# Water Baseline Report

Prepared for:

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# 1 Scope of the Water Quality Baseline Study

## 1.1 Introduction

The Roşia Montană Project is located in a historical mining district that has been active for more 2,000 years. Present open-pit operations combine with old mining works in generating environmental impacts are acknowledged by the local inhabitants, by the mining operators — C.N.C.A.F. MINVEST S.A. Deva, Roşiamin Branch (Roşiamin) — and by the regulatory authorities for environmental protection and water management.

Notwithstanding, the area lacks water quality sampling sections or monitoring wells belonging to the national monitoring network. Moreover, during the last 10 to 15 years of economic decline, water monitoring, which should have been a part of the environmental management by the active mining operations, has been neglected.

## 1.2 Objectives

The objective of the water quality baseline study is to assess the level of physical and chemical contamination of various types of water (wastewater, surface and ground water, and drinking water) in the area.

It is assumed that the future Project development will have a direct impact to water quality in Roşia Valley – between the four proposed open pits, Corna Valley (which is the location of the proposed tailings management facility), and Sălişte Valley.

## 1.3 Project Location

The project area is located in the S.C. Roşia Montană Gold Corporation S.A. (RMGC) mining concession boundary, approximately 80 kilometres northwest of the county capital of Alba Iulia in the Metaliferi Mountains of Transylvania. The Metaliferi mountain region is located south of the Apuseni Mountains and the Arieş River.

The project area includes a portion of the Roşia, Corna and Sălişte Valleys and is centred on the existing MINVEST mining operation. The valleys of the project area are generally steep-sided with settlements developing in a linear fashion along the narrow valley floor.

Landscape of the project area is diverse, featuring ridges, valleys and hillsides, and a range of land uses from contemporary open-pit mining operations to traditional agricultural practices and villages. Landscapes degraded by historical and current mining operations dominate the views in the upper Corna and Roşia Valleys.

The project area drains through the main south-north valley of the Abrud River, which receives the five main right-bank tributaries from Buciumani, Abruzel, Corna, Sălişte and Roşia Valleys, out of which three are very important for the Project — Corna, Sălişte and Roşia Streams. The ridges between these three valleys and the peaks to the east effectively form a natural bowl around Roşia Montană, isolating it from the wider area to the east, north and south.

## 1.4 Project Layout

This report is organised into 5 chapters, as follows: Chapter 1 presents the scope of water quality baseline study; Chapter 2 is a summary of previous water quality investigations carried out in the Roşia Montană area; Chapter 3 describes the methodology used for assessing the baseline conditions concerning water quality; Chapter 4 presents the results of the investigations carried out by RMGC as well as our interpretation; and, the general conclusions of this report are contained in Chapter 5.

# 2 Previous Investigations of Water Quality in the Roşia Montană Area

Water sampling and analyses in the Roşia Montană area have been carried out as part of environmental studies conducted in support of the application for regulatory agreements and environmental endorsements – in accordance with the Romanian environmental legislation. Such activities were also part of baseline conditions studies conducted in conformity with international legislation and, more recently, with national regulations.

The beneficiaries of such environmental studies are the following:

- RMGC Roşia Montană, which is currently carrying out geological exploration activities in the Roşia Montană area; the company has undertaken to develop the Roşia Montană Project for the large-scale mining and processing of gold ores in the area.
- Roşiamin, which has been executing exploration, mining and ore processing activities in the Roşia Montană area.

In 1998, RMGC initiated a series of field investigations and water sampling stages, in support of the following studies:

- Environmental baseline conditions study, including the Environmental Impact Assessment study (EIA) for the geological exploration of the Roşia Montană area for AGRARO CONSULT S.R.L. Bucharest (AGRARO). This was necessary for the environmental permitting of an exploration drilling program and for establishing the baseline environmental conditions and quality prior to any activities to be undertaken by RMGC.
- The EIA study for the Roşia Montană Project, including the environmental baseline conditions study for the area potentially affected by the Project — carried out in 2000–2001 by Knight Piésold (United Kingdom) and AGRARO — in support of the application for the environmental permit of the Roşia Montană Project and to obtain better knowledge of the environmental conditions and quality prior to the commencement of any Project-related activities.

Environmental studies carried out for Roşiamin, during the same evaluation period, have consisted of:

- Level I and Level II Environmental Audits for Roşiamin, by ECOCRISTAL S.R.L. Alba Iulia, 1999, in support of the application for environmental permitting of the Roşiamin.

Although there are analytical results available from the above-mentioned projects, the first consistent water monitoring program was developed starting in 2000.

# 3 Methodology Adopted for Water Quality Baseline Study within the EIA Process

The Water Quality Baseline Study for the area of interest has been initiated in support of the EIA study for the Roşia Montană Project.

The present-referenced baseline studies were commenced before Romanian legislation expressly required such studies, and are in keeping with internationally accepted best practices.

In 2003, after enforcement of the Government Decision No. 918/2002 and Ministerial Orders No. 860/2002 and 863/2002 concerning the implementation of the EU Directive 85/337/EEC, amended by the Directive 97/11/EC regarding the EIA, this requirement became compulsory for projects carried out in Romania.

However, due to reduced funding allotment by most Romanian and foreign investors for EIA purposes, and in pursuit of limiting the duration of the overall EIA process, this legal requirement has not always been fulfilled to international standards.

From the very beginning of the process, the initiators of the Roşia Montană Project had a different approach regarding those practices, paying significant attention to the internationally applicable legislation concerning the assessment of the real condition and quality of the environment, prior to the actual start of the investment. The scope of this study was to protect investors against liabilities related to historical and active mining operations and to provide comparison criteria for the quality of the environment during and after the completion of the Roşia Montană Project.

The activities started in 2000 with a survey of water sources in the area potentially affected by the Project. Based on this survey, a water quality monitoring network was designed. In the meantime, the monitoring network was developed and, at present, is operated by the Environmental Department of RMGC.

## 3.1 Water Pollution Sources

Within the studied area, the quality of water is affected by two major categories of physical and chemical stress factors:

- The discharge into the environment of wastewater generated by ore mining and processing, and containing relevant pollutants – acidity, copper, iron, manganese, arsenic, cadmium, nickel, lead, mercury, selenium, chromium, sulphate, dissolved salts, etc.; and,
- The area's high degree of mineralisation.

Ore mining and processing activities generate highly acidic wastewater and high concentrations of heavy metals and other toxic contaminants. In this environment this type of pollution is identified as Acid Rock Drainage (ARD). The collection of such pollutants involves interception ditches, catchment dams and ponds, as well as plants for wastewater treatment prior to discharge into the environment.

In the case of the ongoing Roşia Montană mine, the ARD generated by the exposure of sulphide-bearing ores to exogenous factors, such as air (oxygen) and water, is collected either by the underground mining works and discharged in untreated form through various adits, or directly discharged into local rivers as surface water runoff from the waste rock piles and other disturbed areas.

The ore preparation plant at Gura Roşiei produces various types of wastewater, which is discharged without treatment directly into the Abrud river. The plant also generates tailings, which are deposited behind the tailings dam in the Sălişte Valley.

The high mineralisation degree of the studied area is responsible for metal concentrations well in excess of the legally allowed limits for surface or ground water quality, generating the so-called "background concentration levels."

Other point sources of water pollution are represented by uncontrolled discharges of domestic wastewater from collective and individual dwellings located along water streams, as well as by diffusive sources related to agriculture and animal farming.

## 3.2 Water Sources Survey

### *3.2.1 Introduction*

The study of water resources (springs and wells) and quality in the Roşia Montană area, has been resumed upon request from RMGC, with the commencement of EIA works for the future Roşia Montană mine, including the baseline conditions studies. The studies were carried out during August 2000 and April 2001, by Knight Piésold (United Kingdom) and AGRARO (Romania). This report presents a comprehensive and very detailed study regarding the condition and quality of local surface and ground water resources in the Roşia Montană area.

During the survey, a team of consultants analysed several possible Tailings Management Facility (TMF) location alternatives in the Abruzel watershed sub-basin (B valley), the Corna watershed sub-basin (C valley) and the Sălişte watershed sub-basin (D valley). The Roşia Valley (R valley) was also studied since it was the main water course affected by historical, current and future mining operations.

The scope of this survey was to contribute to the understanding of the hydrologic watersheds, the effect of springs on existing and proposed ponds, water resources in the area, and initial dewatering requirements.

### *3.2.2 Field Activity*

The field activity took place between September 29 and October 27, 2000, and was carried out by several teams of consultants from the two aforementioned companies. The field work consisted of systematic visiting of all water springs and wells known in the area. For each site a questionnaire was filled out.

A name or an ID number was assigned to each site. The co-ordinates of each site were recorded by means of a GPS device (Magellan). Field determinations of basic parameters, such as temperature, pH, electrical conductivity and redox potential, were also carried out. One or two photographs of each site were taken and a sketch of check points around the site was drawn.

Local inhabitants were interviewed in order to obtain information on the history of the area and of the water source. Details were gathered concerning the use of water, historic variations of flow rates and maintenance of the water sources.

Of the 353 sites, the majority were regular hand-dug wells (140) and springs (176), plus several water courses and ARD discharge outlets. The majority of hand-dug wells were private wells located in courtyards or on household lots. Most of them were in use at the time of the survey.

Of the multitude of surveyed water sources, several representative sites were selected to be included in the RMGC monitoring network. Table 3-1 shows the types and number of sources surveyed during the 2000-2001 campaign, within the main water courses, as well as the types and number of selected sites included in the water quality monitoring system.

**Table 3-1. Surveyed water sources and selected sites for the monitoring network**

| Hydrographic basin/sub-basin | Water source type | Number of surveyed water sources | Number of selected water sources |
|---|---|---|---|
| Abruzel Valley (B) | Springs | 29 | 1 |
| | Hand-dug wells | 24 | 4 |
| | Borewells | 2 | - |
| | Monitoring boreholes | 2 | 2 |
| | ARD/wastewater | 1 | - |
| | Total | 58 | 7 |
| Corna Valley (C) | Springs | 75 | 4 |
| | Hand-dug wells | 85 | 5 |
| | Monitoring boreholes | 2 | 2 |
| | ARD/wastewater | 2 | 1 |
| | Lakes | 2 | - |
| | Total | 166 | 12 |
| Sălişte Valley (D) | Springs | 21 | 4 |
| | Hand-dug wells | 5 | 1 |
| | Monitoring boreholes | 1 | 1 |
| | Lakes | 1 | - |
| | Surface water | 1 | - |
| | Total | 29 | 6 |
| Roşia Valley (R) | Springs | 51 | 5 |
| | Hand-dug wells | 26 | 5 |
| | Monitoring boreholes | 1 | 1 |
| | ARD/wastewater | 3 | 2 |
| | Lakes | 2 | - |
| | Surface water | 1 | 1 |
| | Total | 84 | 14 |
| Abrud River | Surface water | 10 | 10 |
| Arieş River | Surface water | 1 | 1 |
| Roşia Valley | Surface water | 3 | 3 |
| | Runoff from Aprăbuş primary crusher | 1 | 1 |
| Ştefanca Valley | Surface water | 1 | 1 |
| | Total | 16 | 16 |
| Grand total | | 353 | 55 |

The survey was carried out during a period of severe drought, with only two rainy days. Therefore, wells and springs had low water levels and flow rates, and sometimes were even dry.

### *3.2.3 Results of field measurements*

The measured pH of the survey locations was between 2.8 and 10.2, with the majority of values between 7.0 and 8.3. The lowest pH values were determined in 14 samples collected either from impacted water streams or existing mine adits. Practically, all pH measurements in natural springs and wells were close to neutral (pH = 7).

Electric conductivity was between 49 and 1547 µS/cm at 25°C. Numerous samples collected from streams and hand-dug wells displayed values towards the high end of this interval, suggesting a potential contamination of the corresponding sites.

### *3.2.4 The database*

The survey data were added to MS Access database tables. All records were stored as specific data sets for each site. The database was built in such a way as to allow updates by including new monitoring points or new results from subsequent sampling and analysing campaigns.

## 3.3 The Design and Extent of the Monitoring Network

Based on the aforementioned selection of sites, a water quality monitoring network was designed for the studied area. The network was developed both in terms of covered area and types of collected and analysed samples.

The area covered by the monitoring network was extended to include water streams located upstream – Buciumani Valley — and downstream of the studied area — Ştefanca Valley, Şesei Valley and Sartăş Valley. All these water streams cross through areas with active or closed mining works, waste rock dumps and tailings.

At present, the water quality monitoring network operated by RMGC covers approximately 27,000 ha and has the following conventional boundaries:

- Southeast – Buciumani Valley, from Bucium to the confluence of Buciumani Valley and the Abrud River;
- South and southwest – the Abrud River, from upstream of the confluence with Buciumani Valley to the city of Abrud;
- West – the Abrud River, from the city of Abrud to the confluence of the Abrud River and the Arieş River;
- North – the Arieş River, between the confluence of the Abrud River and the Arieş River to the confluence of the Sartăş Valley and the Arieş Valley.

The area covered by the present water quality monitoring network is shown in Figure 3.1.

The water quality monitoring network includes the following types of samples:

- Acid rock drainage and other types of wastewater
- Groundwater:
  - springs
  - wells
  - monitoring boreholes
- Surface stream water
- Water from man-made lakes
- Drinking water from the supply network.

Tables 3-2 to 3-7 contain details concerning the location of sampling points, as per hydrographic sub-basins/basins and sample types. The location of sampling points is given in figures drawn for each type of monitored waters, and presented in Figures 3.2 to 3.7.

### Table 3-2. Location of sampling points for ARD and other types of wastewater

| Hydrographic sub-basin | Sample ID | Wastewater type | Detailed location of sampling points |
|---|---|---|---|
| Roşia Valley | R088 | ARD from underground mine workings | Waters collected from underground mines located underneath Cetate open pit; yellowish-brown color, free of iron hydroxide suspensions |
| | R085 | ARD discharged to the surface via the 714 adit (Gura Minei) | Highly contaminated waters, with high concentration of iron hydroxides (yellowish-red color) |
| | S009 | Runoffs | Runoff on the slopes of Aprăbuş hill, which is the location of the crusher of the Gura Roşia processing plant |
| Corna Valley | C122 | ARD discharged to the surface via an old, downfallen gallery located downstream from Valea Verde waste dump | Spring-like water, highly contaminated, with high concentration of iron hydroxides (yellowish-red color) |

The location of ARD and other wastewater sampling points is shown in Figure 3.2.

## Table 3-3. Location of springs selected for the monitoring network

| Hydrographic sub-basin | Sample ID | Detailed location of sampling points |
|---|---|---|
| Abruzel Valley | B037 | Private spring, tapped, used as domestic water supply source, located on the lower slopes of Abruzel Valley, downstream of the mining operations |
| Corna Valley | C130 | Spring located on the lower slopes of Corna Valley, downstream of Cetate open pit and the two waste rock dumps (Hop and Valea Verde), in Corna village; it replaced the hand-dug well bearing the same ID |
| | C120 | Communal spring, tapped, used as water supply source, located on the lower slopes of Corna Valley, in Corna village, downstream of Cetate open pit and the two waste rock dumps |
| | C088 | Communal spring, tapped, used as water supply source, located on the higher slopes of Corna Valley, in Bunta village |
| | C086 | Private spring, tapped, used as water supply source, located on the higher slopes of Corna Valley, in Bunta village, downstream of spring C088 |
| | C080 | Communal spring, tapped, used as water supply source, located in the floodplain of Corna Valley, in Bunta village |
| Sălişte Valley | D013 | Private spring, located on the higher slopes of Sălişte Valley, tapped and used during pre-communist period for a private mine |
| | D023 | Private spring, located on the higher slopes of Sălişte Valley, tapped, used as water supply source by a small number of families |
| | D004 | Private spring, located on the higher slopes of Sălişte Valley, tapped, used as water supply source by a single family |
| | D025 | Spring located on the lower slopes of Sălişte Valley, north of the active decant pond in Sălişte Valley, used as water supply by people staying in summer hut |
| Roşia Valley | R043 | Communal spring, located on the lower slopes of Roşia Valley, downstream of Tăul Mare, tapped and stored in two concrete storage tanks, used as the main water supply source of Roşia Montană |
| | R078 | Communal spring, located on the lower slopes of Roşia Valley, in Țarina area, tapped, supplies a stream of low flow rate |
| | R059 | Communal spring, located on the lower slopes of Roşia Valley, downstream of mine water discharges from the 714 adit, tapped, used for domestic purposes by several families in Bălmoşeşti village |
| | R011 | Communal spring, located on the higher slopes of Roşia Valley, in Ignatesti village, used for domestic and animal farming purposes |
| | R020 | Communal spring, flowing by gravity, located on the lower slopes of Roşia Valley, in a forest area |

The location of above sampling points is shown in Figure 3.3.

**Table 3-4. Location of hand-dug wells selected for the monitoring network**

| Hydrographic sub-basin | Sample ID | Detailed location of sampling points |
|---|---|---|
| Abruzel Valley | B032 | Communal well, located in the flood plain of Abruzel Stream, downstream of mining works area, in Valea Abruzel village |
| | B028 | Communal well, located in the flood plain of Abruzel Stream, downstream of mining works area and of well B032, in Valea Abruzel village |
| | B025 | Private well, located in the flood plain of Abruzel Stream, downstream of mining works area and of well B028, in Valea Abruzel village |
| | B007 | Private well, located in the flood plain of Abruzel Stream, in the confluence of Abruzel Stream and the Abrud River, downstream of weir AW01, in Bucium Sat |
| Corna Valley | C130 | Private well, located on the lower slopes of Corna Valley, downstream of Cetate open pit and the two waste rock dumps (Hop and Valea Verde), in Corna village *Due to the fact that the owner of the well denied access to the well after first sampling, a second sample had to be collected from a spring located upstream, but keeping the same sample ID* |
| | C111 | Communal well, located on the lower slopes of Corna Valley, downstream of Cetate open pit, the two waste rock dumps, and well C130, in Corna village |
| | C056 | Private well, located on the lower slopes of Corna Valley, downstream of well C111, in Bunta village |
| | C042 | Private well, located in the flood plain of Corna Valley, downstream of well C056, in Gura Cornei; the well is used exclusively for animals |
| | C026 | Private well, located in the flood plain of Corna Valley, downstream of well C042 and upstream of weir CW01, in Gura Cornei; used for land irrigation and animals |
| Sălişte Valley | D002 | Private well, located in the flood plain of Sălişte Valley, downstream of the active decant pond in Sălişte Valley, used by a single family, but not for drinking |
| Roşia Valley | R080 | Private well, located on the lower slopes of Roşia Valley, in the centre of Roşia Montană, used as water source, but not for drinking – because it is located in an area serviced by the communal water supply network |
| | R073 | Private well, located on the lower slopes of Roşia Valley, in an uninhabited area of Roşia Montană |
| | R061 | Communal well, located on the lower slopes of Roşia Valley, downstream of mine water discharge in Roşia Stream, in Balmosesti village, used as water source by a single family |
| | R065 | Private well, located in the flood plain of Roşia Valley, in Balmosesti village, used as water source; high contamination potential from Roşia Stream |
| | R005 | Communal well, located on the lower slopes of Roşia Valley, in Iacobeşti village; spring water quality during dry periods, poor quality during rainy periods |

The location of above sampling points is shown in Figure 3.4.

During the period that followed the water source survey, at the beginning of 2001, six monitoring boreholes were drilled. Subsequently, they were also included in the monitoring network.

**Table 3-5. Location of monitoring boreholes included in the monitoring network**

| Hydrographic sub-basin | Sample ID | Detailed location of sampling points |
|---|---|---|
| Abruzel Valley | B058 | Mining operations area, downstream of Valeni village and upstream of Valea Abruzel village, near Concordia adit |
| | B057 | The area downstream of weir AW01, at the confluence of Abruzel and the Abrud River |
| Corna Valley | C166 | The area downstream of Corna village and upstream of Bunta village, located on the lower slopes of Corna Valley |
| | C165 | The area downstream of weir CW01, in the floodplain of Corna Valley, in Gura Cornei village |
| Sălişte Valley | D029 | The area downstream of weir DW01 and the active tailings dam in Sălişte valley, in the floodplain of the valley |
| Roşia Valley | R087 | The area downstream of weir RW01, downstream of ARD discharge in Roşia valley, in the floodplain of it, in Gura Roşia village |

The location of the monitoring boreholes is shown in Figure 3.5.

In addition to the sampling points established during the water sources survey, the monitoring program was extended to also deal with *the surface water quality*, in order to determine the impact of streams which collect waters from areas affected by mining works or lacking wastewater collection and treatment systems, to the main water streams in the studied area, namely the Abrud and the Arieş Rivers.

As shown in Table 3-6, there are 32 water sampling points established during the water sources survey carried out in the year 2000 and subsequently extended during 2002-2003.

**Table 3-6. Location of surface water sampling points**

| Water stream | Sample ID | Detailed location of sampling points |
|---|---|---|
| Buciumani Valley | S018 | Bucium village, Alba Stream, upstream of confluence with Buciumani Valley |
| | S017 | Bucium village, Buciumani Stream, downstream of confluence with Alba Valley and another tributary (spring) |
| | S019 | Buciumani Stream, downstream of the mining area and before the confluence with the Abrud River |
| Abruzel Valley | S022 | One of the two tributaries (springs) of Abruzel Stream, downstream of Petreni village and upstream of Bisericani village |
| | S021 | One of the two tributaries (springs) of Abruzel Stream, downstream of Petreni village and upstream of Bisericani village |
| | S002 | Abruzel Stream, downstream of the mining area and before the confluence with the Abrud River |
| Corna Valley | S032 | Corna Stream, downstream of the waste rock dump and upstream of Corna village |
| | S033 | Corna Stream, downstream of the waste rock dump area and upstream of Corna village |
| | S004 | Corna Stream, downstream of Corna, Bunta and Gura Roşia villages and upstream of confluence with the Abrud River |
| Sălişte Valley | S034 | Sălişte Stream, upstream of the active decant pond in Sălişte Valley |
| | S007 | Sălişte Stream, downstream of supernatant discharge from the active decant pond in Sălişte Valley and upstream of confluence with the Abrud River |
| Roşia Valley | S029 | Roşia Stream, in the head-water area, downstream of the mining and Roşia Montană village, in Tăul Mare area |

| Water stream | Sample ID | Detailed location of sampling points |
|---|---|---|
| | S030 | Roşia Stream, in the head-water area, downstream of Tăul Mare, the mining works and Roşia Montană village |
| | S031 | Water drainage from the mining area and water runoffs from the waste rock dump, collected by Nanului Valley, before the confluence with Roşia Stream, off Roşia Montană village |
| | S010 | Roşia Stream, downstream of the mine water discharge from the 714 adit, downstream of runoff area from Aprăbuş crusher, and upstream of confluence with the Abrud River |
| Left tributaries of the Abrud River | S005 | Left tributary stream of the Abrud River, downstream of Abrud city and upstream of the confluence with Sălişte Stream, in Abrud Sat |
| | S023 | Left tributary stream of the Abrud River that collects runoffs, from the slopes of Gura Roşia decant pond, downstream of the confluence with Sălişte Stream and upstream of Gura Roşia village |
| Ştefanca Valley | S015 | Ştefanca Stream, downstream of the waste rock dumps belonging to the Roşia Poieni mine and upstream of the confluence with the Arieş River |
| Şesei Valley | S024 | Şesei Stream, downstream of the waste rock dump and Valea Şesei II decant pond belonging to the Roşia Poieni mine and upstream of the confluence with the Arieş River |
| Sartăş Valley | S025 | Sartăş Stream, downstream of Baia de Arieş tailings pond and upstream of the confluence with the Arieş River |
| Abrud River | S020 | The Abrud River, upstream of the confluence with Buciumani Stream, downstream of the mining in Bucium area, in Gura Izbitei village |
| | S001 | The Abrud River, downstream of the confluence with Buciumani Stream and upstream of the confluence with Abruzel Stream, in Valea Abruzel village |
| | S003 | The Abrud River, upstream of the confluence with Corna Stream, in Gura Roşia village |
| | S006 | The Abrud River, downstream of Abrud Sat and upstream of the confluence with Corna Stream |
| | S008 | The Abrud River, upstream of the confluence with Roşia Stream |
| | S011 | The Abrud River, downstream of the confluence with Roşia Stream and downstream of the wastewater discharge from Gura Roşia processing plant and of Gura Roşia village |
| | S012 | The Abrud River, before the confluence with the Arieş River |
| Arieş River | S013 | The Arieş River, downstream of Câmpeni and upstream of the confluence with the Abrud River |
| | S014 | The Arieş River, upstream of the confluence with the Ştefanca Stream |
| | S016 | The Arieş River, downstream of the confluence with Ştefanca Stream and upstream of the confluence with Şesei Stream |
| | S026 | The Arieş River, downstream of the confluence with Şesei Stream and upstream of the confluence with Sartăş Stream |
| | S027 | The Arieş River, downstream of the confluence with Sartăş Stream |

The location of surface water sampling points is shown in Figure 3.6.

Several man-made lakes, locally called ”tăuri,” exist in the area, especially in the hydrographic sub-basins of Roşia and Corna Valleys. Such lakes have been built by the local communities for ore grinding and washing within household mine ventures. At present, the use of such lakes is limited. The monitoring network was extended in 2003 to include seven such man-made lakes.

**Table 3-7. Location of water sampling points related to man-made lakes**

| Hydrographic sub-basin | Sample symbol | Denomination | Detailed location |
|---|---|---|---|
| Roşia Valley | HRM17 | Tăul Mare | The north-east area of Roşia Montană and the (proposed) Jig open pit |
| | HRM18 | Tăul Ţarina | The north-east area of Roşia Montană and the (proposed) Ţarina open pit |
| | HRM16 | Tăul Anghel | The south-east area of Roşia Montană and the north-east area of Cârnic open pit |
| | HRM15 | Tăul Brazilor | The south-east area of Roşia Montană and the north-east area of Cârnic open pit, immediately to the west of Tăul Anghel |
| | HRM13 | Tăul Tapului | The south-west area of Roşia Montană, west of Cetate open pit |
| Corna Valley | HRM12 | Tăul Corna | The north-east area of Corna, south of Cârnic open pit |
| | HRM11 | Tăul Cartuş | The north-east area of Corna, south of Cetate open pit |
| | HRM14 | Tăul Gauri | The west area of Corna, south-west of Cetate open pit |

The location of these sampling points in the monitoring area is shown in Figure 3.7.

The monitoring network was extended to the local water supply network. Available data did not allow the location of sampling points for drinking water.

## 3.4 Operation of the Monitoring Network

### *3.4.1 Monitoring Frequency*

The monitoring program started in November 2000 and continued in 2001 and 2002, on a semi-annual basis, during the dry seasons (spring/fall). In 2003, three sampling campaigns were carried out, with a summer campaign (August) added to the two semi-annual campaigns.

### *3.4.2 Monitored Parameters*

The water quality monitoring program for the future Roşia Montană Project area includes a large number of parameters, in conformance with the applicable regulations concerning the surface water quality (STAS 4706-88 ”Surface Waters – Quality categories and technical conditions”), the industrial effluents discharged into water streams (Government Decision no. 188/2002 for the approval of norms concerning requirements for effluent discharge into aquatic environments, Technical Norm concerning admissible pollutant limits of industrial and sewage wastewater discharged into natural water receptors, NTPA 001/2002), and the drinking water, all valid also for ground water (Law on Drinking Water no. 458/2002 modified and completed by Law no. 311/2004 and STAS 1342-91 “The Drinking Water”).

Apart from the parameters required by the legal documents mentioned above, the monitoring program included a much larger number of parameters, which are presented in the Table 3-8.

**Table 3-8. Monitoring program for water assessment**

| No. | Data type | MU | | No. | Data type | MU | | No. | Data type | MU |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Site ID | | | 26 | F | mg/L | | 51 | NiT | µg/L |
| 2 | Sampling Date | | | 27 | F | meq/L | | 52 | NiD | µg/L |
| 3 | Stereo 70 E | | | 28 | Cl | mg/L | | 53 | PbT | µg/L |
| 4 | Stereo 70 N | | | 29 | Cl | meq/L | | 54 | PbD | µg/L |
| 5 | Valley | | | 30 | SO4 | mg/L | | 55 | ZnT | µg/L |
| 6 | Water Type | | | 31 | SO4 | meq/L | | 56 | ZnD | µg/L |
| 7 | Flow | $m^3/s$ | | 32 | HCO3 | mg/L | | 57 | ZnD | meq/L |
| 8 | temp | $^oC$ | | 33 | HCO3 | meq/L | | 58 | Sb | µg/L |
| 9 | pH | | | 34 | CO3 | mg/L | | 59 | Ba | µg/L |
| 10 | Suspended Matter | | | 35 | CO3 | meq/L | | 60 | CrT | µg/L |
| 11 | Cond | µS/cm | | 36 | NO3 | mg/L | | 61 | CrHex | µg/L |
| 12 | E | | | 37 | NO3 | meq/L | | 62 | Mn | mg/L |
| 13 | DO | | | 38 | PO4 | mg/L | | 63 | Mn | meq/L |
| 14 | BOD | mg/L | | 39 | PO4 | meq/L | | 64 | Co | µg/L |
| 15 | Turbidity | | | 40 | HSiO3 | mg/L | | 65 | Hg | µg/L |
| 16 | AlkT | meq/L | | 41 | HSiO3 | meq/L | | 66 | Mo | µg/L |
| 17 | AlkP | mql | | 42 | AsT | µg/L | | 67 | Se | µg/L |
| 18 | Ca | mg/L | | 43 | AsD | µg/L | | 68 | COD | |
| 19 | Ca | meq/L | | 44 | CdT | µg/L | | 69 | Phenol | µg/L |
| 20 | Mg | mg/L | | 45 | CdD | µg/L | | 70 | CN | µg/L |
| 21 | Mg | meq/L | | 46 | CuT | µg/L | | 71 | Pos | |
| 22 | Na | mg/L | | 47 | CuD | µg/L | | 72 | Neg | |
| 23 | Na | meq/L | | 48 | FeT | mg/L | | 73 | IonBal | |
| 24 | K | mg/L | | 49 | FeD | mg/L | | 74 | TDS_calc | mg/L |
| 25 | K | meq/L | | 50 | FeD | meq/L | | 75 | Measured TDS | mg/L |

The results of field and laboratory measurements are stored in an MS Access database. Due to the large volume and complexity of the data, the database is only accessible in electronic format.

### *3.4.3 Sample collection and analysis*

The physical and chemical determinations were carried out by a qualified private laboratory – S.C. ANALIST SERVICE S.R.L. Bucharest (ANALIST). The laboratory maintained a sample preparation facility in Roşia Montană, for rapid turn-around analyses, sample division and preservation.

The collection and analysis of water samples were carried out according to QA/QC procedures indicated by ANALIST. The laboratory of ANALIST has the Certificate of Attestation no. 228-L/06.10.2003 issued by the Romanian Accreditation Association (RENAR).

After each sampling and analytical campaign, ANALIST published a Technical Report containing also the sampling and analytical procedures. The following is a summary of these procedures:

1. Collection of water samples
   - water samples collected in 5 L plastic bottles, from each sampling point;
   - water samples collected in 250 mL plastic bottles for BOD tests;
   - in situ analysis of instable parameters: temperature, pH, electric conductivity, dissolved oxygen, redox potential;
   - transport of water samples to ANALIST laboratory in Roşia Montană, in the shortest time possible.

2. The activity at ANALIST laboratory in Roşia Montană
   - determination of turbidity and alkalinity;
   - filtration of water samples through 0.45 μm membranes;
   - division of the 5 L water samples, as follows:
     - 1 L for general analyses (total suspended matter, sodium, potassium, calcium, magnesium, chlorides, sulphates, phosphates, fluorides, silicates);
     - 250 mL for dissolved metals (arsenic, cadmium, copper, lead, nickel, selenium, zinc), acidified with 2.5 mL of concentrated nitric acid, after filtration through 0.45 μm;
     - 250 mL for total metals (arsenic, copper, lead, cadmium, nickel, zinc, manganese, cobalt, molybdenum, chromium, Cr6+), acidified with 2.5 mL concentrated nitric acid;
     - 250 mL acidified with 2.5 mL concentrated sulphuric acid for Fetotal and Fe2+, mercury and COD;
     - 250 mL for phenols, treated with 8.5 % phosphoric acid solution and 0.25 g copper sulphate, final pH lower than 2;
     - 250 mL for cyanides treated with 2-3 pellets of sodium hydroxide.

3. Transport ANALIST laboratory in Bucharest.

4. Sample analysis:
   - samples are analysed according to the applicable standard analytical procedures;
   - the equipment used for field and laboratory analysis consists of:
     - HACH SenIon 156 for: pH, temperature, electrical conductivity, dissolved oxygen and BOD;
     - CONSORT P 601 for: redox potential;
     - Burette for alkalinity, chlorides and COD;
     - Analytical balance (0.1 μg) for total suspended matters;

- SPEKOL spectrophotometer for turbidity, sulphates, $Fe_{total}$, $Fe^{2+}$, nitrates, $Cr^{6+}$, phenols, phosphates, cyanides and fluorides;
- FLAPHO photometer for Na, K, Ca;
- Flame atomic absorption spectrophotometer AAS 1 for: manganese, zinc, magnesium;
- Atomic absorption spectrophotometer with graphite furnace VARIO 6 EA for: lead, copper, cadmium, nickel, cobalt, molybdenum, chromium, barium, manganese, zinc;
- Atomic absorption spectrophotometer with graphite furnace and hydride technique VARIO 6 HydroEA for: arsenic, antimony, selenium; and,
- Cold vapor atomic absorption spectrophotometer VARIO 6 HydrHg for mercury.

The detection limits of the used equipment and methods for main pollutants are presented in Table 3-9.

**Table 3-9. Detection Limits of the analytical methods used for physical and chemical measurements**

| No | Parameter | Analytical Method | Detection Limit |
|---|---|---|---|
| 1 | Redox potential | | |
| 2 | Suspended matter | STAS 6953/81 | 0.5 mg/L |
| 3 | pH | STAS 6325/75 | |
| 4 | Turbidity | STAS 6323/88 | 0.1 NTU |
| 5 | Temperature | STAS 6324/61 | |
| 6 | Na | STAS 3223 – 1/91 | 5 μg/L |
| 7 | K | STAS 3223 – 2/91 | 15 μg/L |
| 8 | Ca | STAS 3662/90 | 3 μg/L |
| 9 | Ba | AA, EA | 1 μg/L |
| 10 | Mg | SR ISO 7980/86 | 10 μg/L |
| 11 | Sb | AA, Hydride System | 0.05 μg/L |
| 12 | As (total) | AA, Hydride System | 0.05μg/L |
| 13 | As (dissolved) | AA, Hydride System | 0.05 μg/L |
| 14 | Chloride | STAS 3049/88 | 0.40 mg/L |
| 15 | Sulphate | STAS 3069/87 | 0.40 mg/L |
| 16 | Fe (total) | SR 13315/96 | 1 μg/L |
| 17 | Fe (dissolved) | | |
| 18 | Mn | AA, EA | 1 μg/L |
| 19 | Pb (total) | AA, EA | 1 μg/L |
| 20 | Pb (dissolved) | | |
| 21 | Cu (total) | AA, EA | 1 μg/L |
| 22 | Cu (dissolved) | | |
| 23 | Cd (total) | AA, EA | 1 μg/L |
| 24 | Cd (dissolved) | | |
| 25 | Zn (total) | AA, EA | 1 μg/L |
| 26 | Zn (dissolved) | | |
| 27 | Ni (total) | AA, EA | 1 μg/L |
| 28 | Ni (dissolved) | | |
| 29 | $HCO_3$/ $CO_3$ | SR ISO 9963-1 | |
| 30 | Nitrate | STAS 3048-1/77 | 20 μg/L |
| 31 | Fluoride | STAS 3048-2/77 | 50 μg/L |
| 32 | Conductivity | SR EN 27888/97 | |
| 33 | Se | AA, Hydride System | 0.05 μg/L |
| 34 | Co | AA, EA | 1 μg/L |
| 35 | CN | STAS 10847/77 | 2.5 μg/L |
| 36 | Hg | AA, Hydride System | 0.1 μg/L |
| 37 | Mo | AA, EA | 1 μg/L |
| 38 | Cr (total) | AA, EA | 1 μg/L |
| 39 | Cr (hexavalent) | STAS 7884/91 | 10 μg/L |
| 40 | Phenols | STAS R 7167/92 | 10 μg/L |
| 41 | Phosphate | SR ISO 10304/99 | 10 μg/L |
| 42 | BOD | STAS 6560/82 | |
| 43 | COD | SR ISO 6060/96 | |
| 44 | $SiO_2$ | STAS 9375/73 | |
| 45 | Residue at 105 C | | |

It is to be mentioned that these detection limits are, below the admissible concentration limits for all monitored parameters.

For non-statistical contamination level evaluation purposes, the concentrations below detection limit were considered zero.

### *3.4.4 Selected Parameters for Water Quality Baseline Conditions*

Given the scope of the water quality baseline studies – i.e., assessment of contamination degree in the Roşia Montană area, as a result of non-ferrous ore mining and processing – only a limited number of the monitored parameters (i.e., those considered to be *specific parameters)* were selected for presentation in this present report.

The selection of specific parameters was based on the following:

- The Convention signed on 25 March 2003, between the National Administration ”Apele Române” and the National Research and Development Institute for Environmental Protection (ICIM) Bucharest, and the List of specific parameters and their usage for monitoring wastewater discharges into natural water receptors, included in the Appendix 1 of the Convention;
- The List of parameters analyzed in the Health Impact Assessment carried out by the Public Health Institute in Bucharest and the Environmental and Health Centre in Cluj Napoca, parameters which pose great hazards to human health, identified in concentrations that generated specific diseases among the inhabitants of the studied area;
- Applicable legislation (Government Decision no. 118/2002) concerning the approval of the Action Programme for abatement of pollution in aquatic environments and ground waters, caused by the discharge of hazardous substances, by which the EU Directive 76/464/EEC regarding the pollution caused by certain hazardous substances discharges in the aquatic environment, has been transposed into Romanian legislation. Of the 35 substances prioritised by the Action Program for pollution abatement, only four are specific to gold-silver ore mining and processing, namely: cadmium, lead, mercury and nickel.

By correlating the provisions of the aforementioned documents, the water quality baseline study has focused on the following specific parameters: *pH, arsenic, cadmium, nickel, chromium, lead, selenium, mercury and sulphates.*

The monitoring program establishes that, of these selected parameters, arsenic, cadmium, nickel and lead will be analysed both for total metal and dissolved metal concentration. A mention should be made that the applicable legislation refers only to the concentration of *dissolved metals*.

The purpose of analysing both forms of metals in the analysed water samples is to determine the *total metals / dissolved metals* ratio and to correlate these two concentrations with the pH value. Precipitated metals present in solution can be re-dissolved if the pH or other quality conditions are modified along the route of a given flowing water.

To these specific pollutants, the *bicarbonate ion* is added, a parameter for water alkalinity, which is of particular interest for water quality assessment in mining areas. In fact, alkalinity is an indicator of the neutralisation potential of the acidity, as it is assumed to be the sum of carbonate and bicarbonate ions present in a given solution. This is based on the fact that dissociated carbonic acid is a weak acid, even in the highest concentrations likely to occur in natural waters. Due to the fact that the pH of the analysed samples is below 8.5, the alkalinity generated by the carbonate ion is zero in the entire studied area. The reason behind this is the instability of the carbonate ion in waters with pH lower than 8.5. It is possible that by relating the water alkalinity to the concentration of bicarbonate ions, the latter value could be overestimated, due to the presence of other weak acids in the water. There is no regulatory limit for alkalinity or bicarbonate concentration.

Although *cyanide* will be the main specific parameter for the Roşia Montană Project, this will not be important for the baseline study, as no cyanide is presently used in the monitored area. Although cyanide is included in the monitoring program, it will not be analysed by this report, due to the negative results obtained for cyanide during previous sampling and analysing campaigns.

## 3.5 Criteria for Water Quality Evaluation

The criteria for water quality evaluation have been adapted to the types of analysed water, as follows:

- Wastewater discharged into water streams – Government Decision no. 188/2002 for the approval of norms concerning requirements for effluent discharge into aquatic environments, Technical Norm concerning admissible pollutant limits of industrial and sewage wastewater discharged into natural water receptors, NTPA 001/2002;
- Ground water (springs, wells, monitoring boreholes) – Law no. 458/2002 concerning the quality of drinking water, modified and completed by Law no. 311/2004 and Romanian standard (STAS) 1342-91 ”The drinking water;”

  By Law no. 458/2002, modified and completed by Law no. 311/2004, the EU Council Directive 98/83/EC from November 1998, concerning the quality of water for human consumption, has been transposed into the Romanian legislation.

  Although all the regulations refer to the quality of drinking water, and because Romania has no specific legislation for assessing the quality of this type of water, the accepted practice is to reference both normative documents. The justification lies in the fact that ground water – including phreatic water, is largely used as a water supply source.
- Surface waters (water streams and lakes) – Romanian standard (STAS) 4706-88 “Surface waters” Quality categories and technical conditions.

Although all the water quality regulations have pH value ranges, for the purposes of water quality assessment of this parameter the following conventional ranges of the pH values have been considered:

- 0 – 2.5 strongly acidic character;
- 2.5 – 4.5 acidic character;
- 4.5 – 6.5 moderately acidic character;
- 6.5 – 7.5 neutral character;
- 7.5 – 9.5 moderately alkaline character;
- 9.5 – 11.5 alkaline character; and,
- 11.5 – 14 strongly alkaline character.

For water management in general, the provisions of Law no. 107/1996 – The Law on Water, modified and completed by Law no. 310/2004 – are applied. This law will be amended after transposition of the EU Frame Directive on Water 76/464 from 4 May 1976.

Table 3-10 shows a comparison between the admissible limit concentrations, as provisioned by the three aforementioned regulations concerning water quality.

**Table 3-10. Comparison between maximum allowed concentrations for the quality of various types of water**

| Quality parameter | Measuring unit | Waste water* | Ground water** | Surface water*** | | | Required dilution flow rate**** |
|---|---|---|---|---|---|---|---|
| | | | | 1st cat. | 2nd cat. | 3rd cat. | |
| pH | pH units | 6.5 – 8.5 | 6.5 – 9.5 | 6.5-8.5 | 6.5-8.5 | 6.5-8.5 | - |
| Dissolved Arsenic | μg/L | 100 | 10 | 10 | 10 | 10 | 10 |
| Dissolved Cadmium | μg/L | 200 | 5 | 3 | 3 | 3 | 66.7 |
| Dissolved Nickel | μg/L | 500 | 20 | 100 | 100 | 100 | 5 |
| Dissolved Lead | μg/L | 200 | 10 | 50 | 50 | 50 | 4 |
| Dissolved Mercury | μg/L | 50 | 1 | 1 | 1 | 1 | 50 |
| Total Chromium ($Cr_{total}$) | μg/L | 1000 | 50 | 500 | 500 | 500 | 2 |
| Dissolved Selenium | μg/L | 100 | 10 | 10 | 10 | 10 | 10 |
| Sulphates | mg/L | 600 | 250 | 200 | 400 | 400 | 1.5 |

* Government Decision no. 188/2002 – Technical Norm concerning admissible pollutant limits of industrial and sewage wastewater discharged into natural water receptors NTPA 001/2002

** Law on Drinking Water no. 458/2002 completed and modified by Law no. 311/2004 and STAS 1342-91 “The Drinking Water”

*** STAS 4706-88 ”Surface waters,” Quality categories and technical conditions

**** Ratio between pollutant concentrations in the wastewater and pollutant concentrations in the surface water

The parameters selected for the assessment of surface water quality have the same maximum admissible concentrations (MAC) for all three quality categories except sulphate. For this parameter there is a MAC for category I (200 mg/L), and another MAC for the second and third categories (400 mg/L).

For the purposes of surface water quality assessment, the text is presented only the comparison to category I limits. Although in tables presented in Section 4 sulphate is compared against both MACs.

The admissible limits for selected pollutants in ground waters – including springs and wells – are similar to those established for surface waters (arsenic, mercury and selenium), or even smaller (nickel and lead are 5 times lower, total chromium ($Cr_{total}$) is 10 times lower), with the exception of cadmium limit for drinking water, which is 1.67 higher.

# 4 Investigation Results and Interpretation

This chapter presents the results obtained during the water quality monitoring program, between 2001 and 2003. The evaluation of water quality was based on selected physico-chemical results obtained during the monitoring program and on graphical representations of those results.

The summary of selected data includes several key aspects concerning water quality:

- The total number of collected samples (max. 7);
- The maximum determined value;
- The minimum determined value;
- The samples with values in excess to the maximum admissible concentration (MAC) – as number and percentage; and,

The maximum exceedance of MAC.

The results are presented for each hydrographic sub-basin, starting with the characterisation of wastewater sources (where specific samples were collected and data were available) and following the impact of anthropogenic activities to the quality of ground water (springs, wells, monitoring boreholes) and surface water (streams, lakes). The complete tables of data used for interpretation are attached to section 4.

In addition, for an overall view on the water quality in various hydrographic sub-basins and on each specific parameter at the scale of the entire studied area, an exhibit is given for:

- wastewater;
- ground waters (springs, wells, monitoring boreholes); and,
- surface waters (water courses).

Certain parameters such as arsenic, cadmium, nickel and lead are represented both in terms of dissolved state and total concentrations, on the same exhibit. The exhibits concerning water quality are attached to this report.

Water quality results are presented from the upstream to the downstream of the investigated area, with the identification of impacts generated by the mining works in Roşia Montană and neighbouring areas. Additionally, *the water quality in the central water supply network* of Roşia Montană is presented.

It should be mentioned that water sample types were different from one hydrographic sub-basin/basin to another, and that the monitoring program concentrated on Corna, Sălişte and Roşia Valleys, which will be directly affected by the development of the Roşia Montană Project. The water quality in the hydrographic sub-basins located upstream of Roşia Montană (Buciumani and Abruzel Valleys) was considered of special importance.

The water quality baseline study also included the Abrud and the Arieş Rivers that collect impacted waters from the mining areas located in the monitored area. The purpose of this assessment was to establish the magnitude and spread of surface water pollution in the areas located downstream of these mining operations. The pollution with contaminants that are specific to ore mining and processing may affect downstream usage at considerable distance.

The following paragraphs deal with water quality assessment for each hydrographic sub-basin and for each type of water.

## 4.1 Buciumani Valley

### *4.1.1 Wastewater*

The monitoring program analysed by this report does not include wastewater samples collected on this valley.

However, it is a known fact that along Buciumani Valley, there are several historic mining areas that belong to the Bucium mining area and which may represent pollution sources for ground and surface waters.

### *4.1.2 Ground Waters*

No ground water samples were collected from this area, because Buciumani Valley is located outside the Project footprint. In addition, ground waters in this area are contained in shallow alluvial deposits located near the valley floor. The shallow alluvial groundwater in the valley mostly discharges to surface water as baseflow within the valley.

### *4.1.3 Surface Waters*

The water quality of Buciumani Valley has been monitored through water sampling in three locations. Details concerning the location of these points are presented in Table 3-6 and Figure 3.6.

The results indicated that all three water samples collected at points S018, S017 and S019, had a circum-neutral pH (Appendix A, Table 1), while other parameters were below the maximum allowed limits, including those in quality category I.

Sulphate ion was recorded with values below the limit corresponding to quality category I, i.e., 200 mg/L.

***It is concluded that surface waters in Buciumani Stream were of good quality.***

## 4.2 Abruzel Valley

### *4.2.1 Wastewater*

No wastewater samples were collected from this valley either, although mines belonging to the Bucium area are known in the north-east part of the Abruzel sub-basin. Such works may have a pollution impact to ground and surface waters.

### *4.2.2 Ground Waters*

The monitoring program for this valley included: one spring (Table 3-3 and Figure 3.3), four wells (Table 3-4 and Figure 3.4) and two monitoring boreholes (Table 3-5 and Figure 3.5). All water sampling points are located downstream of mining areas.

The results concerning the water quality of spring B037 (Appendix A, Table 2) indicated that, in spite of a near-neutral character (maximum pH 7.70), some dissolved contaminants exceeded MAC, namely: cadmium in two samples, by a maximum of 1.14 times and nickel, in a single sample, by 1.02 times.

The water samples collected from the four hand-dug wells (Appendix A, Table 3) revealed values equal to or exceeding the MAC for the following parameters:

- sample B032: arsenic in a single sample, by a maximum of 1.32 times and cadmium, also in a single sample, by 1.04 times;

- sample B028: arsenic in a single sample, by 1.40 times and nickel, also in a single sample approximately equal to the MAC;
- sample B025: selenium in six samples, by a max. of 2.30 times;
- sample B007: arsenic in three samples, by a max. of 1.81 times; cadmium in two samples, by a max. of 1.56 times; nickel in a single sample approximately equal to the MAC; lead also in a single sample, by 1.12 times; and selenium in two samples, by a max. of 1.15 times.

All the water samples had a neutral character.

The most contaminated water is that of well B007, which, due to its location, suffers from the negative quality of water in the Abrud River, which is already polluted from upstream.

The water quality in the two boreholes located in the Abruzel Valley, differed substantially (Appendix A, Table 4) due to their location.

In the case of monitoring borehole B058, located in the mining area, the contamination was relatively high, with values exceeding MAC for: arsenic in three samples, by a maximum of 1.63 times; cadmium in two samples, by a max. of 3.20 times; nickel in two samples, by a max. of 2.18 times; lead in a single sample approximately equal to the MAC; total chromium in two samples, by a max. of 6.58 times; and sulphates in six samples, by a max. of 2.87 times.

Water in monitoring borehole B057 – located downstream of the mining area, close to the confluence of the Abruzel Valley and the Abrud River, has a better quality compared to that of B058, with only minor exceeding value for: nickel in a single sample, by 1.82 times and total chromium, also in a single sample approximately equal to the MAC.

Both water samples had a near-neutral character.

**The general conclusion concerning the ground water in Abruzel Valley is that the mining has had a negative influence on its quality, due to elevated concentrations of contaminants that could pose a risk to local inhabitants (arsenic, cadmium, nickel, lead, selenium, total chromium, and sulphates).**

### *4.2.3 Surface Waters*

Surface water quality in the Abruzel Valley was monitored in three sampling sections. Details concerning the location of these monitoring points are given Table 3-6 and Figure 3-6.

Water samples collected in point S022 – located upstream of the mining area, on a right tributary in the Abruzel headwater area, had a near-neutral character, with a single pH value under the allowed limit (6.18). All other parameters were compatible with the Appendix A, Table 3-5).

Although sampling point S021 is located relatively close to S022, but on a left tributary in the Abruzel head water area, it was found to be contaminated. This is due to the fact that the left tributary collects runoffs from the Şesei Valley where the waste rock dumps of Roşia Poieni mine are located. All collected water samples had an acidic character (pH = 2.60 – 3.58). Most other parameters exceeded MAC for: arsenic in two samples, by a max. of 2.50 times; cadmium in all samples, by a max. of 28.37 times; nickel in a single sample, by 4.02 times; lead in a single sample, by 1.33 times; total chromium in a single sample by 1.91 times; selenium in all samples by a max. of 6.77 times; and sulphate in all samples, by a max. of 17.83 times (Appendix A, Table 3-5).

The third water sample from the Abruzel Valley, was collected in point S002, located upstream of the confluence with the Abrud River. Water quality in this point is improved due to dilution by various springs found on the valley's slopes. In such conditions, the acidic character is maintained, but with a variation range from acidic to moderately acidic (pH = 3.74 – 4.83). Concentrations were in excess of limits for: arsenic in a single sample, by 1.06 times; cadmium in all samples, by a max. of 22.33 times; and sulphate ion in six samples, by a max. of 4.16 times.

***The general conclusion is that the Abruzel Stream – which is formed from two tributaries: a clean right tributary and a strongly impacted left one (arsenic, cadmium, nickel, lead, chromium, selenium and sulphate) – is generally contaminated with (cadmium and sulphate) and this contamination is maintained downstream to the confluence with the Abrud River.***

## 4.3 Corna Valley

### *4.3.1 Wastewater*

The water quality monitoring program for the Corna Valley included a single sampling point for wastewater: C122 (Table 3-2 and Figure 3.2).

Corna Valley is located south of the mining operations in Roşia Montană, and is impacted by underground and open pit mining (Cetate and Cârnic) as well as by the Hop and Valea Verde waste rock dumps.

Due to the fact that ARD and runoff in the areas affected by the mining are difficult to intercept for sample collection, a single ARD sample was collected from this hydrographic sub-basin, namely, from a collapsed adit located south of Valea Verde waste rock stockpile.

Although this type of water should theoretically be strongly impacted, significant fluctuations of its quality were recorded during the monitoring period – from highly impacted that is visually identified by the reddish color of iron hydroxides, to less impacted as suggested by the absence of iron hydroxides.

These field observations were confirmed by the analytical results (Appendix A, Table 6): the pH is variable between moderately acidic (pH = 4.35) to neutral (pH = 7.10), with four samples equal to or exceeding the maximum allowed limits for: nickel in a single sample, by 1.07 times; total chromium, in a single sample, by 2.96 times; and sulphate in four samples, by a max. of 3.82 times.

***The conclusion is that the ARD source in the Corna Stream has a significant contribution of total chromium and sulphates.***

### *4.3.2 Ground Waters*

Due to the fact that Corna Valley has no centralised water supply systems, most of the individual water supply sources were surveyed in this area. For this reason, the number of monitored ground water sources was higher in the Corna Valley.

The monitoring program of Corna Valley included: five springs (Table 3-3), four wells (Table 3-4) and two monitoring boreholes (Table 3-5). All water sampling points were located downstream of the mining areas (Figures 3-3 to 3-5).

Due to a lack of an owner's agreement, the water sampling from well C130, located downstream of Valea Verde waste rock stockpile, had to be interrupted and later resumed from a spring located in the same area, but upstream of the well in question. Thus, the sampling point C130 was inserted in Table 3-3**,** which contains details on the location of the monitored springs.

The water quality analysis in spring C130 indicated a circum neutral character (three samples with pH values below the allowed limit of 6.5) and relatively small exceeding of MAC in single samples for: arsenic by 1.02 times; cadmium by 1.28 times; nickel by 1.02 times; selenium by 1.29 times; and sulphate by 1.05 times (Appendix A, Table 8).

Water samples from spring C120 had a near-neutral character, with two samples outside the allowed pH range. Only selenium exceeded the MAC in two samples by a maximum of 1.96 times (Appendix A, Table 7).

The water quality in other springs was also good. The samples collected from spring C088 had a single value in excess for lead, by 1.13 times, whereas the samples from spring C086 displayed also a single value in excess of the limits for cadmium by 1.06 times. The samples from spring C080 had a pH value below the admissible limit of 6.5 (Appendix A, Table 7).

***The water from the monitored springs were good quality due to their location on the higher slopes of the Corna Valley (C086, C088), or due to the fact that their underground source is not connected with the water of the Corna Stream. However, the water from the spring C130 is contaminated mainly with cadmium and selenium.***

The water quality in hand-dug wells was relatively good, with values in excess of the limits for several parameters in a small number of samples. In samples from well C111, located in the center of the Corna village, the following exceeding values were recorded: arsenic in two samples, by a max. of 1.28 times; cadmium in a single sample, by 1.04 times; and lead in a single sample by 1.24 times. Water samples from well C056 in Bunta village displayed no values in excess of maximum allowed limits. Water sample from well C042, located in Gura Cornei village, had excess values for: pH (two values below the limits); cadmium in two samples, by a max. of 1.52 times; and selenium in five samples, by a max. of 2.10 times. In the case of well C026, also located in Gura Cornei village, the following excess values were recorded: pH in a single sample; lead in a single sample, by 1.13 times; and selenium in four samples, by a max. of 1.60 times.

***Although the wells are located in the influence area of the stream, the collected samples indicated a neutral character and reduced contamination with some concentrations of arsenic, cadmium, lead and selenium that slightly exceeded the MAC.***

The water samples collected from the monitoring boreholes: C166 and C165, indicated a high content of suspended solids – due to improper insulation of casing, as well as significant exceeding values for several parameters (Appendix A, Table 9). Monitoring borehole C166, located downstream of Corna village and upstream of Bunta village displayed values in excess for: cadmium in three samples, by a max. of 2.08 times; nickel in a single sample, by 1.02 times; lead in two samples, by a max. of 4.96 times; and total chromium in a single sample, by 11.76 times. Samples collected in monitoring borehole C165, located downstream of weir CW01, had the following values in excess of the limits: cadmium in three samples, by a max. of 1.44 times; nickel in two samples, by 1.05 times; lead in four samples, by a max. of 2.84 times; and total chromium in two samples, by 14.10 times.

The pH value had a near-neutral character, with one single exceedance of the admissible limits of this parameter being identified for the two monitoring wells.

***The water quality in the two monitoring boreholes was relatively similar to other groundwater in the valley, with values in excess for the same parameters: cadmium, nickel, lead and total chromium, of which lead and total chromium had significant concentrations.***

### *4.3.3 Surface waters*

The monitoring of surface waters in the Corna Valley was carried out both for water streams and man-made lakes ("tăuri"). Details concerning the location of these sampling points are given in Table 3-6 and Figure 3.6 – water streams, and Table 3-7 and Figure 3.7 – man-made lakes.

Water samples collected in point S032 had a strongly acidic to acidic character (pH = 2.65 – 2.79) and high concentrations of contaminants, such as: arsenic in all samples, by a max. of 39.2 times; cadmium in all samples, by a max. of 44.7 times; total chromium in a single sample, by 6.68 times; selenium in all samples, by a max. of 1.99 times; and sulphate in all samples, by a max. of 6.12 times (Appendix A, Table 10).

A significant contamination has been identified in water samples collected in point S033, which displayed an acidic character (pH = 2.50 – 2.98) and values in excess of the limits for: arsenic in all samples, by a max. of 8 times; cadmium in all samples, by a max. of 66.00 times; selenium in two samples, by a max. of 2.85 times; and sulphate in all samples, by a max. of 7.98 times (Appendix A, Table 10).

Water collected in point S004 had the best quality, due to the fact that highly contaminated minor streams which collect runoffs from the mining areas located upstream of sampling points S032 and S033, are diluted along their flow path with water from slope springs along the Corna Valley.

However, the water quality parameters in point S004, located upstream of the confluence of Corna Stream and the Abrud River, do not comply with the limits allowed for: arsenic in two samples, by a max. of 1.76 times; cadmium in five samples, by a max. of 1.90 times; selenium in five samples, by a max. of 2.20 times; and sulphate in a single sample by 1.25 times (Appendix A, Table 10).

***The pH value for all the samples collected from the sampling point S004 had a moderately acidic to neutral character, two pH values being lower than the admissible range of pH.***

***In conclusion, Corna Valley is cut by a stream which originates in a mining area, from where acidic waters and very high concentrations of contaminants result: arsenic, cadmium, total chromium, selenium and sulphate. The existence of a large number of springs (75 according to the water source survey) in the hydrographic sub-basin of Corna Valley, leads to lower concentrations downstream, but elevated concentrations for arsenic, cadmium and selenium are maintained down to the confluence of Corna Stream and the Abrud River.***

The monitoring program also included the main man-made lakes in this hydrographic sub-basin (Table 3-7 and Figure 3.7). During the sampling campaign of October 2003, the first samples were collected from Tăul Corna (HRM12), Tăul Cartuş (HRM11) and Tăul Gauri (HRM14).

Analysis results indicated that all three water samples had significant exceeding values for mercury: by 3.72 – 15.60 times; and for selenium: by 2.35 – 5.55 times (Appendix A, Table 11). The highest contamination was found in Tăul Cartuş.

Although springs may feed these man-made lakes, the source of mercury and selenium is related to the historic use of these lakes by small-scale gold ore processing operations.

It should be mentioned that similarly high concentrations of mercury were not found in any other type of water.

## 4.4 Sălişte Valley

### *4.4.1 Wastewater*

The only source of wastewater in Sălişte sub-basin consists of supernatant discharges from the active tailings pond of Sălişte Valley and seepage from the tailings dam. Due to the fact that this wastewater is discharged in a valley, forms a water stream and merges with several slope springs, it was classified as surface water and, thus, correspondingly dealt with in chapter Surface Waters.

#### *4.4.2 Ground Waters*

The quality of ground waters in the Sălişte Valley sub-basin was monitored by sampling from: four springs (Table 3-3 and Figure 3.3), one well (Table 3-4 and Figure 3.4) and one monitoring borehole (Table 3-5 and Figure 3.5).

Water samples collected from the four springs indicated good and very good quality. Values in excess of the limits were recorded for a small number of parameters (Appendix A, Table 12). Samples collected from spring D013 indicated exceedances for the following parameters: cadmium in two samples, by a max. of 1.72 times and nickel in a single sample, by 2.11 times; in samples from spring D004, only for cadmium, in two samples, by a max. of 1.84 times, and in samples from spring D025, for: cadmium in two samples, by 1.30 times and nickel, in a single sample, by 1.06 times. Water from spring D023 had a very good quality with all monitored parameters below the admissible limits. With few exceptions, the pH values of water samples from all four springs were within admissible limits except for a single pH measurement.

***The conclusion about the water quality in the monitored springs is that no negative effects from local mining operations are felt, due to the location of the springs, on the higher slopes of the Sălişte Valley, upstream of the tailings pond. The presence of the cadmium and selenium in small concentrations could be explained by the mineralisation of the area.***

Due to the fact that Sălişte Valley hosts no human communities, the number of wells is small. Thus, the monitoring program included only the well D002.

Owing to its location downstream of the active tailings pond, and in the contamination area of the Sălişte Stream, the samples collected from this well indicated values in excess of the allowed limits for the majority of parameters: arsenic in a single sample, by 1.29 times; cadmium in a single sample, by 2.40 times; nickel in six samples, by a max. of 2.72 times; and sulphate in all samples, by a max. of 2.63 times (Appendix A, Table 13). Water samples had moderately acidic (two samples pH values between 5.94 and 6.5) to neutral character.

***Therefore, the water quality in this well is impacted, due to arsenic, cadmium, nickel and sulphate concentrations.***

Although the monitoring borehole D029 is located close to well D002, also downstream of the tailings dam, the water samples collected from this point were less contaminated. Higher concentrations of suspended solids recorded at the beginning of the monitoring program samples, have been reduced in time.

Value in excess of the admissible limits were recorded for: cadmium in a single sample, by 1.14 times; nickel in two samples, by a max. of 1.60 times; and sulphate in a single sample, by 1.67 times (Appendix A, Table 14).

***The conclusion is that the discharge of decant water from the tailings pond located upstream of the monitoring well in the Sălişte Valley has a negative influence on the quality of ground water intercepted by the monitoring borehole D029.***

#### *4.4.3 Surface Waters*

Monitoring of surface waters in the Sălişte Valley initially consisted of a single point - S007, located downstream of the active tailings dam, but has been extended to the area located upstream of the dam, by point S034 (Table 3-6 and Figure 3-6).

Water samples from location S034 had a very good quality, without any recorded values in excess of the limits for the monitored parameters. In turn, the quality of water sampled in point S007 was impacted, with values exceeding the MAC for: arsenic in two samples, by a max. of 7.30 times; cadmium in five samples, by a max. of 2.63 times; nickel in a single sample, by 1.44 times; total chromium in a single sample, by 1.38 times; selenium in six samples, by a max. of 2.60 times; and sulphate in five samples, by 2.29 times (Appendix A, Table 15). Three samples had an acidic character, with pH values between 3.97 and 6.5.

The high concentration of dissolved metals is explained by the fact that the Sălişte Stream functions practically as an offtake for tailings dam supernatant water and for runoff and seepage from the outer slope of the dam. Runoff and seepage are highly acidic, thus favouring the solubilisation of metals in the body of the dam and in the solid suspensions driven by supernatant waters. Owing to the low number of springs, the dilution of such waters is much reduced.

***The conclusion can be drawn as follows: the water is qualitatively very good down to the upstream end of the tailings pond, but becomes impacted downstream of the active tailings management facilities, especially due to arsenic, cadmium, nickel, total chromium, selenium and sulphates.***

## 4.5 Roşia Valley

### *4.5.1 Wastewater*

Roşia Valley is the most important sub-basin for the Roşia Montană Project. Moreover, the surroundings of Roşia Montană are also the location of the most important underground and open pit mining as well as for numerous waste rock piles of various sizes.

Roşia Valley also collects the waters from the underground network of mines that discharge to the surface in a point called Gura Minei, located at an elevation of 714 m (“714 Adit”). The water flowing from the 714 Adit enters the Roşia Stream and forms a substantial portion of the flow during low-flow periods. Beside this major ARD source, other outlets related to adits of secondary importance, such as Racoşi adit, are active in the Roşia Valley. Runoffs from uncovered mine waste areas that are exposed to exogenous factors add to this ARD associated with the mining.

There is a relatively large number of point or diffuse sources of wastewater in the Roşia Valley associated with the mine and mines wastes. For the scope of the monitoring program, three sampling points were selected as representative of ARD sources in the valley (Table 3-2 and Figure 3.2): ARD emissions from Racoşi adit (R088), ARD emissions from the 714 Adit (R085) and runoff from the primary ore crusher area (S009).

Ground water which is discharged in sampling point R085 (714 Adit) is usually of yellow-orange color, and lacks suspended iron hydroxide. All water samples had an acidic character (pH = 2.68 – 3.03). With the exception of mercury, all other parameters were recorded with values significantly exceeding the allowed limits: arsenic in three samples, by a maximum of 17.38 times; cadmium in five samples, by a max. of 4.07 times; nickel in six samples, by a max. 1.46 times; lead in a single sample, by 1.23 times; total chromium in two samples, by a max. of 2.71 times; selenium in six samples, by a max. of 2.17 times; and sulphate in all samples, by a max. of 4.40 times (Appendix A, Table 16).

All ARD samples from point R088 were acidic (pH = 2.73 – 2.94), and monitored parameters displayed excess values for: cadmium in three samples, by a maximum of 1.21 times; nickel in a single sample, by 1.24 times; total chromium in two samples, by a max. of 4.08 times and sulphate in all samples, by a max. of 3.13 times (Appendix A, Table 16).

Although six samples from point S009 had an acidic to moderately acidic character (pH = 2.75 – 6.84), their loading with pollutants was significantly lower than in the case of ARD samples discharging from the mines. Values in excess of the limits were recorded only for: total chromium in a single sample, by 1.14 times; and sulphate in four samples, by a maximum of 1.38 times (Appendix A, Table 16).

***The conclusion of the monitoring program concerning ARD and other types of wastewater in the Roşia Valley is that the main contamination sources of Roşia Stream are represented by ARD discharges through various mine adits. Such waters display both a strongly acidic character and elevated contents of arsenic, cadmium,***

***nickel, lead, total chromium, selenium and sulphate. Owing to the high flow rate of such waters and to the naturally low flow rate of Roşia Stream, the dilution factor is low, thus leading to the contamination of the water stream downstream of the aforementioned discharge points.***

***Runoffs from areas impacted by open pit mining operations may represent significant sources of pollution, especially if such areas are broad and the discharge into water streams cannot be controlled.***

### *4.5.2 Ground Waters*

The monitoring program related to the Roşia Valley included: five springs (Table 3-3 and Figure 3.3), five wells (Table 3-4 and Figure 3.4) and one monitoring borehole (Table 3-5 and Figure 3.5).

Water from spring R048 – which is one of the water supply sources for Roşia Montană, was characterized by pollutant levels below the admissible limits, with the exception of cadmium which exceeded the limits by a maximum of 1.34 times (Appendix A, Table 17).

Spring R073, which is used as a water source by several families, had also qualitatively good water. Values exceeding the allowed levels were identified only for arsenic, in two samples, by a maximum of 1.04 times (Appendix A, Table 17).

The quality of water from the other three springs was also relatively good, with excessive concentration levels for: spring R059 – arsenic in a single sample, by a maximum of 1.05 times and selenium in two samples, by a max. of 1.90 times; spring R011 – arsenic in four samples, by a max. of 2.63 times and selenium in a single sample, by 1.05 times; spring R020 – cadmium in a single sample by 1.06 times and selenium in four samples, by a max. of 1.70 times (Appendix A, Table 17).

The pH values for the majority of samples were found within admissible limits, less three exceptions in the case of spring R078 and one exception in the case of spring R059 (Appendix A, Table 17).

***The water quality in the monitored springs was good, due to their location on the higher slopes of the Roşia Valley (springs R043, R078) and the fact that they have no connection with the water of Roşia Stream. Occasional values exceeding admissible levels for arsenic, cadmium and selenium are due to the natural background and not to mining activities. The majority of these springs are used as water supply by the local inhabitants.***

Water samples collected from wells located in the Roşia Valley sub-basin were generally of good quality, with a limited number of values up to 2 times higher than the allowed limits (Appendix A, Table 18): well R080 – cadmium in two samples, by a max. of 1.30 times and selenium, also in two samples, by a max. of 2.10 times; well R073 – cadmium in a single sample, by 1.10 times, nickel in a single sample by 1.02 times and sulphate in all samples, by a max. of 2.08 times; well R061 – arsenic in a single sample, by 1.07 times, lead in a single sample, by 1.46 times and selenium in three samples, by a max. of 1.30 times; well R065 – nickel in a single sample, by 2.18 times and selenium in five samples, by a max. of 1.80 times; well R005 – only selenium, in two samples, by a max. of 1.50 times (Appendix A, Table 18).

Recorded pH values in collected samples from these wells were generally found within the allowed limits, with the exception of well R061. Water from this well had a moderately acidic character: 4.40 – 6.09 (Appendix A, Table 18). These lower pH values are due to the negative influence exerted by the Roşia Stream on the well located downstream of an ARD discharge point (R088) to the water stream.

***In conclusion, the water from the wells in the Roşia Stream is generally of good quality, with the exception of well R061 where occasional values in excess of the limits were found for arsenic, cadmium, nickel, lead, selenium and sulphate.***

A single monitoring borehole has been installed in the Roşia Valley (R087), in the area under negative influence from the Roşia Stream, downstream of the point where ARD from 714 Adit is discharged into the stream (Table 3-5 and Figure 3-5).

Water samples from this monitoring borehole displayed high concentrations of suspended solids, due to improper filtration casing. In addition, levels higher than normal were recorded for: arsenic in a single sample, by 1.23 times; nickel also in a single sample, by 4.20 times; lead in three samples, by a maximum of 7.83 times; and total chromium in two samples, by a max. of 17.58 times (Appendix A, Table 19). This high level of water contamination may be due either to the influence of local surface water (identified in sample S031), or to runoff infiltration into the borehole casing.

***The parameters with values above admissible limits found in the monitoring borehole R087 are partly the same with those identified in ARD impacted water, namely: arsenic, nickel, lead and total chromium, thus confirming the idea of a connection between the interior borehole casing and the Roşia Stream.***

#### *4.5.3 Surface Waters*

The monitoring of surface waters in the Roşia Valley has been carried out for both water streams and man-made lakes. Details concerning the location of these sampling points are shown Table 3-6 and Figure 3-6 for water streams and Table 3-7 and Figure 3.7 for man-made lakes, respectively.

Water samples collected from the sampling sections S029 and S030 were of good quality. With the exception of several lower than normal pH values (i.e., all samples from S029 and one sample from S030), all other parameters were found within admissible limits. The location of sampling points S029 and S030 upstream of the mining areas and of Roşia Montană, explains the good water quality recorded.

In the case of sampling point S029, the recorded pH values were outside the admissible range: from 9.45 – moderately alkaline character to 6.04 – moderately acidic character. Samples collected in S030 had a near-neutral character, with values within the admissible limits.

The surface water sampling point S031 is located on a left tributary of the Roşia Stream, which flows on Nanului Valley and crosses a highly impacted area. For this reason, the water quality in this point was poor, with concentrations above allowed levels for: arsenic in two samples, by a maximum of 7.72 times; cadmium in two samples, by a max. of 2.87 times; total chromium in a single sample, by 2.19 times; sulphate in two samples, by a max. of 3.65 times (Appendix A, Table 20). The pH values ranged from 2.77 (acidic character) to 6.49 (neutral character), with all samples outside the allowed limits.

Water samples from point S010, located on the Roşia Valley upstream of the confluence with the Abrud River, had a strong (pH = 2.85) to moderately acidic character (pH = 5.0), and significant concentrations of: arsenic in four samples, by a maximum of 3.33 times in excess of limits; cadmium in all samples, by a max. of 28.67 times; nickel in two samples, by a max. of 1.47 times; total chromium in a single sample, by a max. of 2.88 times; selenium in six samples, by a max. of 4.73 times; and sulphate in all samples, by a max. of 3.96 times (Appendix A, Table 20). The poor quality water in Roşia Stream, at this particular sampling point, is the result of untreated ARD being discharged directly into the stream.

***The general conclusion is that Roşia Stream has a good water quality in its headwater area, but degrades significantly as a result of ARD from mining impacted areas being directly discharged into the main stream or tributaries. Values in excess of the***

***admissible limits were recorded for arsenic, cadmium, nickel, total chromium, selenium and sulphate.***

The monitoring program of this hydrographic sub-basin included also the main existing man-made lakes (Table 3-7 and Figure 3.7). During the October 2003 campaign, the first samples were collected from Tăul Mare (HRM17), Tăul Ţarina (HRM18), Tăul Anghel (HRM16), Tăul Brazilor (HRM15) and Tăul Tapului (HRM13).

Analytical results for all five water samples indicated concentrations well above limits for mercury: 4.50 – 12.92 times and for selenium: 1.96 – 7.61 times (Appendix A, Table 21). The most polluted water is that of Tăul Ţarina, which may be explained by the large number of pre-war private mining operations that were active in the neighboring areas.

Although springs may feed these man-made lakes, the source of mercury and selenium is related to the historic use of these lakes by small-scale gold ore processing operations in which mercury was used to collect the gold. Mercury-contaminated sediments in these lakes may be a concern and may be resulting in the mercury concentrations observed in the water column.

A mention should again be made that similarly high concentrations of mercury were not found in any other type of water.

### *4.5.4 Drinking Water*

The water quality monitoring network has added five monitoring points concerning the two water supply systems of Roşia Montană.

Although analyzed samples were within admissible limits of monitored parameters, they contained: selenium – all five samples; cadmium – one sample; lead – one sample; and total chromium – two samples (Appendix A, Table 22).

***Owing to the negative impact of mining operations on the water resources, and in order to protect human health, capture systems for remote springs located upstream of the affected areas as well as a centralized water supply network, have been built. The determinations carried out on such samples have confirmed that the water delivered by the central supply system is of adequate quality for drinking water.***

## 4.6 Abrud River

The Abrud River is the main recipient of all surface waters from Bucium and Roşia Montană mining areas. The monitoring network operated by RMGC includes several sampling sections that were established to cover the entire water stream from upstream of the confluence with Buciumani Valley (point S020) and downstream to the confluence with the Arieş River (S012) (Table 3-6 and Figure 3-6). Sampling points were located downstream of the confluence between the Abrud River and its tributaries, so that any positive or negative modifications of the water quality would be identified.

The main tributaries of the Abrud River were presented in subchapters 4.1 – 4.5 — all of them are right-hand tributaries. In order to describe the impact of all potential sources of pollution to the Abrud River, the monitoring program was extended to also include some left-hand tributaries of this stream.

Water samples collected from the first monitoring point S020, revealed high pollution levels generated by the mining located upstream and to the south of this point (Bucium area). All samples were acidic to moderately acidic (pH = 3.21 –5.06) and had a reddish-yellow color due to the presence of iron hydroxides. The concentrations of cadmium and sulphate were above the admissible limits in all collected samples: by a maximum of 4.87 times for cadmium and by a max. of 2.40 times for sulphate (Appendix A, Table 23).

After the confluence of the Abrud River with the Buciumani Stream, and owing to the better quality of the latter, the water of Abrud undergoes some dilution. However, the samples collected from point S001 have the same excessive levels of arsenic – in four samples, by a maximum of 2.31 times; cadmium – in four samples, by a max. of 3.87 times; and selenium – in three samples, by a max. of 1.70 times (Appendix A, Table 23). The waters were moderately acidic (pH = 5.82) to neutral in character. The contamination source appears to be runoffs from mining impacted areas, which flow into the main stream as left tributaries.

The next water sampling point on the Abrud River (S003) is located downstream of its confluence with the Abruzel Stream, but close to the confluence with the Corna Stream. Down to this monitoring point, the Abrud River collects several additional left tributaries, which leads to dilution and diminishes the pollution level in the main river. Although excessive levels were recorded for the same parameters, they were lower than the ones described above: arsenic in three samples, by a max. of 1.79 times; and cadmium in four samples, by a max. of 2.43 times (Appendix A, Table 23). Selenium is an exception, with concentrations in excess of the limits, found in six samples, by a max. of 3.40 times. The maximal concentration for sulphate (235.50 mg/L) is above the limit established for category I by 1.18 times. Water samples from this sampling point had a moderately acidic character, with pH values between 4.43 and 6.61.

Point S005 corresponds to the control section on a left tributary of the Abrud River, which flows into the main river downstream of Abrud city. The water of this affluent was relatively clean, but with some concentrations above the limits for cadmium, in four samples, by a max. of 2.53 times (Appendix A, Table 23).

The next sampling point S006 was located on the Abrud River, close to its confluence with the Sălişte Stream. The purpose of this sampling point was to have a control test for point S007, located on the Sălişte Stream. Water samples from point S006 have revealed several parameters in excess of the allowed limits: arsenic – in three samples, by a maximum of 1.22 times; cadmium – in four samples, by a max. of 1.87 times; and selenium – in four samples, by a max. of 1.80 times (Appendix A, Table 23). These waters had a neutral character. Maximal concentration of sulphate (273.00 mg/L) was above the limit established for category I by 1.37 times. By comparing the quality parameters of this sample with the ones of sample S007 on the Sălişte Valley, the negative impact of the tailings facility is identified.

Another water sampling point from the left tributaries of the Abrud River is S023, located on a valley which collects the runoff from the southern and western slopes of a tailings dam under conservation, at Gura Roşia. Such samples revealed a near-neutral character and concentration levels slightly above limits for cadmium – in one sample, by 1.30 times; and selenium – in one sample, by 1.40 times (Appendix A, Table 23). Maximal concentration of sulphate (246.00 mg/L) was above the limit established for category I by 1.23 times.

Point S008 is located on the Abrud River, downstream of the confluence with a stream which collects runoffs from the old tailings pond, but upstream of the confluence with the Roşia Stream. Water samples collected from this point have indicated a near-neutral character and values in excess of the limits for: arsenic – in two samples, by a maximum of 1.76 times; cadmium – in four samples, by a max. of 1.27 times; and selenium – in five samples, by a max. of 2.32 times (Appendix A, Table 23). Maximal concentration of sulphate (276 mg/L) was above the limit established for category I by 1.38 times.

The next sampling point S011 on the Abrud River is located downstream of point S008 and of the confluence with Roşia Valley as well as downstream of the untreated wastewater discharge from the Gura Roşia processing plant. The results point out the impact of pollution sources along the Roşia Valley and of the untreated wastewater's impact to the quality of the Abrud River. This is the most significant impact identified along the Abrud River. Water samples were moderately acidic to neutral character. Admissible limits were surpassed significantly for: arsenic – in five samples, by a maximum of 5.73 times; cadmium – in four samples, by a max. of 2.10 times; and selenium – in four samples, by a max. of 4.32 times

(Appendix A, Table 23). Maximal concentration of sulphate (382.00 mg/L) was above the limit established for category I by 1.91 times.

The last monitoring point on the Abrud River (S012) is located upstream of the confluence with the Arieş River. Monitoring the water quality in this point can help in assessing the impact of wastewater discharged by all types of mining activities from Bucium and the Roşia Montană areas. The water samples from this point reveal values above the admissible limits for the same parameters, with elevated levels of pollution maintained: arsenic – in six samples, by a max. of 4.53 times; cadmium – in six samples, by a max. of 3.03 times; total chromium – in one sample, by 1.09 times; and selenium in all samples, by a max. of 2.30 times (Appendix A, Table 23). Maximal concentration of sulphate (356.00 mg/L) was above the limit established for category I by 1.78 times. The waters had moderately acidic to neutral character.

***The conclusion concerning the water quality in the Abrud River is that the stream in question represents a clear example of impact generated by historic and present mining operations, against a total lack of collection, storage and treatment systems for ARD or other specific sources of pollution. The Abrud waters have an acidic character and significant concentrations of specific pollutants: arsenic, cadmium, selenium and sulphate, along most of the River's length.***

## 4.7 Arieş River

The scope of monitoring the Arieş River was to assess the impact caused by the Abrud River and other mining-related sources to the water quality of this stream. In this sense, samples were collected from sampling sections located both on the Arieş mainstream – from above the confluence with the Abrud River, down to the confluence with Sartăş Stream, and on the main tributaries which cross through neighboring mining areas: Ştefanca Valley, Şesei Valley and Sartăş Valley (Table 3-6 and Figure 3.6).

Water samples collected from the first monitoring point on the Arieş River – S013, revealed a very good water quality. With the exception of two pH values into the weakly acidic domain, no other parameter was found above the allowed limits (Appendix A, Table 27).

The next sampling point – S014, located on the Arieş River, upstream of its confluence with Ştefanca Stream, contained values above admissible limits: arsenic – in four samples, by a maximum of 1.53 times and selenium – in three samples, by a max. of 1.50 times (Appendix A, Table 27). Water samples had near-neutral character. The pollution sources of the Arieş River may be represented by various right-hand tributaries, which cut through highly mineralised or mining areas.

The pollution sources on the Arieş River are related to waste dumps belonging to the Roşia Poieni mine that is the tailings pond under conservation, located on the Ştefanca Valley. In order to characterise the water of this valley, samples were collected from point S015. Analytical results indicated values slightly in excess of the limits, for arsenic – in three samples, by a max. of 1.27 times and for selenium – in three samples, by a max. of 1.60 times (Appendix A, Table 24).

Water samples taken from point S016 located downstream of the confluence between Ştefanca Valley and the Arieş River, have indicated the same contaminants, with lower concentration levels than those recorded for S014, but in a larger number of samples: arsenic – in five samples, by a max. of 1.40 times and selenium – in three samples, by a max. of 1.20 times (Appendix A, Table 27).

***In conclusion, the impact caused by the Ştefanca Valley to the quality of the Arieş River is less obvious due to the relatively low pollution level of Ştefanca Valley and to the increasing dilution flow rate of the Arieş River.***

The next right-hand tributary of the Arieş River is the Şesei Valley, which cuts through an area with numerous sources of pollution, of which the most significant are the waste rock piles and the active tailings dam of Roşia Poieni mine. In order to characterise this valley, water samples were collected at point S024. The results have indicated an acidic (pH = 3.36) to neutral character, and values significantly exceeding allowed levels for: arsenic – one sample, by 1.48 times; cadmium – three samples, by a max. of 23.11 times; lead – one sample, by 1.61 times; total chromium – one sample, by 2.18 times; selenium – four samples, by a max. of 3.24 times; and sulphate – four samples, by a max. of 7 times (Appendix A, Table 25).

The quality of the Arieş River downstream of the confluence with the Şesei Stream is monitored in point S026. Although the Şesei Stream is known as one of the most important sources of contamination for surface waters, its impact to the quality of the Arieş River is not very high, due to the dilution flow rate of the Arieş River. Thus, only two water samples collected from point S026 had a moderately acidic to neutral character, whereas concentrations exceeding the admissible limits were found for cadmium, also in two samples, by a max. of 1.29 times (Appendix A, Table 27).

Another left-hand tributary of the Arieş River is the Sartăş Valley on which the tailings dam of Baia de Arieş mining exploitation is located. Its quality was monitored in point S025, and the results indicated a neutral (pH = 7.88) to alkaline character (pH = 11.45). Pollutants exceed limits for: arsenic – one sample, by 2.42 times cadmium – in three samples, by a max. of 3.10 times; selenium – in four samples, by a max. of 2.30 times; and sulphate – in four samples, by a max. of 5.86 times (Appendix A, Table 26).

After the confluence of the Arieş River with this valley, the quality of the main stream does not change as compared to point S027. A single exceedance of limits concentration was identified: cadmium, by 1.40 times (Appendix A, Table 27).

***The general conclusion is that the Arieş River collects waters with significant chemical loading originating in areas with mining and ore-processing operations, of which, the most important is the Abrud River. Due to the high dilution flow rate of the Arieş River, no significant changes of quality occur. However, cadmium and selenium concentrations in excess of the limits were identified in the monitored area, potentially affecting the downstream water use.***

## 4.8 Summary Evaluation of Water Quality

Based on the described sampling for wastewater, surface and ground water, an overall evaluation of the water quality in the monitored area was carried out for each type of water sample. The evaluation relates to the exhibits presenting schematically to monitoring network in the studied area. The conclusions of this evaluation are given in the paragraphs below.

Wastewater quality evaluation:

Owing to the difficulties encountered in collecting type wastewater samples, such samples were taken only from the Corna Valley (one sample) and the Roşia Valley (three samples).

The wastewater samples were characterised by high acidity (low pH), especially those collected from ARD occurring in the Roşia Valley (Exhibit 4.1.1). The neutralisation potential of such waters is low, with zero bicarbonate concentration in the majority of samples (Exhibit 4.10.1).

ARD represent the main source for ground and surface water contamination with *arsenic* (Exhibit 4.2.1), *cadmium* (Exhibit 4.3.1), *nickel* (Exhibit 4.4.1), *selenium* (Exhibit 4.8.1) and *sulphate* (Exhibit 4.9.1). Lead (Exhibit 4.5.1) and total chromium (Exhibit 4.7.1) contamination were identified in only a limited number of samples. Mercury concentrations were not detected (Exhibit 4.6.1).

Dissolved metal concentrations (arsenic, cadmium, nickel, lead) found in wastewater samples were generally equal to those determined for total metals, mainly due to the low pH values, outside the range of chemical conditions where precipitation of these chemicals normally occur.

Ground water quality evaluation:

The monitoring program for ground water quality consisted of water sampling from springs (15 samples), hand-dug wells (14 samples) and monitoring boreholes (six samples), located in the Buciumani Valley upstream of the Roşia Montană Project and in the Corna, Sălişte and Roşia Valleys within the Project area.

Ground water samples were near-neutral, with pH values generally within the admissible limits (Exhibit 4.1.2). An exception is represented by a well located in the Roşia Valley, in the ARD impacted area, where samples had an acidic to moderately acidic character.

The neutralisation capacity of ground water acidity, as evaluated on the basis of bicarbonate concentrations, is different from one sample to another (Exhibit 4.10.2). Thus, for the most acidic well in the Roşia Valley, the bicarbonate concentration was very low (below 5 mg/L), whereas several wells and springs in the Corna, Sălişte and Roşia Valleys had bicarbonate concentrations within 10 – 150 mg/L. The rest of the samples displayed higher bicarbonate contents, sometimes above 700 mg/L.

*Arsenic* was present in most of the samples; higher concentrations, above the admissible limits were identified in several wells located in the four monitored valleys and in the monitoring borehole located in the Roşia Valley (Exhibit 4.2.2). Due to the relatively reduced arsenic and pH levels, no differences were noticed between total and dissolved arsenic.

*Cadmium* was another contaminant found in the majority of ground water samples, with similar concentrations for both total and dissolved metal (Exhibit 4.3.2). The similarity can be explained by the low pH value that increases cadmium’s solubility. Highest cadmium concentrations were detected in several wells located in the monitored valleys, but also in springs and monitoring boreholes.

*Nickel* was also identified in the majority of samples, with higher concentrations in those collected from monitoring boreholes, and from a well located in Roşia Valley (Exhibit 4.4.2). In several samples, nickel concentrations were occasionally higher, or the total nickel surpassed dissolved nickel values.

*Lead* was identified in a small number of samples. Highest concentrations were found in the samples collected from monitoring boreholes in the Corna and Roşia Valleys and from a well located in Roşia Valley (Exhibit 4.5.2). In some samples, total lead was higher than dissolved lead.

*Mercury* was found in only a very few ground water samples, and only in a single sampling campaign with the exception of the man-made lakes in the Roşia and Corna basins (Exhibit 4.6.2).

*Total chromium* was detected in many of the samples.  However, typically samples from boreholes had the highest concentrations.

*Selenium* appeared in the majority of ground water samples; higher concentrations were detected in water samples collected from wells and springs located in the Abruzel, Corna and Roşia Valleys (Exhibit 4.8.2).

*Sulphate* was another important pollutant analysed in the studied area; higher concentrations were identified in various ground water sources, such as: a monitoring borehole and a well in the Abruzel Valley, and several wells in the Sălişte and Roşia Valleys (Exhibit 4.9.2).

Surface water quality evaluation:

The surface water quality monitoring program consisted of water sampling from the main water streams in the study area – the Abrud and the Arieş Rivers, as well as from their tributaries. Thus, in the hydrographic basin of the Abrud River, water samples were collected from 15 sampling sections located on the main right-bank Abrud River tributaries - Buciumani, Abruzel, Corna, Sălişte and Roşia Streams, from two sampling sections located in several left-bank tributaries, as well as from seven sampling sections located in the main Abrud Valley. In the hydrographic basin of the Arieş River, water samples were collected from three sampling sections located on right-bank tributaries – Ştefanca and Şesei Streams or left-hand tributaries – Sartăş Stream, as well as from five sampling sections located in the main Arieş Valley.

The characteristics of the monitored waters were variable within the moderately acidic to neutral domain. A single exception was represented by alkaline waters collected in the Sartăş Valley and originating in the tailings pond of Baia de Arieş processing plant (Exhibit 4.1.3). The most acidic surface water samples were collected from the Abrud River – downstream of mining works belonging to Bucium area, from a tributary of Abruzel Stream and from Corna Stream – downstream of the waste rock dumps, from Roşia Stream – downstream of ARD discharge points of the Roşia Montană area, and from the Şesei Stream – downstream of the waste rock piles and of the tailings dam belonging to Roşia Poieni mine.

The concentrations of *bicarbonate* in acidic waters are very low or even zero, corresponding to a low or absent neutralisation capacity of this ion. In fact, the bicarbonate concentrations from all over the area (i.e., both the main two local rivers and their tributaries) were low (Exhibit 4.10.3). The only sampling sections with higher concentrations of bicarbonate were those located on a left-bank tributary of the Abrud River and on the Corna Stream, in the area where it collects the water from a series of unimpacted springs.

*Arsenic* was present in the majority of the analysed samples, with higher concentrations in the areas directly affected by mining works, such as the Corna Stream – downstream of the two waste rock dumps; Sălişte Stream – downstream of the supernatant discharge from the active tailings decant pond; Roşia Stream – downstream of the ARD discharge points; and also in the receptor of these tributaries – the Abrud River (Exhibit 4.2.3). The concentrations of total arsenic are closed to those corresponding to dissolved arsenic, due to the pH value, which is below the minimum precipitation limit of arsenic. A different situation was that of a sample collected on the Sartăş Stream where, due to the alkaline character of the water, the total arsenic was higher than the dissolved arsenic. Although the Abrud River had high concentrations of arsenic before the confluence with the Arieş River, no arsenic contamination was identified in the Arieş River, due to the high dilution flow rate of this water stream.

*Cadmium* was another contaminant present in the majority of water samples, with relevance for the local mining operations from: Abruzel Stream sub-basin – downstream of waste rock dumps on Ştefanca Valley and of the mining area; Corna Stream sub-basin – downstream of the two waste rock piles; Roşia sub-basin – downstream of ARD discharge from adit 714; and Şesei Stream sub-basin – downstream of the waste rock dump and the tailings dam (Exhibit 4.3.3). Cadmium contamination of the Abrud River was identified from upstream of the confluence with the Buciumani Stream – due to the numerous mining works above this point, and down to the confluence with the Arieş River. Cadmium was among the few pollutants found in the Arieş River, on the whole monitored stream length, and at some locations during some events exceeded admissible levels. In all samples having a near-neutral character, total cadmium concentrations were close to those corresponding to dissolved cadmium.

*Nickel* was identified in the water samples collected from: Buciumani Stream sub-basin – downstream of the mining works area, Abruzel Stream sub-basin – downstream of the mining works, Corna Stream sub-basin – downstream of the two waste rock dumps, Sălişte sub-basin – downstream of the tailing pond supernatant discharge, Roşia sub-basin – downstream of the ARD discharge point from adit 714 and Şesei Stream sub-basin – downstream of the waste rock dump and tailings pond (Exhibit 4.4.3). The pollution of the Abrud River tributaries resulted in the presence of nickel also in water samples collected from the main water stream, especially downstream of its confluence with the Roşia Stream. A peculiarity of nickel analyses in surface water samples was represented by high concentrations of total nickel, of which only a small part was given by the dissolved fraction, and only in the samples collected during a single field campaign. High levels of total nickel were recorded in the hydrographic basins of both the Abrud and the Arieş Rivers. Such elevated nickel contents may be explained by nickel-rich solid suspensions being drawn by runoffs from mining areas and by the generally higher level of suspended solids in surface waters.

*Lead* above admissible levels was also identified in only a small number of surface water samples collected from: Abruzel Stream sub-basin – downstream of the mining works, Şesei Stream sub-basin and Sartăş Stream sub-basin (Exhibit 4.5.3). Lead contamination of these water streams has not been confirmed during all the sampling campaigns. Total and dissolved lead concentrations were very similar.

*Mercury* pollution was detected in a very few surface water samples, and at very low concentration concentrations. The presence of mercury was only occasionally determined in water samples collected from: Corna Stream sub-basin – downstream of the waste rock dumps and Roşia Stream sub-basin – downstream of the ARD discharge point from the 714 Adit (Exhibit 4.6.3).

*Total chromium* is another pollutant identified occasionally, in several surface water samples collected during two field campaigns from: Abruzel Stream sub-basin – downstream of the mining works, Corna Stream sub-basin – downstream of the waste rock dumps, Sălişte Stream sub-basin – downstream of tailings supernatant discharge, Roşia Stream sub-basin – downstream of mining impacted areas and Şesei Stream sub-basin – downstream of the waste rock dump and the tailings pond (Exhibit 4.7.3). Contamination of the Abrud tributaries also impacts the quality of the Abrud River. Such high concentrations of total chromium may also be explained by a higher level of chromium-bearing suspended solids in the analysed samples.

*Selenium* contamination was detected in a small number of surface water samples from: the Abruzel Stream sub-basin – downstream of mining works, Corna – Stream sub-basin downstream of waste rock dumps, and from the monitored sub-basins of Arieş tributaries – Ştefanca, Şesei and Sartăş Streams (Exhibit 4.8.3). Selenium pollution of the Abrud River was noticed in two areas – downstream of the confluence Buciumani and Abruzel Streams and downstream of wastewater discharge points from the Gura Roşia processing plant and the Roşia Stream, down to the confluence with the Arieş River. Traces of selenium contamination in the Arieş River were identified in several samples, but at lower levels compared to the Abrud River.

*Sulphate* pollution, which is specific to mining areas, was identified in the majority of surface water samples, but with different intensities (Exhibit 4.9.3). The most polluted sampling sections of the Abrud hydrographic basin were those located in: Abruzel Stream sub-basin – downstream of the mining works, Corna Stream sub-basin – downstream of the waste rock dumps, Sălişte Stream sub-basin – downstream of tailings supernatant discharge, Roşia Stream sub-basin – downstream of ARD discharge, and along the Abrud River. The most polluted sampling sections of Arieş hydrographic basin were located in: Şesei Stream sub-basin – downstream of the waste rock dump and the tailings pond and Sartăş Stream sub-basin – downstream of the tailings pond belonging to the Baia de Arieş processing plant. Sulphate pollution was not identified in the Arieş River, due to a smaller number of pollution sources and to a higher dilution flow rate.

# 5 General Conclusions

The target area of the water quality baseline study includes numerous historic and present mining areas located mainly in the Bucium, Roşia Montană, Roşia Poieni and Baia de Arieş perimeters.

Water pollution sources in the study area consist of mining and ore processing activities, and of highly mineralised geological environments.

The mining and ore processing involve specific underground and open pit works which, under the influence of exogenous factors, may generate ARD and leaching phenomena of ore components containing specific pollutants such as: arsenic, cadmium, nickel, lead, selenium, chromium, copper, iron and sulphate.

The assessment of the water quality baseline conditions has been accomplished based on the operation by RMGC of a monitoring network for wastewater, ground, surface and drinking water, between 2001 and 2003.

Although the monitoring program included a large scope of parameters, in conformance with the applicable regulations concerning water quality baseline studies, only: pH, arsenic, cadmium, nickel, lead, mercury, total chromium, selenium and sulphate were selected for evaluation. These contaminants are relevant for the activities in the studied area, and their selection was done in accordance with the recommendations of the Romanian Water Management Authority (Apele Române), regarding the National Program for the abatement of surface and ground water pollution, and in consistency with the risk posed by such parameters to the human health.

The analysis results from the four *wastewater* samples, mainly ARD from the Corna and Roşia Valleys, indicated high levels of arsenic, cadmium, nickel, selenium and sulphates in the majority of the samples and occasionally elevated levels of lead and total chromium.

The ground water quality monitoring program consisted of samples collected from springs (15 samples), wells (14 samples) and monitoring drill holes (six samples), located in the Buciumani Valley – upstream of the Roşia Montană Project area, and in the Corna, Sălişte and Roşia Valleys – within the Project's boundaries.

The contaminants found in the majority of analysed surface and ground water samples were: arsenic, cadmium, nickel, selenium, total chromium; the presence of lead and sulphates was sporadic and reflects localised sources primarily related to mining impacts. Due to the predominantly near-neutral character of the samples, total and dissolved metal concentrations (for arsenic, cadmium, nickel and lead) were largely similar.

The surface water quality monitoring program consisted of sample collection from the main water streams in the studied area – the Abrud and the Arieş Rivers, as well as from their tributaries. Samples were collected from 17 sampling sections located on the main tributaries of the Abrud River and from seven sampling sections located in the Abrud Valley. From the hydrographic basin of the Arieş River, water samples were collected in three sampling sections located along tributaries, and from five sampling sections located in the Arieş Valley.

In the case of surface water monitoring program, the pollutants found in the majority of samples were the following: arsenic, cadmium and sulphates. Nickel, lead and selenium were also identified in a reduced number of samples. Mercury was identified only in a very limited number of samples, and chromium, only occasionally. Owing to the near-neutral character determined in the majority of the analysed water samples, the concentrations of total arsenic, total cadmium and total lead and were close to those corresponding to the dissolved forms.

The most contaminated surface water bodies were those located in mining impacted areas. The main pollution sources include mineral waste stockpiles generated by mining and ore processing activities in Bucium, Roşia Montană, Roşia Poieni and Baia de Arieş areas. The Abrud River, which drains mining perimeters (Bucium and Roşia Montană) or collects tributaries from impacted areas, is contaminated with relevant pollutants such as: arsenic, cadmium, selenium and sulphates. Although Arieş River collects waters from the Abrud River and from other tributaries draining important mining areas (Roşia Poieni and Baia de Arieş), it has a better quality compared to that of its main tributary — the Abrud River. The high dilution flow rate of Arieş River is the main cause behind its reduced pollution. Still, the river maintains selenium and cadmium contamination, in the entire monitored area.

The water quality monitoring of artificial lakes ("tăuri") located in the Corna and Roşia hydrographic basins, has identified mercury and selenium contamination in all of the seven studied lakes. Mercury has not been found in significant concentrations in any other type of waters in the area. It is suggested that pollution is due the historic use of these lakes by small-scale gold ore processing operations, and that contaminated sediments may be the source of the elevated mercury levels in these lakes.

Analysis results for samples of drinking water collected from the two central water supply systems of Roşia Montană and Gura Roşia indicated the presence of specific pollutants, but within the limits allowed by the applicable regulations.

The general conclusion of the water quality baseline study for the Roşia Montană area is that the historical development of mine operations has resulted in the contamination of waters with specific pollutants originating in the local mineralised bodies. Such components are leached by acidic waters generated by the exposure of sulphide-bearing ores to exogenous factors. Surface water pollution propagates at long distances from the Roşia Montană area and other mining impacted valleys, thus affecting the downstream water usage.