

## ASSESSMENT OF SOIL CONTAMINATION BY PETROLEUM HYDROCARBONS AND REMEDIATION MEASURES AT WELL 251, SCĂRIȘOARA NOUĂ, SATU MARE COUNTY

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### RESEARCH ARTICLE

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#### Abstract

The activities of oil extraction, transport, and storage can lead to soil contamination with petroleum hydrocarbons, negatively impacting the environment and land use. This study assessed soil contamination within the perimeter of Well 251 Scărișoara Nouă, located in the extravilan area of Piscoț village, Satu Mare County, a decommissioned oil site that underwent deep abandonment works in 2018. The aim of the research was to determine total petroleum hydrocarbon (TPH) concentrations and establish optimal soil remediation measures.

Twenty soil samples were collected from five points (P1–P5) at depths ranging from 0.05 to 0.9 m, in accordance with standard SR EN ISO 10381, with the locations recorded using a Stonex S9 GNSS GPS device. Laboratory analyses revealed exceedances of alert and intervention thresholds (Order 756/1997), particularly at points P1 and P3 at all depths, and at point P4 at 0.9 m depth.

Based on these results, excavation and transport of contaminated soil to the Suplacu de Barcău bioremediation station were planned, along with measures to restore the soil layer and establish natural vegetation. The study provides an evaluation and remediation model applicable to other decommissioned oil sites, contributing to the reduction of environmental risks and the reintegration of affected lands into economic and ecological use.

**Keywords:** contaminated soil, petroleum hydrocarbons (TPH), environmental monitoring, land remediation, abandoned oil wells.

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### INTRODUCTION

The activities of oil extraction, transport, and storage are major sources of soil contamination with petroleum hydrocarbons, directly affecting environmental quality, biodiversity, and land use (Mishra et al., 2016; Sarkar et al., 2017). In Romania, numerous industrial sites and oil fields are classified as potentially contaminated sites, and current legislation (Law no. 74/2019 on the management of potentially contaminated and contaminated sites) requires their periodic assessment and the adoption of remediation measures to restore lands to safe ecological conditions (Rusu et al., 2013; Roșca et al., 2015).

Well 251 Scărișoara Nouă, located in the extravilan area of Piscoț village (Satu Mare County), represents such a site with completed oil activity (Brejea et al., 2020). Drilling was carried out in 1986 to exploit Miocene and Eocene formations, and production activity

ceased in 2002, after which the site was included in the abandonment program approved by ANRM. The total site area is 1,109 m<sup>2</sup> (900 m<sup>2</sup> for the well pad and 208 m<sup>2</sup> for the access road), with the land previously used as arable/unproductive land and classified as “courtyards, buildings, and roads.”

According to methodological norms, decommissioning and site restoration works involve dismantling technological installations, decommissioning pipelines and concrete elements, selective management of contaminated and uncontaminated materials, and restoring the soil layer using materials from controlled sources (Sorana Oț et al., 2020; Sabău & Șandor, 2013). The site is also located near protected natural areas, requiring additional measures to minimize impacts on habitats and species. In this context, the present study aims to assess the level of petroleum hydrocarbon (TPH) contamination in the soils of Well 251 Scărișoara Nouă and to

identify optimal land remediation measures, based on field investigations and laboratory analyses conducted according to current standards (SR EN ISO 10381). The results provide support for the proper implementation of environmental regulations and the restoration of the land to its original functionality, thereby reducing risks to the environment and public health.

### MATERIALS AND METHODS

The study was conducted within the perimeter of Well 251 Scărișoara Nouă, located in the extravilan area of Piscoț village, Satu Mare County. The total site area is 1,109 m<sup>2</sup>, of which 900 m<sup>2</sup> corresponds to the well pad and 208 m<sup>2</sup> to the access road (dirt road). The land is classified as “courtyards, buildings, and roads,” with previous use as arable/unproductive land. Drilling was carried out in 1986, production activity ended in 2002,

and deep abandonment works were performed in 2018, according to the ANRM agreement.

To assess the degree of soil contamination with total petroleum hydrocarbons (TPH), soil samples were collected from five points (P1–P5) arranged as follows: point P1 in the immediate vicinity of the well casing, and the other four points distributed within the well pad in areas with potential pollution risk. From each point, samples were taken at four depths (0.05 m, 0.30 m, 0.60 m, 0.90 m), totaling 20 samples. The exact locations of the sampling points were determined using a Stonex S9 GNSS GPS device. Sampling, labeling, packaging, and storage of the samples were carried out in accordance with standard SR EN ISO 10381.

Table 1.

Data on the depths of the samples taken for well 251 Scărișoara Nouă

Sample	Sampling Level A (m)	Sampling Level B (m)	Sampling Level C (m)	Sampling Level D (m)	Number of Samples Collected
S1	0,05	0,3	0,6	0,9	4
S2	0,05	0,3	0,6	0,9	4
S3	0,05	0,3	0,6	0,9	4
S4	0,05	0,3	0,6	0,9	4
S5	0,05	0,3	0,6	0,9	4
<b>Total</b>	-	-	-	-	20

The determination of TPH concentrations in the soil samples was carried out in an accredited laboratory, using validated procedures that comply with the applicable method and product standards for each type of sample. The procedures include calibrated equipment, minimum detection limits, and

reporting ranges in accordance with current legislation.

Table 2

**TPH concentration data of samples taken for well 251 Scărișoara Nouă**

Sample	TPH (mg/Kg s.u.)			
	Sampling Level A 0,05 (m)	Sampling Level B 0,3 (m)	Sampling Level C 0,6 (m)	Sampling Level D 0,9 (m)
S1	3350	2890	2100	1500
S2	810	800	802	900
S3	4200	6050	2100	3050
S4	950	820	740	7863
S5	1000	950	800	754

The results obtained were compared with the reference values for total petroleum hydrocarbons (TPH) established in Order

756/1997 for less sensitive land use (normal, alert, and intervention thresholds).

Table .3

**Alert and intervention thresholds for TPH**

Petroleum Hydrocarbons – TPH (mg/kg d.w.)	Normal values	Alert thresholds		Intervention thresholds	
	<100	Sensitive	Less sensitive	Sensitive	Less sensitive
		200	1000	500	2000

The geographical location of Well 251 Scărișoara Nouă and the arrangement of the

sampling points can be illustrated with an image or site plan.

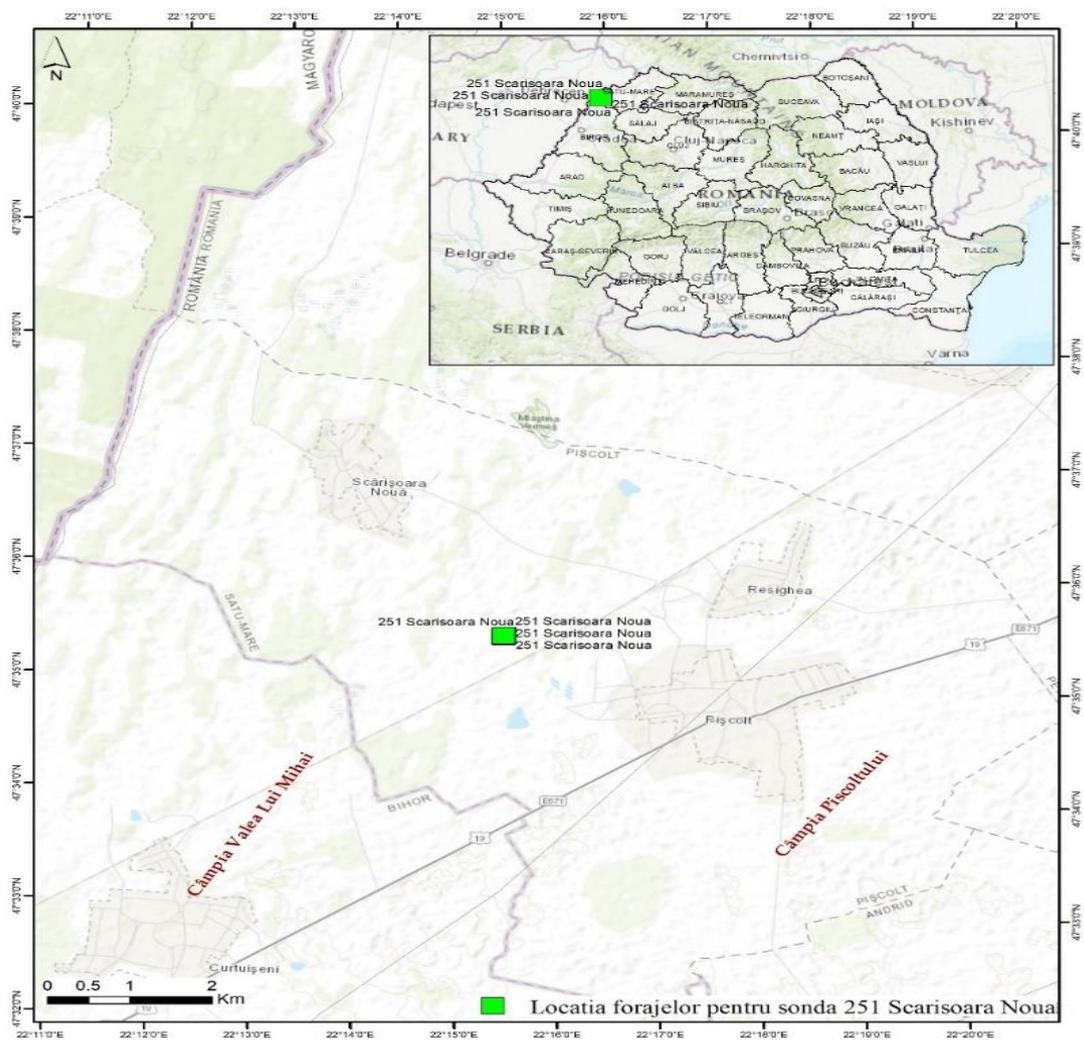


Figure 1 Geographical position of the well 251 Scărișoara Nouă

The distribution of TPH concentrations by depth can be graphically represented to

better highlight the differences between the analyzed points.

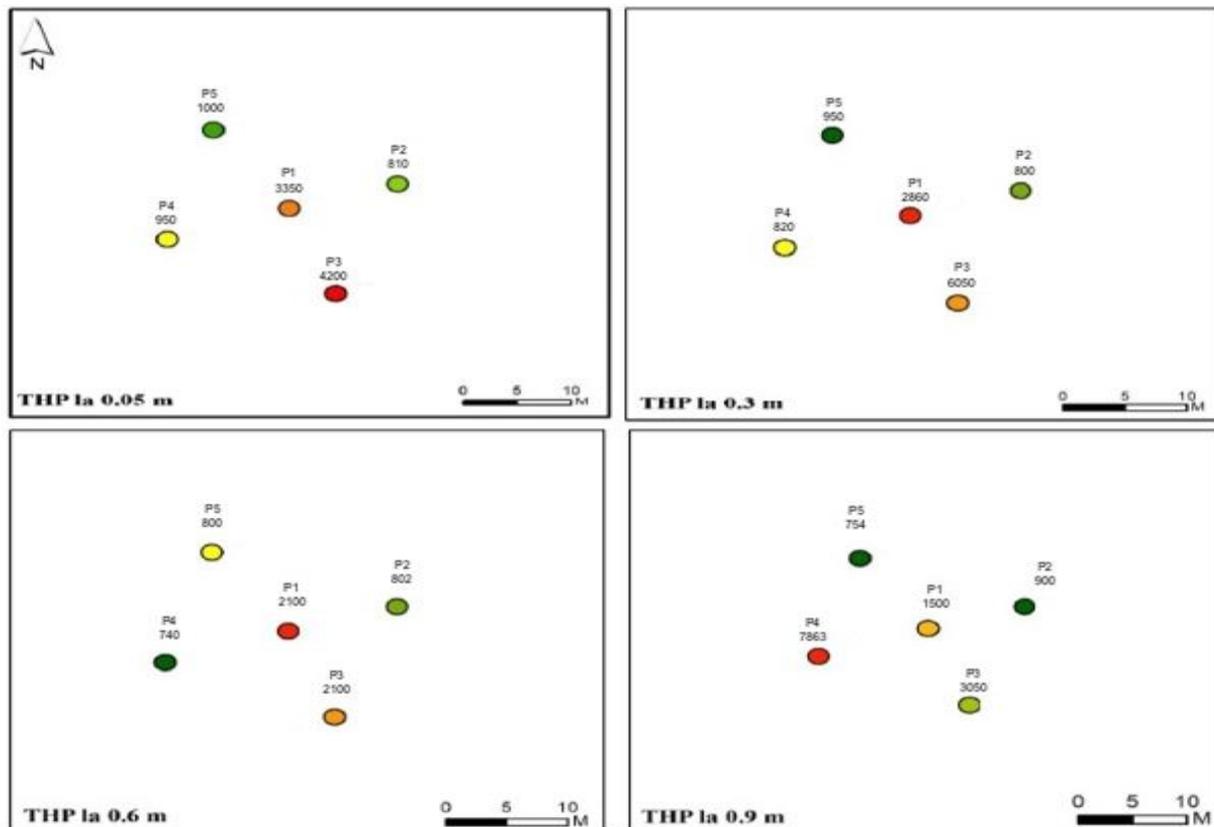


Figure 2 The values of TPH concentrations identified at different depths for probe 251 Scărișoara Nouă

## RESULTS AND DISCUSSIONS

Laboratory determinations of total petroleum hydrocarbons (TPH) in the soil within the perimeter of Well 251 Scărișoara Nouă are summarized in Table 5.2. The results show significant variability between sampling points and depths.

At point P1 (located at the wellhead), TPH concentrations range from 3,350 mg/kg dry weight (d.w.) at 0.05 m depth to 1,500 mg/kg d.w. at 0.90 m. These values exceed the intervention threshold for less sensitive land use (2,000 mg/kg d.w.) at depths of 0.05–0.60 m and the alert threshold (1,500 mg/kg d.w.) at 0.90 m.

Point P3 recorded the highest concentrations, reaching 6,050 mg/kg d.w. at 0.30 m depth, exceeding the intervention threshold at all investigated depths.

At point P4, TPH values remain below the alert threshold at depths of 0.05–0.60 m but exceed the intervention threshold at 0.90 m (7,863 mg/kg d.w.), suggesting accumulation of contaminants at deeper soil layers.

In contrast, at points P2 and P5, TPH concentrations remain below the alert threshold for all investigated depths, indicating areas with minimal pollution impact.

Comparison of the measured values with the thresholds regulated by Order 756/1997 (Table 5.3) highlights significant petroleum hydrocarbon contamination in areas with intensive activity (the wellhead and point P3) and localized deep contamination at P4. This distribution suggests migration of petroleum products from the operational area to lower soil layers, a phenomenon also documented in other studies on decommissioned oil sites.

Based on these results, excavation works were planned for contaminated soil over an area of 200 m<sup>2</sup> and a depth of 2 m at borehole P4, totaling 80 m<sup>3</sup> of contaminated soil, supplemented by 36 m<sup>3</sup> of contaminated soil from cleaning the well cellar. The contaminated soil was transported to the Suplacu de Barcău bioremediation station, and bituminous petroleum products were disposed of in hazardous waste landfills.

The results confirm the necessity of remediation interventions to restore the land to its initial condition and demonstrate the importance of post-abandonment monitoring of oil wells. Furthermore, the study illustrates the applicability of the legislative framework (Law 74/2019, Order 756/1997) in the evaluation and remediation of potentially contaminated sites, providing a model of best practices for similar locations.

### CONCLUSIONS

The study conducted on the perimeter of Well 251 Scărișoara Nouă (Satu Mare County) highlighted the presence of elevated total petroleum hydrocarbon (TPH) concentrations in the soil, exceeding the alert and intervention thresholds established by Order 756/1997, particularly at the wellhead (P1), at point P3 at all depths, and at point P4 at 0.9 m depth. The vertical distribution of contaminants suggests migration of petroleum products to deeper soil layers, a phenomenon associated with previous extraction activities.

Based on these results, and remediation measures were established and implemented, consisting of the excavation and transport of contaminated soil to the Suplacu de Barcău bioremediation station, as well as the disposal of bituminous petroleum products in authorized hazardous waste landfills.

The implementation of these measures contributes to restoring the land to its original condition and reducing risks to the environment and human health. The study demonstrates the importance of systematic monitoring of abandoned oil sites and compliance with the current legislative framework (Law 74/2019, Order 756/1997) to ensure proper management of potentially contaminated sites.

The results obtained can serve as a model of best practices for the assessment and remediation of other similar locations, contributing to the protection of soil resources and the sustainable development of areas affected by oil-related activities.

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