Stantec

Memo

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Reference: **Calculation of the Weighted Running Average Concentration for Surface Water under Baseline Conditions**

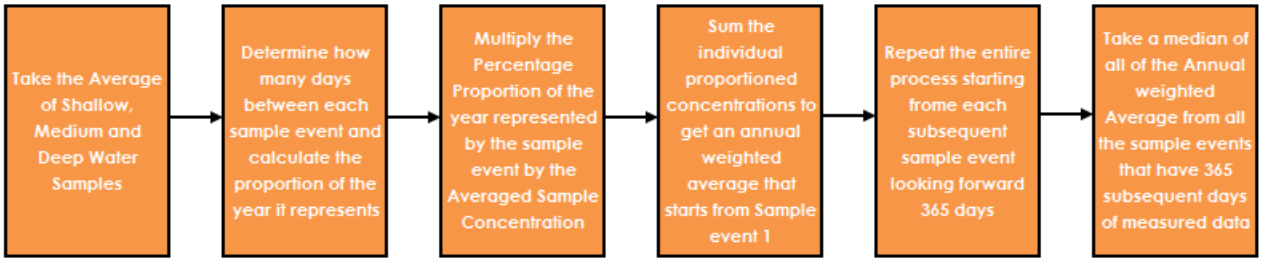
INTRODUCTION

This technical memo has been prepared in response to information requests from the Canadian Environmental Assessment Agency (CEAA) and Health Canada (IR#'s CEAA-028 and HC-028). The information request states:

> "*Annual average surface water quality results were used to screen for metals in surface water. Health Canada guidance recommends use of the maximum observed concentrations to account for seasonally elevated concentrations. Complete the COPC screening for surface water using maximum observed concentrations or provide a rationale for use of average surface water quality results.*"

This technical memo provides a description of how the annual weighted running average concentrations of metals in surface water are calculated and is intended to support the rationale used to justify the suitability of these values for use in the chemical screening process used in the Human Health and Ecological Risk Assessment (HHERA). The Baseline Case concentrations of Chemicals of Potential Concern (COPC)s in surface water used the HHERA were based on a an annual weighted average of surface water, calculated from water sample data collected between 2012 and 2014. Since water samples weren't taken at regular intervals over the almost two years (one year eleven months) of measured water data, a proportioning system was used that assigns a percentage weight to the measured concentrations over the course of 365 days, starting from each sample event. Below is an example calculation of the weighted running average based on water samples from Jacko Lake.

STEP BY STEP PROCESS



The calculation of annual weighted average metal concentration in surface water is a six step process as indicated above. The calculations used in each step of the process are discussed below and sample calculations for each step are provided below.

Reference: Calculation of the Weighted Running Average Concentration for Surface Water under Baseline Conditions KGHM Ajax Air Quality Modelling: CALPUFF to CALPOST Step By Step Guide

Step 1:

Shallow, medium and deep water samples were collected from Jacko Lake. The average of these samples was taken to find a single averaged concentration for each metal, from each time step, that takes into account the different water depths. Due to the depth of Peterson Creek (locations PC02 and PC2.3) only surface water samples were collected from those sample sites. For Peterson Creek sample locations PC02 and PC2.3, step 1 was omitted. All other calculations steps (2 – 6) in this memo were used in the Peterson Creek surface water samples. The results of each of the three surface water sample locations (Jacko Lake, PC02 andPC2.3) were analyzed independently in the human health risk assessment. The following example calculations are based on aluminum. However, the process of finding an annual weighted average was the same as the example calculations for all types of metal.

Table 1 Averaging Sample Depths from Jacko Lake

Sample event #	Sample Date	JACL-S (µg/L) (A)	JACL-M (µg/L) (B)	JACL-D (µg/L) (C)	JACL-Average (µg/L) D = (A + B + C)/3
1	1/10/2012	0.003	---	0.003	0.003
2	2/13/2012	0.003	---	0.003	0.003
3	3/7/2012	0.003	---	0.003	0.003
4	4/26/2012	0.003	---	0.003	0.003
5	5/3/2012	0.0034	---	0.003	0.0032
6	7/11/2012	0.0012	---	0.001	0.0011
7	8/8/2012	0.0011	---	0.001	0.00105
8	9/6/2012	0.0013	---	0.001	0.00115
9	11/6/2012	0.0016	---	0.0011	0.00135
10	1/9/2013	0.001	---	0.001	0.001
11	2/7/2013	0.001	---	0.0012	0.0011
12	5/8/2013	0.0015	---	0.001	0.00125
13	9/4/2013	0.001	---	0.001	0.001
14	11/7/2013	0.0013	---	0.001	0.00115
15	1/9/2014	0.001	---	0.001	0.001
16	4/28/2014	0.001	---	0.001	0.001
17	5/13/2014	0.0011	---	0.001	0.00105
18	5/26/2014	0.0011	---	0.001	0.00105
19	6/10/2014	0.0014	---	0.001	0.0012
20	6/27/2014	0.0093	---	0.0021	0.0057
21	7/8/2014	0.001	---	0.001	0.001
22	7/22/2014	0.0015	---	0.001	0.00125
23	8/7/2014	0.0017	---	0.0011	0.0014
24	8/20/2014	0.0018	0.0019	0.001	0.001566667
25	9/14/2014	0.0013	0.0013	0.0011	0.001233333
26	9/30/2014	0.0013	0.001	0.0019	0.0014

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Step 2:

The number of days between sample events was calculated. For example, between the first and second sampling date (1/10/2012 and 2/13/2012) there are 34 days. The amount of days between the samples was divided by 365 to find out what percentage of the year was accounted for by each sampling event. This entire process was repeated for Jacko Lake and both of the Peterson creek water sample sites.

Table 2 Proportion of year per Sample Event Calculation

Sample event #	Sampling Date	Days between sampling (E)	Portion of year between sampling F = E / 365
1	1/10/2012	34	9%
2	2/13/2012	23	6%
3	3/7/2012	50	14%
4	4/26/2012	7	2%
5	5/3/2012	69	19%
6	7/11/2012	28	8%
7	8/8/2012	29	8%
8	9/6/2012	61	17%
9	11/6/2012	64	18%
Total		365	100%

Step 3:

The measured surface water concentrations from each sample date is then multiplied by the portion of the year it represents. For example, sample event 1 account for 9% of the year. The average concentration of the shallow, medium and deep water samples (0.003) is multiplied by the portion of the year (number of days divided by 365), which results in a weighted concentration for aluminum of 0.00279452 µg/L .

Table 3 Sample Weighting Calculation for Aluminum in Jacko Lake

Sample event #	Sampling Date	Averaged concentration (µg/L) (D)	Portion of year between sampling (F)	Proportioned Concentration (µg/L) G = D × F
1	1/10/2012	0.003	9%	0.000279452
2	2/13/2012	0.003	6%	0.000189041
3	3/7/2012	0.003	14%	0.000410959
4	4/26/2012	0.003	2%	5.75342E-05
5	5/3/2012	0.0032	19%	0.000604932
6	7/11/2012	0.0011	8%	8.43836E-05
7	8/8/2012	0.00105	8%	8.34247E-05
8	9/6/2012	0.00115	17%	0.000192192
9	11/6/2012	0.00135	18%	0.000236712

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Step 4:

Next, the different proportions of concentrations are summed to give a total annual weighted average of the surface water concentrations that start from that sample date for the subsequent year. In this example it is the sum of the proportioned samples 1 through 9 for a final annual weighted average of 0.0021386 that now represent the annual weighted average of sample event 1.

Table 4 Summed Proportion of Aluminum Concentrations in Jacko Lake to find Annual Weighted Average

Sample event #	Sampling Date	Proportioned Concentration (H) = Weighted Sample Event (1+ 2+ 3+ 4+ 5+6+ 7 + 8 + 9) (µg/L)
1	1/10/2012	0.000279452
2	2/13/2012	0.000189041
3	3/7/2012	0.000410959
4	4/26/2012	5.75342E-05
5	5/3/2012	0.000604932
6	7/11/2012	8.43836E-05
7	8/8/2012	8.34247E-05
8	9/6/2012	0.000192192
9	11/6/2012	0.000236712
Total		**0.00213863**

Step 5:

This process is repeated starting with the second (then third, and forth and so on) sample event for the subsequent 365 days to get a weighted annual average that starts from every sample event until there aren't enough days to complete a yearly running average. There were a total of 14 yearly running averages. The previous table shows the annual weighted average starting from sample event 1 and runs till sample event 9 for a total of 365 days. The table below follows the same steps as outlined above but starts with sample event 2 and runs till sample event 10 to account for 365 days. This process is repeated for each sample event until there aren't enough subsequent days from the sample date to complete an annual weighted average.

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Table 5 Annual Weighted Average Calculation for Aluminum in Jacko Lake Starting from Sample Event 2

Sample event #	Sampling Date	Days between sampling (A)	Portion of year between sampling B = A / 365	Averaged Measured Concentrations (µg/L) (C)	Proportioned Concentration (µg/L) D = B × C
2	2/13/2012	23	6%	0.003	0.000189041
3	3/7/2012	50	14%	0.003	0.000410959
4	4/26/2012	7	2%	0.003	5.75342E-05
5	5/3/2012	69	19%	0.0032	0.000604932
6	7/11/2012	28	8%	0.0011	8.43836E-05
7	8/8/2012	29	8%	0.00105	8.34247E-05
8	9/6/2012	61	17%	0.00115	0.000192192
9	11/6/2012	64	18%	0.00135	0.000236712
10	1/9/2013	34	9%	0.001	9.31507E-05
Total	Total	365	100%	0.01985	0.001952329

Step 6:

Lastly, the median of all of the annual weighted averages from each of the sample event is taken to find the final surface water concentration used in the HHRA. In total there were 14 sample events that the annual weighted average could be calculated for.

Table 6 Median of all Annual Weighted Averages of Aluminum in Jacko Lake from all Sample Events

Sample Date	365 day Forward Running Average of Water Concentrations (µg/L)
1/10/2012	0.00213863
2/13/2012	0.001952329
3/7/2012	0.001826301
4/26/2012	0.001573699
5/3/2012	0.00153726
7/11/2012	0.001166575
8/8/2012	0.001178082
9/6/2012	0.001192603
11/6/2012	0.001167534
1/9/2013	0.001132055
2/7/2013	0.001132055
5/8/2013	0.001107397
9/4/2013	0.001229178
11/7/2013	0.001296575
Median	**0.00121089**

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SUMMARY

The annual weighted average was calculated to account for the water samples being taken in at dates that were not evenly distributed in each of the three surface water sample locations used in the Human Health Risk Assessment. The goal was to use the two years of measured data to get water concentrations that are representative of the overall baseline concentrations present in surface water. This same process was used for all other surface water locations.

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