Appendix 2 - Site Characterisation

Biochar based capping of polluted sediment

Biokolbaserad reaktiv barriär för täckning av förorenade sediment

Luleå tekniska universitet

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Appendix A - Pictures and tables

1. Background

Luleå University of Technology (LTU), together with the Norwegian Geotechnical Institute (NGI) and Skellefteå municipality, is carrying out a pilot project funded by the Swedish Geological Survey (SGU) within the framework of the Governments mission *Contaminated Sediments (förorenade sediment)*. The pilot project regards the use of a biochar-based reactive barrier to cover contaminated sea sediments.

As part of the project, a pilot field experiment was carried out to cover a small area of sediment with a mixture of biochar (as reactive agent), bentonite (as the structural material) and salt (to facilitate the sedimentation of the material). The experiment was executed in the bay of Bureå outside an old industrial area, where Bure Träslip operated a wood grinding industry from 1928 until 1992. Wood pulp impregnated with the impregnation agent *Pulpasan,* containing methylmercury, has been transported into the Bay, and the sediment has also been contaminated with different PAH due to the trafficking of the bay during the time in which Bure Träslip was active. The sediment also contains high concentrations of trace elements.

This report will present the field work that was performed in the bay of Bureå in November 2020 in order to characterise the sea bottom and select an appropriate location for the field work.

2. Sampling of the sites

2.1 Site description

On the 11th of November 2020, sea sediment samples were collected in the Bay outside of Bureå. The aim with this field sampling is to evaluate in which area it is most suitable to perform a future pilot covering test. For this, sediment samples were collected and analysed for metals, PAH, and methylmercury.

The investigation sites are shown in Figure 1, and the sampling was performed within 3 areas: the test area (Testområde, orange grid), the reference area (Referensområde, yellow grid), and the backup area (Referensområde reserv, purple grid). Each area was subdivided into a grid of 30x30 meters where sediment was sampled from 9 locations withing each grid. The sampling sites was reached by boat and coordinates for the sampling locations had been transferred to the Boat's GPS system and could be navigated to and found with high accuracy.

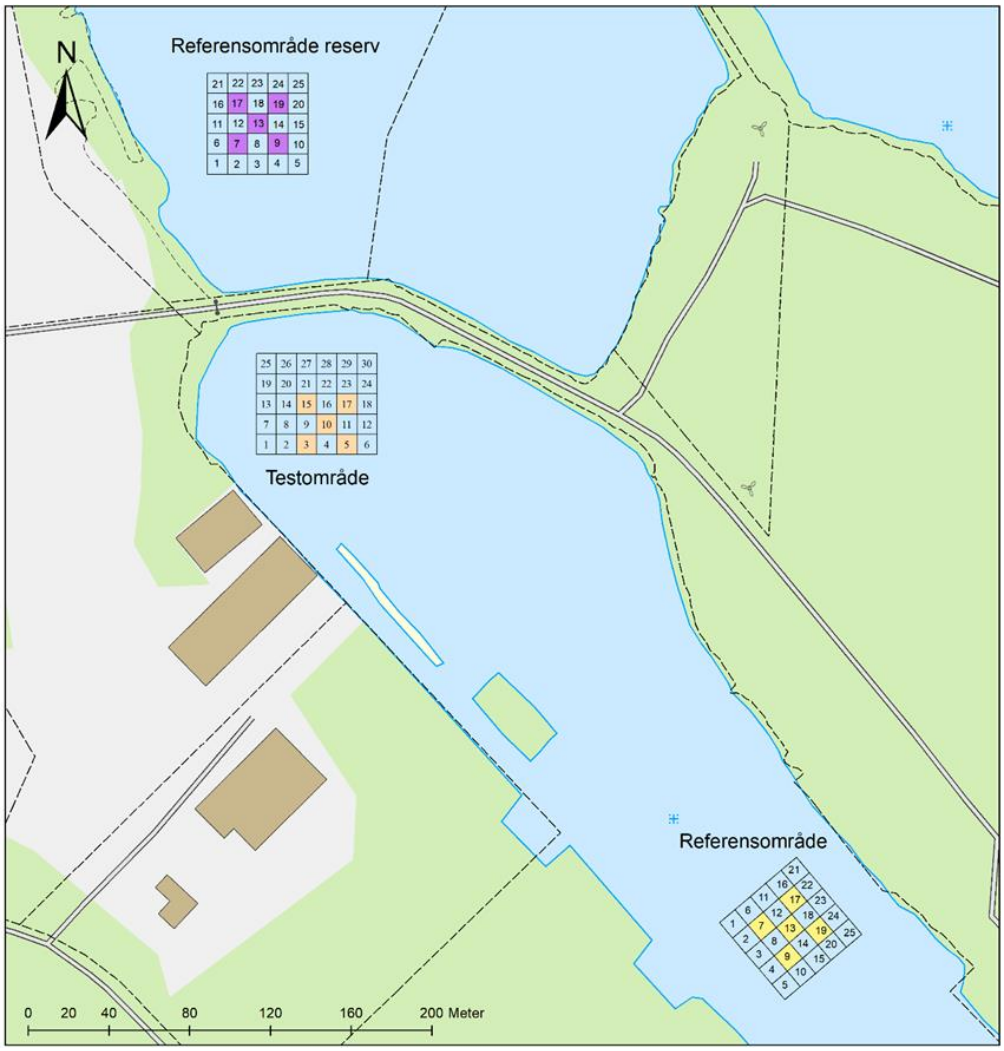

Figure 1 *Map of the Bureå bay with the three sampling locations: The reference area (yellow grid), the test area (orange grid), and the backup area (purple grid) (Ramboll, 2021).*

For the reference area, sediment was collected from locations 7, 8, 9, 12, 13, 14, 17, 18, and 19 within the grid (see Figure 1). For the test area, sediment was collected from locations 3, 4, 5, 9, 10, 11, 15, 16, and 17. For the backup area, sediment was sampled from locations 7, 8, 9, 12, 13, 14, 17, 18, and 19. Composite samples were generated for each area, and 5 single samples were collected and analysed separately to address the spatial variation of the different elements. The locations within the grids highlighter in yellow, orange, and purple (Figure 1) represents the samples that were later sent to analysis.

2.1.1 Sampling procedure

The following described procedure was performed at each sampling location.

The sediment samples were collected with a Van Veer grabber, which was rinsed with sea water in between each sampling. The collected sediment was then poured into a rinsed plastic container and then stirred with a shovel to homogenise the sample. Sediment from each location within the respective area was first sampled in one plastic jar and one glass jar for later metals and PAH analysis.

The remaining sediment in the plastic container was then evenly distributed into eight buckets of 15L, and 1 scoop of sediment was collected in a smaller bucket (see Figure 2) to generate a general composite sample for each area. For each area, the mixed composite sample collected in the smaller bucket (sediment from the 9 locations within the sampling area) was collected in one glass jar and one plastic jar for later metal and PAH analysis.

Samples from some of the locations were documented with pictures showing different colours and texture of the sediment. The undisturbed sediment had a dark brown/black colour and some of the samples had a light brown coloured layer on the top (see Figure 8 in appendix). The sediment varied in texture between the locations, where some of the samples had a firmer texture while others were looser with visible branches and organic material. See appendix for more images from the sampling.

Figure 2 Sampling of sediment in the Bureå Bay (Flodin, 2020).

2.1.2 Sediment analysis

Analysis was performed by ALS Scandinavia AB in Luleå. 10 samples were collected from each area (9 single samples and 1 composite sample), whereas only 6 samples from each area were sent to analysis (5 single samples and 1 composite sample). The samples sent to analysis can be viewed in Table 1 where the three mixed samples are labelled: REF-SAM (reference area), TEST-SAM (testing area), and B-SAM (backup area).

Table 1 Collected samples and chosen analysis.

Sample	Sample type	Area	PAH	Metals	Methyl-Hg
REF-7, REF-9, REF-13, REF-17, REF-19	Single samples	Reference	X	X	X
TEST-15, TEST-17, TEST-10, TEST-3, TEST-5	Single samples	Test	X	X	X
B-7, B-9, B-13, B-17, B-19	Single samples	Backup	X	X	X
REF-SAM	Composite sample	Reference	X	X	X
TEST-SAM	Composite sample	Test	X	X	X
B-SAM	Composite sample	Backup	X	X	X

PAH analysis

OJ-1 PAH (EPA-PAH, 16 st) analysis was performed for the sediment collected in the glass jars, and for the composite samples REF-SAM, TEST-SAM, and B-SAM. The samples were dried at 105 degrees Celsius and analysed for polycyclic aromatic hydrocarbons (PAH) measured in mg/kg dry substance (mg/kg TS). For more detailed information about the analysis package, visit alsglobal.se (see Figure 11 in Appendix).

Metals and methylmercury analysis

MG-1 (metals) analysis was performed for the sediment collected in the plastic jars, and for the composite samples REF-SAM, TEST-SAM, and B-SAM. The samples were dried at 105 degrees Celsius and analysed for dry substance, oxides, silicates, and for content of various trace elements measured in mg/kg dry substance (mg/kg TS). For more detailed information about the analysis package, visit alsglobal.se (see Figure 12 in appendix). Some of the metals included in the MG-1 analysis were mercury, arsenic, copper, lead, sulphur, cobalt, chromium, zinc, and cadmium.

MeHg (methylmercury) analysis was also performed for the samples collected in the plastic jars and for the composite samples. The samples were dried at 105 degrees Celsius and analysed for dry substance and concentration of MeHg measured in ng/g dry substance (ng/g TS).

2.1.3 Data evaluation

The concentration of selected trace elements in the sediment are compared with guideline values in report 4913 and report 4914 (1999) by Naturvårdsverket. Table 2 shows guideline values for some metals in Swedish limnic sediment.

Table 2 *Assessment criteria for inorganic elements in limnic sediment in mg/kg dry substance, report 4913 (Naturvårdsverket, 1999).*

Element	Class 1	Class 2	Class 3	Class 4	Class 5
mg/kg dry substance	Very low concentration	Low concentration	Mediate concentration	High concentration	Very high concentration
Cu	< 15	15 - 25	25 – 100	100 - 500	> 500
Zn	< 150	150 - 300	300 – 1000	1000 - 5000	> 5000
Cd	< 0.8	0.8 - 2	2 – 7	7 – 35	> 35
Pb	< 50	50 – 150	150 – 400	400 - 2000	> 2000
Hg	< 0.15	0.15 – 0.3	0.3 – 1.0	1.0 – 5	> 5
Cr	< 10	10 – 20	20 – 100	100 - 500	> 500
Ni	< 5	5 – 15	15 – 50	50 – 250	> 250
As	< 5	5 – 10	10 – 30	30 – 150	> 150

Table 3 shows guideline values for some metals in sea sediment.

Table 3 *Assessment criteria for inorganic elements in sea sediment in mg/kg dry substance, report 4914 (Naturvårdsverket, 1999).*

	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
FA	1000	1000	10000	2500	50	1000	2500	2500
Class 1	<10	<0,2	<40	<15	<0,04	<30	<25	<85
Class 2	10-17	0,2-0,5	40-48	15-30	0,04-0,12	30-45	25-40	85-128
Class 3	17-28	0,5-1,2	48-60	30-50	0,12-0,4	45-66	40-65	128-204
Class 4	28-45	1,2-3	60-72	50-80	0,4-1	66-99	65-110	204-357
Class 5	>45	>3	>72	>80	>1	>99	>110	>357

To evaluate concentrations measured by the PAH analysis, report 2017:12 by SGU (Sweden geological survey) is used. The classification system is based on measured concentrations of organic pollutants in Swedish sediments, and the report is an updated version of the classification made by The Swedish Environmental Protection Agency (Naturvårdsverket) in 1999 (report 4914 – *bedömningsgrunder för miljökvalitet – kust och hav*). **Table 5** and **Table 6** in appendix shows the classification of PAHs (SGU 2017:12).

Concentrations of different elements are also compared with effect-based limit values, found in report 2018:31 by Havs- & Vatten myndigheten. The classification system presented in report 2018:31 gives limitation values for different elements, in which if they are exceeded can cause hazard regarding toxicity for organisms living in sediment (table 1 in report 2018:31). The effect-based limitation values are based on toxic effects on sediment living organisms.

However, the guideline values (report 2017:12, 4913 and 4914) and the effect-based limitation values (report 2018:13) does not include information for all elements, and therefore not all the elements that has been analysed can be compared with the tables in these reports.

3. Result

In the following sections, the results from the analysis performed for the sediment samples are presented.

In this section, results from the different analysis performed by ALS global are presented in tables and figures. Graphs showing the variations in concentrations of As, Cu, Pb, Hg, Zn, methyl-Hg, and S within the areas are presented in appendix A.

Table 7, 8, and 9 in appendix A show the result for the MG-1 analysis from the three areas, including some of the chosen metals in mg/kg dry substance.

3.1 Result metal analysis

Figure 3 and Figure 4 are two different graphs showing the average concentrations of As, Cd, Cr, Cu, Hg, Ni, Pb, and Zn for the three areas. Observe that the figure has a logarithmic scale. The average values do not include the composite samples (REF-SAM, TEST-SAM, B-SAM).

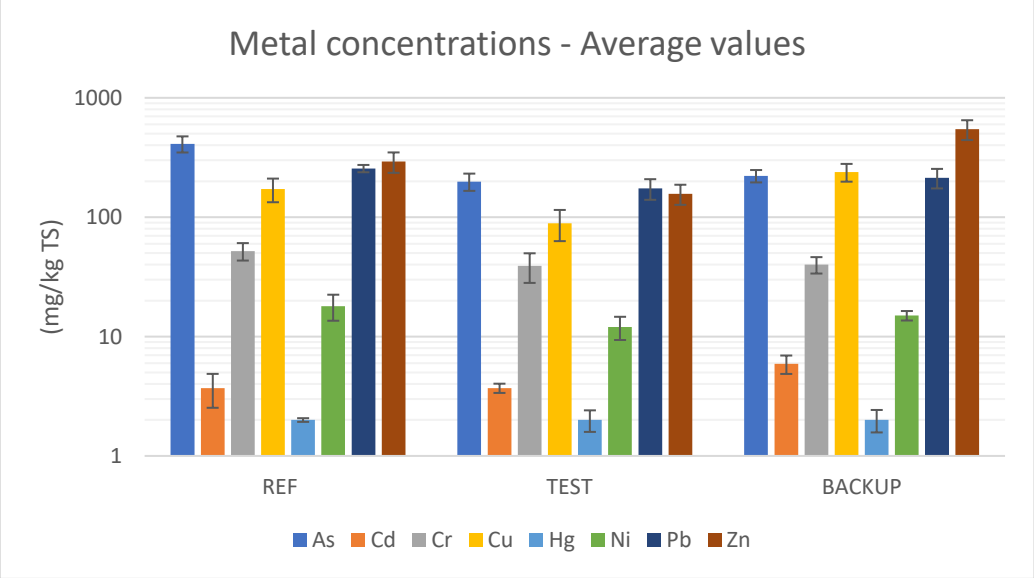

Figure 3. Average values of arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc (mg/kg dry substance) with standard deviation for the three areas, logarithmic scale.

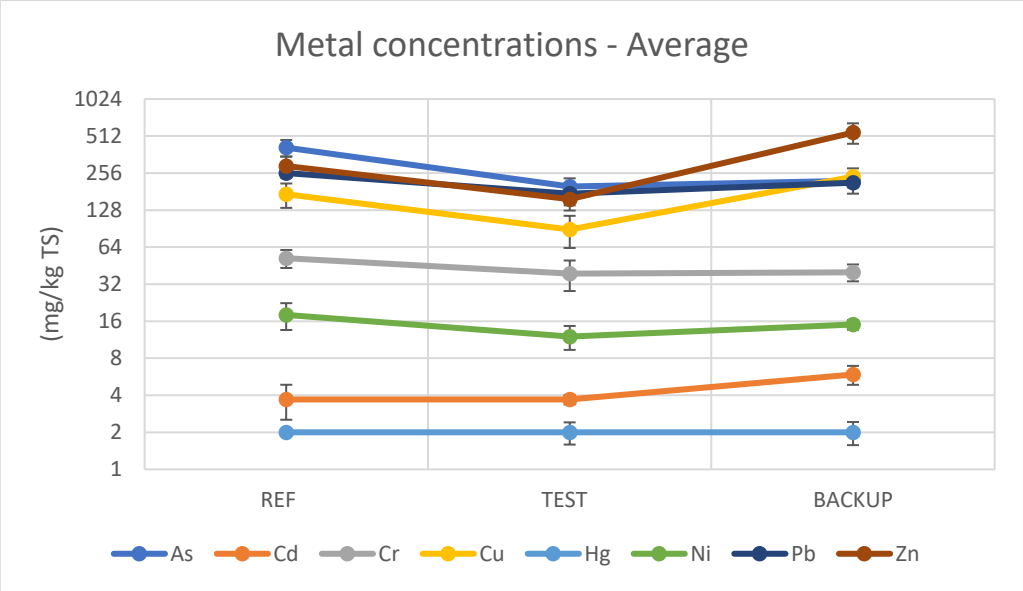

Figure 4. Average values of arsenic, cadmium, chromium, copper, mercury, nickel, lead, and zinc (mg/kg dry substance) with standard deviation for the three areas.

The average levels of arsenic, lead, chromium, and nickel are more elevated in the reference area compared to the other areas, while the concentrations of cadmium, copper, and zinc are more elevated in the backup area. The average level of mercury is approximately the same in all areas (around 2 mg/kg TS). The test area shows the lowest concentrations of copper, arsenic, lead, nickel, and zinc. Average levels of sulphur are shown in Figure 5.

The individual element concentrations in Table 7, Table 8, and Table 9 in appendix are compared to the guideline values in Table 3. In all three area, concentrations of As, Cd, Hg, and Pb exceeds *very high* concentrations, and Ni is found in *very low concentrations*. In the **reference area**, Cu and Cd are found in *high* to *very high* concentrations, and Cr is found in *low/mediate* to *high* concentrations. In the **test area**, Cu shows *high* to *very high concentrations,* and Cr *low* to *mediate concentrations.* The backup area has *very high concentrations* of Cu and *very low* to *low concentrations* of Cr.

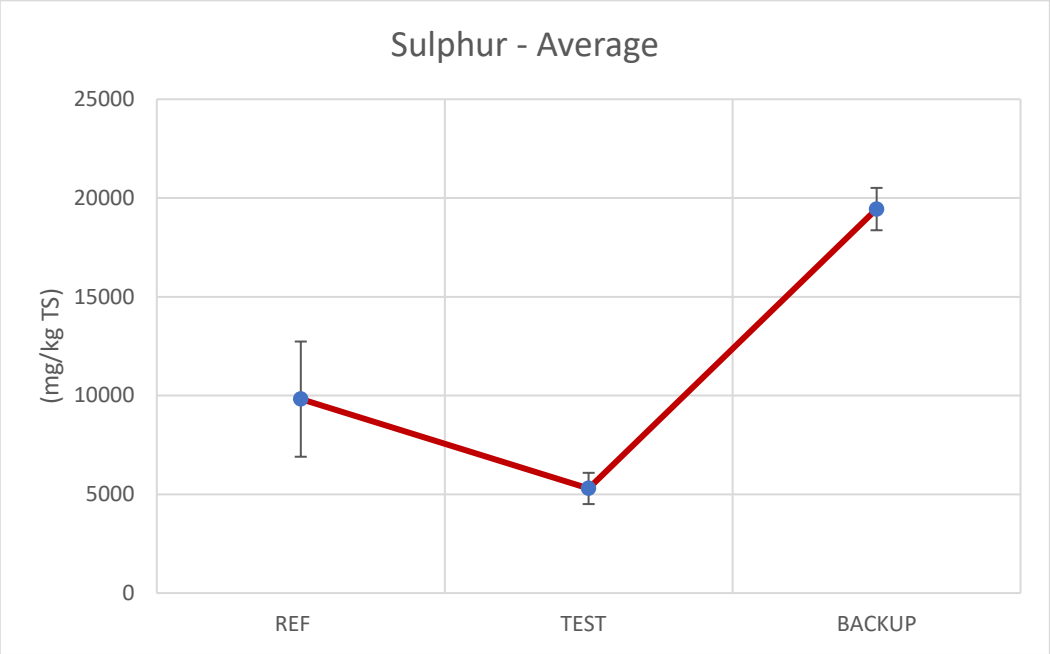

Figure 5. Average values of sulphur in the three areas (mg/kg dry substance) with standard deviation.

The result presented in figure 5 shows that the average sulphur concentration is elevated in the backup area. The lowest concentrations are found in the test area. The standard deviation (variability) is the largest for the reference area.

Table 10 in appendix shows the result for the MeHg analysis for the three areas. Figure 6 shows the average methylmercury concentrations.

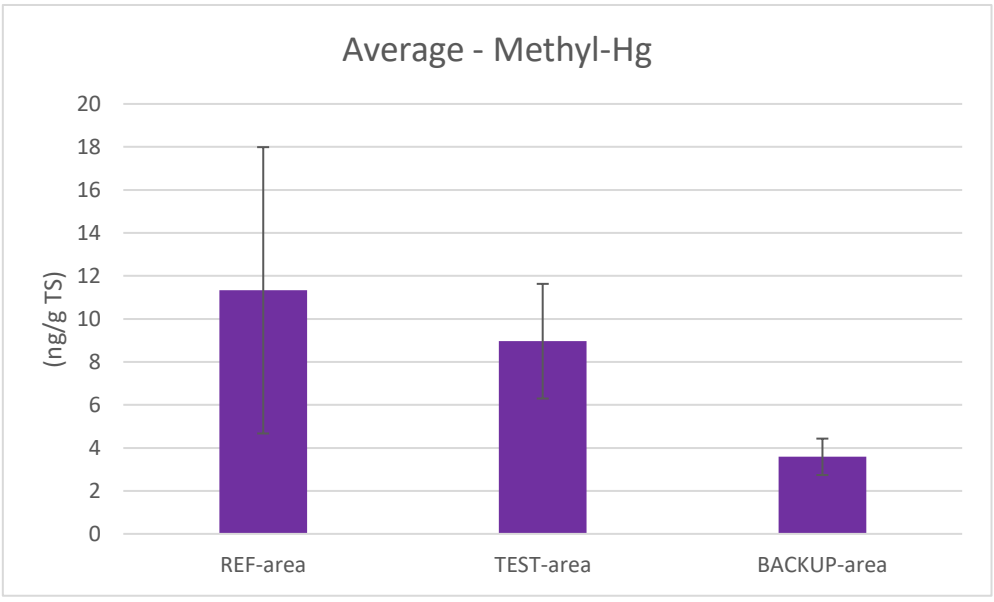

Figure 6. Average concentrations of methyl-Hg for the three areas.

The average values do not include the composite sediment samples (REF-SAM, TEST-SAM, B-SAM). The backup-area shows lower average values of methylmercury than the test- and reference area.

3.1.1 Result PAH analysis

Table 4 shows the result for the OJ-1 PAH analysis. The colouring system of the cells are based on the classification shown in Table 6 in appendix. The classification system did not include the PAH sum L and therefore these are marked with white in the table. Table 4 includes measured values for the sum of the 16 PAH elements, the sum of the low PAH molecules (SUM L), medium PAH molecules (SUM M), and the high PAH molecules (SUM H) in mg/kg dry substance. The average concentrations are calculated from the single samples and does not include the composite sample concentrations. The deviation (Dev %) from the average values is included, and the difference between the average concentrations and composite sample (REF/TEST/B-SAM) is also shown (Diff % SAM/Average).

Table 4. PAH analysis result for the three areas. The red cells indicate very high concentrations of PAHs, and the orange cells indicate high concentrations of PAHs.

Reference area									
Element (mg/kg TS)	REF-7	REF-9	REF-13	REF-17	REF-19	REF-SAM	Average	Dev % from average	Diff % REF-SAM/Average
PAH, sum 16	14	50	14	24	68	18	34	70.7	-46
PAH, sum L	1	4	1	2	5	1	3	64.5	-46
PAH, sum M	7	29	7	12	35	8	18	72.7	-55
PAH, sum H	5	17	6	10	28	9	13	72.1	-33
Test area									
Element (mg/kg TS)	B-7	B-9	B-13	B-17	B-19	B-SAM	Average	Dev % from average	Diff % TEST-SAM/Average
PAH, sum 16	32	35	12	15	15	15	22	49.6	-33
PAH, sum L	4	4	1	1	1	1	2	63.7	-52
PAH, sum M	17	21	6	8	9	7	12	54.1	-41
PAH, sum H	12	10	5	6	5	6	8	40.0	-16
Backup area									
Element (mg/kg TS)	TEST-15	TEST-17	TEST-10	TEST-3	TEST-5	TEST-SAM	Average	Dev % from average	Diff % B-SAM/Average
PAH, sum 16	12	14	15	10	26	8	15	40.6	-49
PAH, sum L	3	4	5	3	8	3	5	44.7	-43
PAH, sum M	6	7	7	5	14	4	8	45.0	-43
PAH, sum H	3	3	3	2	4	1	3	26.0	-74

For the reference area, the measured concentrations of PAH within the area shows high large spatial variability. The test- and backup area shows a smaller, but still large, spatial variability within the areas compared to the reference area. For all three areas the difference is also large between the composite sample concentrations and the calculated average concentrations. Table 4 shows that all areas have *high concentrations* to *very high concentrations* of PAHs.

Figure 7 shows the average values for the different sums of PAH for the three areas (SUM 16, SUM L, SUM M, and SUM L).

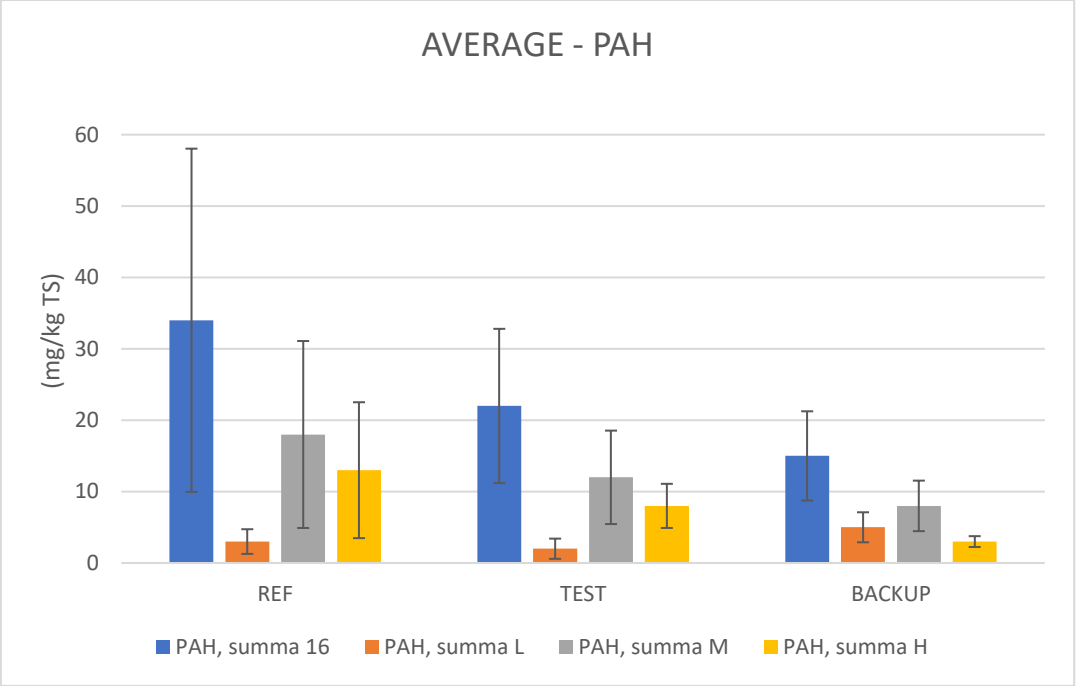

Figure 7. Average values for PAH (mg/kg dry substance) for the three areas. Highest concentrations are found in the reference area.

The refence area appears to have the largest average concentration of PAH Sum 16, PAH sum M, and PAH sum H. However, the standard deviation is large, especially for the calculated PAH sum 16 for the reference area, which indicates a large spatial variation. The backup area shows the lowest concentrations of PAHs, except for PAH sum L.

4. Discussion

Various trace elements are present in the soil in all the three areas in mediate to very high concentrations, comparing with the guideline values in report 4914 (Naturvårdsverket). The highest concentrations of As, Cr, Cu, Pb and Zn are found in the reference area, where Cu, As, Hg, and Pb are found in *very high concentrations*. The highest concentration of Cd is found in the test area, and As, Cd, Hg, and Pb are measured to be in *very high concentrations.* The backup area also shows *very high concentrations* of As, Cd, Cu, Hg, and Pb.

Arsenic has been transported in large quantities to the bay through the previous existing river that used to drain the area. As shows no large spatial variations within the three areas, and this could be explained by that As will spread quite evenly in the sediment during sedimentation. Cu, Ni, Co, Zn, and Pb also shows relatively small spatial variations within the areas. The variations of metal concentrations within the areas could have occurred due to bio turbidity, erosion, and/or ocean currents.

Cadmium (except for Ref-7), lead, and copper (except for Test-15) exceeds effect-based limit values regarding toxicity levels for sediment living organisms (table 1 in report 2018:31, Havs- & Vatten myndigheten). Only Cd, Pb, and Cu were considered in the effect-based limit values classification since these are the only inorganic elements included in the classification.

The composite samples for methylmercury show the highest concentrations in the test area (13 ng/kg dry substance) and the lowest concentrations in the backup area (1 ng/kg dry substance). Mercury in the area has its source from the impregnating agent *Pulpasan* (a product from phenylmercury) that was used in the sawmill for impregnation of the wood pulp and has over the years been released in the bay and spread in the sediment. More about the source of methylmercury in the area can be read about in the report "*Huvudstudie Bureå – Åtgärdsutredning och riskvärdering"* by Ramboll (2019).

The average sulphur concentrations are more elevated in the backup area compared to the test- and reference area. Sediment analysis shows a higher loss of ignition (LOI at 1000 ^{O}C) for the sediment in backup area with an average of 40 % loss compared to 17 % (reference area) and 9 % loss (test area). Historically the area has been dominated by mires, which could have contributed to sulphide sediment formation by the decomposition of organic material. This could explain why higher sulphur concentrations are found in the backup area.

In the bay were the reference- and test-area are located there has historically been a lot of ship traffic in connection to the industry which is believed to be the main source of PAH compounds. The results from the OJ-1 PAH analysis, show that the sediment is contaminated with different PAHs in high to very high concentrations according to the guideline values (report 2017:12 by SGU). The backup area shows the lowest concentrations of PAHs.

The concentration of PAHs is varying within the three areas, which could be explained by the way PAHs are settling during sedimentation. PAHs are hydrophobic and will settle as clusters as they are spread from a source and will therefore not spread evenly in the sediment, but instead be concentrated at different locations depending on where the source of it was and how it was transported (water motions, turbulence while settling). Further, the sediment could have been disturbed by diffusion, bottom living organisms, boat traffic and/or water currents, which also could explain the spatial variations of PAHs within the three areas.

More detailed information regarding evaluation of the contamination situation in the sediment in the Bureå bay can be found in the report "*Miljöteknisk sedimentundersökning, Bureå Träslip*" by Ramboll (2019).

5. Conclusion

By interpreting the results of the PAH, methylmercury, and inorganic element concentrations in the sediment, the two most interesting locations for performing the cover test are the reference area and the test area. The two areas show similar results for concentrations of trace elements, PAHs, and methylmercury. Regarding suitability for performing the covering test, the test area is the most suitable location since it shows high concentrations of inorganic elements and PAH, and since it is located in the bay relatively close to the shore.

A crane lorry is used for spreading the biochar-mixture and therefore it is an advantage to perform the covering in close access to land.

For this reason, the conclusion from this field work is that the test area was suggested for the future capping tests. For the pilot field work in June 2021, the central part of the test area (3x3 cells, *testområde)* was considered for the capping experiment with a biochar-bentonite mixture, while the outer part of the grid was used for monitoring potential spread from the cover material and for performing turbidity tests. Both the test area and the reference area were monitored with diffusion chambers for capturing and analysing organic compounds.

6. References

Havs- och vattenmyndigheten, 2018. *Metaller och miljögifter – Effektbaserade bedömningsgrunder och indikativa värden för sediment* (Report 2018:31). ISBN 978-91-88727-22-0

Naturvårdsverket, 1999. *Bedömningsgrunder för miljökvalitet – kust och hav* (Report 4914). Stockholm: Naturvårdsverket. ISBN 9162049178.

Josefsson S., 2017. *Klassning av halter av organiska föroreningar i sediment* (SGU-report 2017:12). Naturvårdsverket. Available at: http://urn.kb.se/resolve?urn=urn:nbn:se:naturvardsverket:diva-7316

Naturvårdsverket (1999). *Bedömningsgrunder för miljökvalitet Sjöar och vattendrag* (Report 4913). Stockholm: Naturvårdsverket. ISBN 9162049135.

Appendix A - Pictures and tables

Images from the field sampling

Figure 9. Sediment collected with the Van Veer grabber (Flodin, 2020).

Figure 8. Sediment with an oxidized top layer and some organic material (Flodin, 2020).

Figure 10. An overlook of the reference- and test area in the Bureå Bay (Flodin, 2020).

OJ-1 PAH analyse package

Analys av ämne:	Rapporteringsgräns:
naftalen	0.05 mg/kg torrsubstans
acenaftylen	0.05 mg/kg torrsubstans
acenaften	0.05 mg/kg torrsubstans
fluoren	0.05 mg/kg torrsubstans
fenantren	0.05 mg/kg torrsubstans
antracen	0.05 mg/kg torrsubstans
fluoranten	0.05 mg/kg torrsubstans
pyren	0.05 mg/kg torrsubstans
bens(a)antracen	0.05 mg/kg torrsubstans
krysen	0.05 mg/kg torrsubstans
bens(b)fluoranten	0.05 mg/kg torrsubstans
bens(k)fluoranten	0.05 mg/kg torrsubstans
bens(a)pyren	0.05 mg/kg torrsubstans
dibenso(ah)antracen	0.05 mg/kg torrsubstans
bens(ghi)perylen	0.05 mg/kg torrsubstans
indeno(123cd)pyren	0.05 mg/kg torrsubstans
PAH, summa 16	0.4 mg/kg torrsubstans
summa cancerogena PAH	0.18 mg/kg torrsubstans
summa övriga PAH	0.23 mg/kg torrsubstans
PAH, summa L	0.08 mg/kg torrsubstans
PAH, summa M	0.12 mg/kg torrsubstans
PAH, summa H	0.2 mg/kg torrsubstans
naftalen (C1-alkyl.)	0.05 mg/kg torrsubstans
naftalen (C2-alkyl.)	0.05 mg/kg torrsubstans
naftalen (C3-alkyl.)	0.05 mg/kg torrsubstans
fenantren/antracen (C1-alkyl.)	0.05 mg/kg torrsubstans
fenantren/antracen (C2-alkyl.)	0.05 mg/kg torrsubstans
fenantren/antracen (C3-alkyl.)	0.05 mg/kg torrsubstans
dibensotiofen	0.05 mg/kg torrsubstans
dibensotiofen (C1-alkyl.)	0.05 mg/kg torrsubstans
dibensotiofen (C2-alkyl.)	0.05 mg/kg torrsubstans
dibensotiofen (C3-alkyl.)	0.05 mg/kg torrsubstans

Figure 11. OJ-1 PAH analyse package (ALS global, 2021)

MG-1 analyse package

Analys av ämne:	Rapporteringsgräns:
Al_2O_3	torrsubstans
CaO	torrsubstans
Fe_2O_3	torrsubstans
K_2O	torrsubstans
MgO	torrsubstans
MnO	torrsubstans
Na_2O	torrsubstans
P_2O_5	torrsubstans
SiO_2	torrsubstans
TiO_2	torrsubstans
summa oxider	torrsubstans
LOI	torrsubstans
As, arsenik [1]	0.1 mg/kg torrsubstans
Ba, barium	2 mg/kg torrsubstans
Be, beryllium	0.5 mg/kg torrsubstans
Cd, kadmium [1]	0.01 mg/kg torrsubstans
Co, kobolt [1]	0.03 mg/kg torrsubstans
Cr, krom	10 mg/kg torrsubstans
Cu, koppar [1]	0.3 mg/kg torrsubstans
Hg, kvicksilver [1]	0.04 mg/kg torrsubstans
Nb, niob	5 mg/kg torrsubstans
Ni, nickel [1]	0.08 mg/kg torrsubstans
Pb, bly [1]	0.1 mg/kg torrsubstans
S, svavel	8 mg/kg torrsubstans
Sc, skandium	1 mg/kg torrsubstans
Sr, strontium	2 mg/kg torrsubstans
V, vanadin	2 mg/kg torrsubstans
W, volfram	50 mg/kg torrsubstans
Y, yttrium	2 mg/kg torrsubstans
Zn, zink [1]	1 mg/kg torrsubstans
Zr, zirkonium	2 mg/kg torrsubstans

Figure 12. MG-1 analyse package (ALS global, 2021).

Data evaluation – Guideline values PAH

Table 5. Classification of PAH measured in µg/kg dry substance (SGU report 2017:12). Class 1 (klass 1) is very low concentration and class 5 (klass 5) is very high concentration.

Ämne	Klass 1 *Mycket låg halt*	Klass 2 *Låg halt*	Klass 3 *Medelhög halt*	Klass 4 *Hög halt*	Klass 5 *Mycket hög halt*
Naftalen		<4,9	4,9–19	19–63	≥63
Acenaften			<5,5	5,5–33	≥33
Fluoren		<2,0	2,0–9,4	9,4–35	≥35
Fenantren	<7,0	7,0–17	17–50	50–150	≥150
Antracen	<1,0	1,0–3,1	3,1–11	11–45	≥45
Fluoranten	<18	18–45	45–140	140–390	≥390
Pyren	<12	12–30	30–100	100–380	≥380
Bens(a)antracen	<7,5	7,5–19	19–62	62–180	≥180
Krysen	<11	11–26	26–67	67–200	≥200

Table 6. Classification of PAH measured in µg/kg dry substance (SGU report 2017:12). Class 1 (klass 1) is very low concentration and class 5 (klass 5) is very high concentration.

Ämne	Klass 1 *Mycket låg halt*	Klass 2 *Låg halt*	Klass 3 *Medelhög halt*	Klass 4 *Hög halt*	Klass 5 *Mycket hög halt*
Bens(b)fluoranten	<32	32–69	69–200	200–440	≥440
Bens(k)fluoranten	<11	11–28	28–79	79–180	≥180
Bens(a)pyren	<12	12–31	31–99	99–240	≥240
Dibens(ah)antracen	<4,4	4,4–8,9	8,9–27	27–79	≥79
Bens(ghi)perylen	<22	22–62	62–180	180–400	≥400
Indeno(1,2,3-cd)pyren	<24	24–76	76–220	220–530	≥530
Summa PAH_{11}	**<170**	**170–440**	**440–1200**	**1200–2800**	**≥2800**
Summa PAH_{15}	**<250**	**250–440**	**440–1200**	**1200–4700**	**≥4700**
Summa PAH M	**<57**	**57–110**	**110–320**	**320–1700**	**≥1700**
Summa PAH H	**<180**	**180–320**	**320–940**	**940–2600**	**≥2600**

MG-1 analysis results – Tables

Table 7, 8 and 9 show some of the metal concentrations from the MG1 analysis. The tables include the single samples, the composite samples, average values for the single samples, the deviation (%) from the average values, and the difference (%) between the average values and the composite samples. The colouring in the cells is based on the classification system for sea sediment set in report 4914 (Naturvårdsverket, 1999).

Table 7. Metal analysis result for the reference area. The concentrations are given in mg/kg dry substance.

Reference area									
Element (mg/kg TS)	REF-7	REF-9	REF-13	REF-17	REF-19	Average	REF-SAM	Diff % REF-SAM/average	Dev % from average
As	335	467	333	463	461	412	365	-11	15.4
Cd	2.2	5.2	2.5	3.9	4.7	3.7	3.5	-5	31.8
Cr	61	51	59	54	36	52	56	7	18.6
Cu	234	128	211	149	139	172	171	-1	22.4
Hg	2.3	2.2	2.2	2.2	2.3	2	2	-4	3.2
Ni	25	15	22	15	14	18	19	4	24.1
Pb	288	233	260	250	251	256	222	-13	7.0
S	5630	12600	7060	12600	11200	9818	8740	-11	29.7

Table 8. Metal analysis result for the test area. The concentrations are given in mg/kg dry substance

Test area									
Element (mg/kg TS)	TEST-15	TEST-17	TEST-10	TEST-3	TEST-5	Average	TEST-SAM	Diff % TEST-SAM/average	Dev % from average
As	161	258	196	204	178	199	240	20	16.5
Cd	4.1	3.9	3.6	3.9	3.1	3.7	4.1	10	8.8
Cr	32	59	43	33	30	39	42	7	27.6
Cu	55	139	75	98	79	89	93	5	32.0
Hg	1.3	2.3	1.5	1.8	1.1	2	2	4	25.7
Ni	10	17	12	11	10	12	17	45	22.3
Pb	148	241	162	163	154	174	196	13	19.7
S	6590	5760	4560	4490	5080	5296	6460	22	14.9

Table 9. Metal analysis result for the reference area. The concentrations are given in mg/kg dry substance.

Backup area									
Element (mg/kg TS)	B-7	B-9	B-13	B-17	B-19	B-SAM	Average	Diff % B-SAM/average	Dev % from average
As	229	246	191	198	247	217	222	-2	10.6
Cd	7.0	6.7	4.9	4.8	6.3	5.9	5.9	0	15.6
Cr	39	44	30	39	47	30	40	-25	14.1
Cu	272	252	178	207	286	238	239	0	15.5
Hg	2.8	2.5	1.8	2.0	2.7	2	2	-14	16.3
Ni	15	17	13	14	16	18	15	24	8.2
Pb	245	236	161	182	247	207	214	-3	16.7
S	20100	20000	17500	19100	20500	19600	19440	1	5.5

MeHg analysis results

Table 10 shows the result from the MeHg analysis. The table includes the single samples, the composite samples, average values for the single samples, and the deviation (%) from the average values.

Table 10. Methylmercury analysis result for all the three areas. The concentrations are given in ng/kg dry substance.

MeHg									
Area	Element	REF-7	REF-9	REF-13	REF-17	REF-19	REF-SAM	Average	Dev % from average
REF	Methyl-Hg (ng/g DS)	4.33	16.2	4.52	10.20	21.40	7.39	11.33	58.80
Area	Element	TEST-15	TEST-17	TEST-10	TEST-3	TEST-5	TEST-SAM	Average	Dev % from average
TEST	Methyl-Hg (ng/g DS)	9.37	9.42	13.50	6.19	6.33	13	8.96	29.80
Area	Element	B-7	B-9	B-13	B-17	B-19	B-SAM	Average	Dev % from average
B	Methyl-Hg (ng/g DS)	4.87	3.85	2.26	3.26	3.68	1.06	3.58	23.60