

### **PROJECT NAME**      **BIOREMEDIATION OF SOIL CONTAMINATED WITH PETROLEUM HYDROCARBONS**

**LOCATION**                      STSI d.o.o. / MOSLAVAČKA GRAČENICA

**DURATION**                      2015 – on going

**OUTCOME**                      Since 2015, STSI d.o.o. has successfully treated approximately 3,500 tonnes of contaminated soil. Cleaned up soil was reused as construction material for landscaping activities, which is consistent with the concept of circular waste management and sustainable development principles.

## Project Description

### ▶ **BACKGROUND**

Soil contaminated with petroleum hydrocarbon can present a risk to human health and the environment and to deal with that risk, remediation activities are performed. STSI d.o.o., as a member of INA Group, started to develop waste management activities for the purposes of INA d.d., according to the best available techniques.

Today, the method of bioremediation is recognized worldwide as the main method for remediation of soil contaminated with petroleum hydrocarbons. The principle of the bioremediation method is to use a mixed culture of microorganisms to transform hazardous polluting hydrocarbons from the soil into less dangerous products, where the end result can be water and carbon-dioxide.

Soil that has been cleaned up in this way can be reused in the environment. Some of the advantages of the use of natural microorganisms (GMO free) for soil clean-up are:

- there are no new chemicals being introduced into the environment.
- there is no increase in the volume of waste and
- there is no need for construction of special facilities.

Also, when compared to other methods of treatment, this method is much more cost effective and efficient. All the above traits make bioremediation part of the so-called green technology – technology of the future, because it corresponds to the concept of sustainable development.

### ▶ **HISTORY**

Physical, chemical and thermal methods are often used as technologies for clean-up of locations contaminated with petroleum hydrocarbons. However, these procedures were expensive and very often not sufficiently efficient. Therefore, a need arose for the application of less expensive and more ecologically acceptable methods and nowadays, over 25% of all remediation processes refer to biological methods.

This is the reason why, during 2013 and 2014, STSI started the preparations for implementation of the bioremediation process at Moslavačka Gračenica location. At the end of 2014, the necessary waste management permit was obtained, including treatment of 1,800 tonnes of contaminated soil.

At that location, ex situ, “landfarming” bioremediation method is applied, and a combined process of biostimulation and bioaugmentation is used (Figure 1). Bioremediation process is repeated until the target values are achieved, which are considered to indicate cleaned up soil that can be rationally reused in the environment.

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## Sustainability Case Study

Figure 1. Bioremediation process



## Project Results

### ► MAIN RESULTS AND OUTCOMES (WHAT CHANGED?)

Since 2015, by applying the bioremediation method, approximately 3,500 tonnes of contaminated soil, excavated during reconstruction of petrol stations, have been successfully cleaned up. Cleaned up soil was reused as construction material for landscaping activities, which is consistent with the concept of circular waste management and sustainable development principles.

During the reconstruction of the service station (SeS) Petrinja, 1,284.8 tonnes of soil contaminated with petroleum hydrocarbons were excavated. After the receipt and distribution of the soil along the dedicated areas below the canopy, a laboratory analysis was made which determined the following initial concentrations of pollutants – mineral oils (TPH) 1,694.6 mg/kg, BTEX 0.698 mg/kg, PAH 0.655 mg/kg. (Table 1, Graph 1).

Table 1. Analyzed parameters

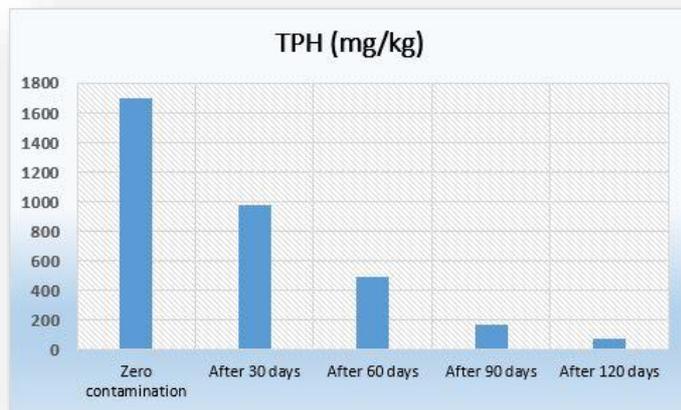
Analyzed parameters	Initial contamination	After 30 days	After 60 days	After 90 days	After 120 days
pH	7.4	8.1	7.1	7.2	7.4
TPH <sup>1</sup>	1,694.6	977.4	496.0	172.4	75.5
BTEX <sup>2</sup>	0.698	<0.1	<0.1	<0.1	<0.1
PAH <sup>3</sup>	0.0655	<0.001	<0.001	<0.001	<0.001

<sup>1</sup>Total Petroleum Hydrocarbons (mg/kg.)

<sup>2</sup>Benzene, Toluene, Ethylbenzene and Xylenes (mg/kg)

<sup>3</sup>Polycyclic Aromatic hydrocarbon (mg/kg)

**Graph 1.** Concentration of TPH during bioremediation



According to the determined concentrations, commercial preparations were applied and the soil was wetted and loosened (aerated) on a weekly basis. Every 30 days, the progress of bioremediation process was monitored (Table 1, Graph 1) and microorganisms and surfactants were re-applied. After a month, decrease in BTEX and PAH was recorded to be below the detection limit, while the concentration of mineral oils was reduced by approximately 40%. After 60 days of bioremediation, the soil was cleaned up by approximately 70%, and after 90 days, by approximately 90%. Target concentrations were achieved after 120 days when 75.5 mg/kg of mineral oils were measured and the bioremediation process was stopped.

Based on the past experience in bioremediation of soil contaminated with petroleum hydrocarbons, STSI d.o.o. have achieved satisfactory results with soil clean-up to the level that can be reused in the environment and our goal is further development and improvement of this method.

#### 4) FURTHER STEPS

In order to adequately address the needs of INA, d.d. for treatment of contaminated soil, STSI started to expand its bioremediation capacities at Moslavčka Gračnica location. Within that project, a new hall has been built (Figure 2) that will enable the treatment of 10,000 tonnes of contaminated soil per year. The process of obtaining all necessary permits is under way, and afterwards, it will be possible to start treatment of soil in a new facility.

**Figure 2.** New hall for bioremediation

