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ABOUT THE ENVIRONMENTAL MANAGEMENT SYSTEM APPLIED IN THE METALLURGICAL COMPANIES AND THE MONITORING PROCESS OF POLLUTANTS IN WASTE WATERS

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ABSTRACT: *The pollution monitoring is a necessary part of any environmental management system, being the basis for a fully informed decision-making process and 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 catchments. The objectives also include monitoring systems, optimization issues, verification and compliance with legislative requirements, such as allowable emission limits. 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 (according to Romanian standards) between 2008-2010. The monitoring plans are designed and implemented to collect data about the water quality and the significant discharges of pollutants from the major sources. In this paper, we present the assessment of emission impact on waters, based on a case study conducted on the company TMK Reşiţa (Romania).*
KEYWORDS: *environmental management system, pollutants, waste waters, monitoring*

INTRODUCTORY NOTES

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.

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.

This study aims to highlight the situation of the site where performs its activities the company TMK REŞIŢA, located on the administrative territory of Resiţa municipality, Caraş Severin county.

The integrated steel plant is located on the right bank of Bârzava River. 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). The major tributaries (with constant flow) of Bârzava River are the brooks: Ţerova, Valea Domanului and Valea Mare. Upstream from Reşiţa municipality, some reservoirs are built.

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. Downstream by ca. 30 km from TMK REŞIŢA and UCM Reşiţa, which are the main pollution sources of Bârzava River, it is located a drinking water station, in Birda. The production site has an area of 356,873 m^2, being located in the northern part of Resita municipality.

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. 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.

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. For the direct and indirect cooling, the casting machine uses water that comes through closed, independent circuits, i.e.:

- *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;*
- *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.*

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.
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.
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 Țerova Brook, unpolluted, with characteristics similar to natural waters.
The storing of the auxiliary materials used in the process is made inside a separate hall, specially arranged for this purpose. The transport and handling are performed with appropriate means, by trained personnel. 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.
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.
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.
Reducing the negative impact on the environment in the regions its operation is an essential condition and one of the main priorities of the strategic development. In accordance with the principle of sustainable development, the efforts were mainly focused on improving the environmental efficiency of production processes, reducing consumption of natural resources, and minimizing waste disposal. [6]
The main tasks in this area – reducing water consumption and gradually reducing the impact on water bodies – must be solved due to the development of recycling schemes and increasing the efficiency of existing treatment facilities.[6] The transition to recycling water supply is a prerequisite for the introduction of new production capacities, modernization and reconstruction of production facilities.

DEVELOPMENT OF A CONCEPTUAL MANAGEMENT MODEL

The Company's system to manage waste from production aims to implement practical actions to reduce waste generation, recycling, disposal and minimization of placement in the environment.
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.
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.
The discharges into the environment from major sources are traced in a general monitoring process of the significant sources of pollutants within the boundaries of an atmospheric area or a river basin. The objectives of the monitoring systems include also process optimization issues, verification and compliance with legislative requirements (i.e. allowable emission limits).
The monitoring plans are designed and implemented to collect data on air and water quality, and the discharges of significant pollutants from major sources. The elements of a monitoring plan typically include the following elements:

- *selection of significant parameters;*
- *method of sampling and transport of samples, specifying the sampling point, frequency, type and quantity of samples, and the test equipment;*
- *analyses of samples or, alternatively, continuous monitoring.*

The conceptual model includes the identification of the potential and actual sources of pollution, the ways of pollution transmission and the sensitive receptors. Based on it, we will further decide the need for investigations or monitoring conducted to achieve the general target of the study (i.e. to obtain a reference point for the current site).
The proposed conceptual model is based on:

- *data on site history and the industrial activities that were held here – for soil and groundwater;*
- *the current technological processes, balances of raw materials, auxiliary materials, utilities;*
- *monitoring of the activity by the holder of this activity;*
- *monitoring carried out by other specialized units – accredited laboratories;*
- *findings, information and recommendations of the steel related reference documents.*

To complement the database on the studied site, we considered the monitoring results of:

- noise measurements at various points on the site and neighbourhood, to gain an insight into the areas most exposed to noise;
- determinations on the premises immission limits, due to the fugitive and diffuse emissions from the electric steel shop and the continuous casting;
- determinations regarding the emissions level;
- highlighting the potential impact of water discharges in Bârzava River;
- groundwater analysis, to determine its degree of contamination.

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 remedial measures applied.

To avoid uncontrolled waste water entering the aquifer systems and/or surface emissaries, we will ensure the implementation of measures. The monitoring results are always the basis of the establishment of technical and organizational measures for groundwater and emissaries protection.
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.

STUDY ON 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 Birda capture and Romania-Serbia border. 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. But, it is required to plan the site quality surveillance. The monitoring of the work activity is made as follows:

- monitoring of air emissions;
- monitoring of groundwater emissions;
- monitoring of pollutants emissions level in soil;

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.

Table 1. Monitoring of air emissions

Monitoring of air emissions		
No.	Indicators	Frequency
1	Powders	continuous
2	Sulphur oxides	half-yearly
3	Nitrogen oxides	half-yearly
4	Chrome (Cr)	half-yearly
5	Nickel (Ni)	half-yearly
6	Manganese (Mn)	half-yearly
7	Lead (Pb)	half-yearly
8	Cadmium (Cd)	half-yearly
9	Zinc (Zn)	half-yearly
10	Benzene	yearly

Table 2. Monitoring of pollutants emissions level in soil

Monitoring of pollutants emissions level in soil		
No.	Indicators	Frequency
1	Cadmium (Cd)	yearly
2	Chrome (Cr)	yearly
3	Copper (Cu)	yearly
4	Zinc (Zn)	yearly
5	Lead (Pb)	yearly
6	Manganese (Mn)	yearly
7	Hydro carbides	yearly
8	Nickel (Ni)	yearly

Table 3. Monitoring of emissions level in waste waters and

Monitoring of emissions level in waste waters evacuated in Bârzava River		
No.	Indicators	Frequency
1	Settled materials	monthly
2	Chlorides	monthly
3	Sulphates	monthly
4	Nitrogen (totally)	monthly
5	Phosphorus (totally)	monthly
6	Synthetic detergents	monthly
7	Iron (totally)	monthly
8	Residuum filtered at 105°C	monthly
9	Ammonium	monthly
10	Chrome (Cr)	half-yearly
11	Copper (Cu)	half-yearly
12	Nickel (Ni)	half-yearly
13	Zinc (Zn)	half-yearly
14	Manganese (Mn)	half-yearly
15	Lead (Pb)	half-yearly

Table 4. The groundwater emissions

Monitoring of groundwater emissions		
No.	Parameters	Frequency
1	pH	yearly
2	Conductivity	yearly
3	Color	yearly
4	Oxidability	yearly
5	Nitrites	yearly
6	Nitrates	yearly
7	Sulphates	yearly
8	Lead (Pb)	yearly
9	Cadmium (Cd)	yearly
10	Nickel (Ni)	yearly
11	Mercury (Hg)	yearly
12	Copper (Cu)	yearly
13	Zinc (Zn)	yearly
14	Chrome (Cr)	yearly
15	Manganese (Mn)	yearly

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.

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 by the discharges named "Eruga" and "Rolling Mills".

The sources of wastewater are:

- 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, named: Platan Discharge, Pasaj Discharge and LDS Discharge.

The rainwater collected from the production site is collected by the internal sewage networks and discharged into Bârzava River, through those two above-mentioned discharge points – Eruga and Rolling Mills.

There is no risk of contamination with toxic substances of the rainwater that washes the production site. In the worst case, these waters will lead dust, but this is deposited in a very short time, as sediment, on the river bottom, being assimilated into the natural environment.

RESULTS & DISCUSSION

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.

Measurements of emission and immission levels were performed continuously by the company. The results of monitoring the particulate matter emissions, sediment particulate emissions and immission level are presented in the Tables 5–7.

Table 5. Monitoring the particulate matter emissions

Prelevation type (standard; sequential; intermittent)	Prelevation duration [h]	Minimal and maximal concentration [mg/m^3]	Maximal admissible concentration [mg/m^3]
Standard - Eruga	24	0.024 – 0.037	0.05
Standard - RMAS	24	0.024 – 0.031	0.05
Standard – LDS	24	0.022 – 0.049	0.05

Table 6. Monitoring sediment particulate emissions

	Prelevation point	Sediment particulate [g/m^2/month]	Maximal admissible limits [g/m^2/month]
1.	Medium Laboratory	6.57 – 12.67	17
2.	RMAS	3.23 – 16.34	17
3.	ERUGA	6.726 – 12.59	17
4.	LDS	10.55 – 15.90	17

Table 7. Immission level

Pollutant	Values [µg/mc]			Admitted [µg/mc]
	Zone Eruga	Zone LDS	Zone RMAS	
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, the following partial conclusions may be listed:

- The concentration of the particulate emissions from suspension falls below the regulated threshold;
- The concentration of the emission sedimentary particulates falls below the regulated threshold;
- The concentration of metals in immission 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 8. Measurements of emission in water. Evacuation – Rolling Mills

	Evacuation – Rolling Mills	
Indicators	Results [mg/l]	Admitted [mg/l]
Manganese	0.032	1.0
Nickel	0.0127	0.5
Zinc	0.037	0.5
Chrome	0.0012	1.0
Copper	0.0248	0.1
Lead	0.0213	0.2

Table 9. Measurements of emission in water. Evacuation – Eruga

	Evacuation – Eruga	
Indicators	Results [mg/l]	Admitted [mg/l]
Manganese	0.033	1.0
Nickel	0.0102	0.5
Zinc	0.066	0.5
Chrome	0.0014	1.0
Copper	0.0321	0.1
Lead	0.0272	0.2

The monitoring results of the emissions to water are presented in Tables 8-9. The quantities of metallic elements (Mn, Ni, Zn, Cr, Cu and Pb) found in the wastewater are presented in Tables 10-11.

Table 10. Quantities of metallic elements (Mn, Ni, Zn, Cr, Cu and Pb) found in the wastewater - Evacuation Eruga

Evacuation Eruga	Mn	Ni	Zn	Cr	Cu	Pb
2008	53.67	16.59	107.33	2.28	52.2	44.24
2009	27.47	2.09	41.21	7.59	26.69	26.81
2010	28.2	6.5	53.3	13	9.6	13

Table 11. Quantities of metallic elements (Mn, Ni, Zn, Cr, Cu and Pb) found in the wastewater - Evacuation Rolling Mills

Evacuation Rolling Mills	Mn	Ni	Zn	Cr	Cu	Pb
2008	130.6	51.83	151	4.9	101.22	86.93
2009	86.37	21.12	168.15	9.56	34.92	116.88
2010	79.45	18.92	154.35	8.7	41.92	72.22

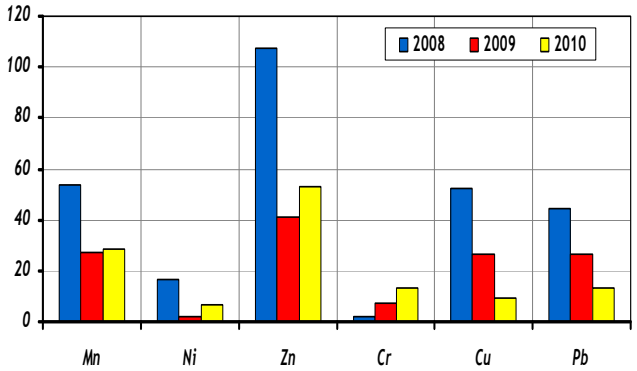

Figure 1. Quantities of metallic elements (Mn, Ni, Zn, Cr, Cu, Pb) found in the wastewater – Evacuation Eruga

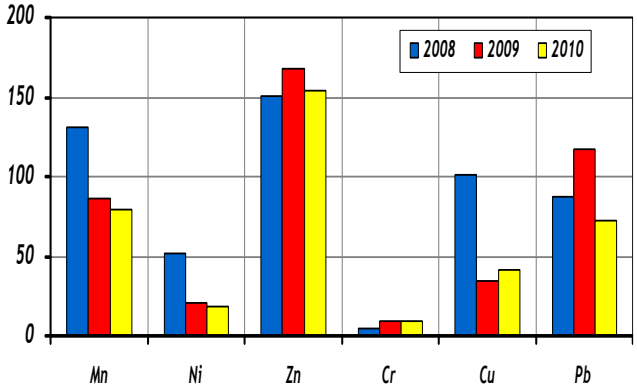

Figure 2. Quantities of metallic elements (Mn, Ni, Zn, Cr, Cu, Pb) found in the wastewater – Evacuation Rolling Mills

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 12. The quality indicators in Tables 13-16 are presented (in the case of Eruga evacuation station, respectively in the case of Rolling Mills evacuation station).

Table 12. Quality indicators

Quality indicators	Evacuation – Eruga [mg/l]	Evacuation – Rolling Mills [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

Table 13. Quality indicators – Evacuation "Eruga" [mg/l]

	Particulate matter	Chlorides	Sulphates	Nitrogen (totally)
2008	10.132	11.621	12.11	2.918
2009	13.427	10.115	10.295	2.371
2010	12.635	6.838	10.182	1.238

Table 14. Quality indicators – Evacuation "Eruga" [mg/l]

	Phosphorus (totally)	Detergents	Matter extractable	Iron (totally)
2008	0.35	0.175	7.458	0
2009	0.227	0.294	3.568	0
2010	0.173	0.13	0.582	0

Table 15. Quality indicators – Evacuation "Rolling Mills" [mg/l]

	Particulate matter	Chlorides	Sulphates	Nitrogen (totally)
2008	35.509	18.474	23.982	3.854
2009	17.271	10.466	13.297	0.7848
2010	7.745	10.036	13.122	1.238

Table 16. Quality indicators – Evacuation "Rolling Mills" [mg/l]

	Phosphorus (totally)	Detergents	Matter extractable	Iron (totally)
2008	0.894	0.219	14.8	0
2009	0.1141	0.098	5.812	0.0434
2010	0.0986	0.009	0.518	0

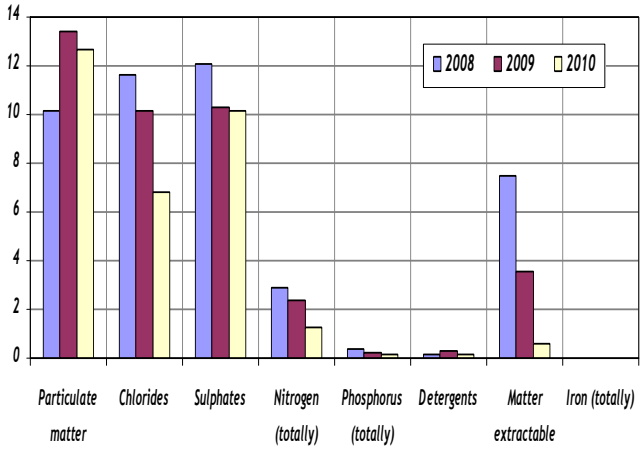

Figure 3. Quality indicators – Evacuation "Eruga" [mg/l] (according to the data included in Tables 13-14)

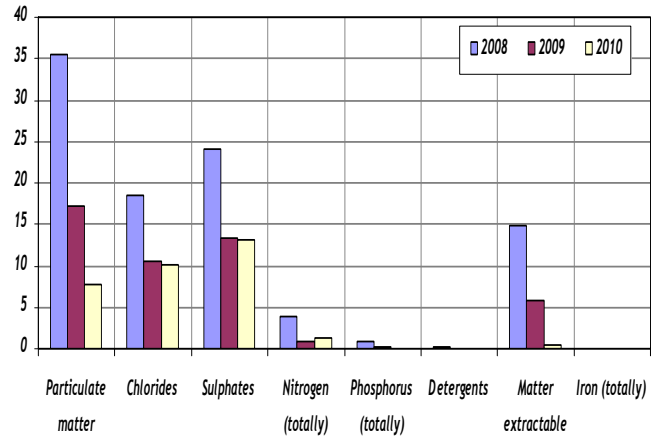

Figure 4. Quality indicators – Evacuation "Rolling Mills" [mg/l] (according to the data included in Tables 15-16)

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.*

CONCLUSIONS

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.

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.

Based on the results of production activities monitoring, carried out on the site of TMK RESITA Company, we can conclude the followings:

- *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 rainwater is collected from the internal sewage networks and it is discharged into Bârzava River through two discharge points – Eruga and Rolling Mills. 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;*
- *The indirect cooling water from the EAF, LF 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;*
- *The company does not generate industrial waste water, but only conventional clean cooling water or reduced pollutant loading cooling water;*
- *The quality of the effluents discharged falls in the imposed discharge conditions (Eruga and Rolling Mills discharges into Bârzava River). The detailed modeling is not required, given the low concentration of discharged pollutants;*
- *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;*
- *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 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.

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