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THE POLLUTANTS MONITORING IN THE INDUSTRIAL WASTEWATERS–A CASE STUDY CONDUCTED IN RESIȚA MUNICIPALITY, CARAŞ SEVERIN COUNTY, ROMANIA

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Abstract: Currently, the big companies should be concerned with achieving environmental performance by controlling the environmental impact of the work they carry out. These concerns fall within the context of developing economic and legislative policies, measures to encourage the environmental protection, increasing concerns of interested parties in the environmental issues and sustainable development. Integrated environmental authorization is issued by the competent authority in order to ensure a high level of protection for the environment as a whole, subject to regulations on the quality of air, water and soil. The monitoring plan must include the monitoring of emissions and imissions in air, the monitoring of emissions in water, the monitoring of the soils qualities and the monitoring of the groundwaters. In this paper, the results of monitoring the particulate matter emissions, sediment particulate emissions and immission level are presented, based on a case study conducted on the administrative territory of Resița municipality, Caraş Severin county (Romania). Based on the results of monitoring the production activities, in order to reduce the pollutant emission and immission levels, some conclusions and remarks are presented. We have analyzed the quantities of metallic elements (Mn, Ni, Zn, Cr, Cu and Pb) found in the wastewater from the areas of steel works and rolling mills, and we performed a calculation of pollutants in water, based on the measurements made, between 2008–2012, in accordance with the Romanian standards and legislative requirements.

Introduction

Many industrial manufacturing processes produce wastewaters containing dissolved metals. Included among them are metals like lead, manganese, nickel, cadmium, zinc, copper and chromium. As a result of improper treatment prior to discharge, many dissolved metals have been found in harmful concentrations in groundwaters which are destined for potable drinking water (Ayres et al. 1994, Chapman 1996, Cushnie 1994). In small quantities, certain heavy metals are nutritionally essential for a healthy life, but large amounts of any of them may cause acute or chronic toxicity (poisoning). In addition to concerns for human health and the environment, an increased desire to reuse and/or recycle industrial wastewaters also requires that metals removal occur in order to meet influent water quality requirement needed by the manufacturing process and equipment (Ayres et al. 1994, Baysal et al. 2013, Omran 2011, Strugariu and Hepuț 2012). Wastewater treatment systems are designed to reduce metal contaminants to meet discharge requirements and/or achieve the water quality level needed for reuse and recycling.

The protection of groundwater and surface water resources and the aquatic ecosystems is to improve and maintain their natural quality, in order to avoid negative effects on the environment and human health, in the context of achieving sustainable development (Chapman 1996, Cusa and Enachescu 1993). The maximum permissible concentrations of pollutants contained in wastewater, discharged into water resources, in permeable soils or depressions with natural drainage and in sewage systems, are determined for the discharge area according to the capacity of the receptors, and are mentioned in the permits and authorizations for water management issued to the water users. Environmental impact of heavy metals was earlier mostly attributed to industrial sources. In recent years, metal production emissions have decreased in many countries due to strict legislation, improved cleaning/purification technology and altered industrial activities. Therefore, regulations for heavy metal containing waste disposal have been tightened (Ayres et al. 1994, Baysal et al. 2013, TMK Annual Report 2011, TMK Annual Report 2012).

The analysis of wastewater for trace and heavy metal contamination is an important step in ensuring human and environmental health. Wastewater is regulated differently in different countries, but the goal is to minimize the pollution introduced into natural waterways (Ayres et al. 1994, Baysal et al. 2013). The National Company "Romanian Waters" seeks, through the national water quality monitoring system, the quality status of groundwater and surface water resources, and the observance of the concentrations of pollutants, included in the regulatory documents issued to users for water quality protection (Alexa et al. 2012, Alexa 2013, Report 2002, Report 2006, Report 2008).

The pollution monitoring is a necessary part of any environmental management system, being the basis for a knowingly conducted decision–making process and for developing environmental management strategies. To ensure a thorough decision, it is essential to be fully convinced that the measurements reflect the reality. The discharges into the environment from the major sources are pursued in a general monitoring process of the significant sources of pollutants within the boundaries of an atmospheric area or a river basin. The objectives also include monitoring systems, optimization issues, verification and compliance with legislative requirements, such as allowable emission limits. This study aims to highlight the situation of the site where performs its activities the integrated industrial company TMK Reşiţa, located on the administrative territory of Resiţa municipality, Caraş Severin county.

The geographic and general context

Reşiţa (Resicabánya [hu], Reschitz [ge]) is a city in western Romania and the capital of Caraş–Severin County (Krassó-Szöreny [hu]), in the Banat region. An important iron and steel center, Reşiţa is the site of blast furnaces, iron foundries, and plants producing electrical appliances, chemicals and machinery. Reşiţa has long been considered as the second–largest industrial center of Romania.

The main watercourse that drains the studied area is Bârzava River (it collects water from an area of 917 km^2 and has a length of 127 km), where the major tributaries, with constant water flow, are the three brooks. The main pollution sources of Bârzava River are the integrated industrial companies (like the above mentioned TMK Reşiţa). The integrated steel plant is located on the right bank of Bârzava River and the production site has an area of 356,873 m^2, being located in the northern part of Reşiţa municipality.

Specific for the company is that, on the above–mentioned territory, the main productive departments are so organized as to constitute virtually separate enclosures, adjacent to the residential and industrial areas. Near the location of the slag dump, there are no protected natural areas, and no areas to protect the natural and cultural patrimony elements. Also, there are no protected areas for the drinking water and the mineral or thermal water springs. Upstream from Reşiţa municipality, some reservoirs are built. Downstream by ca. 30 km from TMK Reşiţa, it is located a drinking water station, in Bârda.

Figure 1. The Caraş–Severin County, in the Banat region of Romania
1. ábra Krassó-Szörény megye, a romániai Bánát régió

The activities of the company TMK Reşiţa are: steel–making by electric arc process, continuous casting and vacuum treatment, for the generation of utilities for the basic activities (TMK Annual Report 2011, TMK Annual Report 2012). Some sectors of the company have ceased the activity or were scraped. Currently, the only activities taking place on site are those related to the electric steel plant and continuous casting, along with support activities of maintenance and supply of utilities which serve the above. From the technological processes, it results metal waste that is further recycled in the process, or liquid solutions that are neutralized and diluted before discharging to sewer (TMK Annual Report 2011, TMK Annual Report 2012).

The storing of the auxiliary materials used in the process is made inside a separate hall, specially arranged for this purpose. Most of the supporting materials are solid (lumps, pellets, or powders) and packed, and they are not stored directly on the ground. They do not fall into the category of dangerous or high toxicity substances, and that's why their management does not require special transportation, storage or handling measures (TMK Annual Report 2011, TMK Annual Report 2012).

The location of the landfill has two impermeable barriers, as follows:

– a natural geological barrier composed of sandy clay, sandstone and conglomerates, with thicknesses of several tens of meters, located beneath the slag dump.
– a built barrier, represented by the actual slag dump, which has an average thickness of 32 m, which was cemented over time, satisfying the conditions of permeability and thickness (permeability of 10^{-9}m/s, layer thickness greater than 0.5 m).

The existence of a natural geological barrier along with another one built assures the required conditions for the deposit waterproofing and groundwater protection. The water from precipitation is discharged into Bârzava River (Ţerova Brook), unpolluted, with characteristics similar to natural waters (Alexa 2012, Alexa 2013, TMK Annual Report 2011, TMK Annual Report 2012).

In the technological process of steel–making by electric arc process, the water is used only to cool the various components of the electric furnace (door, vat, vault, electrode supports) and the installation of flue gas capture and treatment (Alexa 2012, TMK Annual Report 2012). For the direct and indirect cooling, the casting machine uses water that comes through closed, independent circuits, i.e.:

– industrial filtered water–for direct cooling of the billets (secondary cooling) and the opened elements of the casting machine. After cooling, the water is gravity recovered through drains. It is contaminated by heating and iron oxide particles and oils.
– treated water–for indirect cooling in closed circuit, at moulds and closed items. After cooling, the water is entirely recovered on independent circuits having higher temperature, without any contamination;

The water losses from the circuits are normally due to evaporation (at open circuits) or leaks (in closed circuits). The compensation for losses is made in the water station, by adding water of appropriate quality (Alexa 2012, Alexa 2013, TMK Annual Report 2011, TMK Annual Report 2012).

The monitoring activity and the waste water sources

From the data existing at the administrator of the watercourse (Romanian Waters), it results that, over the years, at normal operation of the company production capacities, the Bârzava River water quality was ensured both in the Bârda capture and Romania–Serbia border (Report 2002, Report 2006). On the other hand, it has been frequent accidental pollution due to uncontrolled pollution, especially from the company. The main pollutants were: petroleum products, cyanide and ammonia. This accidental pollution occurred in the production departments which have meanwhile ceased (coke plant, blast furnaces, open–hearth steel plant). In the moment, as result of technological restructuring, it is unlikely to repeat similar phenomena (Report 2002, Report 2006, Report 2007). But, it is required to plan the site quality surveillance.

The company is implementing a balanced, transparent environmental policy. In its operations, the company follows international initiatives and agreements in the field of environmental protection, as well as fulfills national environmental standards and regulations. In accordance with the principle of sustainable development, the efforts during the year were mainly focused on improving the environmental efficiency of production processes, reducing consumption of natural resources, and minimizing waste disposal. A priority of the Strategic Investment Program is the phasing-out of obsolete equipment and the transition to the best available technologies with high economic and environmental performance.

The monitoring of the work activity is made as follows:

– the monitoring of emissions and imissions in air;
– the monitoring of emissions in water;
– the monitoring of the soils qualities;
– the monitoring of the groundwaters

The holder of this activity is required to monitor the emissions of pollutants from the flue and to monthly report the results, observing the frequency and methods of analysis indicated in the monitoring program (TMK Annual Report 2011). The location of monitoring points, the number of control points are established in agreement with the authorities.

All the alerts regarding the accidental pollutions at TMK Reşiţa are from the period before 2000 and refer to the functioning of the sectors that have meanwhile ceased (Alexa 2013, TMK Annual Report 2012, Report 2007). The plants are implementing an integrated approach to solving the problem of water resources, gradually achieving optimization of water consumption, water distribution, use, and sewage.

The main tasks in this area–reducing water consumption and gradually reducing the impact on water bodies–were solved in 2011 due to the development of recycling schemes and increasing the efficiency of existing treatment facilities.

Table 1. The monitoring activities program (TMK Annual Report 2011)
1. táblázat A felügyeleti tevékenységek programja (TMK Annual Report, 2011)

Monitoring of air emissions					
No.	**Indicators**	**Frequency**	**No.**	**Indicators**	**Frequency**
1	Powders	Continuous	6	Manganese (Mn)	half–yearly
2	Sulphur oxides	half–yearly	7	Lead (Pb)	half–yearly
3	Nitrogen oxides	half–yearly	8	Cadmium (Cd)	half–yearly
4	Chrome (Cr)	half–yearly	9	Zinc (Zn)	half–yearly
5	Nickel (Ni)	half–yearly	10	Benzene	yearly
Monitoring of groundwater emissions (pollutants emissions level in soil)					
No.	**Indicators**	**Frequency**	**No.**	**Indicators**	**Frequency**
1	Cadmium (Cd)	yearly	5	Lead (Pb)	yearly
2	Chrome (Cr)	yearly	6	Manganese (Mn)	yearly
3	Copper (Cu)	yearly	7	Hydro carbides	yearly
4	Zinc (Zn)	yearly	8	Nickel (Ni)	yearly
Monitoring of emissions level in waste waters evacuated in Bârzava River					
No.	**Indicators**	**Frequency**	**No.**	**Indicators**	**Frequency**
1	Settled materials	monthly	6	Synthetic detergents	monthly
2	Chlorides	monthly	7	Iron (totally)	monthly
3	Sulphates	monthly	8	Ammonium	monthly
4	Nitrogen (totally)	monthly	9	Residuum filtered at 105°C	monthly
5	Phosphorus (totally)	monthly			
Monitoring of emissions level in waste waters evacuated in Bârzava River					
No.	**Indicators**	**Frequency**	**No.**	**Indicators**	**Frequency**
1	Chrome (Cr)	half–yearly	4	Zinc (Zn)	half-yearly
2	Copper (Cu)	half–yearly	5	Manganese (Mn)	half-yearly
3	Nickel (Ni)	half–yearly	6	Lead (Pb)	half-yearly
Monitoring of groundwater emissions					
No.	**Parameters**	**Frequency**	**No.**	**Parameters**	**Frequency**
1	pH	yearly	8	Lead (Pb)	yearly
2	Conductivity	yearly	9	Cadmium (Cd)	yearly
3	Color	yearly	10	Nickel (Ni)	yearly
4	Oxidability	yearly	11	Mercury (Hg)	yearly
5	Nitrites	yearly	12	Copper (Cu)	yearly
6	Nitrates	yearly	13	Zinc (Zn)	yearly
7	Sulphates	yearly	14	Chrome (Cr)	yearly
			15	Manganese (Mn)	yearly

In the areas of the steel shop and continuous casting machine, there were no major incidents to cause serious damage to any environmental factors. However, it should be noted that in the current operation of the electric steel shop, where the wet gas purification plant has been replaced by a dry cleaning plant (bag filters), the particulate air pollution was greatly reduced, having little impact on the sensitive receptors in the area. The waters are collected in the internal network of sewers for industrial wastewater and discharged into Bârzava River. The indirect cooling water from the EAF (Electric Arc Furnace), LF (Ladle Furnaces) and dedusting plant, which is conventional clean water, is recirculated in the plant. The overflow discharged into Bârzava River is conventional clean water which falls within the permissible limits on discharge (ALEXA 2012, TMK ANNUAL REPORT 2012, REPORT 2007).

In fact, the sources of wastewater are (TMK ANNUAL REPORT 2011):

– the installation of secondary cooling by spraying on the molten steel stream, cooling of the open elements of the continuous casting machine and cutting of the semi–finished products that come from the continuous casting machine; waters containing iron oxide particles (scale) and oils from anointing the parts of the continuous casting machine. These waters are treated in the water station and recycled in full;
– washing the filters with gravel and sand. These waters are filtered and separated from the petroleum products by treatment with surfactants, and then fully recycled;
– other sources (auxiliary activities)–waters with insignificant flow rates and reduced loading;
– overflow from the cooling tower–conventionally cleaned waters,
– domestic wastewater;
– rainwater–from the production area.

The domestic wastewater is collected separately and discharged into the municipal sewage, through three discharge points (ALEXA 2013, TMK ANNUAL REPORT 2011, REPORT 2007).

The rainwater collected from the production site is collected by the internal sewage networks and discharged into Bârzava River, through two of above–mentioned discharge points (ALEXA 2013, TMK ANNUAL REPORT 2011, REPORT 2007). There is no risk of contamination with toxic and dangerous substances of the rainwater that washes the production site. In the worst case, these waters will lead dust, but that is deposited in a very short time, as sediment, on the river bottom, being assimilated into the natural environment.

In order to reduce negative impacts on the air the company is introducing advanced technology with a high degree of industrial emissions purification. Every year activities in this area are carried out, including overhaul of pollution control equipment to improve the efficiency of gas cleaning, etc. The main improvements to reduce emissions are the modernization of gas purification in the electric arc furnace at TMK Reşiţa, where dust emissions were reduced by 5%.

Discussion of results

The background levels of pollutants, such as metals, are measured in air, water and soil, along with other parameters, in preset points and with preset frequencies, by using specified equipment and methods. The objective is to collect and analyze representative samples able to indicate the data to be used in the environmental management system. To ensure acceptable levels of background, predictions of the pollutants concentrations are made, using models and data on emissions from some major sources of pollution, which were subsequently verified by direct observations. Time variations of the concentrations of pollutants in surface and groundwater can occur due to:

– seasonal weather changes;
– phenomena of mining landfills erosion;
– human activities, including the applied remedial measures.

Measurements of emission and immission levels were performed continuously by the pollutants companies. Regarding the monitoring of emissions and imissions in air, the operator is obliged to comply with the emission limit values on each environmental factor (air, water, soil) according to environmental legislation in force. Also, the immission values of pollutants resulting from their activity, are within the specified limits. In sense of the monitoring of emissions in water, the quality indicators of wastewater discharged into the Bârzava River must be within the values specified in the permit for water management. The values of pollutants present in the soil inside the company shall not exceed the limits set. Finally, the concentration values for pollutants in groundwater are compared with the values of the site report, following degradation not take place while the parameters analyzed. The results of monitoring the particulate matter emissions, sediment particulate emissions and immission level are presented in the Tables 2–4.

Table 2. Monitoring the particulate matter emissions
2. táblázat A szállópor kibocsátás monitoringja

No.	Prelevation type (standard/sequential/ intermittent)	Prelevation duration [h]	Concentration limits [mg/m^3]	Maximal admitted concentration [mg/m^3]
1.	Standard–(Discharge Point 1)	24	0.024–0.037	0.05
2.	Standard–(Discharge Point 2)	24	0.024–0.031	0.05
3.	Standard–(Discharge Point 3)	24	0.022–0.049	0.05

Table 3. Monitoring sediment particulate emissions
3. táblázat A szemcsés üledék monitoringja

No.	Prelevation point	Sediment particulate [g/m^2/month]	Admitted limit [g/m^2/month]
1.	Discharge Point 1	6.726–12.59	17
2.	Discharge Point 2	3.23–16.34	17
3.	Discharge Point 3	10.55–15.90	17
4.	Medium Laboratory	6.57–12.67	17

Table 4. Immission level
4. táblázat Immisszió szint

Pollutant	**Values [µg/m³]**			**Admitted [µg/m³]**
	Discharge Point 1	**Discharge Point 2**	**Discharge Point 3**	
Particulate matter	9.5/10.8	10.6/12.4	3.2/8.6	50/150
Sulphur oxides	112/100	100/57	100/100	125/250
Nitrogen oxides	110/100	100/100	100/100	200/100
Monoxide carbon	500/500	500/500	500/500	10.000/6.000
Cadmium [Cd]	0.0014/0.0001	0.024/0.0001	0.0001/0.0001	0.02/0.5
Lead [Pb]	0.069/00002	0.013/0.0074	0.022/0.0045	05/5

Based on the results of monitoring the production activities, in order to reduce the pollutant emission and immission levels, the following partial conclusions may be listed:

– The concentration of the particulate emissions from suspension falls below the regulated threshold;
– The concentration of metals in immission falls below the regulated threshold;
– The concentration of the emission sedimentary particulates falls below the regulated threshold;

No work is required to reduce the emissions and immission of air pollutants. The action plan provided the necessary work to reduce the emissions of air pollutants. This work was completed by the company in due time.

Table 5. Measurements of emission in water
5. táblázat Szennyező anyagok a vízben

Indicators	**Results [mg/l]**		**Admitted [mg/l]**
	Discharge Point 1	**Discharge Point 2**	
Manganese	0.032	0.033	1.0
Nickel	0.0127	0.0102	0.5
Zinc	0.037	0.066	0.5
Chrome	0.0012	0.0014	1.0
Copper	0.0248	0.0321	0.1
Lead	0.0213	0.0272	0.2

The monitoring results of the emissions to water are presented in Table 5. The quality indicators, the water discharge values (measured at the two stations) and the values provided by the norms in force are presented in Table 6.

Table 6. Quality indicators
6. táblázat Minőségi mutatók

Quality indicators	Discharge Point 1 [mg/l]	Discharge Point 2 [mg/l]	Admitted [mg/l]
Particulate matter	26–36	25.4–52	60
Chlorides	7.296–14.245	7.644–10.076	500
Sulphates	16.3–29.2	15.4–25.7	600
Nitrogen (totally)	1.48–3.74	1.1–1.88	10
Phosphorus (totally)	0.182–0.365	0.144–0.398	1
Detergents	0.042–0.204	0.039–0.061	0.5
Matter extractable	7–8.8	6.3–9	20
Iron (totally)	0.32	0.32	5

The quality indicators at the two discharged points and the admitted values in the wastewater are presented in Table 7. The monitoring results of the emissions to water are presented in the same Table 7.

Table 7. Quality indicators
7. táblázat Minőségi mutatók

Discharge Point 1 [mg/l]								
Year	**Parti-culate matter**	**Chlorides**	**Sulphates**	**Nitrogen (totally)**	**Phosphorus (totally)**	**Deter-gents**	**Matter extractable**	**Iron (totally)**
2008	10.132	11.621	12.118	2.918	0.352	0.175	7.458	0
2009	13.427	10.115	10.295	2.371	0.227	0.294	3.568	0
2010	12.635	6.838	10.182	1.238	0.173	0.132	0.582	0
2011	15.232	9.894	12.044	1.881	0.197	0.211	2.978	0
2012	12.788	9.223	11.875	1.421	0.211	0.194	1.875	0
Discharge Point 2 [mg/l]								
Year	**Parti-culate matter**	**Chlorides**	**Sulphates**	**Nitrogen (totally)**	**Phosphorus (totally)**	**Deter-gents**	**Matter extractable**	**Iron (totally)**
2008	35.509	18.474	23.982	3.854	0.894	0.219	14.8	0
2009	17.271	10.466	13.297	0.784	0.1141	0.098	5.812	0.0434
2010	7.745	10.036	13.122	1.238	0.0986	0.009	0.518	0
2011	9.945	11.125	14.166	1.179	0.1122	0.011	1.252	0.0244
2012	10.725	10.432	13.287	0.918	0.0921	0.014	0.882	0

Based on the water emissions measurements, the following partial conclusions may be listed:

– The chemical analysis of the wastewater discharged into Bârzava River indicates that it is within the acceptable limits. The discharge of these waters does not change the quality category of Bârzava River.
– The action plan have been provided the necessary works to reduce the emissions of pollutants in surface water, these works being executed by the company. No further works are required, because the effluents meet the regulated limits.

The monitoring plans are designed and implemented to collect data about the water quality and the significant discharges of pollutants from the major sources. The quality assurance plan formulated the arguments that led to the establishment of the number of sampling points, the location of these points, the sampling frequency, the equipment and methods of sample collection.

Final conclusions and remarks

Based on the information provided by this stage of the study, and on those provided in the documentation accompanying the request for integrated environmental permit for the company site, we further propose a conceptual model of site, to illustrate how the work can affect the quality of the environment and human health. Specifically, based on the results of production activities monitoring, carried out on the site of the company, we can conclude the followings:

– The chemical analysis of the wastewater discharged into Bârzava River indicates that the water composition is within the acceptable limits. The discharge of these waters does not change the quality category of Bârzava River. The quality of the effluents discharged falls in the imposed discharge conditions (discharges into Bârzava River). The detailed modeling is not required, given the low concentration of discharged pollutants;
– After monitoring the emissions and immissions, it was found that they fall within the regulatory limits. We recommend to continue the monitoring and to take the appropriate actions in case of exceeding the current regulatory limits;
– After monitoring the emissions to surface waters, it was found that they fall within the regulatory limits;
– The concentration of the pollutants in soil falls below the alert threshold value. The concentrations of pollutants in groundwater fall below the regulated limits. We found small exceeding values at the indicators Mn and Pb, in the slag dump area. So, the further groundwater monitoring is recommended to track the progress over time of these pollutants;
– The environmental plan provides the necessary works for reducing the emissions of pollutants in soil and groundwater, these works being executed by the company. Likewise, the drillings required for groundwater monitoring on the company site and the slag dump have been made.

As a general remark, we can conclude that the company does not generate industrial waste water, but only conventional clean cooling water or reduced pollutant loading cooling water.

On reaching the alert thresholds (70% of permissible concentrations of pollutants in air emissions, wastewater discharges and ambient air, and the polluting agents for soil environmental factor), the operator has the obligation to supplement monitoring pollutant concentrations and measures to reduction.

To avoid uncontrolled waste water entering the aquifer systems and/or surface emissaries, the implementation of measures must be done. The monitoring results are always the basis of the establishment of technical and organizational measures for groundwater and emissaries protection. In terms of environmental impact assessment, a rigorous quality management is essential for designing studies on the initial conditions and for the subsequent environmental management programs, especially for the sample collection, preparation and analysis, evaluation of the analytical results, choosing locations, especially those for waste disposal.

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A SZENNYEZŐANYAGOK ELLENŐRZÉSE AZ IPARI VÍZSZENNYEZŐDÉSBEN – ESETTANULMÁNY RESIȚA-N, KRASZNA-SZÖRÉNY MEGYÉBEN, ROMÁNIÁBAN

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Kulcsszavak: szennyező anyagok, megfigyelés, szennyvíz, fémes elemek hatása

Jelenleg a nagy cégek figyelme a környezeti teljesítmény elérésére irányul, az általuk végzett ipari munka környezeti hatásainak ellenőrzése során. A fejlődő gazdasági és jogalkotási politikával összefüggésében ezek egyre fontosabb környezeti kérdések, bátorítják a környezetvédelmi intézkedések bevezetését, és az érintett felek egyre növekvő érdeklődésére tarthatnak számot a fenntartható fejlődés kapcsán. Az illetékes hatóságok integrált környezetvédelmi engedélyt bocsájtanak ki a környezet egészének magas szintű védelmének biztosítása érdekében. A szabályozás tárgya a levegő, a víz és a talaj minősége. A felügyeleti általános tervnek tartalmaznia kell a szennyező anyagok levegőbe bocsátását, a vízbe történő kibocsátások nyomon követését, a talajok minőségi ellenőrzését, valamint a felszín alatti vizek monitorozását. Ez a tanulmány a Krassó-Szörény megyei (Románia) Resița önkormányzat közigazgatási területén végzett esettanulmány alapján bontakozik ki, és a szennyező anyagok ellenőrzésének eredményeit mutatja be. A termelési tevékenységek nyomán szerzett ellenőrzési eredmények, valamint a szennyezőanyag-szintek csökkentése érdekében zajlott felügyeleti tevékenységek alapján bizonyos következtetéseket és megjegyzéseket vázolunk fel. Elemeztük az acél- és hengerműhelyek területeiről származó szennyvizekben a fémes elemek mennyiségét (Mn, Ni, Zn, Cr, Cu és Pb) is. A román szabványoknak és jogszabályi követelményeknek megfelelően, a 2008–2012 közötti környezeti tevékenységek, valamint a mérések alapján készült szennyező anyagok vízben található mennyiseége kerül bemutatásra.