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ENVIRONMENTAL ASSESSMENT ON AN INDUSTRIAL SITE LOCATED IN VRANCEA COUNTY ROMANIA

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Abstract

This paper focuses on the application of the usual approach for the environmental assessment of former industrial sites which were disaffected and now are the subject of a real estate transaction or which are brownfields.
The existing Romanian legislation in this field lacks content and must to be completed with other available regulations, even the Romanian GD 1408/2007 on the methods of investigation and assessment of pollution of soil and subsoil was approved but the implementation rules not yet been published. This happens in a context where there is no EU legislation in this matter. To achieve the necessary investigations in order to identify and quantify the pollution of the geological media, most environmental consultants resort to ASTM standards. Besides, the success of the approach is provided by a rich professional experience of the environmental assessors involved.
The case study presented in this paper refers to the approach taken to investigate and to quantify the potential historical pollution for a former industrial land, after the end of activities.

Key words*: ASTM, Environmental Site Assessment, intrusive investigation, Remedial Action Plan (RAP), Total Petroleum Hydrocarbon (TPH)*

INTRODUCTION

After 1990, in Romania much of the industrial units originally built on the outskirts of big cities were virtually dismantled. These locations have now become the subject of residential development, but, because they can be used for this purpose, must undergo auditing in terms of Environmental Site Assessments.
In the last years, an increased importance was paid in identifying historically contaminated sites, evaluating and solving them using the most appropriate methods. The Romanian environmental legislation has also been subject to several changes and additions in this period, but it remains incomplete.
For example, it was approved the GD 1408/2007 on the methods of investigation and assessment of soil and subsoil pollution, and then the implementing rules should have been published. After ten years they have not been published yet, so that environmental consultants who conducted these kinds of investigations are forced to use other available regulation or standards, if they exist. If not, only their experience must solve the different situations. This happens in a context where there is no specific EU legislation in this matter.
Identification and quantification of historical land pollution on which industrial activities were carried out is very important especially in two specific situations: through the procedure of brownfields sites identification and remediation which is a legal obligation of the activity holder and/or landowner; in the beginning of the commercial real estate transaction process. In this second case, the buyer of a property is the most interested to know all the details about a possible historical pollution. Ignoring that problem could cost, because the buyer will become owner of the land for whose decontamination will have to pay.
Also, please note that brownfields redevelopment projects can eradicate urban blight, speed-up remediation of existent pollution and infuse new economic opportunities (Word Bank - The Management of Brownfields Redevelopment, 2010).
Some standards usually used in order to identify and quantify the historical pollution,

are the standards issued by ASTM (American Society for Testing Materials). Throughout its existence, the ASTM was transformed from a simple American organization into a globally recognized leader in the development and delivery of voluntary consensus standards. According to ASTM standards and the international practice, the most usual approach for the full environmental site assessments requires going through following steps:

a) *Phase I Environmental Site Assessment.* The purpose of this Phase I ESA is to identify the environmental conditions in connection with the property and consists of four components: records review, site reconnaissance, interviews and reporting (ASTM E1527-13);

b) *Phase II Environmental Site Assessment.* The main objective of conducting a Phase II ESA is to obtain scientifically valid data concerning the actual property conditions, whether or not such data relate to property conditions previously identified in Phase I ESA (ASTM E1903-11). The Phase II ESA is conducted to determine whether target pollutants are present in the property environment, mainly through physical and chemical testing, and if present, to gain sufficient information regarding the existing contamination.

c) *Phase III Environmental Site Assessment.* The primary objective of a Phase III ESA is to investigate the nature and extent of adverse environmental impact identified by the previous phase and to develop a Remedial Action Plan (RAP). Specific investigations of this phase include the calculation impacted soil and/or groundwater volume, risk assessment, identification of possible remediation options, and sometimes site-specific pilot studies. At the end of this stage it is mandatory to notify the competent environmental authority which must approve the proposed remediation solution (Canadian Council of Ministers of the Environment - Environmental Guideline for Contaminated Site Remediation, 2003).

d) *Phase IV Environmental Site Assessment.* This phase (also known as Remediation/clean-up Phase) may involve the following components: removal and disposal of existing contaminated areas; on site treatment of contaminated soils, groundwater and waste streams; implementation of waste reduction plans, environmental management systems, and other source remedial measures.

e) *Phase V Environmental Site Assessment.* This phase (also known as Completion/Validation Phase) must demonstrate that RAP was fully implemented, providing evidence of actions undertaken.

No international standard exists for the last three ESA phases.

In this context, this paper presents a study case related to the environmental investigations developed on a Romanian brownfield, in order to identify and quantify the existing historical pollution, required by a potential investor interested in land acquisition. The authors applied both national and international legal provisions.

MATERIALS AND METHODS

The subject property of the study case is located in the Focsani municipality, Vrancea County and occupies 19,382 m^2 of land (Figure 1).

Figure 1. Site map location (INIS Viewer)

The property is bordered by the Buzau – Bacau railway (to the West), an industrial area (to the North), a residential area (to the East) and by a public property (to the South).

On the subject property a deposit of petroleum products was in operation between 1952 and 2012.

The storage capacity of deposit was: gasoline 640 m^3; diesel 1,966 m^3; light liquid fuel 1,030 m^3; oil 588 m^3; used oil 120 m^3.

The fuels were pumped from tank wagons into aboveground storage tanks (ASTs). From there they were pumped in service tanks and then into road tankers, to be delivered to local fuel stations.

Oils and light liquid fuel were pumped from tank wagons and discharged to horizontal underground storage tanks (USTs). From these tanks they were pumped to other service tanks for loading road tankers, or barrels and plastic containers.

Some buildings and warehouses were demolished after the cessation of activity.

For the above location an environmental site assessment was made, aimed at identifying the potential historical pollution of the geological media (including identifying of sources and pollutants). To this end, the first three phases of the environmental assessment procedure were completed based on:

- Ministry Order no. 184/1997 approving the procedure for environmental assessments;
- Ministry Order no. 756/1997 approving the regulation regarding environmental pollution assessment;
- Applicable standards.

Phase I ESA. Based on records review and on site visit observation, the following potential sources of pollution were identified:

- Traffic emissions from the tanker trunks;
- Spilled fuels and oils during loading and unloading, due to improper handling or leaks from fittings, pipes and hoses;
- Leaks of technological pipelines;
- Possible cracks in the walls of petroleum product tanks;
- Leaks of the wastewater sewage system;
- Accidental spills during tank cleaning.

Phase II ESA. Based on the data and information obtained during the Phase I ESA, intrusive investigations were recommended to be performed on site.

These investigations consisted of drilling works in order to take and analyze soil samples to identify historical pollution.

No samples were taken from groundwater because it is quartered to over 20 m depth.

The Subject Property layout and all phases investigation locations map are enclosed in Figure 2.

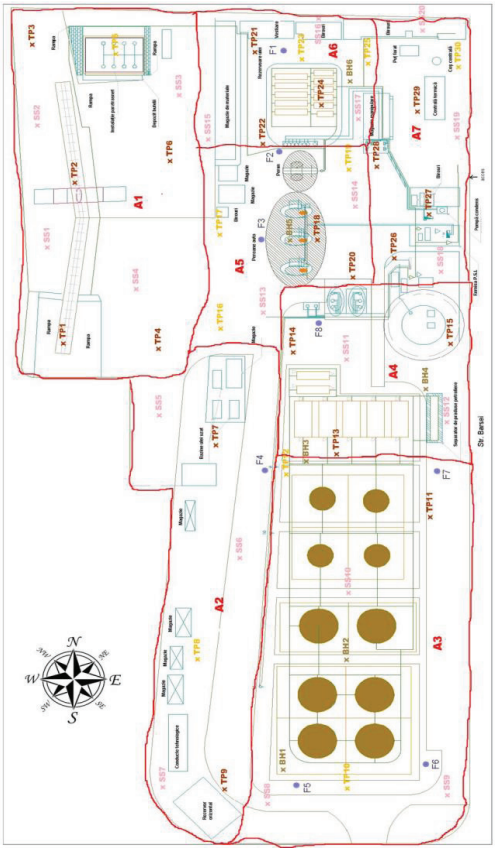

Figure 2. Investigation locations map

Potentially contaminated areas were identified in the northern part of the subject property, near oil USTs area and near road tanks loading platform, in the ASTs formerly contained fuel area, located in south-eastern part of the subject property, near the former pumping station and in the north-western area on the site where the rail tankers unloading ramp was.

Soil sampling was performed according to the applicable Romanian regulations (Ministry Order no. 184/1997 on approving the Environmental Site Assessment Procedure).

Eight (F1 – F8) boreholes were drilled to a maximum depth of 12 m bgl; a total of 31 soil and subsoil samples were recovered in order to be analyzed for TPH and Lead (Pb) in the analytical laboratory.

Samples were stored in pre-cleaned glass containers; the sampled quantities were decided according to the type of analysis and the laboratory requirements. The sample containers were labeled with a unique sample identification number and transported to the analytical lab (certified according ISO 17025:2001) by a consultant representative.

The analyzed parameters were selected as:

- to represent all the potential pollutants for this particular site; the identification of potential sources of contamination was done by relating the nature of past activities on site to visual observations;
- to provide relevant data taking into account any possible remedial actions that may be conducted as a result of significant contamination.

Taking into consideration the former specific activities of the subject property, two parameters were selected to be analyzed (total petroleum hydrocarbon - TPH and Lead).

In order to interpret the analytical results, the Ministry Order no. 756/1997 defines the significance of normal values, the alert threshold and the intervention threshold for contaminants:

- *normal value (NV)* traces of pollutant in air, water, soil or in emissions/discharges*;*
- *alert threshold (AT)* – pollutant concentrations in air, water, soil or in emissions/ discharges, which have the role of warning the competent authorities on a potential environmental impact and which determine the start-up of supplementary monitoring or/and mitigation of pollutant concentrations in emissions/discharges;
- *intervention threshold (IT)* – pollutant concentrations in air, water, soil or in emissions/discharges for which the competent authorities will require risk assessment studies to be performed and pollutant concentrations to be mitigated.

On the other hand, the current Romanian regulations on soil contamination refer both to the sensitive and less sensitive use of land, described as follows:

- *the sensitive use of land (SUL)* is the use of land for residential and recreational areas, for agricultural purposes, as protected or sanitary areas under a restrictive regime, as well as parcels of land foreseen to be used in the future as described above;
- *the less sensitive use of land (LSUL)* includes all the existing industrial and commercial uses, as well as parcels of land foreseen to be used in the future as described above.

The results of the analysis run on the recovered soil samples were compared to the maximum allowable levels imposed for the less-sensitive use of land, taking into account the fact that there is no known intent for a change of land use, other than industrial or commercial, relative to the subject property.

The soil analytical results revealed exceedances of the legal thresholds concentrations of total petroleum hydrocarbons (TPH) for three samples, collected from the borehole F8 (located in the middle of site), at depths of 1.00, 2.50 and 5.00 meters revealed above the intervention threshold. No exceedances of the threshold concentrations were recorded for the other samples.

According to the applicable legislation (MO 756/1997), the exceedance of the intervention threshold indicates a significant soil pollution, in which case it is necessary to implement soil remediation measures. The investigations must continue, in order to define the polluted area and to assess the volume of contaminated soil.

Phase III ESA. The previous step of the environmental assessment revealed contaminated areas.

Therefore, as shown in Figure 2, the subject property was divided in seven areas (A1 - A7) and the proposed sampling plan was as in Table 1. Soil samples would be collected in order to perform the proposed additional analysis. The recovered samples were analyzed in order to confirm the nature and the intensity of the contamination identified during the Phase II ESA and to suggest the most suitable remediation method.

Table 1. Phase III ESA Additional sampling plan

No.	*Sampling works type*	*Number of sampling points*	*Sampling depth (m)*	*Samples/sampling points*	*Number of total samples*
1.	Manual surface soil sampling (SS)	20	0.3; 0.5	2	40
2.	Mechanical excavation trench pits (TP)	10	0.3; 1.0; 2.0; 3.0	4	40
3	Mechanical excavation trench pits (TP)	20	0.3; 1.0; 2.0; 3.0; 5.0	5	100
4.	Mechanical drilled boreholes (BH)	6	1.0; 2.0; 3.0; 5.0; 7.0; 10.0	6	36
	TOTAL	56	-	-	216

Examples from the sample works operations are shown in Figures 3, 4 and 5.

Figure 3. Sampling of SS3

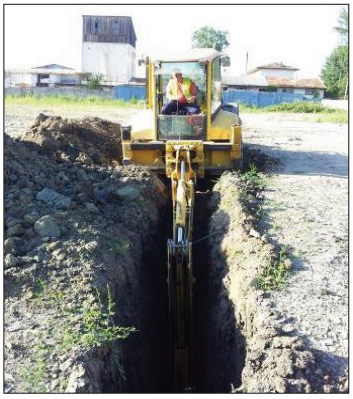

Figure 4. Digging of TP26

Collection, preparation and preservation of the samples were performed in compliance with national and international standards, and with appropriate QA/QC measures.

Figure 5. Drilling of BH4

The soil samples were analyzed for the following indicators:

- surface soil samples: TPH concentration by infrared method (IR) for all samples; TPH concentration by gas chromatography method (GC) for around 30% of samples;
- soil samples from TP excavations and boreholes BH: TPH – IR method (100% of samples); TPH – GC method (28% of samples); taking in account that petroleum hydrocarbon contaminants could generate some volatile organic compounds, 35% of samples were also analysed for BTEX content (Benzene, Toluene, Ethylene, Xylene).

RESULTS AND DISCUSSIONS

The results of TPH content measurements revealed exceedances of the intervention

threshold for less sensitive land use for around 34% of samples, while the alert threshold has been exceeded for 12% of samples (Figure 6).
All the BTEX concentrations were below the alert threshold.
The analytical results for the samples recovered during Phase III ESA were graphically interpolated in SURFER 11, for a relatively accurate view of the spatial extent and volume of contaminated material (Figure 7).

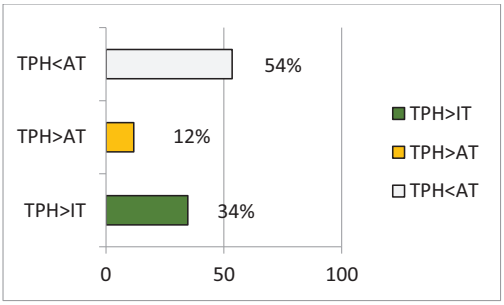

Figure 6 TPH statistics

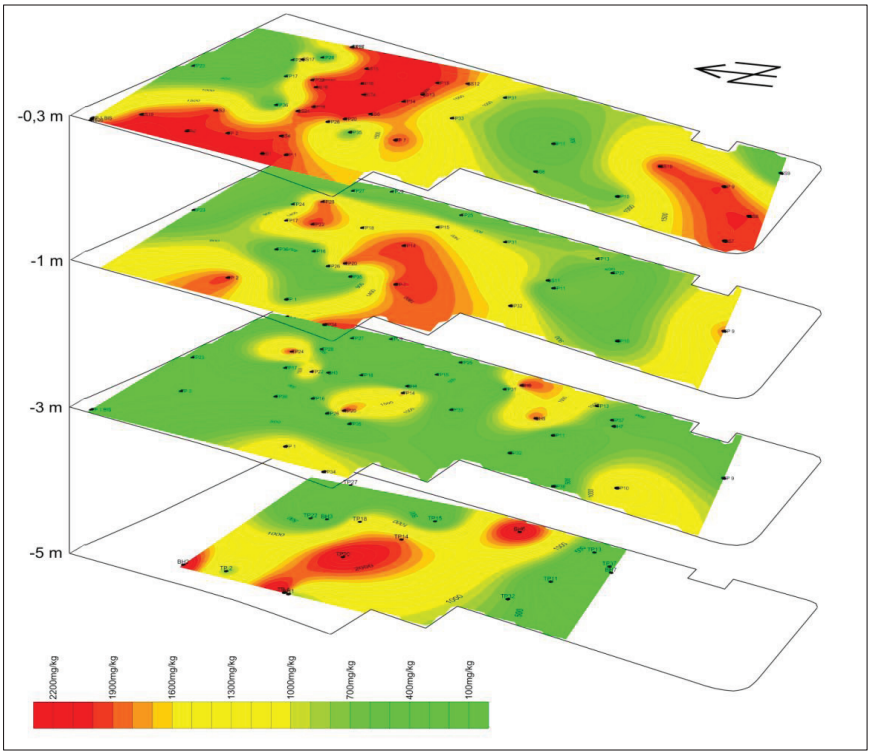

Figure 7. Horizontal cross section of TPH contamination (2D perspectives)

For soil samples recovered from TP excavations and boreholes BHs, the determination of TPH index (hydrocarbon content in the range C_{10} to C_{40}) reveals the fact that the contamination consists of high concentrations of medium and heavy petroleum products such as diesel fuel, light liquid fuel, oils, etc. (Figure 8).

Value	*TPH Index(%)*			
	$C_{10}-C_{12}$	$C_{12}-C_{16}$	$C_{16}-C_{35}$	$C_{35}-C_{40}$
Maximum	17.5	50.9	81.6	20.4
Average	2.1	20.6	69.0	8.2
Minimum	0.2	4.4	33.6	1.2

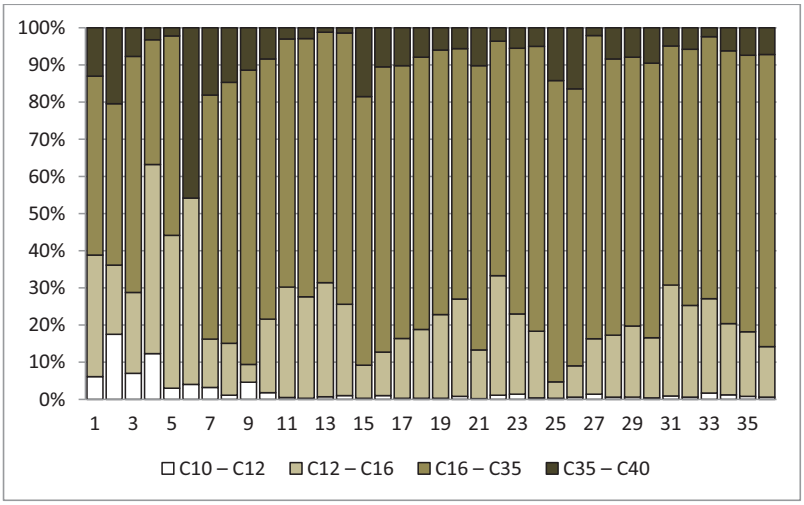

Figure 8. TPH Index statistics

After three successive stages, the environmental assessment for a former industrial site located in Focsani confirmed the presence of an historical pollution with petroleum hydrocarbon.

The analytical results based on intrusive soil investigation during Phase III ESA revealed exceedances of the legal thresholds, as follows:

- TPH concentrations in 34% recovered and analysed soil samples exceeded the IT, the depth of contamination being more than 5 m;
- TPH concentrations in 12% recovered and analysed soil samples, exceeded the AT;
- TPH concentrations in 54% recovered and analysed samples, does not exceeded the AT;
- BTEX concentrations in all 45 recovered and analysed soil samples does not exceeded the AT;
- Lead concentrations in all 31 recovered and analysed soil samples does not exceeded the AT;
- The identified characteristics for fractions of hydrocarbons range C10 – C40, with the highest weight in the C16-C35 range (69%) it can be deduced that the contamination consists of high concentrations of medium and heavy petroleum products that passed through the site for over 50 years.

The total TPH concentrations exceed the intervention threshold (IT), at various depths, as follows:

a) Contaminated area at 0.30 m depth:
   - Zone A - Ramp loading and unloading rail tank wagons approx. 950 m^2;
   - Zone B - Decks loading road tankers approx. 2.300 m^2;
   - Zone C - Pools collecting and storage used oil approx. 50 m^2;
   - Zone D – ASTs park area south-eastern site approx. 600 m^2.

b) Contaminated area at 1.00 m depth:
   - Zone A - Ramp loading - unloading rail tank wagons approx. 50m^2;
   - Zone B - Decks loading road tankers approx. 90 m^2;
   - Zone C - Pools collecting and storage used oil approx. 500 m^2.

c) Contaminated area at 3.0 m depth:
   - Zone B - Decks loading road tankers approx. 10 m^2;
   - Zone C - Pools collecting and storage used oil approx. 10 m^2;
   - Zone D – ASTs park area south-eastern site approx. 60 m^2.

d) Contaminated area at 5.0 m depth:
   - Zone A - Ramp loading - unloading rail tank wagons approx. 12 m^2;
   - Zone C - Pools collecting and storage used oil approx. 450 m^2;
   - Zone D – ASTs park area south-eastern site approx. 130 m^2.

Estimating quantities of soil contaminated above the IT for the former petroleum products deposit Focsani, based on the results obtained in three successive ESA phases, has been used

as reasonable "worst case scenario", argued that in general, any investigation is based on a number of points always finite and limited, horizontally and vertically, also.

The geological media is infinite, inhomogeneous and anisotropic and therefore cannot be guaranteed the real situation in the rest of the geological media, between points investigated, horizontally and vertically. Thus, the volume of soil contaminated with petroleum products above the intervention threshold in Focsani former petroleum products deposit was estimated of around 22,000 m^3.

CONCLUSIONS

Three stages of the environmental assessment for a former industrial site were developed. To this end, the assessors took into account aspects such as:

- Previous industrial activities developed on site;
- Location of different potential sources of contamination as a result of the decommissioning and demolition of some buildings and establishments;
- Intrusive investigations must be more detailed than those required by applicable Romanian legislation, to ensure that the historical pollution of the site has been properly identified and evaluated.

The results of the investigations carried out on quality of the geological media have highlighted the following issues:

- results of the investigations carried out so far have allowed the identification and quantification of the volume of soil (22,000 m^3) contaminated with petroleum products;
- contamination depth is between 0.3 m and 5 m;
- an Remedial Action Plan must be developed, taking into account the results of intrusive investigations and the available good practices used in such situations, and applicable legal requirements;
- if the project site remediation will require achievement of excavations, must take into account the limitations of this report, namely that the results should not be considered exhaustive.

Consequently, soil remediation works are required on the subject property, so the environmental site assessment must be continued.

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