysis may not change where we go.

Elizabeth: not sure we need a fully developed model but do need something more sophisticated than normalization. Any model is going to have error bars.

Pete: Bill, are you talking about this spreadsheet approach and/or the earlier fines normalization method?

Bill: This surface area model

Elizabeth: As was I

Pete: So, what about the simpler grain size normalization model?

Elizabeth: I never objected to it, but it didn't give us a different answer.

Bill: we can consider whether we're taking the right scientific approach and whether we considered the different factors. And what is the number and does it change. I think for including some accounting for the differences in the grain sizes and behaviors, it does make sense for how we

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understand sediment settling. We'll talk more about this method after the meeting, but it allows us to account for something that is a real phenomenon.

Greg: we are working on the presentation in January and also an annotated outline for the memo, and arsenic is still an open topic, which is the opposite of our PCB concentration, as arsenic is biased high. We'll want to regroup on those as we move into the new year.

Elizabeth: Yes, it's a curiosity, but it's not a remedy problem.

Debra: yes, if you're saying the remedy is going to be the remedy.

Elizabeth: if this theory holds true all the way through, ultimately by the time PCBs and D/Fs equilibrate to a concentration, arsenic concentrations may be higher than what they are now, if that's what's coming into the system. So, it doesn't create a problem for the EWG, as arsenic may end up higher than what we predicted they would be.

Dan: January 13 is the large group meeting and we would like to have the draft presentation to you a week before that. That is our highest priority. We might be able to get an annotated outline out before that meeting, but I don't know if that affects anything at the meeting. So we are targeting providing the draft presentation by January 6, and will follow with an annotated outline to EPA for review after that.

Ravi: We don't have a conclusion here, so you need to be open with that in the presentation. We will talk as much as we can before people leave, but I'm not seeing a solution. I'm thinking we need a couple more meetings.

Elizabeth: Do we have a disagreement? If we relegate this to a sensitivity discussion is that a non-starter for you guys? If ultimately EPA's position was to relegate this analysis to a sensitivity analysis is that a deal breaker for EWG?

Debra: I missed the first part of what you said.

Elizabeth: if ultimately EPA's position is to relegate this surface area analysis to a sensitivity analysis.

Dan: Did you also say we could possibly use the simpler grain size normalization as the base case?

Elizabeth: It is my inclination to say yes

Pete: Yes, I'm OK with that

Jeff: that's OK, it's more important to have this in the write up

Ravi: Alison, anything from you?

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Alison: I'm confused about the info EPA still wants. I'd like to know if EPA believes there are fatal flaws, or are you comfortable with what has been brought forward?

Elizabeth: There are no fatal flaws. The main crux is that this mass to surface area weighting shows a substantial change to the result. We would need more info to justify this substantial change. Absent that, it's a theory that is true to some degree, but we can't quantify it, so this becomes an uncertainty or sensitivity. We could do an adjustment for fines normalization, which is almost inconsequential. The data collected 10 miles upstream is probably biased a little bit low, which is something we'll need to look at going forward post-remedy.

Ravi: We'll need to discuss among ourselves and with the tribes, including about the sensitivity analysis Elizabeth mentions.

Dan: We will provide the draft presentation to EPA hopefully the first few days of the first week of January and follow with the annotated outline later. Regarding meetings, I think we are close, so I'm not sure we need more meetings with the small group. We'll talk more about the potential supplemental analysis we discussed today within EWG, and if we think we need another meeting, or if EPA thinks we need another meeting, I guess we could have more, but I feel like we are pretty close, so I'm not sure we need to meet again.

Elizabeth: I agree, I think we're pretty close.

Ravi: Can you send us the materials from today?

Greg: Yes, I'll send you the updated spreadsheet with the calculations I did today.

Dan: We'll also send you meeting notes from small group meetings 4 and 5 today for your review.

Ravi: OK thanks.

Dan: Happy Holidays everyone.

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Particle Size and Mass Balance Calculation

Class	Particle Size and Surface Area Calculation (From KC)									STM Re Calibration (From LDWG PowerPoint)							
										Mass				Surface Area			
	particle radius (m)	particle diameter (um)	surface area (m2)	volume (m3)	sediment density (kg/m3)	mass (g)	fraction of area per mass (m2/g)	foc	%OC	Entering LDW (30 year; MT)	Entering LDW (PCT)	Exiting LDW (30 year; MT)	Exiting LDW (PCT)	Entering LDW (30 year; km2)	Entering LDW (PCT)	Exiting LDW (30 year; km2)	Exiting LDW (PCT)
1a	5.0E-06	10	3.1E-10	5.2E-16	1,590	8.3E-10	0.377	0.029	2.87	484,800	17%	447,200	56%	182,943	56%	168,755	85%
1b	2.0E-05	40	5.0E-09	3.3E-14	1,590	5.3E-08	0.094	0.007	0.72	1,449,000	50%	302,900	38%	136,698	42%	28,575	14%
2	1.3E-04	260	2.1E-07	9.2E-12	1,350	1.2E-05	0.017	0.001	0.13	300,300	10%	50,800	6%	5,133	2%	868	0%
3	5.4E-04	1,080	3.7E-06	6.6E-10	1,350	8.9E-04	0.004	0.000	0.03	684,200	23%	0.0	0.0	2,816	1%	0	0%
Total										2,918,300	100%	800,900	100%	327,590	100%	198,199	100%

Concentration Calculation

Class	Entering LDW (Concentration Units (e.g., ug/kg))		Exiting LDW (Concentration Units (e.g., ug/kg))	
	Calculation	Value	Calculation	Value
1a	Based on surface-area weighting	57	Same as entering the LDW	57
1b	Based on surface-area weighting	14	Same as entering the LDW	14
2	Based on surface-area weighting	3	Same as entering the LDW	3
3	Based on surface-area weighting	0.6	Same as entering the LDW	0.6
All (Suspended Sediment Sample)	Input	17	Mass-weighted Average	38
	QC (Mass-weighted Average)	17	Percent (Exiting/ Entering)	220%

Calculation Notes

Equation to use for surface area weighting:
Concentration for the Grain Size = Weighted Average Concentration * Fraction Surface Area / Fraction Mass

Way to think about the calculation.
Step 1. For a unit kg of suspended sediment, the total contaminant mass (which equals the weighted average concentration for one kg) times fraction of surface area = the contaminant mass for the particle size. Contaminant mass for each size class is smaller than the starting mass.

Step 2. The particle mass for each size class is less than the total unit kg of sediment, so divide by the fraction of mass to get back units of concentration (contaminant mass divided by particulate mass)

Unit kilogram example calculation for calculating concentrations for class sizes

Class	ug contaminant (proportional to surface area)	kg sediment (proportional to mass)	ug/kg concentration (contaminant/sediment)
1a	9.5	0.17	57
1b	7.1	0.50	14
2	0.27	0.10	2.6
3	0.15	0.23	0.6
Total	17.0	1.0	