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LIFE+ project Vopak ExperO3

Newsletter nr. 6 – May 2017

Abstract

At the Vopak Terminal ACS a soil and groundwater contamination with chlorinated aliphatic hydrocarbons, BTEX and petroleum hydrocarbons is present. The contamination is being treated by means of in situ remediation using In-Situ Chemical Oxidation (ISCO) since April 2013. The first phase of the in situ remediation, regarding the former drum storage area, was successfully completed in November 2013. The second phase, focusing on the source area around the former excavation zone, is on-going since then. Due to emission issues, the remediation works were temporarily halted begin 2014. Field emission tests were carried out and, based on the results, optimal injection regimes that eliminate emissions were defined. Also, the liquid tight concrete cover was restored. The injections have been resumed in June 2014. At the same time, the treatment of the plume area in the midway was initiated. Beginning 2015, less than 9 months after the injections have started, the remediation targets were reached in certain areas of the midway. Injections in these areas have been stopped. Since March 2015 injections in the small source area in the tank farm are started. Since January 2016 the injections in the small source area, where the remediation targets are nearly reached, were stopped so that last phase of the remediation, the injections in the big source area in the tank farm, could be started up. In October the full remediation was temporarily stopped due to civil works (renewal tank 60 in the tankpark). In April 2017 the remediation in the big source area of the tank farm was temporarily stopped due to civil works (renewal tank 62 in the tankpark).

The remediation is now ongoing in and around the former excavation zone, in a part of the midway (close to the tank farm) and in the big source area of the tank farm.

Project description

Given the different physical and chemical characteristics of the contaminants in the soil and groundwater at the Vopak terminal ACS, remediation using traditional techniques would result in a time-consuming and expensive process. ISCO therefore offers a promising alternative for the simultaneous remediation of a cocktail of organic contaminants. With this technique, an oxidant is injected in the subsoil, causing oxidation of the contaminants into harmless products. Perozone, a mixture of hydrogen peroxide and ozone, is capable of oxidizing all types of organic contaminants.

Since the presence of strong oxidants causes major issues with regard to health and safety on explosion sensitive (EX-rated) sites, the development of an extensive health and safety plan and continuous monitoring of health and safety parameters during the remediation activities are of prime importance for the project.

This LIFE project focuses on a cost efficient, energy efficient and environmental advantageous innovative remediation technology that can be the solution for in situ remediation of complex contaminations in industrial and high risk areas where it is usually difficult and expensive to remediate using traditional techniques.



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Remediation progress

The initial remediation concept comprises a combination of excavation, ISCO and multi-phase extraction (MPE), as shown in the map.

Since the start of the in situ remediation works, some changes have been made to the original concept. As the MPE was shut down due to environmental permit issues, the contamination is now being treated by only ISCO combined with soil vapour extraction (SVE).

Currently, the remediation targets are reached in the former drum storage and in parts of the midway. The remediation is ongoing in the area in and around the excavation zone (where concentrations were already drastically reduced but are increasing again), in the area of the midway close to the tank farm and in the small source area and big source area in the tank farm.

The remediation status of these zones is visualized in figure 1.

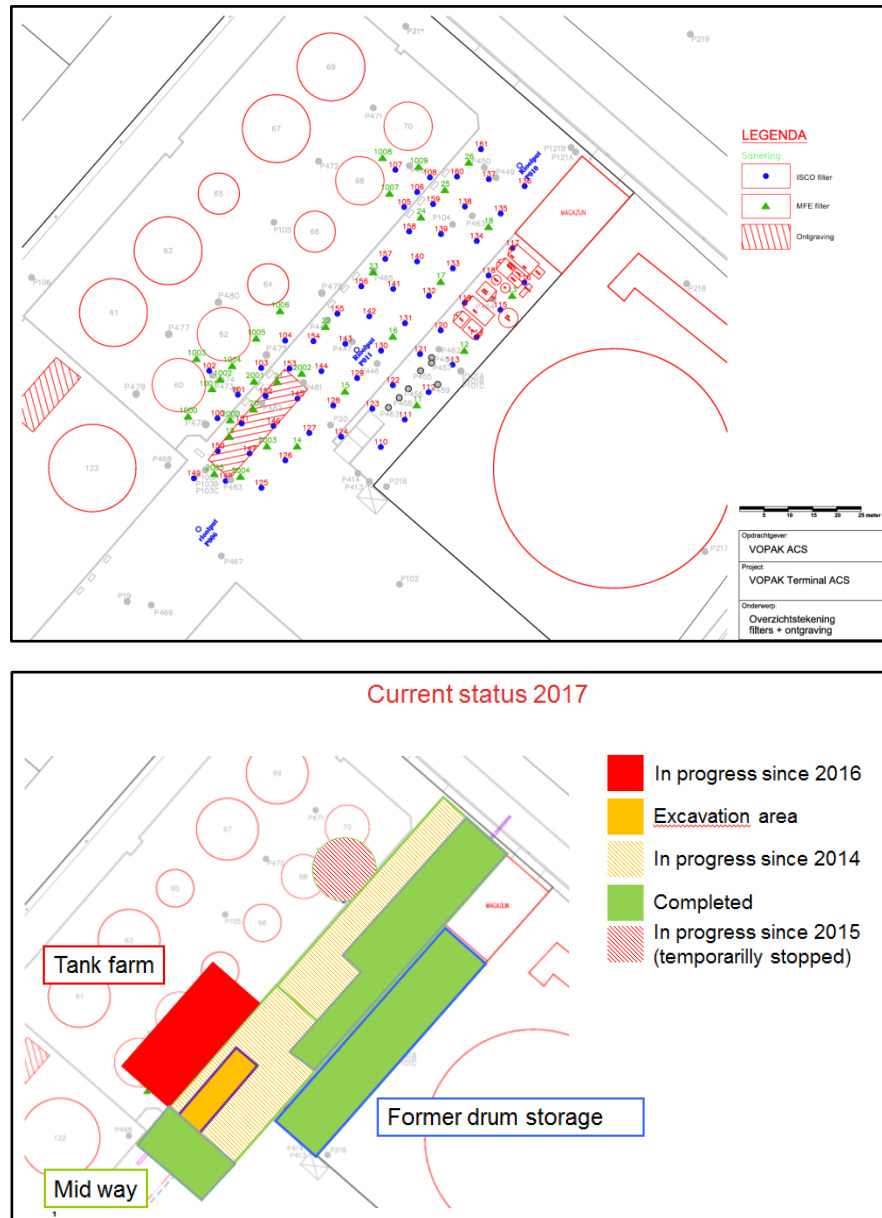


Figure 1. Remediation concept and overview of the remediation progress.



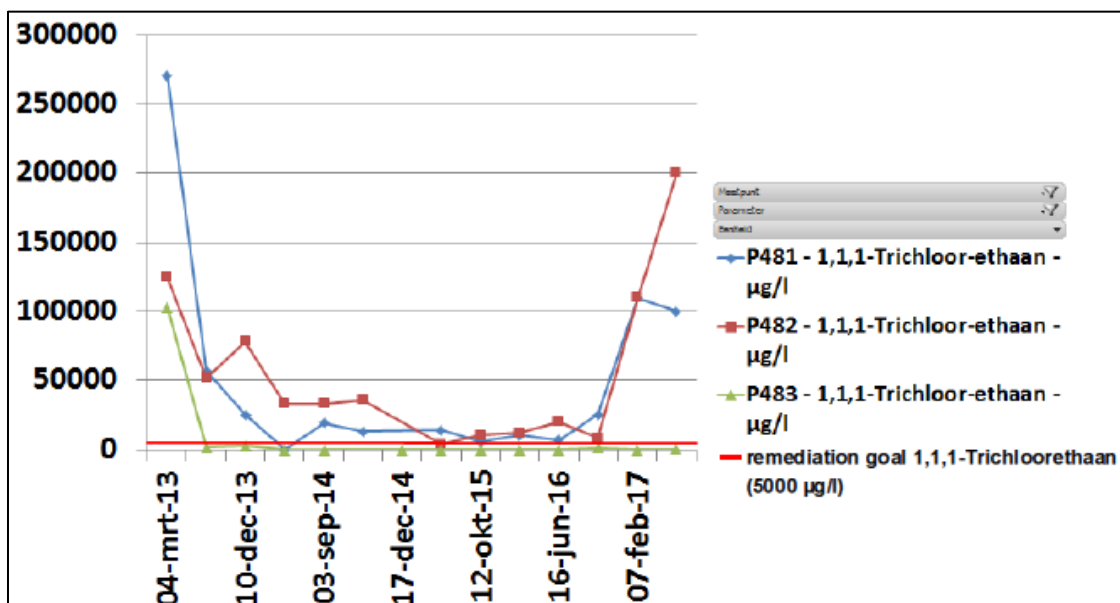
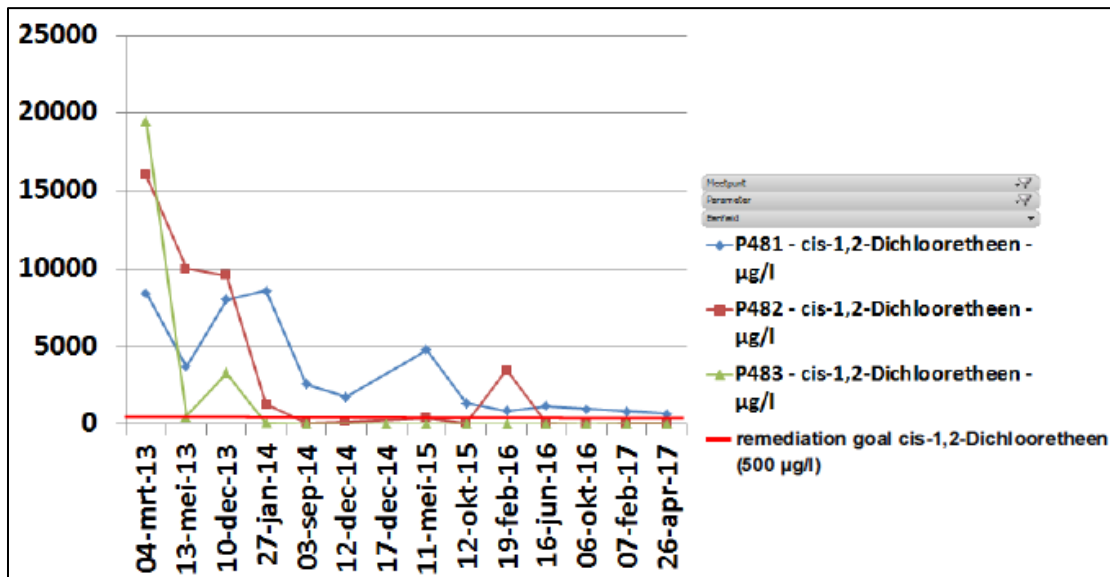
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Source area “excavation zone”

The in-situ remediation using ISCO combined with SVE (soil vapour extraction) in the source area near the excavation zone was started in November 2013. In the beginning only ozone was injected instead of perozone, in order to test the effectiveness of ozone as a sole oxidant in source areas with a high contamination load. As the concentrations started to decrease injections of perozone were started.

Monitoring results

The evolution since 2013 of groundwater concentrations of the most important contaminants is illustrated in the charts below. The red lines indicate the remediation goals as defined in the remedial action plan. Each graph shows the evolution of one contaminant for the three monitoring wells in and around the excavation zone.





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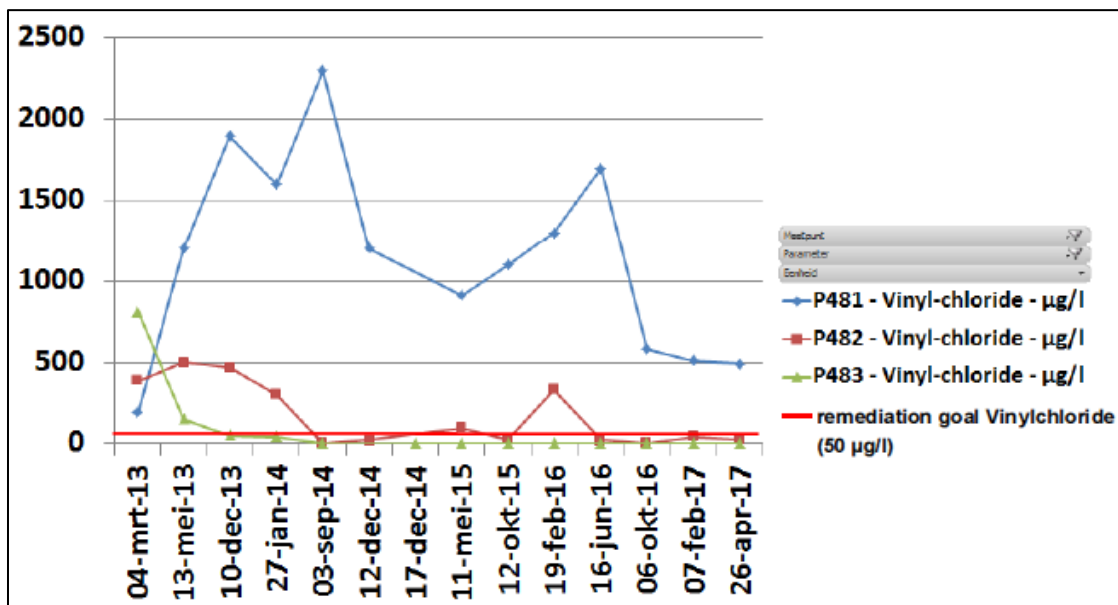
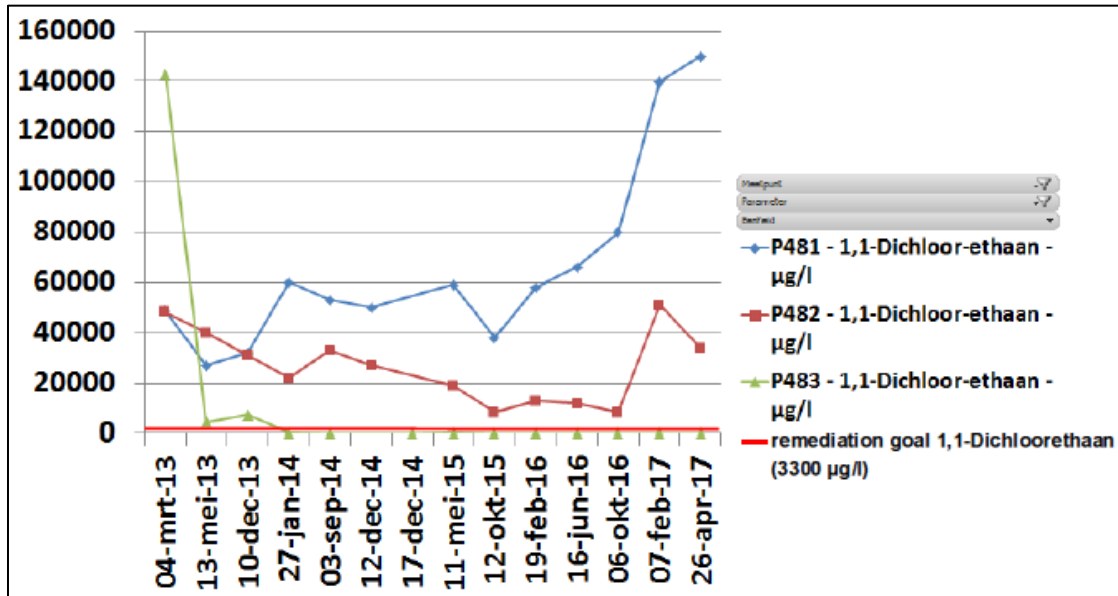


Figure 2. Charts showing the evolution of groundwater concentrations in the monitoring wells during the in situ remediation in the source area around the excavation zone.



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Since the start of the remediation beginning 2013, the results can be considered spectacular. An initial strong decrease after the excavation was noticed in the 3 monitoring wells. After a more or less stable period between end 2013 and end 2014 a further decline is obtained for most of the parameters in wells 481 and 482. Only the chloro-ethanes still stay more or less stable. In P482 the remediation targets for all contaminants, except 1,1-DCA and 1,1,1-TCA, were reached. The contaminant concentrations in the groundwater around P481 were still high for 1,1-DCA and VC. The remediation goals for 1,2-DCE and 1,1,1-TCA were nearly reached. Generally the contamination in P481 was decreased with about 90% compared to the initial concentrations of beginning 2013. It was expected that the concentrations would stabilize at a certain (high) concentration as long as a high mass is present in the soil (as pure product). At a certain moment, when the mass load and hence the dissolution rate will be reduced enough, the groundwater concentrations will decrease (more strongly).

Results of the last campaigns show an increase of the contamination concentration in the groundwater of well P481 and P482 mainly of chloro-ethanes. This indicates that there are still source areas with high concentrations in the soil or even pure product. The reason why this product is released since February 2017 needs to be further investigated. On going civil works in the surroundings could have influenced the remediation area with these results.

The third well (P483) shows a spectacular improvement shortly after the excavation. A few months after the ozone injections started the remediation target values were reached. Based on the results of the monitoring events of September and December 2014, the perozone injections around the area of P483 are stopped. The groundwater monitoring of June 2016 confirmed that the concentrations remain stable and that all remediation target values are met, even after Perozone injections were stopped.

Emissions

After the renewal of the concrete floor no more emissions towards the atmosphere have been noticed.



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Plume area midway

The remediation target values have been reached in the monitoring wells in the midway near the former drum storage area (P446, P449 and P463A). Based on the results of the monitoring events of September and December 2014, the perozone injections in the Midway along the former drum storage are stopped (see Figure 1).

The low groundwater concentrations measured in the monitoring well P463 in april 2017 confirm that the remediation target, except for vinyl chloride, is reached in the area around this well and no relevant rebound occurs after Perozone injections were stopped.

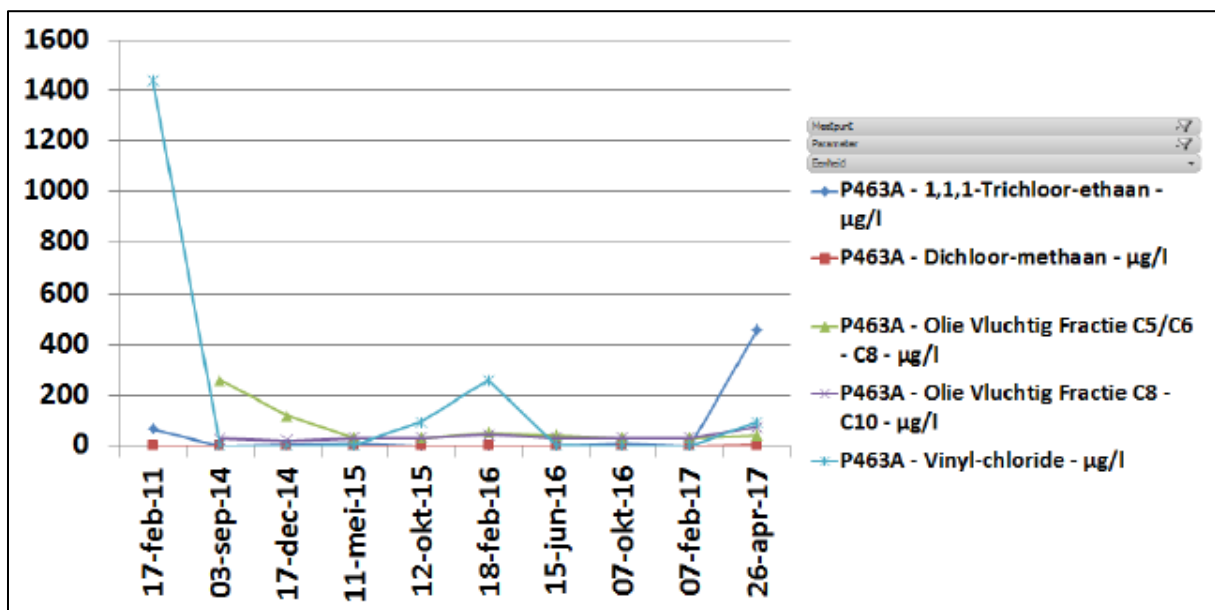


Figure 3. Chart showing the evolution of groundwater concentrations in monitoring well P463A during the in situ remediation (plume area midway).

In the monitoring wells in the midway along the tank farm (P447, P448, P450 and P465) the remediation target values were reached for almost all contaminants except for 1,1-dichloroethane, cis-dichloroethene and vinylchloride in P465. After fluctuating concentrations, 1,1 dichloro-ethane in P448, met in June 2016 the remediation goal for the first time. In P465A 1,1-dichloroethane continues decreasing. Further evolution needs to be checked in the next monitoring events but the results stay very encouraging.

P450 has not been sampled in 2017 because the remediation targets were reached in September 2014.



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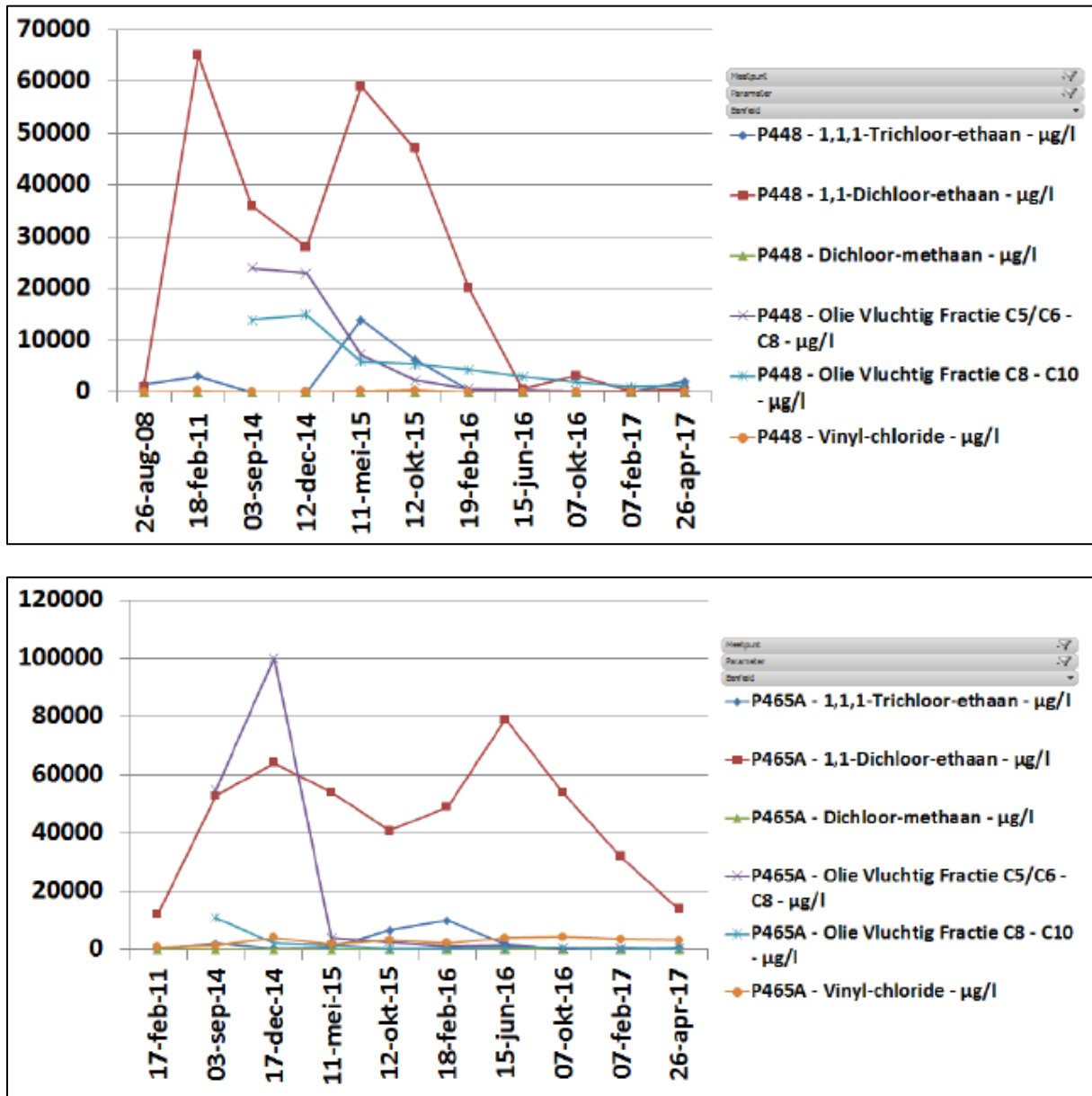


Figure 4. Charts showing the evolution of groundwater concentrations in the monitoring wells during the in situ remediation in the plume area midway.

Emissions

Since February 2015 no more emissions towards the atmosphere have been noticed.



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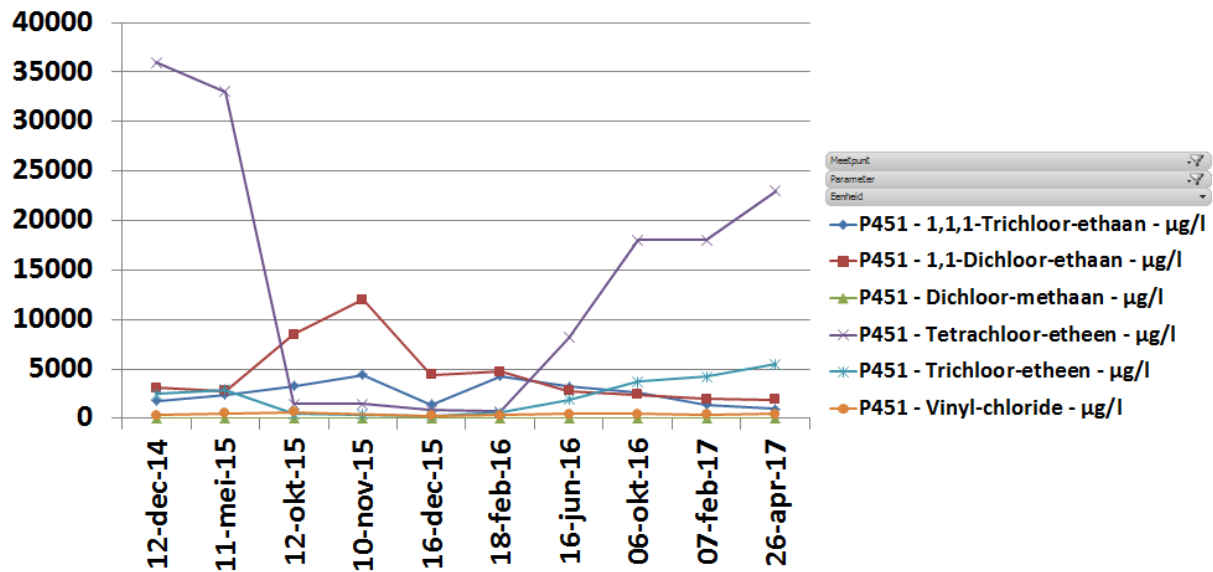


Figure 6. Charts showing the evolution of groundwater concentrations in the monitoring wells during the in situ remediation in the small source area in the tank farm.

Emissions

In the summer of 2015, a hydrogen peroxide leak occurred at tank park (tanks 68 and 70). The injection in these zone started in January 2015. Due to the increased tensions on the fittings by the sagging peroxide pipe, a fitting loosened causing the hydrogen peroxide leak. This leak was observed during the weekly inspections and controls of the above remediation system.

As for ozone, hydrogen peroxide liquid (with low vapour pressure) is strong oxidizing agent, decomposing easily when brought into contact with organic materials (such as the products stored in the tank park). Contact could lead to increasing risk of fire and may even under certain conditions cause explosion.

The tank park is an EX-rated area where severe safety measures are in operation. On instruction of the health and safety manager BADECO, a weekly inspection and control program is in operation at the tank park zones during injection. This program includes both oxygen/ozone/PID and pressure/suction head measurements at the different filters and wells in the tank park. Measurements are executed by the contractor, but regularly completed by measurements by RSK and VOPAK. Rolling out this program, the project accomplishes one of the main goals controlling the in-situ soil remediation of groundwater in an explosion sensitive environment.



Big source area in the tank farm

Mid 2015 phase 4, the remediation by ISCO of the big source area in the tank farm, has been prepared. One of the main risks in the tank farm is the corrosion of the tank floor due to ozone emissions. The tank farm itself is liquid tight but the storage tanks are built on a foundation of stabilized sand and hence the tank floors may come in contact with ozone.

Four soil vapor monitoring wells have been installed in the tank farm. The 4 wells are installed just next to the 4 storage tanks (60, 62 and 64) that are situated in the injection influence radius. Possible ozone emissions should be captured by the vertical soil vapor extraction wells/MFE-filters (1000-1006) situated around the injections wells (see figure). The efficacy of this system will be monitored by the four soil vapor monitoring wells (486, 487, 488, 489). If ozone concentrations or increased oxygen concentrations are detected in the vapor monitoring wells, the injections will be stopped immediately and additional actions have to be implemented to prevent contact of ozone with the tank floors.

The remediation of the big source area in the tank farm started in January 2016. Due to the renewal of tank 60 in the tankfarm the installation is completely stopped during Octobre 2016. Due to the renewal of tank 72 in the tankfarm the remediation of the big source zone in the tank farm is completely stopped during April 2017. During these civil works the continuing of injection is estimated as too riskfull.

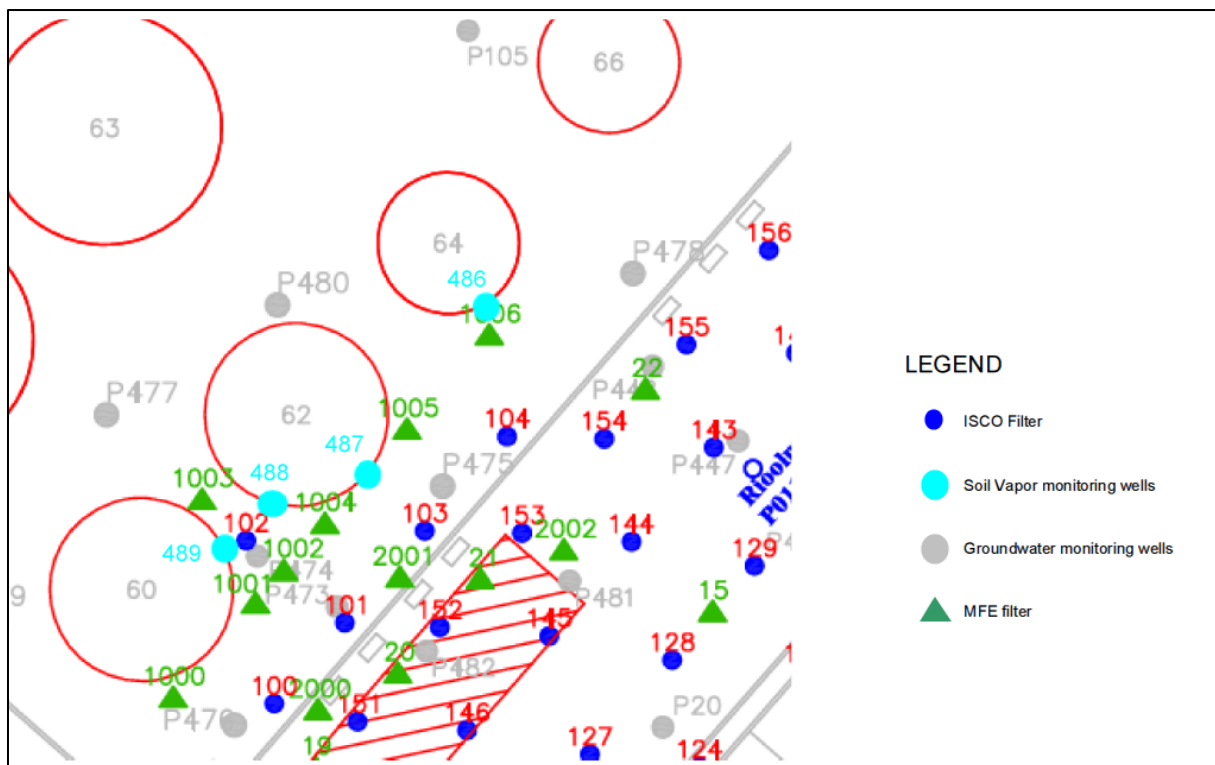


Figure 7. Indication of the positions of the soil vapor monitoring wells in the tank farm.



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Exceedance of remediation goals are only observed in wells P473 and P475. After one month of injections in the big source area of the tank farm the concentration of volatile total petroleum hydrocarbons and also the chloro-ethanes has decreased remarkably in these wells. After more then a year these concentrations remained more or less stable above the remediation goals.

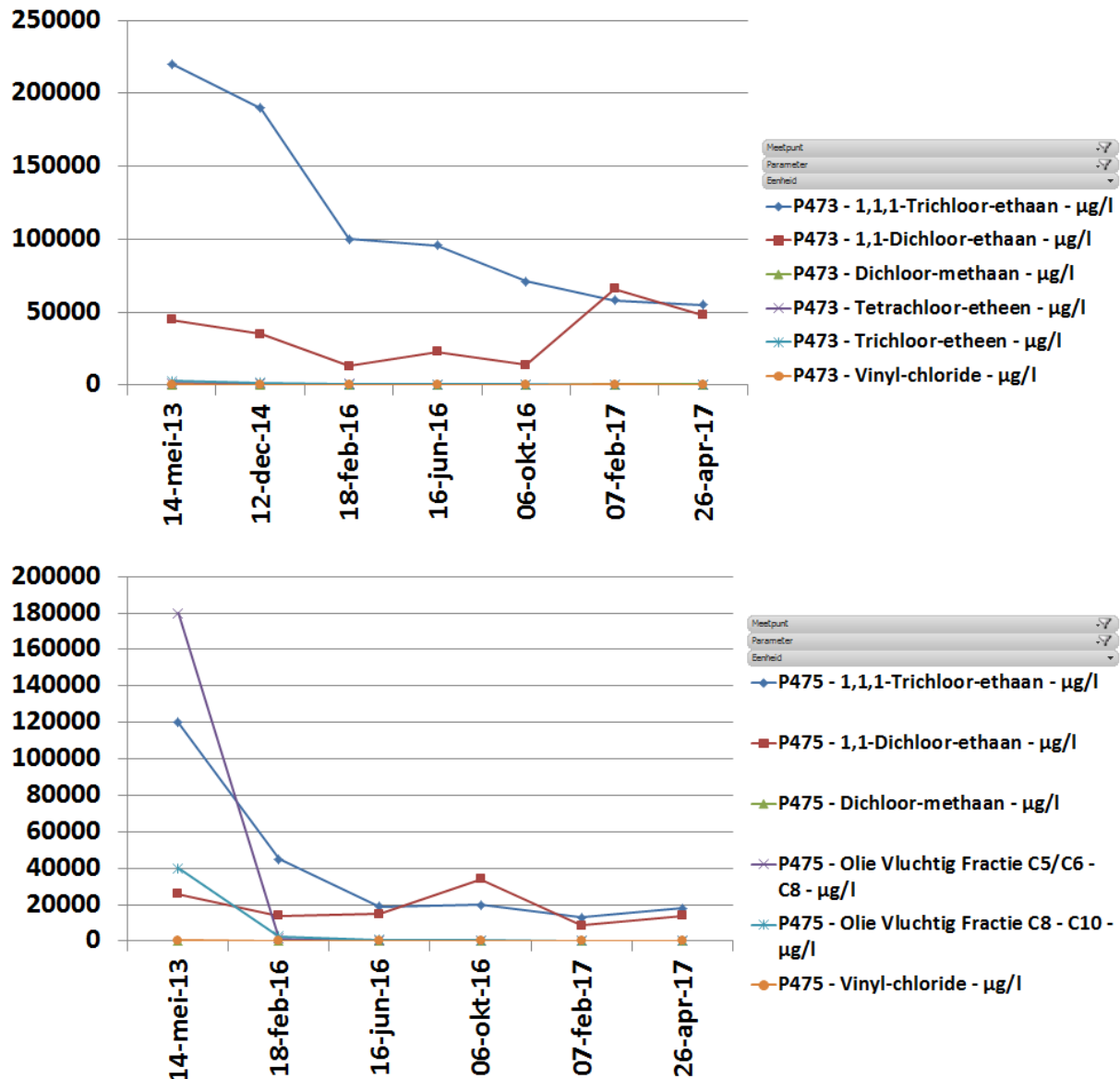


Figure 8. Charts showing the evolution of groundwater concentrations in the monitoring wells during the in situ remediation in the big source area in the tank farm.

Emissions

No emissions towards the atmosphere or soil vapour close to the tanks have been noticed.



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Next steps

The injections in the excavation zone around P481 and 482, in the Midway along the tank farm and in the big source area in the tank farm will be continued. Further investigation of the cause of the increasing concentrations around P481 en P482 is needed. As soon as capacity becomes available the injections in the small source area need to be restarted. The duration of the injections in the high mass zones will be longer than initially estimated due to the H&S limits of the vapour emissions. However, both further optimization of the injection regime should be considered depending upon the results in the near future without causing emissions in order to accelerate the remediation.

The next monitoring event is scheduled for August 2017.

More information

More information can be found on the project website www.vopak-experO3.be.