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Subject:	Further Crawford Creek CUL Discussion
Start:	Monday, July 12, 2021 2:30:00 PM
End:	Monday, July 12, 2021 4:30:00 PM
Location:	Microsoft Teams Meeting
Attachments:	2021-07-07 Response to 6-9-21 WDNR Email (Part 1) .pdf

Hi Everyone,

Attached to this meeting invitation are responses to prior WDNR comments on the averaging and NAPL topics (per John Sager 6/9/2021 email).

We would like to talk through these items during our scheduled call on July 12.

As a side note, the group is still preparing responses to the WDNR cleanup level and risk assessment comments, so we plan to provide those responses mid next week (Part 2), and then schedule an additional call with WDNR on or about July 19, if that can be arranged.

The proposed agenda for the July 12 call is:

* Sample averaging clarifications
* Data sufficiency
* NAPL/Principal Threat Waste (PTW) discussion

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Responses to WDNR Comments/Requests (John Sager 6/9/2021 email) – Part 1
Crawford Creek and Tributary GLLA Project – Superior, WI

This document provides responses to certain comments and requests submitted via an email from John Sager of WDNR dated June 9, 2021, related to the Crawford Creek and Tributary Great Lakes Legacy Act Project in Superior, WI. Mr. Sager's email was sent in response to a May 26, 2021 conference call between USEPA, Beazer and WDNR, where Beazer presented proposed modified human health risk-based clean-up levels (CULs) for floodplain materials and the use of data averaging for comparison of sample data to CULs. Certain of WDNR's comments/requests (those related to data averaging and NAPL) are repeated below in bold, followed by responses in italics. Responses to the remaining WDNR comments/requests (those related to CULs) will be provided separately.

Slide 9 references NR720.07(2)(b). Although NR720.07(2)(b) allows the use of an alternative approach for determining standards exceedances with DNR's approval, the notes associated with NR720.07.(2)(b) state averaging soil concentrations is not appropriate as the sole method for addressing sites with significant soil contamination.

Response: We are not proposing to use averaging "as the sole method for addressing sites with significant soil contamination." What we are proposing is the use of both depth and area-weighted averaging to represent the concentration of constituents within an exposure area to which a receptor may potentially be exposed and, therefore, to use such average concentrations for comparison to numeric CULs.

As we described in some detail during the May 26, 2021 call, in most settings, over the course of the many years assumed for exposure (in the case of the floodplain, 75-175 days per year[1] for 24 years, equal to 1,800 to 4,200 visits) receptors are assumed to visit different parts of the exposure area, not just a single location. It is the arithmetic average of constituent concentrations in an exposure area that represents the concentration that results from such long-term, repeated exposures. To account for the uncertainty about the arithmetic average, the 95% upper confidence level of the arithmetic average (95UCL) is proposed to estimate potential exposures.

Comparing CULs to constituent concentrations on a point-by-point basis would assume that all of the many visits (in the case of the floodplain, between 1,800 and 4,200 depending upon which site-specific recreator exposure frequency is assumed) result in contact with only a single sampling location. It does not seem reasonable to assume an exposure scenario in which a receptor visits only a single sampling location, or a specific depth interval at a single sampling location, 1,800 to 4,200 times.

There is no evidence that indicates that receptors have in the past, are currently, or would in the future, visit only a single sampling location, or a specific depth at a single sampling location, in the floodplain 1,800 to 4,200 times. The typical assumption of a receptor visiting different portions of the floodplain is supported by the property owner interviews. Consequently, it is our opinion that using a 95UCL for comparison to numeric CULs is a more appropriate approach than comparing data on a point-by-point basis, as it more accurately represents how receptors potentially contact floodplain materials.

[1] 75 days is the site-specific recreator exposure duration proposed by Beazer during the May 26, 2021 conference call. 175 days is the recreator exposure frequency proposed in WDNR's June 2020 CUL memo.

The DNR requests a description of the method of averaging being proposed and specific examples for various areas of the site including an explanation of how exposure units will be defined considering the conceptual site model. The DNR does not typically approve depth averaging.

The overall proposed approach to estimating the 95UCL of the surface area weighed average for an exposure area has several steps. Each of these steps is described in the bullets below and more details regarding the bootstrap methodology discussed below, with an example output file, are provided in Attachment 1.

- *<u>Depth weighted average concentration.</u> For each constituent at each sampling location, the depth weighted average concentration of that constituent is calculated. When constituent concentration data are available for several intervals, the depth weighted average concentration is calculated by weighting the constituent concentration in each interval by the fraction of the length of the entire exposure depth that is comprised by each interval with a constituent concentration. For example, if the 0-0.25' interval has a concentration of 1 ppm and the 0.25-1' interval has a concentration of 10 ppm, the depth weighted average concentration for the 0-1' interval is 7.75 ppm ([0.25'/1' x 1 ppm] + [0.75'/1' x 10 ppm] = 7.75 ppm), not 5.5 ppm, which is the straight arithmetic average concentration of the two sample intervals ([1 ppm +10 ppm]/2 =5.5 ppm). At some sampling locations constituent concentrations were not available for all depth intervals within the exposure depth. In those cases, the concentration in the adjoining interval was assumed to represent the concentration in the interval for which a concentration was not available. Depth weighting can be done for any assumed exposure depth (e.g., 0-1', 0-4').*
- *<u>Surface area weighted average concentration (SWAC).</u> The depth-weighted constituent concentration at each sampling location within an exposure area is weighted according to the fraction of the exposure represented by that sampling location. The area represented by each sampling location is determined using Thiessen polygons (i.e., nearest neighbor). The surface area weighted concentration of each location is used to estimate the SWAC for that exposure area. The table below presents an example SWAC calculation for a hypothetical dataset with eight samples in an exposure area. The table presents the constituent concentration at each sample as well as the fraction of the exposure area represented by each sample location. The arithmetic and surface area weighted average concentrations are presented at the bottom of the table. For this example, the arithmetic average is 3.8 ppm and the SWAC is 4.7 ppm.*
- *<u>Estimating the 95UCL of the SWAC.</u> To account for the uncertainty associated with estimating the SWAC from the available dataset, the 95UCL of the SWAC is calculated using a bootstrap procedure. That procedure uses the area-weighted concentrations to calculate 1,000-5,000 unique SWACs for the dataset, each with a sample size equal to the number of samples in the exposure area, and then selects the 95th percentile of the distribution of SWACs as the 95UCL of the surface area weighted average concentration. For the hypothetical data set shown in the table below, the 95UCL of the SWAC is 6.8 ppm while the 95UCL recommended by ProUCL is 5.8 ppm (note: ProUCL cannot be used to account for this method of area weighting).*

Sample Number	*Fraction of Exposure Area*	*Concentration (ppm)*
1	*0.1*	*1*
2	*0.15*	*1*
3	*0.1*	*2*
4	*0.1*	*2*
5	*0.05*	*4*
6	*0.1*	*4*
7	*0.15*	*6*
8	*0.25*	*10*
Arithmetic Average		***3.8***
SWAC		***4.7***
ProUCL 95% UCL		***5.8***
95% UCL of SWAC (bootstrap)		***6.8***

Consistent with use of the property based on discussions with property owners, we propose the use of three exposure areas, defined based on existing topography and site features:

- *Samples from along the Tributary to Crawford Creek ("Sub-Area A") represent one exposure area;*
- *Samples from the Crawford Creek floodplain above the railroad embankment ("Sub-Areas B and C") represent a second exposure area; and*
- *Samples from the Crawford Creek floodplain below the railroad embankment and upstream of the confluence of Crawford Creek with the Nemadji River ("Sub-Area D") represent a third exposure area.*

Also, the proposed use of average concentrations was not plainly identified as an objective for previous site investigation efforts so it is not clear there will be sufficient data in all exposure areas to justify an appropriate alternative approach such as averaging.

Regarding data sufficiency, it is unclear how the data set would be considered sufficient for a point-by-point approach, but not sufficient for an averaging approach. That said, we believe the existing data set is sufficient to estimate 95UCLs needed to prepare the Focused Feasibility Study. As described above, the proposed approach acknowledges the existence of uncertainty in the true arithmetic average concentration of an exposure area by estimating the 95% upper confidence limit of the SWAC. The difference between the 95UCL and arithmetic average is linked to the size of the data set. Large data sets, presumably with greater certainty, have 95UCLs closer to the arithmetic mean of the data set than do smaller data sets with presumably with less certainty. The key point is that use of the 95UCL accounts for uncertainty of the data set.

Moreover, as pointed out during the May 26, 2021 call, sampling within the floodplain is biased with existing samples preferentially collected from areas assumed to have elevated constituent concentrations. Where samples do not exist along the edges of the floodplain, the averaging approach conservatively assumes that elevated concentrations near the creek bed are also present along the edges of the floodplain (this is a conservative assumption because where there are samples at the edges of the floodplain, they have significantly lower concentrations than samples closer to the creek). If additional *data were collected from portions of the floodplain distant from the creek bed and the measured concentrations were lower than assumed currently by the methodology, the 95UCLs would decrease and the area potentially requiring remediation would also decrease. In other words, the existing data set combined with the spatial averaging approach results in a conservative estimate of exposure.*

Nevertheless, as we have acknowledged in the past, it is anticipated that some additional data may need to be collected as part of a pre-design investigation, once a remedy has been selected. Such additional data collection may be necessary regardless of whether a point-by-point or area-weighted averaging approach is used.

Identify how the averaging concept will account for the presence of nonaqueous phase liquid (NAPL), that is, principal threat waste that requires active remediation.

Response: Analytical data exist for much of the area where NAPL impacts have been mapped. As such, analytical data from NAPL-impacted media would be used for data averaging the same as analytical data from non-NAPL-impacted media. For NAPL-impacted areas where analytical data do not exist, it can be conservatively assumed that such areas would exceed one or more numeric CULs.

With respect to the comment regarding principal threat waste (PTW), we are not aware of any reference to this in NR 700. To date, there has been no discussions regarding PTW as it pertains to NAPL, and as such there has not been a determination at this site that NAPL is a PTW.

As described in EPA guidance (1991, 1997[2]), the mere presence of NAPL does not automatically trigger a PTW designation. NAPL can appear in many different forms, and the physical and chemical conditions at a site—specifically sites with fine-grained material and low hydraulic conductivity (like the Crawford Creek floodplain materials)—have a significant influence on the mobility of NAPLs. The visual observation of "blebs, globules, small nodules, or thin stringers" does not indicate that the NAPL will be highly mobile or cannot be reliably contained. The 1991 guidance also states:

> *"Principal threat wastes are those source materials considered to be highly toxic or **highly mobile** that generally **cannot be reliably contained** or would present a significant risk to human health or the environment should exposure occur."*
>
> *"Other source materials can be safely contained and that treatment for all waste will not be appropriate or necessary to ensure protection of human health and the environment, nor cost effective."*

For NAPL identified at depth in the Crawford Creek floodplain, data collected during prior investigations indicates it is not highly mobile, due in part the low hydraulic conductivities associated with the presence of extensive dense clays. With regard to NAPL present in shallower materials of the floodplain, remedial options are available that have been proven effective at other sites to effectively contain the NAPL in place (e.g., placement of a reactive cap along the banks and bottom of Crawford Creek to mitigate the potential for NAPL present in the shallow floodplain materials from entering the Creek). We consider the use of a cap to be active remediation.

In addition, the following Remedial Action Objective has been established for NAPL: "Address the potential for exposure to DNAPL and sheens." The FFS will evaluate a range of remedial alternatives/actions to achieve this RAO.

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[2] *A Guide to Principal Threat and Low Level Threat Wastes* (USEPA 1991); *Rules of Thumb for Superfund Remedy Selection* (USEPA 1997).

The DNR requests full citation for the references shown in the various slides presented during the May 26, 2021 meeting:

- **Slide 10 – "EPA guidance supports depth-weighted averaging (USEPA 1996)"**

  USEPA 1996. Soil Screening Guidance: User's Guide, April 1996. Office of Solid Waste and Emergency Response: Washington, DC, EPA/540/R-96/018.

- **Slide 11 – "EPA guidance supports averaging across an exposure area (USEPA 1992)"**

  USEPA 1992. Supplemental Guidance to RAGS: Calculating the Concentration Term. Guidelines for Exposure Assessment. U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC, EPA/600/Z-92/001, 1992.

Attachment 1 – Bootstrap Methodology Details and Example Output File

Beazer proposes to use a bootstrap methodology for estimating the 95% upper confidence limit of the arithmetic average (95UCL) of a dataset used to represent the concentration of a constituent in an exposure area. The proposed bootstrap methodology weights the probability of selecting each sample concentration used to estimate an arithmetic average concentration for an exposure area. Each sample's weighting is based on the fraction of the exposure area each sample is assumed to represent. The area of the floodplain represented by each sample location is determined using Thiessen polygons[1]. Thus, in the proposed bootstrap methodology, each concentration does not have an equal chance of being "sampled"; instead, its chance of being sampled depends on the fraction of the exposure area it represents (samples representing a larger portion of the exposure area have a greater chance of being "sampled" than samples representing a smaller portion of the exposure area). The resulting 95UCL from the proposed bootstrap methodology represents a surface area weighted average concentration (SWAC)[2].

An example of an output from the Arcadis bootstrap model for TCDD-TEQ in Area D for the 0-1' depth interval is provided in Table 1. A summary of each column in Table 1 is presented below:

- Polygon ID: List of all polygons within Area D.
- Result: The 0-1' depth-weighted TCDD-TEQ concentration (ND=1/2DL) in ng/kg assigned to each polygon.
- D_result: Detect flag (1=detect, 0=non-detect). This is an internal bookkeeping designation. All values are 1 given it was assumed that the concentration of not detected congeners were equal to one-half the detection limit when deriving the TCDD-TEQ concentration of a sample.
- Weight: the fraction of Area D comprised by the polygon representing that sample location.
- Wtd Conc: (result column) x (weight column). Note that samples in the output table are rank ordered based on the quantity in this column.
- 95 UCL: 95UCL using the bootstrap statistical method. The top green cell, 28.23 ng/kg, is the 95UCL of the SWAC of all polygons in Area D (i.e., no polygons are assumed to be remediated). The subsequent rows present residual 95UCL of the SWAC assuming the sample in the row associated with the 95UCL, and all samples in the rows above this sample and row, have been remediated and replaced with a non-detect concentration (i.e., a value equal to lowest congener-specific full detection limit in the subject dataset). For example, in Table 1, the 95UCL of 16.61 ng/kg (the cell immediately below the green cell) is the SWAC assuming that one polygon has been remediated (CF-01-C).
- Sum of Weighted Replacements: Successive sums of the fractions from the "weight" column. The fraction shown in each row is equal to the sum of the polygon areas with a greater weighted concentration (Wtd Result). Effectively, this column represents the fraction of the total area of samples/polygons that need to be remediated to achieve the 95UCL of the SWAC shown in the adjoining 95UCL column.

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[1] The Thiessen polygon geostatistical approach involves using software (for example, ArcGIS) to draw polygons within an overall area of interest (e.g., the floodplain) so that each polygon contains one sample point, and the area within that polygon is closer to that point than it is to any other sample location. All soil within a polygon is then assumed to have the same concentration as that polygon's sample point. This approach reflects the underlying assumption that the concentration of a compound in soil can be represented by the sample point closest to that location. Note that software-generated Thiessen polygons were used for floodplain samples in Sub-Areas B, C, and D. For Sub-Area A, where samples were collected from transect lines extending relatively short distances up the steep tributary banks, polygons were manually drawn rather than using ArcGIS software.

[2] USEPA's ProUCL software includes a bootstrap method for estimating the 95UCL of a dataset used to represent the concentration of a constituent in an exposure area. However, in USEPA's ProUCL software, each sample concentration has an equal probability of being selected when estimating the arithmetic average concentration of a dataset (i.e., it does not account for surface area weighting).

Table 1. Example Bootstrap output
Area D: Depth and Area Weighted 0-1': 2,3,7,8-TCDD TEQ (ND=1/2 DL)
Superior Off-Site

					95 UCL *	Sum of Weighted Replacements
PolygonID	Result	D_Result	Weight	Wtd Conc (sorted)	28.23	0
CF-01-C	326	1	0.012521105	4.081880177	16.61	0.012521105
CF-01-D	80.125	1	0.016311576	1.306965046	14.53	0.028832681
CF-06-B	19.3	1	0.062117358	1.198865002	13.37	0.090950039
CF-07-A	19	1	0.05000539	0.950102418	12.49	0.140955429
CF-01-B	93.1	1	0.009709683	0.903971506	9.81	0.150665112
CF-08-D	5.41	1	0.130835594	0.707820565	9.27	0.281500706
FP-01	36.4	1	0.018751133	0.682541235	8.31	0.300251839
CF-03-A	12.44	1	0.052595424	0.654287072	7.67	0.352847263
CF-06-D	8.5	1	0.076139449	0.647185313	6.97	0.428986712
CF-06-A	7.605	1	0.061954114	0.471161034	6.49	0.490940825
CF-07-B	16.7	1	0.025777537	0.430484865	6.04	0.516718362
CF-05-B	22.605	1	0.017663745	0.399288962	5.57	0.534382107
CF-05-C	31.3	1	0.010860165	0.339923168	5.00	0.545242273
CF-05-D	13.235	1	0.024614177	0.325768636	4.46	0.56985645
CF-02-B	18.355	1	0.014416139	0.264608228		0.584272589
SO-D04	58.2	1	0.004255275	0.24765699		0.588527863
CF-01-A	5.88	1	0.041109655	0.241724773		0.629637519
CF-10-B	2.835	1	0.084349826	0.239131757		0.713987345
CF-04-B	6.14	1	0.036058353	0.221398285		0.750045697
SO-D06	55.735	1	0.003767644	0.209989644		0.753813341
SO-D02	2.975	1	0.065560549	0.195042634		0.819373891
SO-D03	14.515	1	0.010529342	0.1528334		0.829903233
SO-D01	3.595	1	0.032135713	0.115527887		0.862038945
CF-09-A	1.28	1	0.086124797	0.11023974		0.948163742
CF-03-C	12.45	1	0.008204045	0.102140366		0.956367787
SO-D05	14.525	1	0.007003366	0.101723889		0.963371153
CF-02-C	6.41	1	0.012589956	0.080701619		0.975961109
CF-03-E	2.9045	1	0.024038891	0.069820958		1

Note: 95UCL calculations stopped once the WDNR Non-Industrial RCL of 4.8 ppt was achieved.