Site Progress Report 2/2017

EUROPEAN UNION
European Regional Development Fund

Interreg
Central Baltic

INSURE
Innovative Sustainable Remediation

SITE PROGRESS REPORT

University of Helsinki

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Corresponding authors/institutions in parenthesis

1. Janakkala, Finland (University of Helsinki)

The Janakkala site was studied in 2013/14 related to an experimental remediation project in project TANKKI, by Nordic Envicon Oy and UHEL. The site is located in Mäkelänkuja 4, Janakkala, on a residential area on the premises of a single household not within any major ground water area. The leaking was due to a hole in a private heating oil tank dug in the ground (Fig 1a-c.). The tank was left intact, and was suggested to remain so by the landowner.

In November 2013 soil samples taken by Ramboll Finland Oy from the depth 2,5-3m had average C_{10}-C_{40} concentration of 1900 mg/kg within an area of 14 m^2 around the tank. After the remediation studies in October 2014 the C_{10}-C_{40} levels were 1300 mg/kg on average. At the time it was concluded that the bioremediation procedures had minor effect on the contamination levels and the poor success was suggested to be connected to the low permeability of the clayey soil type. The area between the tank and the house was excluded from the original sampling plan as well as the remediation studies but was later found to be a possible source for further contamination.

It was suggested that higher contamination levels can be found in points with higher permeability i.e. the areas under and in close proximity with the tank and can be accessed in a more successful manner if the treatment solution is distributed via the tank itself. For sampling and introduction of liquids, five holes with perimeter of 4 cm were drilled into the tank bottom. From the test drillings it was inspected that samples could be obtained to depth 30 cm from the tank bottom.

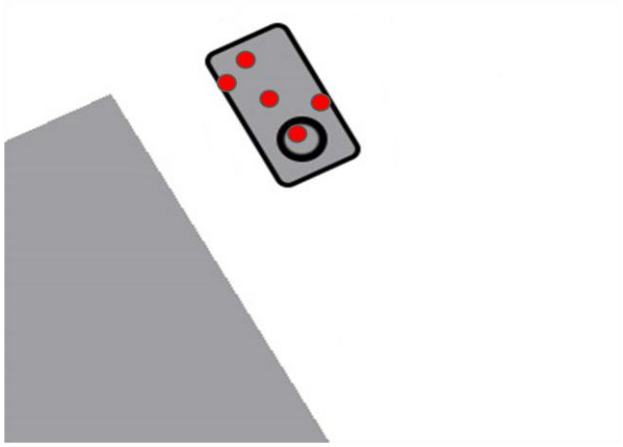

Fig. 1a-c. a-b. Site Janakala **c.** drawing of the site with sampling/ injection holes drilled into the tank bottom marked by red spots.

Fenton's reagent based chemical oxidation was chosen as the remediation method. 1,5 cubes of 15 m% H_2O_2 was introduced into the soil twice with 2 week interval in October 2016. The volume of the introduced liquid and the peroxide concentration was calculated as being sufficient for the end concentration of 2 mol when diluted to the approximated volume of water near the perimeters of the tank, but not intolerably high even without proper dilution. Tri-sodium citrate was added as chelate to affect the solubility of catalytic iron, in dose 25 kg, because of positive remarks on literature as well as the slightly optimistic results in a large scale pilot performed in Soilia field research station in the spring of 2016.

All samples were sent to Novalab Oy, for oil hydrocarbon analysis. The results showed a clear decrease in contamination levels but with some hot spots remaining. The average concentration from all samples decreased from 19 000 mg/kg dw to 7000 mg/ kg dw, a 64 % decrease, but with soil heterogeneity and mobilization of soil suspected to have played a role. Because of the suspected antimicrobial effect of both the added H_2O_2 and oxygen released in to soil, 20 kg's of diesel-contaminated soil with oil degrading bacteria was added into the tank with 200 liters of water and with calcium peroxide as the oxygen source and Suomen salpietari as the nitrogen source. The bioaugmentation/ -stimulation was started in

November 2016 and will continue until April 2017. In April the soil will be sampled and if the later part of the treatment has proven successful a wider area around the tank will be thoroughly sampled for a risk analysis to be performed by an outside party. With high levels of contamination remaining in the soil, biostimulation will be continued throughout the warm season for approximately six more months. The effect of added peroxide on the biological activity of the soil will be tested in laboratory scale in spring 2017. The respiration levels will be measured from samples taken from the site during the biostimulation procedure.

2. Motala, Sweden (Motala community, Populus Group)

Motala pilot area “Södra stranden” is a complex area next to Vättern with industrial activity and with many properties and also contaminants. It’s also an attractive area close to the lake Vättern and Motala City. The area has been investigated before, but not as a whole, and contaminants have been found. To get better knowledge about the area some investigations have been done within INSURE.

Fig. 2.1. Motala pilot area, near water with houses and business side by side

In period 1 (January 2016) Motala started with ordering six historical investigations (Mifo fas 1, according to the Environmental Government) in the pilot area. For the other properties Motala already had historical investigations or assessed that there was no need for such.

After the historical investigations, the next step was to perform general environmental risk assessment. Because of the complexity of the area, Motala decided to divide it into smaller subareas. The investigations were also performed in several steps. As the first step, a tree sample investigation was done in April 2016 with the purpose to investigate the spreading of trichloroethylene in the pilot area. Unfortunately the tree samples didn't show anything, probably because the trichloroethylene contaminant is so far below ground. During the next step Motala investigated the trichloroethylene and oil contamination with MIP (membrane interface probe) in June 2016. The third and last part of the investigations was performed in June 2016 with the aim of getting an overview of all the contaminants in the pilot area. In this part the ground, groundwater, sediments and surface water were all investigated. The report from the investigations was ready in September 2016.

Fig. 2.2. MIP investigation June 2016

A lot of contaminants were found in the pilot area and even though there's a better knowledge about the area, there's still work to do. The contaminants in the area come from different sources like finishing industry, oil depots, marina, filling material etc. Some contaminants are in the surface soil, like metals and oil products in the filling material whereas some contaminants are down to 19 meters underground, like trichloroethylene. The pilot site is under conversion to becoming a residential area and in some places has to be remediated or restricted before further land use changes can be undergone. The next step is now to investigate the risks associated with the contaminants further according to the future land use. The report from the risk assessment will be ready in February 2017.

Discussions with POP and UHEL were started in 2016 to find a suitable site in the area to work on. Stenavadet is an industrial site where TCEs and oil hydrocarbons have been used. On the bases of that and previous reports it was decided that POP would work on TCE contaminated area seen on the map as the violet area (Fig 2.3) to the right where traces of TCE was found in a ground water well. A skype meeting was held in January, 2017, with POP and Therese Hjälm, about site investigations in Stenavadet. It was agreed upon that Vatten och samhällsteknik would take ground water samples from Stenavadet and from

Lindquists verkstäder known as sampling spot MS-39 with water samples for filtration included, and that a contact person would be defined and further informed about the filtering procedure. Samples will be taken in February 2017. As for now a pilot site for UHEL hasn't been defined, but it has been discussed that it will preferably be a smaller area with sufficient concentrations of volatile organic compounds.

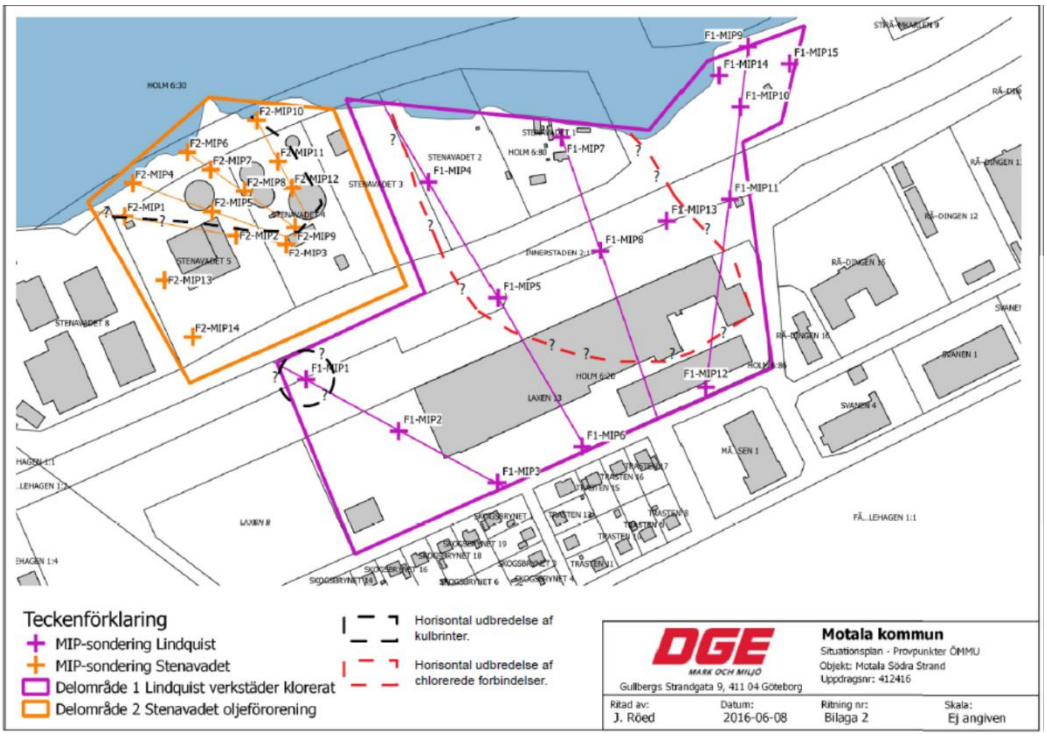

Fig. 2.3. Södra stranden pilot site, technical drawing

3. Valmiera, Latvia (Populus Group, Valmiera City Council, University of Helsinki)

The Valmiera pilot site, Dzelzela-iela 9, was visited by POP in 23.9.2015. In connection to the visit, discussions about the Dzelzela-iela 9 site were held with the major of the city of Valmiera. The major told about the plans for restoring the site. He was thinking that the constructions of the site could be removed and the material re-used so that the removal would not be an economic problem.

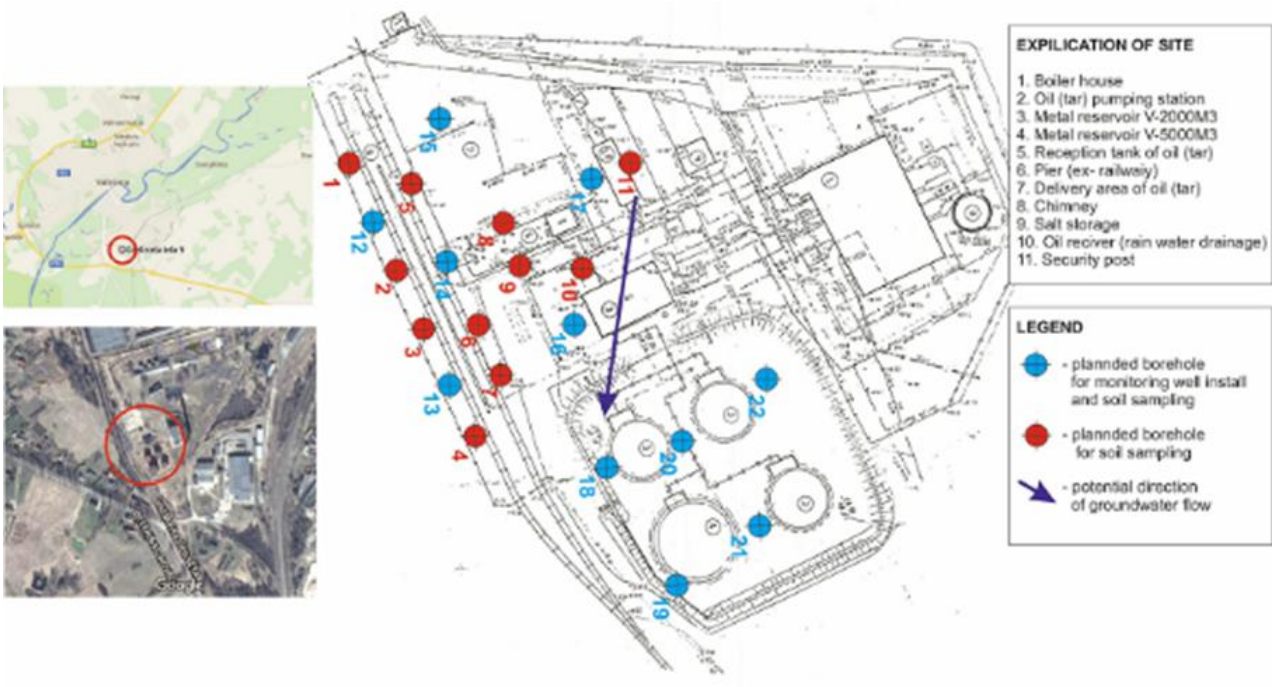

Fig. 3.1. Valmiera site: map, air photograph and technical drawing.

UHEL visited the site in January 2016. At the INSURE meeting in Riga, October 2016, UHEL and POP met a Latvian consultant about the future sampling of the pilot site. So far only one sample had been taken for chemical analysis and sent to UHEL. Characterization of Mazut has been on-going in UHEL Almalab facilities from summer 2016 onwards. Since the analysis of the soil for oil hydrocarbons is commonly done according to standard method ISO 16703, applicable only to aliphatic carbon chain lengths C_{10}-C_{40}, aromatic compounds as well as the problems associated with the sulfur content require further analysis. The analysis protocol was also discussed with the local professionals during the Riga meeting.

POP visited Valmiera a second time since the beginning of INSURE in October 19th 2016 and the progress of the pilot site was discussed. At the meeting they were informed that part of the area with the rail, seen on the enclosed map (Fig 3.1), was not owned by the city, but by a private company. It was then unclear how samples on that area could be taken, since it requires approval of the site owner. A sampling plan was received by UHEL and POP from VAL for comments in November 2016.

Fig. 3.2 a-b. Old rail on Valmiera pilot site and persons visiting the site in 2015.

For the time being, Valmiera has finalized technical specification for investigation and their Procurement Committee is expected to announce a tender. Contractor will be chosen via Procurement procedure. The results from the investigation sampling are expected to be ready in late spring 2017.

4. Villähde/ Nastola, Finland (University of Helsinki)

The site was studied in 2013/14 in relation to experimental remediation project by Nordic Envicon Oy and Helsinki University in project TANKKI. The study site is located in Villähde Finland on an industrial area. The contamination is due to a tank filling accident in the early 2000s. The site is within a 1-class ground water area (0453251 Villähde). The treatable part of the site is uncovered and not in use while the contamination is likely to have spread under built structures, some of them still in use. The C_{10}-C_{40} levels of the soil in depth 11-13 m were 100 mg/kg both before and after the remediation studies in autumns 2013 and 2014 respectively.

POP visited the site with UHEL, in October 2015, and it became clear the contamination was too deep in the ground for phytoremediation. Biostimulation was suggested as the treatment method, but aided with electro-kinetic pumping to enable horizontal movement of the injected

solution, both because a concrete floor denied full access from above ground and because during the TANKKI project, no horizontal movement could be ensured by conventional methods.

In June 2016 the site was prepared for the *in situ* treatment. In total six drillings were performed to depth 12m, to enable installation of two rows of electrodes in perforated plastic tubes. The cathode side was thoroughly sampled; samples from depths at which 2/3 of the samples carried a strong diesel-odor were analyzed for oil hydrocarbon content, resulting in samples from depths 7 to 11 m being analyzed. The treated zone was hence 10x3x3,5 and approximately 100 m3 in volume and 130 t in weight. The total nitrogen and phosphorus concentrations were analyzed from three random samples, nitrogen content was under the detection limit and hence the suspected limiting nutrient. Phosphorus concentrations in the soil exceeded the targeted level.

Fig. 4.1. Drilling/ installation of perforated tubes at site Nastola in June 2016

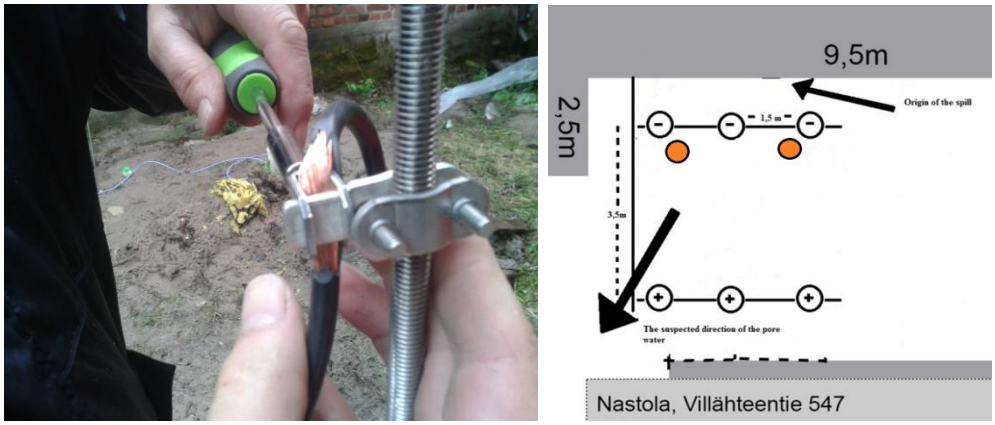

Fig. 4.2 a-b. a. Installation of electrodes. **b.** Electric circuit formed by the electrodes, original sampling performed in cathode wells (-) locations, control sampling locations marked by orange spots.

Fig. 4.3. Installation of the water injection system

The treatment was started in week 25 of 2016 and carried out weekly until week 43 (18 weeks in total), with weekly injections of 10 kg's of Suomen salpietari (nitrogen content 27%, 14,5% ammonium, 12,5 % nitrate) in 2 m^3 of water spread unto the electrode wells within a couple of hours. A 200 V/DC voltage was set between the electrodes and kept on for the duration of the injection. The effect of watering could be seen in elevated current and corrosion of the anode electrodes could be observed as hypothesized. On week 47 two

drilling were performed between the three cathodes, near the spots with the highest measured concentrations.

The concentrations in the soil prior to the treatment were mostly under the detection limit even when a strong odor was observed. Two of the 15 samples had concentrations preceding the threshold value for C_{10}-C_{40} oil hydrocarbons (300 mg/kg) and the lower guideline value for C_{10}-C_{21} distillates (300 mg/kg) with an obvious hotspot of 3200 mg/kg dw in 7-8 m depth near the origin of the spill. After the treatment the three samples with concentrations over the detection limit averaged 100 mg/kg dw and no hot spots with higher overall concentrations were found. In April the soil will be thoroughly sampled from an area within and immediately outside the experiment square for a risk analysis to be performed by an outside party.

5. Vidzeme, Latvia (Populus Group)

POP visited Vidzeme in Latvia the 22-23.9.2015 to have a look at the polluted areas in the Vizeme region with 5 different sites visited: Vecanckini, Pakalni, Veiči-Umpurti, Krustmaļi and Dzerbene Castle household building. After the visit VPR suggested the Dzerbene and Vecanckini would be the pilot site for INSURE, and it was agreed that chemical sampling of the site was to be done. A sampling plan was prepared in the beginning of 2016 for Dzerbene and Vecanckini. The chemical analysis results from May 2016 showed that there were no organic contaminants on these sites. POP informed VPR to immediately choose another site.

Fig. 5.1. Krustmali site

The 31.5.2016 VPR informed that they had chemical analysis data from 2012 from the Krustmali site which was found to contain pesticides (DDT and triazines). At the end of June 2016 Krustmali was suggested as the pilot site of VPR.

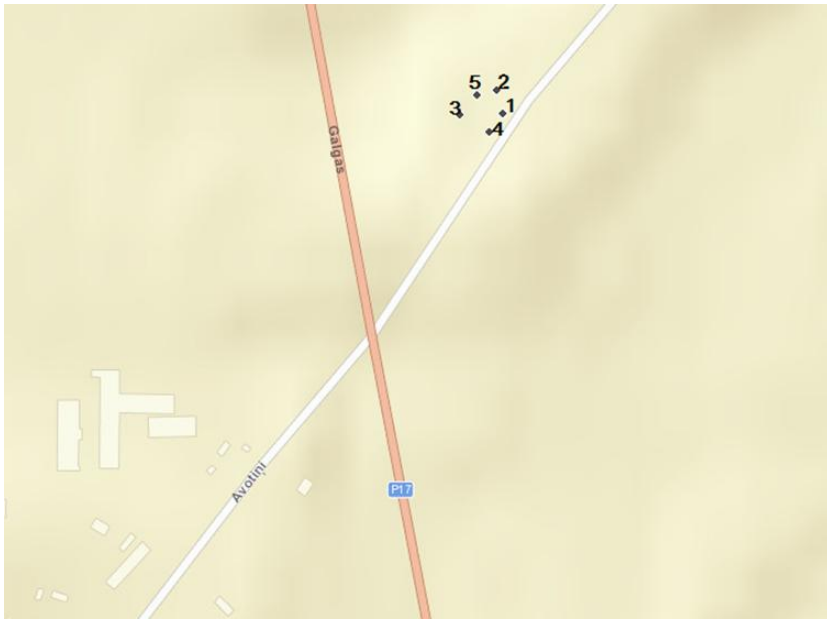

Fig. 5.2. Vizeme region and site locations

The sampling process took place on October 18th, 2016. Soil samples were obtained with a shovel. Composite samples of different deeps were sampled (10, 25 and 50 cm) by collecting soil from subsamples taken over a wide area (50 cm) and placing them into a hermetic plastic bag. Each of the five sampling spots was sampled in three different deeps.

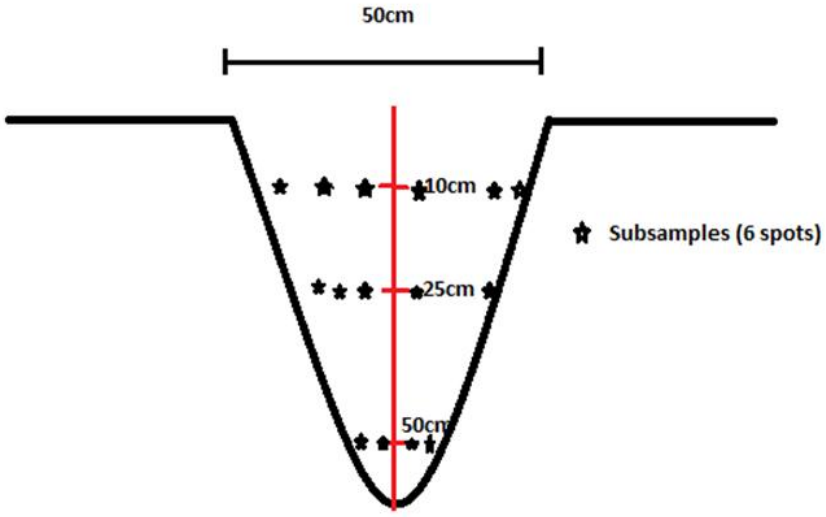

Fig. 5.3. Krustmali sampling schematic picture

DNA was extracted from each depth in every sampling spot. The DNA was successfully amplified from each of the 9 samples for microbial analysis (Bacteria) by the end of the year 2016.

6. Virrat, Finland (Populus Group)

POP has with Natural Resources Institute Finland (Luke) planned remediation for the hydrocarbon polluted Kiertotie 18 site, 936-409-10-167 in Virrat. The owner of the site was earlier, by authorities, urged to remediate the site. The first option was excavation, but then LUKE suggested in situ treatment. The *in situ* possibility was discussed with Pirkanmaan ELY (PirELY) and POP and finally, PirELY decided to take part in the remediation costs, and the now approved remediation plan was written in 2016. The owner of polluted site has taken part in all meetings held about the site.

Kuva 1. *Ilmakuva kohdealueesta ja likimääräiset kiinteistörajat (www.paikkatietoikkuna.fi)*

Fig. 6.1. Air photo of site Virrat with approximate property lines

It was concluded on the bases of previous site investigation that phytoremediation would be good option for the Virrat site. A biological remediation plan was done by LUKE for the oil polluted Kiertotie 18, Virrat site and submitted to the local environmental authority, PirEly after meeting held 19.4.2016 (with representatives from LUKE, city of Virrat, Pirkanmaa ELY and owners of estate). The plan is to remediate the target area mainly by phytoremediation (The total area for remediation is ca. 1500m2) using trees and their associated microbes. In addition to biological remediation about two truckloads of soil contaminated with heavy metals will be removed in 2017.