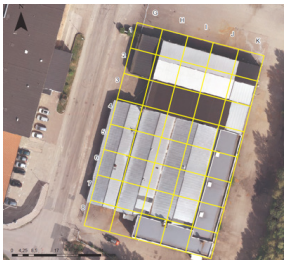
Remediation of soil and groundwater from a former surface treatment industry

In June 2018, Envytech won a private partnering contract for a demolition and remediation project for a former surface treatment industry. Contaminants of concern involved heavy metals such as copper, chromium, zinc, arsenic and cyanide. Selected samples had been analyzed for PFAS, which had shown low to moderate levels of PFAS. Contaminants had also been detected in the groundwater. Measured levels indicated very high levels of both metals as well as PFAS.

After the demolition of the building had been finished, classification of the soil was carried out by sampling in so-called Selective Unit Volumes (SEV) of 10 x 10 x 0,5 m. The classification was performed in 0,5 depth intervals down to the groundwater level, about 2 m bgl. 30 samples were taken from each SEV and mixed to a sample that was sent to laboratory. The classification gave the following four different classes of contaminated soil and concrete:

Light Hazardous waste - IFA
Light Hazardous waste with PFAS - IFA PFAS
Non Hazardous concrete with PFAS - IFA PFAS concrete
Hazardous waste - FA



Depth (m)	Level (mg/kg TS)	Copper Cu	Chromium Cr (total)	Chromium 6+	Nickel Ni	Zinc Zn	Cyanide (total)	PFOS	Sum PFAS SLV 11
Shallow	Average	75	43	**11**	**195**	208	18		
	Median	**36**	**12**	**5**	**91**	**130**	**7**		
	Max	310	500	59	1200	950	87		
	Min	4	2	1	2	18	1		
0,5-1	Average	170	**155**	**30**	**267**	**751**	**393**	13	**20**
	Median	54	62	10	110	340	**530**	13	**20**
	Max	630	500	135	**1830**	**4500**	**610**	13	**20**
	Min	11	4	4	7	17	**38**	13	**20**
1-2	Average	116	**290**	9	30	321	**245**	**37**	**41**
	Median	45	71	5	21	105	38	**36**	**45**
	Max	**770**	**2100**	**30**	89	**1700**	**1000**	**70**	**71**
	Min	2	4	0,1	4	11	2	5	6,3
2-3	Average	160	**406**	4,1	70	448	**404**	3,9	4,9
	Median	21	20	3,5	24	59	104	3,9	4,9
	Max	1700	4500	11	560	2700	1400	4,8	5,8
	Min	2,1	4,1	0,1	3,5	34	6,2	3,0	4,0
3-4	Average	30	68	**12**	27	213	55	0,8	2,0
	Median	17	12	2,6	27	170	61	0,8	1,9
	Max	65	**390**	**52**	52	450	98	1,5	2,5
	Min	5,7	4,2	0,8	13	61	1,3	0,3	1,6
4-5	Average	33	66	9,5	37	300	19	0,3	1,3
	Median	29	26	9,0	26	329	18	0,3	1,3
	Max	80	**250**	**19**	100	**500**	38	0,3	1,3
	Min	7	2	1,0	9	140	3	0,3	1,3
PSRV	<2	200	150	10	100	500	80	8	8
PSRV	>2	200	150	3,0	40	500	33	3	3
MKM		**200**	**150**	**10**	**120**	**500**	**120**	**20**	**20**
FA		**2500**							

Average levels of metal, Cyanide and PFAS, based on analysis of 103 soil samples 2012-2017.

The PFAS contaminated soil could be divided into two groups, soil contaminated with lower PFAS levels, 20–100 µg/kg, and higher contaminated PFAS soil with levels of about 1000 µg/kg. To determine if these concentration levels could be stabilized in this particular soil, test with the addition of Rembind Plus were carried out by Eurofin's laboratory. For soil with lower PFAS levels (20-100ug/kg), tests were performed with the additin of 3% Rembind Plus. For soil with higher levels of contamination (1000 ug/kg) tests with the addition of 3% and 5% of Rembind Plus were performed.

Substance	Levels sum PFAS SLV 11	pH	Leachate test	Rembind	Sum PFAS SLV 11	Reduction PFAS in leach
Unit	ng/kg			%	ng/l	%
PFAS sample 1	1100	7,5	LS/2	0	230 000	0,0
PFAS sample 1	1100	7,6	LS/8	0	27 000	0,0
PFAS sample 1	1100	7,8	LS/2	3	8 500	96,3
PFAS sample 1	1100	7,7	LS/8	3	1 500	94,4
PFAS sample 1	1100	7,5	LS/2	5	4 600	98,0
PFAS sample 1	1100	7,7	LS/8	5	1 100	99,5
PFAS sample 2	60	7,6	LS/2	3	4 300	0
PFAS sample 2	60	7,7	LS/8	3	970	0
PFAS sample 2	60	7,6	LS/2	3	590	86,3
PFAS sample 2	60	7,7	LS/8	3	77	92

Results from lab tests performed for verification of the function of Rembind on current soils and to identify what amount of Rembind that would be sufficeint to reach the required concentrations of PFAS in leachate.

The results showed that soil with lower levels of PFAS would obtain sufficient reduction of its PFAS leaching properties with 3% Rembind Plus. This as results show PFAS concentrations of 590 ng/l at LS/2. For soil with PFAS concentration > 200 µg/kg, results show that an addition of 5% Rembind Plus brings the PFAS concentrations down to 4 600 ug/kg for the LS/2 analysis.

As the soil when excavated comprised large amounts of gravel, stones and rocks (< 40 mm), all soil was initially shifted through a tumble shifter to minimize the amounts of mass that would have to be treated. Assessment was made in dialogue with the county administrative board, that rocks larger then 40 mm, after analysis on crushed and grounded material, showing concentrations below the site specific criterias, could be returned to the property and used as backfill. This to increase the sustainability of the project and open up for a circular economy approach.

Sample markning	I800 PFAS	I800 PFAS LS/2	I806 PFAS	I806 LS/2
PFOS (ng/l)	47	1600	19	2100
Summa PFAS SLV 11 (ng/l)	47	1800	21	2300

Results for samples from the separated stone fraction. Both total PFAS concentration and leachate concentration at an LS/2 analysis is presented.

The shifted soil was treated by mechanical mixing and addition of water and Rembind Plus. The result was a homogeneous material where the different materials could not be distinguished.

When the soil had been stabilized, control samples were collected and sent to Eurofins laboratory for leachate tests and PFAS analysis. Control sampling was also carried out for the rock fraction >40 mm. All treated materials were cleared for deposit except one batch. This was however deposited within the other treated soil and were therefore not considered to cause a risk to the surroundings.

In total, the project handled 1000 tonnes of metal contaminated soil, 3000 tonnes of PFAS contaminated soil and 950 tonnes of PFAS contaminated concrete. The project was was finished in early May 2019. The report for the project will be handed over to the EPA at the end of June.

Rembind Plus

RemBind Plus is a powdered product designed to bind irreversibly to organic contaminants such as TPH, PAH, PFOS, PFC and PCB, and also some heavy metals including chromium, arsenic and mercury, to prevent leaching.

The full-scale treatment process involves mixing of RemBind with soil or waste at a rate of 2% - 10% by weight using soil blending equipment and process water. Within 24 hours the contaminants will be chemically fixed and the reduction in leachability can be used to make a case for safe disposal, storage or reuse (depending on the local regulations).

Selected samples of contaminated soil treated with Rembind Plus have been subjected to the rigorous Multiple Extracton Procedure MEP, US EPA Method 1320. The method has been developed to determine the longevity of bindings. Results from the MEP test show that soil treated with Rembind Plus 100 passed the stringent test which simulates 1000 years of acid rain in an omproperly designed sanitary landfill.

How it works