Chapter 4 – Environmental and Social Baseline

Vares Polymetallic Mine ESIA
Draft V0.3

September 2021

Adriatic Metals

wardell armstrong

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4 ENVIRONMENTAL AND SOCIAL BASELINE

4.1 Baseline Introduction

4.1.1 Methodology

The baseline study provides an analysis of environmental and social data to enable the detailed characterisation of existing conditions in the study area. The baseline considers receptors throughout the area that could be influenced throughout the construction, operation, closure and aftercare phases of the Project. Baseline analysis has been designed to provide a basis for the subsequent assessment of potential impact, design of mitigation measures and the management and monitoring of residual effects.

WAI conducted an Environmental and Social Scoping Study (ESSS) in Q1 2020 for the Vares Project. The ESSS considered the Project design available at the time of writing as well as existing baseline information, both from historic sources and collected as part of the in country environmental permitting process for the two sites.

The environmental and social baseline presented here has been collected in accordance with the scope of work laid out in the ESSS. As the Project design has progressed and new data has emerged, the baseline design has remained under constant review to ensure all sensitive receptors and project components are considered within the sampling design and collection period.

Baseline data collection management has largely been the responsibility of the Adriatic Metals environmental team, with oversight from WAI as required. Baseline data collection has been undertaken by numerous contracts, directly engaged by Adriatic Metals, as defined in Table 4.1.1.

Table 4.1.1: Baseline collection contractors and team

Topic	Specialist / Company involved in data collection
Project Management	Kate Harcourt, Adriatic Metals Environmental and Social Specialist Associate Vildana Mahmutovic, Environmental and Social Manager, Adriatic Metals
Climate Data	Two meteorological stations on site, owned by Adriatic Metals.
Geology and Geochemical Analysis	Joe Crummy – Adriatic Metals associate Geochemistry Specialist. Analysis undertaken by ALS laboratories.
Air Quality	Dust deposition monitors installed and samples collected by Adriatic Metals. Analysis of ambient air quality undertaken by Zenica Institute. Gradko tubes used for NOx and SOx analysis installed and collected by Adriatic Metals.
Noise	Zenica Institute
Soils and land capacity	Soil sampling and analysis undertaken by the Federal Institute of Agropedology, BiH. Sampling undertaken by Adriatic Metals.
Water Resources	Mr.sci. Esad Oruč – water studies specialist. Surface and groundwater quality analysis undertaken by the Institute for Chemical Engineering, Tuzla.

Table 4.1.1: Baseline collection contractors and team	
Topic	**Specialist / Company involved in data collection**
	Water level data records completed by Adriatic Metals.
Biodiversity	IBAT report dated August 2020 by WAI?. EIA report developed by Enova consultant, 2019. Desk and field-based studies undertaken by Zenica Institute.
Archaeology and Cultural Heritage	National Museum of BiH, Sarajevo.
Social and Community Baseline	Enova Consultants – Veovaca household survey. Tuzla Mining Institute – Rupice household Survey Adriatic Metals – community outreach team WAI site visits: November 2019, February 2020, April 2021

4.1.2 Environmental Study Area

The study areas have been defined by topic, see Table 4.1.2, and are delineated in Drawing 4.1.1 with further detail provided in the following baseline chapters.

The Environmental Study area encompasses identified sensitive receptors across and adjacent to the entire Project footprint comprising the Vares Processing Plant and associated infrastructure, haul route and Rupice underground mine and surface infrastructure. It should be noted that the baseline study areas identified here do not necessarily represent zones where the influence of a potential impact may have a measurable effect; they have been defined to contextualise the environmental and social setting in the project area. To that end, the environmental study area comprises the Project footprint plus a 5km buffer zone.

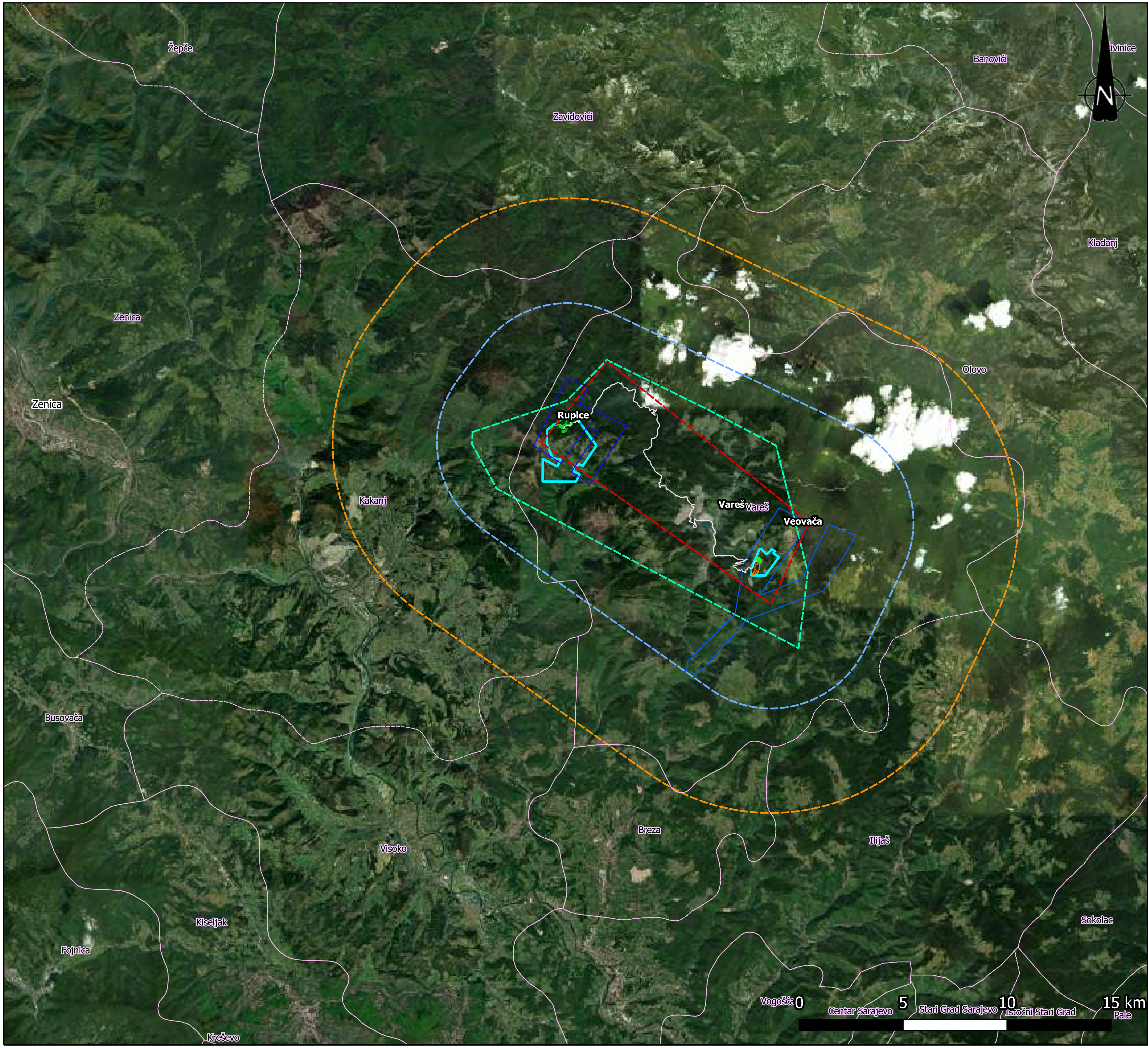
Regarding hydrological studies, the study area includes the catchment of major rivers in the region, with monitoring points upstream and downstream of the Project.

4.1.3 Social Study Area

The social study area has been developed based on multiple levels, as shown in Drawing 4.1.1. Initially the national context, then the regional context focused on the entirety of the Vareš Municipality and to a lesser extent on Kakanj Municipality, due to the proximity of the Rupice mine to the border between the two.

The local study area has identified key communities near mine infrastructure, as well as communities who have shown significant interest in the Project by engaging with communication activities. The study area also considers the environmental study area and anticipated environmental impacts to ensure comprehensive coverage of the region.

Chapter 4.11 provides more detail on the breakdown of this study area.



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Key

Municipality Boundaries

Environmental Study Areas

- Local Study Area
- Biodiversity Desk Study Area
- Regional Study Area

Social Study Areas

- Local Study Area

Hydro Study Areas

- Local Study Area
- Local Study Area
- Haul Roads
- Site Infrastructure
- TSF
- Concession Boundary

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT

Adriatic Metals PLC

PROJECT

Vares Project ESIA

DRAWING TITLE

Environmental & Social Study Areas for the Vares Project

DRG No. ZT520182/4.1.1		REV A
DRG SIZE A3	SCALE 1:250,000	DATE September 2021
DRAWN MBW	CHECKED BY AM	APPROVED BY AA

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Table 4.1.2: Defined Study Areas		
Aspect	**Extent of Study Area**	**Outline Description / Key components**
Climate & Climate Change	National, Regional and Local	National data is based on published sources. The local setting has been developed from a range of sources, including two meteorological stations installed by Adriatic Metals at the two sites (Rupice & Vares Processing Plant). GHG emissions relate to project specific activities and have been subdivided into Scope 1, Scope 2 and Scope 3 emissions.
Soils, contaminated land, and land use	Local	Primary data has been collected from within the Project footprint. Additional information has been obtained from land adjacent to the Project footprint and has been referred to where this data also informs the assessment. Contaminated land assessment has been confined to areas of land disturbed during the previous period of mining.
Biodiversity	International, National and Local	International and national data is based on published sources. A 10km and 50km buffer from project infrastructure were used for a desk-based study. Local data is based on surveys undertaken between 2019 and 2021 by in country consultants, focused on the Project-affected area, which includes the project footprint and adjacent areas defined by the biology of individual taxa and species studied. A breakdown of Ecologically Appropriate Area of analysis (EAAA) is provided in Chapter 4.5, in accordance with EBRD PR6.
Air Quality, Noise and Vibration	Local	The local study area is defined by the communities located in close proximity to Vares Processing Plant and along the haul route. These comprise Tisovci, Pržići, Daštansko, Višnjići, Položac, Semizova Ponikva and Gornja Borovica. There are no additional communities identified as sensitive receptors for noise and air quality. Non-residential receptors, including mammals and plant communities are included in the assessment and within the study area delineated by baseline monitoring identified above.
Hydrology	National, Regional and Local	The local study area is the focus of baseline data collection programme, utilising monitoring points upstream and downstream of the project area. There are two key hydrological features included within the Rupice study area; 1) The Vruci Potok (Hot Stream), located west of the mining concession, which flows in a north westerly direction before joining the Trstionica River, and 2) The Borovicki Stream, located east of the mining concession, which flows south-westwards and joins the Bukovica River. The Rupice study area is separated by a ridgeline which runs from

Table 4.1.2: Defined Study Areas		
Aspect	**Extent of Study Area**	**Outline Description / Key components**
		west/south-west to east/north-east. The Hot Stream, and the Rupice concession area, are located on the western side of the ridgeline and sit within a separate surface water catchment to the Borovicki, which is located to the east of the ridgeline. At the Vares Processing Plant, the Mala River forms the primary hydrological feature within the area, flowing in a south/south-westerly direction before joining the Stavinja River to the south of the Veovaca concession area.
Hydrogeology	Regional and Local	The local setting has been defined based on borehole data obtained from 11 boreholes within the Bukovica River catchment and the Vrući Potok catchment (Trstionica Basin). The primary water baring rocks within the study area are dolomites, limestones and dolomitic limestones, noted in close proximity to the Rupice mining concession and monitored by the BRP and BRW borehole series. Karstic features have also been noted in north-easterly areas of the study area, giving rise to cavernous aquifers with high conductivity and storage.
Geology and Geochemistry	Regional and Local	Regional geology data has been obtained through published resources. Detailed characterisation of the project area has been done through the use of data obtained and assessed by Adriatic Metals for the development of the mine plan. Local geochemical data has been collected from core and rock types within the project footprint.
Socioeconomics, Human Rights and Community health & safety	National, Regional and Local	National data is based on published sources. The Regional setting comprises the Zenica Doboj Canton as well as the entirety of the Vareš Municipality. The local setting comprises key communities located in close proximity to Project infrastructure. Close to the Vares Processing Plant this comprises: Tisovci, Pržići, Brezik, Daštansko and Višnjići. For the Rupice site and along the haul route this comprises Gornja Borovica; Donja Borovica, Osredak, Semizova Ponikva, Positionžac, Pogar and Vareš Majdan. Household surveys were completed at the closest settlements and engagement was carried out with community leaders and representatives for all key communities.
Archaeology and Cultural Heritage	Regional and Local	The local setting includes land within the Project footprint, together with additional information obtained from land adjacent to the Project footprint that has been referred to where this data also informs the assessment. Regional information was obtained from published resources and covers an area of 5km buffer from Project footprint.

Table 4.1.2: Defined Study Areas		
Aspect	**Extent of Study Area**	**Outline Description / Key components**
Landscape and Visual Impact	Regional and Local	The study area has been defined based professional experience and on the recommendations contained in the UK's Landscape Institute and the Institute of Environmental Management and Assessment's guidelines[1] (GLVIA). It encompasses a 5km offset from Vares Processing Plant infrastructure together with a 2km offset from the Rupice project infrastructure and haul route.

[1] Guidelines for Landscape and Visual Impact Assessment, Third Edition, by the Landscape Institute and Institute of Environmental Management and Assessment (2013)

4.2 Climate

4.2.1 National and Regional Climatic Conditions

The climate of BiH varies from a temperate continental climate in the northern Pannonia lowlands along the Sava River and in the foothill zone, to an alpine climate in the mountain regions, and a Mediterranean climate in the coastal and lowland areas of the Herzegovina region in the south and southeast.

Located in a highland region, Vareš has a humid continental climate, with an average temperature of 11.0°C, with highs of 33 – 36°C in the summer (July to August) and lows around –2°C to -5°C in the winter months (December – February)[1]. Record low temperatures around -20°C have been recorded in January and February. Vares' typically receives an average annual total of 100 mm of precipitation per year, ranging from approximately 40mm in August and 150mm in December. Precipitation is approximately 90.7mm per year, ranging from 127 mm in June to 61 mm in February, with an average of 48 snow days per year[2].

4.2.2 Long Term Climate Trends

The nearest permanent weather monitoring station was located in Vares between 1960 – 1990, at an elevation of 767m above mean sea level (amsl), located approximately 7km west of the Vares Plant Site (1065m amsl). Representative climate values for the 30-year period (1960 – 1990) at Vares climate station are presented in Table 4.2.1.

Table 4.2.1: Long term climate trends (1960-1990)[3]

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Daily mean Temperature (°C)	-3.0	-1.8	2.1	6.0	10.8	14.4	17.0	16.7	12.6	8.6	2.7	-0.5	7.5
Precipitation (mm)	70	61	81	92	120	127	92	80	100	96	85	84	90.67

4.2.3 Onsite Weather Station

Site–specific meteorology data has been collected through the installation of two weather stations, one at each of the two sites (Vares Process Plant and Rupice). The weather stations were installed in 2019 but following a review by WAI, the locations were moved in April 2020 and July 2020 for Vares Process Plant and Rupice respectively, to allow smooth airflow and ensure sufficient distance from any obstruction. On-site weather data has been collected for June 2019 to April 2021 (22 months) for Vares Process Plant and for September 2019 to April 2021 (19 months) for Rupice. The location of the weather stations is provided in Table 4.2.2 overleaf.

[1] Vares, Federation of Bosnia and Herzegovina, BA Climate Zone, Monthly Averages, Historical Weather Data
[2] Eastern Mining (May 2019). Water Balance Analysis for Technical Water Supply at Mine and Processing Plant "Veovaca"
[3] Eastern Mining (May 2019). Water Balance Analysis for Technical Water Supply at Mine and Processing Plant "Veovaca"

Table 4.2.2: Location of Weather Stations	
Site	**Location**
Vares Process Plant	X: 6528314; Y:4888570.
Rupice	X: 6518618; Y:4894028

The weather stations collect all relevant and required information namely temperature, humidity, rainfall, wind direction, wind speed and radiation. Results from the weather stations are collated and are prepared into monthly reports, according to BiH legislation. Each parameter is reported on a day-by-day basis for the hours of 0700, 1400 and 2100. Reports also include average values for each parameter.


Photo 4.2.1: **Weather Stations (left Vares Process Plant, right Rupice)**

4.2.4 Temperature

Temperatures at both Vares Process Plant (Figure 4.2.1) and Rupice (Figure 4.2.2) follow the seasons of a temperate climate with temperatures increasing from winter to summer. Temperature steadily increased from January to July with maximum monthly temperatures in July being 18.9°C higher than maximum temperatures recorded in January for Vares Process Plant and 16.1°C higher than the maximum temperature recorded in January at Rupice. Temperatures begin to drop in August, with minimum temperatures again being recorded in January. The maximum, minimum and average monthly temperatures recorded at the weather stations are presented in Figure 4.2.1 and Figure 4.2.2 overleaf.

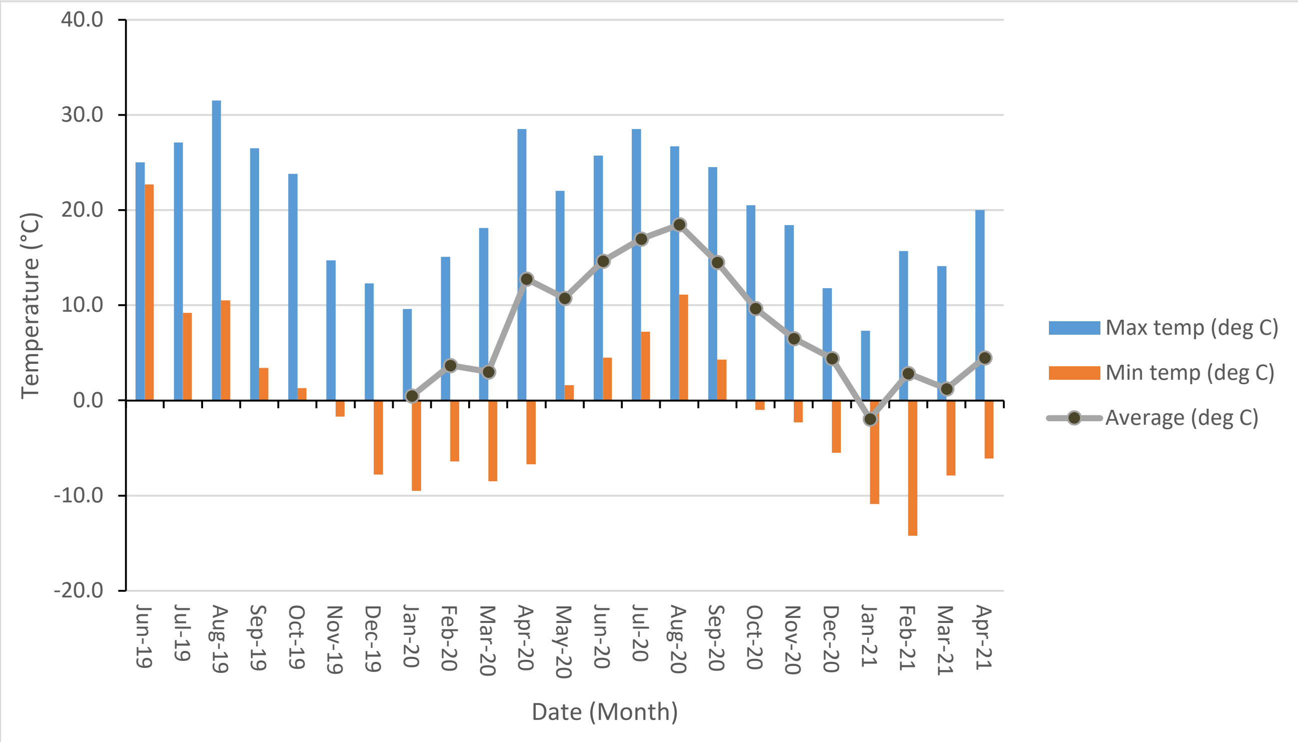


Figure 4.2.1: Temperatures recorded at Vares PP

NB: *Average values not available for Jun-Dec 2019*

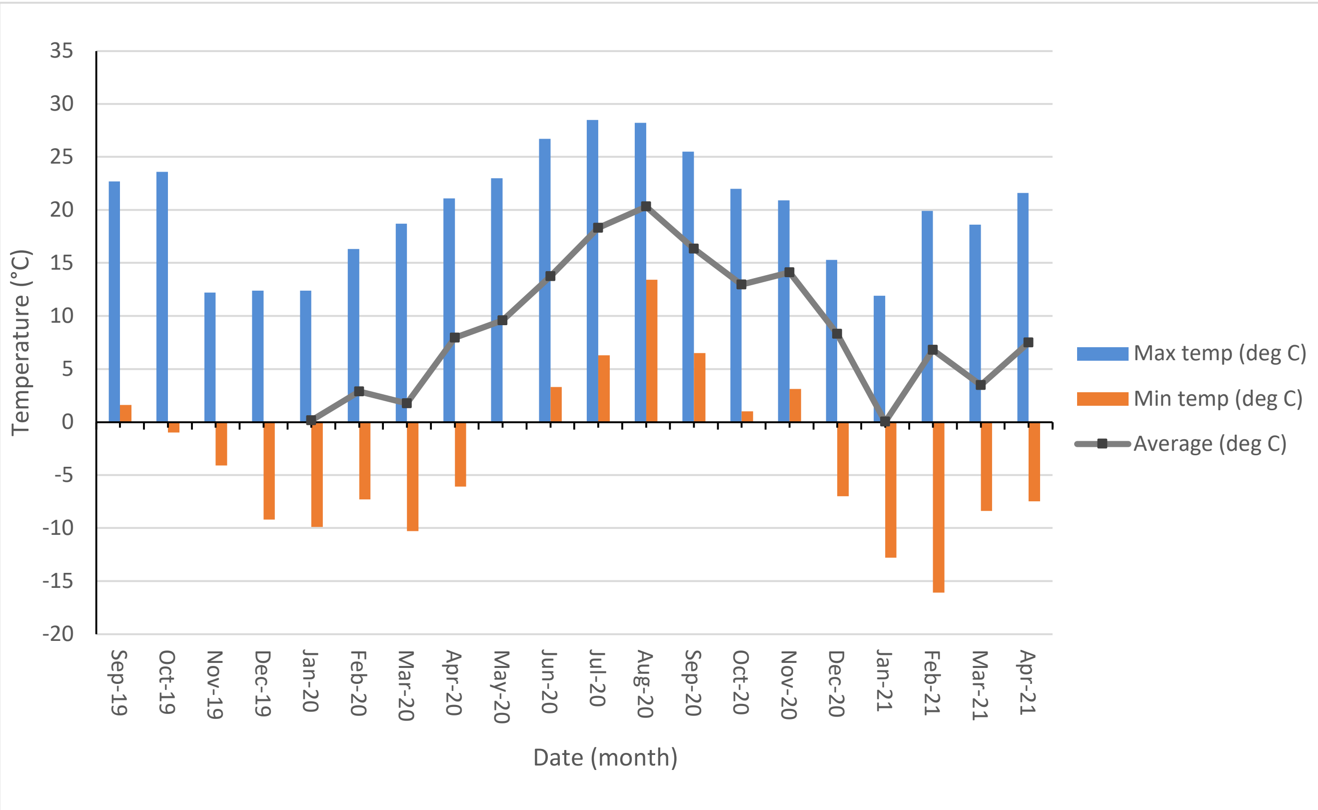


Figure 4.2.2: Temperatures recorded at Rupice

NB: *Average values not available for Jun-Dec 2019*

4.2.5 Precipitation

The region is characterised by high relative humidity levels. Both sites exhibit similar rainfall patterns with most of the rainfall occurring during summer months (May – September), and least rainfall during the winter months. The annual rainfall recorded at Vares Process Plant (1017.2mm) is higher than the rainfall received at Rupice (907.8mm) during the same time (April 2020 – April 2021). Figure 4.2.3 provides the records of precipitation at both the sites.

The minimal rainfall received between June 2019 and January 2020 at Vares Process Plant compared to the other months was likely due to an unsuitably positioned weather station. This was moved to a new location (X: 6528314; Y:4888570) in April 2020 to be at a more suitable height from the ground and less exposed to updraft. Additionally, the gap in rainfall data at Rupice for February 2020 is due to anomalous data recorded. This months' data has therefore been excluded from the analysis due to its unrepresentative nature.

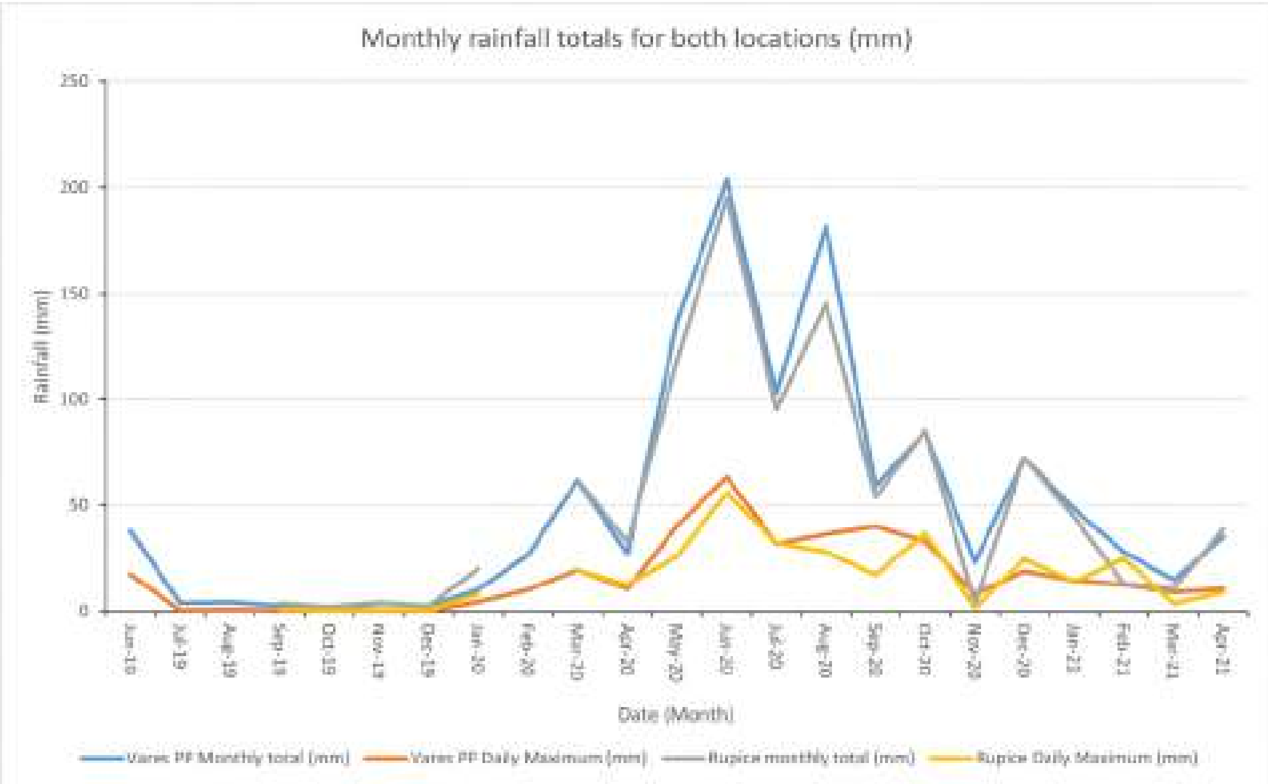


Figure 4.2.3: Monthly precipitation totals at Vares PP and Rupice

NB: *Values not available for Feb 2020 at Rupice due to erroneous results*

4.2.6 Wind

As Figure 4.2.4 and Figure 4.2.5 suggest, the prevailing wind directions at the Process Plant and Rupice are southwest and south south-westerly respectively. Additionally, a good frequency of winds from the north-easterly quadrant occur at both. Generally, both Vares Process Plant and Rupice experience low wind speeds, with about 80% of the recorded winds at both sites being less than 4m/s.

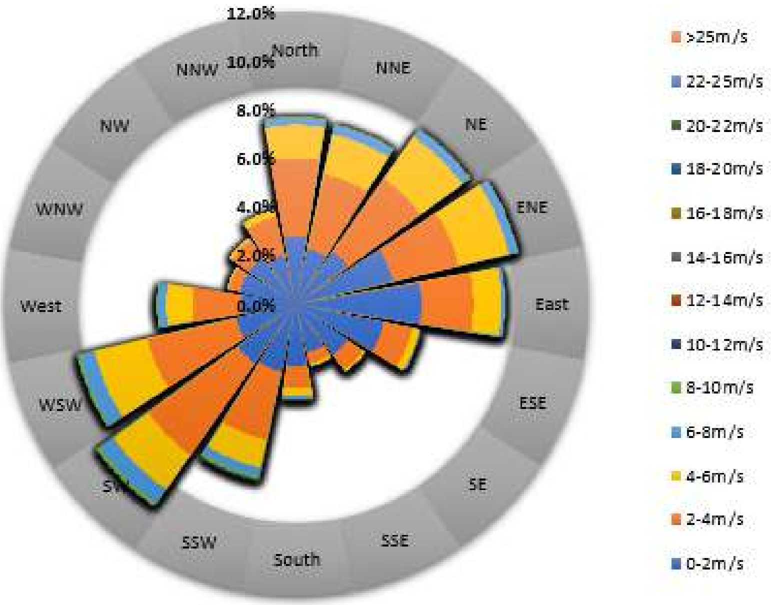


Figure 4.2.4: Wind Rose – Vares PP (May 2020 – April 2021)

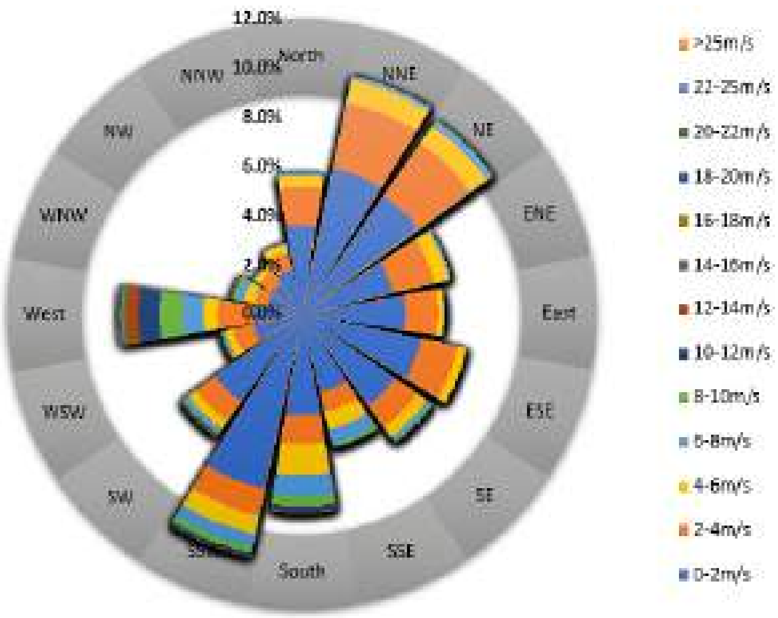


Figure 4.2.5: Wind Rose - Rupice (May 2020 – April 2021)

Site wind data used in this report was collected over a twelve month period between May 2020 and April 2021, as within these months the data was consistently logged every 15 minutes from the same two met stations; Rupice and Vareš PP, thus ensuring continuity in the dataset. Prior to April 2020, the previous meteorological station at Veovača experienced updraft exposure and hence the data collected was likely to be unrepresentative of the true wind conditions for the proposed site, while earlier data from Rupice was potentially compromised by the met station being located in a sheltered position. Although the data used only covers a one year period, it is expected to be the most representative data available.

Data from the Global Wind Atlas does not yet extend to cover the same period as the onsite wind data collected, so it is not clear whether the years' data was from a particular high or low wind speed year. However, it is evident from the 10 years' worth of data presented in Figure 4.2.6, below, that mean annual wind speeds have varied by approximately +5% to -7% over the last decade.

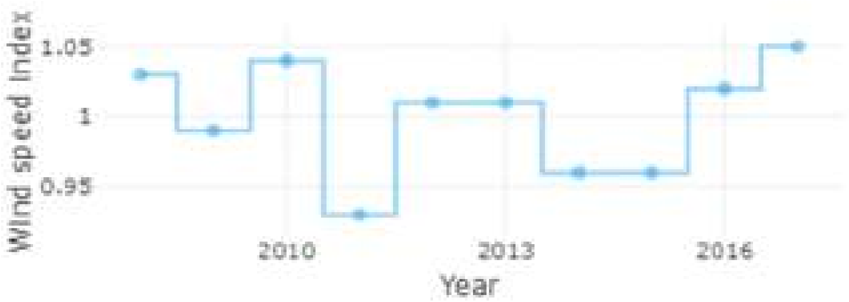


Figure 4.2.6: Variability in Annual Mean Wind Speeds in Vicinity of Site (2008-2017)

(Source: Global Wind Atlas[4])

The fact that only one year's worth of detailed meteorological data is available is not expected to compromise assessments that rely on site wind conditions, such as the noise and air quality assessments.

[4] Global Wind Atlas 'Temporal data – Wind Speed Variability' - Centre (Lat, Long): 44.136885°, 18.355408°, Address: Vareš, Vares municipality, Zenica-Doboj Canton, https://globalwindatlas.info/ (Accessed: 13/08/2021)

4.3 Geology and Geotechnics

4.3.1 Regional and District Geology

The Vares Project is located in the geological Alpine orogenic belt within the Balkans region; specifically, in the central eastern boundary of the internal Dinarides and the Adria derived thrust sheets as shown in Figure 4.3.1. The Dinaride orogen formed due to the opening and closure of the Vardar Ocean, as well as intervening arc belts. The Dinaridic crust is built up by thrust slices derived from the Adriatic microplate and are comprised of the western carbonate platform and series of southwest verging nappe belts to the east, which developed during the Alpine collision event.

The Vares Project is located in the Durmitor Nappe, which forms part of the Internal Dinarides. Closure of the Vardar Ocean resulted in the development of a westward verging Dinaride fold-and-thrust belt, including the Durmitor Nappe. The geology of the Durmitor Nappe consists of lower and middle Triassic and Jurassic volcanic and sedimentary rocks; the deposits of the Project are hosted within these deep-water sediments, which form part of an antiformal thrust belt striking northwest. Deposition of these deep-water limestones and radiolarian-bearing mudstones and chert in the Jurassic occurred due to rapid deepening of the basin.

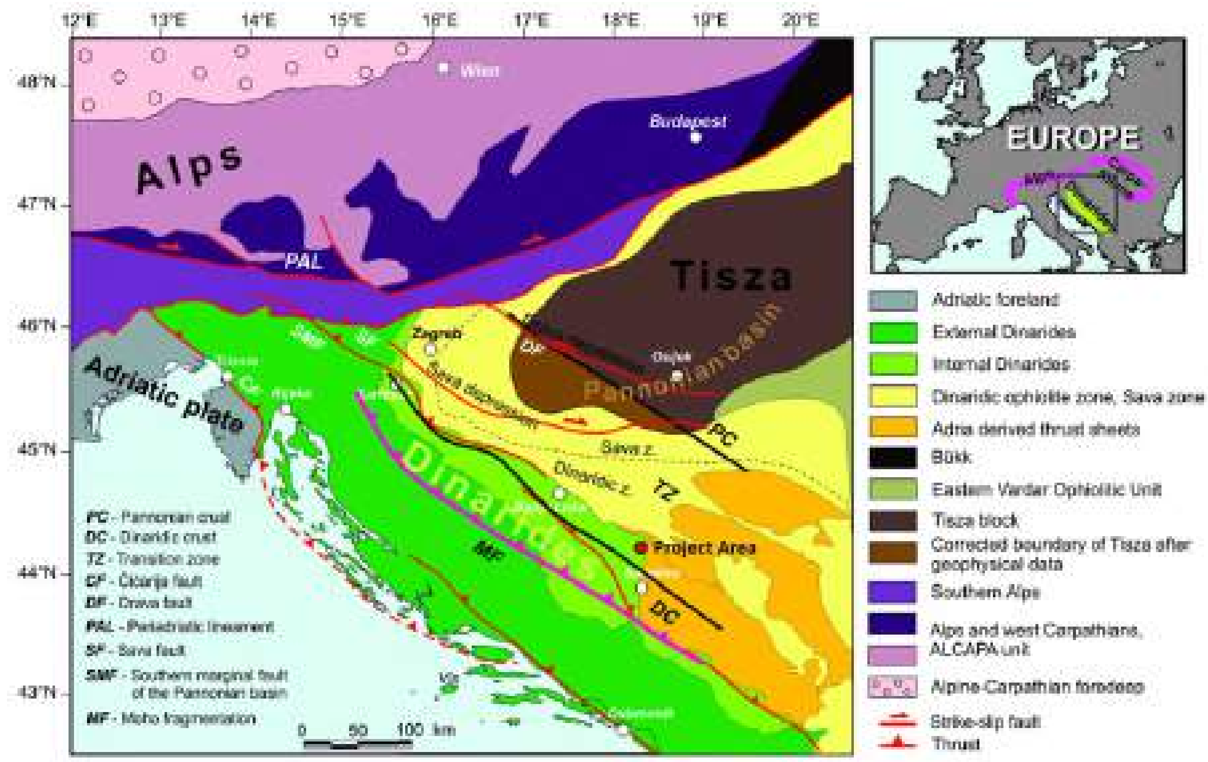


Figure 4.3.1: Tectonic map of the wider area, according to Schmid et al. (2008). The Superimposed Boundaries of the Pannonian Crust, Transition Zone, Dinaridic Crust, and Moho Fragmentation are based on Gravity Modelling (Šumanovac 2010).

4.3.2 Seismicity

Bosnia's seismo-tectonics follow the Mediterranean marine regime. Earthquakes occur mostly in the outer Dinaric Alps (southern Bosnia), while the strongest earthquakes occur within the Sarajevo Fault system in southern and northwestern Bosnia. Crustal loading such as snow, rain, or reservoir inundation, represents the most important secondary seismogenic sources in the region.

Published data indicates that the seismicity of the Project area is moderate, with a Peak Ground Acceleration (g) of 0.14g[1] for a return period of 475 years (10% probability of returning in 50 years) as shown in Figure 4.3.3.

A site specific seismic study was undertaken in August 2021 by Bosnian company Rudex d.o.o. Sarajevo. The study concludes that the Project is situated near to moderately active epicentral zones. Due to the seismotectonic structure of the terrain in some epicentral zones, at a distance of 20 to 40 km from the location, earthquakes with a maximum magnitude of M = 5.1 Richter can be expected.

In contract to published data, the site specific study shows that for a 500 year return period the peak ground accelerations is 0.128g and for a 10,000 year return period the PGA = 0.216g. These figures have been used in the design of the Tailings Storage Facility to ensure a robust structure is developed.

[1] Seismic Hazard Maps "Support of Capacities of the institute for Standardization of Bosnia and Herzegovina in the Area of Implementation of EUROCODES" Karta PGA (eurokodovi.ba)

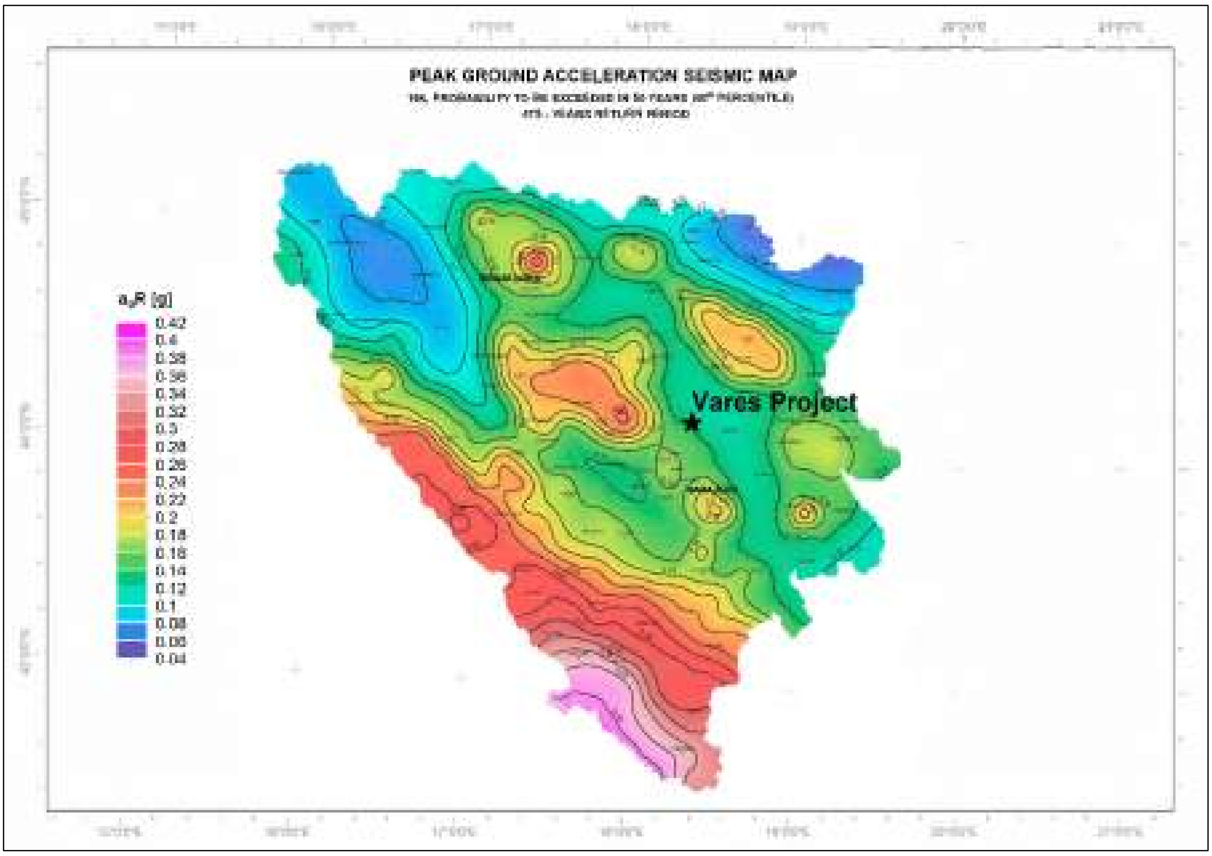


Figure 4.3.3: Seismic Hazard Map for Bosnia and Herzegovina[2] for a Return Period of 475 Years (10% Probability of Recurring in 50 Years) and Showing Approximate Location of Project

An initial seismic risk assessment was undertaken by Avoca Geotec Limited, with the following conclusions:

- The orebody runs parallel to major NW-SE trending faults that are the main source of slip-slide movement in the Balkan area;
- Historically the main events occur in the immediate Zenica area with a magnitude of 4-5 on the Richter Scale;
- Several significant perpendicular faults intersect the major fault and traverse the orebody;
- The low rock strength makes the rocks 'soft' and more ductile; and
- Large (20x25x50m) stope voids will be created by mining.

Utilising the rock mass characterisation, best practice experience, observational data and numerical modelling the seismic risk can be identified, quantified and mitigated prior to its occurrence. A systematic approach has been undertaken by the geotechnical consultants to design the mine and mine sequencing in such a way as to minimise stress and mitigate the potential for seismic risks.

[2] BAS. EN 1998-1:2018 Eurocode 8: Design of Structures for Earthquake Resistance—Part 1: General Rules, Seismic Actions and Rules for Buildings—National Annex; Institute of Standardization of Bosnia and Herzegovina: Sarajevo, Bosnia and Herzegovina, 2018.

4.3.3 Local Geology and Structural Controls

Rupice at the western end of the Vareš mineralised trend is hosted within a west northwest-striking antiformal thrust-bound belt of Triassic rocks surrounded by Jurassic carbonates. Ladinian (Middle Triassic) alkaline pillow basalts occur in a zone between the deposits, apparently stratigraphically underlying the host rocks to the mineralisation.

The host sequence at Rupice comprises Middle Triassic limestone, dolostone, calcareous and dolomitic marl, and a range of mostly fine-grained siliciclastic rocks including cherty mudstone, mudstone, siltstone, and fine-grained sandstone. The siliciclastic rocks are commonly red, though locally green. The internal Triassic stratigraphy is not well defined, partly due to fault-related structural complexity and alteration but, in general, a footwall sandstone is overlain by marls and dolostones that host the mineralised horizon, with a hangingwall that commonly includes a laminated ferruginous dolomitic mudstone.

4.3.4 Mineralisation

The overall mineralisation at Rupice is described as a polymetallic sulphide deposit. The mineralisation between Rupice and the second phase Veovaca deposit share many characteristics, both are considered to form two parts of the same mineral system, where polymetallic sulphide mineralisation has replaced favourable host rocks with a mixed siliciclastic and carbonate sedimentary succession.

The Rupice deposit was previously described as Sediment Exhalative (SedEx) and being hosted in fine-grained sediments that was formed by submarine hydrothermal fluids[3]. The current mineralisation theory is dominantly replacement style with subordinate veining. The mineralisation has been interpreted to preferentially replace carbonate-bearing lithologies, primarily dolostone and dolomitic sedimentary breccia with subordinate mineralisation in dolomitic marls. Dolomitization is interpreted to be an important “ground preparation” alteration event.

The main mineralised horizon is a brecciated dolomitic unit that dips at around 50° to the northeast and has been preferentially mineralised with base, precious and transitional metals. The Triassic sequence has been intensely deformed both by early stage ductile shearing and late stage brittle faulting.

The mineralogy at Rupice consists of abundant barite with sulphides including sphalerite, galena, chalcopyrite, pyrite and minor tetrahedrite, stibnite and cinnabar. The mineralisation also contains silver and gold in significant quantities. The majority of the mineralisation occurs as massive sulphides and, in areas, can be exceptionally high-grade within wide intervals of up to 65m; however, mineralisation style varies to a disseminated and breccia-matrix within, and even to stockwork and vein style. The primary mineralised horizon is a brecciated dolomitic unit which dips at approximately 50° NE. The primary gangue mineral associated with the Rupice deposit is quartz, which occurs in locally extensive zones of hydrothermal silicification, particularly in the footwall dolostone.

[3] Adriatic PFS 2020

To date, the massive sulphide mineralisation at Rupice has a defined strike length of 650 metres, with an average true-width thickness of around 20 metres. However, mineralisation at Rupice still remains open towards the north and down-dip to the south as shown in the geology map in Figure 4.3.2.

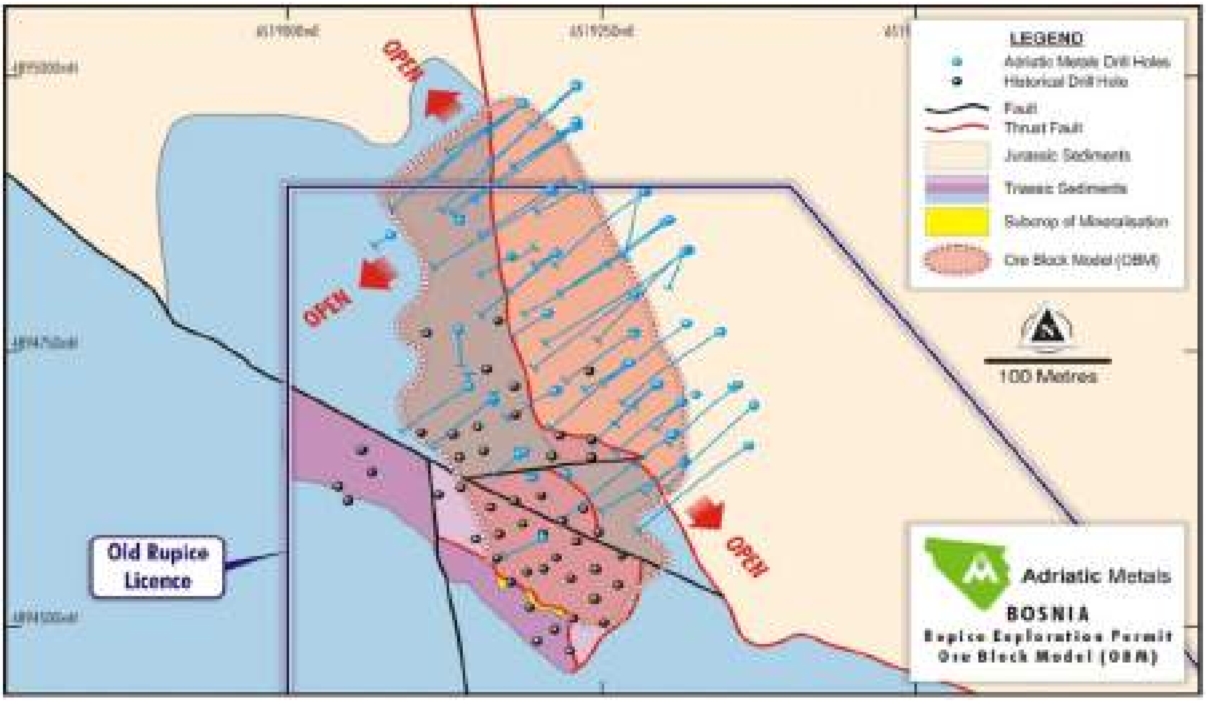


Figure 4.3.2 Geology and Drilling Outline at Rupice (Source: Adriatic 2019 ASX Release)

4.3.5 Geotechnics

For the Rupice deposit underground mining is anticipated with access to the workings via two parallel declines developed from the surface and suitable for trackless equipment. The dimensions of the access are anticipated to be developed as the following: 5.5m wide and 5.8m high with a maximum gradient of 16%, following the excavation of a box cut. To allow access for sub-level development, internal decline ramps will be developed off the main decline; these ramps are anticipated to have the following dimensions, 5.2m wide and 5.2m high with a maximum gradient of 14.3%.

Twin stand anchor bolts will be developed in the hanging wall in a fan shape at the ends of the ore-drives prior to the slotting being done to improve hanging wall stope stability on retreat. The mine plan proposes a mechanised longhole blast-hole retreat method for stoping.

Bolting has been proposed in the hanging wall to pin the beddings together using 2.4m long fully grouted tendons at 1.25m spacings, a layer (75-100mm) of fibre reinforced shotcrete has been allowed where bedding is broken or undercut (turnouts, crosscuts).

The foot wall rocks are mainly a turbulent sandstone (SST) and although well bedded and foliated are silicified and less faulted than the other strata. In general, they will be in fair ground and permanent excavations and access drives will be sited in this horizon. Ground stabilisation will likely consist of

2.4m long fully grouted rock bolts at 1.35m spacings with the application of a 50mm layer of fibre reinforced shotcrete where the bedding is broken (turnouts, crosscuts).

A surface sealant such as shotcrete or thin skin liners will be required in addition to bolting when intersecting faulted zones. Provision for additional support measures is anticipated when intersecting crosscutting faults.

The mineralised zone is in fair to good ground and is massive with tight jointing. A systematic bolting pattern to create self-supporting arches using 2m long friction bolts at 1.5m spacings is recommended with a 50mm application of fibre reinforced shotcrete on contacts and jointed ground.

Rupice will use a backfill method where waste rock and dewatered tailings will be used to create two types of backfill: Cemented aggregate fill (CAF) and Paste aggregate fill (PAF). The key difference being that PAF contains a combination of filtered tailings material, fine aggregate and 5% cement, whereas CAF contains coarse aggregate with 7% cement. PAF therefore forms a denser material for backfill. In total 2,172,866m^3 of backfill material is required, approximate 53% of which will be PAF material. Backfilling of waste rock into the open stopes will utilise 14t load haul dump unit (LHD), but stope backfilling will mostly try to utilise the backfill plant and system.

4.4 Soils

4.4.1 Study Area

This chapter describes the soil characteristics of BiH before focusing on the morphology and chemical properties of the soils present in the project study area. The study area for soils has focused predominantly on the Project footprint to include Rupice, the haul route and the Vares Processing Plant. Additionally, sampling has been undertaken across the previously operational Veovaca Open Pit and close to associated infrastructure to ensure a comprehensive baseline. Further background sampling has been undertaken in communities around the Vares Processing Plant. An extended definition of the Study area and the Project Affected Area is presented in Chapter 4.6 Land Use.

4.4.2 National context

The 1:5,000,000 FAO/UNESCO Soil Map of the World[1] characterises BiH as having eight main soil types within the country. These consist of fluvisols to the north, lithosols and rendzinas to the south and south-west. The bulk of the central areas of the country comprise of cambisols, See Figure 4.4.1. BIH is characterised by a hilly and mountainous landscape occupying 83.5 % of the land area (of which 57.2 % is mountainous). Most soils in the country are on slopes above a 13 % gradient[2]. Hilly terrain provides additional challenges for agricultural production and are generally managed and natural, forests. Forestry in BiH covers 45.6 % of land, with agriculture covering 49.4% with urban areas extending to 5% of the total landuse (further details on Land Use are detailed in Chapter 4.6).

[1] Available online at: http://www.fao.org/soils-portal/soil-survey/soil-maps-and-databases/faounesco-soil-map-of-the-world/en/ [Accessed 14 August 2020].

[2] Markovic and Lukac. 2009. Causes of soil damages in Bosnia and Herzegonina and soil protection measures. Soil Protection Activities and Soil Quality monitoring in south Eastern Europe Conference, Sarajevo – Bosnia and Herzegovina. 18th-19th June.

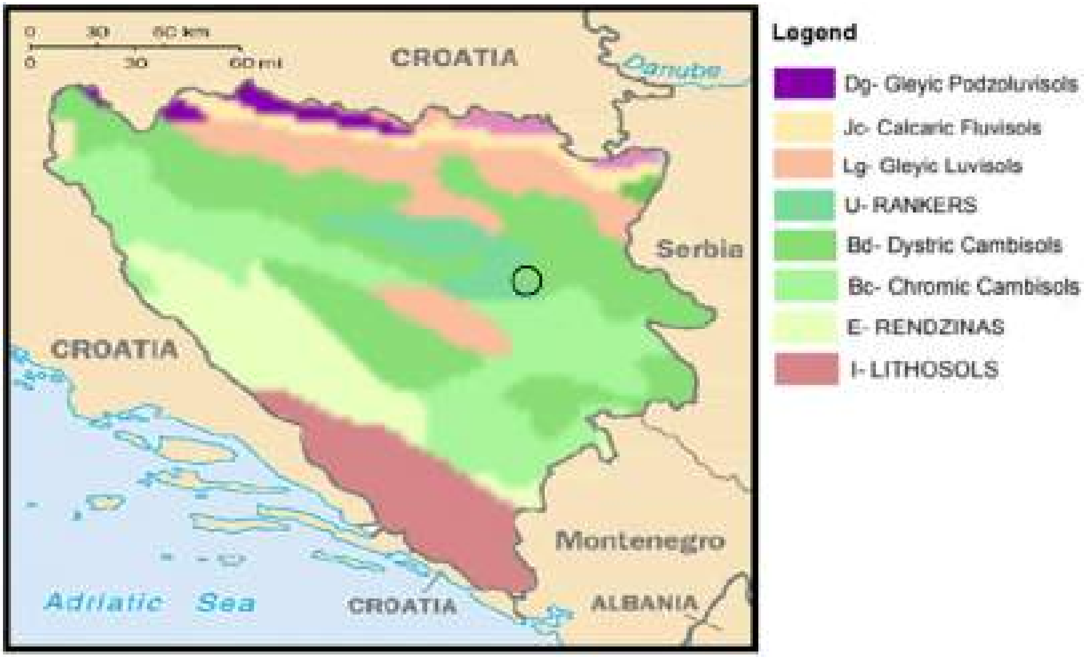


Figure 4.4.1: Soils within the Boznia and Herzegovina area.
Map adapted from the FAO/UNESCO Soil Map of the World, Europe and overlaid with country boundaries. The black circle denotes the project area.

Soil contamination is known to be wide-spread in BiH as a consequence of industrialisation, mining and associated infrastructure and the conflicts of the last century. 'Heavy' metals, PCBs, chlorinated hydrocarbon pesticides and persistent organic pollutants are among the contaminants of issue across the country. BiH does not currently have an environmental protection body and hence limited data is available regarding the quantification and monitoring of contamination within soils and limited protection is currently in place. The assessment of contamination within the project affected area, has been based on Good International Industry Practice (GIPP), namely IFC and EBRD guidance documents.

4.4.3 Soils in the Project Affected Area

Soils within the project affected area are within an I-Bc-27-2/3bc soil unit, in which Chromic Cambisols of medium to fine texture dominate and Chromic Luvisols with inclusions of Rendzinas, Orthic Luvisols and Cambisols can be present. In general, Cambisols can support productive agricultural land, where climate and topography allow, and horizon differentiation tends to be weak with structure formation in the soil profile and mostly brownish discolouration. Chromic Cambisols are more typical in undulating or hilly terrain. The majority of this region is state owned forestry interspersed with areas of current and historic mining operations, meadows of mixed land use and settlements.

Top and sub soil texture, within the project affected area are of a sandy consistency, given the geology the region (Chapter 4.3), which identifies that the underlying bedrock consists of Triassic and Jurassic deposits. The bedrock is made up of limestone, dolostone, calcareous and dolomitic marl, fine grained siliciclastic rocks including mudstone, siltstone and fine-grained sandstone.

The underlying geology and ore characteristic of the region contain high levels of metallurgical compounds, therefore it is anticipated that high background levels of the certain metals, is likely. Ore samples in the region contain high levels of Al, Cu, Fe, Pb, Mn and Zn. Additionally, the most recent round of project sampling has highlighted high background levels of thallium and mercury mineralising from pyrite and other ore sulphides, which may also be present at elevated concentrations within the soil profile.

4.4.4 Baseline Sampling

4.4.4.1 Methodology

To assess the baseline conditions within the project affected area soil surveys were completed in May and July 2020 for samples located in the Rupice and Vares Processing Plant regions by the Federal Institute of Agropedology. Haul route soil sampling was undertaken in March 2021 by the Adriatic Metals environmental and geological team.

Soil sampling and analysis was undertaken for both natural (chemical and physical) and contaminated soils at identified locations, as defined in Table 4.4.1 and shown on Drawings 4.4.1-3.

Table 4.4.1: Locations of Soil Survey Points

Name*	Description	Analysis	Land Use
Natural Soils			
RS-01	Rupice Infrastructure Footprint	Physical & Chemical	Forestry
RS-10		Physical & Chemical	Forestry
VS-01	Within Planned TSF Footprint	Physical & Chemical	Forestry
VS-06	North of Vares Processing Plant (PFS WRD)	Physical & Chemical	Forestry
VS-07		Physical & Chemical	Forestry
VS-08		Physical & Chemical	Forestry
VS-09	Upstream of historic TSF	Physical & Chemical	Forestry
VS-10		Physical & Chemical	Forestry
Contaminated Analysis			
C-VS-01	Close or within footprint of previous operational Veovaca Open Pit	Contaminants	Forestry
C-VS-02			Forestry
C-VS-03			Residential
C-VS-04			Residential
C-VS-05			Residential
C-VS-06	Edge of village of Daštansko, close to Veovaca Open Pit		
C-VS-07	Village of Tisovci		
C-VS-08	Downstream of planned TSF		
C-VS-09	Downstream of historical TSF		
C-VP-01	Within the Vares Processing Plant area	Contaminants	Industrial
C-VP-02		Contaminants	Industrial
C-VP-03		Contaminants	Industrial
C-VP-05		Contaminants	Industrial
C-VP-06		Contaminants	Industrial
C-VP-07		Contaminants	Industrial
C-VP-08		Contaminants	Industrial
C-VP-09		Contaminants	Industrial
C-VP-10		Contaminants	Industrial
C-VP-11		Contaminants	Industrial

Table 4.4.1: Locations of Soil Survey Points			
Name*	**Description**	**Analysis**	**Land Use**
Haul Route Sampling			
ST-01 to ST-17 **(ST-01, 12)^**	Haul Route	Physical & Contaminants	Forestry
ST-18 to ST-23		Physical & Contaminants	Residential
ST-24 to ST-38 **(ST-25, 37)^**		Physical & Contaminants	Industrial
ST-39 to ST-52 **(ST-49)^**		Physical & Contaminants	Forestry
ST-53 to ST-58		Physical & Contaminants	Residential
ST-59 to ST-102 **(ST-61, 73, 85, 97)^**		Physical & Contaminants	Forestry
ST-103 and ST 104		Physical & Contaminants	Residential
ST-105		Physical & Contaminants	Forestry
*Sample name location and description designation: RS = Rupice, VS = Around the Vares Processing Plant Region, VP = Within Vares Processing Plant, ST = Haul route and C = contaminated land sample. ^Sample names in brackets and bold for Haul Route were sent to the external laboratory.			

4.4.4.2 Sampling Procedure

Natural soil sampling for physical and chemical analysis was undertaken by excavating a 50 x 50 x 50 cm pit into the sub soil and taking a representative sample from the top soil horizon. Samples along the haul and access track together with sampling for contaminated land analysis was undertaken using a hand held soil auger to extract a soil core down to a maximum depth of 1.2 m. The haul route sampling survey consisted of taking one sample approximately every 250m along the 28km route (a total of 105 samples – Appendix 4.4.1). Approximately 2kg soil samples were collected to provide a representative sample for chemical analysis.

4.4.4.3 Analysis

Soil samples were analysed for a range of physical and chemical characteristics, and potential contamination. Sampling was undertaken along the extent of the haul route (Appendix 4.4.1, Drawing 4.4.3), as well as those mapped in Drawings 4.4.1 to 4.4.2. Analysis undertaken for each sample is outlined in Table 4.4.1**Error! Reference source not found.** above and can be summarised as:

- physical attributes (2 at Rupice, 5 in vicinity of Vares Processing Plant, and 105 along the haul route);
- chemical attributes (2 at Rupice and 5 in vicinity of Vares Processing Plant); and
- heavy metals and organic contaminants (sub sampled in 9 samples within vicinity of Vares Processing Plant, 10 samples directly within the Vares Processing Plant area, and 105 samples taken along the haul route).

Physical surveys were undertaken by soil scientists using standard soil horizon descriptions following the Food and Agriculture Organisation of the United Nations (“FAO”) guidance, achieved using a soil auger and spade, taking soil cores to a maximum depth of 1.2m.

Physical surveys provided, where possible:

- Texture description (inferring sand, silt, clay content)
- Colour (Munsell system)
- Consistency (hardness)
- Estimated stoniness (% of stones greater than 2cm)
- Presence of organic material (e.g. roots, wood)
- Any evidence of contamination
- Any relevant observations

Chemical surveys and analysis were performed in accordance with the Law on Agricultural Land (F BiH 52/09), specifically the Instruction on procedure, actions and conditions for performing soil fertility control (Official Gazette of FBiH No 72/2009) and Instruction on the Unique Methodology for Classification of Agricultural Land into Rating Categories (Official Gazette of FBiH No 78/2009) and Instruction on compulsory unique methodology for developing recultivation projects (Official Gazette of FBiH No 73/09) and Rulebook on defining allowed quantity of harmful and hazardous materials in soil and testing methods (Official Gazette of FBiH No 72/09).

Chemical surveys and analysis provided:

- pH
- Nutrient availability: Nitrogen (N), Phosphorus (P), Potassium (K), Magnesium (Mg)
- Electrical conductivity (EC)

In addition, in the former Veovaca Open Pit:

- SOM (soil organic matter found through loss on ignition or equivalent analysis)

Samples analysed for contamination within the former Veovaca Open Pit were taken by removing the top layer of vegetation (top few cm of soil) with depths of samples at each coordinate being noted. Samples were then divided into two suitable bags to prevent evaporation of hydrocarbons and other elements/compounds. Bags were then sent to the laboratory. Samples from the haul route were taken using a similar methodology. They were analysed using a handled XRF analyser and a subset of nine samples (ST-01, ST-12, ST-25, ST-37, ST-49, ST-61, ST-73, ST-85 and ST-97) were bagged and sent to the laboratory to confirm the results of the XRF analysis. Bagged samples were analysed at the Institute for chemical engineering, Tuzla, in accordance with the relevant BiH standard e.g. BAS ISO: 11466:2000 and BAS ISO: 11047:2000 for heavy metal content.

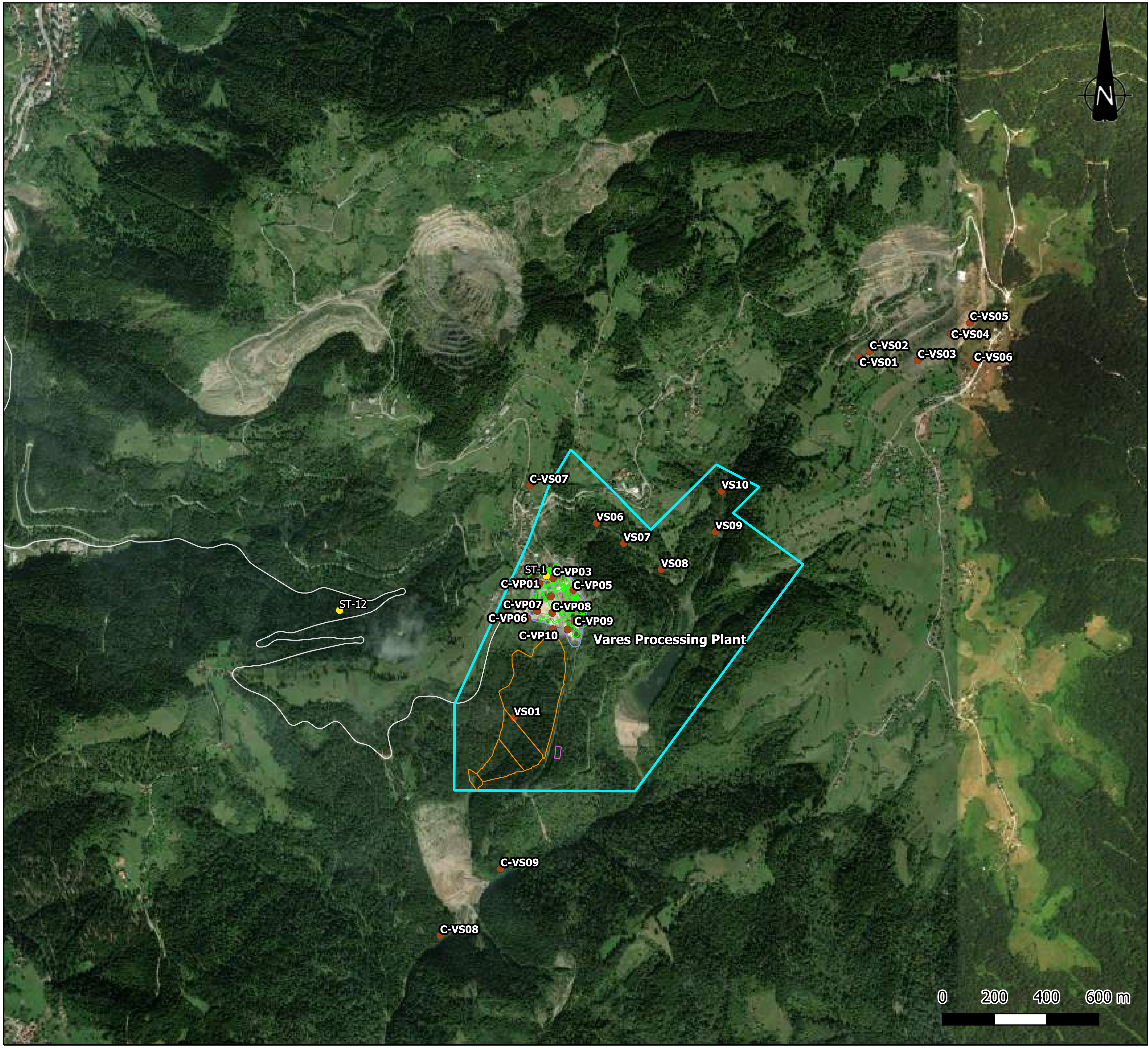
The analysis for contamination included:

- Heavy metal content.

Additionally, at the Vares processing plant and in the nearby region:

- pH,
- Other organic pollutants, including PAH.

The chemical and physical attributes of the topsoil and contamination concentrations from Rupice and the Vares Processing Plant were analysed at the Federal Institute of Agropedology Laboratory Testing Sector, Sarajevo. Samples obtained along the haul route were analysed at Adriatic Metals own laboratory as well as at the Tuzla Institute for Chemical Engineering.



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Key

- Soil Monitoring Locations
- Haul Roads
- Tailings Storage Facility
- Vares Processing Plant
- Concession Boundary

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT

Adriatic Metals PLC

PROJECT

Vares Project ESIA

DRAWING TITLE

Soil and Contaminated Land Monitoring Locations
Vares Processing Plant

DRG No. ZT520182/4.4.1		REV A
DRG SIZE A3	SCALE 1:20000	DATE September 2021
DRAWN MBW	CHECKED BY AM	APPROVED BY AA

wardell armstrong

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Key

- Soil Monitoring Locations
- Rupice Infrastructure
- Haul Road
- Concession Boundary

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT

Adriatic Metals PLC

PROJECT

Vares Project ESIA

DRAWING TITLE

Soil and Contaminated Land Monitoring Locations
Rupice

DRG No. ZT520182/4.4.2		REV A
DRG SIZE A3	SCALE 1:15000	DATE September 2021
DRAWN MBW	CHECKED BY AM	APPROVED BY AA

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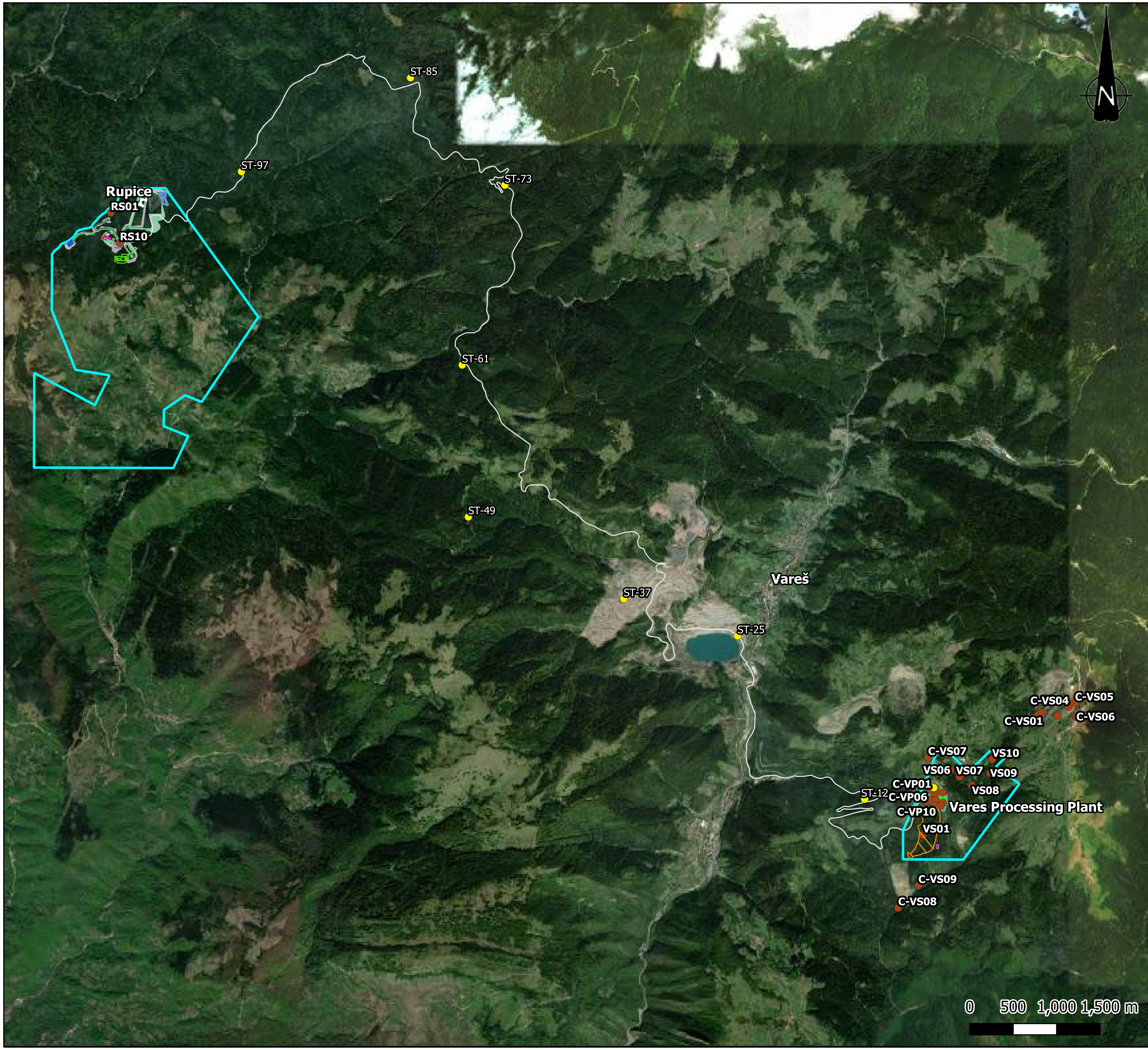

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Key

- Soil Monitoring Locations
- Soil Haul Route Sample Locations (Sent For External Lab Analysis)
- Haul Road
- Concession Boundary

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT
Adriatic Metals PLC

PROJECT
Vares Project ESIA

DRAWING TITLE
Overview Of Soil and Contaminated Land Monitoring Locations

DRG No. ZT520182/4.4.3		REV A
DRG SIZE A3	SCALE 1:60000	DATE September 2021
DRAWN MBW	CHECKED BY AM	APPROVED BY AA

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4.4.5 Soil Physical Attributes

Detailed results of the physical analyses are presented in Appendix 4.4.2 for Rupice and Vares areas and Appendix 4.4.3 and 4.4.4 for the haul route. They comprise all available data from the survey points submitted for physical analysis. A summary of these results is provided here.

4.4.5.1 Profile characteristics

The surveyed soils exhibited varying levels of development. Contaminated soil samples were on occasion only taken at 30 cm depth (very shallow), with extremely stony surface layers, whilst other samples were taken from deeper profiles at 70 cm deep. Samples were not separated into topsoil and subsoil and as such the analysis reflects the overall soil profile and not specific to either the topsoil or subsoil horizon.

4.4.5.2 Texture

The chemical survey determined the proportion of sand, silt and clay in samples. Results show soil textures to include sandy loams, sandy clays, and clays within the forest soils and along the haul route. Forest sample RS1 had a clay content as high as 27.60% and is classified as a clay loam textured soil, whilst other forest samples ranged from 2.2 - 16.30%. Along the haul road textural analysis was competed in the field and all samples showed a sandy texture ranging from more finely textured sand, likely in areas with more mudstone, to coarsely sandy soils, likely in areas with more sandstone. A higher clay content enables soils to retain cations such as Calcium (Ca), Mg, K and Ammonium (NH_3), with a low cation exchange. However, these are susceptible to waterlogging and loss of structure through compaction, if handled in wet conditions. The lighter textured soils identified along the haul route had a higher content of sand, exhibiting higher cation exchange, with an increased risk of erosion from soil stockpiles, exposed soil profiles and where soil surface has been exposed due to removal of vegetation.

4.4.5.3 Organic matter

Forestry samples contained moderate to high levels of soil organic matter (SOM), ranging from 5.76 to 24.93 % with an average of 13.01 %. Higher SOM and humus contents can be indicative of a more fertile soil as humus acts as a water and nutrient reservoir, supporting soil structure development and biological activity.

The linear route of haul road is along existing minor roadways surrounded by areas of forest. The soil profiles were varied in texture and structure. The hue of the top soils varied from a typical weathered and mineralised soils with a red hue (e.g. ST-66, 2.5YR 4/3 REDDISH GRAY) which will have lower organic matter content, to greys (e.g. ST-17, 5YR 5/1 GRAY), to dark browns (e.g. ST-58, 7.5YR 4/34 BROWN) and blacks (e.g. ST-81, 5Y 2.5/1 BLACK) which is indicative of high organic matter.

The spatial variability of the soils along the haul route can be linked with the current land use, areas of existing roads (as noted in the physical survey “relevant observations”) and samples taken closer to Vares Processing Plant were generally more weathered and previously disturbed. Whereas soils within the forested areas had a darker hue, generally of neutral pH, and of higher SOC.

4.4.5.4 Soil profile drainage characteristics

Physical characteristics of the natural soil profiles within the project affected area were generally aerobic well-draining soils, typical of sandy loams. Certain exceptions exhibit lower permeability (VS06, VS07 and RS01), due to the higher clay content in top and sub soil horizons. Forest soils ranged from light brown through dark brown, with sample RS10 being black in colour. This colour profile is a good indicator for well-developed soils which are aerobic with higher SOM content. The lack of mottling in the lower horizons, is again a characteristic of well-draining soils. All samples were odourless and contained a variable stones content which was more evident in the sub soil horizon.

4.4.6 Soil Chemical Attributes

Detailed results of the chemical analyses are presented in Appendix 4.4.2 for Rupice and the area around the Vares Processing Plant. Data from the haul route is contained in Appendix 4.4.3 and 4.4.4. These three appendices contain all available data from the survey points submitted for chemical analysis.

4.4.6.1 pH

Samples from the forested soils across the study area showed pH levels ranging from slightly acidic (5.2) to slightly alkaline (8.43). Natural soil samples at Rupice showed acidic pH levels of 5.22 and 5.34. The more acidic RS01 sample was located towards the bottom of the wooded valley. Sampling along the haul route verified this, with pH levels recorded from 3.6 – 6.1 (very acidic – acidic), within the vicinity of Rupice.

Along the haul route the pH ranged from 3.6 (very acidic) to 8.8 (alkaline) with an average pH of 7 (neutral). The highest pH of 8.8 was recorded at point ST-34 above the Smreka lake along an existing road, within this area the pH ranged from 8.0 - 8.8 (alkaline). The most degraded and reddened soils were also found in this area, this is likely due to a naturally elevated iron content of 42,654 mg/kg at ST-61.

Within the vicinity of the Vares Processing Plant, the most acidic sample was approximately 500m to the south (VS01), within the planned TSF valley. This is possibly indicative of ARD and ongoing or historic acidification such as from runoff flowing south from the process facility. Samples taken within the site of the Vares Processing Plant, and assessed for contaminants, (“C-VP”) were all alkaline in pH with a maximum of 8.37. Most other sampling around the Vares Processing Plant area shown neutral pH, averaging 7.58, with only acidic sample (C-VS-03), slightly west of Dastansko town and within the previous operational area of Veovaca Open Pit.

4.4.6.2 Available nutrients

Measures of the levels of essential plant nutrients, namely N, P and K were provided for all samples in the chemical survey. P was found to be in low (< 100 mg/kg) concentrations in the soil samples except for one sample south of the Veovaca Open Pit, and two samples within the Veovaca Process Plant site (C-VS-01, C-VP-06 and C-VP-07), all of which were over 200 mg/kg. This suggests some spillage may have occurred during the previous period of mining.

K levels are often elevated in South Eastern Europe, between 150 – 1300 mg/kg. In the project area K concentrations were measured between 120 mg/kg in the forest soils at Rupice to 2550 mg/kg for samples taken around the Veovaca Open Pit (C-VS-03). Within the project affected area the N concentration ranged from 0.4 to 5.4 g/kg; South Eastern Europe soil N is generally low in the range < 15.5 g/kg compared to more intensively farmed soils further to the west of Europe.

Along the haul route N, P, K were not measured. The cation exchange capacity however, gives an indication of the availability of nutrients to plants, and was 24 cmol(+)/kg, with a range of 17 – 44 cmol(+)/kg. This is similar to that found in the Vares Processing Plant and Rupice regions which averaged 25 cmol(+)/kg. It is expected that the nutrient levels along the haul route are similar to those found in the natural soils around Vares Processing Plant and Rupice.

The average sample depth was 66 cm and ranged from 45 - 100 cm, this is below the main plant rooting zone which usually has low plant available nutrients compared to the topsoil.

4.4.6.3 Soil contamination

Samples were taken at representative locations across the Vares Processing Plant site and at disturbed locations where there was deemed to be a high potential for contaminants. One sample was taken in the village of Tisovci, as well as within and close to the Veovaca Open Pit and downstream of the historic Tailings Storage Facility. Full results for the contaminated land analysis excluding the haul route are presented in Appendix 4.4.5.

The results of heavy metal analysis for contaminated land samples along the haul route are presented in Appendix 4.4.3 & 4.4.4 for laboratory analysis and Appendix 4.4.5 for XRF analysis. Comparing the XRF analysis to the laboratory results for heavy metals, the values varied in their correlation to the laboratory results, and hence only the laboratory results have been considered in this baseline. The nine locations represent one sample approximately every 2.5 – 3 km along the route, covering one or two locations within each region of the haul route (except for Rupice where natural soil sampling underwent chemical analysis).

Guidance for contamination levels

At present BiH do not have guidance regarding contamination in soils. The current policies in place aim to create an environmental protection body prior to 2030, with regulatory guidance and monitoring of soils, in-keeping with the current EU standards. Although soil is not subject to a coherent set of rules in the EU, the European Commission takes action to ensure its sustainable use.

As a comparison to the currently available standards regarding soils in BiH the assessment of laboratory samples was undertaken against the Rulebook on Determination of Permitted Quantities of Harmful and Dangerous Substances in the Soil in the Official Gazette of the Federation of BiH[3]. The aim of these guidelines are specifically to protect agricultural land and are used in this assessment as a general comparison, due to lack of contaminated land guidance.

Although comparable to International Standard Values, there are differences, for example BiH levels have lower target levels for cadmium and mercury. It was assessed that loamy soils rather than clay soils were most representative of the site, giving slightly lower limits than if those for clay soils were applied. Further to this, comparison between international guidance, Canadian Soil Quality Guidelines (CCME) Canadian Council of Ministers of the Environment and Soil Guideline Values (SGV) and the laboratory results has been made.

Given the BiH guidelines are for agricultural soils only, and as the project affected footprint does impact on agricultural land, the following methodology has been undertaken. Where natural background levels exceed the BiH agricultural and CCME limit within the project area with no history of contamination, the value which will be considered as contaminated will be set at the maximum recorded concentration of natural soils in the area + 15% tolerance. Otherwise, contaminated limits are identified to conform with CCME requirements for agricultural soils.

The assessment of soil contamination against BiH and CCME guideline values are shown in Table 4.4.2.

[3] Sluzbene Novine Federacije BiH. (2009) Pravilnik o utvrdivanju dozvoljenih kolicina stetnih I opasnih tvari u zemljistu I metode njihovog ispitivanja, Issue 72, Page 14.

Table 4.4.2: Comparison of laboratory results to BiH and International Soil Guideline Values for all samples											
Analyte	**Results range (mg/kg-1)**	**BiH Guideline Value* (mg/kg-1)**	**Exceedances**	**CCME Guideline Value** (mg/kg-1)**	**Exceedances**	**"Natural" levels in project area**				**Exceedance of max "Natural" level IF over BiH or CCME limit**
						Min	**Av**	**Max**	**Max + 15%**	
Arsenic (As)	17 – 642	15	**14** C-VP-01,02,03,05,06,07,08,09,10,11 C-VS-01,02,06	12	**14** C-VS-01,02,06,08 C-VP-01,02, 03,05,06,07, 08,09, 10, 11	<1	<1	<1	n/a	n/a
Boron (B)	1.1 - 65	40	**4** C-VP-06,10,11 C-VS-05	ND	ND	1.2	1.48	1.9	n/a	n/a
Cadmium (Cd)	0.22 - 51	1	**13** C-VP-01,02,03,05,06, 07, 08,09,10,11 C-VS-06 ST-61, 85	22	**3** C-VP-05,07,08	0.9	1.27	1.7	n/a	n/a
Chromium (Cr)	19 – 477	80	**10** C-VP-03,06,10 C-VS-01,02,03,04,05 ST-01, 12	87	**9** C-VP-03,06 C-VS-01,02,03,04,05 ST-01, 12	19	43	58	n/a	n/a
Cobalt (Co)	5.7 – 52	45	**1** C-VS-03	300	**0**	5.7	10	12.6	n/a	n/a
Copper (Cu)	16.3 - 1423	65	**14** C-VP-01,02,03,05, 06,07, 08,09,10,11 C-VS-04,05,06,07	91	**10** C-VP-01, 02, 05, 06, 07, 08, 09, 10, 11 C-VS-06	16.3	30	44.1	n/a	n/a
Lead (Pb)	5.6 – 32,337	80	**17** C-VP-01,02,03,05, 06,07, 08,09,10,11 C-VS-01,05,06,08 ST-25, 37, 61	600	**11** C-VP 01, 02, 03, 05, 06, 07, 08, 09, 10, 11 C-VS-06	5.6	47.9	162	n/a	n/a
Mercury (Hg)	0.14 – 27.4	1	**15** C-VP-01,02,03,06,07,09,10,11 C-VS-05,06 ST-01, 25, 37, 61, 73, 97	50	**0**	0.3	2	5	n/a	n/a
Nickel (Ni)	10.4 – 584	40	**20** C-VP-01,02,03,05,06,07,08,10,11	89	**10** C-VP-03,06,10	10.4	46	80.5	n/a	n/a

Table 4.4.2: Comparison of laboratory results to BiH and International Soil Guideline Values for all samples										
Analyte	**Results range (mg/kg-1)**	**BiH Guideline Value* (mg/kg-1)**	**Exceedances**	**CCME Guideline Value** (mg/kg-1)**	**Exceedances**	**"Natural" levels in project area**				**Exceedance of max "Natural" level IF over BiH or CCME limit**
						Min	**Av**	**Max**	**Max + 15%**	
			C-VS-01,02,03,04,05 ST-01, 12, 61, 73, 85, 97		C-VS-01,02,03,04,05 ST-01, 12					
Zinc (Zn)	12 – 22,983	150	**19** C-VP-01,02,03,05,06,07, 08,09,10,11, C-VS- 01,04,05,06 ST-01,12, 25,37,61)	410	**13** C-VP-01,02,03,05,06,07,08,09, 10,11 C-VS-06 ST-01,61	12	214	826	950	12 no. (C-VP- 01,02,03,05,06,07, 08,09, 10,11 and ST-01,61)
Thallium (Tl)	0.1 – 7.6	ND	ND	ND	ND	0.1	5.02	7.6		
Total PAH (excl. Haul Route)	0.2 – 2.1	2	**1** C-VP-07	ND	ND	ND	ND	ND		n/a
Sulphides (excl. Haul Route)	2.3 – 4351	400	**1** C-VS-05	ND	ND	ND	ND	ND		n/a
Cyanide (excl. Haul Route)	0 – 5.25	ND	ND	8	**0**	ND	ND	ND		n/a
Phenols (excl. Haul Route)	0.25 – 7.46	ND	ND	3.8	**10** VP-01,06,07, 08,09 VS-01,02,03,04,05	ND	ND	ND		n/a

*Official Gazette of the federation of BIH Levels for loamy soils
**Canadian Soil Quality Guidelines, Canadian Council of Ministers of the Environment (industrial)
***"Natural" levels calculated using ST-12, 49, 61, 73, 85 and 97 – these areas are currently forestry.
^ Dutch Intervention Values (Values for soil have been expressed as the concentration in a standard soil assumed to be 10% organic matter and 25 % clay).

4.4.6.4 Discussion of Exceedances

All samples tested for heavy metal contaminants, with the exception of ST 49, exceed BiH or other international guidelines. This suggests background (natural) concentrations do have elevated levels of heavy metals, extreme elevated levels are likely due to localised increases possibly due to spillages, losses through water or air diffuse pollution over a long history of mining activity in the area.

Vares and Rupice Regions

Samples located in the previous worked area at Veovaca (C-VS 01-05), as well as sample C-VS-06, located on the edge of the worked area close to Daštansko, were found to contain high concentrations of heavy metals, exceeding BiH guidelines for several parameters as well as CCME guidelines in some instances (seeTable 4.4.2). It is anticipated that these exceedances are the result of previous mining activities and potential spillages. Although limits were exceeded for several elements, concentrations were relatively much lower than those found at the Vares Processing Plant.

Samples recovered from the Vares Processing Plant (C-VP) were recorded as highly contaminated material containing the highest amounts of heavy metals. Numerous exceedances above BiH levels were recorded including for As, B, Cd, Cr, Cu, Hg, Ni, polycyclic aromatic hydrocarbons (PAH), Pb and Zn. Two samples (C-VP-05 and C-VP-08) have 22,313 mg kg^{-1} and 32,337 mg kg^{-1} respectively for Pb concentrations, exceeding the 80 mg kg^{-1} as per BiH guidelines or 750 mg kg^{-1} for Industrial UK SGVs and suggesting concentrate spillage. Elevated concentrations of As were found at the process plant as high as 642 mg kg^{-1}, easily exceeding BiH, SGV, and CCME levels. Cd and Cu exceeded BiH guidelines in every sample at the process facility, with three samples exceeding CCME guidance for Cd but every sample for the latter, although samples did not exceed SGV's. Boron narrowly exceeded BiH guidelines at the process plant and within the Veovaca Open Pit at a maximum of 65 mg kg^{1}. Highly contaminated material is evident only in the previously operational areas (VPP and Veovaca Open Pit). Contaminants identified are non-mobile heavy metal contaminants restricted to the areas of past activities. Groundwater was not found to be present in the area of the process plant (See Chapter 4.6), thus meaning no pathway to surrounding areas exists.

Cyanide was present above detection limits in a restricted number of samples, with the highest levels of contamination around the Vares Processing Plant (5.25 mg kg^{1}). However, all concentrations were within the CMME industrial guidelines set at 8 mg kg^{1}.

Haul Route

Soil samples along the haul route varied widely in the concentrations of contaminants. One sample exceeded no limits (south of Požac in forested area - ST-49), whilst others located in areas of previous industrial land (ST-61) exceeded several BiH limits. Most of the exceedances were for the BiH guidelines for agricultural soils rather than other international guidelines. Along the proposed haul route elevated levels of contamination was seen in the laboratory results for Cd, Cr, Pb, Hg, Ni and Zn. Although the XRF and laboratory results were not always in agreement, the XRF results did also indicate high levels of Cr, Cd, Ni and Zn in most sample locations. Based on the widespread elevated levels of these elements there is likely high background levels in the bedrock which has been bought to the surface and concentrated in areas with historic mining activities.

4.4.6.1 Other elements of note

Thallium (Tl) was raised as having elevated levels in the project region. The data for Tl in soils in the project region is limited as this was added to the analyte list in the final round of sampling. The "natural" Tl levels averaged 5.02 and ranged from 0.1 to 7.6 mg/kg. All samples analysed for Tl (9 in total) were under the maximum "natural" level[4]. Published studies[5] indicate Tl in soils is due to deposition form rapid urbanisation, coal burning and similar industrial activities. Global soil concentrations averaged 1.5 mg/kg, for example 1.65 mg/kg recorded in forest soils in the Czech Republic, whereas localised hotspots of 19.3 mg/kg have been recorded in Spain in the topsoil horizon.

No guideline limits could be found for Fe in soils, typical naturally occurring levels can range from 20,000 to 550,000 mg/kg depending on underlying geology and weathering. All the soil samples analysed fell below 200,000 mg/kg and hence the Fe concentration is within the natural range.

4.4.7 Summary

Soil surveying within the project affected area has identified that chromic cambisols are the prevalent soil types. The chemical analyses which include particle size distributions identified soils as sandy loams, sandy clays and clays, with a stony sub soil horizon. Soil pH using the 1M KCl method ranges from 3.73 (acidic) to 7.95 (alkaline). Soils were generally found to have high levels of SOM, and nutrient content typical of forest soils, although disturbed soils exhibited potentially limiting levels of phosphorous and nitrogen.

Almost all samples tested for heavy metals exceeded current BiH guidelines, however these apply to agricultural soils, which are not present within the project affected area. In many cases within the Rupice and Vares Processing Plant areas of significant contamination were recorded that exceeded Industrial CCME limits (Table 4.4.2). BiH agricultural limits were exceeded in relation to As, B, Cd, Co, Cr, Cu, Hg, Ni, Pb, Zn as well as PAHs and Sulphides. Industrial CCME values were exceeded for As, Cd, Ch, Cr, Cu, Ni, Pb and Zn and Commercial UK SGV were exceeded for As and Pb. Due to the fact that some samples did not exceed BiH levels, and very high concentrations of some contaminants such as Pb are present, most exceedances likely related to historic mining operations.

Contamination within the project area, concentrated in locations with previous mining activities, is expected. However, it is also present for a smaller number of elements away from the Vares Processing Plant and along the haul route, the exact boundaries of this contamination are not

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[4] The natural maximum level is considered the maximum recorded concentration of natural soils in the area + 15% tolerance. Anything above this would be considered contaminated.
[5] Luo et al., 2020. Thallium contamination in agricultural soils and associated potential remediation via biochar utilization. Biochar. 2, 33-46.

currently well defined due to limited policies within BiH. By applying international guidance (CCME) elevated concentrations of 'heavy' metals are present in the soils within the processing facility areas and at several points along the haul route. Specific considerations for the handling and reuse, of these soils will be included in the soils management plan and possible mitigation measures are discussed in the impact assessment (Chapter 5.3).

4.5 Biodiversity

4.5.1 Introduction

This biodiversity chapter outlines the available information regarding the biodiversity and ecosystems of the Vares project area.

Relevant domestic and international legislation and policy have been used to inform the baseline for biodiversity and ecosystems that might be affected by the Project. This includes the national laws of Bosnia & Herzegovina (BiH) relating to nature conservation and protection as well as relevant international conventions and agreements signed by BiH. The requirements of potential financial lenders (in particular Equator Principles and EBRD Performance Requirements) to the Project with respect biodiversity and ecosystem services are also considered.

Desk and field studies have been undertaken by the University of Zenica, Institute "Kemal Kapetanović" in Zenica (Zenica Institute). This report utilises survey data gathered during autumn 2020 and spring and early summer 2021, referenced within the report by Zenica Institute[1].

The Vares Processing Plant is located at an altitude of approximately 1,060m above sea level to the east of Vares, on the southern slopes of Zvijezda Mountain. The Rupice deposit is located within a largely forested environment on Zvijezda Mountain, at an altitude of approximately 900 – 1,280m above sea level. Both sites have been previously subject of an EIA for in-country permitting procedures.

This report references relevant resources including existing and commissioned reports:

- Environmental Impact Study for the Project of Renewal of Lead, Zinc and Barite Ore Exploitation and Processing Facility at the Location of Veovača I - Tisovci I - Veovača II. *Eastern Mining. D.o.o* (September 2019);
- The desk study report by the University of Zenica (20-08-20);
- Integrated Biodiversity Assessment Tool (IBAT)[2]; and
- World Bank Group Biodiversity Risk Screen.

Web-based resources including:

- Protected Planet[3]; and
- Convention on Biological Diversity[4].

[1] S T U D Y On Biodiversity At The Exploration And Exploitation Areas Of The Lead, Zinc And Barite Ore Deposits „Rupice-Juraševac-Brestić“And „Veovača I-Tisovci“ And „Veovača Ii“ Including The Transport Road Rupice-Veovača, Municipality Of Vareš
[2] Report generated on 24/08/2020 (GMT) by Alison Allen under the project number 4799-10884 held by Wardell Armstrong International
[3] https://www.protectedplanet.net/country/BIH
[4] https://www.cbd.int/doc/world/ba/ba-nr-05-en.pdf

4.5.2 Definition of Terms

There is an expectation that EBRD-financed projects are designed and operated in compliance with good international practices relating to sustainable development. The PR relevant to biodiversity is EBRD PR6, the objectives of which are as follows:

- Protect and conserve biodiversity using a precautionary approach;
- Adopt the mitigation hierarchy[5] approach, with the aim of achieving no net loss of biodiversity, and where appropriate, a net gain of biodiversity; and
- Promote good international practice (GIP) in the sustainable management and use of living natural resources.

The assessment considers an Ecologically Appropriate Area of Analysis (EAAA)[6] for each species or species group in particular for 'priority biodiversity features' and 'areas of critical habitat'. 'Priority biodiversity features' (PBF)[7] and the most sensitive biodiversity features, identified as 'areas of critical habitat' (ACH),are defined as follows and taken directly from Table 1 of the 2020 guidance note for PR6[8]:

Criterion	Priority Biodiversity Feature	Critical Habitat
1. Priority ecosystems		
Threatened ecosystems (a) Habitats listed in Annex 1 of EU Habitats Directive (EU members only) or Resolution 4 of Bern Convention (signatory nations only) (b) IUCN Red-List EN or CR ecosystems	(PR6 para. 12-i) (a) EAAA is habitat type listed in Annex 1 of EU Habitats Directive or Resolution 4 of Bern Convention (b) EAAA** < 5% of the global extent of an *ecosystem* type with IUCN status of CR or EN	(PR6 para. 14-i) (a) EAAA is habitat type listed in Annex 1 of EU Habitats Directive marked as "priority habitat type" (b) EAAA ≥5% of global extent of an ecosystem type with IUCN status of CR or EN (c) EAAA is ecosystem determined to be of high priority for conservation by national systematic conservation planning
2. Priority Species and their Habitats		
Threatened species (a) Species and their habitats listed in EU Habitats Directive and Birds Directive (EU members only) or Bern	(PR6 para. 12-ii) (a) EAAA for species and their habitats listed in Annex II of Habitats Directive, Annex I of Birds Directive, or Resolution 6 of Bern Convention	(PR6 para. 14-ii) (a) EAAA for species and their habitats listed in Annex IV of the Habitats Directive (See EU restrictions)

[5] The mitigation hierarchy comprises measures taken to avoid impacts to biodiversity from the outset of development activities, and where this is not possible, to implement additional measures that would minimise, mitigate and, as a last resort, offset and/or compensate any potential residual adverse impacts.

[6] The landscape level distribution of the feature requiring study, considering the ecological patters, processes and functions that are necessary to support that feature.

[7] Priority biodiversity features are a subset of biodiversity that is particularly irreplaceable or vulnerable, but at a lower priority level than critical habitats.

[8] Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources (v. January 1, 2020). Sept 10, 2020

Convention (signatory nations only) (b) IUCN Red List EN or CR species (c) IUCN Red List VU species (d) Nationally or regionally (e.g., Europe) listed EN or CR species	(b) EAAA supports < 0.5% of global population OR < 5 reproductive units of a CR or EN species. (c) EAAA supports VU species (d) EAAA for regularly occurring nationally or regionally listed EN or CR species	(b) EAAA supports ≥ 0.5% of the global population AND ≥ 5 reproductive units of a CR or EN species (c) EAAA supports globally significant population of VU species necessary to prevent a change of IUCN Red List status to EN or CR, and satisfies threshold (b) (d) EAAA for important concentrations of a nationally or regionally listed EN or CR species
Range-restricted species	(PR6 para. 12-ii) (a) EAAA for regularly occurring range-restricted species	(PR6 para. 14-iii) (a) EAAA regularly holds ≥ 10% of global population AND ≥ 10 reproductive units of the species***
Migratory and congregatory species	(PR6 para. 12-ii) (a) EAAA identified per Birds Directive or recognized national or international process as important for migratory birds (esp. wetlands)	(PR6 para. 14-iv) (a) EAAA sustains, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population at any point of the species' lifecycle (b) EAAA predictably supports ≥10 percent of global population during periods of environmental stress

*Quantitative thresholds derived from IUCN Key Biodiversity Area Standard and aligned with International Finance Corporation's (IFC) Guidance Note 6 (rev. 2019)
**EAAA = *ecologically appropriate area of analysis*, as defined above
***The IUCN Key Biodiversity Areas standard cites the following definition for reproductive unit: "the minimum number and combination of mature individuals necessary to trigger a successful reproductive event at a site. Examples of five reproductive units include five pairs, five reproducing females in one harem, and five reproductive individuals of a plant species."

In addition, relevant literature and internet sources were reviewed to identify the potential presence of:

- Legally protected areas for nature conservation within a theoretical zone of influence (ZoI) of the Project9, and areas which are internationally recognised as having high biodiversity, including potential Natura 2000 sites, Biosphere Reserves, Key Biodiversity Areas, Global 200 Ecoregions, Endemic Bird Areas (EBAs), Important Bird Areas (IBAs) and areas listed within the national 'Strategy and Road Map for Protection of Biological and Landscape Diversity (2015-2020)';
- Species which are protected in BIH or on the 'red list' in BIH (based upon Habitats Directive10 (EU HABITATS DIRECTIVE (92/43/EEC) and Birds Directive (Council Directive 79/409/EEC);

[9] The Zone of Influence for Biodiversity is defined as 10km buffer from Project Infrastructure.
[10] Species protection under the Habitats Directive. All in all, over 1.000 animal and plant species, as well as 200 habitat types, listed in the directive's annexes are protected in various ways:
Annex II species (about 900): core areas of their habitat are designated as sites of Community importance (SCIs) and included in the Natura 2000 network. These sites must be managed in accordance with the ecological needs of the species.

- Species or sub-species which are considered by specialists to be threatened, declining or endemic either in BIH or in the region (Balkans);
- Areas of critical habitat according to the definition in EBRD's PR6;
- Species which might suggest or trigger the presence of critical habitat according to PR6. This includes species which are listed by International Union for Conservation of Nature (IUCN) as being endangered or critically endangered at a global and European level as well as species meeting other criteria listed in the Performance Standards; and
- Habitats or ecosystems which might be associated with key evolutionary processes or are associated with ecological functions that are vital to maintaining the variability of biodiversity features (described as critical habitat features), defined in PR6.

Throughout this report, the term 'concession areas' refers to all land within the concession area boundaries and the haul road route. The term 'project area' relates to the actual footprint of the project within the concession areas at Rupice along the haul road and at the Vares Processing Plant.

Ecosystem Services
Ecosystem services can be defined as the many and varied benefits to humans provided by the natural environment and from healthy ecosystems.
Sustainability of ecosystem services depends on the use of natural resources. Human health, availability of food and water, cultural inspiration, protection against natural disasters, and many other socio-economic aspects depend on diversity and the state of ecosystem directly. Ecosystem Services are covered in Chapter 4.13.

4.5.3 Desk Study Results

4.5.3.1 Biodiversity Context

The complex geology, climate and position in south east Europe give rise to a high biodiversity in BiH. The climate has Mediterranean influences to the south, continental to the north of the mountains and various montane climates within the mountains themselves. With approximately 5,200 taxa of vascular plants in a relatively small country, BiH has some of the highest species density and diversity in Europe.

The Dinaric Alps are distinguished by their high level of endemism owing to geographically separated highlands, biogeographic regions and the peninsula repeatedly becoming an isolated glacial refugia. It is estimated that there are over 500 endemic plant taxa, but a full national inventory has yet to be

Annex IV species (over 400, including many annex II species): a strict protection regime must be applied across their entire natural range within the EU, both within and outside Natura 2000 sites.
Annex V species (over 90): Member States must ensure that their exploitation and taking in the wild is compatible with maintaining them in a favourable conservation status.

collated. The faunal diversity in BiH is also high, with 18 species of amphibian, 29 reptile, 99 mammal and 330 bird taxa.[11]

The latest data from the respective red lists in BIH indicate the following:

- Red List of Republika Srpska (RS) contains 818 species of vascular plants; 304 bird species; 46 fish species; 57 mammal species; 20 amphibian species; 25 reptile species; 273 insect species (Official Gazette of RS, No. 124/12);
- Red List of the Federation BiH (FBiH) contains 658 plant species; 27 mammal species; 40 bird species; 6 reptile species; 4 amphibian species; 36 fish species, as well as a great number of different species of invertebrates (Official Gazette of FBiH, No. 7/14).

4.5.3.2 Protected Areas

The Strategic Plan for Biodiversity 2011 – 2020, including twenty Aichi Targets, is elaborated in five strategic areas. BiH, as a Party to the United Nations Convention on Biological Diversity (UNCBD) as of 2002, follows the global trends in conservation. Protected areas in BiH are listed in Table 4.5.1 and shown on a map at a National level in Figure 4.5.1.

In BiH, specific responsibility for nature conservation rests with the Federal Ministry of Environment and Tourism (FMoET), necessitating the development of strategies, plans and adequate reports as a National Focal Point to the Convention on Biological Diversity (CBD).[12]

The Tajan Natural Monument, 6km from the Rupice concession area consists of numerous mountain peaks, underground streams, canyons, waterfalls, caves, karstic springs as well as archaeological interest. The Konjuh protected landscape (IUCN Category 5 approximately 13.75km to the north east of Vares Processing Plant) and the Bijambare protected landscape (IUCN Category 5 approximately 13.75km to the south east of Vares Processing Plant) are shown on Drawing 4.5.1. These areas are proposed to become protected as the Zvijezda-Tajan-Konjuh National Park; designated for its ecosystem biodiversity, landscapes and valuable natural resources that have developed under the influence of specific geological, pedological and ecological conditions.

Table 4.5.1: Protected Areas in BIH (CBD, 2019)

[11] The Strategy of Bosnia and Herzegovina and Action Plan for Biodiversity and Landscape's Protection (NBSAP BiH 2008-2015). https://www.cbd.int/doc/world/ba/ba-nbsap-01-en.pdf.

[12] Fifth National Report To The United Nations Convention On Biological Diversity Of Bosnia And Herzegovina. (May 2014). https://www.cbd.int/doc/world/ba/ba-nr-05-en.pdf

Category according to the FBiH and RS Laws on Nature Protection	IUCN Category	Location	Surface (ha)	Entity	Total Locations
Protected Nature Areas (PNA)	I.a and I.b	Special Nature Reserve Lisina	560,6	RS	4
		Strict Nature Reserve Lom	297,82	RS	
		Special Nature Reserve Gromiželj	831,3	RS	
		Strict Nature Reserve of the Janj Virgin Forest	295,0	RS	
National Park (NP)	II.	NP Sutjeska	16.052,34	RS	3
		NP Kozara	3.907,54	RS	
		NP Una	19.800,0	FBiH	
Nature Park (NtP) (cantonal regulations only)		Nature Park Blidinje	35.800,0	FBiH	2
		Nature Park Hutovo blato	7.411,0	FBiH	
Nature Monument (MN)	III.	NM Pećina Ljubačevo	45,45	RS	12

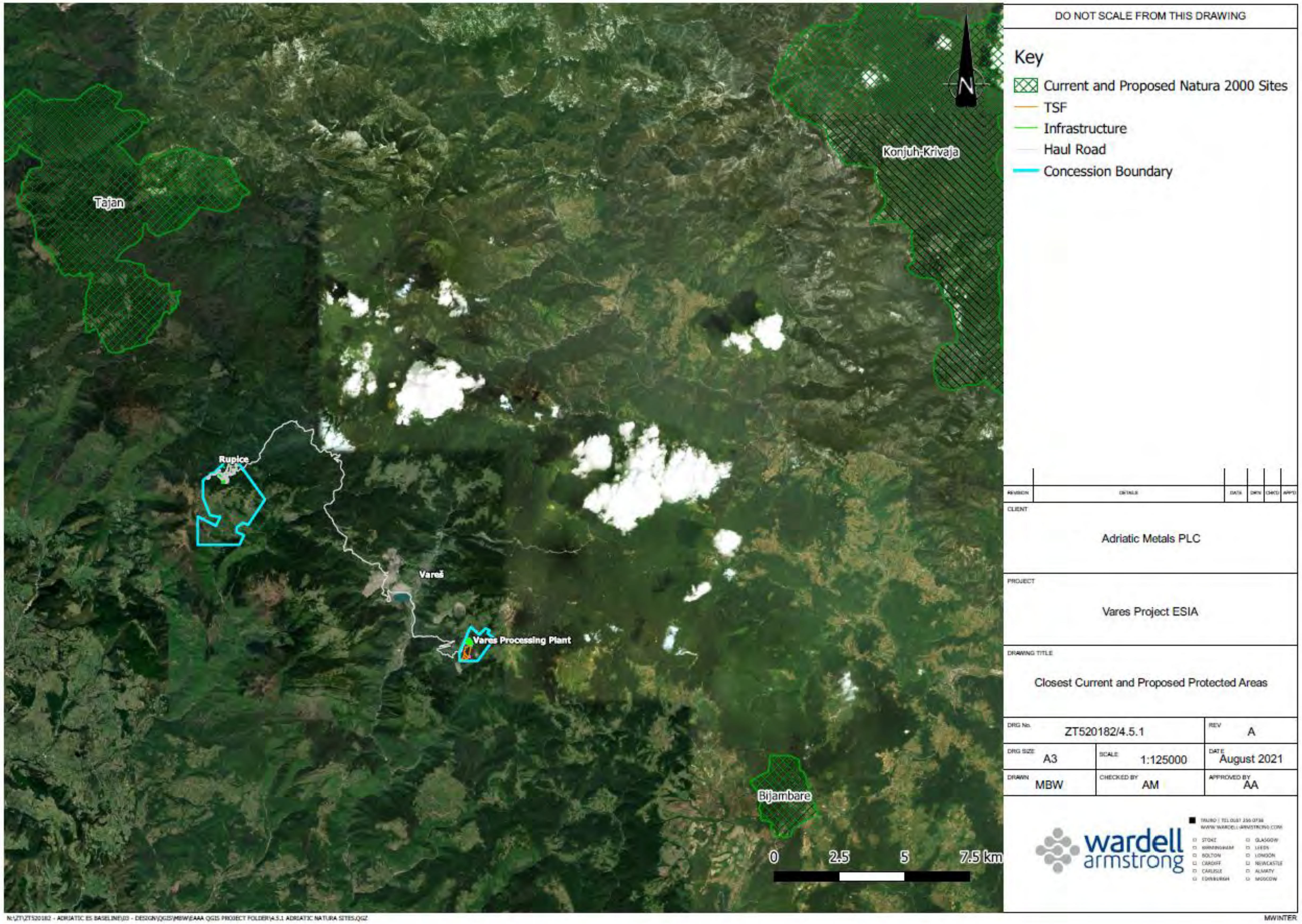
Category according to the FBiH and RS Laws on Nature Protection	IUCN Category	Location	Surface (ha)	Entity	Total Locations
		NM Jama Ledena	28,26	RS	
		NM Pećina Đatlo	43,42	RS	
		NM Pavlova pećina	13,40	RS	
		NM Vaganska pećina	12,0	RS	
		NM Pećina Rastuša	11,39	RS	
		NM Pećina Orlovača	27,01	RS	
		NM Žuta Bukva	0,5	RS	
		NM Skakavac	1.430,7	FBiH	
		NM Prokoško jezero	2.225,0	FBiH	
		NM Vrelo Bosne	603,0	FBiH	
		NM Tajan	3.510,0	FBiH	
Habitat Management Area (in RS only)	IV.	-	-	-	-
Protected Landscape (PL)	V.	PL Bijambare	497,00	FBiH	3
		PL Bentbaša	147,70	FBiH	
		PL Konjuh	8.016,61	FBiH	
Protected areas for resources management (in RS only)	IV.	Protected area for resources management „University Town"	27,38	RS	1
Total			101.594,42		25

Source: State of the Environment in BiH, 2012 with updated data

Ramsar sites	Surface (ha)
Hutovo blato (FBiH)	7.411,0 ha
Livanjsko polje (FBiH)	45.800 ha
Bardača (RS)	3.500 ha
IBA	**Surface (ha)**
Hutovo blato (FBiH)	7.411,0 ha
Boračko jezero (FBiH)	26 ha
Bardača (RS)	3.500 ha

Source: State of the Environment in BiH, 2012

Figure 4.5.1: Protected Areas in BiH



Drawing 4.5.1: Current and Proposed Protected Areas

The following protected areas are located in the area of the municipality of Vareš[13]: Each protected feature mentioned below is located outside the project area.

1. Bukovički ponor (Bukovica abyss) - Pogari – Protection category III natural resource by Decision No. 06-51/1-68;
2. Giant lime tree *Tilia grandifolia*[14] L. in the village of Donja Borovica – it is estimated to be over 350 years old, due to its height and appearance represents a botanical rarity and as such it was protected as a Protection category III natural resource by Decision No. 08-433/1-59 (natural monument);
3. Four giant lime trees in the village of Ivančevo – Protection category III natural resource (natural monument);
4. Source of the Stavnja River above the town of Vares - Protection category III natural resource by Decision No. 06-275/1-58 (natural monument);
5. Waterfall on the Očevija River near the village of Očevija, municipality of Vares. A natural monument with an area of 0.4 ha - I Protection Degree by Decision No. 08-275/1-58;
6. Ponikva cave above the town of Vares - Protection category III natural resource by Decision No. 08-276/1-58 (natural monument), consisting of a main channel serving as road tunnel and two smaller ones that are active and represent the habitat for various bat species;
7. Peatland "Đilda" or Tentina bara (Tento's bog) is a special botanical reserve on Zvijezda Mountain near Vares, vegetation class Oxycocco-Sphagnetea Br.-Bl. Et Tx 1043 (high peatland) and Scheuchzerio-Caricetea fuscae (Nordh.36) (low peatland) and wetland on gley soil vegetation of Phragmitetea R.Tx et Prsg. 1942 class, or Magnocaricetalia Pignatti 1953 variety. This peatland is protected as a Protection Category IV natural resource (special reserve) by Decision No. 08-429/1-59. Some endemic plants are represented in this peatland, the most famous is endemic plant buck bean/ bog bean/ common bog bean. (*Menyanthes trifoliata* L.). The peatland complex covers approximately 10 ha. Đilda or Tentina bara is the biggest bog, located approximately 10 km from Vares, on the north side of Zvijezda Mountain, at an altitude of approximately 1,060m. This habitat is a naturally raised complex of peatland on moss substrate (Natura 2000 code: 7110),
8. The peatland located on the left side of the road from Pogar to Gornja Oćevija on Zvijezda Mountain has been protected since 1959 as a special botanical reserve that

[13] Based on the available data taken from the Zenica-Doboj Canton Zoning Plan (2009-2029), Municipality of Vares Zoning Plan (1999-2015), Feasibility Study for Protection of the Zvijezda Mountain Area, data base of the Zenica-Doboj Canton Institute for Urbanism and Physical Planning, Federation BiH Ministry of sport and Culture Register of the Protected Natural Heritage and other data bases.

[14] Synonym of *Tilia platyphyllos*.

administratively belongs to the municipality of Vares. This habitat is a naturally raised complex of peatland on moss substrate (Natura 200 code 7110).

The United Nations (UN) Environmental Program in Bosnia and Herzegovina have recently incorporated sites 1 to 8 mentioned above into a single spatial unit and proposed an area for protection as a part of the future category IV protected area – 'Protected area of Zvijezda Mountain with sustainable use of natural resources'. The future protected area ends above the settlements of Velika and Mala Mekuša, approximately 3km north east from the Vares Processing Plant. The Zvijezda Mountain area is currently utilised by residents of Vares for foraging of herbs, mushrooms and plants, as well as for hunting activities. This aspect is further discussed in Chapter 4.13 – Ecosystem Services.

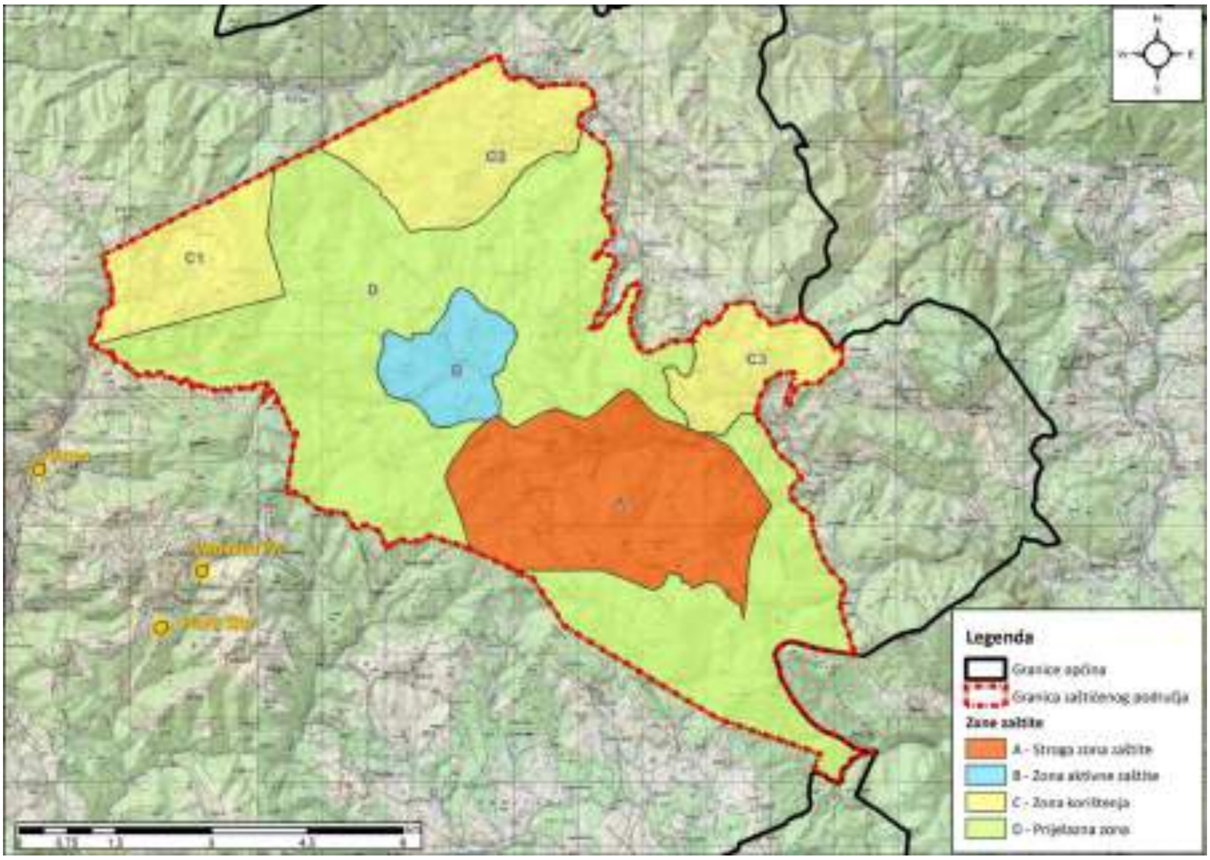


Figure 4.5.2: Proposed protected area of Zvijezda Mountain

The Feasibility Study for the Protection of Zvijezda Mountain area, municipality of Vares (2014) provides for four protection zones within the protected area with different degrees of protection, as follows:

- Strict protection zone (orange) – area of extraordinary and unique values (e.g. water supply, important historical locations, important habitats, endemic and endangered species), which corresponds to Protected Area Management Categories II and III, located approximately 5km east of the Vares Processing Plant;
- Active protection zone (blue) – area of high natural value for conservation where significant management activities in the area are stipulated. The objective is to

conserve, rehabilitate or revitalise the area and this zone includes two subzones: (i) habitat conservation and rehabilitation zone and (ii) species protection zone with elimination of invasive species, and it corresponds to Protected Area Management Category IV;

- Use zone (yellow) – is a zone of lower conservation value that is managed for other reasons important for development of the protected area and that can conditionally be divided into different subzones by type and planned use: (i) inhabited zone, (ii) traditional agriculture zone, (iii) recreational and tourist infrastructure zone, which corresponds to IUCN Protected Area Management Category IV; and
- Transitional zone (green) – is located around the outer border of the protected area or between different zones or encompassing the entire protected area. The role is to act as a buffer between different zones and in general, includes two subzones: (i) buffer zone and (ii) transition zone. This corresponds to IUCN Protected Area Management Category V and IV.

4.5.3.3 Species of Conservation Concern

The International Union for the Conservation of Nature (IUCN) Red List of Threatened Species™ is widely recognized as the most comprehensive, objective global approach for evaluating the conservation status of plant and animal species. The IUCN Red List plays an increasingly prominent role in guiding conservation activities of governments, NGOs and scientific institutions. Species are classified based on their conservation status according to Figure 4.5.3 below.

Not Evaluated	Data Deficient	Least Concern	Near Threatened	Vulnerable	Endangered	Critically Endangered	Extinct in the wild	Extinct
NE	DD	LC	NT	VU	EN	CR	EW	EX

Figure 4.5.3 IUCN Red List Categorisation

Desk study information provided within the IBAT report indicates the possible presence of several IUCN red listed species within 50km of the project study area, as shown in Table 4.5.2 below. No restricted range species were identified within the IBAT report.

Table 4.5.2 IUCN Red Listed Species within 50km of The Project Study Area

Taxonomic Group	Common name	IUCN Status	Potential presence within project area
Fish			
Acipenser sturio	Atlantic sturgeon	CR	No suitable habitat present
Acipenser gueldenstaedtii	Russian sturgeon	CR	No suitable habitat present
Huso huso	Beluga	CR	No suitable habitat present
Anguilla anguilla	European eel	CR	**Possible – streams and ponds**

Table 4.5.2 IUCN Red Listed Species within 50km of The Project Study Area			
Taxonomic Group	**Common name**	**IUCN Status**	**Potential presence within project area**
Hucho hucho	Danube salmon	EN	**Larger watercourses downstream of project**
Salmo obtusirostris	Soft-mouthed trout	EN	**Possible – streams**
Squalius microlepis	Imotski chub	EN	**Possible – ponds and lakes**
Mammals			
Mustela lutreola	European Mink	CR	No suitable habitat present – not found in BiH according to IUCN Red List
Birds			
Neophron percnopterus	Egyptian Vulture	EN	Highly unlikely – forests and cliffs[15]
Falco cherrug	Saker Falcon	EN	No - habitat unsuitable[16]
Gastropods			
Marstoniopsis vrbasi	Gastropod	CR	**Possible - wetlands**
Plagigeyeria zetaprotogona	Gastropod	EN	**Possible - wetlands**
Iglica bagliviaeformis	Gastropod	EN	**Possible - wetlands**
Theodoxus subterrelictus	Metkovich Cave Nerite	EN	**Possible - wetlands**
Plants			
Hypnum fertile	Fern	CR	**Possible – wooded streams**
Sorbus bosniaca	Bosnian whitebeam	EN	**Possible – mountain slopes**
Malacostraca			
Austropotamobius pallipes	White-clawed Crayfish	EN	**Possible – streams and rivers**
Insecta			
Metrioptera prenjica	Prenj Meadow Bush-cricket	EN	No – lives at higher altitude grassland
Buprestis splendens	Insect	EN	No – pine forest habitat not present within area
Vinodolia uviatilis	Insect	EN	**Possible - wetlands**
Ropalopus ungaricus	Insect	EN	**Possible – forests with sycamore**
Ampedus quadrisignatus	Insect	EN	**Possible - beech-oak woods of lowlands and foothills**

[15] Species absent according to European Breeding Bird Atlas 2 – Distribution, Abundance and Change (2020).
[16] Species absent according to European Breeding Bird Atlas 2 – Distribution, Abundance and Change (2020).

4.5.3.4 EU Protected, BiH Protected, Endemic or Threatened Species

The desk study undertaken by Zenica Institute shows relatively few records were available for the area. Records available include barn owl *Tyto alba,* the rock fly *Leuctra digitata*, the rock fly *Leuctra hippopoides*, Compton tortoiseshell *Nymphalis l-album* and the hermit beetle *Osmoderma eremita.* These records were returned from the vicinity of the Project areas. All these species are listed VU or EN in FBiH.

The following plants identified by Zenica Institute through research are FBiH Bosnian or Balkan endemic or locally threatened species local to the study areas. These species have been listed due to their potential presence near to project areas, although no exact locations for the records were available.:

- Balkan daphne *Daphne blagayana, sin. Thymelaea dendryobryum*
- Yugoslav rock bell *Edraianthus Jugoslavicus, sin. Edraianthus graminifolius*
- Pančić alpine sow-thistle *Cicerbita pancicii, sin. Mulgedium alpinum var.pancicii*
- Gregersen spurge *Euphorbia gregersenii*
- Spleenwort *Asplenium cuneifolium*
- Forked spleenwort *Asplenium septentrionale*
- Liver Leaf *Hepatica nobilis*
- 'Hainaldova nevesika' *Athamantha haynaldii*
- Dinaric damask violet *Hesperis dinarica*
- Rock carnation *Dianthus petreus*
- Bosnian mullein *Verbascum bosnense*
- Narrow-leaved figwort *Scrophularia tristis*
- Stiff hedgenettle *Stachys recta*
- Bog bean *Menyanthes trifoliata*
- Alpine hawkweed *Taraxacum alpinum*
- Hawkweed *Hieracium waldsteinii*
- East alpine violet *Festuca panciciana*
- Early purple orchid *Orchis maculata*
- Pyramidal orchid *Anacamptis pyramidalis*
- Greater butterfly-orchid *Platanthera chlorantha*

It should be noted that in BiH and FBiH there is no national planned monitoring system for biodiversity or reliable existing information on the distribution of protected, endangered and endemic species of flora and fauna.

4.5.4 Field Survey Methodology

4.5.4.1 Existing Field Surveys

The initial desk study report by Zenica Institute and the project design have been continually reviewed and used to inform the field surveys.

Surveys in the field are designed based on literature review, proposed project design and consultation with relevant biodiversity specialists.

Existing field surveys prior to those undertaken by Zenica Institute in 2020 and 2021 were limited to those undertaken in July 2019 by Enova, to inform the EIA for the Veovaca open pit and Vares Processing Plant. The extent of survey work was extremely limited; a desk study was undertaken where general habitats, flora and fauna were described as being potentially present within the area. A zoobenthos survey was undertaken using kick-sampling methods upstream and downstream of the historic tailings dam on the Mala Rijeka stream and the Jaglenac stream. Two terrestrial transect surveys were also undertaken attempting to identify fauna within the project area; one upstream and one downstream of the historic tailings dam.

During the kick sampling, the following protected or rare species were found; stone crayfish *Austropotamobius torrentium* – an IUCN DD, Annex V and BiH VU species, was found at sample point 1 within a tributary stream not affected by water flow from the historic tailings dam (see Figure 4.5.4 below). The two-toothed goldenring dragonfly *Cordulegaster bidentata* (IUCN NT and FBiH VU) was found at sample points 1 and 3.

Water in the lower part of the Mala Rijeka stream below the historic tailings dam was found not to support macrozoobenthos suggesting very poor water quality downstream of the old tailings dam.

The walked faunal transect surveys (Figure 4.5.1) were extremely limited in both extent and duration, being undertaken at two locations in one month of the year (July 2019). Therefore, the results are not considered comprehensive and only provide a limited amount of data on the faunal assemblage of the area. Nonetheless the following protected or rare species, or signs thereof, were encountered during the transect surveys; yellow-bellied toad *Bombina variegata* Annex II; IV; BiH NT-C, agile frog *Rana dalmatina* Annex IV, a potential den site of brown bear *Ursus arctos* Annex II; IV; BiH VU, grey heron *Ardea cinerea* BiH VU, and wall lizard *Podarcis muralis* Annex IV.

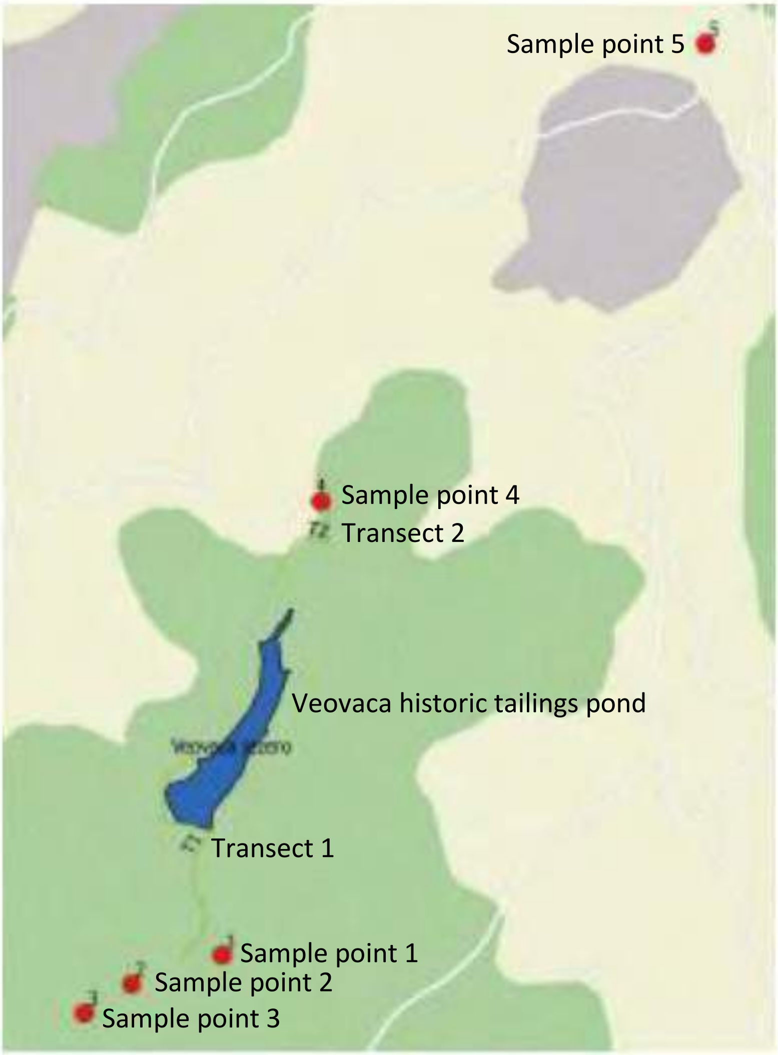


Figure 4.5.4: Enova Sample Locations

4.5.4.2 Methodology Overview

The concession area for the Rupice deposit covers a much larger extent than the actual area of proposed above and below ground works, which are shown on Drawing 4.5.1.

The field surveys initially aimed to describe and map broad habitats within the concession areas, including the project working areas. These initial results were then used to identify areas required for further detailed research and habitat mapping in the spring/summer season of 2021, as the project layout and design was progressed. Additionally, for the purposes of this assessment, the parts of the proposed haul road that fall within the Rupice concession are considered within the Rupice area.

Desk study and representative sampling was used to map broad habitat types. Following this, further detailed flora and habitat mapping surveys were undertaken in spring 2021, concentrating on project impact areas within the concession boundaries and identified EAAAs.

Fauna surveys utilised desk study records, confirmed and potential project impact zones and areas of suitable habitat to inform the survey locations.

In all instances, a summary of the survey methodology and locations is provided below. Further detail on survey methodology and full species lists can be found in Appendix 4.5.1, the report by the Zenica Institute and are not repeated here.

Surveys were undertaken at several locations during late summer/autumn 2020 and spring/early summer 2021. The survey areas, indicating EAAAs are mapped on drawings 4.5.3-4.5.9.

In addition, a site visit was undertaken by Wardell Armstrong in late April 2021. The site visit included driving to, walking around or viewing from a distance large parts of the of the project areas with the Zenica Institute Biodiversity team to discuss areas for further research and EAAAs. The site visit was undertaken by Associate Director (Ecology) James Richardson and Principal Environmental and Social Specialist Alexandra Mitchell.

The site visit also involved interviews with the local hunting, fishing and forestry groups.

Habitats and Flora

Broad habitat mapping was undertaken in October 2020 (Drawing 4.5.2) with further detailed flora surveys being undertaken in May and June 2021 focusing more closely on the proposed impact zones of the project, See Figure 4.5.5, Figure 4.5.6 and Figure 4.5.8. The EAAA for flora is shown in Drawing 4.5.3. Habitats and flora surveys at Rupice were undertaken at six representative sites, at eight representative sites close to the Vares Processing Plant and along the route of the planned transport road at six representative sites, a minimum of 50m wide on both sides of the proposed route.

To inform the habitat categorisation, the following data was gathered or determined:

- Habitat type according to EUNIS classification and Natura 2000 - territorial affiliation of species according to habitat type at each investigated locality;
- Orographic position (exposure, slope and geographical coordinates);
- Geological and pedological characteristics of each locality (type of geological base and soil);
- General vegetation coverage at each investigated locality; and
- Floristic composition and diversity, i.e. determination of represented plant species that may trigger the presence of PBF or ACH.

Fungi

Fungal surveys were undertaken in October 2020, and May and June 2021, in order to monitor both late and early fruiting species. During the field surveys, research was conducted by walking along each representative transect, recording each species of fungi at the research sites and paying special attention to the potential presence of any protected, endangered and endemic fungal species which could be affected by the project. The EAAA for Fungi is shown in Drawing 4.5.4

Fauna

Field surveys were undertaken in October and November 2020, and May and June 2021. The surveys targeted amphibians and reptiles (herpetofauna), icthyofauna (fishes), macrozoobenthos, terrestrial invertebrates, ornithofauna (birds) and mammals, including bats. Surveys were undertaken within the project areas of Rupice and the Vares Processing Plant (including the planned TSF), as well as areas up to 150m from the proposed haul road. Special attention was paid to determining the presence of protected, endangered and endemic species. A building inspection with regards roosting bats in the Droškovac transfer station, Vareš (Associated Facility) was also undertaken in August 2021.

Herpetofauna

The appropriate EAAA for amphibians was determined prior to sampling by mapping any flowing or static waterbodies within or near to the project areas as shown on Drawing 4.5.5. Due to the generally mountainous terrain, suitable breeding habitat for amphibians within the project areas is limited to the streams and their immediate vicinities, as well as the historic tailings dam lake at Tisovci. Surrounding terrestrial habitat is fairly consistent and comprises mostly degraded spruce forest on sloping ground, but other habitats, smaller in extent such as grassland, are also present.

For reptiles, establishing an appropriate EAAA involved sampling different habitat types within and near to project areas that could support reptiles, such as rocky habitats, scrub, grassland and forest. Surveys were undertaken during suitable weather conditions, using a walked transect methodology, using binoculars and searching under rocks, potential refugia or basking sites and suitable vegetation. Where required, specimens were captured for identification in the field or photographed for subsequent identification.

Surveys were undertaken in autumn 2020 and spring 2021 in order to spot basking adult or neonate reptiles at different times of year and to capture both the terrestrial and aquatic phases of amphibians.

Icthyofauna

The appropriate EAAA for icthyofauna (Drawing 4.5.6) was determined and revised during the survey process, by selecting survey points on suitable watercourses/waterbodies both upstream and downstream from potential project infrastructure. Surveys were undertaken in October 2020 and May and June 2021. Methodology included discussion with local anglers, as well as undertaking walked transects along suitable watercourses, using direct observation and photography. No electrofishing was undertaken. The research placed special emphasis on identifying the habitats of fish species listed in Table 4.5.2. Surveys were undertaken at ten different locations on streams with potential to be affected by the Rupice, haul road and Vares Processing Plant project areas.
The locations were as follows:

- Rupice: the Vrući stream – one location, Borovički stream - two locations,
- Vares Processing Plant: the Mala river with tributaries - four locations; and
- Haul road: the Zagarski stream - three locations. (The Zagarski stream survey points were added following the site visit in April 2021 and the subsequent alterations to the proposed haul route).

The local fishing society was also consulted by Wardell Armstrong during the April 2021 site visit, and the fishing society annual report was provided for reference.

Macrozoobenthos
Field research of macrozoobenthos was performed at the same locations as icthyofauna in October 2020 and May and June 2021. Survey methodology used kick-sampling and searching under rocks, stones and using direct observation under torchlight for crayfish species.

During the field research, special attention was paid to the potential presence of protected, endangered and endemic species of macrozoobenthos, such as the FBiH stone flies *Leuctra digitata* and *Leuctra hippopoides* and the IUCN EN white clawed crayfish.

Terrestrial Invertebrates
An appropriate EAAA for terrestrial invertebrates was established by sampling different habitats, and focussing on locations where species with the potential to trigger PBF or ACH might be found. The mapped EAAA is shown in Drawing 4.5.7. Field surveys for terrestrial invertebrates were undertaken in October 2020 and May and June 2021 at six locations, in order to sample species with late and early phenologies. The survey focussed on following transects within project footprint areas. Special attention was paid to the potential presence of IUCN or FBiH CR, EN or endemic species through identification and sampling of their habitats and to determine areas of particular interest for their invertebrate assemblage, such as wetland areas, primary forest and species rich grassland.

Ornithofauna
An appropriate EAAA was established for ornithofauna which covered the entire project area at Rupice, Vares Processing Plant and the haul road with an additional 50m buffer, as shown in Drawing 4.5.8. Initial ornithological surveys were undertaken during October 2020 in order to sample any resident species and to determine areas of potential breeding habitat for protected or rare species. Spring surveys were then undertaken to survey for breeding birds during May and June 2021 at six representative locations at Rupice, along the haul road and at Vares Processing Plant. From these six central locations, survey methods then included walked transects and vantage point surveys to identify breeding bird species present. The vantage point surveys enabled a greater visual envelope in order to spot any displaying raptors which may otherwise be difficult to survey using the transect methodology.

Mammals

The appropriate EAAA for mammal surveys was based on an extensive desk study, discussions with hunting organisations and local residents, and field survey. Although no physical surveys were done more than 150m or so from concession area boundaries, the desk study and consultation part of the EAAA included references from the hunting organisation over 4km away. The EAAA is mapped in Drawing 4.5.9.

Mammal surveys were conducted in October and November 2020, and May and June 2021 at six representative locations but covering all of the Rupice project area as well as forested areas close to the Vares Processing Plant. The methodology used walked transects and stationary observation within the project areas, including up to 150m either side of the proposed haul road route. Signs of mammal presence such as faeces, odour, hairs, excavations, foraging signs and paw prints were searched for. Remote cameras were also placed for longer time periods at six potentially important locations within the project areas such as stream/road intersections, forest clearings and caves/tunnel entrances. Locations of the camera traps are shown in Drawing 4.5.9.

Special attention was paid to signs of the presence and habitats of protected, endangered and endemic species of mammals such as brown bear, Eurasian lynx, grey wolf and bats. The field research included three dusk transect surveys for bats at Rupice, along the haul road and at Vares Processing Plant, as well as locating potential roost sites such as caves or abandoned buildings within areas potentially affected by the project activities. The transect surveys were required in order to determine the species diversity and extent of bat foraging within the project areas. The surveys included a detailed inspection of abandoned buildings in the vicinity of Vares Processing Plant and abandoned buildings and infrastructure on the section of the proposed haul route in the valley of the Zagarski stream (an abandoned underground magazine). Searches for the presence of tree roosts e.g. in woodpecker holes, or large hollow old trees within forested areas to be affected by the project were also carried out.

The local hunting organisation was also consulted by Wardell Armstrong during the April 2021 site visit.

A building inspection for bats in the Droškovac transfer station, Vareš, was carried out in August 2021 by Zenica Institute (Figure 4.5.7). The building inspection followed the latest guidance[17] and aimed to ascertain the level of suitability of the buildings for roosting bats in the area proposed to be used as an Associated Facility to the project. The survey included an internal and external inspection of all safely accessible buildings/structures and a dusk survey on 3 August 2021.

4.5.5 Results

4.5.5.1 Protected Sites (Rupice, Haul Road and Vares Processing Plant)

[17] Bat Surveys for Professional Ecologists: Good Practice Guidelines, 3rd ed., 2016

The closest protected site to the Vares Processing Plant is the proposed buffer zone of the Zvijezda Mountain, 1.1km to the north east of the Vares Processing Plant. The most sensitive parts of the proposed designated site are located over 3km away with significant topographical barriers in between. The buffer zone separates the most sensitive parts of the proposed Zvijezda Mountain site from the project area, as is its purpose.

The closest protected area to the Rupice project area is the Tajan Natural Monument (IUCN Category 3), at its closest point approximately 6km to the north of the Rupice concession boundary.

It is not anticipated that the project will impact significantly on any protected site.

*4.5.5.2 **Rupice***

Table 4.5.3 below lists the identified habitat types based on field research undertaken in autumn 2020 and spring 2021, with associated habitat codes according to the European Habitats Information System (The European Nature Information System - EUNIS). These are also shown in Figure 4.5.5. The Table also references the Guide to Habitat Types of BiH, according to the Directive on EU Habitats (Natura 2000) and the NATURA 2000 Regulation - Protected Areas in Europe and includes a brief habitat description and protection status. PBF and ACH are mapped in Drawing 4.5.10.

Where an impact to a habitat is expected and it is considered PBF or ACH, **it is highlighted in bold**.

Table 4.5.3: Identified Habitats at Rupice

EUNIS	Natura 2000	Habitat Name	Habitat Description	Protected or likely PBF / ACH and Potential Impact
G3.1F53 [18]	9410	Acidophilic spruce forests of hilly to mountainous belt (*Vaccinio-Piceetea*)	This coniferous forest habitat is dominant within the Rupice project area. The dominant species is Norway spruce *Picea abies* and occasional silver fir *Abies alba* on siliceous rocks containing limestone and various types of siliceous soil. These forests are mostly monodominant in nature and inhabit colder and edaphically fresher habitats on silicate rocks with limestone on which different types of silicate soils are present. The ground flora is mostly poor due to the dense, even aged canopy in which the following species dominate: round-leaved bedstraw *Galium rotundifolium*, male fern *Dryopteris filix-mas*, shield fern *Polystichum aculeatum*, wood sorrel *Oxalis acetosella*, greater wood-rush *Luzula sylvatica* and brambles *Rubus fruiticosus* Agg.	**Habitat type listed in Annex 1 of Habitats Directive (PBF).** **Due to poor management, condition of this forest is likely to be classed as 'unfavourable inadequate'.**

[18] EUNIS -Factsheet for Acidophilous Picea forests of the montane to alpine levels (Vaccinio-Piceetea) (europa.eu)

Table 4.5.3: Identified Habitats at Rupice				
EUNIS	**Natura 2000**	**Habitat Name**	**Habitat Description**	**Protected or likely PBF / ACH and Potential Impact**
			The spruce forest is managed commercially as high forest as confirmed by the forestry service, where trees are harvested when they reach C.70cm diameter. Consequently, there are no old trees, very little standing dead wood, poor structural and species diversity and ground flora is generally sparse other than in along forestry tracks and roads where *Anemone hepatica* (FBiH VU) may also be found. 	
G1.61	9110	Acidophilic beech forests (Luzulo-Fagetum)	This habitat is represented in the south and southeast parts of the concession in the wider area of the settlements of Donja and Gornja Borovica. This habitat is represented in the mountain belt of Zvijezda mountain on silicate carbonate sedimentary substrates. This habitat has been widely affected by deforestation. Various understorey species are present. The canopy is dominated by beech *Fagus sylvatica* with rare specimens of sycamore maple *Acer pseudoplatanus*, Bosnian maple *Acer obtusatum* and European ash *Fraxinus excelsior*. Understorey vegetation and shrubs is predominantly common hornbeam *Carpinus betulus*, common hazel *Corylus avellana*, mountain ash *Sorbus aucuparia*. The herbaceous layer contains Solomon's seal *Polygonatum multiflorum*, round-leaved bedstraw *Galium rotondifolium*, sanicle *Sanicula europaea*, male fern, lettuce fetid *Aposeris foetida*, greater wood rush and white wood-rush *Luzula luzuloides* amongst other occasional species.	Habitat type listed in Annex 1 (PBF). Habitat is outside of project footprint and impact zone.

Table 4.5.3: Identified Habitats at Rupice				
EUNIS	**Natura 2000**	**Habitat Name**	**Habitat Description**	**Protected or likely PBF / ACH and Potential Impact**
				
H3.1B2	8220	Silicate rocky slopes with hazmophitic vegetation	Silicate rocky slopes with hazmophitic vegetation are azonal character habitats represented in the silicate rocks fissures with sparse hazmophitic vegetation. Extreme ecological factors that dominate these habitats enable the development of sparse hazmophitic vegetation which can include various endemic, relict and endangered plant species. One **range restricted and FBiH VU** plant species was recorded – Bosnian sandwort *Minuartia bosniaca.* No other rare or protected species were found. 	Habitat type listed in Annex 1, contains endemic species and is therefore a PBF. This habitat is found outside of project footprint and impact areas, including the location where Bosnian sandwort was found (considered a PBF, shown on drawing 4.5.10 is outside of project impact zone.
E1.833	6230*	Mat grass grassland (*Nardus stricta*)	Mat grass grasslands are dry to mesophilic grasslands with *Nardus stricta* as the dominant species. They develop on slightly inclined terrain within the mountainous belt, in areas with little	Priority habitat type listed in Annex 1 (if species rich then considered ACH).

Table 4.5.3: Identified Habitats at Rupice				
EUNIS	**Natura 2000**	**Habitat Name**	**Habitat Description**	**Protected or likely PBF / ACH and Potential Impact**
		Abundant with species	rockiness on the surface. They are typical for silicate massifs but they also occur on carbonates, only at the plateaus where the soil is deeper and more acid. They resulted from clearing forest or bush vegetation. Due to a relaxation in summer grazing, a significant portion of the Annex I priority habitat has undergone natural succession towards a forest community dominated by various types of trees (beech, mountain maple, etc.). Within the Rupice concession area, this habitat is found mainly on the central plateau area. Generally, matgrass *Nardus stricta* is dominant with the following plant species being frequent: yarrow *Achillea millefolium*, arrow-jointed broom *Genista sagitallis*, dyer's broom *Genista tinctoria*, field scabious *Knautia arvensis*, St. John's wort *Hypericum perforatum*, lemon thyme *Thymus pulegoides*, meadow saffron *Colchicum autumnale*, and tormentil *Potentilla erecta* as well as other occasional species listed in the Zenica Institute report. Stemless gentian *Gentiana acaulis* FBiH VU (IUCN LC) was located in this habitat. 	Habitat not considered particularly species rich at this location due to nutrient enrichment from livestock grazing and so likely to be considered PBF. Previously the haul road was proposed to impact this habitat. The new haul road route avoids this habitat by approximately 500m and it will not be affected by the project.
G1.2	3240	Alpine rivers and their ligneous vegetation with *Salix elaeagnos*	This habitat type in the project area is represented on the banks of the lower reaches of mountain streams: Vrući stream, Borovički stream and Bukovički stream. This habitat is represented in a very narrow and intermittent belt in in the form of small strips immediately adjacent to the watercourses and is characterized by high soil moisture, which is reflected in the specific floristic	**Habitat type listed in Annex 1 and therefore this habitat is PBF.** **Habitat contains FBiH CR species and qualifies as PBF.** **Habitat has the potential to be affected by the project**

Table 4.5.3: Identified Habitats at Rupice				
EUNIS	**Natura 2000**	**Habitat Name**	**Habitat Description**	**Protected or likely PBF / ACH and Potential Impact**
			composition of plant communities dominated by hygrophilous species. **The FBiH CR species marsh marigold** *Caltha palustris* was found. This species is common and widespread throughout Europe (IUCN LC) but local impacts to this species should be avoided. 	**through water abstraction and construction impacts.**
C2	3260	Water courses from plateaus to the mountainous belt with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	This habitat type in the project area is represented along the eastern and northern boundaries of the Rupice concession area; the Borovički stream which flows on the far eastern side and Vrući stream which flows towards the northern border of the concession and flows into the river Trstionica. These watercourses are characterised by fast and variable flow, low temperature, clear water and a rocky-gravel bed, as well as specific faunal communities characteristic of high quality water. 	**Habitat type listed in Annex 1 and therefore this habitat is PBF.** **Habitat proposed to be affected during construction and operation through water abstraction.**
H 1.26	N/A	Small, dry caves	In the eastern part of the concession area of Rupice, between the villages of Donja and Gornja Borovica, two small dry caves have been registered, with small entrances (Sutjeska and Bojana). Field examination concluded that they were not inhabited by more significant	This habitat would be considered PBF or ACH if found to support bats and was impacted by the project. However, no protected or rare fauna was noted during field

Table 4.5.3: Identified Habitats at Rupice				
EUNIS	**Natura 2000**	**Habitat Name**	**Habitat Description**	**Protected or likely PBF / ACH and Potential Impact**
			troglobionts or troglophilic zoocenoses and do not contain significant species of fauna. The nearest substantial cave confirmed to provide bat roosting habitat is Grčki kamen located 2km from the project area. 	research and the caves are outside of the project impact area. Not considered a PBF.
J 2.1	N/A	Buildings	This habitat type is in the Rupice project area is represented by two small villages: There are a smaller number of scattered houses, auxiliary and abandoned buildings with a very small number of permanent residents (Gornja Borovica - 7 inhabitants and Donja Borovica - 28 inhabitants) along the local road and one religious building and local cemetery.	No – all houses in the Rupice concession are outside of the project footprint.

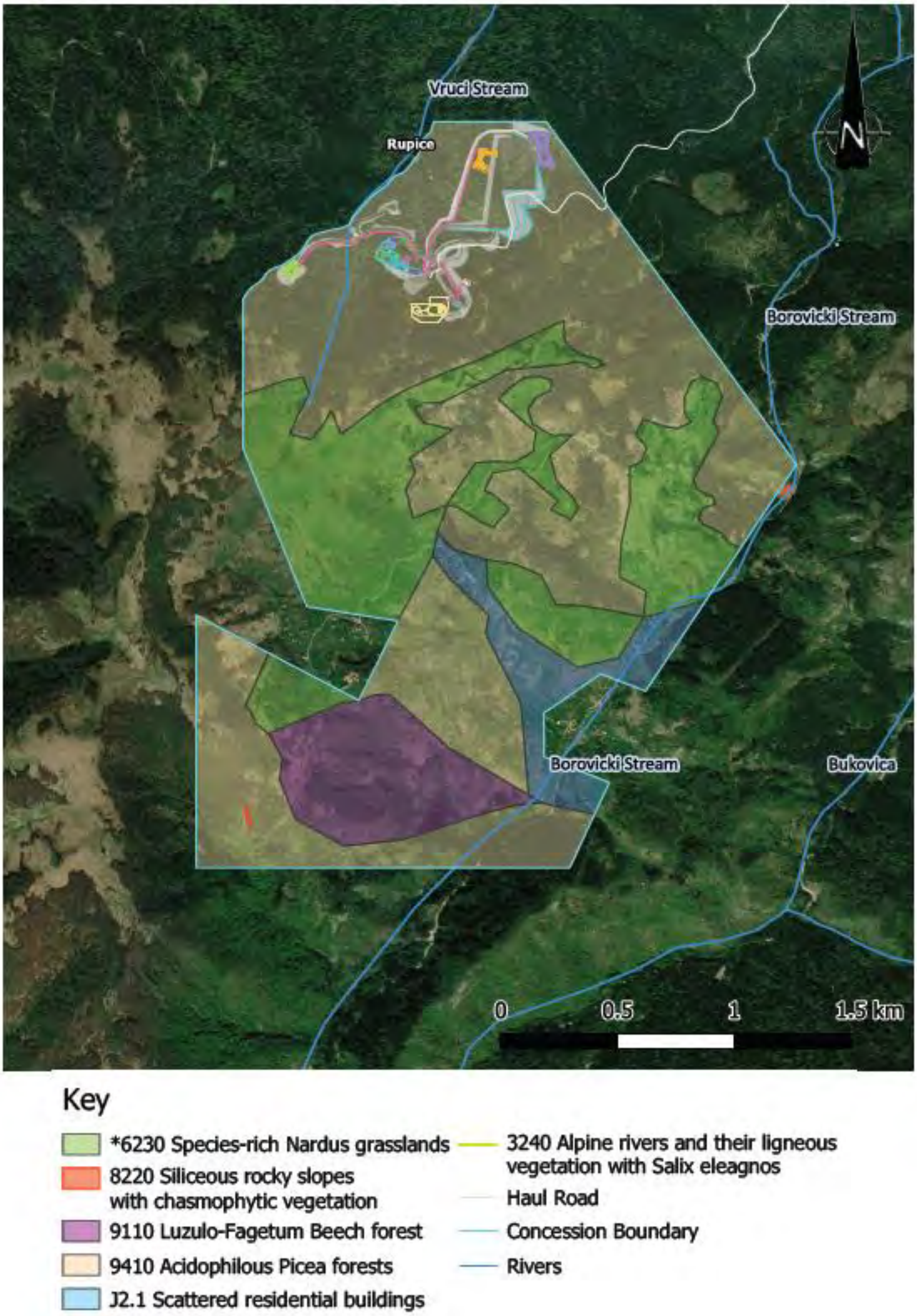


Figure 4.5.5 Habitats within the Rupice Concession

Fungi

Several species of fungi were identified during the surveys at Rupice. The only species of conservation concern located was the IUCN DD and FBiH VU *Climacocystis borealis* which causes heartwood rot of trees. Its habitat is mixed beech forests with firs and spruce. This species was located at the proposed site of the Rupice mine and the area proposed for the formation of a working plateau from which the planned transport route starts. This species was found to be widespread in the local area outside of the project working zones and so the project is unlikely to affect the conservation status of this species.

There are no species of fungi found that would trigger the presence of PBF or ACH and this species group does not require any special avoidance, mitigation or compensation at this location.

Fauna

Herpetofauna

Reptile and amphibian species recorded within the Rupice concession area included yellow bellied toad *Bombina variegata,* Greek frog *Rana graeca,* agile frog *Rana dalmatina,* green toad *Bufo viridis,* fire salamander *Salamandra salamandra,* eastern green lizard *Lacerta viridis,* nose-horned viper *Vipera ammodytes* and adder *Vipera berus.*

Several individuals of Annex IV *R. graeca* and *B. variegata* were found in streamside pools along Vrući and Borovički streams. Multiple individuals of Annex IV *B. viridis* was found along the banks of the Borovicki stream upstream and downstream of Donja Borovica. *R. dalmatina* and *V. ammodytes* are listed under Annex IV of the EU Habitats Directive and were found within the spruce/fir forest. Nose-horned viper was also recorded from beech forest, rocky habitats and *Nardus stricta* upland grassland. The Annex IV sheltopusik *Ophisaurus apodus,* sand lizard *Lacerta agilis,* green lizard *L. viridis* and Aesculapian snake were recorded from the *Nardus stricta* grassland habitat. Sand lizard was recorded from the hazmophytic rock slope habitat and Annex IV smooth snake *Coronella austriaca* was recorded between the local road and Borovički stream, upstream from the village of Donja Borovica associated with rocky streams. Annex IV Wall lizard *Podarcis muralis* is likely to be common in all rocky habitats but was not found within the proposed working area due to lack of suitable habitat.

The yellow-bellied toad breeds in small streams, temporary pools and ponds. According to Zenica Institute and desk study, this IUCN LC species is widespread and relatively common in the region and found in most aquatic habitats in the project areas. The Rupice project area is not crucial for supporting local populations of any amphibian species although impacts to watercourses providing breeding habitat should be avoided as **the presence of an Annex IV species of frog and toad mean the watercourses would be classified as critical habitat**.

The project area or haul road within the Rupice concession are not crucial for supporting the populations of local reptile species. The impact zone is fairly localised at Rupice and centred upon dense, managed spruce forest whereas the most important reptile habitats are associated with open habitats such as grassland, rocky outcrops and wetland areas. Extensive suitable habitat will remain within and outside of the concession area.

There are no known caves or underground river systems within or connected to the project area that could support olm *Proteus anguinus* (IUCN VU, Annex II, IV).

Photo 4.5.1 Fire salamander and yellow-bellied toad

Icthyofauna

The Vruči stream does not hold enough water to support viable fish populations. The fish assemblage within the Borovički stream is predominantly made up of populations of two common and widespread species: brown trout *Salmo trutta* and bleak *Alburnus bipunctatus* which is consistent with the information obtained from the local fishing society. No IUCN CR European eels were found and the fishing society confirms that they are absent from the local watersheds.

No threatened or protected fish species were located during the surveys that would otherwise trigger the presence of PBF or ACH. Further downstream away from the concession area, the watercourses become suitable for a wider variety of fish species such as barbel and Danube salmon and **as such impacts to watercourses have the potential to affect rare or protected fish species outside the project area.**

Ornithofauna

A relatively limited number of bird species were observed during the surveys, which were undertaken as a scoping visit in autumn 2020 and then breeding bird surveys in May and June 2021. Dense, commercially managed spruce forest does not support a particularly great diversity of species and as such the results are not unexpected.

Relatively common and widespread species observed during the breeding season include blackbird *Turdus merula,* marsh tit *Poecile palustris,* chaffinch *Fringilla coelebs,* greenfinch *Chloris chloris,* raven *Corvus corax,* buzzard *Buteo buteo* and cuckoo *Cuculus canorus* amongst other species of least conservation concern. There are no areas within or near to the project area that support a particularly diverse, important breeding bird assemblage.

The Birds Directive Annex I species hazel grouse *Tetastes bonasia* was recorded within the habitats bordering the spruce forest and upland *Nardus* grassland, as well asthe beech forest habitats at Rupice. Hazel grouse was also recorded once along the route of the haul road. Scops owl *Otus scops* FBiH-NT was recorded from the *Nardus stricta* upland grassland habitat in autumn 2020 as well as at two locations along the proposed haul road. There are also desk study records of the Annex I species pygmy owl *Glaucidium passerinum* and three-toed woodpecker *Picoides tridactylus* from the general area. These species would be associated with mature forest but were not found to be breeding within or near to project areas. Through desk study the regional breeding population of pygmy owls is known to be outside of the project footprint areas over 2km to the north, and as such this species is unlikely to be affected by the proposals.

Hazel grouse prefers mixed species forest and forest edge and its main habitats will therefore remain intact well away from the project areas. However, when nesting the presence of Annex 1 hazel grouse during the breeding season within the Rupice project area or haul road means nesting areas would qualify as a PBF (refer to drawing 4.5.10, Drawing 4.5.14)

Terrestrial Invertebrates

Several common and widespread species were found during the autumn 2020 and spring 2021 surveys. No protected or threatened invertebrates were found during the October and November 2020 surveys. In the acidophilic beech forests within the Rupice concession area, one vulnerable insect species; the longhorn beetle *Morimus funereus* was found. This species is IUCN VU and listed on Annex II of the Habitats Directive **meaning that the species and its habitat where it was found would be a PBF**. The habitat where this species was found will not be affected by project activities.

Records of the bark beetle *Osmoderma eremita* were returned from the desk study. This Annex II species prefers decaying wood, of oak, beech and willow. This species was not found during the surveys and its preferred habitat lies outside of project impact areas within deciduous forests.

Although there are habitats and species within the Rupice concession area that would trigger the presence of PBF (Drawing 4.5.16), none are located within or near to project areas due to the generally degraded forest habitat within the project area.

Zoobenthos

Watercourses are represented in the Rupice project area by two permanent streams; Borovički potok, which flows along the extreme eastern side of the of the concession area and Vrući potok, which flows through a small part of the northern border. These mountain streams are characterized by rapid flow, variation in water quantity, and high quality of oxygen-rich water, low water temperature and rocky-gravel bed. The associated zoobenthos fauna that was surveyed in autumn 2020 and spring 2021 consists of a small number of species but with high populations which are characteristic of high water quality.

Two vulnerable species; *Perla marginata* (a stonefly) FBiH-VU and stone crayfish *Austropotamobius torrentium* IUCN-DD and FBiH-VU were found. These species are characteristic species of clear, fast flowing high quality water. Stone crayfish was found in the Borovički stream, upstream from the village of Donja Borovica. As the stone crayfish is IUCN DD, but locally VU and likely to be decreasing, **this species should be considered as PBF and impacts to the Borovički stream minimised.**

Photo 4.5.2 Stone Crayfish

Mammals

The surveys in autumn 2020 and spring 2021 (Drawing 4.5.15) recorded several common and widespread species such as red squirrel *Sciurus vulgaris,* roe deer *Capreolus capreolus,* wild boar *Sus scrofa,* edible dormouse *Glis glis,* beech marten *Martes foina* as well as other small rodents and carnivores of lowest conservation concern.

The surveys did not find any suitable bat roosting sites within or near to project areas that could be affected by the work. The nearest bat roosting habitat is located in a hard-to-reach cave called Grčki kamen below Vranovac, which is located outside the Rupice concession in the wider area of Osredak. Grčki kamen cave is over 2km as the crow flies from the project area and no impacts upon this habitat are expected.

Suitable bat roosting habitat is also located in a cave Šajinovički kamen near to the small village of Položac, which is over 4km as the crow flies from the Rupice project area. The most important bat habitat is located in the Ponikva cave located north of the town of Vareš, through which a public road passes. The surveys did not identify any trees with potential to support breeding or hibernating bats, due to the way the forest is managed. The project areas are likely to provide foraging habitat however there is extensive similar habitat throughout the local and wider area and so the importance of the project area for foraging in a local context is low.

Detailed field research by Zenica Institute in autumn 2020 and spring 2021 using field surveys and remote cameras did not find evidence of Bosnian grey wolf *Canis lupus kurjak* or brown bear *Ursus arctis* utilising the Rupice project area. There are no suitable denning sites for these species within or near to the proposed project footprint. However, in February and March 2021, signs of brown bear were recorded by local workers (footprints in the snow) on the way to Gornja Borovica within the spruce forest and near to the meteorological station towards Rupice within the *Nardus* grassland habitat.

Field research and data collection from various sources, including the local hunting society, concluded that the main bear denning and foraging habitat is located outside the Rupice project area and outside the potential zone of disturbance from project activities. It is likely that the bear that was recorded was simply passing through the area and it is possible that grey wolf occasionally uses the area to pass through whilst hunting or dispersing to territories. The project area is not considered crucial in maintaining the population of either species at a local level. The nearest bear hibernation habitat in relation to the project area is located in a cave called Šajinovički kamen, south of Osredak.

The local hunting society reported the rare occurrence of lynx within the wider area but that the project area does not provide suitable denning or regular hunting habitat for this species, and no signs were found during the field surveys.

As such, the Rupice project area does not form habitat crucial in maintaining the local or regional populations or brown bear, grey wolf or lynx. The critical habitat lies outside of project areas largely to the north towards Konjuh and is shown on drawing 4.5.15.

The European wildcat *Felis sylvestris* was recorded during consultation with the local hunting organisation as being present predominantly on Konjuh Mountain which extends north of the municipality of Vareš, as well as along the river Krivaja (outside the municipality of Vareš). These areas of over 8,100 ha are planned for protection “Zvijezda - Tajan - Konjuh“. This species is listed on Annex IV of the Habitats Directive and as such ACH for this species is located outside of the project areas shown on drawing 4.5.19 Denning habitat was not recorded within the project areas for this species and generally the managed spruce forest is not considered good quality habitat due to lack of cover and likely low prey density.

4.5.5.3 Vares Processing Plant

The natural or semi-natural habitats would likely have been similar to those at Rupice but have been influenced to a much greater extent by previous mining works and other human activity in the vicinity. The contemporary habitats are dominated by secondary woodland and scrub regeneration, with large areas of ruderal and ephemeral vegetation. Watercourses within the project area show signs of discharge from former mining work and surveys by Enova found a depleted aquatic fauna downstream from the tailings dam. This survey work has since been updated by Zenica Institute.

Table 4.5.4 lists the identified habitat types based on field research undertaken in autumn 2020 and spring 2021, with associated habitat codes according to EUNIS. The Table also references the Guide to Habitat Types of BiH, according to the Directive on EU Habitats (Natura 2000) and includes a brief habitat description and protection status..

Table 4.5.4: Identified Habitats around the Vares Processing Plant

EUNIS	Natura 2000	Habitat Name	Habitat Description	Protected or likely PBF / ACH and Potential Impact
G3.1F53	9410	Acidophilic spruce forests of hilly to	This habitat is represented in enclaves on both sides of the Mala Rijeka and its northern tributaries, and south of the settlement of Tisovci and further in a wider area outside the	**Habitat type listed in Annex 1 of Habitats Directive (PBF).**

Table 4.5.4: Identified Habitats around the Vares Processing Plant

EUNIS	Natura 2000	Habitat Name	Habitat Description	Protected or likely PBF / ACH and Potential Impact
		mountainous belt (*Vaccinio-Piceetea)*	settlements surrounding the project area of Vares Processing Plant. In terms of description and management impact, it is the same forest type as found at Rupice – where larger trees are removed and the general forest structure is poor. In smaller areas (in the form of small enclaves), apparently primary spruce forests are present in the area downstream from the tailings dam, on both sides of the Mala river. These areas appear not to have been logged, or have been selectively logged in a more sympathetic manner as to preserve the characteristics of this forest type. This more important spruce forest habitat is largely outside of the project impact area.	**Due to poor management, condition of much of this forest is likely to be classed as 'unfavourable inadequate'.** **Small enclaves are likely to have higher conservation priority in areas either side of the Mala river downstream from the tailings dam (see drawing 4.5.10)** **The project working area falls within this habitat including the above-ground infrastructure and proposed dams.**
G1.2	*91E0	Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)*	This habitat is present in smaller areas along the right (northern) tributary of the Mala river close to the Vares Processing Plant in the form of narrow and intermittent strips along the banks of this mountain stream (upstream of the historic tailings dam). In this habitat, a hygro-mesophilic community of grey alder *Alnus incana* has developed on alluvial deposits formed along a mountain stream in cooler and shaded places within the acidophilic spruce forests. Grey alder is joined by rare individuals of common ash *Fraxinus excelsior*, sycamore, spruce, black elder *Sambucus nigra*, hazel, buckthorn *Rhamnus alpinus* and other woody species. The herbaceous layer consists of the following frequent species: giant horsetail *Equisetum telmateia*, marsh horsetail *Equisetum palustre*, creeping buttercup *Ranunculus repens*, Angelica *Angelica*	**Priority habitat type listed in Annex 1 and therefore ACH.** **Habitat will not be affected by the planned project work.**

Table 4.5.4: Identified Habitats around the Vares Processing Plant				
EUNIS	**Natura 2000**	**Habitat Name**	**Habitat Description**	**Protected or likely PBF / ACH and Potential Impact**
			sylvestris, wood sorrel *Oxalis acetosella*, nettle leaved speedwell Veronica *urticifolia*, butterbur *Petasites hybridus* amongst other occasional species. 	
E1.2	6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)	This habitat is represented in a small area located north of the Vares Processing Plant, and close to the historic Veovaca Open Pit. Numerous species characteristic for thermophilic meadows are represented in this habitat. These grasslands are used only for uncontrolled grazing and are quite neglected, and as such are not fertilised and have developed an interesting flora. 	Habitat type listed in Annex 1 of Habitats Directive (PBF) – only considered a priority habitat if rich with orchid species, which this location is not. Habitat is outside of any proposed impact zone.
G1.2	N/A	Marginal vegetation – reeds and tall herbs	This habitat is represented in the area of the area around the tailings dam at Tisovci. This habitat has developed under modified conditions.	No – habitat not listed as EU Habitats Directive Annex habitat, and is modified habitat.

Table 4.5.4: Identified Habitats around the Vares Processing Plant				
EUNIS	**Natura 2000**	**Habitat Name**	**Habitat Description**	**Protected or likely PBF / ACH and Potential Impact**
				
J3.3	N/A	Abandoned surface mine	This type of habitat is located in the abandoned surface mine of Veovaca and is characterised by natural pioneer tree species seeded from the surrounding forest, shrubs and grassy vegetation characteristic of tertiary ecosystems. Frequent species include silver birch *Betula pendula*), aspen *Populus tremula*, grey alder goat willow *Salix caprea*, silver fir, Norway spruce, sycamore, smoke tree *Cotinus coggygria*, hawthorn *Crataegus monogyna*, dog rose *Rosa canina.* Frequent herbaceous species include black bent *Agrostis gigantea*, chicory *Cichorium intybus*, carline thistle *Carlina vulgaris*, colt's foot *Tussilago farfara*, danewort *Sambucus ebulus*, creeping thistle *Cirsium arvense*, candlestick thistle *Cirsium candelabrum*, wild carrot *Daucus carota*, lemon thyme *Thymus pulegioides,* and common toadflax *Linaria vulgaris* as well as a few occasional herbaceous species. 	N/A – not species rich or abandoned for such a length of time that an interesting flora has been able to develop.
J6.1	N/A	Dry dumps (*Artemisietea)*	These habitats are found in derelict places, overgrown ruins, by roads, derelict	N/A

Table 4.5.4: Identified Habitats around the Vares Processing Plant				
EUNIS	**Natura 2000**	**Habitat Name**	**Habitat Description**	**Protected or likely PBF / ACH and Potential Impact**
			construction sites and dams where various types of waste are dumped.	
C2	3260	Water courses from plateaus to mountainous belt with vegetation *Ranunculion fluitantis Callitricho-Batrachion*	This habitat type in the project area is represented along the Mala Rijeka watercourse and its tributary. These watercourses are characterized by fast flow, low water temperature and a rocky-gravel bed. Specific animal communities of benthos dominated by species characteristic of high-water quality and populations of salmonid are usually present, as well as certain species of herpetofauna.	**Habitat type listed in Annex 1 of Habitats Directive (PBF).** **The modified scheme potentially places a dam to the south of the existing tailings dam, over the existing stream.**
J2.1	N/A	Scattered housing	This type of habitat is represented in the project area of Vares Processing Plant by scattered buildings in small villages: Tisovci, Pržići, Daštansko and Višnjići. There are a small number of scattered houses and auxiliary facilities in these villages. Within this habitat, the vegetation of trampled habitats, arable land and fences is predominant.	No – no buildings are proposed to be lost under the proposals and this is not an Annex listed habitat.

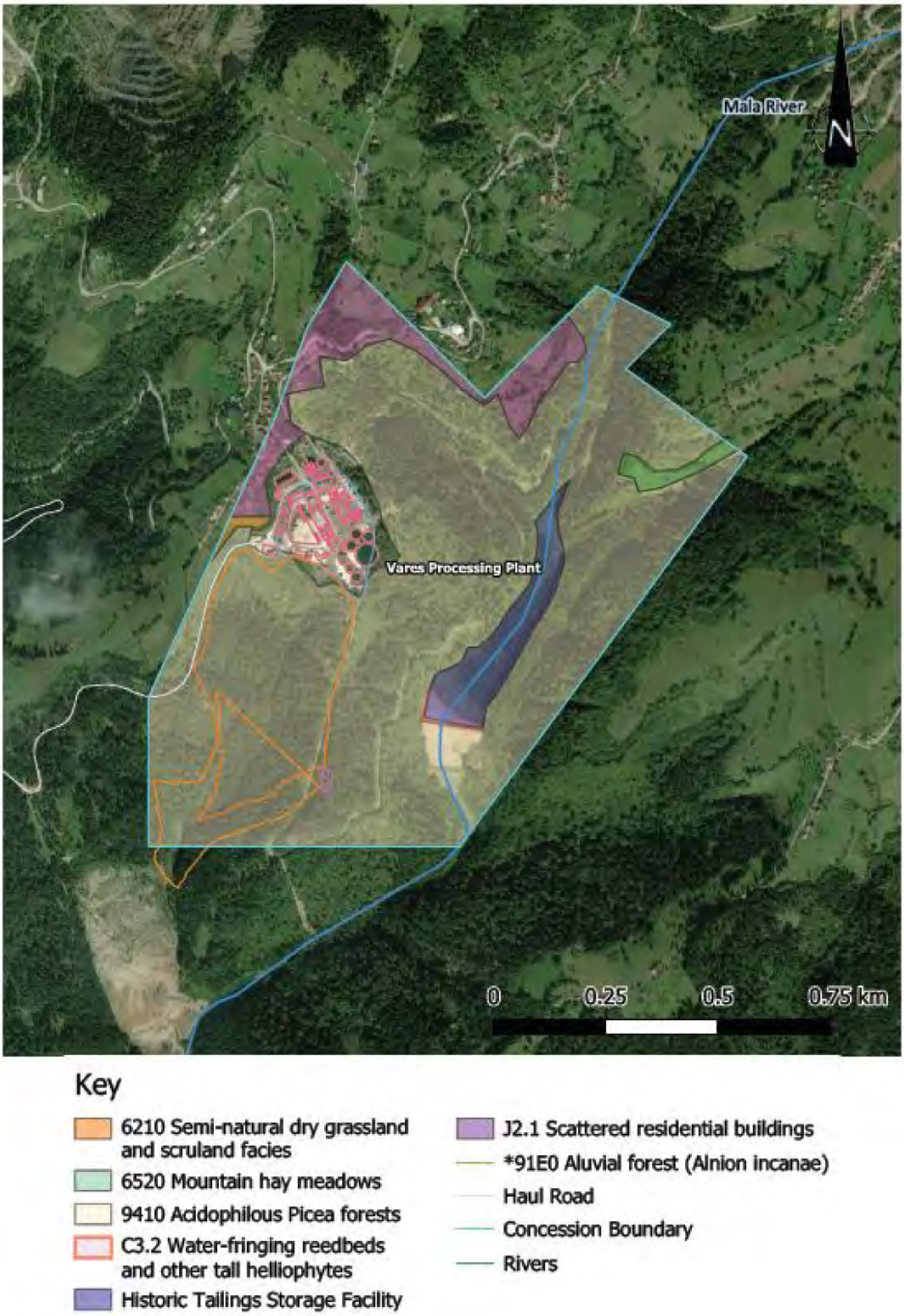


Figure 4.5.6 Habitat mapping within the concession of the Vares Processing Plant

Flora

One invasive species – Japanese knotweed *Reynoutria japonica* was found at a few locations near to the existing access road to Vares Processing Plant, north of the site, as well as in the historic Veovaca open pit (see drawing 4.5.18). This species should be avoided or treated with an approved herbicide to prevent its spread, as it can come to dominate certain habitats especially along watercourses.

Annual fleabane *Erigeron annuus* was also found within the open pit and this species is now widespread and common throughout Europe.

Fungi

The FBiH VU and IUCN DD species *Climacocystis borealis* was found within the spruce-fir forest habitat between the Vares processing plant and planned TSF location. This species is likely to be found elsewhere in the locality and was found widely at Rupice.

No other threatened or protected species of fungi were found during the autumn 2020 surveys and this species group does not require any special avoidance, mitigation or compensation.

Fauna

Herpetofauna

The following protected or threatened reptile species were found during the surveys near to the existing tailings dam; smooth snake (Annex IV), nose-horned viper (Annex IV) and green lizard (Annex IV). Wall lizard (Annex IV) was found in several places around the project area in rocky locations.

The following protected or threatened amphibian species were found during the surveys; yellow bellied toad (Annex IV), Greek frog (Annex IV) agile frog *Rana dalmatina* (Annex IV) and green toad (Annex IV) as well as a large breeding population of common toad *Bufo bufo* in the tailings lake itself.

Populations of yellow bellied toad were found in numerous places in small pools along the Mala River and its tributary flowing from the Vares Processing Plant. Greek frog was found in small pools along the Mala Rjeka as well as around the historic tailings lake. Agile frog and green toad were found in the general area of the planned TSF south of the Vares Processing Plant.

There are no known caves or underground river systems within the project area that could support the presence of olm.

Several Annex IV species of amphibian and reptile have been found within the project area. Whilst the project area is not considered crucial to maintain the local populations of these species, they are nonetheless **trigger species for designating ACH** and provisions will need to be made to ensure their populations at a local level experience no measurable overall adverse impacts.

Macrozoobenthos

The results of zoobenthos research undertaken in autumn 2020 and spring 2021 indicate that the water quality in the Mala Rijeka watercourse downstream from the tailings dam is good. Certain species indicating good water quality were found; (*Baetis sp*.), *Trihoptera* (*Philopotamus variegatus, P. montanus, Rhyacophila philopotamoides*, etc.) amongst others.

The Annex II, IUCN EN and FBiH EN white-clawed crayfish was found during sampling in autumn 2020 and spring 2021 in the Mala Rijeka, at a sample location downstream of the natural lake and the former waste rock dump indicating that **this habitat is a PBF for this species**.

Photo 4.5.3: White clawed crayfish found during the surveys

Photo 4.5.4: Downstream from Veovaca Open Pit and at the confluence of this stream into Mala river (Right)

Ornithofauna

Species recorded during the visit by Wardell Armstrong and during the spring surveys around the area of the open pit included black redstart *Phoenicurus ochrurus,* willow tit *Poecile montanus,* buzzard, great tit *Parus major,* raven, chiffchaff *Phylloscopus collybita,* chaffinch and hooded crow amongst other species of the lowest conservation concern.

Species recorded from the spruce forest and areas around the tailings dam during the Zenica Institute surveys, in addition to the above included common woodland and wetland edge species such as great spotted woodpecker *Dendrocopus major,* nuthatch *Sitta europaea,* grey wagtail *Motacilla cinerea,* grey heron *Ardea cinerea,* mallard *Anas platyrhynchos* as well as less frequent species such as hawfinch *Coccothraustes coccothraustes* and nightingale *Luscinia megarhynchos.*

The largely modified nature of the Vares Processing Plant area means that the species or assemblages that would otherwise trigger PBF or ACH are absent. No species are reliant on the habitats at the site to maintain local populations and all are widespread and sometimes common in Europe although some species such as mallard, nightingale and hawfinch are showing local or regional declines.

Nesting and foraging habitat for waterfowl (mallard) and birds requiring aquatic habitats (e.g grey heron, grey wagtail) should be protected where possible and considered during construction and operation.

Icthyofauna

Two species of fish were found in the Mala river and the tailings lake (where fish are known to have been introduced). These are brown trout *Salmo trutta* and chub *Squalius cephalus*. It is estimated that in the Mala river the population of brown trout is 7,159 and the population of chub 651[19].

It is important to note that a hatchery has been established on the section of the Mala Rijeka 4 km upstream from the mouth of the Stavnja river. This should be considered when implementing protection measures for this watercourse as all waters from the project area ultimately flow into this river.

No threatened or protected fish species were located during the surveys that would otherwise trigger the presence of PBF or ACH. Further downstream away from the concession area, the watercourses become suitable for a wider variety of fish species such as barbel and Danube salmon and **as such impacts to watercourses has the potential to affect rare or protected fish species outside the project area.**

Mammals

Field searches and remote cameras did not find any signs of brown bear, Eurasian lynx or grey wolf in the area. However, in April 2021, a bear was sighted walking close to the Vares Processing Plant in the village of Tisovci in search for food. This area does not represent the normal migratory routes of brown bear and sightings in this relatively disturbed area are very rare. According to the data of the "Zvijezda" Vareš Hunting Association and the local population, the main foraging and denning sites of bears are towards the settlement of Karići and further towards the Konjuh protected area and over 1km outside of the project area.

Bats

Field research undertaken in May 2021 at dusk, registered over 23 bat flights over the historic tailings dam lake and foraging activity around the spruce forests. In addition, during May 2021, a bat day roost was found in an abandoned building of the former pumping station above the historic tailings dam

[19] (Source: Annual program to improve fisheries in 2021 for the fishing zone Vareš, Association of Citizens of Sport Fishermen "Vareš" Vareš, 2021)

where a single lesser horseshoe bat *Rhinolophus hipposideros* was found (see drawing 4.5.17). Other buildings were inspected for roosting bats but none were found, as shown on drawing 4.5.17. Lesser horseshoe is FBiH-EN as well as Annex II and IV Habitats Directive. The nearest bat breeding habitat is in the caves at Ponikva and Šainovički kamen, which are over 4km and 8km, respectively from the Vares Processing Plant.

The aforementioned abandoned building is not proposed to be affected by the project **but may be considered as a PBF or ACH**. Large areas of suitable foraging habitat will remain, and the project area is not considered crucial foraging habitat in the context of the local area.

Photo 4.5.5: Lesser horseshoe bat found in an abandoned pumping station building.

Other bat species recorded from the data search near to the historic tailings dam, at forest edges or open areas around the Vares Processing Plant included; greater horseshoe bat *Rhinolophus ferrumequinum,* greater mouse-eared bat *Myotis myotis,* lesser mouse-eared bat *Myotis oxygnathus*, serotine bat *Eptesicus serotinus,* bent winged bat *Miniopterus schreibersii,* barbastelle *Barbastella barbastellus* and alpine long-eared bat *Plecotus macrobullaris.* **All bats are protected under the Habitats Directive and should be taken into consideration with regards lighting impacts over foraging areas.**

Droškovac transfer station, Vareš

The building inspection undertaken in August 2021[20] found the majority of buildings/ structures to have negligible potential to support roosting bats. This is due to the poor state of the structures; lacking roofs, windows, being generally open to the elements and light intrusion making them highly unlikely to support roosting bats due to a general lack of shelter or stable environmental conditions for roosting.

The exception was a few rooms on the ground floor and the basement of the abandoned administration building (point 4, Figure 4.5.7). This was confirmed by the presence of three lesser

[20] REPORT on examining the habitat of bats in abandoned buildings and other structures in the area of the planned transfer station Droškovac in Vareš

horseshoe bats. The building was not considered to provide suitable habitat for maternity roosts, rather it is being used as a day roost by a small number of non-breeding individuals.

Figure 4.5.7: Surveyed Buildings at Droškovac transfer station, Vareš.

The abandoned Droškovac pit shaft (point 8 on Figure 4.5.7) was not thoroughly inspected due to health and safety concerns but is considered likely to provide suitable roosting habitat (including for hibernation).

The abandoned administration building at point 4 and the abandoned mine shaft at point 8 **should be considered as PBF** but are not proposed to be affected by project activities.

4.5.5.4 Haul Road

Table 4.5.5 lists identified habitat types based on field research undertaken in autumn 2020 and spring 2021, with associated habitat codes according to the European Habitats Information System (The European Nature Information System - EUNIS). The Table also references the Guide to Habitat Types of BiH, according to the Directive on EU Habitats (Natura 2000) and the NATURA 2000 Regulation - Protected Areas in Europe, and includes a brief habitat description and protection status.

The results provided by Zenica Institute in November 2020 and May/June 2021 indicate that the habitats present within the route of the haul road are as follows in Table 4.5.5. PBF and ACH are mapped in Drawing 4.5.10.

Table 4.5.5: Habitats Present within the Route of the Haul Road

EUNIS	Natura 2000	Habitat Name	Habitat Description	Protected or likely PBF / ACH and Potential Impact
G3.1	9410	Acidophilous *Picea* forests of	In terms of description and management impact, it is the same forest type as found at Rupice –	**Habitat type listed in Annex 1 of Habitats Directive (PBF).**

Table 4.5.5: Habitats Present within the Route of the Haul Road				
EUNIS	**Natura 2000**	**Habitat Name**	**Habitat Description**	**Protected or likely PBF / ACH and Potential Impact**
		the montane to alpine levels (*Vaccinio-Piceetea*)	where larger trees are removed and the general forest structure is poor. 	**Areas of this habitat will need to be removed or modified in order to expand or create the new haul road.**
E2.3	6520	Mountain hay meadows	Mountain meadows are represented along the haul route at Položac - Semizova Ponikva. Meadows in the locality Položac - Semizova Ponikva have not been cut or grazed recently, and are undergoing vegetation succession. On larger slopes and sunnier areas, mountain meadows now replace thermophilic meadows in some areas. 	**This habitat is included in Annex I of the Habitats Directive (PBF) and is proposed to be impacted by the new haul road.**
E5.4	6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	The habitat is found on the section of haul road on the section Položac - Semizova Ponikva that passes north of the village of Položac for approximately 1.4 km. This habitat is dominated by hydrophilic plant species. These hydrophilous tall herb fringe communities are developed on hydromorphic soil in a small depression 1.5 km long and 5 -15 m wide. Although no species were found that were rare or protected, the habitat itself is Annex 1.	**This habitat is included in Annex I of the Habitats Directive (PBF) and is proposed to be impacted by the new haul road.** **FBiH CR marsh marigold was also found in this habitat – a PBF.**

Table 4.5.5: Habitats Present within the Route of the Haul Road				
EUNIS	**Natura 2000**	**Habitat Name**	**Habitat Description**	**Protected or likely PBF / ACH and Potential Impact**
				
C2	3260	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	This type of habitat is represented on the route of the haul road at Zagarski stream where a section of the proposed haul road passes towards the village of Bijelo Borje. This habitat is also represented on a very short section of the planned road that passes over the existing regional road (R444a) along the Bukovica riverbed, at a length of approx. 200 m. These watercourses are characterized by fast flow, fluctuation of flow, occurrence of torrents, low water temperature and rocky-gravel bed. 	**This habitat is included in Annex I of the Habitats Directive (PBF). The lower section of the stream has been culverted and therefore does not meet the Annex 1 criteria.** **This habitat is proposed to be affected through the construction of the haul road alongside or in the stream valley.**
H5.6	N/A	Trampled areas (*Plantaginetea majoris*)	This type of habitat is found next to existing forest roads that will be used for the construction of the haul road, and which are used for forestry works. These habitats are subject to trampling and the soil is usually compacted, poorly aerated and has variable humidity.	Habitat not threatened or protected.
J3.3	N/A	Abandoned surface mines	Abandoned surface mines (Veovaca and Diknjići) and industrial plant (Tisovci) are overgrown on smaller areas with individual and	Habitat not threatened or protected.

Table 4.5.5: Habitats Present within the Route of the Haul Road				
EUNIS	**Natura 2000**	**Habitat Name**	**Habitat Description**	**Protected or likely PBF / ACH and Potential Impact**
			significantly sparse pioneer tree species, shrubby and grassy vegetation that is characteristic of these types of habitats with undeveloped land and unfavourable ecological conditions (tertiary).	

Figure 4.5.8: Habitat mapping along haul route

Flora

Nine plant species were found which are included in the FBiH red lists as NT (two species) and VU (seven species). No IUCN or FBiH EN or CR species were found along the route of the proposed haul road within the overall spruce forest habitat.

Also, seven plant species (*Ulmus glabra, Cicerbita pancicii, Leucanthemum praecox, Hepatica nobilis, Telekia speciosa, Asplenium septentrionale and Cephalanthera rubra*) were found in this habitat, which are included in the Red List of FBiH flora as VU. Three vulnerable plant species *C. pancicii*, *T. speciosa* and *C. rubra* were found on the section of the road that goes along the route of the existing forest road from Požac – Kota. In a Europe-wide context they are widespread **but their VU status within Bosnia should be considered where possible e.g. through transplanting or creation of new habitat**.

In the habitat of hydrophilic boundary tall forbs, on the section of the route that passes north of the village Požac, one FBiH CR species marsh marigold was located, as well as two FBiH plant species *Angelica sylvestris* and *Telekia speciosa*. **Marsh marigold is considered a PBF due to its CR status in FBiH.**

At the location of the proposed haul road along the Zagarski stream, one FBiH NT plant species *Dipsacus pilosus* and three FBiH VU plant species *Hepatica nobilis, Leucanthemum praecox* and *Asplenium septentrionale*, were found.

Two FBiH VU species of plants, *Angelica brachyradia* and *Gentiana acaulis* were found in the mountain meadow habitat present along the planned haul road. **In addition, two plant species *Knautia dinarica* and *Crepis conyzifolia*, which are endemic to Bosnia and Herzegovina, were present in this habitat which is already considered PBF**. Other species of plants present in the mountain hay meadow meadows in the study area are IUCN or FBiH LC (full lists found in the report by Zenica Institute, Appendix 4.5.1).

Given that Dinarian dame's rocket and other FBiH VU species listed in the desk study were not found inside the planned project areas, it is considered unlikely that the project activities will affect local populations of these species where they are present.

Fungi

The FBiH VU and IUCN DD species *Climacocystis borealis* and clustered coral mushroom *Ramaria botrytis* - FBiH CR were found next to the forest road on the site that rises above the right bank of the river Bukovica towards Donja Borovica (see drawing 4.5.12).

C. borealis has been found to be widespread in the local area. The locations of these fungi were near to an area of existing haul road and as such, with standard protection measures these fungi species should not be affected by the project.

Photo 4.5.6 Ramaria botrytis

Fauna

Herpetofauna

Reptile and amphibian species recorded within the survey area surrounding the existing haul road, or within the path of the proposed new roads included yellow bellied toad, agile frog, green toad, fire salamander, eastern green lizard, slow worm *Anguis fragilis,* Aesculapian snake *Zamenis longissimus,* nose-horned viper, sheltopusik and adder.

L. viridis, Z. longissimus and *V. ammodytes* are listed under Annex IV of the Habitats Regulations and were found intermittently along the route of the proposed haul road but their main habitat will not be affected by the project and standard mitigation measures can ensure these species are not affected during construction.

A large local population of Annex IV yellow bellied toad was found in Zagarski stream at each of the three sample points, green toad and agile frog triggering the designation of critical habitat along this stream. Fire salamander was also found breeding.

Chiroptera

The nearest potential roost sites are located at Greek Stone cave (Grčki kamen) which is approximately 1.8km from the proposed route of the haul road. No trees or other suitable roosting sites were located along the proposed haul road route.

A similar range of foraging bat species were encountered along the proposed haul road as at the Vares Processing Plant.

As much of the haul road is existing, and extensive habitat remains outside of the proposed new haul road areas, it is unlikely that this aspect of the project will impact upon the conservation status of any bat populations.

Ornithofauna

Surveys along the proposed haul route between Rupice and Tisovci located a total of 38 different bird species potentially breeding nearby, of which:

- Four species of birds (scops owl, rook *Corvus frugilegus,* nightingale and great grey shrike *Lanius excubitor* are categorized as FBiH NT.
- Three species; hobby *Falco subbuteo*, horned lark *Eremophila alpestris* and eagle owl *Bubo bubo* are categorized as FBiH-VU.
- Two species peregrine *Falco peregrinus* and eagle owl are included in Annex I of the Birds Directive and are subject to special conservation measures relating to their habitats, in order to ensure their survival and reproduction in their range. Peregrine falcon breeds mostly on rock faces or buildings which will not be affected by this project. Eagle owl prefers dense forest and rocky outcrops for nesting.
- Five species; woodcock *Scolopax rusticola*, jackdaw *Corvus monedula*, rook, song thrush *Turdus merula* and starling *Sturnus vulgaris*) are included in Annex II of the Birds Directive.

Annex I eagle owl was recorded foraging near to the haul road. The preferred habitats for foraging and nesting are the rocky outcrops outside of the concession areas and as such the PBF for eagle owl is unlikely to be impacted by the project (see Drawing 4.5.14)

Zoobenthos

Since the proposed route of the haul road was amended in early 2021, additional surveys were undertaken on the Zagarski stream. The haul road route is proposed to follow the course of this stream in places. Numerous populations of stone fly *Perla marginata* FBiH VU and other species of stonefly, were found on all three investigated sample points. These species are an indicator of clean water and are extremely sensitive to pollution but appear widespread in watercourses in the area. No crayfish species were found in this stream that would otherwise be an additional trigger for PBF.

Mammals

Consultation with local hunting organisations suggests that brown bear and grey wolf are present intermittently within the wider area of the project locations, and that the nearest potential denning site for brown bear is over 2km away to the north of Semizova Ponikva in a remote cave. The existing route of the proposed haul road is highly unlikely to form significant habitat for these species, which generally are considered likely to avoid anthropogenic features the majority of the time.

The local hunting organisations registered the presence of four Bosnian wolf in spring in the general hunting area but no specific location was given. One Eurasian lynx was observed near Igrište outside of the concession areas to the south west. According to the hunting association "Zvijezda", the wolves move between Semizova Ponikva and Rupice and the wider area.

Grey wolf, lynx and brown bear prefer forested or otherwise remote areas where they can find sheltered conditions for denning and feeding. Brown bear but may occasionally approach nearby settlements in search of food. Known brown bear habitats are located in a cave caled Šajinovićki kamen at the Sokolova stijena site, which is over 1.5 km from the planned transport route. Bear habitats are located in the northern and eastern parts of Zvijezda Mountain towards Gostović and

Konjuh. This area is designated for habitats supporting brown bear, according to the *"Establishment Decision breeding areas where there are ecological and natural conditions for the survival of brown bear of the Federal Ministry of Agriculture, Water Management and Forestry number: 07- 02-128-4 / 08 dated September 2008"*.

According to the hunting association "Zvijezda", eight bears have been registered in the wider Mount Zvijezda area. By collecting information from of the local population, one bear sighting was recorded near the proposed part of the haul road at Položac - Semizova Ponikva in late spring 2020, likely from Šajinovički kamen. A bear was also spotted in the vicinity of Pogar vilage in early autumn 2020.

The report advises that the project areas are not considered crucial to maintain the conservation status of brown bear (or grey wolf), although a potential denning site was mentioned in the Enova report. This area was located and assessed in spring/summer 2021 and no signs were found.

Although the project areas do not form regular foraging, denning or breeding habitat for grey wolf, Eurasian lynx and brown bear, these wide-ranging mammals should be considered PBF and addressed in the impact assessment as it is likely the proposed road will cause barrier impacts to large mammals and therefore fragmentation of habitat. Detail of mitigation for this is provided in Chapter 5.4.

*4.5.5.5 **PBF and ACH Summary***

Table 4.5.6 - Table 4.5.8 summarise the PBF and ACH located in the EAAAs at Rupice, the VPP and along the haul road.

Reptiles
Several Annex IV reptiles have been found during the surveys, are likely to be widespread and fairly common throughout the EAAA and may be present in low numbers within the Project areas at Rupice, along the haul road and at the VPP/TSF. Species include nose-horned viper *Vipera ammodytes*, wall lizard *Podarcis muralis*, smooth snake *Coronella austriaca*, sheltopusik *Ophisaurus apodus*, sand lizard *Lacerta agilis* and green lizard *L. viridis*.

Table 4.5.6: PBF and ACH qualifying species and habitats identified in the vicinity of Rupice

Habitat or Species	**Rationale for importance**
Mat grass grassland (*Nardus stricta*) abundant with species	Priority habitat under Habitats Directive if species rich. Likely PBF as not considered species rich by Zenica Institute, but a precautionary approach treats it as ACH.
Acidophilic spruce forests of hilly to mountainous belt (*Vaccinio-Piceetea*)	This habitat type is listed in Annex 1 of the EU Habitats Directive and is therefore considered a PBF despite generally poor management due to forestry practices throughout the EAAA. This is the dominant habitat at Rupice.

Table 4.5.6: PBF and ACH qualifying species and habitats identified in the vicinity of Rupice	
Habitat or Species	**Rationale for importance**
Acidophilic beech forests (*Luzulo-Fagetum*)	Habitat type is listed in Annex 1 of the Habitats Directive and is therefore considered a PBF. The Habitats Directive Annex II bark beetle *Osmoderma eremita* was located in this habitat – also PBF.
Alpine rivers and their ligneous vegetation with *Salix elaeagnos*	Habitat type is listed in Annex 1 of the Habitats Directive and is therefore considered a PBF – lower reaches of the watercourse flowing from/past the Rupice concession area.
The FBiH CR species marsh marigold *Caltha palustris*	This habitat also supports the FBiH CR species marsh marigold and further qualifies as PBF, although marsh marigold is common and widespread at a global scale. Also potential for downstream effects to other PBF/ACH.
Water courses from plateaus to the mountainous belt with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	This habitat type is listed in Annex 1 of the Habitats Directive and is therefore considered a PBF. Found along the Vruči and Borovički watercourses. Also potential for downstream effects to other PBF/ACH.
Silicate rocky slopes with hazmophitic vegetation	This habitat type is listed in Annex 1 of the Habitats Directive and is therefore considered a PBF. The range restricted and FBiH VU plant species Bosnian sandwort *Minuartia bosniaca* located in this habitat – also PBF.
Agile frog *Rana dalmatina* Greek frog *Rana graeca* Green toad *Bufo viridis* Yellow-bellied toad *Bombina variegata*	Although these IUCN LC species are widespread and relatively common in the region they are listed under Annex IV of the Habitats Directive and are therefore qualifying species for ACH where they are present as a breeding species – along Vruči and Borovički watercourses.
Hazel grouse *Tetrastes bonasia*	This is an Annex I Birds Directive species which breeds in mixed and coniferous forest, observed within the Rupice area during the surveys and is considered a PBF.
Stone crayfish	This species is IUCN-DD but is FBiH-VU and relatively restricted in its habitats (clean, fast flowing water). As such it is treated as IUCN VU

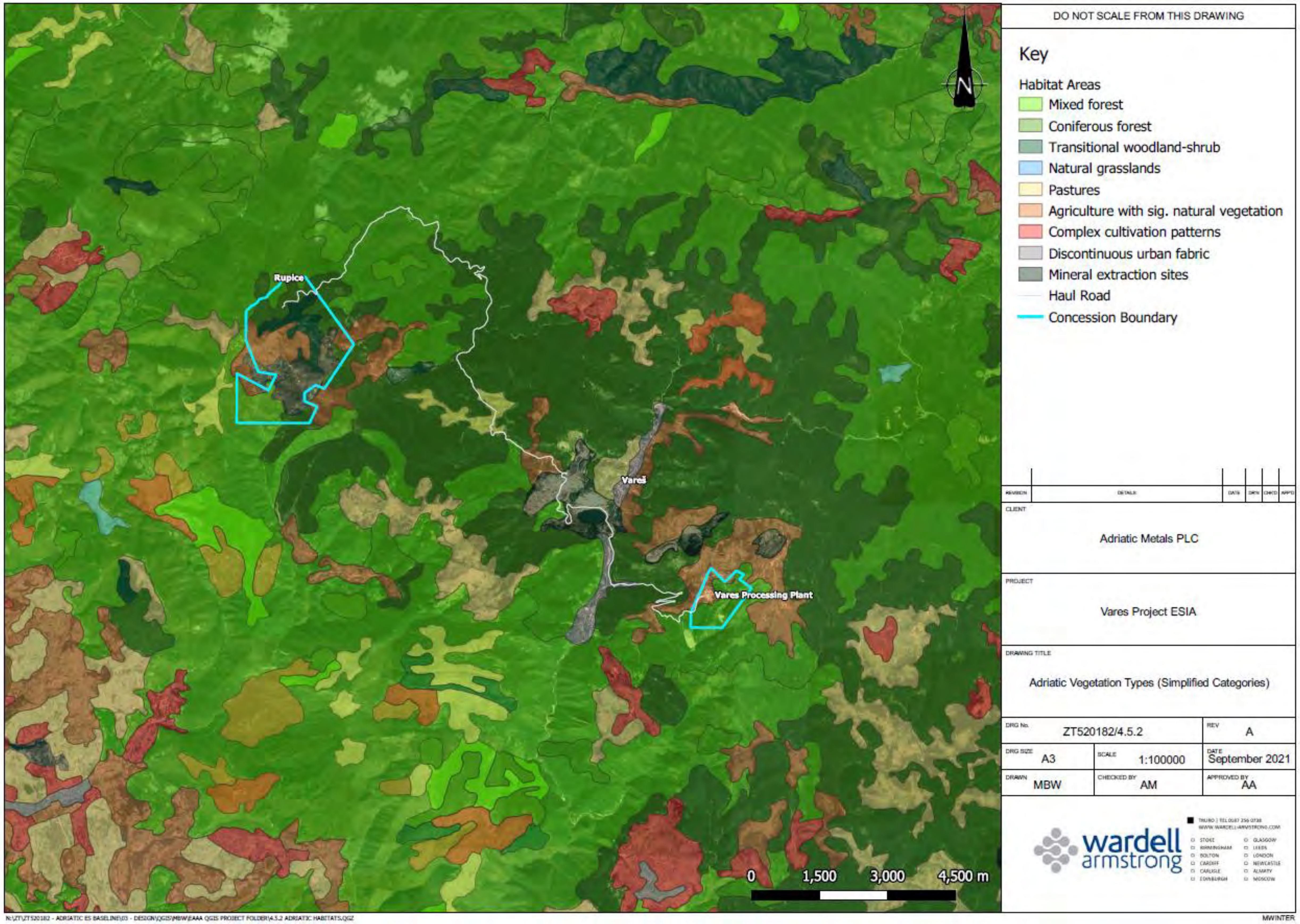
Table 4.5.6: PBF and ACH qualifying species and habitats identified in the vicinity of Rupice	
Habitat or Species	**Rationale for importance**
	and therefore as a PBF as a precaution. It was found in the Borovički stream.

Table 4.5.7: PBF & ACH qualifying species & habitats identified in the vicinity of the Vares Processing Plant	
Habitat or Species	**Rationale for importance**
Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)	Habitats Directive Annex I Priority habitat type and therefore qualifies as ACH, also associated with stream corridor. This habitat is located between the old tailings dam and the Veovaca open pit.
Acidophilic spruce forests of hilly to mountainous belt (*Vaccinio-Piceetea*)	This habitat type is listed in Annex 1 of the Habitats Directive and is therefore considered a PBF despite generally poor management due to forestry practices throughout the EAAA. This is the dominant habitat at the Vares Processing Plant AOI. Smaller enclaves of this habitat outside of the AOI along the Mala River were of higher quality due to lack of forestry management.
Water courses from plateaus to the mountainous belt with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	This habitat type is listed in Annex 1 of the Habitats Directive and is therefore considered a PBF. Found along the Mala River and its eastern tributary. Potential for downstream effects to other PBF/ACH.
Semi-natural dry grasslands and scrubland on calcareous substrates (*Festuco-Brometalia*)	Habitats Directive Annex I habitat. Not rich with orchids so considered PBF rather than ACH.
Lesser horseshoe bat *Rhinolophus hipposideros*	FBiH-EN as well as Annex II and IV Habitats Directive. A former pump house building near the existing tailings dam which formed a day roost for a lesser horseshoe bat – PBF due to low numbers of individuals and low roost importance.
Agile frog *Rana dalmatina* Greek frog *Rana graeca* Green toad *Bufo viridis* Yellow-bellied toad *Bombina variegata*	Although these IUCN LC species are widespread and relatively common in the region they are listed under Annex IV of the Habitats Directive and are therefore qualifying species for ACH where they are present as a breeding species – along the Mala River and the existing tailings dam.

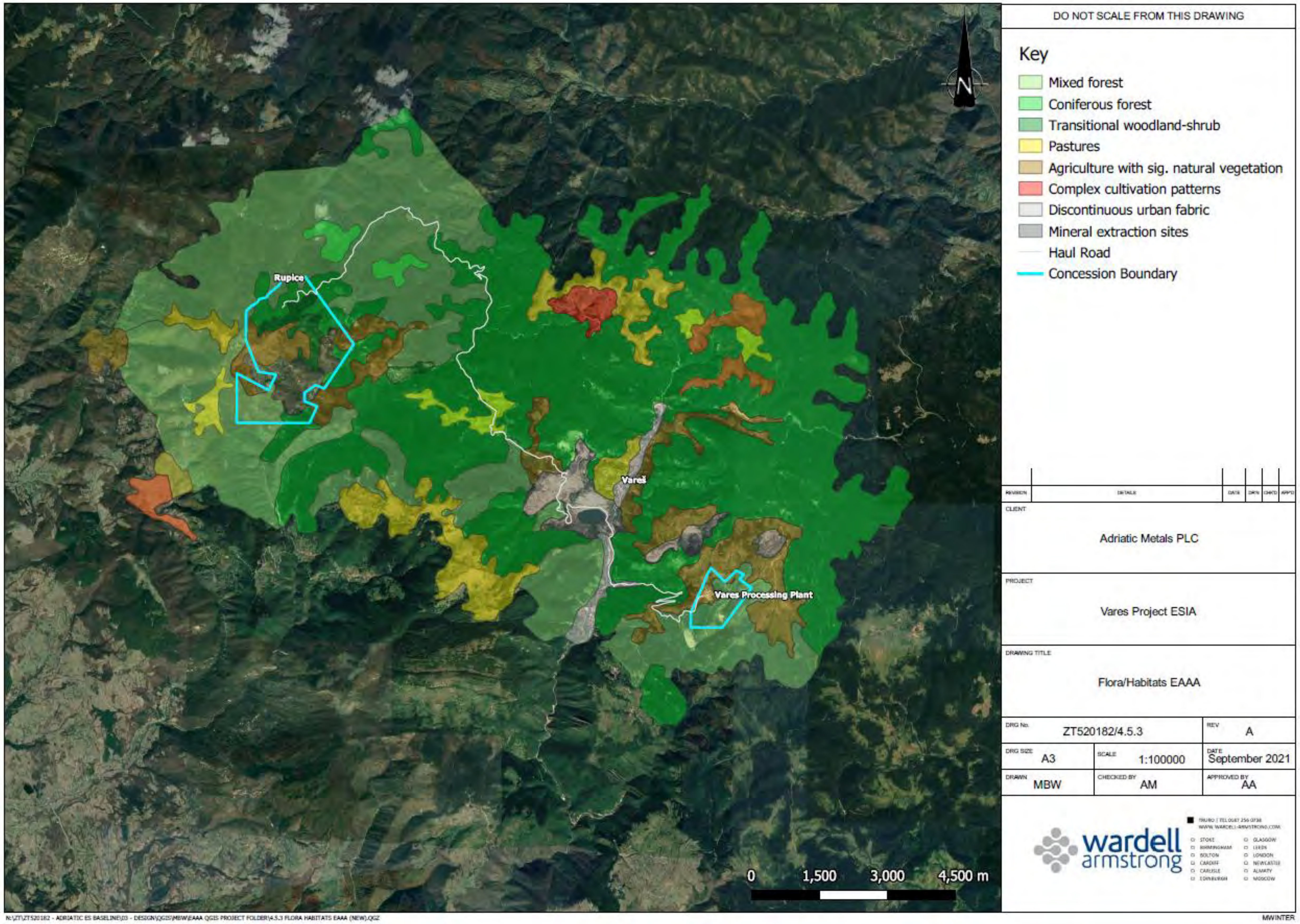
Table 4.5.7: PBF & ACH qualifying species & habitats identified in the vicinity of the Vares Processing Plant	
Habitat or Species	**Rationale for importance**
White-clawed crayfish *Austropotamobius pallipes*	Two specimens of this Annex II, IUCN EN and FBiH EN species were found during the surveys and therefore this species qualifies as a PBF, along with its habitat – the Mala River downstream of the proposed TSF.

Table 4.5.8: PBF & ACH qualifying species & habitats identified in the vicinity of the Haul Road	
Habitat or Species	**Rationale for importance**
Acidophilic spruce forests of hilly to mountainous belt (*Vaccinio-Piceetea*)	This habitat type is listed in Annex 1 of the Habitats Directive and is therefore considered a PBF despite generally poor management due to forestry practices throughout the EAAA. This is the dominant habitat along the existing and proposed haul road.
Mountain hay meadows	Located along the haul route at Položac to Semizova Ponikva. Habitat is listed in Annex I of the Habitats Directive and is therefore PBF.
Dinaric widowflower *Knautia dinarica* *Crepis conyzifolia*	Two Balkan endemic plant species were found in this habitat, which are considered to be PBF (although they are relatively common in their endemic region)
Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	Located on the proposed haul road section between Položac - Semizova Ponikva that passes north of the village of Položac for approximately 1.4 km. Habitat is listed in Annex I of the Habitats Directive and is therefore PBF.
The FBiH CR species marsh marigold.	This habitat also supports the FBiH CR species marsh marigold and further qualifies as PBF, although marsh marigold is common and widespread at a global scale.
Water courses from plateaus to the mountainous belt with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation	This habitat is included in Annex I of the Habitats Directive (PBF) and is found along the Zagarski Stream for about 1km. The lower section of the stream (0.7km in length) has been culverted and therefore does not meet the Annex 1 criteria. The Bukovica river is also likely to meet this criteria which will be confirmed by ongoing survey work.

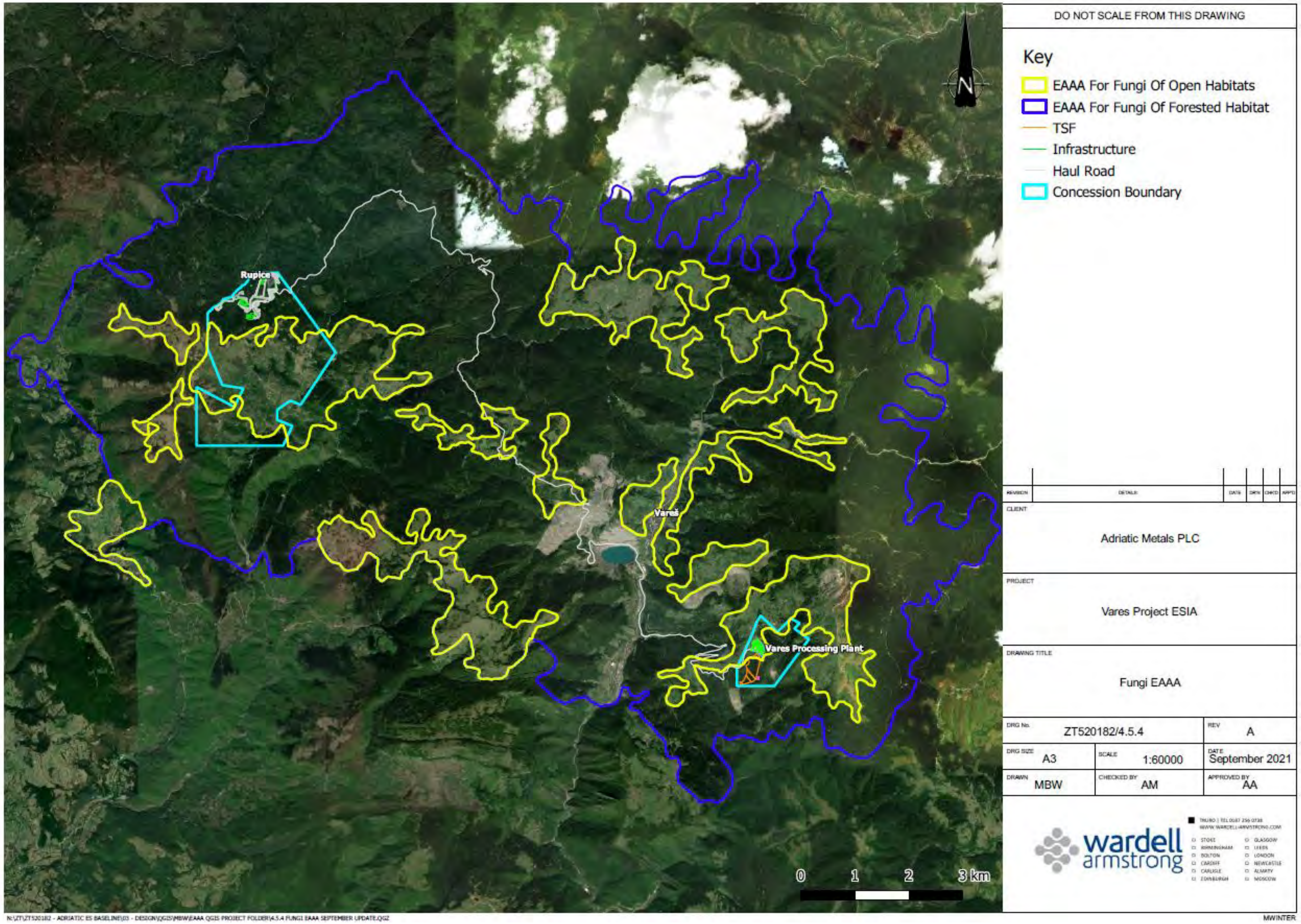
Table 4.5.8: PBF & ACH qualifying species & habitats identified in the vicinity of the Haul Road	
Habitat or Species	**Rationale for importance**
Clustered coral mushroom *Ramaria botrytis*	Classified as FBiH CR, but globally widespread (A widely distributed species, it is found in North America, North Africa, central and eastern Europe, Australia, and Asia) and therefore considered a PBF rather than ACH.
Haul road – spruce forest habitat Pančić blue sow thistle *Cicerbita pancicii* Heart-leaved ox-eye daisy *Telekia speciosa* Red helleborine *Cephalanthera rubra*	In a Europe-wide context these are widespread but their VU status within Bosnia and likely decreasing populations in the Balkans means they have been considered an important biodiversity feature within this BIA.
Haul road – Zagarski Stream Liverwort *Hepatica nobilis* Ox-eye daisy *Leucanthemum praecox* Forked spleenwort *Asplenium septentrionale*	
Haul road – mountain meadow Angelica *Angelica sylvestris* Stemless gentian *Gentiana acaulis*	
Agile frog *Rana dalmatina* Green toad *Bufo viridis* Yellow-bellied toad *Bombina variegata*	Although these IUCN LC species are widespread and relatively common in the region, they are listed under Annex IV of the Habitats Directive and are therefore qualifying species for ACH where they are present as a breeding species – along the Zagarski stream.
Brown bear *Ursus arctos* Bosnian grey wolf *Canis lupus kurjak* Eurasian lynx *Lynx lynx balkanicus* Wildcat *Felis sylvestris*	The main habitats for these species are in the wider landscape to the north and east of the Project areas associated with Konjuh and Zvijezda mountains. Although the project areas do not form regular foraging, denning or breeding habitat for grey wolf, Eurasian lynx, brown bear or wildcat and therefore can't be considered critical habitat for these species, these wide-ranging and often elusive mammals are considered PBF and addressed in the impact assessment with regards the haul road as a precautionary measure.
Eagle owl *Bubo bubo*.	Annex I Birds Directive species – this PBF species was recorded foraging near to the proposed haul road.



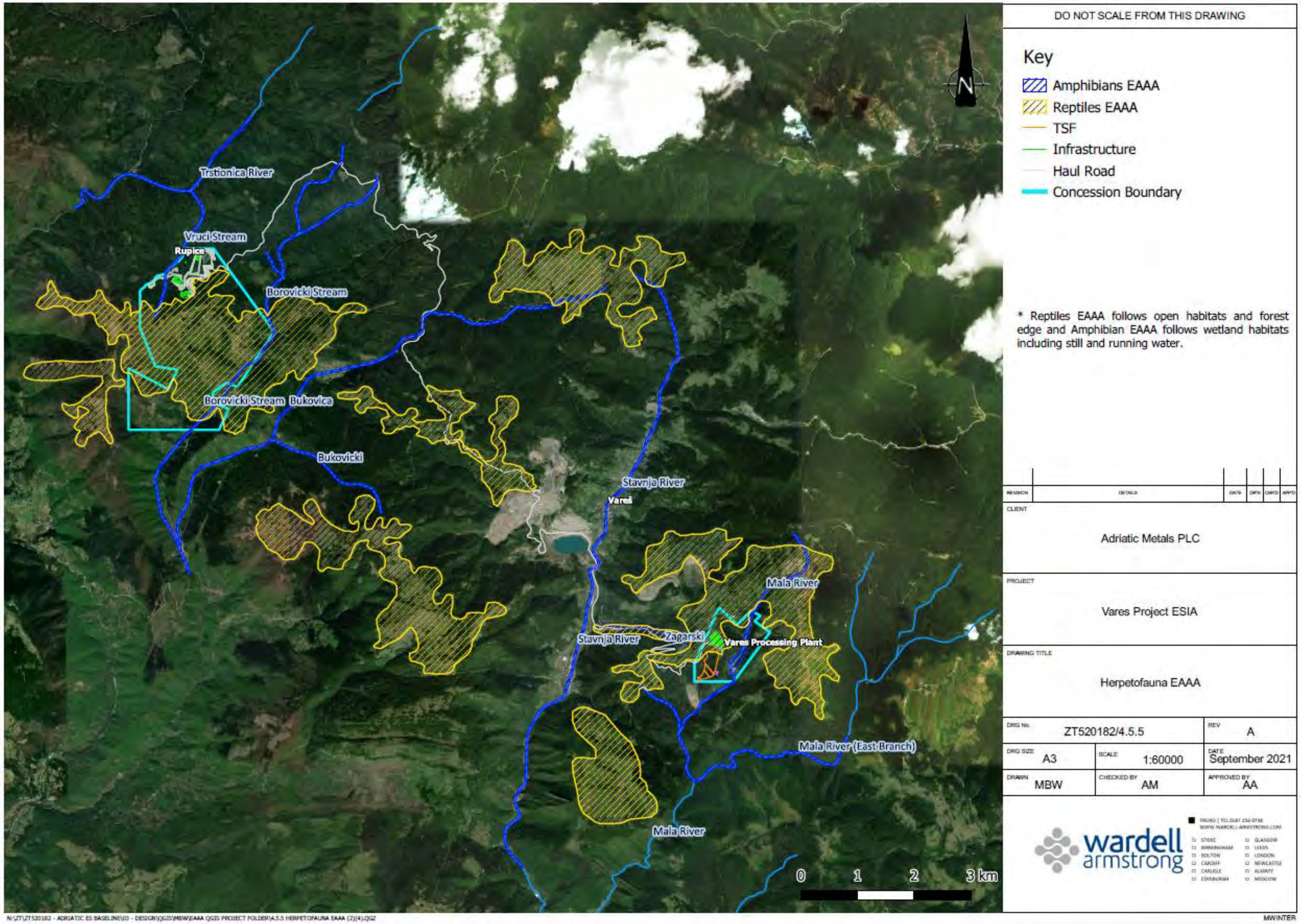
Drawing 4.5.2: Adriatic Habitats from Desk Based Study



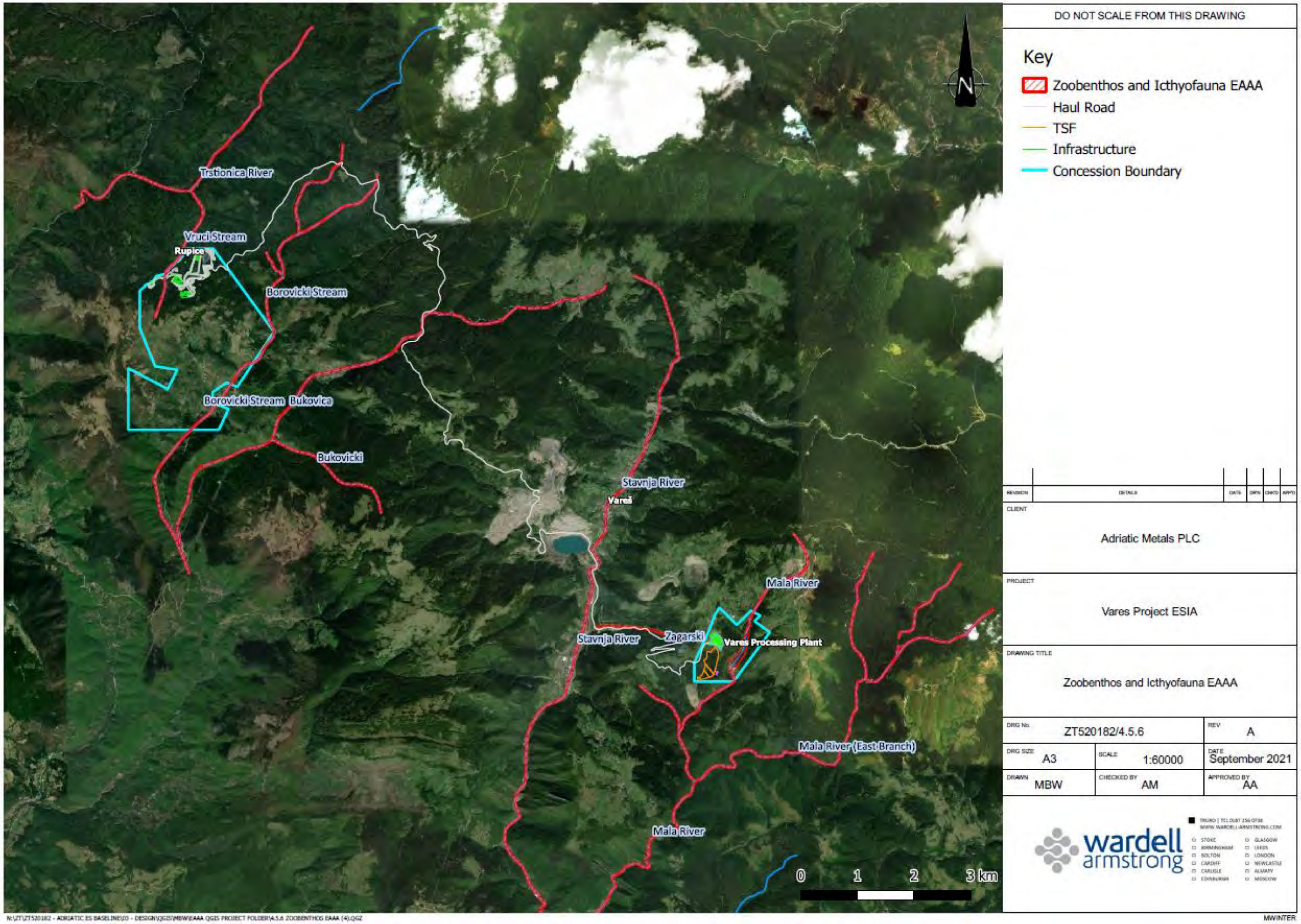
Drawing 4.5.3 : Flora EAAA



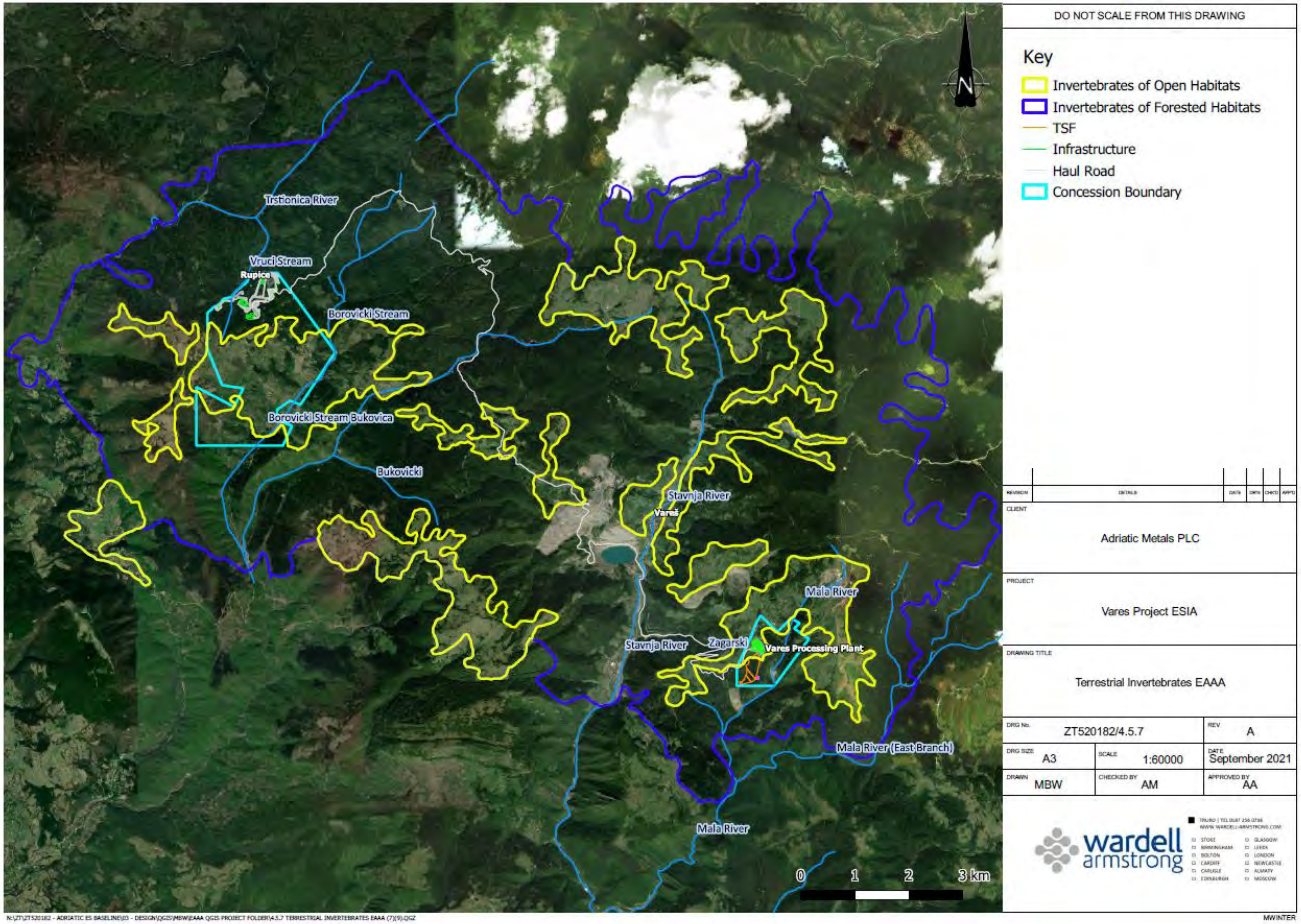
Drawing 4.5.4 : Fungi EAAA



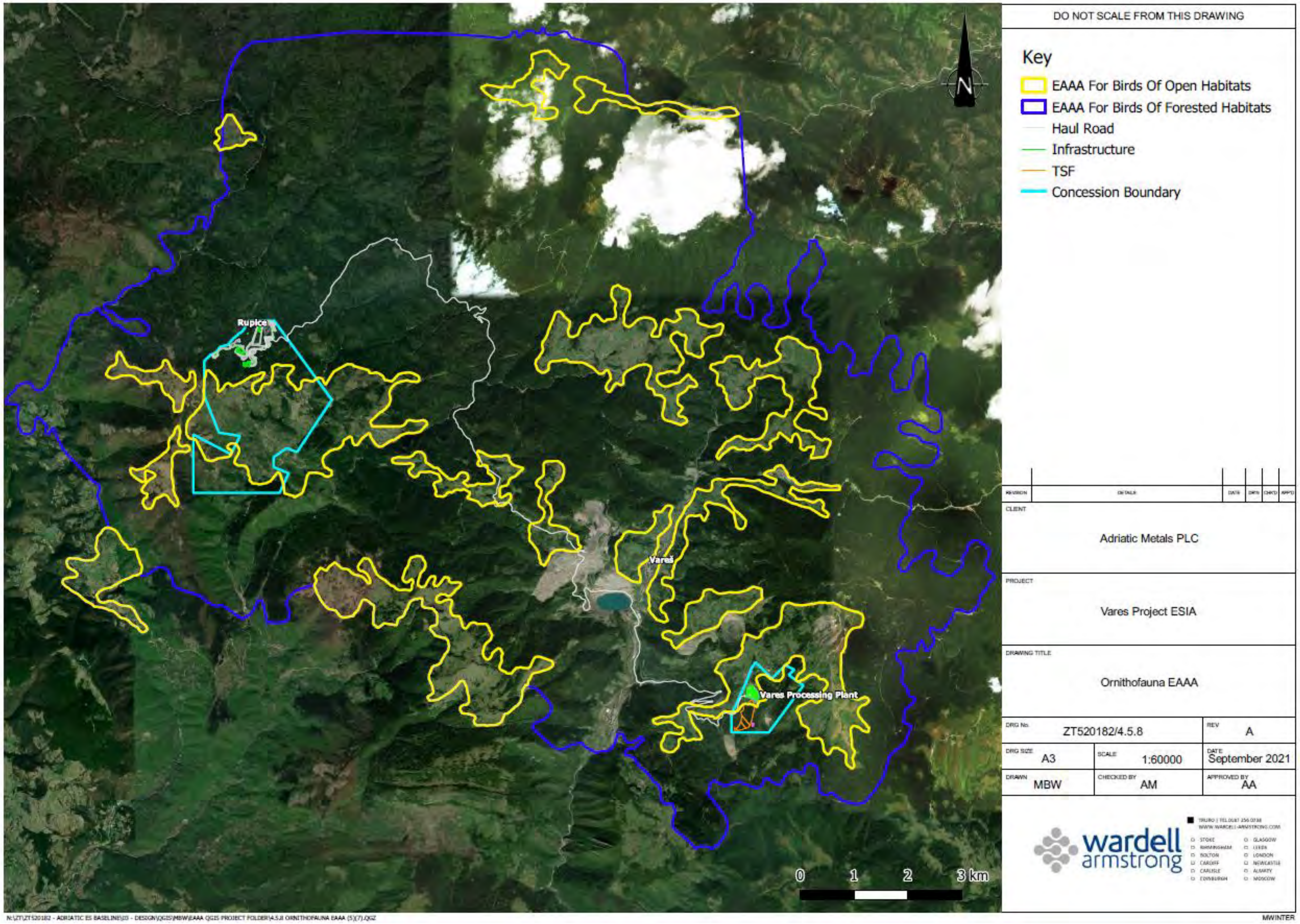
Drawing 4.5.5 : Herpetofauna EAAA



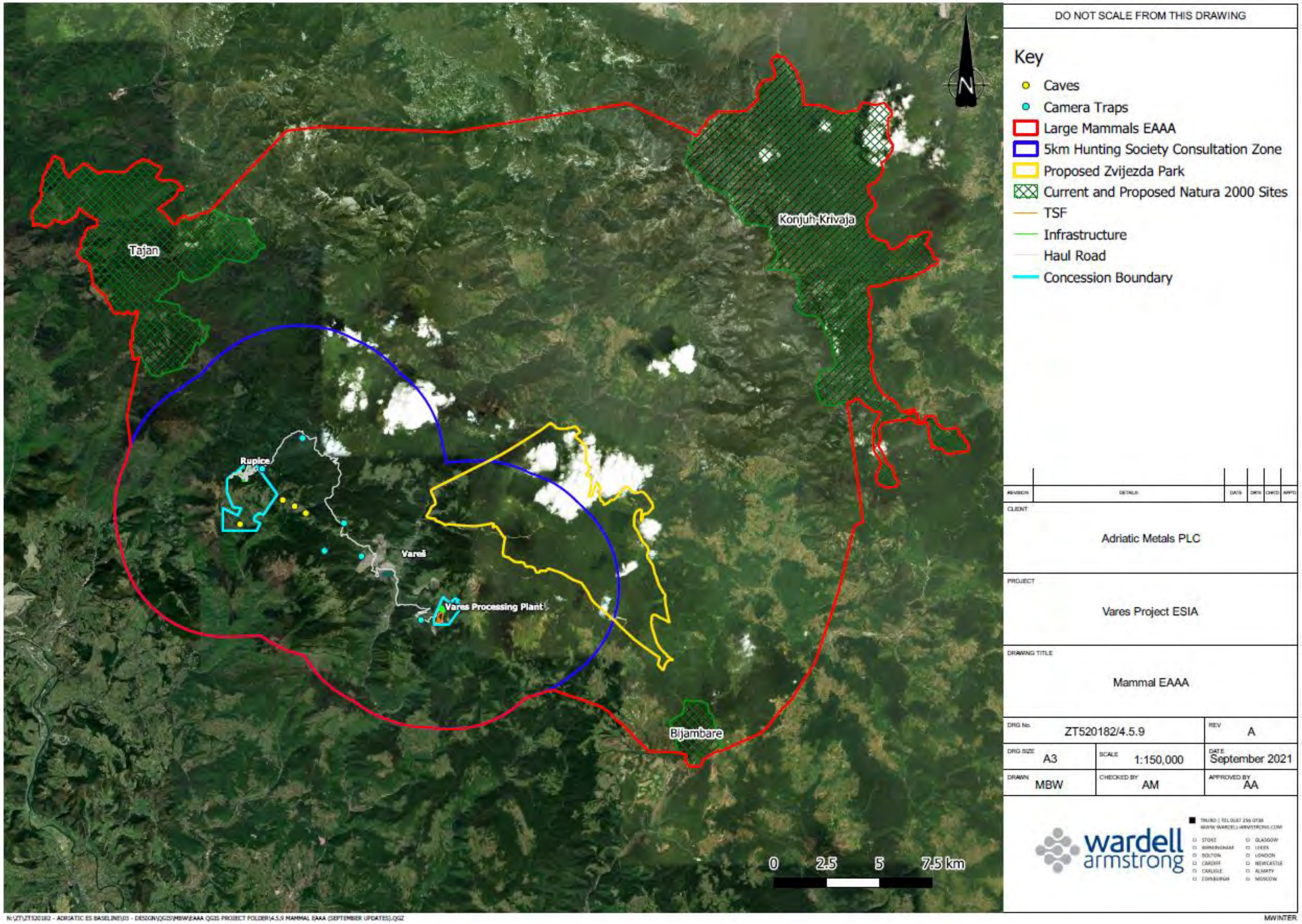
Drawing 4.5.6 : Zoobenthos and Icthyofauna EAAA



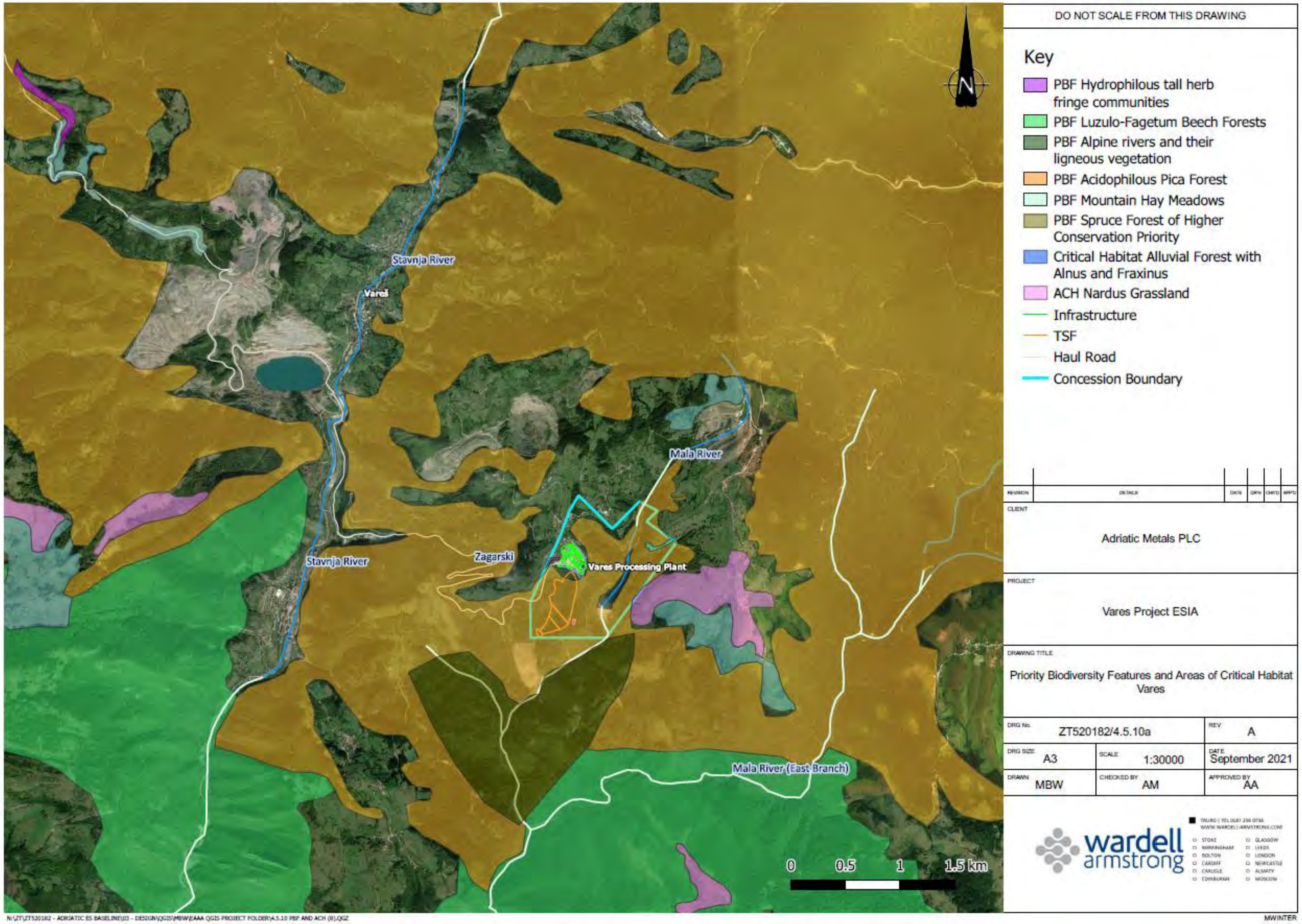
Drawing 4.5.7: Terrestrial Invertebrates EAAA



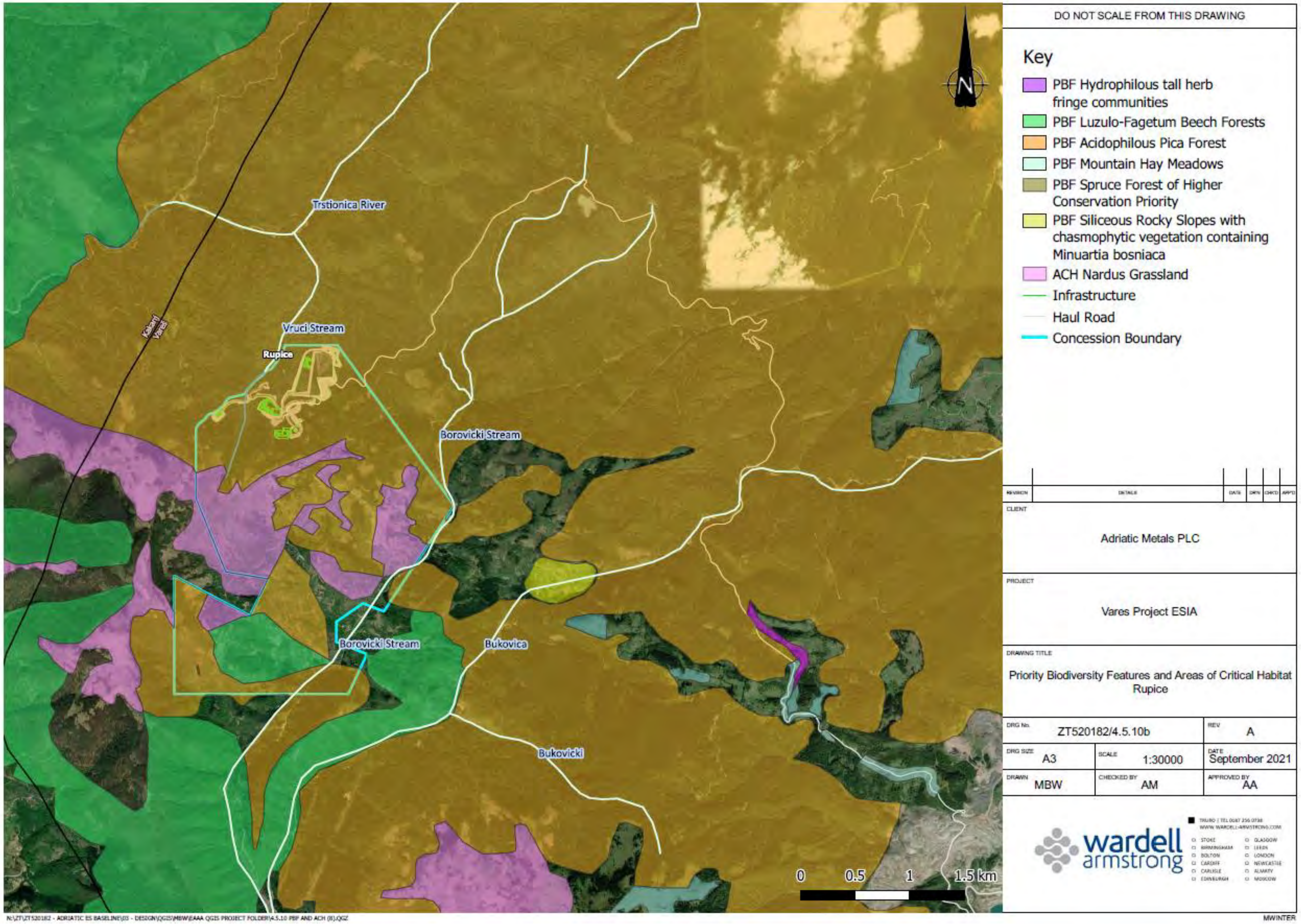
Drawing 4.5.8: Ornithofauna EAAA



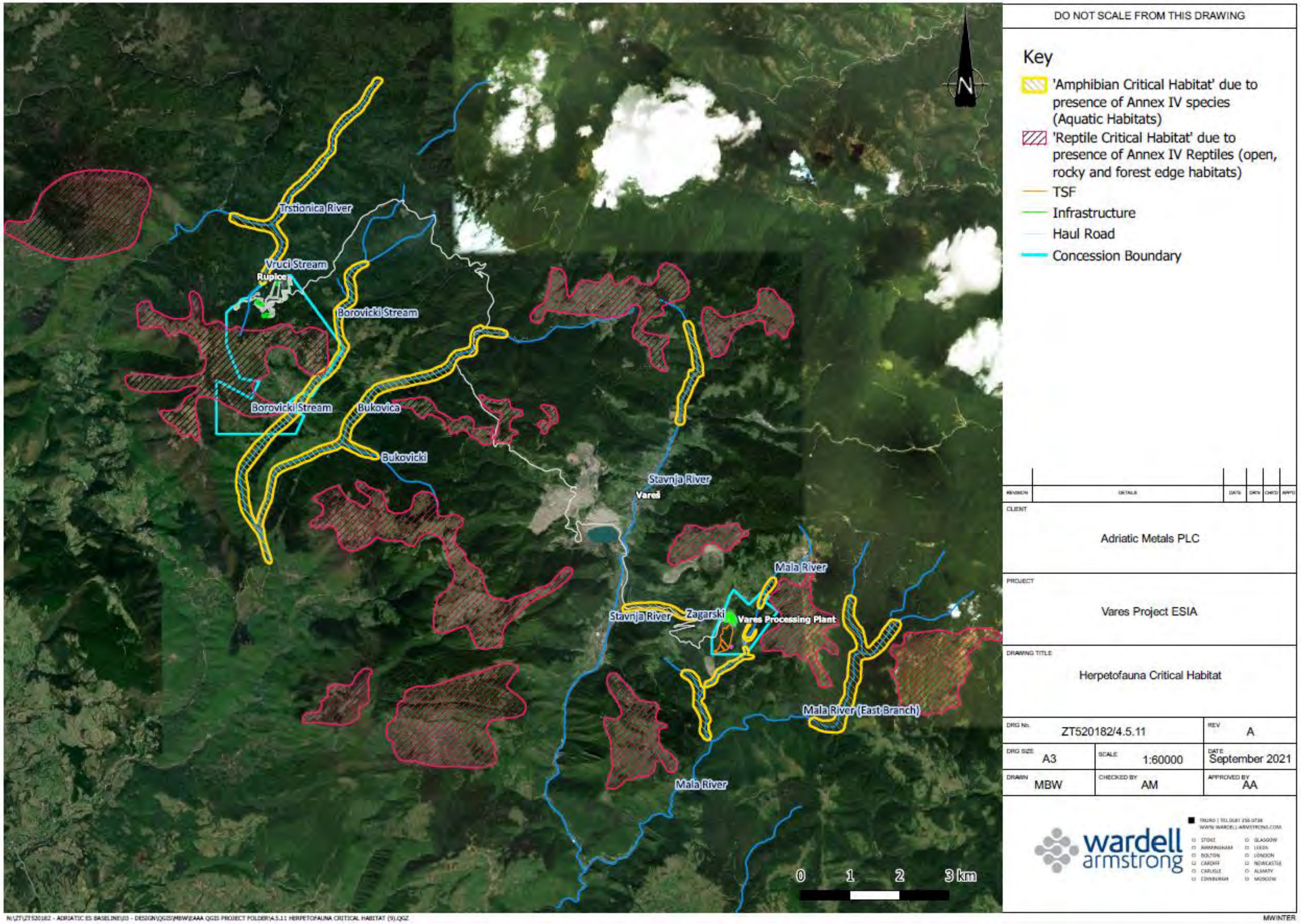
Drawing 4.5.9: Mammals EAAA



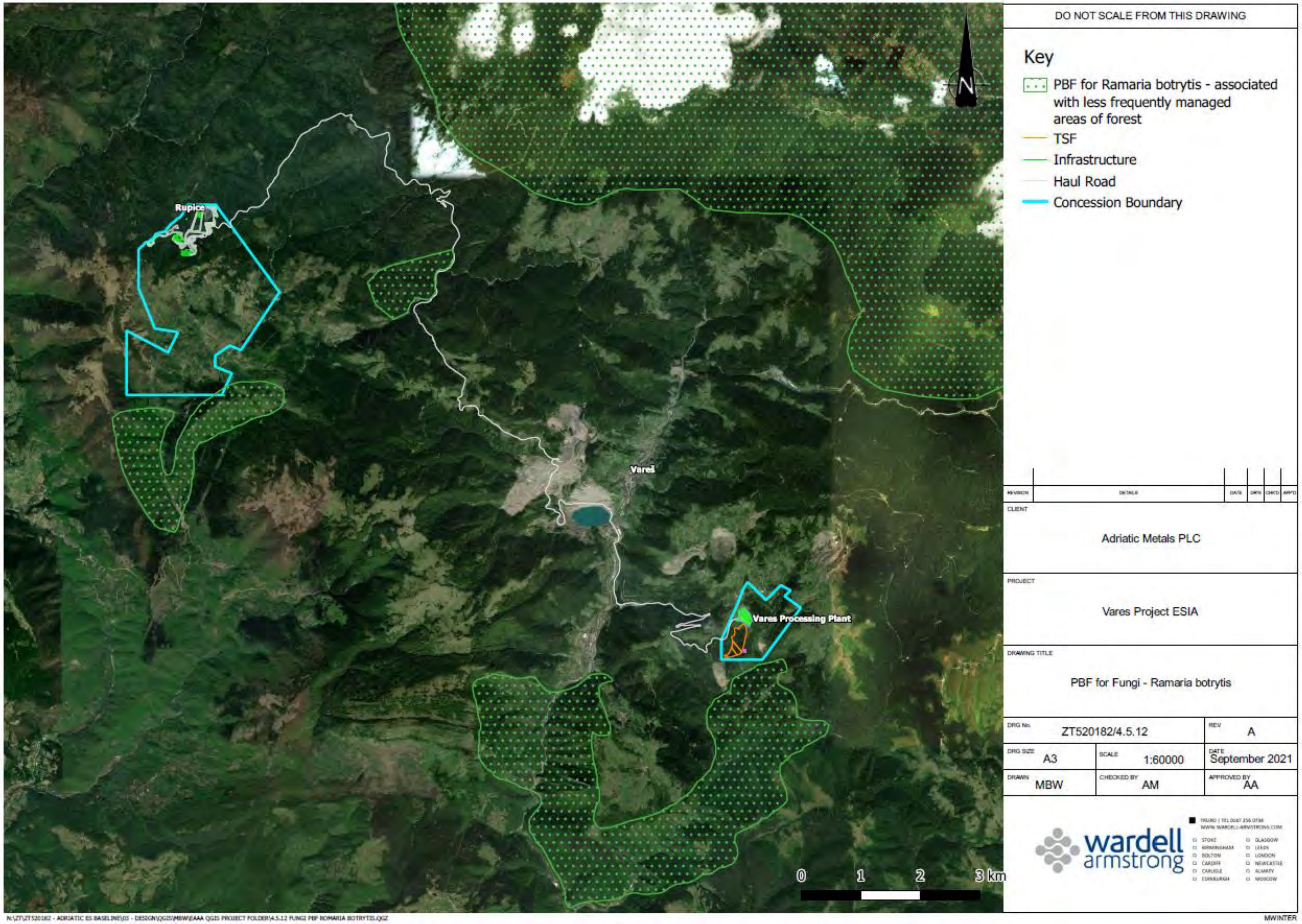
Drawing 4.5.10a: PBF and ACH Mapping Vares Processing Plant



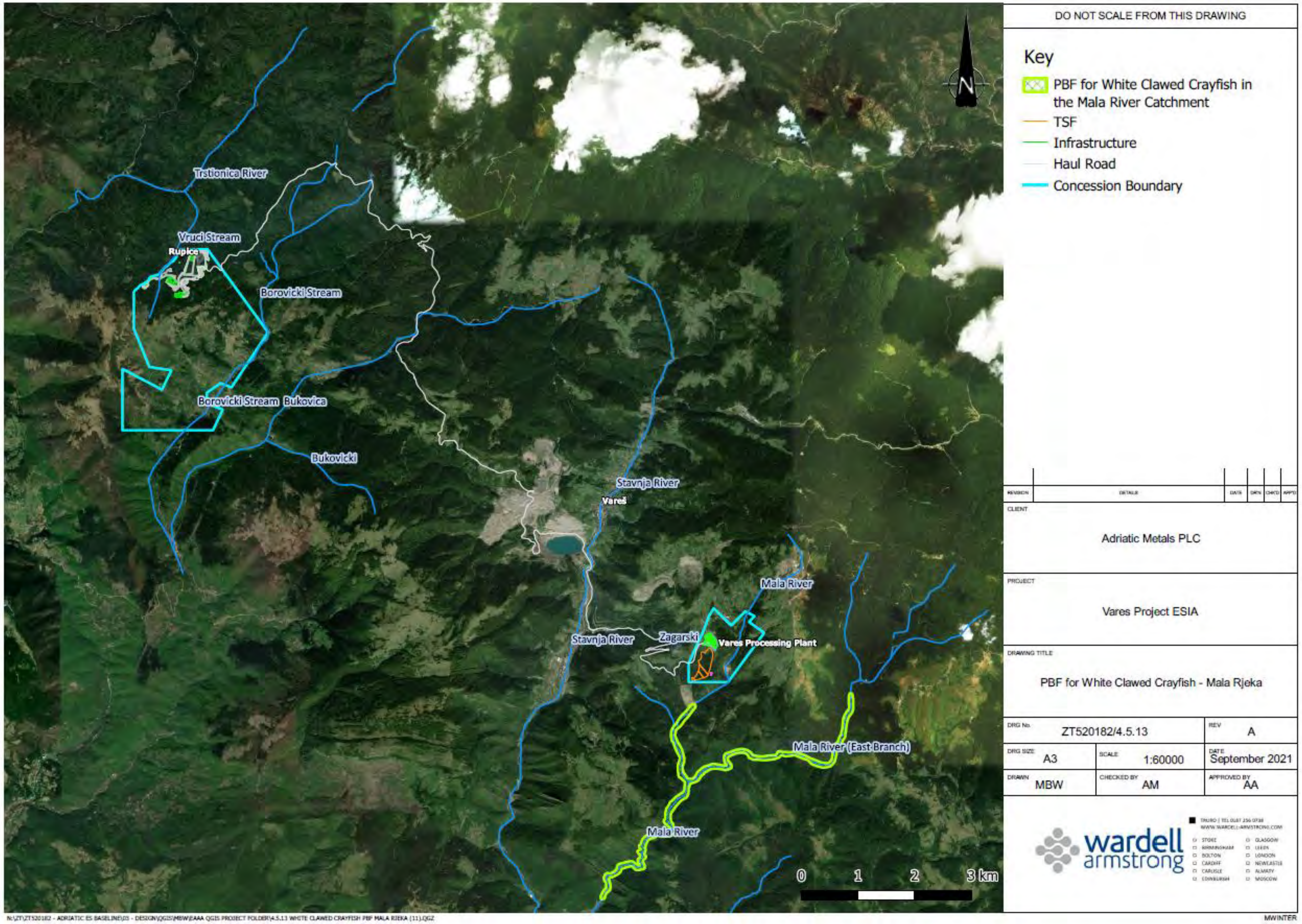
Drawing 4.5.10b: PBF and ACH Mapping Rupice and Haul Route



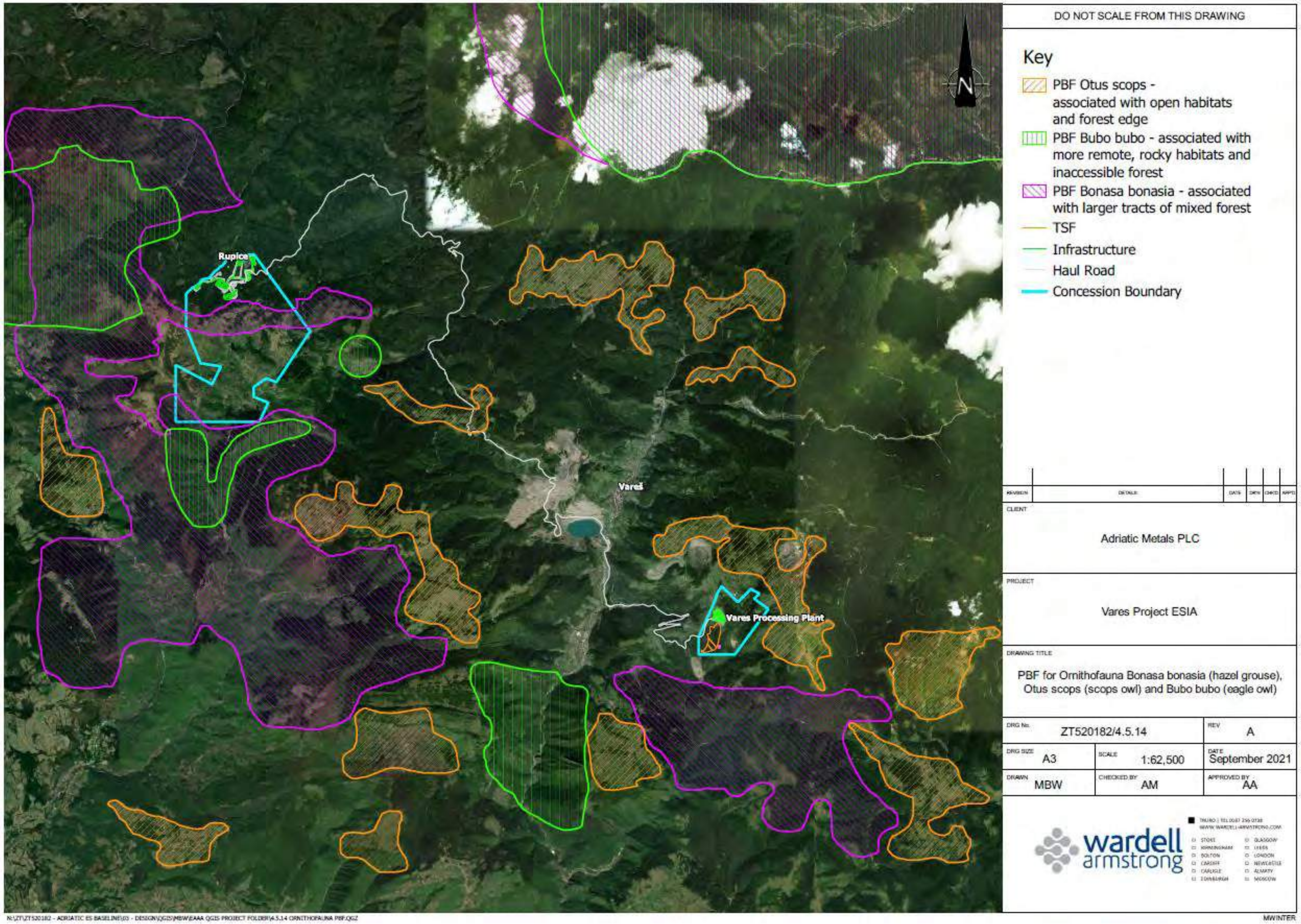
Drawing 4.5.11: Herpetofauna Critical Habitat



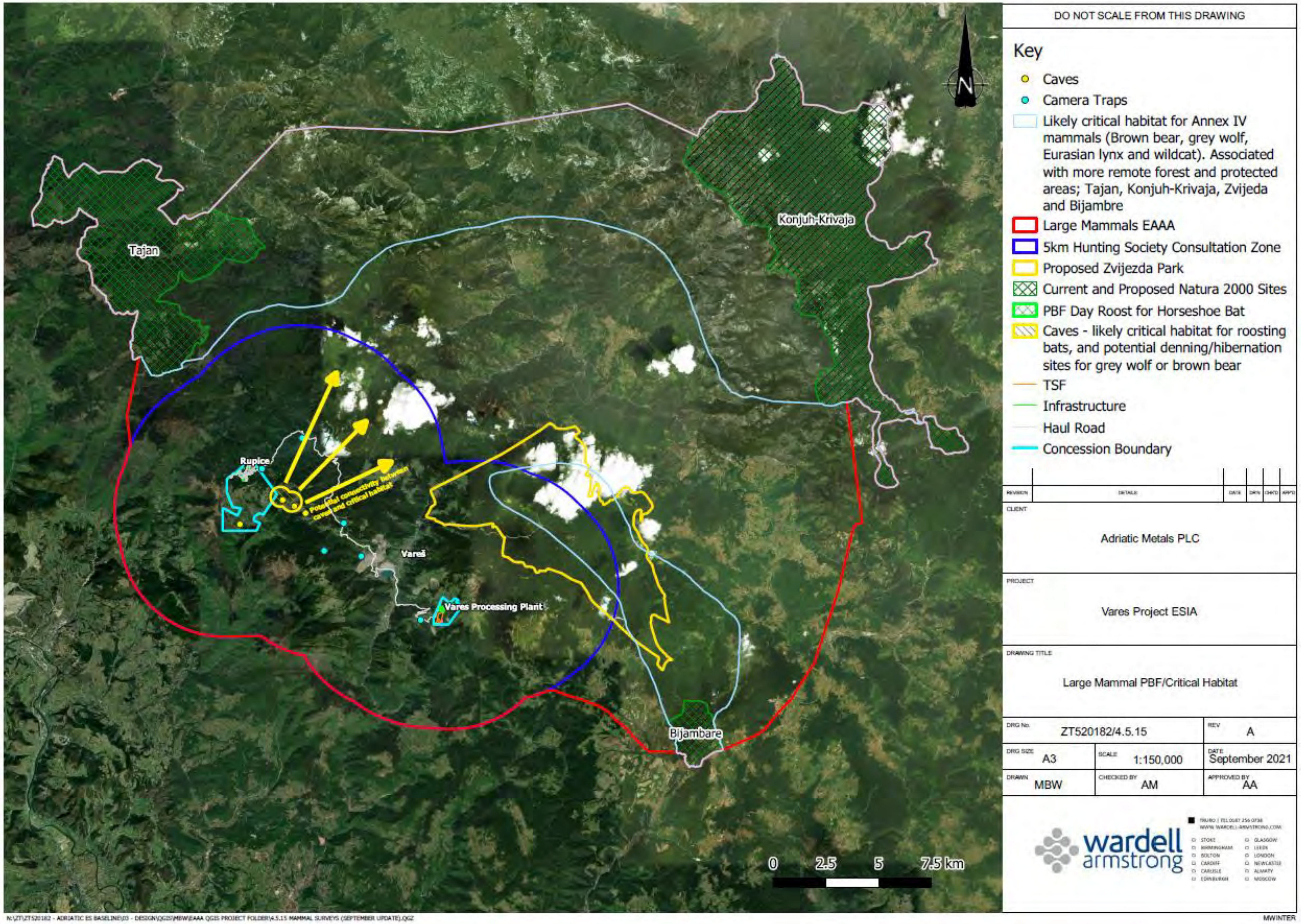
Drawing 4.5.12: PBF for Fungi



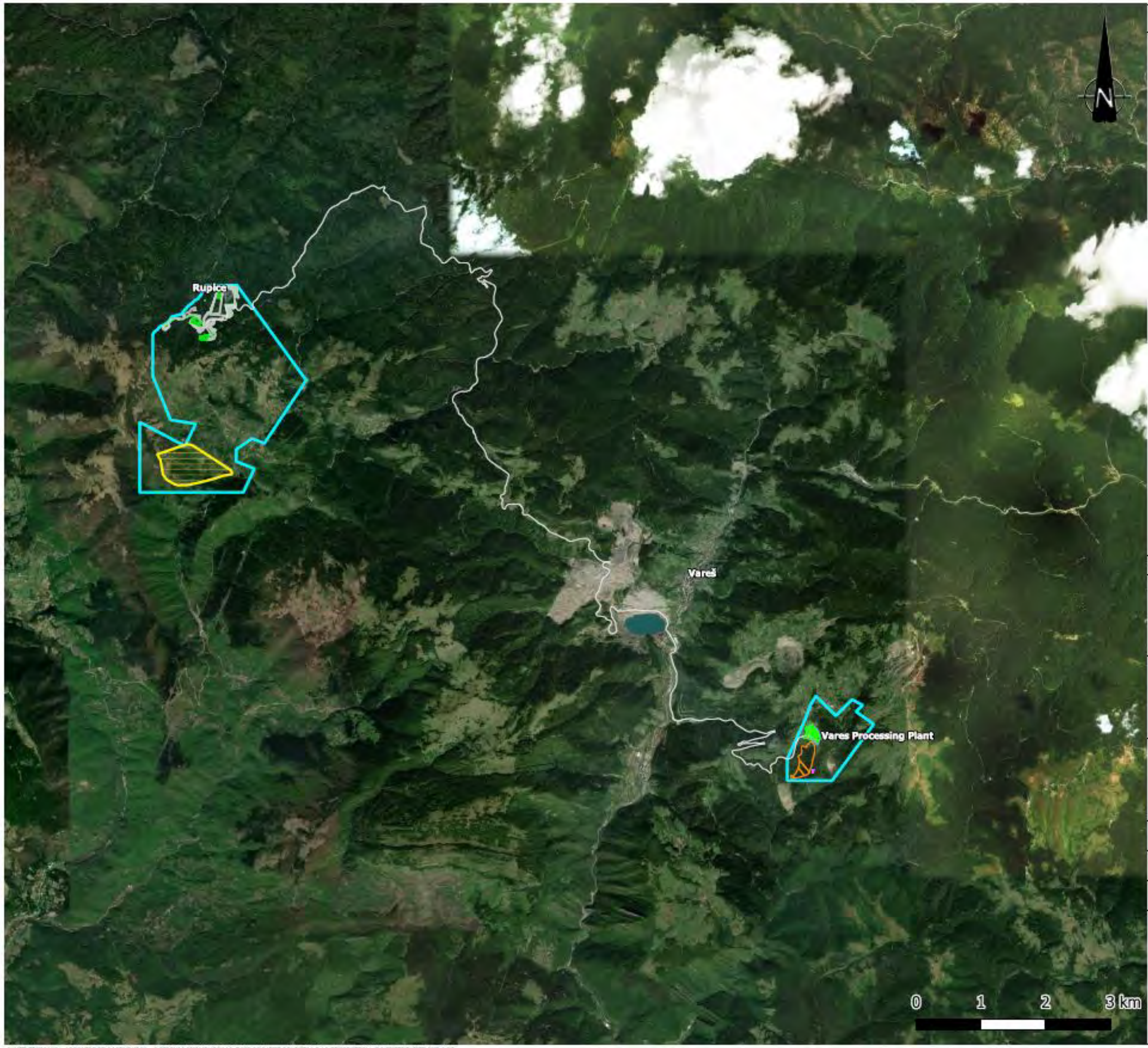
Drawing 4.5.13: PBF for Whiteclaw Crayfish



Drawing 4.5.14: PBF for Ornithofauna



Drawing 4.5.15: Mammal Surveys



DO NOT SCALE FROM THIS DRAWING

Key

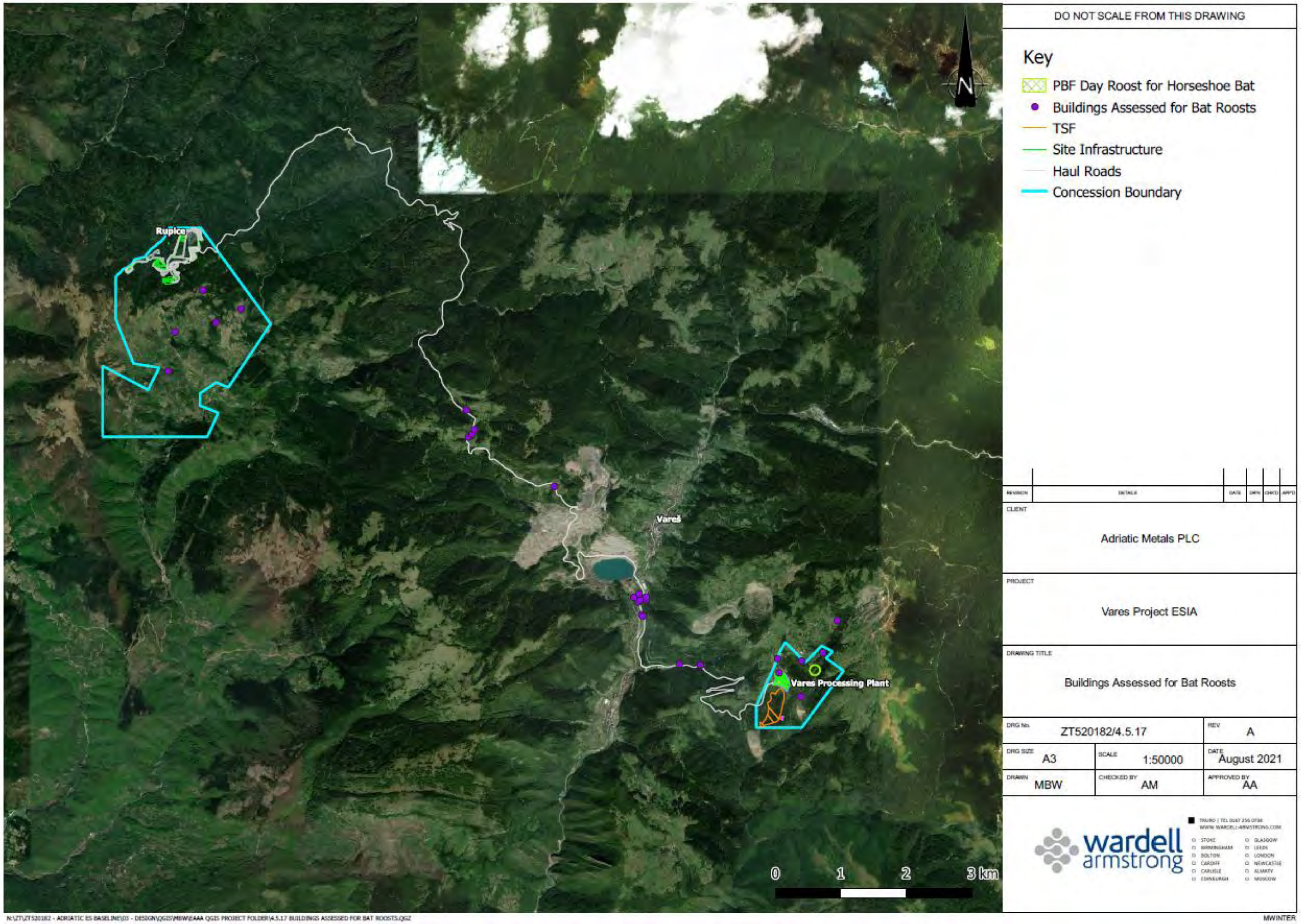
- Terrestrial invertebrates PBF (Morimus funereus). Beech longhorn beetle - associated with less disturbed beech forest
- TSF
- Infrastructure
- Haul Road
- Concession Boundary

CLIENT	Adriatic Metals PLC
PROJECT	Vares Project ESIA
DRAWING TITLE	PBF for Terrestrial Invertebrates Morimus funereus

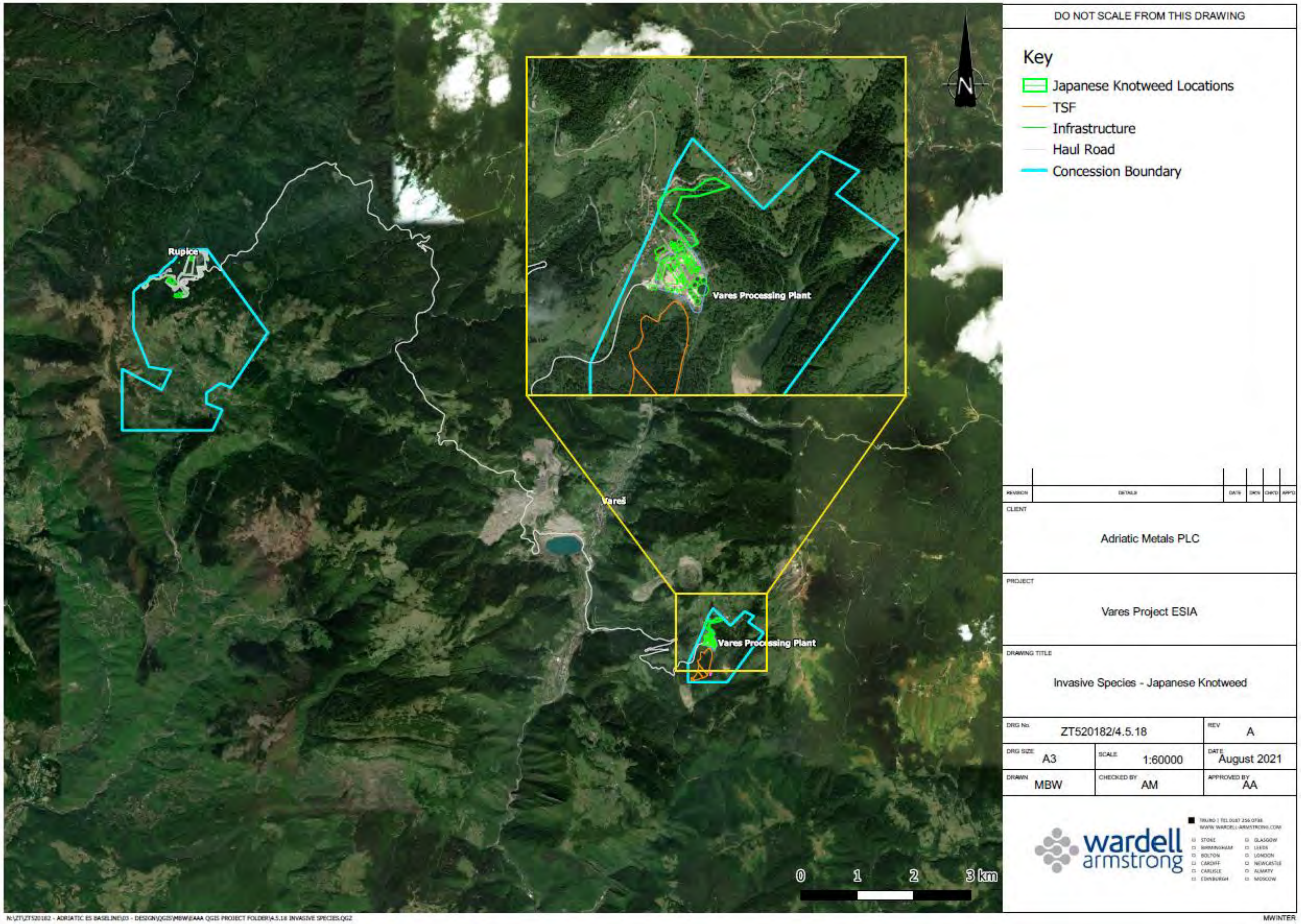
DRG No.	ZT520182/4.5.16			REV	A
DRG SIZE	A3	SCALE	1:60000	DATE	September 2021
DRAWN	MBW	CHECKED BY	AM	APPROVED BY	AA

MWINTER

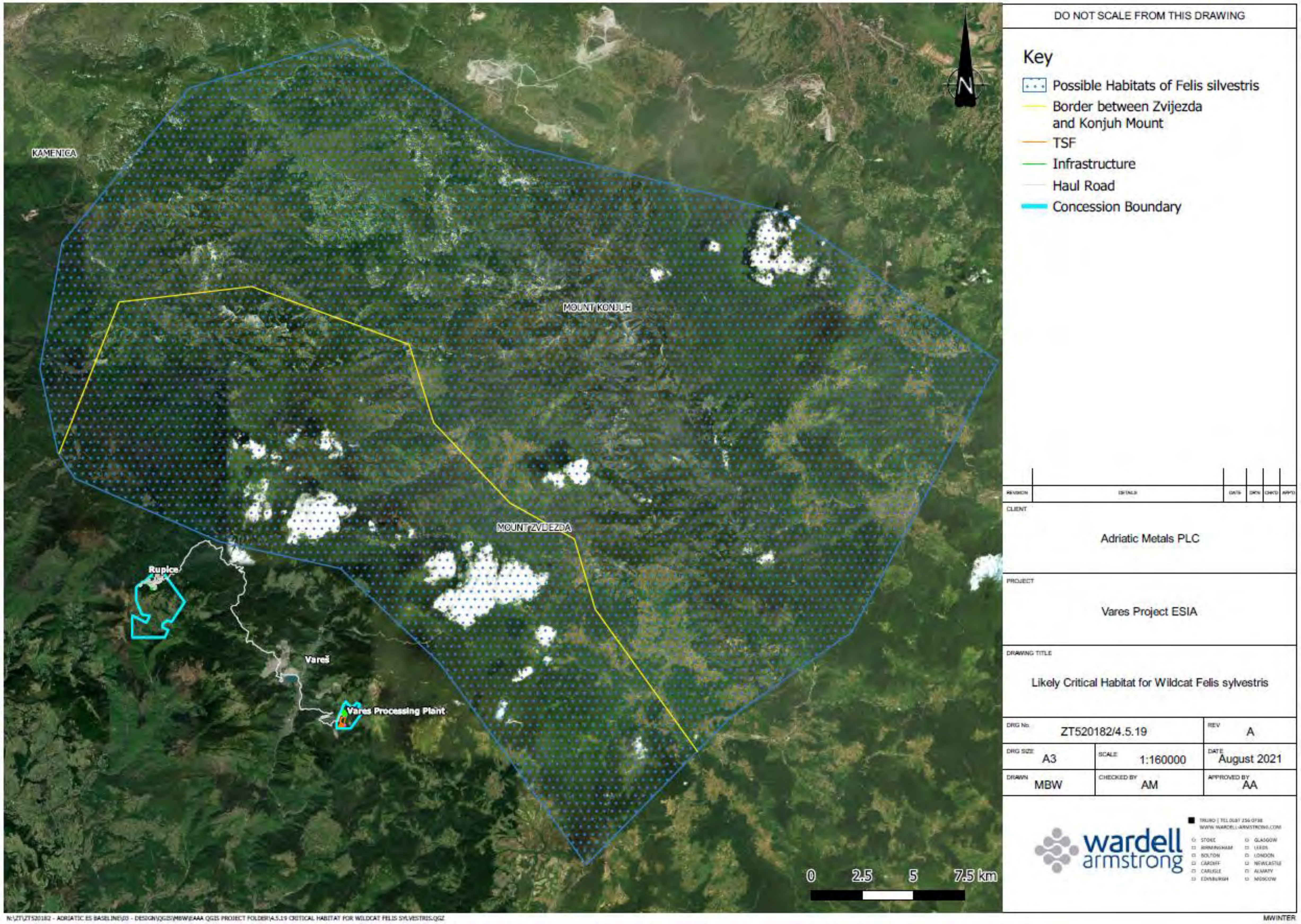
Drawing 4.5.16: PBF for Terrestrial Invertebrates



Drawing 4.5.17: Buildings Assessed for Bat Roosts



Drawing 4.5.18: Invasive Species Mapping



Drawing 4.5.19: Anticipated Critical Habitat for Wildcat

4.6 Land Use

4.6.1 National Context

Bosnia and Herzegovina (BIH) has an area of 5,121,000ha, and an estimated population of around four million people. BIH is primarily a mountainous country, covered in forest with an average altitude of 500m. The highest peak (Maglić Mountain) is recorded at 2,387m. Out of its total surface area, 42% consists of mountains, 24% of hills, 29% of karst areas and 5% of lowlands[1]. In BIH, 85% of the land use is forestry and agriculture (including pasture and intensive crops) as shown in Table 4.6.1 and Figure 4.6.1.

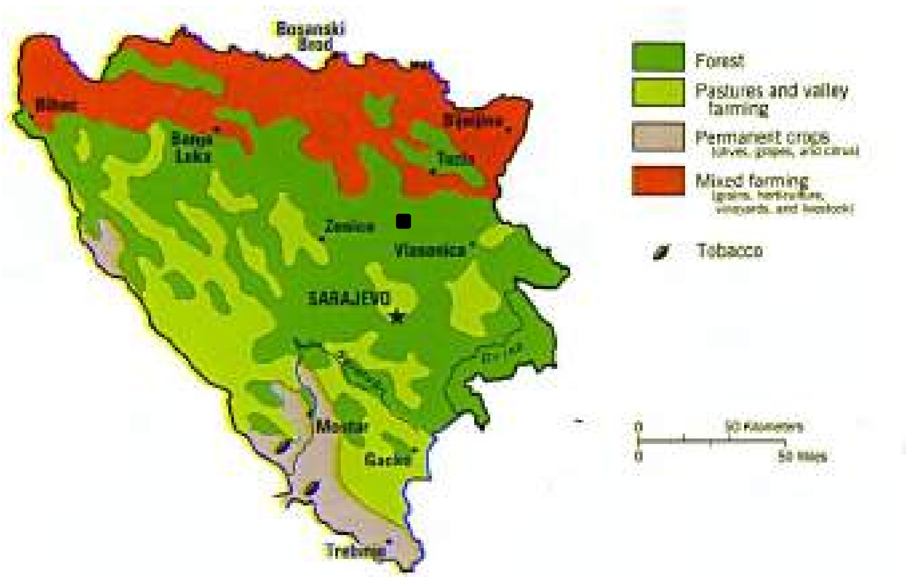


Figure 4.6.1: Land use of Bosnia and Herzegovina[2]. The location of the Project affected area is shown by the black square.

Table 4.6.1: Land Area and Land use of Bosnia and Herzegovina (BIH)[3]		
Land Use	**Area (ha)**	**Proportion (%)**
Inland water	1,000	0.02
Agricultural land	2,212,300	43.2
Forestry	2,187,900	42.7
Other Land (includes built-up and related land, barren land, other wooded land, etc)	721,000	14.08
Total	**5,121,000**	**100**

[1] Bosnia and Herzegovina Ministry of Foreign Trade and Economic Relations, 2012

[2] South-East Europe HNV farming network. Available at <http://see.efncp.org/countries/bosnia-and-herzegovina/general-info/> accessed 01/06/2021.

[3] Knoema world data atlas. Available at < https://knoema.com/atlas/Bosnia-and-Herzegovina/topics/Land-Use/Area/Land-area> accessed 24/05/2021.

Although land use in BIH is predominantly forestry, pasture and agriculture, land fragmentation has resulted in an estimated four million land parcels in the pre-war period[4]. In addition, post-war, the presence of land mines impact on land-use across the country. Although agricultural land accounts for nearly 50 % of the total territory, BIH is not rich in high quality agricultural land[5].

4.6.2 Land Use in Project Affected Area

4.6.2.1 Definitions

The Project footprint is defined as the land on which mining and processing, along with the associated infrastructure such as workshops, warehouses and roads is and will be located. The project affected area is defined as the project footprint plus the area likely to be affected by mining operations; this can include regions affected physically by construction works and through the impacts of ongoing works, such as noise, dust and subsequent impacts on ecology. These are outlined in more detail in Table 4.6.2.

Table 4.6.2: Project footprint and affected areas extended definitions.

Land take	Area (ha)	Description
Project footprint	56.5	The area of land that will be occupied by the mine and related infrastructure as described in Chapter 3 – Project Description.
Project affected area	3,096	The area of land that comprises the Project footprint plus a 1km buffer around mining locations and 0.5km along the haul route. This includes, with increasing affected area: • *Restricted areas* - adjacent to the limits of each of the project areas. • *Disturbed areas* - Land likely to be affected during both construction (disturbance of topsoil) and operations (as a consequence of dust deposition on vegetation, thereby potentially reducing the value of the land for agricultural use). • *Areas within the project fenceline* - land which will not be occupied by Project infrastructure but will be restricted due to perimeter fencing. • *Ecologically disturbed areas* - from pollution (particularly near roads where emissions such as NOx, SOx and particulates generated by mine vehicles, could potentially influence the ecology of the vegetation) and noise (which may affect behaviour of larger animals).

[4] Participatory Land Use Development in Bosnia and Herzegovina
[5] Agricultural Land Use and Land Losses in Bosnia and Herzegovina in the Period 1961-2018

4.6.2.2 Project specifics

Soil survey information (Chapter 4.5) indicates the soils within the Project affected area are generally described as Chromic Cambisols, which are typical of undulating and / or hilly terrain. These soils are known to support economic agricultural activity, where climate and topography allow. Numerous areas of disturbed land (resulting from former mineral extraction) and associated settlements are within the Project affected area, as shown by the aerial imagery in Drawing 4.6.1. The mining disturbed land includes old mine workings including the lead, zinc, and barite mine at the Vares Processing Plant. Desk based satellite imaging and research as well as site visits to the Project affected area have been undertaken and these have informed the baseline evidence.

The Rupice mine is located within an afforested environment on Zvijezda Mountain, at an altitude of approximately 900 – 1,280 m above sea level. Chapter 4.5 Biodiversity baseline identifies the Project affected area in this region to be prdominantly scattered spruce forest, as well as mixed grasslands / pasture and other agricultural uses and several watercourses.

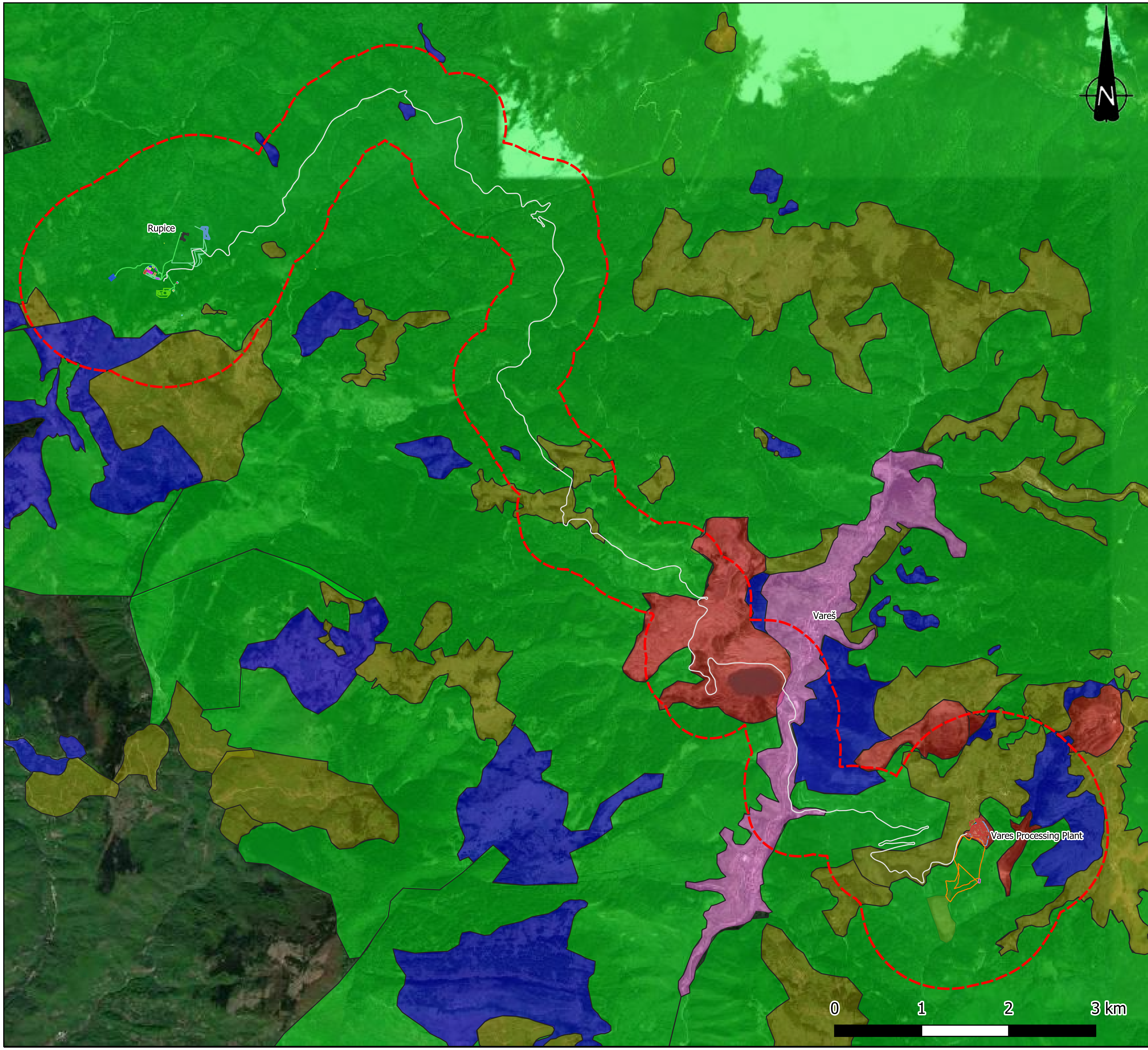
The Vares Processing Plant is located at an altitude of approximately 1,060m above sea level on the southern slopes of Zvijezda Mountain between the villages of Pržići and Daštansko. Chapter 4.5 Biodiversity Baseline identifies that the Project affected area in this region is dominated by coniferous forest habitat (spruce and fir) growing on siliceous soils and rocks. Some areas of rocky slopes and grassland are also present, with several watercourses. The area of the Processing Plant itself is a brownfield previous industrial site.

The Haul route is a 24km stretch that passes between Rupice and the Vares Processing Plant. Chapter 4.5 Biodiversity Baseline identifies that the Project affected area in this region is again dominated by montane-alpine forest, managed by the Vareš Forestry Commission, but will however pass through all land uses.

Table 4.6.3 informs the estimated area per land-use within the project affected area (including a 1km buffer around mining locations and 0.5km buffer along the haul route). This confirms the area comprises mainly forestry (70.41%), followed by residential, industrial and mixed land. Land use for the project affected area is shown visually in Drawing 4.7.1. The land ownership within the project footprint comprises mainly of state-owned forestry. For the early development of Rupice six private land parcels in total have been identified as requiring acquisition, this has occurred through 2021. Land Acquisition has been undertaken in accordance with local law and the requirements of EBRD Performance Requirement 5.

Table 4.6.3: Land use within the Project affected area*		
Land Use**	**Area (ha)**	**Area (%)**
Forestry	2179	70.41
Residential (urban and rural)	456	14.72
Industrial	244	7.87
Mixed land dominated by meadows	217	7.01
Total	**3,096**	**100**
* The area comprises the exact footprint of the Project infrastructure plus a 1km buffer at mining locations and 0.5km buffer along the haul route. **Land-use based on the Aerial view on Google Earth for the Project Affected Area.		

The way in which the population utilises the different land types discussed here is presented in Chapter 4.13 Ecosystem Services.



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Key
- Urban Residential Land
- Rural Residential Land
- Managed Forestry Land
- Existing Industrial Land
- Mixed land, dominated by Meadow
- Project Affected Area
- Site Infrastructure
- Haul Road

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT
Adriatic Metals PLC

PROJECT
Vares Project ESIA

DRAWING TITLE
Land Use Mapping

DRG No. ZT520182/4.6.1		REV A
DRG SIZE A3	SCALE 1:60,000	DATE July 2021
DRAWN MBW	CHECKED BY AM	APPROVED BY AA

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4.6.3 Summary

The Project affected area is located as shown in Figure 4.6.1 comprises two areas with works associated directly with mining activities (Rupice and Vares Processing Plant) and the haul route between the two, and is located within the central mountainous region of BIH. The primary land use is forest (including spruce and fir) interspersed with areas of meadow, extremely limited arable farming, human settlements, together with former mining land and associated infrastructure.

The baseline evidence on land use has been based on aerial imaging, photographs and knowledge from site visits that depict vegetation cover, forestry and agricultural uses. Although agricultural land accounts for nearly 50% of BiH, no agricultural census has been carried out, therefore there is no official data to inform the study. The ariel imagery in the region near the project area shows no large areas in agricultural use, and any crops grown will likely be within the vicinity of settlements.

The total area of land affected by the project has been calculated based on the aerial imagery and the Project layout. The project footprint comprises of 56.5ha and the total project affected area (with generous buffer region for all possible impacts) of 3,096ha.

4.7 Air Quality

4.7.1 Introduction

This chapter details of the baseline study carried out to define the existing air quality in the study area. The baseline data collection has focussed on the air quality parameters which are likely to be generated from project related activities and have the potential to affect human health or the environment. The pollutants of interest for the baseline study include suspended particulate matter (PM_{10} and $PM_{2.5}$ and larger particle size nuisance dust), nitrogen oxides (NO_x) and sulphur dioxide (SO_2).

4.7.2 Pollutants of Interest

4.7.2.1 Particulate Matter (PM_{10} and $PM_{2.5}$) and Dust

Airborne particulate matter varies widely in its physical and chemical composition, source and particle size. Particles up to 10µm that are inhalable into the upper respiratory tract are known as PM_{10} and particles up to 2.5µm, which are respirable deep into the lungs, are known as $PM_{2.5}$. These particles are of concern as they are small enough to enter the respiratory system and at certain elevated concentrations can affect human health. PM_{10} and $PM_{2.5}$ can travel in excess of 1km from the point of release. The principal sources of $PM_{10/2.5}$ are combustion activities, such as vehicle exhausts, woodstoves, power plants, etc. Because particles originate from a variety of mobile and stationary sources their chemical and physical compositions vary widely. $PM_{10/2.5}$ can be directly emitted or can be formed in the atmosphere when gaseous pollutants such as SO_2 and NO_x react to form fine particles.

Larger mineral dust particles, between 10 and 75µm in size, do not pose the same health effects as smaller $PM_{10/2.5}$ particles and are generally referred to as nuisance dust, as human concerns generally relate to the soiling of surfaces. Mineral particles between 30 and 75µm have a relatively high mass and settling velocity and tend to deposit naturally within 100m of the point of release, however 30µm particles can travel up to 300m from the point of release. Particles in the size range of 10-30µm tend to fall out of the atmosphere between 100m and 250m from the point of release under normal meteorological conditions. Modelling studies have also shown that deposition rates decrease significantly (in an almost logarithmic manner) with increasing distance from the source. Deposition of these larger dusts may have detrimental effects on plant growth due to the obscuring of leaf surfaces leading to reduced photosynthesis and growth rates.

4.7.2.2 Nitrogen Oxides and Sulphur Oxides

Nitrogen oxides (NO_x) is a term used to describe a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2). These are inorganic gases formed when oxygen and nitrogen (both readily available in the atmosphere) combine and are also a by-product of combustion of fossil fuel by vehicles, industrial processes and power generation. There is some evidence that long-term exposure to NO_2 at concentrations above 40–100µg/m^3 may decrease lung function and increase the risk of respiratory symptoms. Oxides of nitrogen are also a precursor for ozone formation, which at ground level can have potential effects on human health and damage to vegetation.

The largest anthropogenic source of SO_2 is the combustion of sulphur containing fossil fuels (particularly coal and oil); however, SO_2 is also produced during metal smelting and other industrial processes. Sulphur dioxide also occurs naturally through volcanoes, forest fires, the oceans and decaying plant matter. The oceans, wetlands and lakes act as natural sinks for SO_2.

Both chronic and acute exposure to SO_2 can cause damage to the respiratory system; there is also a link between chronic high-level SO_2 exposure and heart disease. SO_2 can dissolve in moisture in the atmosphere forming sulphur acids (commonly known as "acid rain"). These attack the outer protective waxy coatings of leaves, affecting plant growth. Sulphur acids may also acidify soils and waterways, causing wider environmental effects.

4.7.3 Existing Emission Sources

With minimal industry and associated traffic, particularly since the closure of the iron foundry, it is perceived that Vareš has low industrial emissions and good air quality in comparison to cities such as Sarajevo. The two primary sources of pollution currently are from the burning of wood for domestic heating and the emissions from vehicles. Additional sources of dust come from operational sawmills in the area, namely that in Daštansko, northeast of the Vares Processing Plant. Wood dust can have negative impacts on human health and requires a separate set of standards, the Occupational Safety and Health Administration (UE-OSHA) sets an exposure limit. The impact of wood dust from sawmills is however most relevant for occupational health impacts and can result in a variety of adverse health effects such as dermatitis, allergic respiratory effects, mucosal and nonallergic respiratory effects, and cancer.

4.7.4 Air Quality Standards and Limits

As per IFC and EBRD guidance, when selecting impact assessment thresholds and criteria, consideration must be given to both international standards and local standards, with preference given to the most stringent criteria.

4.7.4.1 National Standards

BiH has an extensive legal and policy framework for air quality and management. The principal legislation is the Law on Air Protection of the BiH, which was adopted in 2003 and amended in 2010. This legislation provides the backbone of the legal framework for environmental protection and gives the Ministry of Environment and Tourism the responsibility for developing an Air Quality protection strategy for 10 years, which must be enacted through regulations. Currently, the Government of the BiH is implementing the Strategy for Environmental Protection 2008–2018, which includes the Strategy for Air Protection (FBiH 2010). The legislation also includes detailed provisions to control emissions from stationary sources.

The 'Regulation on the method of air quality monitoring and defining the type of awareness materials, cross-border values and other air quality standards (O.G. FBiH No. 1/12)' sets air quality limit values and air quality standards. The air quality standards reflect the transposition of EU Directive 2008/50/EC. The 'Regulation on air quality monitoring (O.G. FBiH No. 12/05)' sets air quality limit values and targets for planning and defines information and alarm thresholds for timely action in case of short-term occurrences of high pollution concentrations.

The 'Regulation on monitoring the emission of pollutants into the air (O.G. FBiH No. 9/14)' establishes the obligations of operators to carry out the verification or monitoring of pollutant emissions from stationary sources of pollution and defines the sources that are subject to these requirements, as well as the methodologies that must be used.

4.7.4.2 International Standards

Air quality guidelines with regards to mining activities are provided in the IFC General EHS Guidelines. These are adopted from the World Health Organisation's (WHO) Air Quality Guidelines (AQGs) and interim targets for ambient air quality. The EBRD's E&S Policy refers to the standards set up under relevant European Union Directives (Directive 2008/50/EC).

WHO/EU standards are focussed on PM_{10} and $PM_{2.5}$ as, according to the scientific studies their guideline references, these size particles present the most serious risk to human health. Total suspended particulates (TSP) are generally associated with nuisance effects such as soiling of property, visual impacts, and deposition in the eyes and nose. They are not considered to present the same health risks, and no WHO/EU guideline values have been published specifically for TSP.

Table 4.7.1 lists the ambient air quality guidelines that were considered, and highlights those that will apply to the Project.

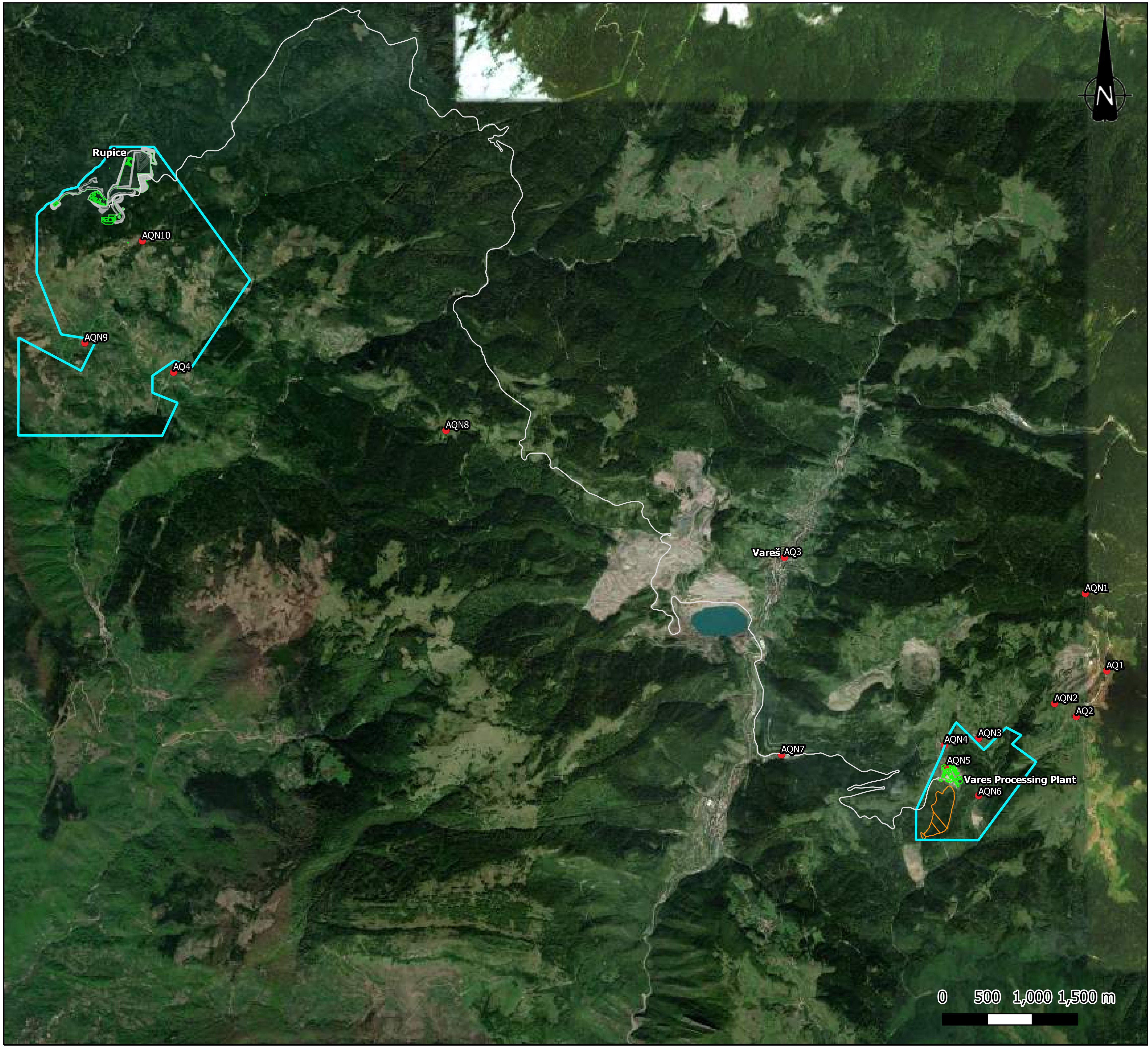
Table 4.7.1: Ambient Air Quality Guidelines Applicable to the Project			
Pollutant	**National Standards**	**EU Air Quality Standards[1]**	**WHO/IFC Guideline[2]**
Dust Deposition Rates	***200 mg/m^2/day 350 mg/m^2 measured over a 4-week period***		
Total Suspended particles (TSP)		-	-
PM_{10}	40µg/m^3 annual mean 50µg/m^3 24 hour mean	40µg/m^3 annual mean 50µg/m^3 24 hour mean	***20µg/m^3 annual mean 50µg/m^3 24 hour mean***
$PM_{2.5}$	20µg/m^3 Annual mean	25µg/m^3 24 hour mean	***10µg/m^3 annual mean 25µg/m^3 24 hour mean***
SO_2	***50µg/m^3 annual mean*** 125µg/m^3 24hour mean 350µg/m^3 1-hour mean	125µg/m^3 24hour mean 350µg/m^3 1-hour mean	***20µg/m^3 24-hour mean 350µg/m^3 1-hour mean***
NO_2	40µg/m^3 annual mean 85µg/m^3 24hour mean 200µg/m^3 1-hour mean	40µg/m^3 annual mean 200µg/m^3 1-hour mean	***40µg/m^3 annual mean 200µg/m^3 1-hour mean***
Carbon Monoxide (CO)	3 mg/m^3 annual mean 5 mg/m^3 24hourmean 10 mg/m^3 8-hourly mean	10 mg/m^3 8-hourly mean	**30 mg/m^3 1hour mean 10 mg/m^3 8-hourly mean**
Lead (Pb) in total dust	***0.1*** µg/m^3 ***(4-week period)***	-	-
Cadmium (Cd) in total dust	***0.002*** µg/m^3 ***(4-week period)***	-	-
Zinc (Zn) in total dust	***0.4*** µg/m^3 ***(4-week period)***	-	-
Titanium (Ti) in total dust	***0.02*** µg/m^3 ***(4-week period)***	-	-
Arsenic (As) in total dust	***0.004*** µg/m^3 ***(4-week period)***	-	-
Nickel (Ni) in total dust	***0.015*** µg/m^3 ***(4-week period)***	-	-
Mercury (Hg) in total dust	***0.001*** µg/m^3 ***(4-week period)***	-	-
Wood Dust	-	***3 mg/m^3 8-hourly mean***	-

Within the Project area, the majority of sensitive receptors are identified as inhabitants or users of residential properties and religious monuments / buildings. An air quality monitoring programme has been developed to establish the baseline air quality for the project. The air quality has been monitored at 10 locations near to the Vares Processing Plant and Rupice areas as well as along the planned haul route. The details of the locations are provided in Table 4.7.2 and Drawing 4.7.1.

[1] European Union, Air Quality Standards under Directive 2008/50/EU

[2] World Health Organization (WHO). Air Quality Guidelines Global Update, 2005

Table 4.7.2: Air Quality Monitoring Locations			
Name	**Longitude**	**Latitude**	**Description**
AQ1	18.371	44.151	Daštansko – close to open pit, NW of Open pit
AQ2	18.367	44.146	Daštansko – located at Mosque
AQ3	18.327	44.162	In Vares – Church yard
AQ4	18.242	44.180	Borovica Donja
AQN1	18.368	44.158	North of open pit
AQN2	18.364	44.147	Residential property - South of open pit
AQN3	18.354	44.144	Pržići
AQN4	18.349	44.143	Closest residential property, above crusher, Tisovci
AQN5	18.349	44.141	Offices at process plant
AQN6	18.354	44.138	Down valley of crusher, up valley of TSF
AQN7	18.326	44.142	Mlakve, along haul route
AQN8	18.280	44.175	Semizovna Ponikva – on haul route
AQN9	18.229	44.183	Borovica Gornja
AQN10	18.237	44.193	Proposed location of Rupice surface infrastructure



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Key

- Air Quality Monitoring Locations
- Site Infrastructure
- TSF
- Haul Road
- Concession Boundary

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT
Adriatic Metals PLC

PROJECT
Vares Project ESIA

DRAWING TITLE
Air Quality Monitoring Locations

DRG No. ZT520182/4.7.1		REV A
DRG SIZE A3	SCALE 1:60000	DATE September 2021
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The details of the parameters and frequency of monitoring is provided in Table 4.7.3.

Table 4.7.3: Monitoring Parameters, Frequency and Methods

Parameter	Monitoring locations	Frequency	Monitoring method
Dust deposition	All locations	Continuous (monthly data recovery) for 12 months.	Using Frisbee dust deposit gauge and sticky pads. Frisbee gauge consists of an upturned Frisbee with a loose-weave foam insert, mounted on a tube which feeds a 5 – 10 litre collection pot. The dust gets caught in the foam and washed through into the pot by precipitation. The contents of the collection pot are filtered, and the particulate on the filter used to determine monthly deposition. Monthly deposits should be stored and bulked quarterly to be tested for heavy metals (see below) at specified points.
TSP, PM10, PM2.5	All locations	Once in every season over a period of 24 hours (total 3 samples)	Mobile sampling equipment designed to measure particulates using low volume sampling pumps, which can also recover SO_2, NO_x, CO, O_3, H_2S.
NOx and SO_2	AQN2, AQN5, AQN6 and AQN10	Once in every season over a period of 24 hours (total 4 samples)	Mobile sampling equipment designed to measure particulates using low volume sampling pumps, which can also recover SO_2, NO_x, CO, O_3, H_2S.
Heavy metals in dust (Arsenic, Cadmium, Chromium, Zinc, Molybdenum, Lead, Mercury, Copper & Nickel)	AQN5 and AQN6	One sample bulked quarterly over a 12-month period (total 3 samples)	Analysis of dust collected through mobile sampling equipment
NO_2 and SO_2	All locations	Continuous (monthly data recovery) for 12 months	Using Gradko diffusion tubes The acrylic tubes are designed for passive sampling of airborne gases. The tube contains an adsorbent material which can then be analysed by UV/Visible Spectrophotometry with reference to a specific calibration curve, appropriate to this methodology. The tubes have a recommended exposure length typically in the order of 4 weeks, after which time they are removed from their sampling location, replaced and returned to the manufacturer's accredited laboratory for analysis.

Baseline monitoring for NO_2 and SO_2 has been undertaken using Gradko diffusion tubes. The acrylic tubes are designed for passive sampling of airborne gases. The tube contains an adsorbent material which can then be analysed by UV/Visible Spectrophotometry with reference to a UKAS (United Kingdom Accreditation Service) calibration curve, appropriate to this methodology. The tubes have a recommended exposure length typically in the order of 4 weeks, after which time they are removed from their sampling location and returned to the manufacturer's accredited laboratory for analysis.

To validate the data, additional samples have been collected by SQS using a mobile air quality monitoring station (Figure 4.7.1) which comprises a completely autonomous system. The mobile air quality monitoring station has been used to measure NO, NO_2, NOx, SO_2, CO, PM_{10} and $PM_{2.5}$. The details of the equipment and methods used are provided in Table 4.7.4.

Table 4.7.4: AQMS – Details of equipment and methods

Equipment	Parameter	Method
ENVEA Type: AF22e	SO_2	BAS EN 14212:2013
ENVEA Type: AC32e	NO/NOx/NO_2	BAS EN 14211:2013
ENVEA Type: CO12e	CO	BAS EN 14626:2013
ENVEA Type: O342e	O_3	BAS EN 14625:2013
DIGITEL Type: DPA14	PM_{10} and $PM_{2.5}$ mass concentrations	BAS EN 12341:2015

Figure 4.7.1: Mobile Air Quality Monitoring Station

4.7.5 Monitoring Results

4.7.5.1 Dust

The measured dust deposition results were recorded to be intermittently high, with exceedances recorded at six locations (refer Drawing 4.7.1 and Figure 4.7.2). At some locations, the concentrations recorded were approximately six times the national standards.

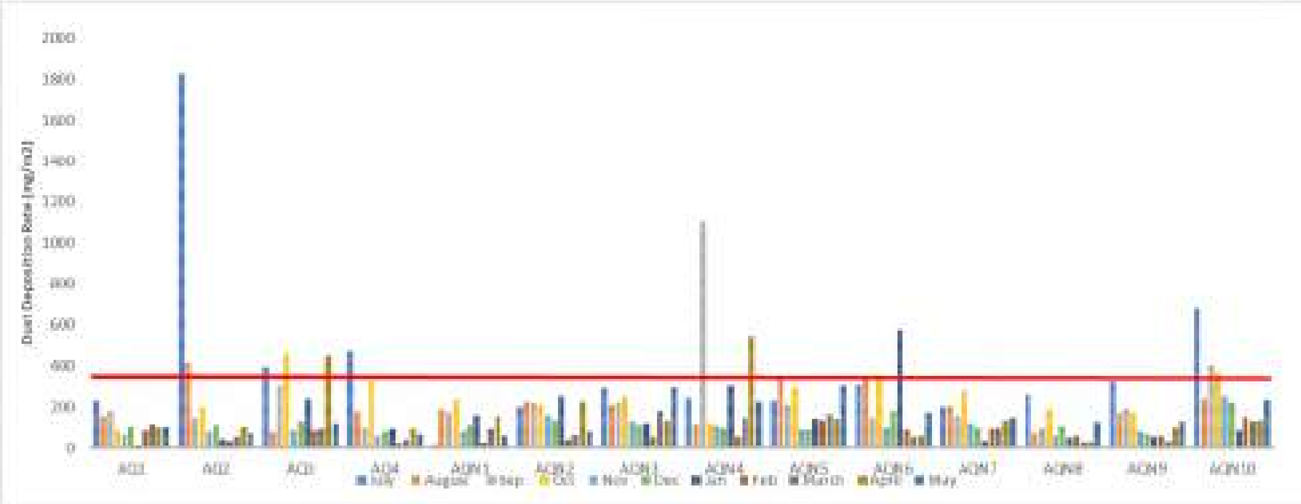


Figure 4.7.2: Dust Deposition rates (mg/m²/4 week period)

4.7.5.2 Metal Concentrations

The heavy metal concentrations have also been measured in the deposited dust. The concentrations of lead, nickel and arsenic show exceedances of the national standards.

Table 4.7.5: Heavy Metals Content in the Total Sediment (μg/m²day)

Measuring location		Cd	Cr	Zn	Mo	Pb	Cu	Ni	As	Hg
Standard		0.002	-	0.4	-	0.1	-	0.015	0.004	0.001
Q1	AQN6	0.0013	0.0185	0.320	0.0026	**0.495**	0.032	**0.019**	0.0013	0.0003
	AQN5	0.0013	0.0053	0.003	0.0026	0.008	0.018	0.021	**0.004**	0.0003
Q2	AQN6	0.0009	0.0046	0.327	0.0093	**0.239**	0.026	0.009	0.0005	0.0002
	AQN5	0.0002	0.0042	0.069	0.0021	0.013	0.004	0.004	0.002	0.0002
Q3	AQN6	0.0006	0.009	0.389	0.001	**0.435**	0.024	0.001	0.00025	0.0001
	AQN5	0.0001	0.001	0.05	0.001	0.025	0.012	0.006	0.00077	0.0001

4.7.5.3 PM_{10} and $PM_{2.5}$

The PM_{10} and $PM_{2.5}$ levels monitored using the mobile air quality monitoring station are presented in Figure 4.7.3 and indicate that the measured levels are well within the standards (25μg/m³ for PM_{10} and 50μg/m³ for $PM_{2.5}$). At the majority of the sites, there is a strong correlation between the PM_{10} and $PM_{2.5}$ concentrations, with the $PM_{2.5}$ concentrations accounting for 80% of the PM_{10} concentrations.

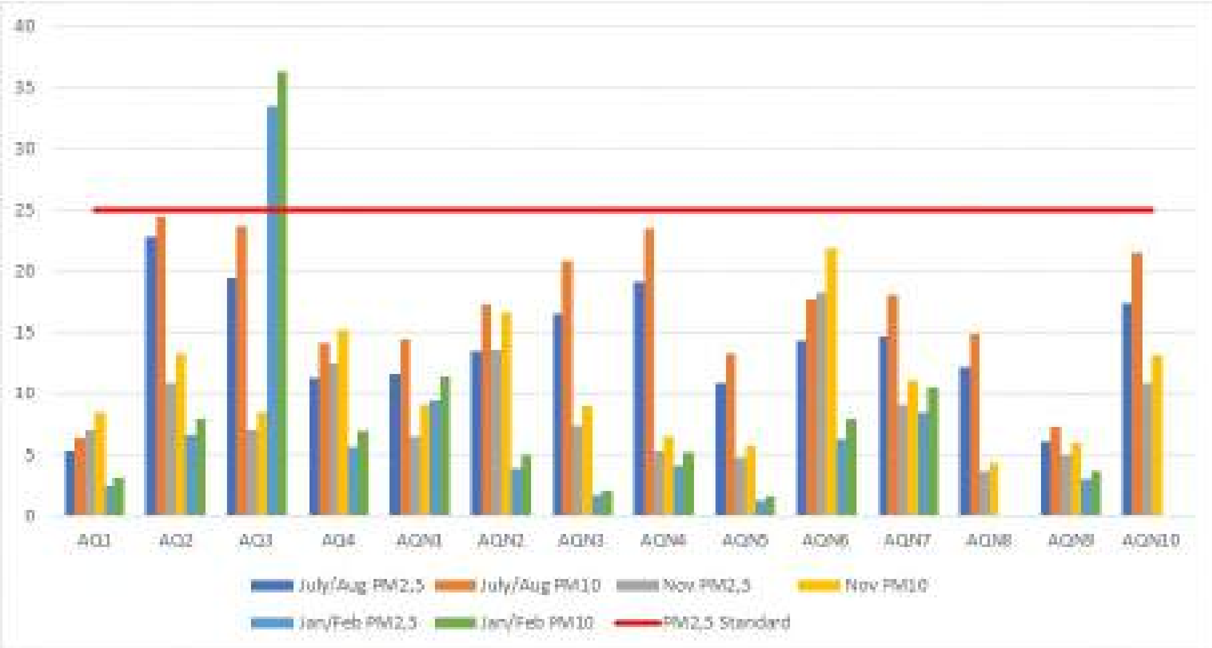


Figure 4.7.3: PM_{10} and $PM_{2.5}$ Concentrations (µg/m^3)

4.7.5.4 SO_2 and NO_2

The monitoring data collected for SO_2 and NO_2, using Gradko diffusion tubes is presented in Figure 4.7.4 and 4.7.5. An analysis of the average values for SO_2 and NO_2 indicates that the air quality in the area is good with the concentrations well within the standards (50 µg/m^3 for SO_2 and 40 µg/m^3 for NO_2) adopted for the project (refer Table 4.7.1).

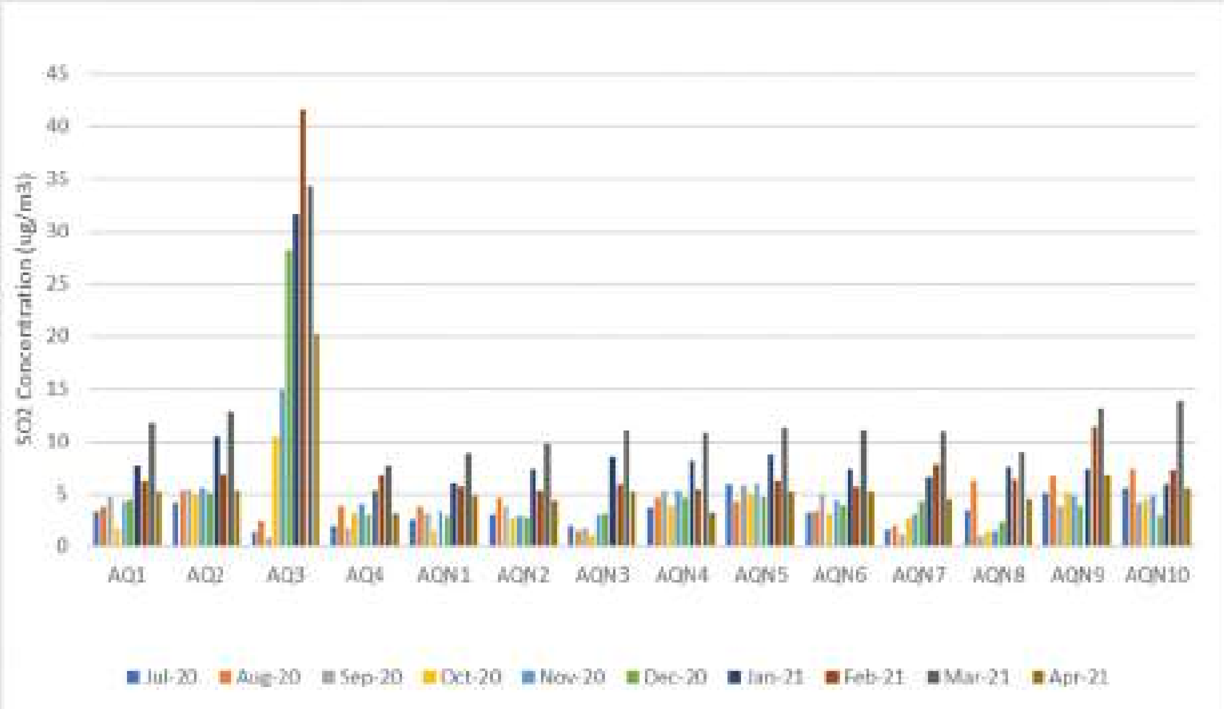


Figure 4.7.4: SO_2 Concentrations (μg/m³)

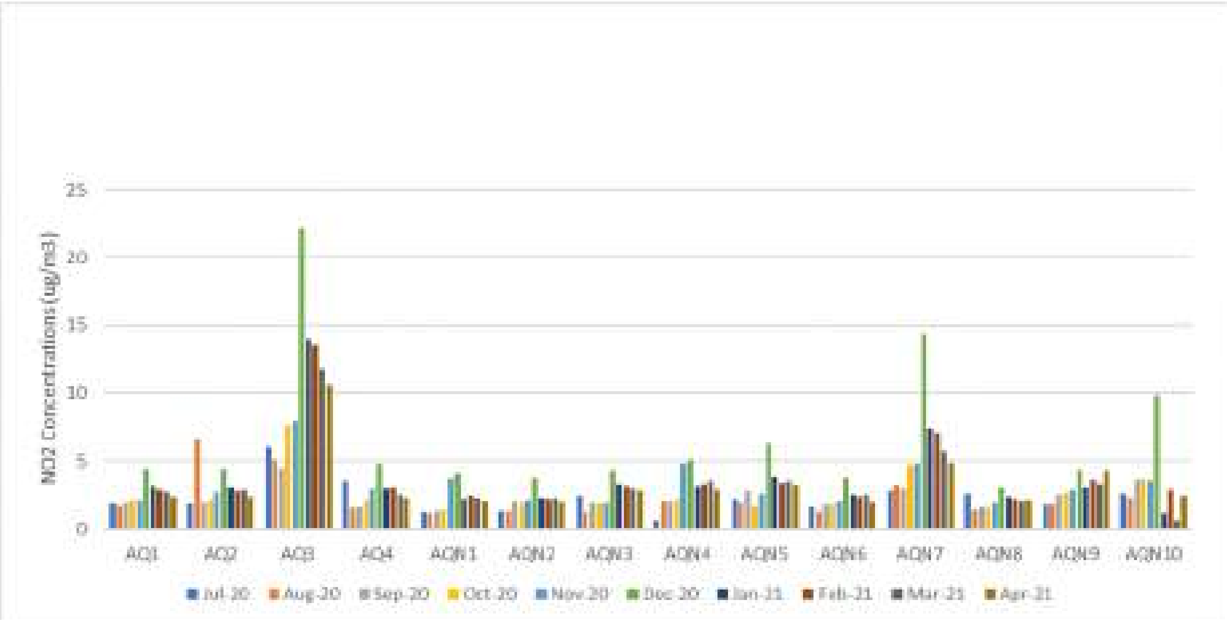


Figure 4.7.5 NO_2 Concentrations (μg/m³)

In addition to the monitoring by Gradko diffusion tubes, the NO, NO_2, NOx and SO_2 levels have also been measured using the AQMS at four locations. The results are provided in Figure 4.7.6 and indicate that the NO_2 and SO_2 levels are within the 24-hour mean standards (200 μg/m³ for NO_2 and 20 μg/m³ for SO_2), however the values for SO_2 are mainly well below the standards, with the exception of monitoring site AQ3.

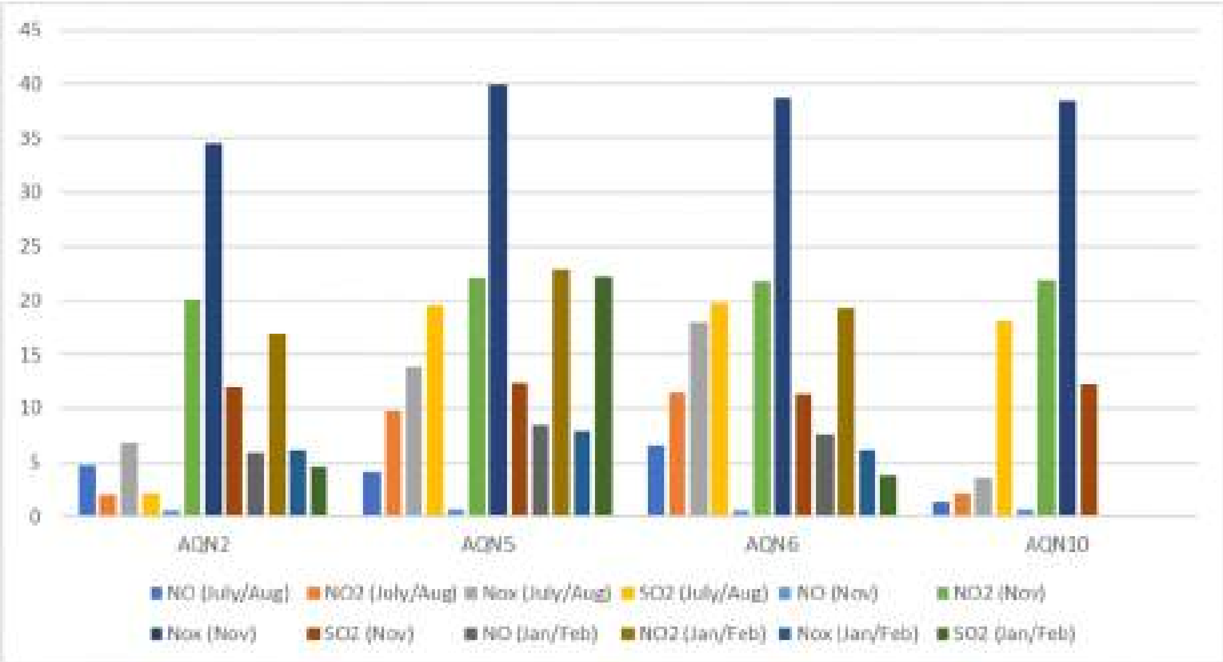


Figure 4.7.6: NO, NO_2, NOx and SO_2 Monitoring Results (Mobile AQMS)

4.7.6 Discussion of Results

The dust deposition rates recorded are observed to be very high and exceed the national standards at six out of ten locations. High dust deposition rates are considered to be associated with nuisance effects such as soiling of property, visual impacts, and deposition in the eyes and nose. The high background levels are likely to be associated with the presence of dust generating industries, such as sawmills, and due to burning of fossil fuels at large scale thermal plants and at household level. The dust nuisance effects have been identified as an area of concern during the stakeholder consultations, and are likely to be major cause of complaints, if not managed appropriately.

The metal concentrations recorded in the deposited dust are also high and exceed the national standards. It is recommended that the concentrations of metals are also recorded in the ambient air at a single location, to establish the human health impacts.

The SO_2 concentrations (24-hour measurements) were also recorded to be high and close to the prescribed standards. The use of firewood, coal and other combustible materials in individual stoves and furnaces with poor emission controls and the use of fuel with a high sulphur content in district heating systems is likely to be a major cause of the high sulphur dioxide concentrations. The provisions of EU Directive 1999/32/EC on reduction of sulphur content in certain liquid fuels have not yet been transposed to provide a more favourable treatment to domestically produced petroleum products. This could also be a reason for the high SO_2 concentrations in the area.

The concentrations of dust and SO_2 are likely to be worse in the winter period due to increased burning of solid fuels for heating and stable weather conditions associated with low temperatures and wind speeds which can lead to inversions in such topographic settings. It is likely that exceedances of SO_2

may be recorded in the winter season. The international standards require that projects located within poor quality airsheds should ensure that any increase in pollution levels is as small as feasible and amounts to a fraction of the applicable short-term and annual average air quality standards considered for the project. The project design will therefore have to take into consideration the long-term wind data to ensure the infrastructure is planned in a way to minimise impacts on the downwind communities, and along access roads.

4.8 Noise Baseline

4.8.1 Study Area

The noise environment and associated study area of the Project has been considered for the existing sensitive receptors close to the Project infrastructure and planned activities. The nearest existing sensitive receptors are the settlements of Tisovci, Pržići Kolonija, Daštansko and Vareš town. The majority of the area surrounding the project is quiet and residential in nature. The main source of noise in these settlements is occasional traffic. Drawing 4.8.1 shows the noise monitoring locations, proposed working area, and haul road associated with this project.

The project consists of two main operations, namely the Vares Processing Plant at Tisovci and the Rupice underground mine to the north west with a haul road linking the two. Both of these project areas and the associated haul road have the potential to have an adverse impact on the existing sensitive receptors in regard to noise.

The Vares Processing Plant is located in close proximity to existing residential dwellings. The closest residential dwelling to the processing plant lies approximately 35m to the north west. The site is bound to the East by woodland with a residential dwelling approximately 396m to the north. The South of the site is bound by woodland with no residential dwellings. The processing plant lies in close proximity to existing sensitive receptors, there is no legal requirement for an increased buffer zone if mitigation measures are installed to reduce the noise emissions from the proposed development.

The Rupice mine is located to the north west of the Vares Processing Plant and is situated in a rural area of woodland with no sensitive receptors in close proximity to the proposed operations. The closest sensitive receptor lies approximately 330m south of the Rupice mine.

4.8.2 Noise Monitoring Methodology

Noise baseline has been undertaken by Zenica institute and consisted of two external baseline daytime noise surveys to date, from 8th May to 11th June 2020 and from 15th to 23rd September 2020 and one night-time noise survey in December 2020. All noise measurements were undertaken using Class 1 noise monitors and following the procedure included in BAS ISO 1996-1:2005; BAS ISO 1996-2:2008 – Noise description and measuring. All noise measurements were undertaken with the microphone between 1.2m and 2.0m from the ground and more than 3.0m from any other reflecting surface in coordination with the guidance stated in Law on Noise Protection (“Official Gazette of F BiH” No 110/12).

Daytime noise measurements were taken at seventeen monitoring locations; these are considered representative of ambient noise levels at existing sensitive receptors. Night time monitoring was taken at select locations, closest to where night time activity is anticipated. The noise monitoring locations were identified based on the proximity to the proposed operations and to other noise sources, such as vehicular traffic. The details of the noise monitoring locations are presented in Table 4.8.1 and their locations are shown in Drawing 4.8.1.

The noise impact assessment considers internal and external noise impacts however assumptions have been made in regard to the noise attenuation provided by the façade and glazing. An assumption of a reduction of 13dB to the façade level. This level is the attenuation provided by a typical building façade, containing slightly open windows, to the externally measured level. In the case of a complaint, internal noise measurements can be undertaken to ensure the internal noise levels are achieved, and an investigation into the source of the increased noise emissions can be undertaken and mitigation can be implemented accordingly.

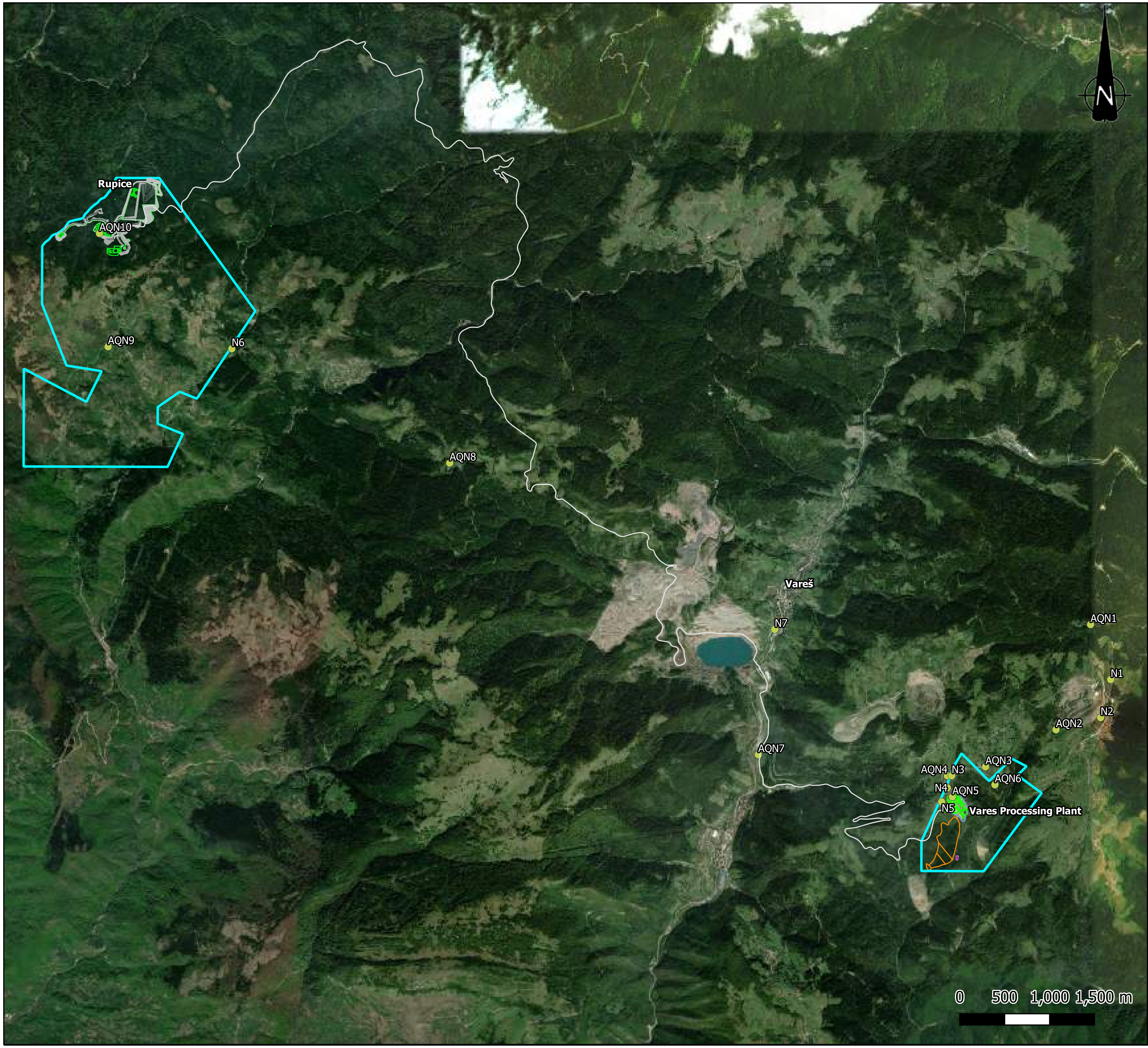
Table 4.8.1: Noise and Vibration Monitoring Locations

Location	Description	x	y
N1	Daštansko – close to open pit, NE of Open pit	6530098	4889877
N2	Daštansko – east of open pit	6529990	4889463
N3	At old Crusher	6528337	4888812
N4	At the entrance to process plant	6528282	4888671
N5	North west of Vares Processing Plant at closest residential property	6528226	4888516
N6	Borovica Donja – on haul route	6520309	4893508
N7	Vareš – incoming road	6526357	4890422
AQN1	North of open pit	6529870	4840491
AQN2	Residential property - South of open pit	6529494	4889427
AQN3	Pržići	6528709	4888913
AQN4	Residential property, above historic crusher building, Tisovci	6528283	4888804
AQN5	Offices at Vares Processing Plant	6528344	4888572
AQN6	Down valley of old crusher, up valley of TSF	6528814	4888707
AQN7	Mlakve, along haul route	6526178	4889037
AQN8	Semizovna Ponikva – on haul route	6522734	4893524
AQN9	Borovica Gornja	6518934	4893524
AQN10	At proposed location of Rupice surface infrastructure	6518833	4894779

4.8.3 Noise Monitoring Results

Noise monitoring was carried on from May 8th to June 11th and from the 15th to the 26th of September 2020. A summary of the noise monitoring results is presented in Table 4.8.2.

Table 4.8.2: Daytime Baseline Noise Monitoring Results						
Location	Noise Levels (dB(A))					
	May – June 2020 Survey			September 2020 Survey		
	Date	L90	LAeq	Date	L90	LAeq
N1	11/06/2020	32.7	42.8	16/10/2020	28.3	43.2
N2	11/06/2020	20.5	24	16/10/2020	23.6	32.9
N3	04/06/2020	35	44.8	16/10/2020	25.3	38.9
N4	04/06/2020	20.4	28.4	23/10/2020	30.1	38.1
N5	04/06/2020	42.4	48.1	23/10/2020	30.4	41.6
N6	08/05/2020	37.1	42	15/10/2020	27.9	38.4
N7	11/06/2020	23.6	29.8	23/10/2020	21.6	32.4
AQN1	11/06/2020	20.3	18.6	16/10/2020	19.8	28.6
AQN2	11/06/2020	30	40.4	16/10/2020	23.1	37.9
AQN3	04/06/2020	46.1	54.8	16/10/2020	45.8	51.3
AQN4	04/06/2020	20.4	20.1	16/10/2020	22.3	31.3
AQN5	04/06/2020	21.3	30.8	16/10/2020	26.3	31.6
AQN6	11/05/2020	34.7	50.8	23/10/2020	38.5	46.2
AQN7	11/06/2020	36.2	47.4	23/10/2020	38	51.8
AQN8	08/05/2020	37.9	44.4	15/10/2020	31.9	45.8
AQN9	08/05/2020	32.4	55	15/10/2020	37.3	58.7
AQN10	08/05/2020	37.2	46.2	15/10/2020	30.4	37.9



DO NOT SCALE FROM THIS DRAWING

Key

- Noise Monitoring Locations
- TSF
- Infrastructure
- Haul Road
- Concession Boundary

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT
Adriatic Metals PLC

PROJECT
Vares Project ESIA

DRAWING TITLE
Noise Monitoring Locations

DRG No. ZT520182/4.8.1		REV A
DRG SIZE A3	SCALE 1:60,000	DATE September 2021
DRAWN MBW	CHECKED BY AM	APPROVED BY AA

wardell armstrong

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MWINTER

The baseline results supplied by Zenica Institute have been compared to the highest permissible noise levels stated in The Federation of Bosnia and Herzegovina Law on Noise Protection and the project standards detailed in Chapter 2 . The Law on Noise Protection states the highest permissible noise levels for various premises based on use; the limits for residential dwellings are shown in Drawing 4.8.1 Noise monitoring Locations above.

In the May and June noise survey the highest recorded LAeq recorded was 55 dB LAeq at AQN9; the source of this noise was not recorded. The noise monitoring results show that in the September 2020 survey noise levels were recorded of up to 58.7 dB LAeq(A) which exceeds the highest permissible limit for external noise. Therefore, the noise assessment will consider potential mitigation measures which could be implemented to ensure that the project does not exceed the required noise limits at the receptors and ensure the proposed project does not contribute to an increase in the ambient noise levels.

In addition to this the existing background noise levels at N2, N4, AQN1, AQN 4 and AQN 5 are exceptionally low. Mitigation measures will be considered during the noise assessment to ensure that the potential impact on the existing sensitive receptors is minimised at these locations.

Night-time noise monitoring has been undertaken at Monitoring Locations N5 and AQN5 closest to the proposed processing plant on the night of the 10th December 2020. Locations close to the haul road and mining areas of the project have not been measured due to the remote nature of these locations resulting in a increase of 3dB may be impossible, therefore mitigation measures will be implemented to reduce the potential noise impact as far as practically possible. The noise monitoring results are detailed in Table 4.8.3.

Table 4.8.3: Night-time Baseline Noise Monitoring Results

Location	Noise Levels (dB(A))		
	May – June 2020 Survey		
	Date	L90	LAeq
N5	10/12/2020	18.8	21.6
AQN5	10/12/2020	19.4	19.4

As shown in Table 4.8.3 above, the measured L90 is extremely low during the night-time period. Mitigation measures will be considered during the noise assessment to ensure that the potential impact on the existing sensitive receptors is minimised at these locations. The measured noise level have the potential to be lower than normal due to restrictions on movements due to the COVID-19 pandemic limiting traffic movements however as the potential impact is being assessed to these levels this provides a worst case scenario and ensures a robust assessment.

4.9 Hydrology & Hydrogeology

4.9.1 Introduction

This water baseline chapter outlines available information and interprets the principal hydrological and hydrogeological processes affecting environment and community stakeholders within the Rupice mining concession, Vares Processing Plant (VPP) and their respective surrounding areas.

This chapter details the baseline water monitoring programme that was designed by WAI at the end of 2019 following earlier studies conducted as part of a Bosnian EIA submission (Enova, Sept.2019). WAI redesigned the hydrological programme in 2019 and made recommendations for more monitoring points following the earlier work so as to increase resolution of data and improve the understanding of hydraulic interaction between groundwater, springs and surface water systems in the catchments of interest. The baseline describes all results collected on-site and from catchment monitoring established upgradient and downgradient of the site facilities and also in reference 'control' catchments outside the area of influence of the project. Where relevant, the data and monitoring installations that had been previously established has been incorporated into this baseline. The hydrological monitoring programme is ongoing and is subject to continual review and improvement with the intent that this will be an important part of operational compliance monitoring as the project develops.

Water quality results have been compared to BiH water quality standards where possible and EU Environmental Quality Standards (EQS) and Water Framework Directive (WFD) UK Drinking Water Standards (see section 10.5 for further details). Baseline monitoring on site has now surpassed 12-months of data collection. Baseline water monitoring following the 12-month monitoring period is still ongoing; however has been scaled back to continue recording key parameters that will be important indicator determinants relevant to ongoing environmental management during the construction and operation phases. This chapter provides an overview of the baseline, up to the end of May/June 2021.

Key aspects and focus areas noted within the ESIA Scoping Study V1.0, 2020 (WAI, 2020 - Report Ref: MM1366[1]) were later updated by WAI in 2021[2] and formed the basis for the design of the baseline monitoring programme. Within the Scoping Study, water studies were separated into three categories:

- Hydrology;
- Hydrogeology, and
- Water Supply.

[1] Wardell Armstrong, 2020. Environment and Social Scoping Study. Job Number: ZT52-0176. *Report Reference: MM1366, V1.0.*
[2] Wardell Armstrong, 2021. Environment and Social Scoping Study. Job Number: ZT52-0182. *Report Reference: MM1458, V2.0.*

The methodology for the baseline programme including how data gaps have been addressed was set out in the ESIA Scoping Study V1.0, 2020 (WAI, 2020 -Report Ref: MM1366[1]).

4.9.2 Methodology

The methodology undertaken for the ESIA hydrology and hydrogeology baseline is summarised in outline form below as an overview of the various work stages performed from 2018 to date. Project monitoring locations for Rupice study area and VPP study area are provided in Drawing 4.9.1 and Drawing 4.9.2 respectively.

4.9.2.1 Hydrology

Hydrological monitoring and studies have been undertaken in the catchments at the VPP and Rupice sites since 2018 to build a data-base describing surface water flows, correlated rainfall and meteorological information, water quality analyses, and hydraulic tests to determine the baseline hydrological processes and behaviour.

A desk-top review was undertaken in May 2019 by Esad Oruč[3] which established the principal catchment and long-term regional meteorological characteristics of the Mala River[4]. The study aim was to develop the basis of understanding of the hydrology of the Mala river in terms of rainfall, evaporation, water balance and flow regime so that possible sources of water for processing plant water supply could be evaluated. The study led to the installation of instrumented flow monitoring at the location 'PPV-3' – an already constructed, concrete outlet structure with uniform dimensions that was suitable for automated streamflow measurements downstream of former mining related infrastructure. In addition, an automated weather station was established at the process plant site at Tisovci. Calculations based on catchment size and mean monthly precipitation were developed to estimate the likely flow variability in the Mala and set monitoring specifications.

A similar desktop review was conducted in the Rupice catchment to establish surface water flow monitoring stations on the principal water course - the Borovički potok (Borovica river). Here, two surface flow measurement stations were established. The first (PP-I) was set-up on a pre-existing structure at the Sastavce concrete impoundment and pumping station located upstream of the village of Donja Borovica. The second flow measurement point (PP-II) was established under a foot bridge in the middle of Donja Borovica. Flow measurements at the measurement points were instrumented following refurbishment with a perforated stilling-well. Water pressure transducers were set at daily recording intervals to measure the hydraulic head of the stream. A weather station was established near the top of the Kiprovac ridge.

[3] Esad Oruč is an independent hydrogeologist based in Sarajevo who leads a team of associate researchers that have significant capability in groundwater and surface water studies who have been working on the Vares project since 2018 and specified the installation of the project wells, piezometers and weirs in accordance with BiH standards.

[4] Water Balance Analysis For Technical Water Supply At Mine And Processing Plant "Veovača". Prepared by Esad Oruč, Sarajevo, May 2019

Following the ESIA Scoping Study V1.0, 2020 (WAI, 2020 -Report Ref: MM1366[1]) it was concluded that additional amendments were needed to more fully characterise the hydrology to meet the dual objectives of ESIA baseline characterisation and water supply feasibility. This was based on the recognition that the stream flow recordings in the VPP catchment area (the Mala river) were influenced by a regulating effect from the upstream TSF. The amendment comprised:

1 Repositioning of both weather stations to locations which would satisfy more representative climatic and meteoric conditions;
2 Addition of further flow measurement devices along the Malariver upstream and downstream of PPV-3;
3 Addition of further flow measurement devices along the Borovica river upstream of PP-I to distinguish inflows from two separate sub-catchments. The PP-I location was also noted to be affected by the on-off cycle of pumping from the Sastavce structure which provides water for Donja Borovica and drilling water used Eastern Mining's exploration activities and therefore was not representative of natural flows;
4 Addition of new flow and water quality measurement devices on the Vrući Potok ('Hot stream') to the west of the mine area;
5 Synchronisation between stream flow and weather station recording and increase in automated measurement frequency to 15-minute intervals to provide a higher resolution to the analysis of daily and peak flow events.
6 Updated hydrological analysis of results.

The amendments to the hydrological baseline were implemented in stages in 2020 with the measurement intervals changed in April 2020, relocation of the weather stations between June to August 2020 and, following hydraulic modelling, design, fabrication and municipal consent applications, installation of the new broad-crested weir structures between September to November 2020.

In conjunction with the 2020 flow monitoring programme, a revised and expanded suite of water quality and chemistry sampling and analysis was undertaken.

Water supply options to the mine and processing facility have been assessed in parallel with the ESIA baseline work. This has entailed a review of the demand forecast required by the development, potential supply sources, their level of current commitment and their potential for deployment. The latter aspect has included a detailed water resource review of water availability and minimum flows required to maintain environmentally acceptable conditions under different seasonal conditions and return periods. The water supply work is detailed in the project's feasibility study. Minimum environmental flow has considered ecologically acceptable flow (Q_{eaf}) that have been determined using quantification techniques specified by Bosnian regulations as well as evaluating deployable abstractions that leave sufficient water in the streams to meet the needs of local community water users. Water supply information for existing water users in the catchments in which the mine and development is located has been reviewed in terms of current usage, potential resources and capacity.

4.9.2.2 Hydrogeology

Accompanying the 2019 Esad Oruč[5] work, a program of hydrogeological investigations was undertaken. This constituted primarily the installation of three vertical piezometers (BRP-1,2,3) and three monitoring wells (BRW-1,2,3) which targeted the Rupice mineralisation zone. The piezometers and wells were used to obtain a record of hydrogeological formations and aquifer units, groundwater level variations and hydrogeological properties of the water bearing zone by means of continuous rate pumping tests and analysis of recovery phases.

Following the ESIA Scoping Study V1.0, 2020 (WAI, 2020 - Report Ref: MM1366[1]) four additional monitoring wells were designed and specified to provide a baseline characterisation of groundwater upgradient and downgradient of the Rupice orebody so that monitoring of effect of groundwater changes outside of the underground mining zone could be recorded. Additional shallow monitoring wells around the Vares process plant and the existing tailings facility were designed to evaluate contaminated groundwater requirements for the process plant remediation and construction phase. The Rupice catchment where the underground mine will be located is influenced by dolomitic limestone hydrogeology of the area which results in spring discharges, a modified streamflow hydrograph due to groundwater baseflow discharges into the river basins and rapid recharge components affecting groundwater flow. Additional measurements were established to record flow, water level and water chemistry of the surface water, additional spring monitoring and groundwater wells. In both catchments the frequency of recordings for stream flow and water level measurements were increased to 15-minute intervals so that the effect of storm events and short-term rainfall (recharge pulses) could be evaluated, as these were likely to convey rapidly through the limestone catchment and be materially significant to the water balance of the hydrological systems. The amendments made to the groundwater monitoring program included:

1. Installation of four new monitoring wells named the Rupice Environmental Water 'REW' series to differentiate these from the existing BRP (Rupice Piezometer) and BRW (Rupice Well) installations.
2. Increase in automated measurement frequency to 15-minute intervals to provide a higher resolution to the analysis of daily and peak flow events.
3. A revised and expanded suite of water quality and chemistry sampling and analysis.
4. Updated hydrogeological analysis of results.

4.9.3 Relevant Water Receptors

4.9.3.1 VPP

[5] Oruč, Sarajevo 2020. Elaborate of Hydrogeological Explorations Of Deposits Of Complex Ore Of Lead, Zinc And Barite, Rupice- Vareš

The Mala river is a Class II registered water body[6] that comprises an upland stream that is a tributary of the Stavnja River. The Stavnja basin is a sub-basin of the River Bosna, the third longest river in Bosnia which flows north through the centre of Bosnia for some 282 km before discharging to the Sava River, a transboundary river. In the area of the mine and for a distance of 3km downstream from the southern edge of the historic Veovaca open pit the catchment is heavily modified by former mining activities. This includes two sub-surface culverts that divert the river beneath an historic TSF and an iron mine rock dump. Downstream of the rock dump for a further 6.1km the Mala river flows through a steeply incised wooded valley before reaching a confluence with the Stavnja river. There are no known abstractions on the Mala River in the vicinity of the VPP (WAI, 2020 - Report Ref: MM1366[1]).

The planned haul route follows the Zagarski stream, a tributary of the Stavnja River, for approximately 1km, this is located in a vegetated steep sided valley 0.5km west from VPP. The haul route was planned in this location at a late stage in project design, as such no monitoring data is currently available. The baseline for this stream has been described from a biodiversity perspective in Chapter 4.5. Monitoring has now been initiated and will be incorporated into the detailed design of the haul route which is currently ongoing and due to be complete December 2021.

4.9.3.2 Rupice

There are two water courses within the area of influence of the Rupice development comprising the Borovički stream, a mountain stream located close to the eastern margin of the Rupice concession and the Vrući Potok ('Hot stream'). The Borovički stream flows for approximately 8 km in a south-westerly direction to its confluence with the Bukovica river, a tributary of the Bosna River. Downstream of Rupice, the Borovički stream flows through the village of Donja Borovica, where it is used by the municipality for sewage dilution i.e. as a receiving water for outflows. The Vrući stream is a small mountain stream to the north of the Rupice concession which flows north for 2.5 km from its source to its confluence with Trstionica, a tributary of the Bosna River and which appears to have no formal designation or use as it has been heavily impacted by frequent muddy run-off from forestry activities during the monitoring period.

The principal water resource feature of relevance to the Rupice development is the Bukovica public water supply which provides water for approximately 40,000 inhabitants of Kakanj city and is administered by the Zenica-Doboj Canton. The public water supply abstraction point is located approximately 8km south of the Rupice development comprising a waterworks located on the flanks of the Bukovica river valley. The source is located in the vicinity of the settlement of Kraljeva Sutjeska, approximately 2.5 km upstream from the confluence of the Bukovica into the Trstionica river. The

[6] BiH controlled waters are classified according to the 'Uredba O Kategroikaciji Vodotoka' regulation issued as part of the BiH 'Sluzbeni' 42/67 Directive which identifies each water course in the Republic. Accordingly, the River Stavnja is in Category III, the Mala River, Borovicki steam and Vruči potok are in Category II category and all water supply sources are automatically regarded as Category I. The lowering category designation implies worsening natural water quality and/or degradation. Water quality results from each water course are expected to comply with the respective Category value listed in the Decree on Hazardous and Harmful Substances in Waters. Specific parameter values in the BiH system differ from the EU WFD Environmental Quality Standards. There is significant divergence between the systems, the BiH categories are prescriptive and relatively indifferent to establishing improving status towards a goal of overall good status. The EU system urges jurisdictions to classify systems from degraded through to pristine (based on chemistry, flow and aquatic ecology) and then establish rolling 5 year programmes of measures for continual improvement which need to assimilate cost-benefit and catchment management principles.

abstraction is sourced from groundwater (karstic dolomitic limestone) with reliance on recharge from the Borovica stream. The abstraction has a series of concentric Sanitary Protection Zones (SPZ) around it which restrict certain potentially contaminative activities. The mine concession is outside the edge of Zone 3 of the pre-2012 boundary zoning system. Boundary 2 under this system is delineated by a 250m wide buffer from the centre line of the Borovica stream and clips the southeast corner of the Rupice concession area. Boundary 3 is based on the total surface water catchment for the stream and follows the Kiprovic ridge line (catchment boundary). SPZ regulations brought out in 2012 use a different (hydrogeological) system for defining zones (4 zones) based on travel times which require modelling, and it is understood this has not yet been ratified. SPZ's within the Rupice Concession are shown on Drawing 4.9.1.

The 2012 SPZs will be based on:

- Zone 1: defined as the immediate 10m border of the pumping station,
- Zone 2: defined as the boundary of the 1-day travel time distance to the source. In exceptional cases where there are very high groundwater flow velocities (>2.5 km/day) the protection zone may also be established further than the 1-day travel time distance.
- Zone 3: defined as the boundary of the 10-day travel time distance to the source (also with exceptions for high velocity groundwater).
- Zone 4: defined from the edge of the Zone 3 boundary to the total catchment limit.

Under the 2012 system, underground mining, disposal of underground tailings and hazardous material storage at surface are prohibited from zones 2 and 3 and restricted (i.e. allowable with additional protection measures) in zone 4. Determination of the SPZs for the Bukovica water system has been undertaken by IBIS d.o.o. in 2018 and the Municipality of Kakanj are in the process of ratifying the zones into designations. The reasonably foreseeable outcome is that the Rupice site is excluded from the Bukovica SPZ entirely or falls within Zone 4 (the total catchment). Groundwater analysis of flow directions at the site is necessary to confirm if potentially adverse groundwater flow (and water quality aspects) could migrate from the operations into the SPZ. Given the distance (>8km) from the source the risk of affecting the water supply is negligible. The estimate of time for ratification is two years according to reports on similar situations with other companies and municipalities. Adriatic has been liaising closely with the Kakanj Municipaility on this since June 2020. Only the preliminary (new) Zone 2 boundary has been indicated which follows a 50m buffer around part of the Borovica river up to a point approximately one km south of the village of Gornja Borovica, the majority of the SPZ follows the Bukovica stream valley to the east of the Rupice development area. The preliminary (new) Zone 2 boundary is much smaller than the previous (extant) Zone 2 boundary with respect to the Borovica stream and it follows that the other zones will be similarly sized smaller in the next revision and unlikely to overlap the mining area. In the unlikely event that the new zonation includes the mine concession in Zone 3 then the results of risk assessment, groundwater modelling and mitigating factors regarding the mine's activities will be available to demonstrate no risk to water resources.

Nearer to the site is the Kings spring water bottling plant located immediately south of Donja Borovica and reliant on karst groundwater flow. The bottling plant is a private enterprise and protection measures are necessary to ensure the source water is also not at risk from the development. The water bottling point has been modelled as a compliance point within the groundwater numerical model, although it is noted that groundwater flow direction at Rupice is northwards and away from this location and the relatively low water inflows expected into the mine (currently expected to be in the order of 75m^3/d) are insufficient to cause a flow reversal or interference to the catchment of the bottling plant.

4.9.4 Water Resources

4.9.4.1 Supply

Approximately 76% of the population (urban and rural areas and settlements) in the Municipality of Vareš is connected to a reticulated water supply system managed by JKP Vares. The remaining population that is not covered by the public system use private springs. All primary water supply is derived from karst springs with the most important being the Očevje spring in the Krivaja river basin. In addition to Očevje, Vareš is also supplied from smaller spring sources, in the vicinity of the VPP site the Lalića Mlin spring provides water to Pržiće, Tisovce and has a yield in the range of 6 to 15 l/s. Smaller isolated spring sources provide water for Dastanko, Donja and Gornja Borovica have a yield of approximately 8 - 10 l/s. There is some transfer and exchange capacity with the Stupni Do water supply system - Sedra spring.

Hydrologically the available water resource far exceeds the current population demands i.e. the amount of renewable karst groundwater available for abstraction from springs is far higher than that which is being withdrawn. The main constraint is the supply infrastructure which in many rural areas of the Vares municipality is in poor condition due to lack of maintenance which falls as a responsibility to the local communities. Additionally rural water is not reliably sterilised and a high proportion of samples of bacteriological analysis appear to be contaminated (Vares Muncipal Strategy, 2016). The quality issues may arise because water chlorination of the springs (which are karstic and hence have rapid infiltration and through flow from surface sources) is not systematically applied and spring water may have bacterial contamination. Dry season water shortages that occur in most rural water supply systems are generally not due to lack of resource but difficulties in managing the available resource i.e. system connection. JKP report that based on multi-year monitoring (over 10 years), the amount of water used for public water supply abstracted from all springs is approximately 100 to 110 l / s, as follows:

- the city area has approximately 70 to 80 l/s; and
- rural areas have approximately 30 to 40 l/s.

All springs and water supply systems managed by JKP have sanitary protection zones (SPZs) defined by municipal ordnance with supporting technical gazetted documentation and water permits.

There is an existing, functioning water supply pipeline that goes to the plant site at VPP. This water is currently used at the VPP by the project development team under Permit Reference Number: UP-I/25-1-40-365-4/19. It comes from a small reservoir tank with 300m^3 capacity of which Adriatic Metals currently has access to around 6l/s primarily controlled by available capacity on the pipeline. The pipeline was built for the old plant and may need some minor upgrade work.

The actual urban area water supply needs are approximately 14 to 20l/ s (for the population and economic entities) and that consumption has been progressively declining, therefore there is excess supply capacity of approximately 40 to 60l/s. (Development Strategy Water Supply 2017-2026, Vares municipality, JKP d.o.o. Vares)

In the dry season, water shortages occur in most rural water supply systems due to poor management.

4.9.4.2 Wastewater

Wastewater infrastructure is generally under-developed in Vareš. Whilst approximately 70% of households are connected to a public sewerage system (predominantly in the Vareš urban area) there is no treatment and so untreated sewage is discharged to the river Stavnja. In the rural populace and for many households unconnected to sewerage, domestic wastewater is disposed via septic tanks or direct discharge into local watercourses with no treatment. At Donja Borovica inhabitants require a minimum flow in the Borovica stream to clear their sewage effluent discharges.

4.9.5 Regulations

Groundwater and surface water quality samples in both the Rupice and VPP catchments have been assessed against the *Bosnian Maximum Permissible Concentrations (Decree on Hazardous and Harmful Substances in Waters)* regulations[7].

The *Decree on Hazardous and Harmful Substances in Waters* describes substances and their maximum permitted concentrations by individual water classes, which are considered either hazardous or harmful substances. Definitions of hazardous and harmful substances, as provided within the *Decree on Hazardous and Harmful Substances in Waters*, are provided below:

- *Hazardous substances are substances, energy and other causes that by their physical, chemical and biological composition, quantity and other properties may endanger human life and health and survival fauna and flora and the state of the environment.*

[7] Bosnian MPC Guidelines. Law on waters of the Federation of Bosnia and Herzegovina ("Official Gazette of FBiH", No. 70/06. Implementing Codes for use of Water Classes (Vode Kategorizaciji, Uredba Vlade Federacije BiH za 2007.) In Summary: streams are regulated under Class II MPC values, water sources i.e. Springs and Groundwater within Sanitary protection Zones I-IV are regulated under Class I MPC Values. Class I MPC values are comparable with European EQS protection values (same for As, same as Drinking Water Standards for Ba, less stringent on Pb and Zn, more stringent on Hg).

- *Harmful substances are substances that can cause chemical, physical and biological changes to property of water as a result of which the use of water for useful purposes is limited or prevented.*

The *Decree on Hazardous and Harmful Substances in Waters* sets out Bosnian Maximum Permissible for two types of waters:

- *I-II Class Surface Waters; and*
- *III-IV Surface Waters.*

Results have been assessed against the more stringent I-II Class Surface Waters maximum permissible concentrations in line with designated classes of the Borovicki, Mala, Stavnja, Bukovica and Trstionica Rivers.

Where *Bosnian Maximum Permissible Concentrations* guideline values do not exist, Groundwater and spring water results have been compared with UK Drinking Water Standards (UKDWS) and surface water results have been compared with EU Environmental Quality Standards (EQS's). Numeric Assessment Criteria are provided in Table 4.9.1. The most stringent value has been highlighted for each parameter which forms the selected assessment criteria for use in the project.

Table 4.9.1: Assessment Criteria for Groundwater and Surface Water Analysis.

Parameter	Units	Detection Limit	Guideline Value		Bosnia Maximum Permissible Concentrations (Decree on Hazardous and Harmful Substances in Waters)	
			EQS	UKDWS	I - II Class Surface Water	III - IV Class Surface Water
Calcium	mg/l	/	-	250	-	-
Magnesium	mg/l	/	-	50	-	-
Sodium	mg/l	0.2		200	-	-
Potassium	mg/l	0.2	-	12	-	-
Chloride	mg/l	/	250	250	-	-
Sulphate	mg/l	/	400	250	-	-
Fluoride	mg/l	0.002	-	1.5	300	1500
Phosphate	mg/l	0.001		-	-	-
Physio-Chemical Parameters						
Electrical Conductivity	µS/cm	/		2500	-	-
Nutrients						
Ammoniacal Nitrogen as N (filtered)	mg/l	0.02	0.3	-	-	-
Ammoniacal nitrogen as N	mg/l	0.02	0.39	-	-	-
Nitrate as N	mg/l	0.005		50	0.5	1.5
Minor Ions						
Aluminium	µg/l	1	-	200	1500	1500
Arsenic	µg/l	1	50	10	50	50
Barium	µg/l	10	-	1000	1000	4000

Table 4.9.1: Assessment Criteria for Groundwater and Surface Water Analysis.						
Parameter	Units	Detection Limit	Guideline Value		Bosnia Maximum Permissible Concentrations (Decree on Hazardous and Harmful Substances in Waters)	
			EQS	UKDWS	I - II Class Surface Water	III - IV Class Surface Water
Boron	µg/l	20	-	1000	-	-
Cadmium	µg/l	0.5	0.25		0.5	5
Chromium	µg/l	6	3.4	50	1	6
Copper	µg/l	3	1	2000	2	10
Iron	µg/l	6	1000	200	100	1000
Lead	µg/l	10	1.2	10	2	80
Manganese	µg/l	2	123	50	50	1000
Mercury*	µg/l	1	0.07	1	0.02	0.1
Nickel	µg/l	3	4	20	15	30
Selenium	µg/l	1	-	10	10	10
Tin	µg/l	2	-	-	100	500
Zinc	µg/l	1	10.9	5000	50	80
Cyanide (total)	µg/l	/	1	50	1	100
Sulphide	µg/l	/	-	-	2	5
Total TPH	ug/l	20	-	10	-	-
Total PAH	ug/l	0.1		0.1	0.2	1

EU Environmental Quality Standards (EQS's) are used throughout EU (and accession) jurisdictions to assess the quality of surface waters. EQS's are defined below:

> *EU environmental quality standards (EQSs) concern the presence in surface waters, of certain substances or groups of substances identified as priority pollutants because of the significant risk they pose to or via the aquatic environment. These standards are in line with the strategy and objectives of the EU's Water Framework Directive (Directive 2000/60/EC)*[8].

UK Drinking Water Standards (UKDWS) are defined within the Water Supply (Water Quality) Regulations 2016 and came into force on 27th June 2016 immediately after the commencement of the Private Water Supplies (England) Regulations 2016(a)[9]. UKDWS, primarily based on World Health Organisation guidelines are used as a comprehensive and coherent set of values defining minimum public health drinking water standards in line with the EU Water Framework Directive.

4.9.5.1 Permit Requirements

Separate water permits are required for the Rupice and VPP sites and are prerequisites in the planning process to obtain Environmental and Exploitation Permits for mining. VPP has already secured a

[8] THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION (2018). Environmental quality standards applicable to surface water. Last accessed: 08/12/2020. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Al28180
[9] Environment Agency (2016). Water Supply (Water Quality) Regulations (2016). Last accessed 07/12/2020. Available at: https://www.legislation.gov.uk/uksi/2016/614/pdfs/uksi_20160614_en.pdf

Preliminary Water permit (dated 11th July 2019, Reference Number: UP-I/25-1-40-365-4/19) issued by the Sava River Watershed Agency. The permit conditions define temporary water controls for demolition, remediation and some construction works at VPP.

At Rupice, a preliminary (water supply) water permit has been granted. Pending final decision on the water supply source, the preliminary permit will go through a consenting process with the local Municipality and the Sava River Authority (in the case of the Trstionica source) before converting to a final permit for the operations. Consent approval requires a nationally licensed engineering company to submit design drawings for the water infrastructure (intake and any hydraulic structures). This will be undertaken during the detailed design stage when local contractors and utilities are used to progress the feasibility design engineering cases forward into execution planning which is expected to follow direct from the project stage-gate sanction following completion of the feasibility study (October 2021).

Pending the next revision to the Bukovica SPZ boundaries, the current (pre 2012) SPZ boundaries remain in force. It is expected that the site will be re-modelled outside of the future sanitary boundaries but may possibly be still considered to be within the total catchment area of the Bukovic supply.

4.9.6 Baseline - Hydrology

4.9.6.1 Background

The project is located in an area of BiH that experiences a humid continental climate, with an average annual precipitation of approximately 970 mm (Institute for Hydrotechnics, 2013).

The hydrological regime is driven by pluvial (rainfall) and nival (snowmelt) events, meaning that in general, the highest surface water flows are experienced in the spring following snowmelt and, in the autumn when there is increased rainfall. The hydrological network is very well developed with mountainous catchments characterised by numerous streams feeding larger rivers. Due to the mountainous nature of these watercourses, they are characterised by short, flashy responses to rainfall events, i.e. hydrographs have short, steep rising and falling limbs.

The Vares region sits across two hydrological basins[10]:

- Stavnja and Misoča basin; and
- Krivaja basin.

Both basins are sub-basins of the River Bosna, the third longest river in Bosnia which flows north through the centre of Bosnia for some 282 km before discharging to the Sava River, a transboundary river, in Bosanski Šamac, a town in the north-east of the Srpska Republic.

[10] Vareš Municipality (2009): Local Ecological Plan. Cited in Enova (2019).

The closest watercourses to the project site all form part of the Bosna River network:

- Borovički stream;
- Vrući stream;
- Trstionica and
- Mala River.

The Borovički stream and Vrući stream are located in close proximity to the Rupice Concession.

4.9.6.2 Borovički Stream

Borovički stream is located c. 1.5km east of the Rupice Concession and flows for approximately 8 km in a south-westerly direction to its confluence with Bukovica, a tributary of Bosna River. In its upper reaches, the channel of the Borovički Stream is approximately 2m wide and 1m deep with a gravelly/rocky bed. Vegetation in the channel is restricted to close to the channel banks. As it passes through Donja Borovica, the stream is retained within an artificial channel with natural bed and vertical concrete walls. It is approximately 3m wide and 1.5m deep. Four flow monitoring points are located along the Borovički stream (PP-I – PP-IV). PP-I, PP-III and PP-IV are located upgradient of Donja Borovica. PP-II is located within the village of Donja Borovica. Further information on these monitoring points is provided below. A water offtake pump station, Sastavce pump station, supplying exploration drilling works at the Rupice concession has been installed on the Borovički stream upstream of PP-I. A concrete narrow-crested weir has been installed across the channel, with the offtake pipe installed to the right (upstream) of the weir and the pumps housed on the right bank of the channel immediately downstream of the weir.

4.9.6.3 Vrući Stream

The Vrući stream is a small mountain stream to the west/north of the Rupice concession. The stream receives runoff from the Kiprovac ridge and flows are maintained during summer by groundwater and spring-flow discharge. The name Vrući Potok means 'hot stream' but it is not known where the term derives from and whether it refers to an unusual characteristic of the stream. Groundwater discharges as baseflow into the low points of the river basin. The stream flows north for 2.5km from its source to its confluence with Trstionica, a tributary of Bosna River.

One flow monitoring point (PP-V)) is located along the Vrući stream. PP-V is c.100m north of the Rupice concession. Additionally, a surface water quality monitoring point (Hot Stream Upstream WQ measurement) has been utilised to confirm upgradient baseline condition of the surface watercourse. Hot Stream Upstream WQ measurement is located c.150 upstream of the PP-V. Further information on these monitoring points is provided in Section 2.4.

Based on empirical flow estimation methods (outlined by Oruč et. al. (2019) and subsequently updated by WAI, May 2021) the average annual flow estimates for the Borovički and Vrući streams are 223l/s

(PP-II) (based on data collected between April 2020 and March 2021) and 20l/s (PP-V) (based on data collected between December 2020 and May 2021) respectively. In drier months between May and September flows in the Vrući stream have been recorded below 5l/s (PP-V) increasing to approximately 13l/s for periods of approximately 6 hours following rainfall. Flows increase substantially in late autumn, winter and spring.

A flow duration curve was developed to describe the flow regimes at the PP-II site, Figure 4.9.1 (WAI, May 2021).

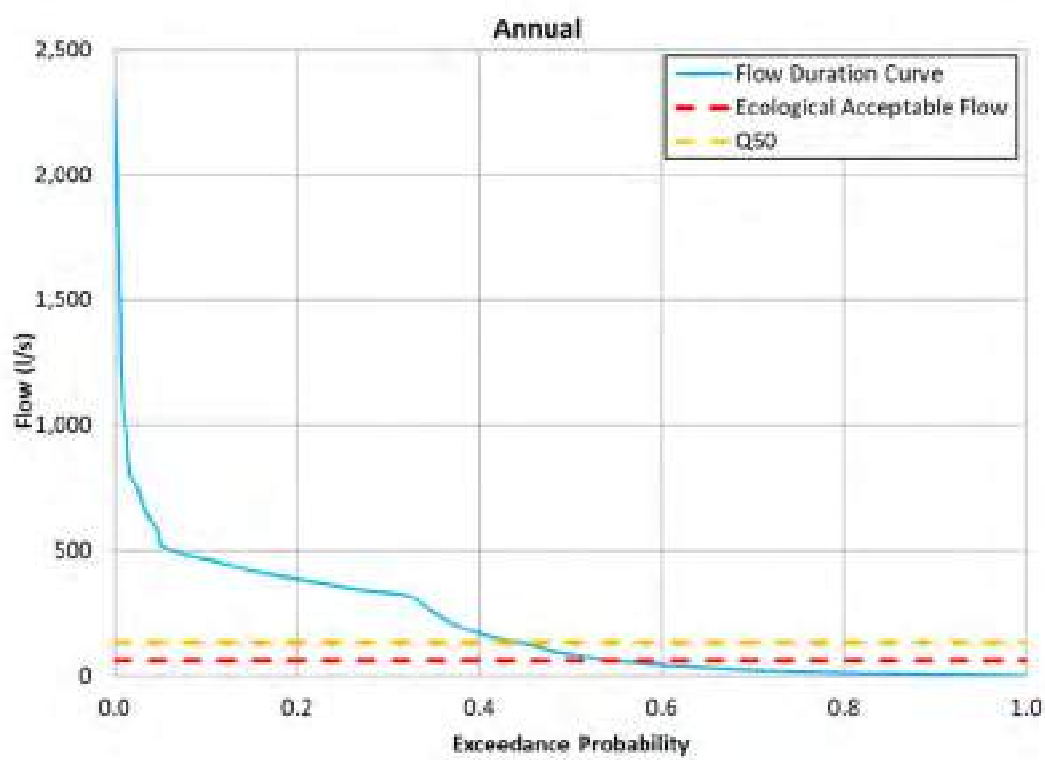

Figure 4.9.1: Flow Duration Curve April 2020 to March 20201 Borovički Stream (PP-II)

From the flow duration curve, using a more conservative empirical method for flow derivation (as opposed to the observation record which may have been skewed during the recording period by atypical wet weather events) the Q50 (median) and the low flow regime (Q10) can be derived. The minimum environmental flow required to be maintained in the Borovički and Vrući streams are 60.9 l/s (PP-II) and 10.1l/s respectively (Summer conditions – May – August) and 15.4/s and 3.8l/s (winter conditions – November – April).

The flow calculations for the Vruci Potok have been derived from a flow record less than one year and is therefore not yet compliant with BiH regulations. It is also important to note that there have been a number of logger errors during the recording period at the PP-II monitoring location.

4.9.6.4 Trstionica

Flow measurements undertaken on the Trstionica have been recorded upstream of the confluence with the Hot Stream over seven rounds in July 2021. The data available suggests an average flow of approximately 42 l/s with an increase in flow to 366 l/s following a wet weather event.

4.9.6.5 Mala River

The Mala River is located within the VPP concession area. This mountain stream is a tributary of the Stavnja River, itself a tributary of the Bosna River. It has several smaller branches, one of which flows southwards through the VPP concession. This smaller branch is described in this section and is referred to as the Mala River.

The Mala River has its source upstream of the VPP concession and flows south-west for approximately 3.3km through the concession to its confluence with the larger Mala River which then flows and joins the Stavna a further 14 km downstream at Podlugovi As stated, the upstream Mala river effectively disappears beneath the open pit to remerge downstream of the southern pit margin. The channel is approximately 1m wide throughout its length with a gravelly/rocky channel bed. It is carried in a culvert for approximately 1km under the existing tailings pond and tailings embankment (dam) before discharging to a small concrete basin with a broad crested weir at its downstream end and then returning to its natural channel. The concrete basin is located approximately 300m downstream of the tailings dam. Further downstream of the tailings pond the Mala river is again diverted into a portal and culverted to re-emerge forming a lake empoundment upstream of where the the Vares iron ore waste rock dump blocks the Mala valley.

An eastern branch of the Mala river, hereafter referred to as the Mala River (eastern branch) also flows south-westerly, c.2km east of the Mala River (as indicated by the hPPV-7 monitoring point in Figure 4.9.2), before joining the mainstream channel at their confluence, c.2km south of the proposed mineral processing facility.

Six flow monitoring points (PPV-3 – PPV-6, PPV-10 and PPV-11) are located along the Mala River. PPV-6 is located up-gradient of the VPP concession, PPV-4 and PPV-5 are located upgradient of the tailings dam but down gradient of the existing open pits, whilst PPV-3, PPV-10 and PPV-11 are located down-gradient of the tailings dam.

Average flow estimates for the Mala river are presented in Table 4.9.2. Results from PPV-3 are taken from measurements taken between May 2020 and June 2021 (12-month period), whilst results from PPV-5 have been collected between December 2020 and May 2021.

Table 4.9.2: Average Flow values for Mala River		
Catchment	**Area (km²)**	**$Q_{Average}$ (l/s)**
PPV-5 - Upstream near existing mine	0.90	17.6
PPV-3 downstream of TSF (measured)	-	115.0

A flow duration curve was developed to describe the flow regimes at the PPV-3 site, Figure 4.9.2 (WAI, Oct 2020).

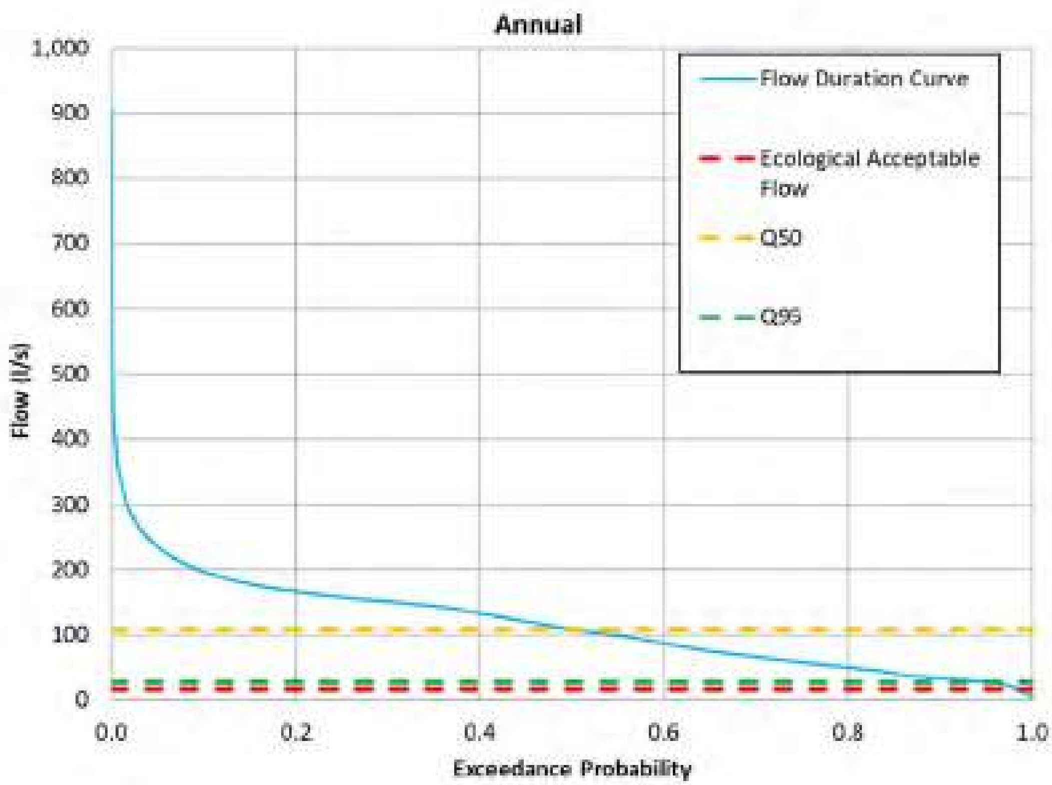

Figure 4.9.2: Flow Duration Curve April to August 2020 Mala River (PPV-3)

From the flow duration curve, the Q50 (median) and the low flow regime (Q10) can be derived. The minimum environmental flow required to be maintained in the river Mala at all times downstream of any reservoir or abstraction point is 17.2l/sec 16.1l/s in summer (May – Oct) and 13.0l/s in winter (Nov-April). This has been derived by calculating 10% (winter) and 15% summer of average flow rates in accordance with the BiH regulations. A more conservative approach would be to adopt the Q95. Q95 values for the annual monitoring period is 26.7l/s (27.43l/s summer and 26.8 winter) as presented in the green dashed line of Figure 4.9.3 .

4.9.6.6 Assimilative Capacity

The ability of the local watercourses to assimilate waste-water flows is important for both sites because at VPP storm water run-off, attenuated first through overland flow will interact with the Mala river, at Rupice the Vrući Potok will ultimately receive (treated) site drainage and wastewater outflows from the on-site ablutions.

The Mala river assimilative capacity is calculated as a factor of 9 (dilution) for low flow conditions and 27 for average flow compared to the nominal annual run-off rate. No sewage will be discharged into the Mala.

The Vrući Potok assimilative capacity is calculated as a factor of 0.5 (dilution) for low flow conditions and 2 for average flow compared to the nominal annual run-off rate. Treated sewage discharge assimilative capacities are 20 and 80 for runoff and treated sewage effluent respectively. This applies to the approximate 1500m reach until it flows into the Trstionica at which point the assimilative capacity increases substantially to over 4 and 168 for runoff and effluent respectively using the conservative average flow condition.

4.9.7 Baseline Hydrogeology

4.9.7.1 VPP

The main elements of the VPP site are discussed in turn: the former process plant site area, the historic TSF area, and the historic Veovaca open pit.

4.9.7.2 Process Plant Site

The VPP is located on a low permeability Jurassic-Cretaceous formation which is part of the northern flank of the anticline forming the mineralisation structure. Groundwater flow is not significant, the terrain being primarily drained by surface runoff.

The processing plant has previously been characterised as a brownfield site with known contaminated land status. The site is undergoing remediation as part of its redevelopment. The JICA 2014 report[11] reported underground and above ground storage tanks, in poor condition and probably leaking, containing a variety of unidentified organic contaminants including but probably not limited to NADAR flotation reagent. The remediation of wastes and wastewater management is controlled by the site's demolition permit conditions.

Samples of river water taken from the nearby Mala River catchment, both upstream and downstream of the site have existing concentrations of lead and zinc above BiH Maximum Admissible Quality concentrations (Enova, 2019)[12]. The elevated levels are indicative of general background geochemistry in the area and the contribution of metalliferous seeps from the Veovaca pit and road side walls mixing with the headwaters of the Mala river.

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[11] The Project for Master Plan for Remediation of Hot Spots in BiH, Japan International Cooperation Agency JICA Expert team, May 2014

Residents from Tsovci village close to the north and western site boundaries obtain their water supply from a pipeline and reticulation system sourced from a drilled groundwater production well at Lalića Mlin located east-southeast from the VPP and existing open pit and between the settlements Višnjići and Brgule. The source at Lalića Mlin is essentially in the next (eastern) valley and a separate catchment. The well is in a forest area installed into limestone and with its own source protection buffer zone, according to the Enova 2019 Environmental Impact Study[12].

In August 2020, investigation piezometers (MW20-05, MW20-01, MMW20-02) were drilled at the VPP to a depth of 40m with no water strike or groundwater encountered in the three boreholes which were located at the likely upgradient, side and downgradient margins. The program was terminated after the three initial holes were found to be dry confirming no water table present at elevations that could reasonably be assumed to interact with surface related contaminant sources. Based on the thick hard-rock unsaturated zone encountered, it can be assumed that effects from contaminant leaching would be negligible. As such, the information demonstrates no basis for the need to derive remediation or risk-based action levels for groundwater protection in the area of VPP. In effect this means the clean-up of the site is wholly driven by removal of surface materials, wastes and demolition relating to human health protection criteria (rather than human health + groundwater).

4.9.7.3 Existing Veovaca Open Pit

An existing open pit left over from previous historic operations is located c. 1650m north-east from the VPP. Although the existing open pit is not part of the project it likely has an influence over much of the pre-existing baseline character of the Mala River and therefore is considered when determining the study area's baseline character.

The open pit has a small water course that flows along the pit base along a line that separates exposed ore rock face (west and north-west) from historically dumped wastes, east- southeast. The water course has flows less than 5l/sec which are derived from pit wall seeps and are evidently ochreous. The pit was formerly kept dry by sump drainage channels on the lower benches of the pit which collected rainfall and surface water. No well-points or borehole pumps were reported to have been used during prior operation of the pit. The pit base has four shallow monitoring wells installed which record a shallow water table several metres below the current pit base. Downstream (south) of the current pit margin, springs and seeps emerge in the vegetated slopes which form the head stream of the Mala river.

4.9.7.4 Rupice

The Rupice prospect is located on the western slope of Kiprovac Ridge. The prospect has southern and northern extensions identified as Jurasevac-Brestic and along the Borovica corridor: Kraljeva Jama,

[12] ENOVA, 2019. Environmental Impact Study for the Project f Renewal of Lead, Zinc and Barite ore Exploitation and Processing Facility at the Location of Veovaca I- Tisovci I – Veovaca II.

Siroki Radakovac, Ceo Sutjeska and Zakruzje24. A high-grade mineralised zone has been identified and hydrogeological drilling to date has targeted this.

Rupice is mainly drained by the Borovički stream, which is a tributary of the Bukovica River. It is also believed that part of the Rupice area is drained by the Vrući stream towards the Trstionica Basin in the northeast. The hydrogeological setting of the Rupice area is characterised by a fine-grained Triassic aged fractured dolomitic limestone with low bulk permeability. Although karst is not in direct contact with the deposit, the area is in close proximity to bare karst hillsides towards Osredak a few hundred metres east, and underhanging caves and caverns along the Borovic Donja road. Furthermore, paleo karst voids may be present, at depth in the dolomitic limestone. This landscape is described as having a complex system of sinks and hydraulic connections between groundwater and surface water with rapid and open exchange of water between the surface and subsurface.

A hydrogeological conceptual model developed for the Enova 2019 Environmental Impact Study[12] describes the Rupice high grade mineralised zone as being partly enclosed within a dolomitic limestone aquifer host rock, as well as the dolomite forming sections of the hanging wall. The dolomitic limestone aquifer is overlain and partially confined by cherts. The aquifer is a fracture flow system, with preferential flow zones developed in areas of fracturing and along fault brecciated margins of unit blocks. The aquifer geometry comprises a series of complex compartments created by repeating (duplex) thrust sequences. The aquifer is variably confined and unconfined depending on location. Recharge from rainfall infiltration is more developed at peripheral areas where bare karst and fissured limestone is exposed. A near simultaneous increase in groundwater level was observed in three BRP piezometers during a period of snowmelt in late February / early March 2018. This suggests a relatively direct and rapid groundwater transport system which also correlated with an observed temperature drop in groundwater at this time.

Lower Triassic sandstones and clays form the aquifer base and cherts and iron and manganese hardpans form confining layers. In the Brestic-Jurasevac area which forms the general south eastward extension from the high-grade mineralised zone, the aquifer is considered to be larger and more continuous than the blocks in the Rupice area. A hydrogeological conceptual cross-section is included in the impact assessment chapter (Chapter 5.7) to illustrate groundwater features associated with the mine. On the basis of piezometry showing significant different heads (i.e. 90m difference) in adjacent dolomite blocks and reports of sub-artesian and artesian water strikes in some of the exploration boreholes it is concluded that there is a likelihood of confined groundwater being encountered during mining (refer to Section 3, Project Description Dewatering). The degree of interconnection and storage that will control the overall drainage and outflow into a mine is being assessed by ongoing numerical modelling. A preliminary analysis of hydrogeology and inflows was completed at the PFS stage (WAI, 2020). Given the confined nature of the groundwater system and some artesian responses seen, it is assumed that relatively high pressure heads will be encountered during mining. The inflows may deplete relatively rapidly as limited storage in the system is exhausted, however as there are indications of direct recharge pulses associated with seasonal effects on exposed limestones and dolomites in the vicinity of the mine, it must conservatively be assumed that there will be continuous inflows throughout the life of mine.

4.9.8 Baseline Programme

A baseline collection programme has been designed to assess hydrological and hydrogeological conditions within the Rupice and VPP concessions. The baseline collection programme is comprised of surface water and groundwater quality sampling as well as groundwater elevation monitoring and stream gauging. The baseline collection programme is outlined in greater detail below.

4.9.8.1 Hydrology – Monitoring

Within the Rupice concession, two weirs located on the Borovički stream (PP-I and PP-II) were constructed, calibrated and recorded since 2018. These have been supplemented by two additional weirs (PP-III and PP-IV) designed to measure the run-off from the Kiprovac ridge unaffected by the abstractions occurring at the Sastavce pool. Furthermore, a new weir (PP-V) has been constructed along the Vrući stream to the north of the Rupice concession area. Photographs showing weir design at PP-IV (Photo 4.9.1) and PP-V (Photo 4.9.2) are provided below.

Photo 4.9.1: Weir Installed along the Borovicki at monitoring Point PP-IV.

Photo 4.9.2: Weir Installed along Vruci Potak at PP-V

Within the VPP concession, one existing weir along the Mala River has been utilised (PPV-III) downstream of the old tailings dam, whilst five new weirs have been installed (PPV-4 - PPV-6, PPV-10 and PPV-11). Each flow monitoring station has been specifically site-selected, hydraulically designed, and permitted. Largely the weirs are broad-crested weirs, with a sharp crested rectangular weir at PPV-11 which is the small water course flowing in the base of the existing pit. Stilling wells using 50mm diameter screened piping have been used to house divers (pressure transducers) at the weirs. Pressure transducers have been set up to record water levels every 15 minutes. Barometric loggers have been installed within the Rupice and VPP concessions to compensate water elevations according to atmospheric changes. Meteorological data collection has been synchronised with surface water flow rate measurements. Table 4.9.3 provides information on each flow monitoring point, including the watercourse, weir type and status of weir. Drawing 4.9.1 and Drawing 4.9.2 provide maps of monitoring programmes employed at Rupice and VPP respectively.

Table 4.9.3: Hydrological Flow Recording

Monitoring Point	Watercourse	Weir Type	Status
PP-I	Borovički stream (Sastavce Pond)	Broad Crested Weir	Existing
PP-II	Borovički stream (below village)	Broad Crested Weir	Existing

Table 4.9.3: Hydrological Flow Recording			
Monitoring Point	**Watercourse**	**Weir Type**	**Status**
PP-III	Borovički stream (west tributary)	Broad Crested Weir	Constructed for ESIA Baseline
PP-IV	Borovički stream (north tributary)	Broad Crested Weir	Constructed for ESIA Baseline
PP-V	Vrući stream	Broad Crested Weir	Constructed for ESIA Baseline
PPV-3	Mala River (below TSF)	Broad Crested Weir	Existing
PPV-4	Mala River (above TSF)	Broad Crested Weir	Constructed for ESIA Baseline
PPV-5	Mala River (near future reservoir site)	Broad Crested Weir	Constructed for ESIA Baseline
PPV-6	Mala River (pit stream)	Broad Crested Weir	Constructed for ESIA Baseline
PPV-10	Mala River (above lower lake)	Broad Crested Weir	Constructed for ESIA Baseline
PPV-11	Mala River (below lower lake)	Sharp Crested Weir	Constructed for ESIA Baseline
Trstionica 1	Trstionica, upstream of the confluence with the Vruci Potak	n/a	n/a
Trstionica 2	Trstionica, down-stream of the confluence with the Vruci Potak	n/a	n/a

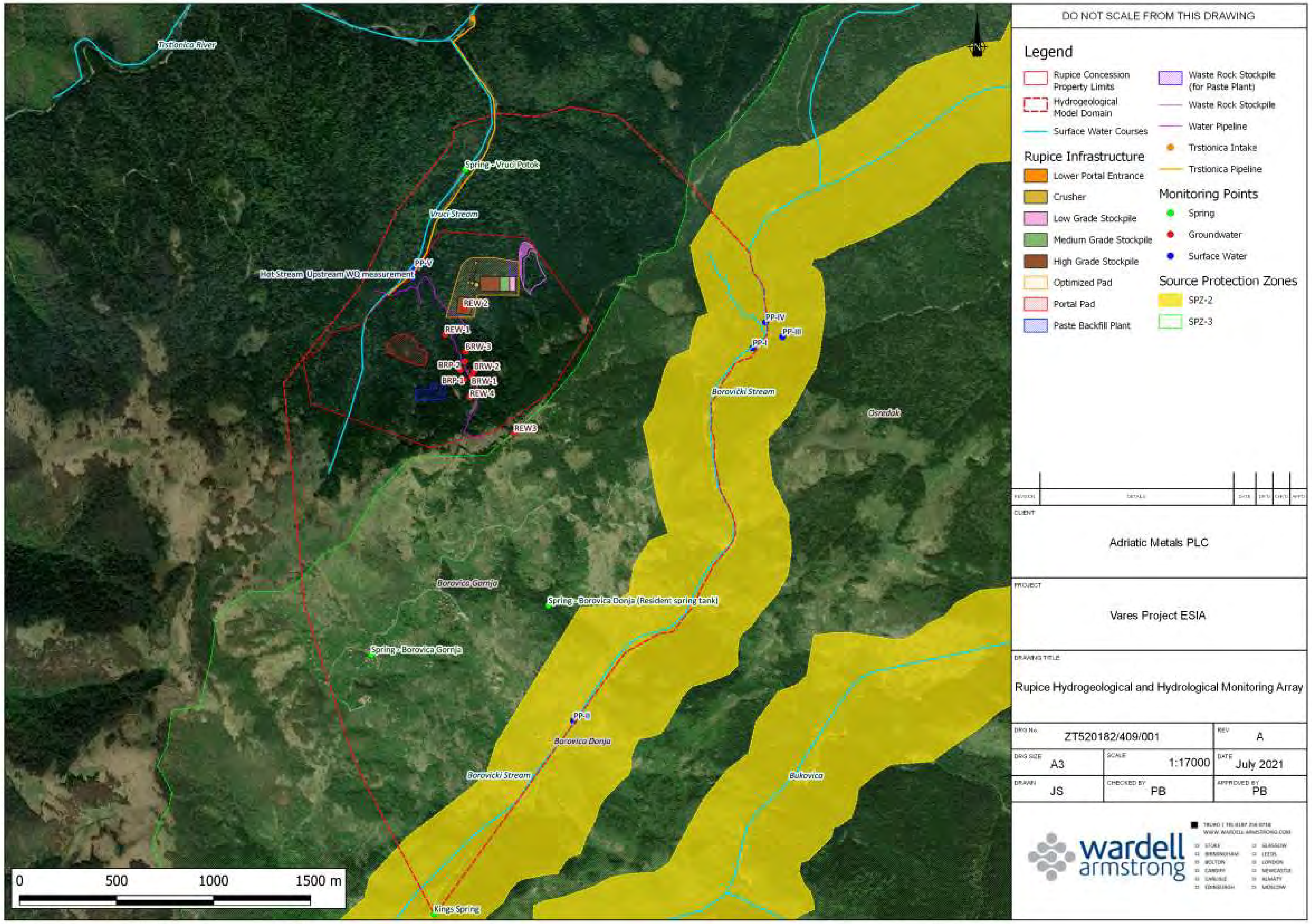
Trstionica River

Monitoring on the Trstionica River was excluded from the initial ESIA baseline monitoring as it lies outside of the concession area. The Trstionica River has been included at a later date, as the Vruci Potok which was assessed as a candidate option has proved, after monitoring, to be insufficient in reliable yield to meet supply requirements. Data collection and monitoring along the Trstionica is ongoing, with works beginning in June 2021. A breakdown of the ongoing works being undertaken on the Trstionica River is provided below:

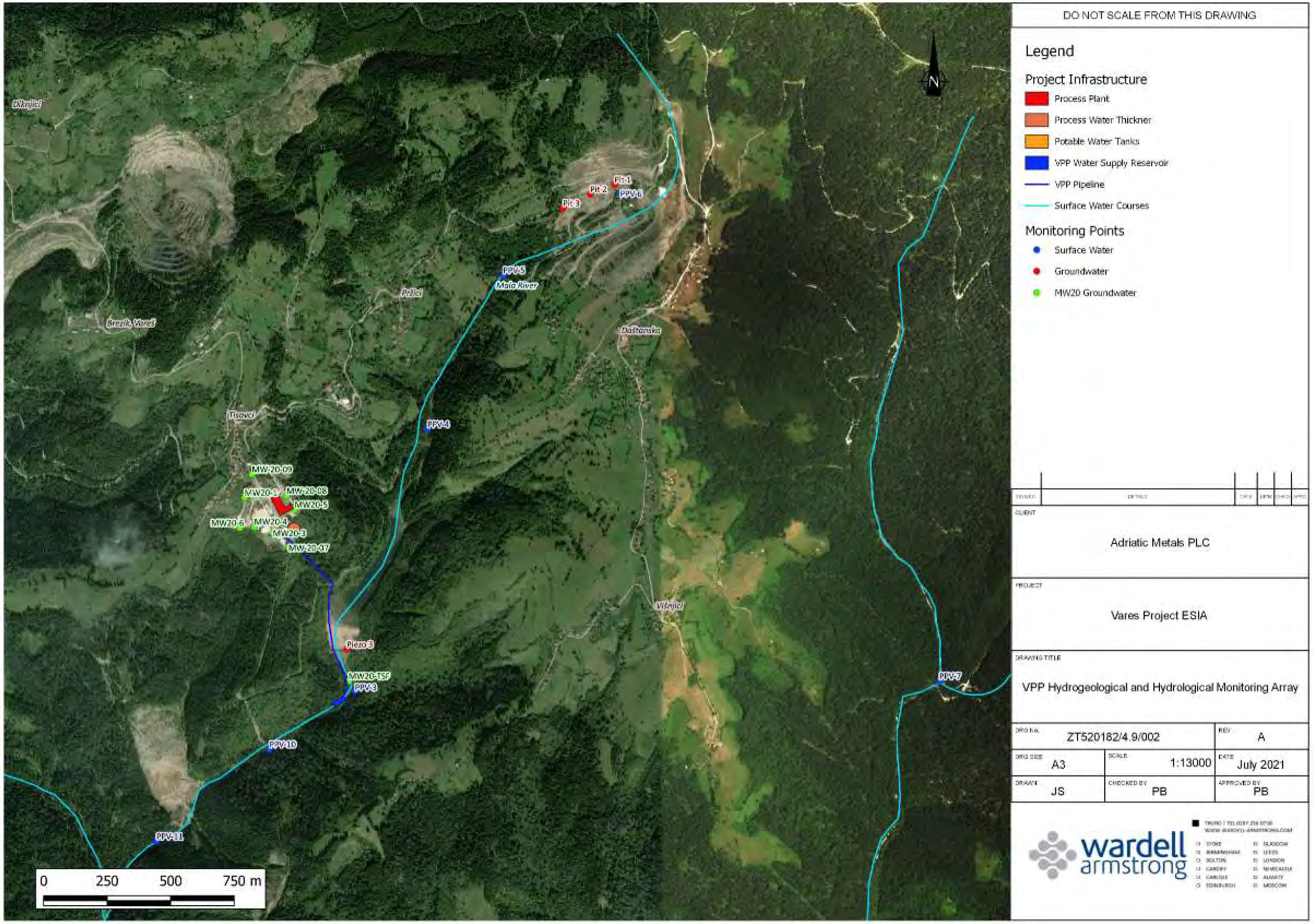
- A photo record of viable locations (with sufficient riverbank space to install a pumping station and intake) upstream and downstream of the confluence with the Vruci Potak;
- Installation of staff gauge, measuring the height of the river level, at the upstream monitoring location;
- Collection of spot flow measurements of river height and velocity (using an impeller meter) at both locations. At least six manual measurements spaced over a 3 week period, on each occasion physio-chemical measurements (temperature, pH, conductivity, turbidity) should be taken;
- Surveys of the river cross sections at both monitoring points, divided into vertical sections (0.3m apart). Velocity should the be recorded at a set depth;
- At least two full-parameter (i.e. as per the ESIA monitoring) water quality samples and laboratory analysis;

- Simple stilling wells and pressure level recorders set up with a diver to get a continuous flow record. Hydrological analysis will be undertaken on this to develop some correlations with other records and predict a longer term flow variation.

The Trstionica is a Class I river regulated by both the local municipality (Kakanj) and the Sava River Agency. Ongoing monitoring comprises stream flow measurements, profiling and water quality sampling and analysis.



Drawing 4.9.1: ESIA Monitoring Locations at Rupice



Drawing 4.9.2: ESIA Monitoring Locations at VPP

Water quality sampling has been undertaken on a monthly time-step within springs and surface watercourses (Vrući stream, Borovički stream and the Mala River) as part of the baseline data collection programme. Surface water and spring water quality sampling began in May 2020 with most recent data collected in May 2021. Table 4.9.4 provides information on surface and spring water sampling.

Table 4.9.4: Summary of Surface and Spring Sampling

Monitoring Point	**Sample Type**	Water Course
Rupice		
Spring - Gornja Borovica (Spring Box)	Spring	N/A
Spring – Gornja Borovica (Residents Spring)	Spring	N/A
Spring Vrući Potok (Hot Stream)	Spring	N/A
PP-I	Surface Water	Borovički stream
PP-II	Surface Water	Borovički stream
PP-III	Surface Water	Borovički stream
PP-IV	Surface Water	Borovički stream
PP-V	Surface Water	Vrući stream
Hot Stream Upstream WQ measurement	Surface Water	Vrući stream
VPP		
PPV-3	Surface Water	Mala River
PPV-4	Surface Water	Mala River
PPV-5	Surface Water	Mala River
PPV-6	Surface Water	Mala River
PPV-7	Surface Water	Mala River (Eastern Branch)
PPV-10	Surface Water	Mala River
PPV-11	Surface Water	Mala River

Water samples have been analysed for **Major Ions**, including: Ionic Balance, Carbonates, Alkalinity, Calcium, Magnesium, Sodium, Potassium, Chloride, Fluoride, Sulphate, Phosphate. **Physio-Chemical Parameters**, including: Electrical Conductivity, Total Dissolved Solids, pH and Total Suspended Solids. **Nutrients**, including: Ammoniacal Nitrogen as N (filtered), Ammoniacal Nitrogen as N. Nitrate as N and Biochemical Oxygen Demand. **Minor ions**, including: Aluminium, Arsenic, Barium, Boron, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury, Nickel, Selenium, Tin, Zinc, Cyanide (total) and Sulphide. **Micro-Biological Indicators of Sanitary Contamination**, including: E-Coli and F-Coli. **Hydrocarbons**, including: Total TPH and Total PAH. From November 2020, Thallium was sampled within both spring and surface water samples following its discovery within the orebody during metallurgical testwork. In-field handheld physio-chemical measurements, including Total Dissolved Solids, pH, Electrical Conductivity, Temperature and Dissolved Oxygen have also been taken.

4.9.8.2 Hydrology – Results

Flow

Surface water levels have been recorded automatically at PP-II – PP-V (Rupice) and PPV-3 – PPV-6, PPV-10 and PPV-11 (VPP) monitoring points between 02/04/2020 and 31/05/2021. PP-II and PPV-3 host the longest hydrographic monitoring period, whilst the other monitoring points were installed more recently. Automated elevation readings have been compensated using barometric recordings and converted to flow rates using site-specific coefficients (Esad Oruč, August 2020). Flow rates recorded at each of the monitoring points are summarised in Table 4.9.5. PP-II and PPV-3 hold the longest hydrographic records, with the other ESIA monitoring points not being installed until Q4 2020.

Table 4.9.5: Stream Flow Statistics

Monitoring Point	Flow Rate (l/s)		
	Min	Max	Average
PP-II	0	2308	199
PP-III	0.73	468	40
PP-IV	0	448	49
PP-V	0.3	171	20
PPV-3	3	906	112
PPV-4	2	167	32
PPV-5	0	198	17
PPV-6	0	5	0.5
PPV-10	1	533	206
PPV-11	0.1	32	3

Figure 4.9.4 and Figure 4.9.5 plot flow rates recorded within the Rupice and VPP concessions respectively, with rainfall recorded at respective weather stations.

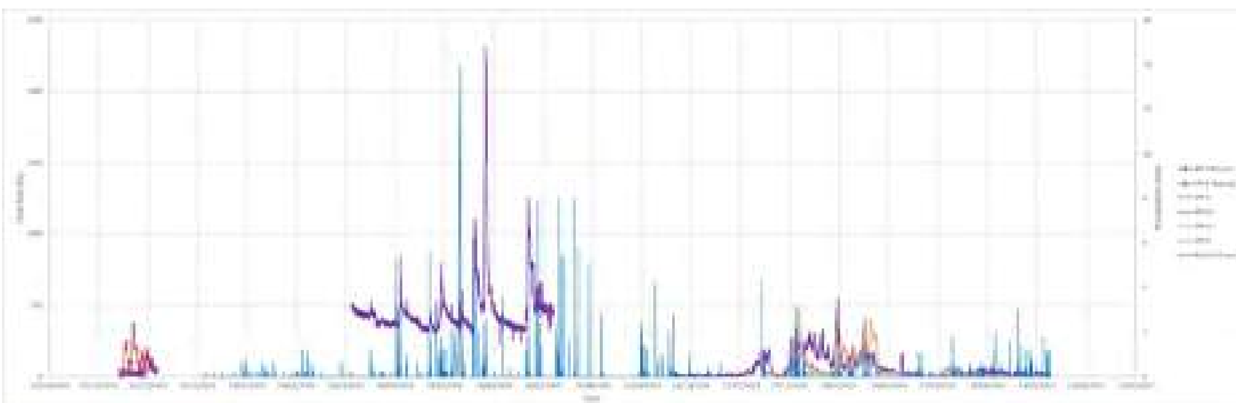


Figure 4.9.4: Surface Water Flow Rates Plotted with Rainfall Data at Rupice

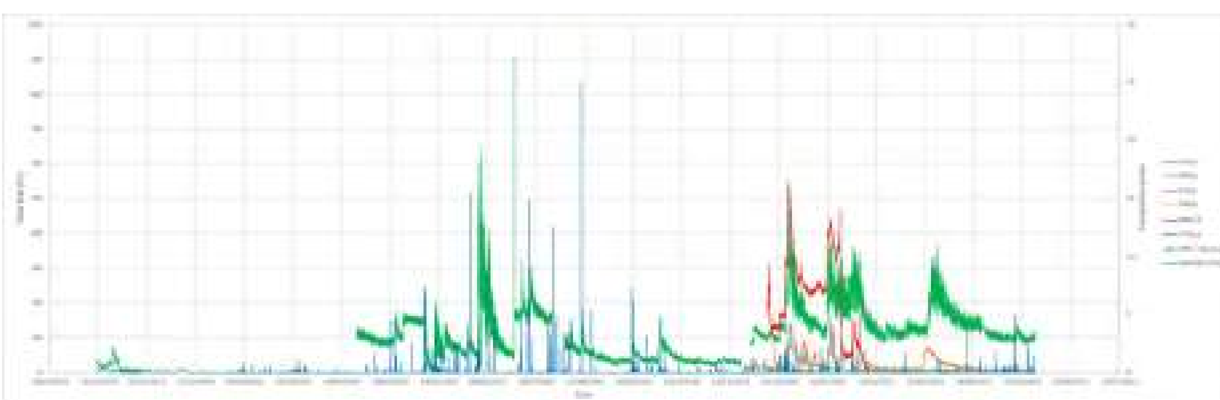


Figure 4.9.5. Surface Water Flow Rates Plotted with Rainfall Data at VPP

Average flows (Qo), Q95 and Q50 for PPV-3 (Mala) and PP-II (Borovicki) are provided in Table 4.9.6 below.

Table 4.9.6. Flow rates recorded at PPV-3 and PP-II

Mont. Point	Flow Rate	Annual May - June (l/s)	May - Oct 2020 (l/s)	Nov - Apr 2020/21 (l/s)
PPV-3	Qo	114.97	107.62	129.94
	Q50	107.76	91.22	119.71
	Q95	26.70	27.43	26.80
	Ecological Acceptable Flow (Qeaf)	-	16.1	13.0
PP-II	Qo	222.70	405.97	75.54
	Q50	133.727	390.244	40.957
	Q95	8.95	3.95	4.05
	Qeaf	-	60.9	7.6

Flow rates recorded at PPV-3 (Mala River) display slightly subdued hydrographs in comparison to PP-II (Borovički Stream). The catchment of PPV-3 is greatly modified with both the Veovaca open pit acting as a potential sink and a significant stretch of the stream watercourse culverted beneath the tailings dam and receiving decant overflow from the TSF supernatant. The flow recorded at PPV-3 includes a component of flow from a side valley, the component of culverted flow of the Mala which flows beneath the historic TSF and a further side-stream which is believed to be a piped drain collecting the old TSF decant water. In general, flow rates respond rapidly to rainfall events at all of the monitoring locations. The flow in the Mala river is shown to accrete significantly downstream. Flow rates within both PPV-3 and PP-II were recorded at their highest following a period of prolonged rainfall at the end of June 2020 and to a lesser extent following high rainfall conditions in December 2020 and January 2021. Flow rates were at their lowest in PPV-3 and PP-I in November 2020 when rainfall events were limited. Flow rates within the Vruci Potok display a more subdued hydrograph when compared to flows seen within the Borovicki.

As expected within a steeply sloping mountainous environment, the hydrographs above display short-lived flashy responses to rainfall events. In general in the unmodified Rupice catchments, flow rates respond rapidly to rainfall events. The Borovički stream at PP-II appears to have a higher baseflow rate to the flow rates seen within the Mala River at PPV-3 between March and August 2020. Baseflow to the Borovički stream appears to be sustained at around 400 – 500 l/s during this time, whilst baseflow to the Mala River appear to be sustained at around 100 – 200 l/s. However, following equipment calibration and a data gap associated with equipment failure, the Borovički flow rate is seen to drop substantially (flow appears to drop by c. half). This coincided with a period of reduced rainfall compared to the previous monitoring period and therefore it is unclear whether this is a true representation of the system or erroneous equipment reporting. Flow monitoring along the Mala

River does show a drop throughout September to December in line with what is being shown by these Rupice data.

Peak flow events observed within Figure 4.9.4 and Figure 4.9.5 appear to correspond to periods of sustained high rainfall/high rainfall events but not necessarily short-term peak events. Baseflow to each of the streams appear to maintain moderate flows during periods of low rainfall. It is noted that flow rainfall events during April and May 2020 are much higher than those experienced during the same months in 2021.

Flow rates within springs in the Rupice Concession, identified in Table 4.9.4, have been recorded on a monthly time-step, between April 2020 and May 2021, at the same time as water quality samples were taken. Spring flow rates were recorded using a stopwatch and container. Results from monitoring vary between 1l per 6.2 sec on 08/07/2020 to 1l per 22 sec on 10/10/2020. Figure 4.9.6 indicates spring flow rates with precipitation recorded at the three springs displayed in Table 4.9.4.

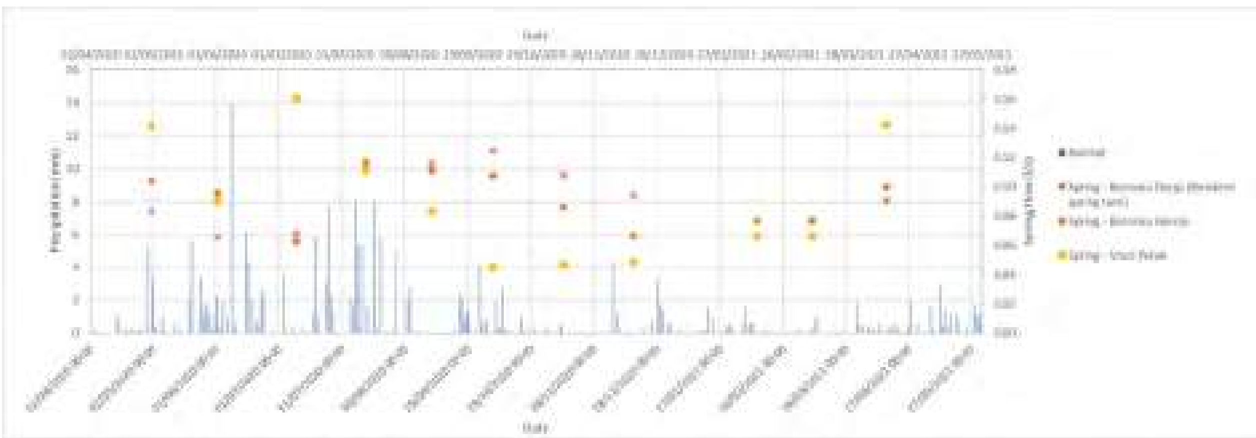


Figure 4.9.6: Spring Flows from Manual Measurements with Monthly with Precipitation

Flows within the Vrući Potok Spring appear the most varied, recording the highest and lowest Spring flow rates during the monitoring period. In general, spring flow rates appear to follow the rainfall hydrograph, recording highest flows following periods of high rainfall (spring months) and lowest flows during periods of low rainfall (summer months and winter freezing conditions). Flow rates are at their greatest in April 2020 and 2021 and October 2020.

Surface Water Quality

Surface waters and spring sample results have been compared to Bosnian Maximum Permissible Concentrations (Decree on Hazardous and Harmful Substances in Waters) regulations. Where absent, sample results are compared to EU EQS values.

Surface water quality within the Borovički and Vrući Potok appears slightly alkaline with pH values ranging from 7.85 – 8.49 and an average of 8.15. Conductivity varies between 63 and 360 µS/cm.

Spring samples are also slightly alkaline, however have a slightly lower pH range of between 7.24 and 8.49 and an average of 8.02. Conductivity within the springs at Rupice are slightly higher than those seen within the surface waters within the Rupice concession with values ranging from 179 - 471 µS/cm. Results from the Mala river within the VPP concession indicate a wider pH range, however predominantly alkaline. The pH values on the Mala River range between 6.83 – 8.54 and an average of 8.25. Conductivity values within the Mala River are higher than those seen within the Rupice concession, ranging between 202 and 1253 µS/cm.

Surface and spring water samples have been analysed to determine hardness in terms of mg/L CaCO3. Each watercourse has been analysed to determine hardness class. Hardness classes are broken down below:

- 0 to 60mg/L – Soft Water;
- 60 – 120mg/L – Moderately Hard Water;
- 120 – 180mg/L – Hard Water; and
- >180mg/L – Very Hard Water.

Table 4.9.7 below demonstrates the range of hardness reported within surface waters and springs.

Table 4.9.7: Hardness Results within Surface Waters and Springs

Surface Watercourse	Parameter	Minimum Concentration (mg/l)	Maximum Concentration (mg/l)	Average Concentration (mg/l)
Borovički	**Ca**	19	60.1	37.4
	Mg	2.2	12.1	5.1
	Hardness (mg/L of CaCO3)	**56.5**	**200**	**114**
	Hardness	Soft Water	Very Hard Water	Moderately Hard Water
Vrući Potok	**Ca**	50	70.1	60.2
	Mg	2.4	19.4	10.6
	Hardness (mg/L of CaCO3)	**135**	**255**	**194**
	Hardness	Hard Water	Very Hard Water	Very Hard Water
Rupice Springs	**Ca**	46	82.1	67.3
	Mg	0.9	21.8	10.3
	Hardness (mg/L of CaCO3)	**119**	**295**	**210**
	Hardness	Moderately Hard Water	Very Hard Water	Very Hard Water
Mala	**Ca**	44.1	156	103.6
	Mg	7.2	82.6	39.2
	Hardness (mg/L of CaCO3)	**140**	**729**	**420**
	Hardness	Hard Water	Very Hard Water	Very Hard Water

In general surface watercourses and springs across both catchments (Rupice and VPP) are comprised of hard waters. The Borovicki Stream, on average, is classed as a 'Moderately Hard Water' stream, with the minimum values recorded along the Borovicki Stream, classed as 'Soft Water' (56.6mg/L) and maximum values classed as 'Very Hard Water' (200 mg/L). Water within Vrući Potok and Rupice

Springs are comprised of harder waters, on average classed as 'Very Hard Water' (194mg/L and 210mg/L respectively). Water within the Mala River is the hardest throughout both catchments, on average classed as 'Very Hard Water' (420mg/L) with an average hardness two times greater than those seen within the Vrući Potok and Rupice Springs.

Surface water quality samples within the VPP concession indicate exceedances of: Magnesium, Sulphate, Nitrate as N, Zinc, Lead, Aluminium, Total Cyanide, Manganese, Nickel, Selenium, Copper, Iron, Cadmium, Thallium and Chromium with respect to Bosnian MPC Class I-II guidelines. Water quality results have been obtained from a Veovaca borehole ('Pit 1') located beneath the existing pit. The monitoring point was sampled quarterly for all of the ESIA analytical suite (metals, major ions) and graphical results are presented in Appendix 4.9.9. This shows exceedances for arsenic, cadmium, iron, lead, manganese, mercury, selenium and zinc which is interpreted to be from the former mine workings.

Surface water quality samples within the Rupice concession indicate exceedances of: Nitrate as N, Ammoniacal Nitrogen, Cadmium, Zinc, Lead, Total Cyanide, Manganese, Copper, Iron, Chromium, Selenium, Thallium and Aluminium with respect to Bosnian MPC Class I-II guidelines.

Spring Samples within the Rupice concession indicate exceedances of: Nitrate as N, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Nickel, Selenium, Zinc, Thallium and Total Cyanide with respect to Bosnian MPC Class I-II guidelines. With the identification of Thallium at concentrations above assessment criteria in springs and groundwater at both catchments it was decided to extend the analysis of Thallium to surface water samples as of March 2021. Thallium was reported at concentrations of 21 µg/L in PPV-6 (Mala) and 14 µg/L in PP-II (Borovicki – Rupice) which are about half the concentration seen in the spring water samples and similar to the groundwater concentrations.

Suspended solids within surface water samples have been plotted alongside precipitation to evaluate how turbidity in the natural water courses changes during wet weather events. Figure 4.9.7 and Figure 4.9.8 provide suspended solids recorded within surface waters over the monitoring period at Rupice and VPP respectively.

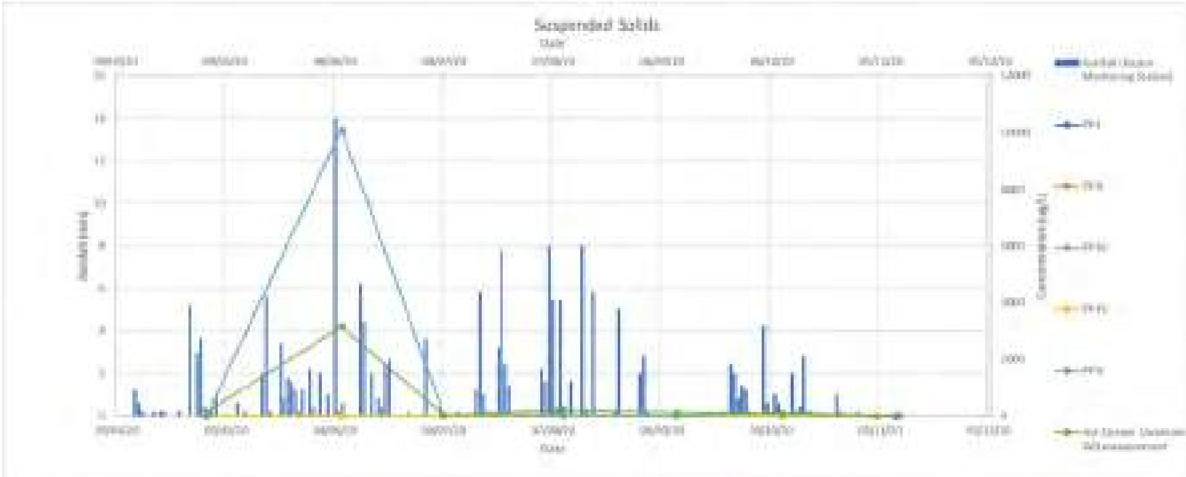


Figure 4.9.7: Suspended Solids Recorded at Selected Monitoring Points within the Rupice Catchment throughout the Monitoring Period

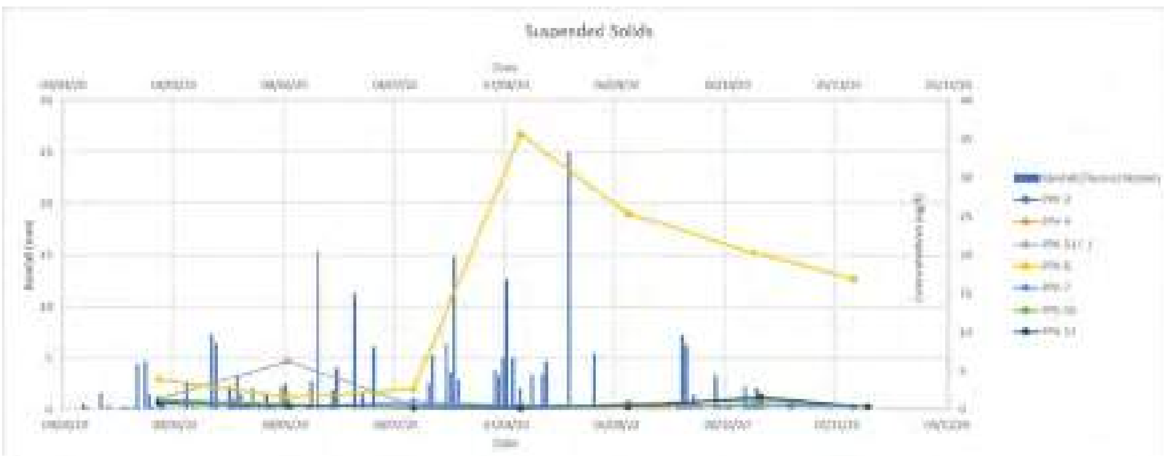


Figure 4.9.8: Suspended Solids Recorded at Selected Monitoring Points within the VPP Catchment Throughout the Monitoring Period

Suspended Solids within the Hot Stream Upstream WQ Measurement and PP-V monitoring points within the Rupice catchment show a marked increase following a high intensity rainfall event in June 2020. Suspended solids within PPV-6 in VPP are also recorded as high following a period of high rainfall.

Coincident with this, concentrations of Fe, Mg, Al, Mn, SO_4 and Cl are also seen to increase following rainfall events and periods of high rainfall within the Rupice catchment. Similarly, concentrations of Mn, Cl and Mg are also seen to increase as a result of rainfall within the VPP catchment. This implies that heavy or prolonged rain mobilises sediment from soil run-off (based on the mineralogy) which is being flushed through surface watercourses hence the suspended sediment loadings. Heavy metal parameters including Ba and Zn appear to be unaffected by rainfall. Graphs of this flush event within Rupice and VPP are provided within Appendix 4.9.1 and Appendix 4.9.2, respectively.

Water quality results have also been analysed using piper plots to determine water typing. Figure 4.9.9 shows Rupice and VPP surface water results plotted together. Figure 4.9.10 shows just VPP surface water results. Figure 4.9.11 shows just Rupice surface water results. Figure 4.9.12 shows Rupice spring results.

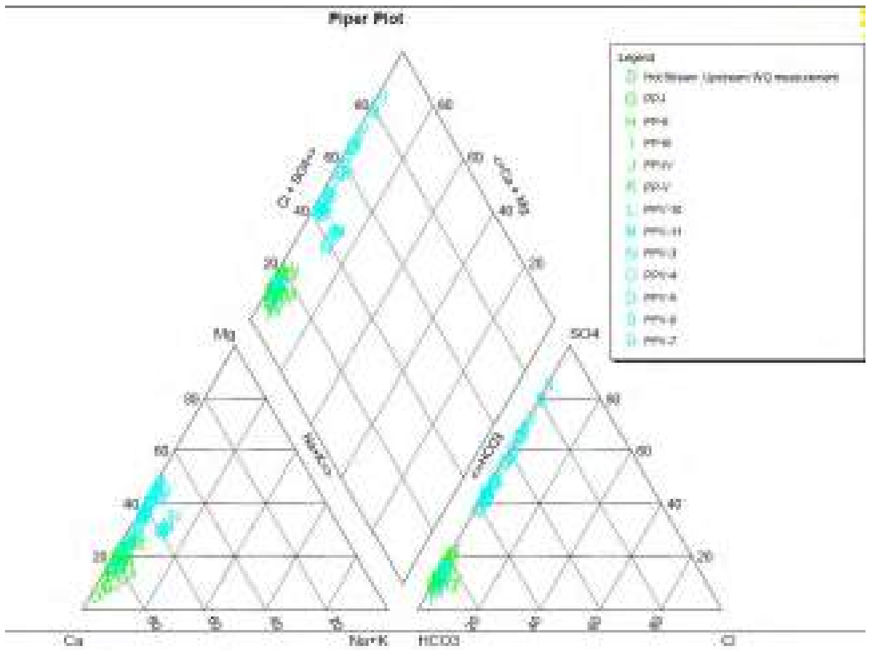


Figure 4.9.9: Piper Plot of Surface Water Quality Results from Rupice Catchment (green) and VPP Catchment (blue)

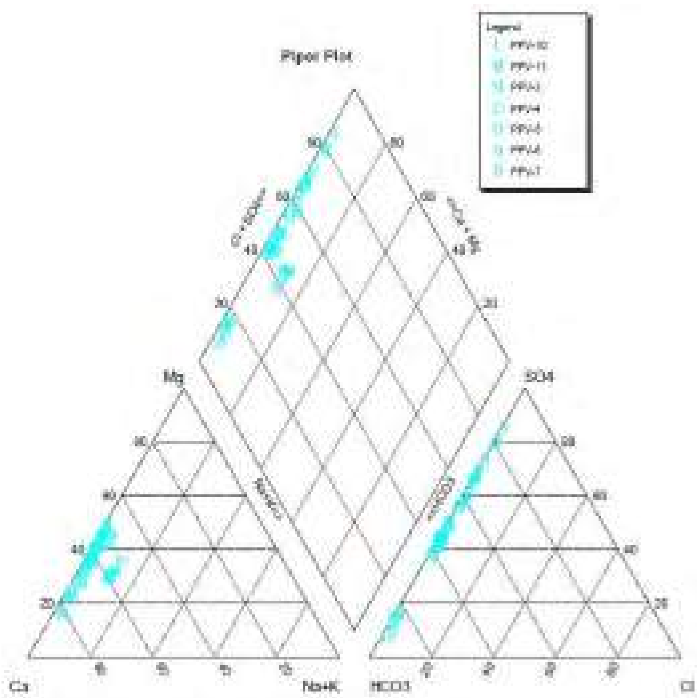


Figure 4.9.10: Piper Plot of Surface Water Quality Results from VPP Catchment

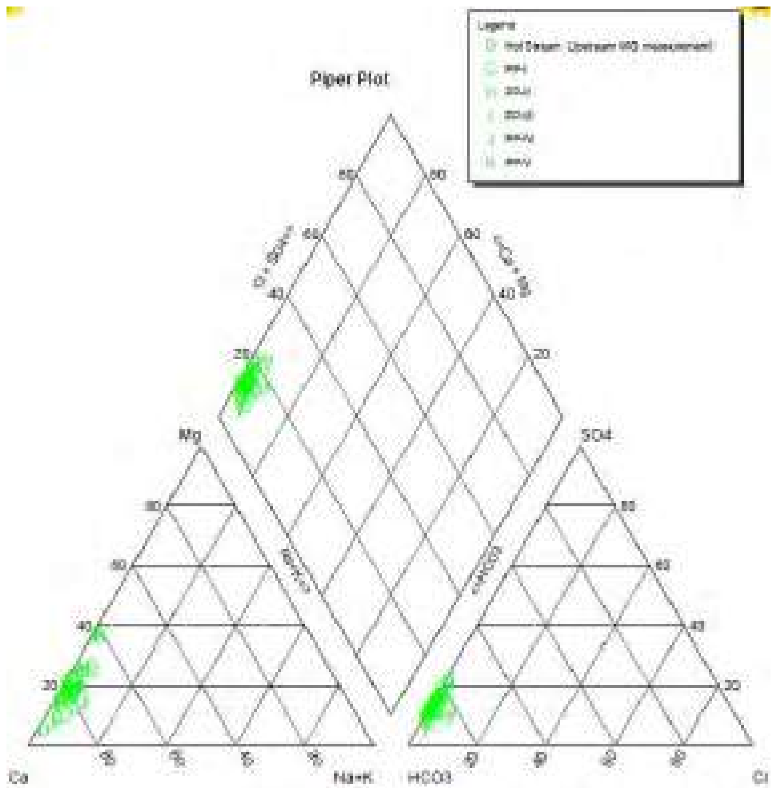


Figure 4.9.11: Piper Plot of Surface Water Quality Results from Rupice Catchment

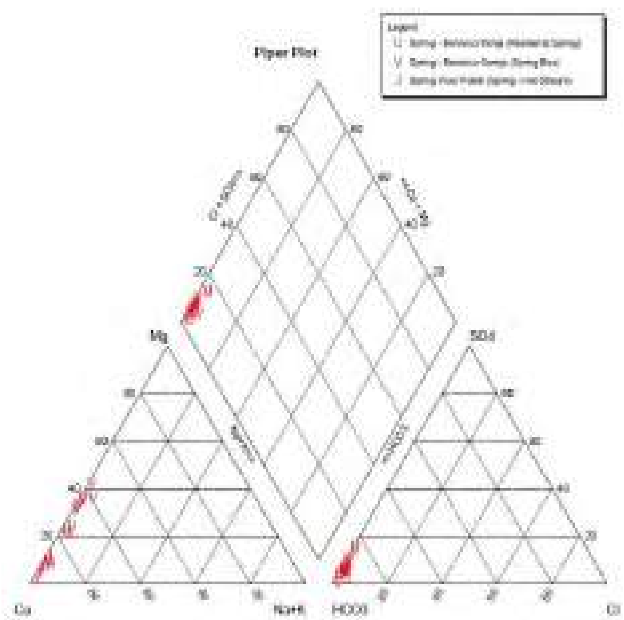


Figure 4.9.12: Spring Water Quality Results from Rupice Catchment

The Piper plot analyses of the surface water and spring samples within the Rupice catchment appear similar, heavily dominated by calcium cations and bicarbonate anions and therefore primarily Ca-HCO_3

water type. Magnesium anions are also present as a secondary cation within some samples up to c. 40% meq/l therefore some samples display a Ca-Mg-HCO_3 water type.

Results from surface water samples within the VPP catchment are more varied, indicated by a slightly higher magnesium cation concentration than samples seen at Rupice. Calcium, however, remains the dominant cation within the VPP catchment. The anion concentrations at VPP are very varied, between bicarbonate dominated waters and sulphate dominated water. This differs from the heavily bicarbonate dominated waters seen at Rupice. Water types at VPP are primarily Ca-Mg-HCO_3-SO_4 and Ca-Mg-SO_4-HCO_3 with some samples displaying Ca-Mg-SO_4 and Ca-Mg-HCO_3 water types.

Graphical results of parameter concentrations compared to guideline values throughout the monitoring period are provided in Appendix 4.9.3 for VPP, Appendix 4.9.4 for Rupice surface water and Appendix 4.9.5 for Rupice spring waters. Full surface water results within conditional formatting to highlight exceedances are presented in Appendix 4.9.6 for VPP, Appendix 4.9.7 for Rupice and Appendix 4.9.8 for Rupice spring water. There are no indications of pre-existing hydrocarbon or PAH presence in the surface waters.

The results for nutrients and other water quality parameters such as ammoniacal nitrogen, nitrate and Biochemical Oxygen Demand in both catchments indicate the presence of low-level agricultural analytes, typically below assessment criteria level but nonetheless discernible. Surface waters have low-level bacterial counts indicative of typical natural soil and catchment runoff.

4.9.8.3 Hydrogeology – Monitoring

Groundwater Elevations

Groundwater elevations within six existing boreholes (BRP-1 – BRP-3 and BRW-1 – BRW-3) have been recorded every 15 minutes using automated pressure transducers within the Rupice concession between April and November 2020. Pressure measurements following the issue of the PFS in November 2020 were relaxed to hourly measurements, up until the end of May 2021. . All locations are still being monitored. Manual groundwater elevations have also been collected on a quarterly basis to cross check transducer data. Groundwater elevations recorded within pressure transducers have been compensated for barometric pressure and converted into meters above mean sea level (m AMSL).

Additionally, four new wells, Rupice ESIA Wells (REW-1 – REW-4), have been drilled to gain further understanding of the site's baseline condition. Monitoring within these boreholes began in February 2021.

No automated pressure transducers are employed with the VPP concession. Water levels are currently monitored manually within four existing boreholes (Piezo-3 and Pit 1 – Pit-3). Three new wells (MW20-01, MW20-02, MW20-05) have been drilled and found dry. A fourth shallow monitoring well is to be installed to measure the phreatic surface elevation downstream of the TSF.

Groundwater Quality

Groundwater quality sampling has been undertaken on a quarterly time-step within the Rupice and VPP concessions as part of the baseline data collection programme. Groundwater quality sampling began in May 2020 on a quarterly basis with the most recent data collected in May 2021.

At Rupice, three existing monitoring wells (BRW-1 to BRW-3) were sampled in May, August and November (2020) as well as February and May 2021 providing 12 months of baseline data. Four newly drilled wells, Rupice ESIA Wells 1 - 4 (REW 2 and REW 3) were also sampled in August, October, November, December 2020 and February and May 2021. Groundwater samples were analysed for a baseline suite of metals, major ions and nutrients.

Groundwater samples at VPP were also collected on a quarterly basis from 2 wells (Pit 1, Piezo 3) in May, August, and November 2020 and February and May 2021. Groundwater samples have been analysed for the same suite as the surface/spring samples, minus the Micro-Biological Indicators of Sanitary Contamination. From November 2020, thallium has also been analysed within groundwater samples. In-field handheld physio-chemical measurements, including Total Dissolved Solids, pH, Electrical Conductivity, Temperature and Dissolved Oxygen have also been taken.

Drawing ZT520182/4.9.1 and Drawing ZT520182/4.9.2 above provide maps of monitoring locations at Rupice and VPP respectively.

4.9.8.4 Hydrogeology – Results

Groundwater Elevations

Results from manual dips at VPP are provided in Table 4.9.8 below.

Table 4.9.8: Groundwater Elevations (VPP)

Monitoring Point	Manual Dip (mASL)											
	01/05/20	01/07/20	11/08/20	10/09/20	09/10/120	05/11/20	09/12/20	22/01/21	15/02/21	02/03/21	13/04/21	06/05/21
Piezo 3	905.8	905.8	906.0	905.8	903.1	-	905.7	905.7	905.4	905.7	905.8	905.5
Pit 1	1030.1	1031.7	1032.7	1030.0	1030.4	1030.5	1030.0	1032.2	1032.8	1030.9	1031.9	1030.8
Pit 2	1046.6	1049.1	1049.1	1046.4	1046.9	1047.0	1046.4	1050.7	1047.0	1047.5	1049.4	1047.1
Pit 3	1057.4	1057.9	1057.8	1057.5	1057.6	1057.6	1057.2	1057.4	1057.6	1057.7	1057.7	1057.6

Groundwater elevations are highest at the Pit 3 monitoring location recorded as a maximum of 1057.9m AMSL. Groundwater elevations are lowest at monitoring point Piezo 3, recorded at a lowest elevation of 903.1m AMSL.

Results from automated pressure transducer monitoring within the Rupice groundwater wells have been plotted with rainfall data recorded within the Rupice concession and are provided in Figure 4.9.13 below.

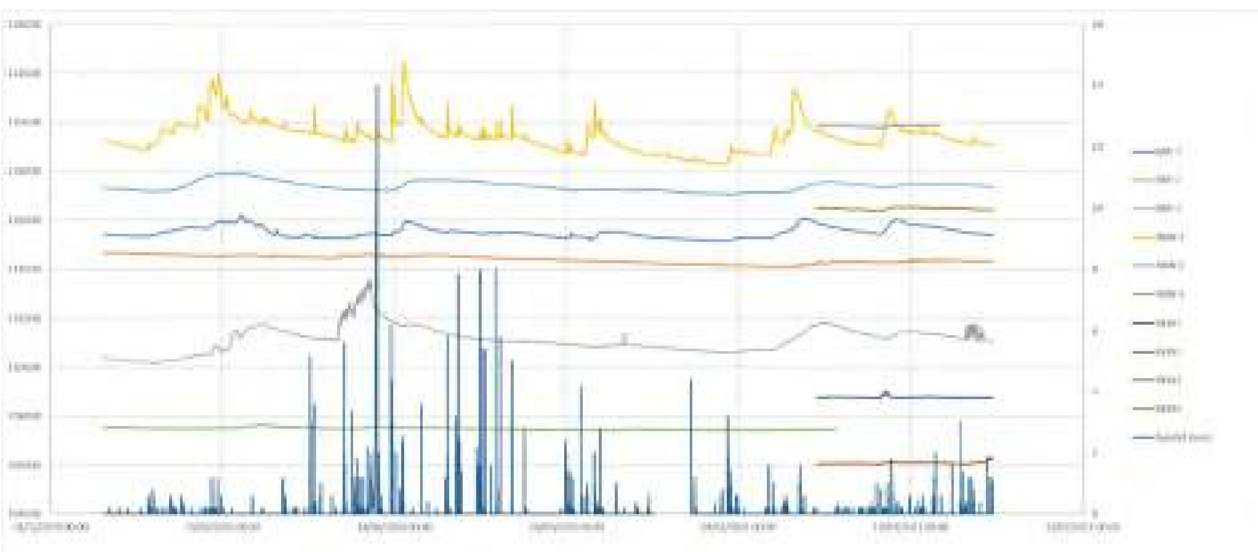


Figure 4.9.13: Groundwater Elevations (Rupice) Versus Rainfall (May - November 2020).

Groundwater elevations within BRW-2, BRW-3, BRP-1 and BRP-2 display a relatively stable groundwater condition with elevations remaining relatively consistent throughout the monitoring period. Groundwater elevations within BRP-3 display increasing groundwater elevations (approximately 20m increase) from mid-late May 2020, corresponding to a period of prolonged rainfall within the area. Groundwater elevations in BRW-1 display a more dynamic groundwater hydrograph, corresponding with rainfall events with short-term increases in the order of 25m before receding within a matter of days to near the original level. This indicates BRW-1 is likely in hydraulic continuity with recharging rainwaters and responding quickly to rainfall events, whilst the other monitoring boreholes are potentially more hydraulically isolated from recharging rainwater. Groundwater levels recorded in the new REW wells confirm the general groundwater flow direction (northwards) and show similar timing in response to recharge events. REW 1 shows a short-term response to one rainfall event resulting in a defection of water level of a few metres.

A detailed analysis of groundwater levels (piezometry), flow directions and behaviour is included in Groundwater Inflow into the Rupice Underground Mine Report (WAI, 2020 – Report Reference WS0002)[13]. Although measured groundwater levels indicate discrete compartmentation in dolomite units with fault bounded contacts, a general groundwater flow direction (in the zone of mineralisation) is towards the north indicating general groundwater discharge to low lying parts of the Trstionica basin from groundwater on the eastern half of the Kiprovac Ridge.

Groundwater Quality

As per Section 10.5, groundwater results have been compared to Bosnian Maximum Permissible Concentrations (Decree on Hazardous and Harmful Substances in Waters) regulations. Where absent, sample results are compared to WFD UKDWS.

Groundwater quality within REW wells (Rupice) appear slightly alkaline with pH values ranging from 7.48 – 8.17 and an average of 7.74. Conductivity varies between 342 and 549µS/cm. Groundwater results within the BRP-BRW wells (Rupice) appear slightly similar/slightly more alkaline than values seen in the REW wells, ranging between 7.68 and 8.2 with an average of 7.89. Conductivity values range from between 249 and 341µS/cm.

Groundwater quality within VPP appears slightly alkaline with pH values ranging between 7.52 and 8.04 and an average of 7.76, very similar to values seen at Rupice. Conductivity values are higher however, varying between 287 and 860 µS/cm.

Groundwater samples have also been analysed to determine hardness in terms of mg/L CaCO3. Each watercourse has been analysed to determine hardness class. Hardness classes are explained in section 10.8.2 above.

Results indicate that groundwaters within the Rupice concession (REW and BRW wells) range between ‘Moderately Hard Water’ (109mg/L) and ‘Very Hard Water’ (230mg/L). On average, waters are classed as ‘Hard to Very Hard’ within the Rupice concession. Waters within the VPP concession are harder,

[13] Wardell Armstrong 2020. Groundwater inflows into the Rupice Underground Mine. *Report Reference: WS0002, V0.2. Job Number ZT52-0186.*

ranging from ‘Hard Water’ (154mg/L) to ‘Very Hard Water’ (534mg/L). On average, waters are classed as ‘Very Hard’ within the VPP concession.

Groundwater quality samples within the Rupice concession indicate exceedances of: Ammoniacal Nitrogen as N (filtered), Ammoniacal Nitrogen as N, Nitrate as N, Arsenic, Cadmium, Iron, Lead, Selenium, Tin, Zinc and Thallium with respect to Bosnian MPC Class I-II guidelines. Bold parameters indicate hazardous substances.

Groundwater quality samples within the VPP concession indicate exceedances of: Magnesium, Sulphate, Ammoniacal Nitrogen as N (filtered), Arsenic, cadmium, Iron, Lead, Manganese, Selenium, Tin, Zinc and Thallium.

Groundwater quality results have also been analysed using piper plots to determine water typing. Figure 4.9.14 shows a piper plot for all groundwater samples collected within the Rupice and VPP concessions.

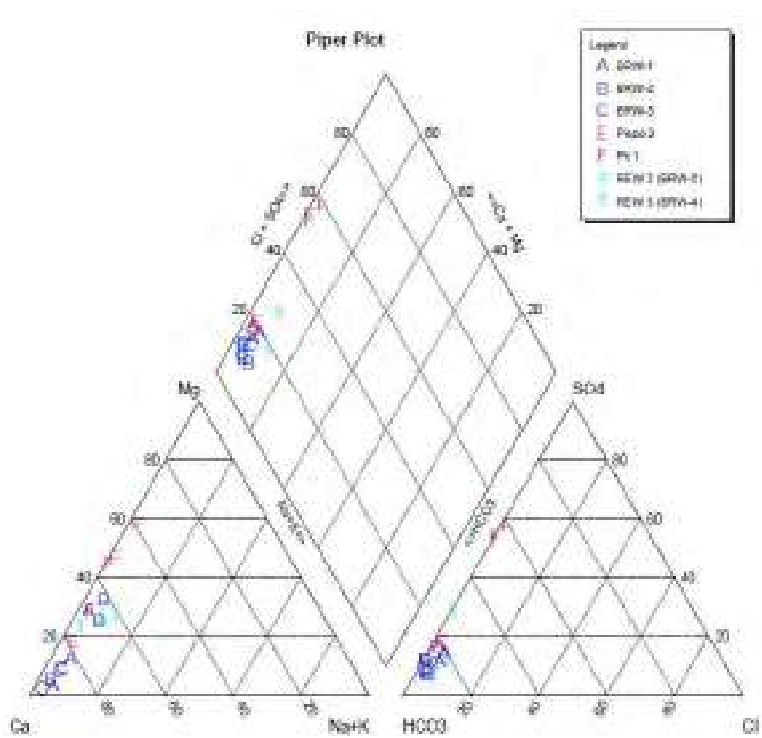


Figure 4.9.14: Piper Plot of Groundwater Samples Collected within Rupice (dark and light blue) and VPP (pink)

The results from the Rupice and VPP catchments (groundwater and surface water) show close correlation in grouping together as distinct water types dependent on location. This suggests a potential high level of exchange between the surface and groundwater systems at each site.

Results from groundwater samples collected from monitoring wells within the Rupice concession appear similar to the Rupice surface water results. Water samples are dominated by calcium cations and bicarbonate anions and therefore primarily Ca-HCO_3 water type. Magnesium anions are also present within some samples up to c. 40% meq/l therefore some samples displayed more of a Ca-Mg-HCO_3 water type.

Similar to surface waters within VPP catchment, results from groundwater samples within VPP concession are more varied, indicated by a slightly higher magnesium cation concentration than samples from seen at Rupice. Calcium, however, remains the dominant cation within the VPP catchment. The Anion concentrations at VPP are very varied, between bicarbonate dominated waters seen within Piezo 3 and sulphate dominated water seen within Pit 1. This differs to the heavily bicarbonate dominated waters seen at Rupice. Samples collected from Pit 1 display a Ca-Mg-SO4-HCO_3 water type, whilst samples collected within Piezo 3 are Ca-Mg-HCO_3 and Ca-HCO_3 water types.

Graphical presentation of results of parameter concentrations compared to guideline values throughout the monitoring period are provided in Appendix 4.9.9 for VPP and Appendix 4.9.10 for Rupice. Full Groundwater results are presented in Appendix 4.9.11 and Appendix 4.9.12.

Water quality parameters (temperature, EC, dissolved oxygen) recorded in groundwater generally show higher TDS and slightly lower dissolved oxygen in groundwaters compared to surface waters associated with aquifer mineralisation and some change in redox state as groundwater moves along the flow path.

4.9.9 Interpretation

The Mala river catchment is heavily modified in the area of the mine, both in terms of physical hydrology due to portals and culverts that regulate flow and background water quality. The average annual flow in the river (Q_0) has been estimated to be 114.97l/s. The flow accretes along the river in the vicinity of the VPP as a number of side tributaries contribute to flow. A minimum ecological flow to be sustained in the Mala is estimated to be between 17 - 27 l/s depending on season.

The Mala river water quality has a magnesium bicarbonate sulphate water type with neutral to slightly alkaline pH. The water is hard to very hard reflecting the carbonate catchment. Baseline water quality indicates some dissolution of the mineralisation probably associated with the existing pit which is noted to have small scale ochreous and acidic seeps from the western pit wall. This adds barium, iron, zinc and sulphate to the river water although there is sufficient dilution and neutralisation from the surrounding dolomitic catchment that the reported concentrations are below the assessment criteria. The river water quality is generally good with low TDS and suspended solids. The recorded levels of BOD and nutrient are low and reflect typical tributary inflows from the rural catchment.

Groundwater results at the VPP concession area recorded in the embankment of the historic TSF and below the base of the existing pit indicate exceedances of assessment criteria for iron, lead, zinc, barium, mercury, arsenic and selenium.

At Rupice, the Borovicki stream average annual flow in the river (Q_0) has been estimated conservatively to be 222.70l/s based on flow data. The hydrograph shows rapid response to rainfall events although the short-term rainfall intensity is not the main control over streamflow response; rather the antecedent rainfall period appears to modify both the baseflow response and flashy component more directly. This implies that a component of interflow is affecting the stream flow in the river. The Vrući Potok (hot stream) has not been monitored long enough to draw firm conclusions on its long-term hydrology, however it appears to show a similar but more subdued hydrographic response when compared to the Borovicki. The Q_0 of the Vrući Potok has been calculated as 20 l/s. Despite the inference about interflow processes no discernible change in spring flow rate has been observed with varying rainfall or seasonality as yet. The measured springflows appear relatively constant year-round.

The water quality of the Borovicki shows slight exceedances of cadmium, lead, mercury and zinc. The Vrući Potok results indicate periodic very poor water quality on occasions with TSS exceeding 10,00mg/L accompanied by significant increases in cadmium, copper, chromium, iron and manganese above assessment criteria. The stream becomes muddy during wet weather as demonstrated by a correlation between rainfall intensity and a marked increase in suspended sediment. In the main, parameters such as iron, magnesium and sulphate concentrations are elevated during very wet (storm) conditions indicating soil sedimentation. No major increase in the metal concentrations associated with the Rupice mineralisation is observed, the above elevated metals occurring in wet conditions are attributed to soil runoff.

Groundwater at Rupice is primarily associated with a Triassic age dolomitic limestone unit which itself has low primary porosity and permeability but due to significant faulting and fault breccias enables a degree of fracture flow to occur between limestone compartments and fault margins. The water bearing zone is a series of compartmented blocks. Groundwater levels in most wells generally respond to wet and snow melt periods with a gradual rise in groundwater level as recharge from the surface permeates into the saturated zone. BRW1 and to a much lesser extent REW 1 are the only wells that show an almost immediate response to individual rainfall events indicating at these locations there is a more direct form of link with the surface so that recharge is controlled by both an overall increase in storage in the aquifer from permeating groundwater as well as some discrete, complete fracture connections that affect these wells.

The recorded data suggests the main groundwater flow direction is northwards probably constrained within impermeable bounding faults and displaced structural units. This includes a prominent normal fault along the north-east of the mine-section which sets impermeable ("J,K") flysch mudstones and turbidites against the mine area. The faulting of the dolomitic limestone creates a compartmented confined groundwater system in which hydraulic continuity is maintained by fracture flow mechanisms within the limestone and fault connections between lithological blocks.

Infiltration of precipitation into the outcrop in the peripheral areas of the massif is direct but diffuse. The majority of infiltration is likely to deplete quickly within a rapid transport, near surface interflow system that discharges into streams and springs.

From analysis of the water levels and the system response to recharging and seasonal effects, the wells show an annual fluctuation based on a seasonal recharge of between 8 to 20m. The wells all show a similar seasonal trend and recession.

Pumping tests indicate a low transmissivity groundwater system with moderate to low storage which accounts for the relatively high groundwater level fluctuations observed.

The Rupice groundwater has a neutral to slightly alkaline pH and a water type that is strongly calcium bicarbonate as compared to the more magnesian and sulphate VPP groundwater. The groundwater has a baseline water quality that comprises exceedances of arsenic, iron, lead, zinc, selenium, mercury, cadmium and thallium, base metals are attributed to the ore body, thallium is a regionally present metal. Dissolved barium is present at moderate concentrations, but which do not exceed assessment criteria. The concentrations of these metals vary considerably between monitoring rounds but are generally consistently in excess of their respective assessment criteria.

4.10 GEOCHEMISTRY

4.10.1 Introduction

This section describes the existing baseline conditions across the Vares Project area that influence, or are influenced by, the geochemical environment; and gives the results of geochemical characterisations to-date. These studies help to define the potential for acid generation and/or metal leaching from the rocks excavated and exposed by the mining project.

4.10.2 Study Area

The study area for this assessment is predominantly within the Rupice area and the immediate vicinity in which soils and water could potentially be affected by geochemical consequences of Project activities. Run-off and seepage are highly unlikely to extend beyond 3km from the site boundary, given the predominant neutralising geology, as context for assessing the geochemical impact. The study also includes the Vares Plant and Tailings Storage Facility (TSF) to understand potential geochemical impacts from tailings.

The Vares Project is in a mountainous area, with predominant forest and meadows with rural agricultural land-use and an alpine/continental climate of warm summers, cold winters, annual precipitation of around 1,088mm and an average of 48 snow days per year. Springs and small streams follow the relief and are influenced by variable seasonal rainfall. Hydrogeology is dominated by karst-type systems and dolomitic limestone aquifers with connectivity and flow between surface and groundwater.

4.10.3 Geology and Mineralisation

The Vares Project deposits are hosted within Triassic and Jurassic volcanic and sedimentary chalks and deep-water limestones, with sediments composed of cavernous limestones, dolomites, dolomitic limestones, limestones and keratophyres. The Vares mineralization is of strata-bound replacement style within carbonate-bearing rocks, including dolostone, dolomitic marl, and dolomitic breccia. Mineralization varies from massive to disseminated and vein style and is characterized by iron carbonate, barite and sulphides including pyrite, sphalerite, galena and chalcopyrite. Metal associations include zinc, lead, copper, silver, gold, arsenic, antimony and mercury.

Mineralisation at Rupice consists of sandy limestone, marl and clay with intercalations of sandstones, limestone, dolomite, and dolomitic limestone. The deposit contains abundant barite with variable amounts of sulphides as sphalerite, galena, chalcopyrite, pyrite and minor tetrahedrite, stibnite and cinnabar. Most mineralisation is massive and in areas can be high grade in thick intervals of up to 65m; however, it also varies to a disseminated and breccia-matrix, and to stockwork and vein style. The main gangue minerals are quartz (15%) which occurs in locally extensive zones of hydrothermal silicification, particularly in the footwall dolostone; carbonates (9%); pyrite (6%) and mica (3%).

High sulphide contents, particularly with >5% pyrite, suggest that there is potential for generation of acid from oxidation when mineralisation is exposed during mining activities. However, the carbonate limestone/dolomite host rock provides neutralization capacity, especially with geochemical control for ore stockpiles and waste rock dumps included in the mine plan.

4.10.4 Historical Mining and Processing

The history of mining and exploration in the area has led to some legacy contamination. In the Vares area, there is evidence of extensive historical surface mining and diggings at Mekuse, a village immediately north of Veovaca, undertaken during the Austrian-Hungarian period around 1867-1918. Open pit mine production at Veovaca commenced in 1983 and continued for over three years. The processing plant associated with this mining period, located 2km from the Veovaca open pit, concentrated Veovaca ore by flotation. The average composition of the ore was 23-30% barite and 3.5-4.4% total zinc and lead sulphides and during operations produced an average 12t/h of barite concentrate (at around 90% $BaSO_4$), 0.4t/h lead concentrate, and 0.3t/h zinc concentrate.

Processing included crushing and storing of raw ore, a separation unit, wet grinding, collective flotation, barite separation, and lead and zinc separation. The coarse rougher fraction of tailings was transported by truck and tipped to a tailings dumpsite that formed a scree slope 800m southwest of the flotation plant and 600m downstream of the tailings pond. The tailings produced were composed largely of silicate/carbonate matrix with high residual concentrations of lead, zinc, and barite still present. There is soil contamination of the site from these activities. The fine tailings were deposited as a slurry to a valley Tailings Storage Facility (TSF), with the TSF embankment dam designed and constructed using coarse tailings. The municipality has managed the site since the plant was abandoned.

4.10.5 Previous Studies

Two earlier campaigns of sample collection were undertaken before the 2020 WAI ESIA baseline study at the Vares Processing Plant site: as part of the 'Master Plan for Remediation of Hotspots in Bosnia and Herzegovina'[1] in 2014; and during the Enova EIA baseline studies in 2019. These analysed soil and water samples from various points around the old processing plant and TSF. Results showed elevated levels of heavy metals, including Cd, Pb, Cu, and Zn, although average soil pH was 8.06 and all water samples were also alkaline, the lowest pH being 7.3.

These old legacy deposits reflect material stockpiled and/or spilled from the various processing units prior to the abandonment of the operations and are not necessarily useful indicators of the geochemistry of the ore material to be exploited. However, the presence of high contamination levels after more than 30 years suggests that despite the spread of contaminants around the site and beyond, they are not readily mobilised to disperse away from source.

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[1] JICA, 2014. The project For Master Plan for Remediation of Hotspots In Bosnia And Herzegovina, May 2014. Japan International Cooperation Agency, JICA Expert Team (Nippon Koei Co., Ltd.)

At the old TSF pond and dam, five samples of surface water, one sample of sediment and 2 of dam material were analysed for heavy metals; together with 3 soil and 3 water samples collected from upstream of the TSF as background samples.

The tailings sediment contained elevated concentration of Pb (around 3,000 mg/kg) Zn, Fe and Mn (over 1000 mg/kg) and As compared to background values. There was no significant difference in the chemical composition of the pond sediment and the tailings dam material, confirming that the dam was constructed from the process tailings.

No serious pollution contamination was found in the tailings supernatant pond water samples, although values of some heavy metals were slightly higher than the criteria for surface water. However, surface water samples from both above and below the TSF contained elevated Cd, Pb, Cu, and Zn, although the exceedance was small and it was assumed that this was due to natural geological characteristics of the area. Soil sampling carried out as part of the current baseline studies along the proposed haul road and outside of the Project area between the Vares Processing Plant and Rupice has shown some elevated heavy metal levels, above National limits for Cd, Cr, Pb, Hg, Ni and Zn; and pH showed wide variability, ranging from 3.6 to 8.8.

The water quality of the river above the TSF (VAR-BG-5) was characterized by high sulphate (460.8mg/l) and zinc (0.356mg/l) and slightly increased concentration of fluoride and mercury compared to other water background samples (around Vares), and conductivity was also high (1,026µS/cm). Similar characteristics were found in downstream samples but with lower concentrations of zinc and sulphates, possibly due to dilution. A water sample from the toe of the tailing dam was found to be very similar to the upstream Mala Rijeka River sample (VAR-BG-5), rather than to samples from the TSF pond, which may indicate that water comes from the Mala Rijeka pipe culvert rather than from seepage through the dam wall. All these water samples were alkaline.

The Rupice project area was apparently exploited selectively in Roman and Saxon times possibly due to the high silver content of the lead ore. In the south-eastern part of the Rupice concession further occurrences of sphalerite-galena-chalcopyrite vein mineralization in the Juraševac-Brestic area were exploited in underground adits. Mining of barite took place during 1959 and 1960; and further highly selective underground mining began in 1965. Limited water samples analysed in 2019 from Rupice, were slightly alkaline with pH 7.3 – 7.5 and with moderate EC measurements.

4.10.6 Adriatic Exploration Drilling

At Rupice, 8 holes over 1800m were completed in 2017 to target down plunge mineralisation, to confirm historic results and assay additional elements Cu, Au and Ag, and which found significant grades that correlate with the Zn and Pb mineralisation. A further drilling programme in 2018/19 undertook 46 holes. Drilling at Rupice has provided core of suitably representative samples of both ore and waste rock for ARD and metal leaching testwork and studies.

4.10.7 Water Quality Baseline Results

Ambient water quality has been monitored across the Project monthly since May 2020 for the ESIA baseline studies and shows most natural water, both from surface streams and rivers and groundwater sampled from wells and boreholes is alkaline, predominantly around pH 7.7-7.8. Only one surface water sample from the Mala Stream upstream of the existing Veovaca open pit, in October, 2020, was below neutral at pH6.83; while at Rupice, the only 2 results below pH7 were from handheld measurements from one of the groundwater boreholes drilled on the deposit, at pH6.21 in August and pH6.3 in November, 2020.

However, despite high pH, most of these natural waters show some elevated levels of various metals. At the Vares Processing Plant site many of the samples from locations in the vicinity of the deposit exceed WQ limits for magnesium and sulphates, together with occasional exceedances of Fe, Zn, Mn and more rarely of Cr and Cu. Cadmium is also raised in some of the samples, and mercury, although the analytical detection level is too high to fully understand exceedances. Monthly variations may be indicative of rainfall flushing of accumulated salts following dry spells. Sample locations downstream of the historic tailings pond generally have lower metal levels, apart from PPV11, immediately below the coarse tailings dump.

At Rupice, almost all the surface waters have elevated zinc, with one location closest to the deposit also with raised Fe and Mn; and a single sample with high Al. Thallium is raised in the Rupice hydrogeology wells and in samples from the natural springs in the area. No samples were analysed from the old adit.

Three groundwater samples were analysed from Rupice in 2019, taken following completion of the pump tests as part of the hydrogeological research program. Analysis was cursory and did not include any heavy metals, but again demonstrated that the natural groundwater condition is slightly alkaline with moderate EC measurements. Subsequently, the three monitoring wells were sampled periodically (quarterly) through 2020 and into 2021, along with four new wells (BRW-4 – BRW-7) drilled for the hydrogeological baseline data collection programme, with groundwater samples analysed for major ions, physio-chemical parameters, nutrients and minor ions (heavy metals). Results show that groundwater within the Rupice concession appear slightly alkaline with pH values ranging from 7.24 – 8.2. Conductivity varies between 249 and 549µS/cm. Water samples are dominated by calcium cations and bicarbonate anions and therefore primarily of Ca-HCO3 water type, although some samples displayed more of a Ca-Mg-HCO3 water type. Metal analyses show exceedances of N, nitrates, As, Cd, Cu, Fe, Pb, Mn, Se, Sn, Zn and Tl with respect to Bosnian MPC Class I-II guidelines. Concentrations of these metals vary considerably between monitoring rounds.

Details of these metal loadings are given in Chapter 4.9, Hydrology and Hydrogeology, but the results suggest that water pH is dominated by the carbonate geology, although many of the metals concentrated in the local mineralisation naturally leach out even in alkaline conditions.

4.10.8 Baseline Studies

A program of ARD/ML test work has been undertaken on Rupice deposit lithologies. Waste materials have been characterized in terms of lithology and potential reactivity based on the level of mineralization and weathering products from drill core. Comparison of these shows good correlation with modelled geology. The Reactivity Domains defined were:

- ORE – Ore zone material above cut-off grade;
- HWMISED - Hangingwall Mineralised (below ore grade) mixed dolomite and other lithologies;
- FWMISED - Footwall Mineralised (below ore grade) mixed dolomite and other lithologies;
- HWSED - Unmineralised Hangingwall, mixed dolomite and other lithologies;
- HWSEDNLI - Unmineralised Hangingwall, non-carbonate sediments;
- FWSED - Unmineralised Footwall, mixed dolomite and other lithologies;
- FWSEDNLI - Unmineralised Footwall, non-carbonate sediments;
- FLTZN - Major fault zone above the mineralized sequence; and
- LSTCHRT - Limestones and Cherts above the mineralized stratigraphy.

The sulphidic ore material is likely to produce ARD, low pH and metal leaching, while the partially mineralized hangingwall and footwall sediments (HWMISED and FWMISED), which comprise an envelope around the orebody are expected to be mildly reactive lithological units. The remaining host-rock units are unlikely to generate acid given the high carbonate content and neutralizing capacity. The spatial distribution of these materials has been mapped and modelled from core.

Thirty-four samples of Rupice waste rock were sent to the ALS laboratory at Bor, Serbia, for Acid Base Accounting (ABA) testing, focused on the mineralized hanging wall and footwall units, with individual samples of other host-rock materials. Sample selection was not necessarily volumetrically representative of the mine plan wastes. No paste pH measurements were taken but it appears that Acid Potential (AP) was based on calculated Sulphide S%; Neutralising Potential (NP) calculations from inorganic C% differ significantly from titrated NP results; and the neutralizing effects of dolomitic material may be exaggerated. Despite HW and FW mineralized material containing between 1.45% and 5.32% S, most of the samples tested as Non-Acid Generating, with high Neutralising Potential (NP). Only 2 samples of the FWMISED gave Potentially Acid Generating (PAG) negative Net Neutralising Potential (NNP) results, together with 3 other footwall lithology samples. This ABA testing may be indicative rather than wholly reliable.

Additional samples of ore-grade material were sent for ABA testwork. These ore material samples were obtained from a previous metallurgical testing sample and may have been exposed to weathering for some time before testing. Around 100kg of the material was used for a field trial experiment, discussed below, and ABA samples taken from each of the different composite materials as below. Description of the samples together with the calculated NNP are given in Table 4.10.1, which show that, except the dolomite breccia, all the ore materials have high negative NNP, that is, acid generation far exceeds the neutralizing capacity. As the mineralization in the dolomitic breccia is confined to fractures and veins, the sample may not be fully representative of this ore material.

Table 4.10.1: Ore Sample Descriptions and NNP Results

Sample	Description	NNP tCaCO3/t
1	Massive ore with high content of Zn, Pb	-729
2	Massive ore (massive barite), with high content of barite, low Pb, Zn	-356
3	Dolomite breccia with mineralisation in fractures, veins, high content of Cu	327
4	Massive ore with high content of Au, Ag, Zn, Pb, BaSO4	-479
5	Dolomite with pyrite	-605
6	Silicified dolomite breccia with barite blades and sulphides in veins	-88

Two further pulp samples were tested for paste pH and ABA in 2020, both of which also gave high negative NNP results, which further suggests that most of the ore material at Rupice is Potentially Acid Generating (PAG).

Acid Base Accounting and NAG tests were undertaken on two tailings samples from initial flotation process testwork on Rupice ore – Barite Tailings and Barite Tail/Pyrite Concentrate Blend. The ABA tests showed that the tailings, as expected, are acid generating with high S% and negative NNP (Table 4.10.2). However, NAG pH for both samples were above pH4.5 in the first cycle of sequential tests, suggesting that neutralizing capacity may exceed acid generation. Kinetic NAG results indicate that the likely time lag before acid conditions develop under atmospheric oxidizing is less than 14 months (and as little as 9 months for the pyrite blend sample).

Table 4.10.2: ABA testing results on Barite tailings

Sample	S%	MPA	NP	NNP	NPR
BT 001	7.76	242.5	184	-59	0.76
BT/PCB 002	8.48	265	181	-84	0.68

MPA – Maximum Potential Acid; NP – Neutralising Potential; NNP – Net Neutralising Potential; NPR – Neutralising Potential Ratio (MPA/NP)

In August 2021 additional ARD/ML testwork was undertaken on a sample of high barite tailings from recent pilot process testing. This material has high sulphur content with 13%S but low Ca/Mg, giving 406 MPA; 48 NP; NNP of -358; and NPR 0.12. NAG pH was above pH4.5 but below 7. Leachate analysis showed very high levels of Pb and Zn (3680 and 3350ppm respectively), as well as high Cu, Mn, Cr, As, Sb, Ni, and V; and elevated Ba, Mo and Cd. These results indicate that the material is highly reactive, acid generating and likely to produce contaminated leachate when exposed to atmospheric conditions when placed on the proposed dry stack TSF, without mitigating design and management.

Further leach/leachate tests are being undertaken on monolithic cemented tailings backfill test samples at various setting/curing times, to assess the reactivity of tailings once incorporated into UG backfill. These samples have used the latest permutation of process tailings from pilot trials and the current design backfill mix ratio of tailings, aggregate and cement. Results are expected in H2 2021 but given the high rock carbonate content, binding nature of the pozzolanic reactions and 5% cement addition, it is unlikely that acid generation or metal leaching will be significant.

Whilst no additional Net Acid Generation (NAG) tests; Toxicity Characteristic Leaching Procedure (TCLP) or lab based long-term, kinetic leaching Humidity Cell Tests (HCT) have been undertaken to identify specific contaminant issues or rates of acid generation and metal leaching of the Rupice deposit, various field observations and investigations have provided additional insights into the characterization of the Rupice rock materials.

4.10.8.1 Field Trials

Field leach-pad trials initiated at the Rupice site have been running since April/May 2020, testing each of the characterized units, using core selected by examination of the drill-hole database. Ore material was collected from samples rejected from metallurgical testing as described above. This and broken core composited from each waste unit type were loaded into plastic drums open at the top for rainfall and free draining at the bottom for effluent collection. A mixed reactive and unreactive sample was also included to assess the effect of co-disposal (of PAG and NAG waste) on acid generation and metal leaching; and a blank. Effluent volumes are measured after every significant rainfall event and samples taken for hand-held measurement of pH/Conductivity/dissolved oxygen and alkalinity. Monthly samples have also been collected since May 2020 (when there is sufficient effluent) and sent to the laboratory in Tuzla for chemical analysis. Unfiltered samples have been used for analysis, but one round of sampling was sent for analysis of both filtered and unfiltered effluents to determine dissolved- and particulate- contaminate levels.

Photo 4.10.1: Field Leach Trials set up at Rupice

These trials have been complicated by apparently acidic rainfall, with pH as low as 4.5, possibly from anthropogenic pollution derived from industrial activities to the west of Rupice. However, the data clearly shows acid generation from the ore and immediately adjacent mineralized FW and HW rocks, but the rest of the waste rocks are highly buffered and although some elements leach even in alkaline conditions, these are at significantly lower levels than from the ore and reactive material.

The major contributors to contamination of effluents in the dissolved phase are the reactive materials ORE, HWMISED and FWMISED. The metal contents of these effluents are typically above the relevant EU drinking water and industrial discharge limits. Some contamination is released by the unreactive materials, specifically sulphate, copper, iron, manganese, aluminium and magnesium. While the levels are substantially lower than from the reactive lithologies, they are sometimes above the EU drinking water limits, although similar to natural waters in the area.

The co-disposal field trial test of mixed reactive and unreactive rock materials has shown that acid generation can be countered, but while this lowers the leachability of the reactive materials, effluent still has some values above EU limits for sulphate, copper, manganese, aluminium and magnesium.

High concentrations of suspended materials are generated by rainfall impact on the unreactive materials, but this has not been seen in the reactive materials.

The first seven months of field measurements, together with laboratory analyses have been collated and show the following trends:

- Ore material has been highly reactive from the start with pH consistently below 4, high TDS and elevated metal values, especially Al, Cu, Fe, Pb, Mn and Zn.
- HWMISED and FWMISED materials both had first flush low pH of 3.5 and 3.75 respectively, and high TDS, but with the HW material giving much higher metal concentrations than the FW. While fluctuating (in July pH was up to 6), these materials are generally still generating acid and have high but reducing TDS and a slightly lower metal loading than the ore material.
- All of the other materials have shown little first flush highs and have been consistently pH neutral or alkaline. With few exceptions, despite moderate TDS, metal contents are low.
- The mixed reactive and unreactive materials test has so far produced neutral to alkaline pH and few significantly elevated metals, which suggests that the unreactive predominantly carbonate-rich waste rock can be used to effectively neutralize any acid produced.
- Most of the metal loading is dissolved.

A separate field leach test has been set up using artificial irrigation with spring-water as a proxy for groundwater to simulate effects on underground exposure of rock within mine development.

4.10.8.2 Observations of Core Weathering

Observations of old core from Rupice have been used to define the body of reactive rock around the orebody. It was seen that the HW and FWMISED intersections display visual effects of air exposure reactions in older core that has been in storage for over 14 months. This includes orange/brown iron hydroxide staining, fine crystalline gypsum growths and sulphate growths on the surface of the core, in sharp contrast to the unreacted rocks comprising the rest of the host-rock sequence. Using these features, the reactive rock has been logged, and where necessary tested, through drill-core that has been stored for >14months, on all 2017 and 2018 core and some of the earlier 2019 core, and the information plotted on drill sections. Modelling was then undertaken to develop a wireframe showing the distribution of these MISED materials.

Photo 4.10.2: FWMISED 2017 core showing reaction during storage and low-pH values

The wireframe shows that the MISED materials form an envelope around the Rupice orebody. The old core provides spatial coverage around the main part of the orebody but there is no old core from up-dip of the orebody, or in the deeper footwall areas where the bulk of the underground development will be located. A proxy to observed reactivity was required to extend the wireframe over these areas. Manipulation of total sulphur analyses; logged sulphide minerals recorded in the drill-hole database; and metals grades, was performed and showed a broadly similar spatial distribution of reactive rock to that of the core observations, so could be extended out to map the entire drilled rock volume. This wireframe was then overlain on the mine development schedule to illustrate where and when reactive rock will be excavated and sent to surface. This shows that most of the mine development is out-with the reactive material.

4.10.8.3 Thallium

Following analysis of metallurgical testing products, a concern was raised about potentially high thallium levels in the concentrates, that could suggest a thallium contamination issue. From the limited analysis, it appears that occurrence is quite defined but with potentially high concentrations where it does occur. Thallium in ore reports to the product streams rather than tailings, which could present a smelter problem. There was no analysis for thallium in any of the original monitoring or testing of ground or surface water, but this has been added to the normal components for analysis subsequently to determine if there is any thallium naturally dissolving from the Vares rocks. It is suspected that occurrence is associated with pyrite and the other ore sulphides and therefore, as suggested by head grade and process analyses, will concentrate with the target metals. It is unlikely to be high in the waste rock, unless/except where there is high pyrite.

The most recent round of lab analyses from the Rupice field experiment included thallium. In contrast to the analysis above, these results show that thallium is leaching from some of the unreactive materials, at levels close to analytical detection limits, but which exceed the EU drinking water limit of 0.002mg/l. No thallium was detected in the effluents from the reactive materials at Rupice, including from the ore effluent. As context, analyses from the existing Veovaca open pit seepages, similarly near detection level but above drinking water limit thallium was seen in one of the seepages.

Baseline water quality monitoring has also detected thallium in samples from the Rupice deposit groundwater wells as well as the natural springs in the area, including one used for residents' water supply. This issue will need continuing monitoring given the potential negative impact of thallium on human health. Further discussion around thallium is provided in Chapter 4.4 Soils and Contaminated Land, Chapter 4.9 Hydrology and Hydrogeology and in Chapter 4.12 Community Health, Safety & Human Rights.

4.10.9 Summary

Results of the various geochemical testing undertaken to define the baseline conditions of the geology to be encountered by mining of the Rupice deposit show that the ore material and the mineralised envelope around the ore are potentially acid generating and that this lower pH is likely to increase leaching of metals. This may occur wherever such rock is exposed - within the mine workings; on ore stockpiles; in the tailings storage facility; and, where underground development occurs within this material and within temporary waste rock dumps. Conversely, the remaining host rock units are predominantly carbonate-rich with high neutralising capacity and alkaline effluent. These materials naturally buffer potential localised acid production but even in alkaline conditions, can still show some, though reduced metal leaching.

The modeled wireframe that shows the distribution of the mineralized reactive materials across the orebody is a valuable tool for predicting when potentially PAG rock will be brought to surface as part of the mine scheduling. This model will be updated with any new data or geochemical understanding from the continuing characterization work.

Ongoing field trials will continue to provide understanding of the different rock units at the Project; and the leach tests on cemented backfill will determine if there is any level of geochemical risk from the tailings backfill.

Given the prevalence of dolomite and other carbonate rock in the area, together with the limited- and spatially understood occurrence of potentially PAG material, it is unlikely that ARD will be a significant risk for the Project and can be managed. While metal leaching has been shown to occur even under alkaline conditions and is a natural condition of the surface and groundwaters in the area, a good understanding of this allows development of mitigating design/management measures.

4.11 Socioeconomic

4.11.1 Socioeconomic Setting

The socioeconomic setting and study area is defined at multiple levels. The national setting is the entire of Bosnia and Herzegovina (BiH), the second level encompasses the Federation of Bosnia and Herzegovina. The regional setting covers the Zenica and Doboj Canton, and more specifically the municipality of Vareš, in which the Project is located, and to a lesser extent the municipality of Kakanj, as the Rupice proposed site lies adjacent to the border.

Table 4.11.1 Land Area for Entities in BiH

Entity	Land Area (km^2)
Bosnia and Herzegovina	51,197
Federation of Bosnia and Herzegovina	26,120
Zenica-Doboj Canton	3,415
Vareš Municipality	390
Kakanj Municipality	377

At the local level the closest communities and settlements to Project infrastructure are considered in most depth. At the Vares Processing Plant these are:

- Tisovci;
- Pržići;
- Brezik;
- Daštansko;
- Višnjići.

For the Rupice site and along the haul route, the key communities are:

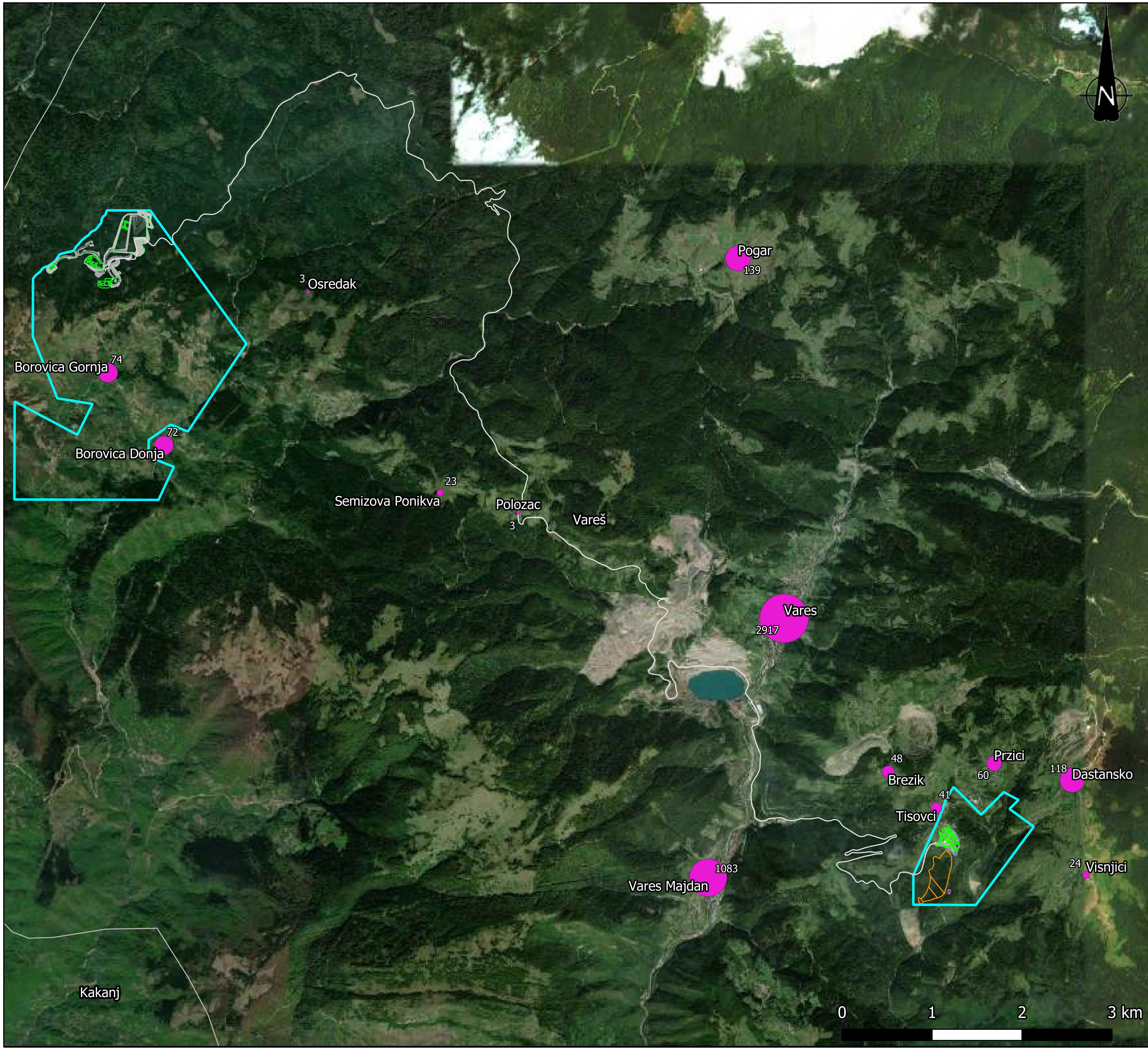
- Gornja Borovica;
- Donja Borovica;
- Osredak;
- Semizova Ponikva;
- Položac;
- Pogar; and
- Vareš Majdan.

The town of Vareš is the only urban centre in the municipality, with all other villages classed as rural communities. Vareš town holds all key services such as the police station, municipality buildings, health centre and schools (see Chapter 4.12 for detailed Community Health and Safety information). Adriatic Metals have an established information centre in Vareš, allowing a central place for project affected people and stakeholders to gain information or raise concerns or queries with the company.

The border of Kakanj municipality begins directly adjacent to the Rupice Project area. Several communities do lie relatively close to this border, though a mountain ridge is present between these and the Rupice site. Site infrastructure is not planned to be developed close to these communities, and they do not lie in the path of the main haul route. This has meant the Kakanj villages have not been included within the household survey, though consultation with community leaders was undertaken to gain an understanding of the demographics and characteristics of these villages, namely:

- Bastašići;
- Lipnica;
- Nažbilj;
- Halinovići;
- Slagoščići;
- Zlokuće; and
- Vukanovići.

The local socioeconomic study area is shown in Drawing 4.11.1.



DO NOT SCALE FROM THIS DRAWING

Key

Key Communities
- Size Of Dot Indicates Population Size
- Municipality Boundary
- Infrastructure
- TSF
- Haul Road
- Concession Boundary

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT
Adriatic Metals PLC

PROJECT
Vares Project ESIA

DRAWING TITLE
Key Communities

DRG No. ZT520182/4.11.1		REV A
DRG SIZE A3	SCALE 1:60000	DATE August 2021
DRAWN MBW	CHECKED BY AM	APPROVED BY AA

wardell armstrong

4.11.2 Methodology

Socioeconomic baseline information and data for the Vares Project has been compiled using various methods and data sources. The baseline has been informed initially by desk top analysis of existing and public information, including government websites, NGO reports and other online information and through a stakeholder mapping exercise (Appendix 4.11.1).

The field collection of data for the social baseline was initiated in November 2019, by WAI and Adriatic Metals Associate, Kate Harcourt, and has continued throughout 2020 and 2021. The baseline study comprises the collection and analysis of quantitative and qualitative data through three main components: a) the collection of existing statistical and historical information, namely 2013 and 1991 census data at the national, regional and local levels; b) key stakeholder interviews and surveys including with the Vareš municipality mayor, community leaders and religious leaders; and c) results and analysis of household surveys of the closest communities to the project and related infrastructure.

Additionally, documentation of all stakeholder engagement activities undertaken by Adriatic Metals was provided and reviewed for the compilation of this baseline. A stakeholder mapping exercise was completed as part of the scoping study which was used to develop the social study area (Drawing 4.11.1) and subsequent baseline studies. Sensitive receptors and project affected people have been identified and categorised.

The following documentation has been fundamental in the compilation of this chapter:

- Enova EIA and permitting documents for Veovaca and Tisovci (2020);
- Household surveys undertaken by Tuzla institute for Rupice (2020);
- Stakeholder Engagement Plan;
- Grievance mechanism; and
- Minutes and documentation of stakeholder engagement activities including that of the public liaison committee.

WAI has undertaken three site visits to Vareš and the surrounding settlements for the purpose of collecting data for the social baseline, completed in November 2019, February 2020 and April 2021. Due to Covid-19 restrictions some planned consultations were not possible and have been undertaken by the environmental and social team on site or via phone, where required. WAI held meetings with key stakeholders (Table 4.11.2), with the aim of obtaining data for the social baseline.

Table 4.11.2: Social Baseline Key stakeholder meetings

Name and Position	Discussion topic
Mr. Zdravko Marošević; *Mayor of Vareš Municipality*	District-level discussions and context about the Project. Discussion on environmental monitoring, location of monitoring and required permits.
Mr. Ivan Lovrić *Bobovac Radio and Newspaper*	Understanding of methods of disseminating information, audience reach, perceptions of community.

Table 4.11.2: Social Baseline Key stakeholder meetings	
Name and Position	**Discussion topic**
Mr. Almir Čikmiš *Tourist Information Centre*	Current state of tourism in the region, future and current international cooperative projects to improve tourism.
gdin. Ramiz Zubača *Imam*	Social baseline and general understanding of the project area. Discussion on environmental monitoring and placement of monitoring points at Mosque in Daštansko.
Fra Leon Pendic *Catholic Priest*	Social baseline and general understanding of the project area
Mr. Mirnes Hrvat *High School Principal*	Social baseline and general understanding of the project area – education levels, number of students and progression to future education.
Social Services	Social baseline and general understanding of the project area
Unemployment Centre	Social baseline and general understanding of the project area
Health Centre (Head Nurse and Finance Director)	Social baseline and general understanding of the project area – approximate health statistics and knowledge of formal statistics available.
Police Station	Social baseline and general understanding of the project area – crime level and general perception of population.
Vareš Library	Data obtained regarding local history, archaeology and cultural heritage. General social baseline data.
M.Z. Pržići Mrs Jasna Mirčić, M.Z. Daštansko Mr. Damir Ahmedović *Community Leaders – Przici and Daštansko*	Social baseline and general understanding of the project area. Each leader provided an overview of their village / area and the past and current social characteristics as well as their vision for the future.
Community Leaders – Kakanj Municipality	Dissemination of Project information, data gathering for social baseline, implementation of the grievance mechanism.
Mr. Izudin Muftić-povjerenik *Community Leader - Vareš*	Discussion on environmental monitoring and placement of monitoring points, implementation of the grievance mechanism and data gathering for social baseline.
Mr. Midhat Džafo *Community Leader – Vareš Majdan*	Discussion on environmental monitoring and placement of monitoring points, implementation of the grievance mechanism and data gathering for social baseline.
Community Representatives - Brezik	Discussion on environmental monitoring and placement of monitoring points, implementation of the grievance mechanism and data gathering for social baseline.
Community Representative - Tisovici	Discussion on environmental monitoring and placement of monitoring points, implementation of the grievance mechanism and data gathering for social baseline.
Community Representatives – Višnjići	Implementation of the grievance mechanism and data gathering for social baseline.
Community Representatives - Mllakve	Dissemination of Project Information, implementation of the grievance mechanism and data gathering for social baseline.
National Museum - Sarajevo	Data gathering for social baseline, consultation regarding archaeology and cultural heritage in Project area.
Federal Institute for Aracheology	Data gathering for social baseline, consultation regarding archaeology and cultural heritage in Project area.
Mr. Vinko Gajić *Community Leader - Javornik*	Data gathering for social baseline, implementation of the grievance mechanism.
Mr. Stjepan Petrović *Community Leader - Pogar*	Data gathering for social baseline, implementation of the grievance mechanism.
Mother Theresa Foundation	Information gathering for social baseline, identification of elderly vulnerable groups and the work of the NGO.

Table 4.11.2: Social Baseline Key stakeholder meetings	
Name and Position	**Discussion topic**
M.Z. Borovica Mr Grga Vukančić, *Community Leader - Borovica*	Discussion on environmental monitoring and placement of monitoring points in Daštansko, implementation of the grievance mechanism and data gathering for social baseline.
Mr. Mujo Kamenjaš *Vareš Hunting Association*	Data gathering for social baseline, ecosystem services and biodiversity.
Mirnesa Avdukić & Alma Demirović *Vareš Forestry Commission*	Data gathering for social baseline, ecosystem services and biodiversity
Mr. Ilhan Klančević *Vareš Sports Fishing Association*	Data gathering for social baseline, ecosystem services and biodiversity

A survey of 68 households was conducted by Enova EIA consultants in Q1 2020, around the Vares Processing Plant, covering the settlements of Pržići, Tisovci, Daštansko, Brezik and Višnjići. A second survey of 58 households was conducted by the Tuzla Institute for Mining in Q3 2020 at settlements close to the Rupice site and along the haul route, namely Gornja Borovica, Donja Borovica, Osredak, Semizova Ponikva, Položac and Pogar. The number of surveys undertaken per village is presented in Table 4.11.3.

Table 4.11.3 Household Survey Respondents by Village		
Village	**Occupied Households**	**Number of Surveys**
Pržići	28	17
Tisovci	17	14
Brezik	20	5
Daštansko	47	26
Višnjići	14	6
Gornja Borovica	20	9
Donja Borovica	16	14
Semizova Ponikva	4	4
Osredak	1	1
Položac	2	2
Pogar	43	28
NB: the exact number of occupied households in each village is not certain and some of the data is taken from the 2013 census. It is known that out migration has been abundant and village sizes have diminished. During household surveys all houses were approached and the survey was undertaken by all those willing.		

Ongoing consultation and stakeholder engagement is a key component to the operation of Adriatic Metals. The Information Centre, established in Vareš, is open 5 days a week. A record of all consultations occurring is maintained here and this was also provided to WAI for analysis. A summary and review of all stakeholder engagement and consultation is provided in Chapter 8.

4.11.3 Administrative Composition

Bosnia and Herzegovina (BiH) is structured into four governmental tiers at State, Entity, Canton and Municipal levels. The two entities within the State of BiH are the Federation of BiH (FBiH) and the

Republika Srpska, additionally Brcko is a self-regulating district, located in the northeast of the country.

The Project is located in the Federation of Bosnia and Herzegovina, the FBiH is divided into 10 Cantons, each with their own cabinet, constitution, parliament and judicial powers. The 10 cantons are then further divided into municipalities. The Vareš Project is located in one of 12 municipalities, Vareš, within the Zenica-Doboj Canton, the project footprint lies east of the border of Kakanj municipality. Vareš Municipality consists of 24 community centres, comprising 81 settlements. The municipality mayor is elected every 4 years and the current mayor is a member of the Croatian Democratic Union of Bosnian and Herzegovina. The mayor represents the lowest part of federal government and he holds a constitutional position, supported by local council.

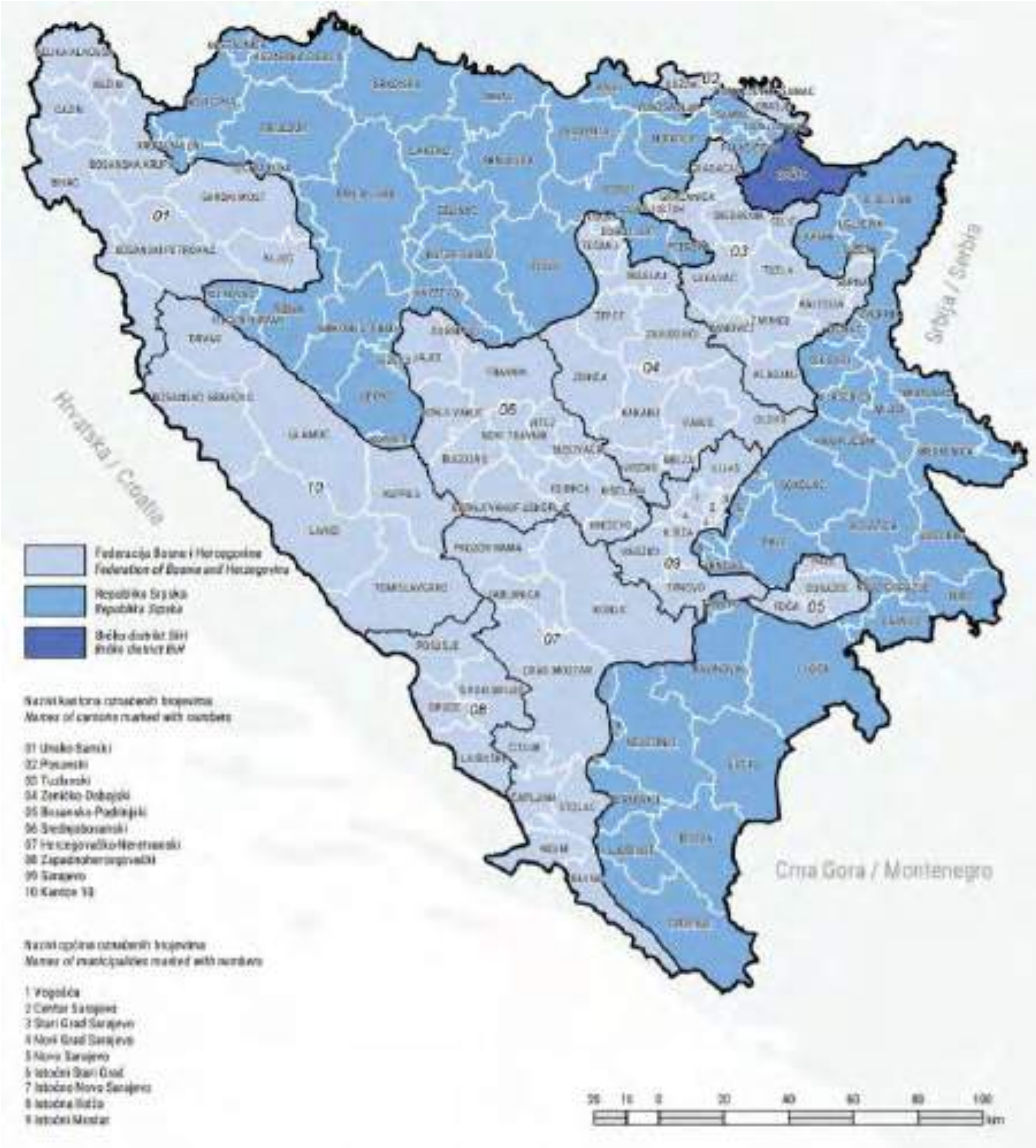


Figure 4.11.1 Administrative Map of Bosnia & Herzegovina

The mayor of Vareš reports that the social situation across the region has deteriorated over recent years, with many of the young, working age population leaving to find employment elsewhere, leaving an elderly population behind. Adriatic Metals has good relations with the mayor, who highlighted the importance of community engagement in allaying the concerns of local people regarding the poor practices of previous mining and metallurgy operations.

According to the mayor, prominent social issues within the municipality are linked to the lack of active industry leading to unemployment, and the remote elderly population, for whom care services are limited. The Cantonal level 10-year development plan was passed in 2018. The mayor indicated that industry, in particular the mining industry, has priority within the plan as well as supporting infrastructure such as housing.

For each community centre, there is an elected leader, who resides within the community and liaises with the municipality government on local issues. The community leaders in the closest settlements to the Project have regular liaison with Adriatic Metals. In accordance with reports from the mayor, all community leaders stated that the main social issue they face is the continuous depleting population, leaving mainly elderly people behind in remote locations with limited access to medical treatment and social care. Poor roads in the region and lack of public transport were reported, making access more difficult, particularly in winter months.

4.11.4 Demographics

4.11.4.1 National and Regional Demographics

Zenica-Doboj Canton occupies just under 7% of total land area of BiH, Vareš Municipality occupies approximately 11% of the Zenica-Doboj Canton (Table 4.11.4).

Table 4.11.4: Administrative Units Land Area

Unit	Area (km^2)
Bosnia and Herzegovina (BiH)	51,197
Federation of Bosnia and Herzegovina (FBiH)	26,120
Zenica-Doboj Canton	3,415
Vareš Municipality	390.1

Between 1960 and 1988, the population of BiH increased from about 3 million to just over 4.5 million (according to the World Bank), where the population peaked. The onset of the Bosnian War in 1992 led to an ongoing decline in the total population, which during the last census of 2013 was recorded as 3,531,159 and a population density of 69.2 inhabitants per km^2, as shown in Table 4.11.5.

Following a sharp decrease in population in 1990-1991, this has now steadied, though continued to decline at a population growth rate of -1.7% in 2013. The municipality of Vareš has followed the country trend of a declining population, though at a higher rate than the national average. In 1991 the population of Vareš was recorded as 22,203, dropping to 8,892 in 2013, a decrease of approximately 60%.

Table 4.11.5: Administrative Unit Population Data

Unit	1991*	2013	2019 (estimate**)
BiH	4,377,033	3,531,159	3,301,000
Vareš Municipality	22,203	8,892	-
BiH Population Growth Rate (%)	-2.1	-1.7	-0.7

*NB Population data for 1991 has been adjusted from the census to represent new state and municipality borders.

** Estimate provided by the World Bank Group, World Development Indicators

4.11.4.2 Study Area Demographics

While the wider study area has been inhabited for centuries, as described in the cultural heritage baseline (Chapter 4.15), there have been some significant recent changes. With closure of major industry in the region at the beginning of the 1990s, paired with the onset of the Bosnian war, many people moved away from the area, a trend that generally continues today. Population data for the municipality of Vareš is shown in Table 4.11.6; the decreasing trend mirrors that of the country, though the dramatic change (-60%), is far more exaggerated in Vareš, when compared nationally. Local demographic data, drawn from the 2013 census is shown in Table 4.11.7.

Table 4.11.6: Census Population Data for Vareš Municipality

Census Year	1971	1981	1991	2013	
Population	25,523	22,822	22,203	8,892	
				Female	Male
				4,519	4,373

Table 4.11.7: Key Communities population data

Village	Area (km^2)	Distance to Vareš (km)	Population 1991	Population 2013	Inhabited properties (2013)	Inhabited Properties (2020)
Vareš town	6.99	-	5,888	2917	1,261	-
Vareš Majdan	1.5	3.5	3,162	1083	471	-
Pržići	1.42	9.0	234	62	28	-
Tisovci	1.69	8.0	153	41	17	-
Brezik	1.58	9.0	196	48	20	-
Daštansko	3.37	11.5	296	118	47	-
Višnjići	5.13	12.0	113	24	14	-
Gornja Borovica	9.61	18.0	521	74	48	20
Donja Borovica	4.33	18.0	468	72	37	16
Semizova Ponikva	7.19	9.0	118	23	9	4
Osredak	5.37	15.0	88	3	≤3	1
Položac	2.44	7.0	31	3	0	2
Pogar	11.28	7.5	372	139	64	43

The population density of Vareš is significantly lower than the national average at 22.8 inhabitants per km^2, likely due to the largely rural population with only one urban centre, Vareš town. Between 1991 and 2013, there was some migration within Vareš from rural areas to the urban centre. It is understood that many younger people have made that move in search of work and social activities, with transport to Sarajevo and other major cities more convenient from Vareš town.

Photo 4.11.1 Typical Rural village in the Project area

Despite migration from rural villages to Vareš town, the population density in the urban area still decreased by almost 50% between 1991 and 2013 (Table 4.11.8), representing the movement of young people to Sarajevo, other cities and abroad. The declining trend is visible through population data for all of the key communities and villages close to the Project (Table 4.11.7), as well as others across the municipality. In 1991 there were no uninhabited settlements in Vareš, in 2013 this rose to 21, and is predicted to have continued rising. Within the identified key communities, 3 of the villages have less than 10 households still present.

Table 4.11.8 Urban and Rural Population split in Vareš

Year	Population Density (inhabitant per km^2)		Population % split	
	Urban	Rural	Urban	Rural
1991	842.1	42.6	26.5	73.5
2013	417.2	15.6	32.8	67.2

The household surveys undertaken in 2020 reveal that most respondents were born in the same village, or at least in Vareš municipality, with many living there since birth, or with only a short break living away during the war. All respondents either own their own home or stated that it is officially owned by a living or deceased relative. Of those surveyed, none were living in rented property. The property cadastre is being updated currently in Vareš and there is significant effort to ensure all properties are registered in the correct or current name of the owner. Most households have owned their home through multiple generations and feel a strong connection to the area.

Household size has decreased between 2013 and present day (Table 4.11.9). Across all key villages there are only 10 households with school age or younger children present (according to the household survey results). Single occupancy households are rife, with many widows and widowers present. This is particularly true around the Rupice Project area in the remote community of Borovica.

Table 4.11.9: Mean Household Size

Village	Mean Household size (2013 census)	Mean Household size (2020 survey)	Number of households with children	Single occupancy households
Brezik	2.7	1.4	-	3
Tisovci	2.6	1.9	-	6
Pržići	2.5	2.2	2	4
Višnjići	2.0	1.7	-	3
Daštansko	2.2	2.6	4	7
Donja Borovica	4.3	1.2	-	12
Gornja Borovica	3.5	1.0	-	9
Osredak	n/a	4.0	1	-
Pogar	2.3	2.0	3	12
Položac	n/a	1.5	-	1
Semizova Ponikva	2.6	2.3	-	-

Across the whole of BiH the ratio of the male to female population is relatively even with respect to the total percent of the population and across the age ranges. Within Zenica-Doboj Canton, males and females had a similar population size, 149,837 and 154,153 respectively, however males made up nearly twice as much of the total labour force as women in 2013.

Family life is the cornerstone to local communities around Vareš. Men are generally seen as the head of households, particularly in rural villages, whilst most women are not employed but operate as housewives, evident throughout the household surveys. Of those households surveyed, 50% are headed by women, the majority of whom are widowed, receiving their husbands' monthly pension.

Further details about gender-specific context and risks, including Gender-Based Violence and Harassment (GBVH) from a human rights approach can be found in Chapter 4.12.

4.11.4.3 Age

The age profile for Vareš Municipality in Figure 4.11.2 highlights an ageing population, consistent with the trend across BiH. Approximately 17% of the population is aged 15 or less. In Vareš, the gender split of the working age population is relatively equal. However, in the older population aged 55 and above the percentage of woman is increasingly greater than that of men. It is anticipated that this is due to the loss of life during the Bosnian war, where many men will have fought, combined with the slightly greater life expectancy of woman (79.72) compared to that of men (74.75). This is illustrated in local data collected during household surveys, where there is a high number of single occupancy households headed by women.

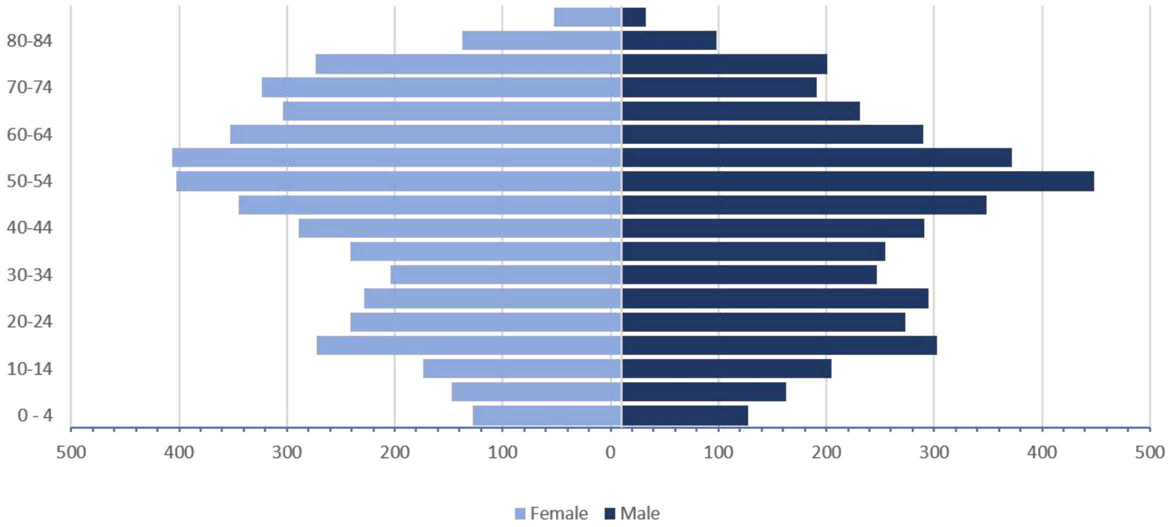


Figure 4.11.2: Population Pyramid for Vareš Municipality (2013)

The ageing population seen in Figure 4.11.2 is even more exaggerated within the rural communities close to the Project site. Across all key communities presented in Table 4.11.10, 32% of the population is over the age of 65 (2013 census), increasing to 48% in 2020, according to household survey results, as shown in Figure 4.11.3. This change is most dramatically shown in the communities of Gornja Borovica and Semizova Ponikva, where the population of over 65s has increased by more than 50%. It should be noted that Osredak does show an exception to this, however this settlement has only one occupied residence where the grandchildren of the residing couple have moved into the house whilst their parents work abroad.

Table 4.11.10: Percentage of Population by Age Bracket

Key Community	2013 census				2020 Household survey results			
	0-18	18-40	40-64	65+	0-18	18-40	40-64	65+
Brezik	4%	16%	43%	37%	0%	0%	17%	83%
Tisovci	7%	20%	41%	32%	0%	7%	26%	67%
Pržići	11%	16%	45%	27%	3%	9%	41%	47%
Višnjići	4%	13%	38%	46%	0%	10%	40%	50%
Daštansko	15%	23%	37%	25%	11%	22%	39%	28%
Donja Borovica	4%	13%	39%	44%	0%	0%	20%	80%
Gornja Borovica	1%	19%	42%	38%	0%	0%	11%	89%
Osredak	0%	33%	33%	33%	50%	0%	0%	50%
Pogar	13%	15%	43%	29%	8%	12%	43%	37%
Položac	0%	0%	0%	100%	0%	0%	33%	67%
Semizova Ponikva	9%	22%	48%	22%	0%	0%	22%	78%
Total	**9%**	**17%**	**41%**	**32%**	**6%**	**11%**	**34%**	**48%**

NB: Red – Greater than 45% change experienced, blue – 20-45% change experienced. Remained experienced <20% change.

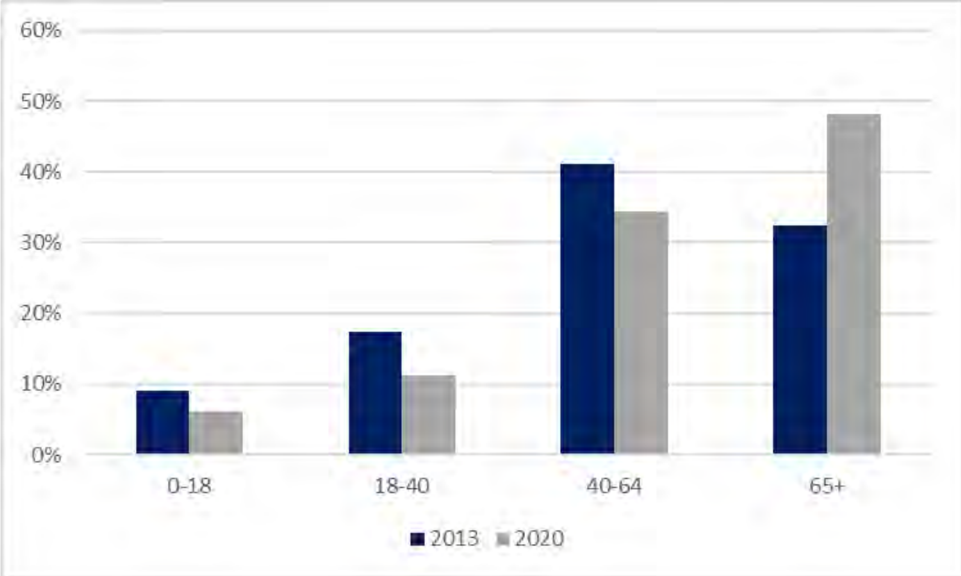


Figure 4.11.3: Percentage of Population According to Age Groups - Vareš Municipality

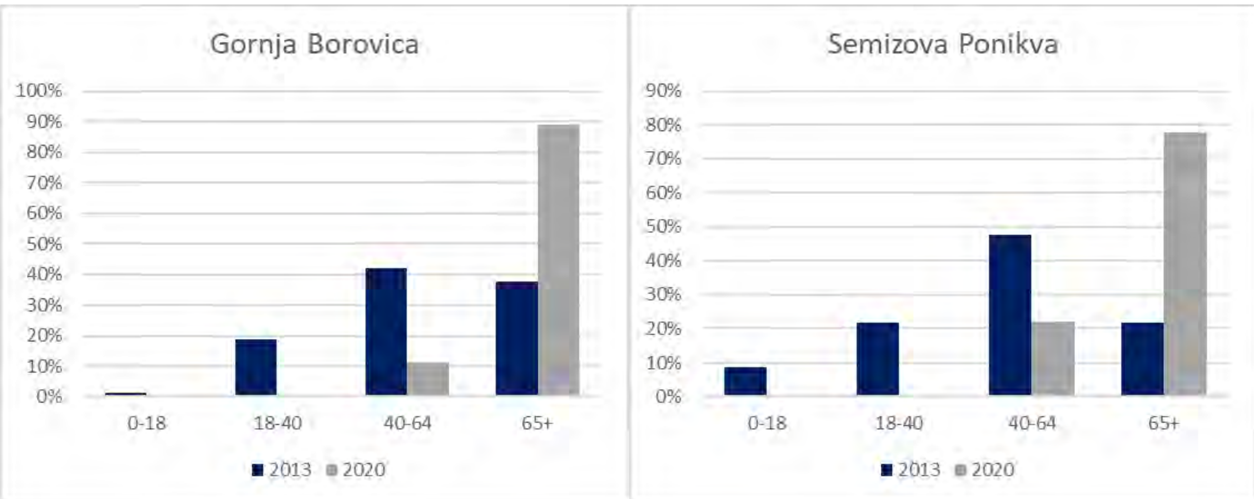


Figure 4.11.4: Percentage Population per Age Bracket for Two Communities with Highest Change 2013 - 2020

4.11.4.4 Ethnicity, Religion and Language

In BiH ethnicity and religion are closely linked. The largest three ethnic groups are the Bosniaks (predominantly Islam), the Serbs (predominantly Orthodox) and the Croats (predominantly Catholic). The Bosnian war (1992-1995) saw many people forcibly displaced from their homes; the conflict and proceeding sensitivities between the three main ethnicities meant that no census was recorded between 1991 and 2013. Article 12 of the law on Census of the Population, Household and Dwellings in BiH in 2013 stipulated that persons are not obliged to give data on their ethnic/national affiliation and religion.

As shown in Figure 4.11.5, Vareš municipality has a majority of Bosniaks, mirroring that of the FBiH and the Zenica-Doboj Canton, followed by Croats and then Serbs and others. Within Vareš municipality there is a larger proportion of Croats when compared to the Canton and Federal statistics. The difference is likely due to the close contact and settlement of Croats during and after the Bosnian War.

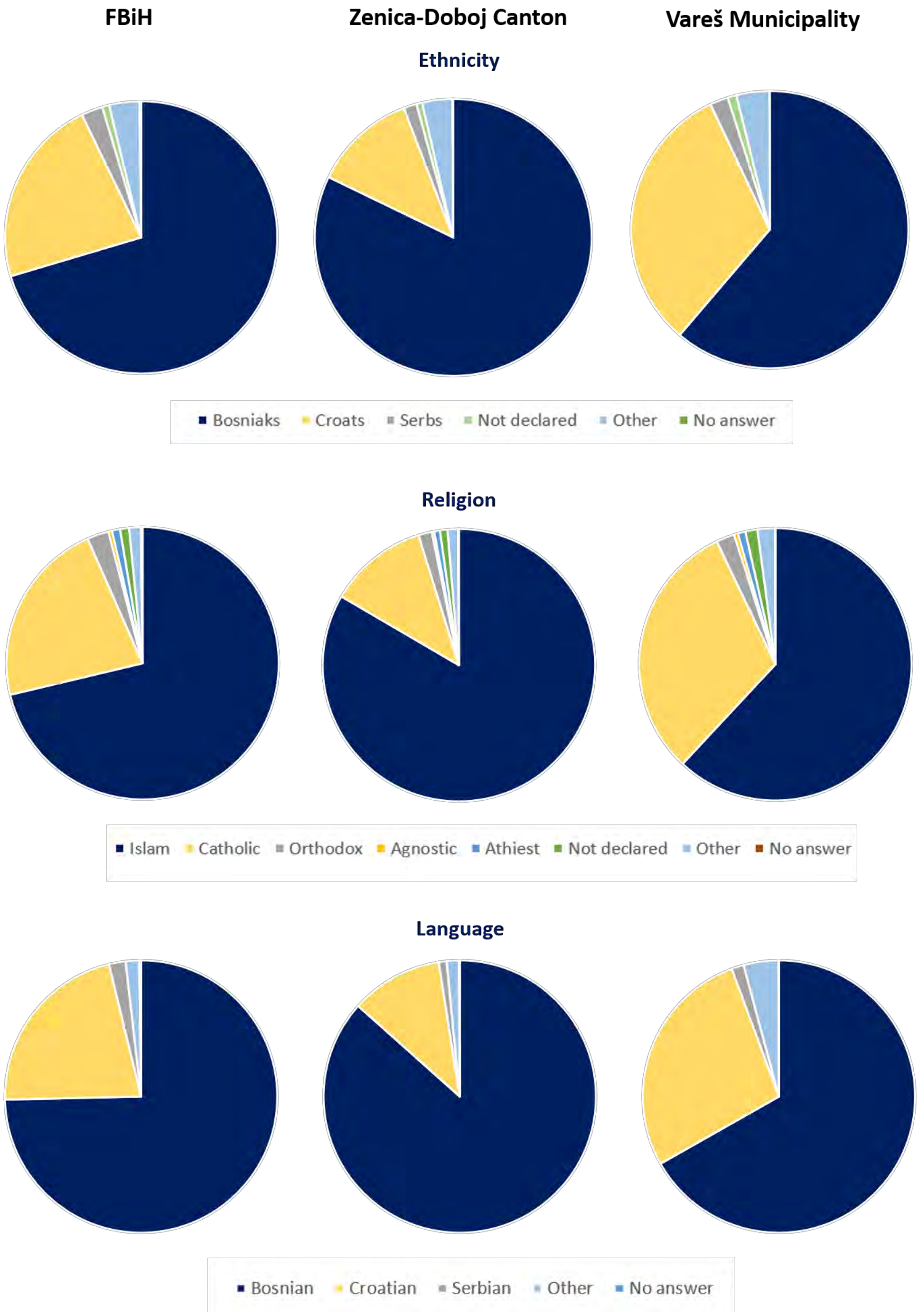


Figure 4.11.5: Ethnicity, Religion & Language at Different Administrative Levels (2013)

Despite the sensitivities, people in Vareš showed a strong connection to their ethnicity and religion, making this a key part of their lives. Each community has a strong identification with a specific ethnicity, though the villages are not explicitly limited to each ethnic background. Figure 4.11.6 shows how ethnicity across Vareš varies.

Daštansko and Vareš Majdan are predominantly Bosniak communities, whilst all key communities are predominantly Croat. Northern territories are predominantly Croatian; only Vareš town comprises of Bosnian and Croatian in approximate equal quantities. Through the years from 1991 to 2013, the Croatian percentage typically appears to increase across Vareš however, in Vareš town there was a 153% increase in the Bosniak population in the same period.

Figure 4.11.6 Vareš Municipality Colour Coded by Ethnic Majority
Blue = Croatian, Dark Green = Bosnian, Red = Serbian, Light Green = approximately equal between Bosnian/Croatian, Grey = Not included in 2013 census.

Table 4.11.11: Ethnic % of the Population of the identified Key Communities for the Project, of the Municipality of Vareš

Town/village	Bosniaks		Croats		Serbs		Others	
	1991	2013	1991	2013	1991	2013	1991	2013
Vareš	18.1	45.9	51.5	43	10.6	2.4	19.7	8.7
Pržići	0	0	94.6	100	0.4	0	4.7	0
Tisovci	0.7	0	90.8	100	0.7	0	7.8	0

Table 4.11.11: Ethnic % of the Population of the identified Key Communities for the Project, of the Municipality of Vareš								
Town/village	Bosniaks		Croats		Serbs		Others	
Brezik	12.2	2.1	71.4	91.7	11.7	4.2	4.6	2.1
Daštansko	79.4	87.3	16.2	12.7	0.0	0.0	4.4	0
Višnjići	0	0	64.6	83.7	27.4	16.7	8	0
Vareš Majdan	9.9	56.2	40.4	27.1	23.8	5.4	26.0	11.3
Gornja Borovica	0	0	99.6	100	0	0	0.4	0
Donja Borovica	0	0	98.3	100	0.4	0	1.3	0
Semizova Ponikva	0	0	82.2	100	0	0	17.8	0
Osredak	0	0	98.9	100	0	0	1.1	0
Položac	0	0	83.9	100	0	0	16.1	0
Pogar	0.3	0	80.1	100	0.5	0	19.1	0

The three official languages of BiH are Bosnian, Croatian and Serbian. The mother tongue of citizens was recorded in 2013; this closely follows ethnicity (Figure 4.11.5). In Vareš municipality the prominent language is Bosnian, this is widely spoken and understood. All ESIA and project documentation should be made available in Bosnian language to ensure it is understood at the community level.

4.11.5 Economics and Livelihoods

4.11.5.1 Income and Livelihoods

According to 2010 data, Vareš Municipalities GDP per capita was lower than the Zenica-Doboj Canton average, the FBiH average and the national average.

Across BiH employment by composition is split into agriculture, industry and services. As of 2018 in BiH 52% of employed people worked in services, 32% in industry and 16% in agriculture[1]. Over 60% of the population of BiH live in rural areas, with agriculture providing the backbone of the rural economy, employing 20% of the total workforce and contributing 6.4% of the total GDP[2]. Poverty is more common in rural areas, and job opportunities outside of agriculture are sparse.

At the end of 2019 there were 54,307 people registered as unemployed in the Zenica-Doboj Canton. The 2020 covid-19 pandemic has caused this number to rise in 2020, peaking at 58,624 in August. Since the 2013 census, unemployment has risen by approximately 58% in Zenica-Doboj Canton, a trend that is mirrored in Vareš. As of October 2020, there was a total of 943 unemployed people of working age in Vareš. Through discussion with the unemployment centre in Vareš it is evident that a

[1] http://www.bhas.gov.ba/data/Publikacije/Bilteni/2019/NUM_00_2018_TB_0_EN.pdf
[2] Bajramovic. S, et al, Agriculture and agricultural policy in Bosnia and Herzegovina. In Agricultural Policy and European Integration in Southeastern Europe, 2014.

large majority of those registered as unemployed are elderly and waiting to reach retirement age which is 65 years in BiH.

This trend is particularly acute in the key villages close to the Project, with 73% of household heads being retired, 17% being unemployed and just 11% in employment. As shown in Table 4.11.12, the unemployment rate in key villages is higher than the Vareš municipality average, though a large proportion of these people are elderly and likely awaiting retirement.

Table 4.11.12: Employment Data at Entity Levels (2013)

Entity	Working age population	Employed	Unemployed	Retired	Person performing household duties	Unable to work	Other
FBiH	1,862,272	635,246	200,326	368,934	295,895	33,161	328,710
Zenica-Doboj Canton	303,990	100,289	33,736	59,141	57,535	4,473	48,816
Vareš Municipality	7,947	2,320	611	2,271	1,515	124	1,106
% of working age population (Vareš)		29%	8%	29%	19%	2%	13%

Vareš municipality has a history of mining and industrial activities in the region. The Iron foundry located in Vareš Majdan was a major employer until its closure in the early 1990s. Many of the retired and elderly population were previously employed at the foundry carrying out numerous tasks. Equally, Energoinvest, previous operators of the Veovaca mine and process plant, employed a large proportion of the working age population.

Of those currently working, according to the household survey, most are employed or self-employed in the services industry, mirrored by the high number of services businesses in Vareš (Table 4.11.13). Included in the crafts and services industry are trades people, hairdressing, shoemaking, mechanics, radio, IT services, and opticians. Many respondents did not wish to disclose their income, though 73% of people receive their monthly income from pension. In addition to employment, some receive money from family living overseas and a small number receive social benefits in the form of unemployment allowance or disability allowance.

Table 4.11.13: Operational Businesses in Vareš Municipality

Business area	Number of businesses
Catering and Accommodation	29
Crafts and Services	49
Retail	29
Private Companies	29

Commercial Agriculture	30
Transportation	11

4.11.6 Education

In the key communities, the majority of residents have not undertaken any form of higher education (Figure 4.11.7). Those that have, have predominantly taken specific trade courses. It was noted that a higher proportion of woman attained elementary education as their highest form, when compared to that of men.

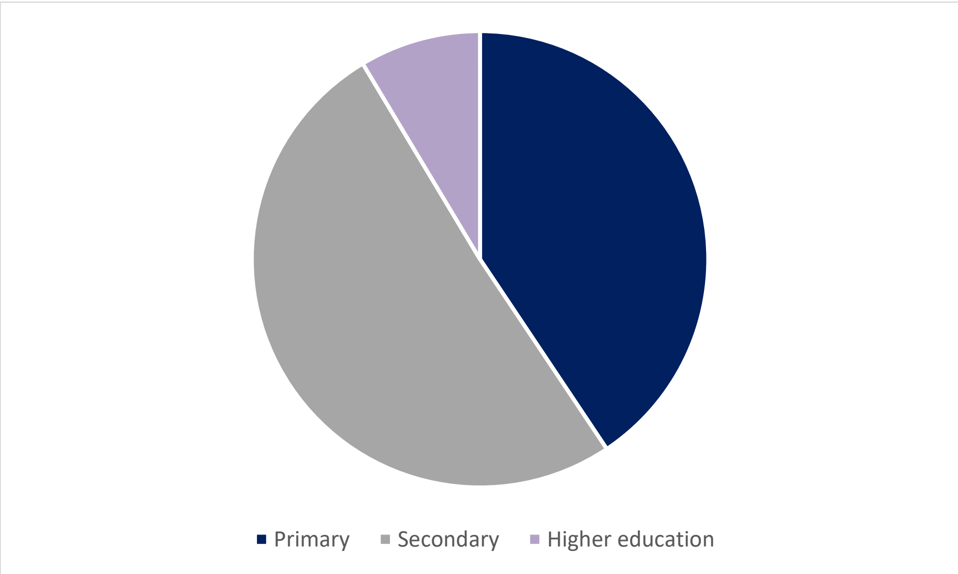


Figure 4.11.7: Highest form of Education attained in Key Communities (2020 Household Survey)

The high school, located in the centre of Vareš, currently has 151 pupils enrolled with 20 teachers, some of whom are part time. However, the school's capacity is 1,500 pupils. Of those enrolled 90 are boys and 61 are girls. There is an approximate 91-100% pass rate in recent years. The school has been engaged with Adriatic Metals and the headteacher sees much potential for future collaboration and capacity building for students. The school previously taught technical specialities related to the mining and iron and steel making industries, with these laboratory facilities still available.

With no higher education facilities in Vareš, most pupils will continue their education in Sarajevo, with social sciences being the most popular current topic. In 2013, 491 people living in the Municipality had completed university degrees (5.5%). Very few of those who move away for higher education have returned to the area, primarily due to the minimal economic opportunities.

There are 53 children currently enrolled in primary schools across the municipality but this number, along with those in high school, is decreasing yearly. Primary schools are located in Vareš as well as one in Borovica and one in Ržići.

Photo 4.11.2 Assembly Hall of Vareš High School

4.11.7 Leisure and Tourism

A tourism information centre was opened in the centre of Vareš in May 2017; since this date the number of tourists visiting Vareš is seen to have slowly increased. Visitor numbers are heavily seasonal, with most coming in the summer months (April – November) for hiking, mountain biking, and to visit cultural and historic monuments. Prior to the outbreak of the Bosnian War, tourism in the area was well established, alongside the mining and industrial activities at the time.

The Via Dinarica hiking trail[3], described as a "mega hiking trail across the Western Balkans" is currently being developed. The 'green trail', one of three routes, will pass directly through the town of Vareš and onto the medieval centre of Bobovac and will be suitable for hiking and mountain biking. The trail begins in Albania and extends through Croatia and BiH, ending in Slovenia. Further walking trails are

[3] https://viadinarica.com/en/

also being developed in the area, with mountain guides and mountain bikes available for hire at the tourism information centre.

Between 2013 and 2016, German Organisation HELP[4] carried out work in Vareš through Income Grants Assistance schemes for micro and small businesses, namely support to local tourism activity development.

Several cultural and leisure activities take place in Vareš municipality, many of which are often sponsored or supported by Adriatic Metals. An International Art Colony, an artist retreat allowing the artists to gain inspiration from the surrounding nature and cultural heritage, occurs yearly in Bobovac in June and is arguable the largest event in the area.

The historic iron ore pit located at the southern extent of Vareš (Photo 4.11.3) is utilised by the local community for swimming activities in the summer months and locally as a beauty spot. The proposed haul road will go around this pit and could impact the unofficial use of this facility.

Land within the municipality is utilised for hunting and fishing for recreational purposes. Household survey results revealed that only a small number of people (10 for hunting and 6 for fishing), partake in these activities. In 2021 there were approximately 50 members of the sports fishing association who utilise their catch for personal consumption, commercial fishing in rivers is illegal and not practiced in this area. The Vares Hunting Association has 375 members who partake in recreational hunting activities across the municipality, predominantly on an ad hoc basis. To support these activities a trout farm and hotel and a hunting lodge are present. The hunting lodge has been utilised by Adriatic Metals as accommodation for drilling crews. A detailed assessment of both fishing and hunting, including associated land use, is presented in Chapter 4.13 Ecosystem Services.

[4] http://www.help.org.ba/en/

Photo 4.11.3 Historic Iron Ore Pit in Vareš

Several sites of cultural and heritage interest are located in the wider project area. These attract visitors from both BiH and overseas, these are detailed in Chapter 4.15 Archaeology and Cultural Heritage, and include:

- Historic town of Bobovac;
- Old Mosque in Karićima from the Ottoman era; and
- Oćevija Village, ancient pre-industrial blacksmith trade.

4.11.8 Traffic and Transport

4.11.8.1 Project Context

Road infrastructure in the Project area is poor comprising weathered asphalt and unsurfaced routes, particularly around the Rupice site. There is a distinct lack of public transportation, predominantly around the rural communities and residents rely largely on lift shares or taxis for transportation needs. There is one daily bus service route that is utilised by school children and others who wish to travel to Vareš. In the identified key communities, 41% of households have access to a private car, whilst over 50% rely on either lift shares, taxis or public transport.

The Project design means that haulage of ore and tailings will occur between the Rupice mine and the Vares Processing Plant, utilising a combination of existing roads and roads that will be either upgraded/widened or constructed. The current plan for haulage has been designed in such a way that heavy industrial traffic will be diverted around the main urban centre of Vareš town as far as possible.

The product concentrate will be loaded into 20-foot standard intermodal containers at the plant site. Trucks will haul the containers to the rail siding in Vareš. An Integrated Tool Handler (ITH) or forklift truck will unload the haul trucks and load the containers onto flat rail cars for transport approximately 230km to the Port of Ploče in Croatia; from where they will be shipped to the off taker. Empty containers will be returned by rail to the rail siding at Vareš and back to the plant site for loading of the next consignment.

More vehicles are expected to be on the roads during construction and operation of the Project, and because of the close proximity of some communities and settlements to the Project, adverse impacts may occur. These impacts include deterioration of the roads and increased traffic leading to more traffic accidents for both road users and pedestrians.

4.11.8.2 Traffic Surveys

Traffic surveys were conducted twice for 24-hour periods in July and October 2020 at four locations: Vareš, Semizova Ponjkva, Borovica Gornja and Tisovci. Two surveys were conducted at each location, one midweek (Thursday) and one at the weekend (Saturday), each lasting 24 hours. The volumes of traffic recorded and turning counts (Appendix 14.11.2) illustrate that the junction located at Vareš had the highest traffic volumes, approximately 10 times more than other locations.

Table 4.11.14: Baseline Measured Traffic and Link Capacity

Junction ID	Baseline 2020 (PCU/day)	Baseline 2020 (PCU/hr)	Baseline Vehicles /hr	Baseline HGVs	HGV %average (Baseline Pk%H)	Link Capacity
TS1	40	6	6	0	0.0%	1380
TS2	29	4	4	1	25.0%	1005
TS3	3292	494	475	7	1.5%	1358
TS4	308	46	43	2	4.7%	1310

* PCU – Passenger Car Units e.g. One HGV equates to 2.5 PCUs. To obtain peak hour flows a 15% margin was applied.

4.12 Human Rights and Community Health and Safety

4.12.1 Human Rights

Chapter 2 of the ESIA presents the list of the international labour and human rights conventions signed or ratified by BiH as of February 2021 (Office of the High Commissioner on Human Rights, 2021). These ratified conventions are considered as legally binding commitments for the state's responsibility to protect human rights, and the Project sponsor's responsibility to respect them. In addition, international standards apply to businesses regarding human rights, representing non-binding implications of existing IFI standards, such as:

- The United Nations Guiding Principles (UNGP) for implementing the United Nations "Protect, Respect, Remedy" Framework, focusing on the business responsibility to respect human rights;
- The IFC PS recognise the same responsibility, including elements related to human rights dimensions in IFC PS1, PS 2, PS 4 and PS 7;
- The Equator Principles, including Principles 1, 2 and 10; and
- EBRD's commitment to the respect for human rights in project finance by the EBRD and specific mentions in PR1 and PR5, though covered across all Performance Requirements to some degree.

The following human rights context characterisation is based on the socioeconomic baseline chapter (Chapter 4.11) and additional primary and secondary data collection activities from a rights-based approach. Potential human rights risks are detailed in the following sections either as potential gaps in the national context or as part of the background history of the region linked to post-conflict risks.

4.12.1.1 Labour and Working Conditions

As detailed in Section 2.5, BiH has ratified all fundamental international labour conventions from the International Labour Organisation (ILO). The legal workweek in BiH is 40 hours, with 10 hours per week overtime and a possible further extension, although seasonal workers may work up to 60 hours. There is no provision for premium pay in the FBiH, and there must be a minimum rest period of at least 30 minutes during the workday.

Occupational health and safety (OHS) requirements are established in the national law (United States Department of State, 2021). However, there is reportedly limited enforcement on working hours, daily and weekly rest or annual leave, and labour regulations are not effectively enforced. Whilst labour inspectors are permitted to make unannounced inspections, the number of inspectors is reportedly insufficient (United States Department of State, 2021). Governments and entities make only limited efforts to improve occupational health and safety and it is further noted that hazardous conditions, particularly in the metal and mining industries, are apparent. Nonetheless, as of mid-October 2020, there were no reports of serious injury or death arising from industrial accidents.

Non-discrimination in labour

Discrimination based on race, ethnicity, sex, gender, age, disability, language, sexual orientation or gender identity, HIV-positive status, other communicable diseases, social status, religion and national origin is prohibited by labour laws and regulations. While the regulations are generally enforced by the government, discrimination in employment and occupation was found to still occur (United States Department of State, 2021). Discrimination and hate speech against LGBTI individuals has been found to be widespread and the law prohibiting this discrimination is not fully enforced.

The UN Committee on the Elimination of Discrimination against Women observed in a 2019 study in BiH that there is a low level of representation of women in the labour market. The Committee specifically mentioned the following risk conditions (UN Committee on the Elimination of Discrimination against Women, 2019):

- Persistence of gender pay gaps and occupational segregation in the public sector;
- Disproportionate high number of women who undertake unpaid agricultural and domestic work, as well as the protracted process of ratifying the Domestic Workers Convention, 2011 (No. 189) of the ILO;
- Lack of specific employment strategies directly targeting women, particularly in disadvantaged groups (see intersectional vulnerability in section 13.5 below).
- Disparity in maternity benefits;
- Unpaid social contributions by employers, risking pension and health insurance benefits of women; and
- Sexual harassment incidences among one in six employees in the workplace (see section 13.4 for more details).

4.12.1.2 Freedom of Association, Movement and Expression

In BiH, the law provides freedom of association and internal movement and the government generally respects these rights. However, some restrictions remained. During the COVID-19 pandemic, children and people aged 65 and over were placed under a 24-hour curfew, and the Council of Ministers issued a decision limiting the movement of undocumented migrants outside of migrant centres. Both restrictions were ruled by the BiH Constitutional Court as violating civil rights, noting its disproportionality to tackling the health emergency. The measure has now been reversed.

BiH has laws in place to protect a high level of freedom of expression that apply to all persons, including the press, in public, online, academically and at cultural events. Freedom of peaceful assembly is also provided by law whilst expression of racial, ethnic or other hate speech is prohibited by law. However, informal groups holding gatherings unannounced to police have been recorded as being disbanded by police with members being summoned for interrogation (United States Department of State, 2021).

4.12.1.3 Security

Over the last 17 years to 2017, (the last year for which figures are publicly available) the crime rate in BiH has decreased from 2.60 intentional homicides per 100,000 inhabitants in 1990, to 1.20 per 100,000 inhabitants in 2017[1] , a drop of 77%. Between 2016 and 2017 the crime rate decreased in by 7.69%, from 1.30 per 100,000 inhabitants to 1.2.

Incidents of crime in Vareš are understood to be of low severity and low frequency, with approximately 30 occurrences within the municipality per year. The number of crimes continues to decrease, with approximately 70 occurrences in 2014. Violent crimes are minimal, with the last murder reportedly occurring approximately 20 years ago. Crimes related to drugs, alcoholism and prostitution are reportedly not currently prevalent in the area. However, crimes related to gender have been linked to alcohol consumption (see Section 4.12.4).

An interview with the police station in Vareš gave information that approximately 40 staff are employed within the police force in the municipality, including office and administration staff. The police station reports to the Canton commissioner, who in turn reports to the Federal Police Administration.

According to international observers, there are reports of police impunity concerning security services in both entities of BiH[2] (United States Department of State, 2021). In spite of these reports, international observers acknowledge that there are internal affairs investigative units within all police agencies. The government has provided training to police and security forces designed to combat abuse and corruption and promote respect for human rights. The field training manuals for police officers also include ethics and anticorruption training components (United States Department of State, 2021). However, there is a lack of clear division of jurisdiction and responsibilities among the 17 law enforcement agencies in BiH, which has reportedly resulted in occasional confusion and overlapping responsibilities (United States Department of State, 2021). In addition, there is a reported lack of follow-through on allegations against police abuses, which have fed the perception of police impunity.

According to international reports, ineffective prosecution of war crimes committed during the 1992-95 armed conflict continued to be a problem (United States Department of State, 2021).

4.12.1.4 Persons with Disabilities

Laws in BiH prohibit discrimination against people with physical, intellectual, sensory and mental disabilities. The FBiH has a strategy for advancing the rights and status of persons with disabilities for

[1] Source: World Bank
[2] Reports refer to a lack of follow-through on allegations against police abuses and lack of prosecution of sexual violence instances reported during the 1992-95 conflict. Observers have reportedly considered police impunity widespread, especially concerning impunity for some crimes committed during the war.

the period 2016-21, which was developed in accordance with the Convention on the Rights of Persons with Disabilities. Laws also require increased accessibility to buildings for persons with disabilities (United States Department of State, 2021). However, despite these advancements, authorities rarely enforce requirements, exemplified by the construction of public buildings without access for persons with disabilities, hindering their ability to engage in public processes and hearings. Additionally, the legislation lacks a uniform legal definition of disabilities and employment discrimination is frequent. Priority in allocating support is given to those disabilities resulting from the 1992-1995 conflict, irrespective of whether they are civilian victims or war veterans, over other persons with disabilities.

4.12.1.5 Child Labour

Bosnian law sets the minimum age for employment at 15, and a valid health certificate is required for persons between the ages of 15 and 18. These age groups are also prohibited from working at night or fulfilling hazardous roles. In 2020, the government did not receive any reports of child labour at places of employment, although no dedicated child labour inspections took place. General perception among society and officials is that the exploitation of child labour in the area is rare (United States Department of State, 2021).

4.12.1.6 Ethnic Minorities

Discrimination against minority ethnic groups reportedly occurs throughout the country, although is thought to be in decline. Discrimination in employment occurs in both the government and private sector, which is prohibited by law but not adequately enforced. In 2019, 130 hate crimes were recorded in BiH, resulting in only one conviction.

According to the NGO “Interreligious Council”, promoting dialogue among the religious communities in the area (Muslim, Serbian Orthodox, Roman Catholic, and Jewish), attacks against religious symbols, clerics, and property continued in 2019 (United States Department of State, 2021). The following issues were reported as concerns of continuous discrimination against ethnic minorities: unresolved claims on property restitution for religious institutions; continuous expression of racial, ethnic and other intolerance in public discourse; segregation of ethnicities in public universities with ethnic stereotypes embedded in textbooks; barriers to language rights for returnee students of different ethnic groups; ethnic quotas based on population census which undercounted ethnic minorities; and a lack of a comprehensive strategy on national minorities.

Romani women are most likely to experience widespread discrimination, with an unemployment rate of 95% and significant homelessness rates. A 2013 census suggested there were 12,583 persons registered as Roma in BiH although the actual number is thought to be approximately 40,000 persons (United States Department of State, 2021).

4.12.2 Gender-Based Violence and Harassment

Comprising a range of behaviours, Gender-based Violence and Harassment (GBVH) includes sexual exploitation, abuse and harassment, violence that can be physical and / or psychological, as well as financial abuse (CDC; EBRD; IFC, 2020). GBVH is directed at people because of their sex or gender and it can disproportionately affect them, which can constitute a human rights violation.

The current national and local conditions regarding GBVH are presented in this section of the ESIA based on available information. The information is supported by GBVH-specific legal framework and best international practice requirements, presented below.

BiH has ratified international conventions (see Chapter 2.5 for complete details) that relate directly to the avoidance and reporting of GBVH (UN Office of the High Commissioner for Human Rights, 2020):

Table 4.12.1: International and regional conventions and commitments on GBVH for BiH.

Convention	Description
1979: The UN Convention on the Elimination of all Forms of Discrimination Against Women (CEDAW)	Succession on 1 September 1993 – This convention recognises GBV as a form of discrimination that inhibits women's ability to enjoy rights and freedoms on an equal basis to men
1989: The UN Convention on the Rights of the Child (UNCRC)	Succession on 1 September 1993 – States the rights of every child, including the right to be safe from violence.
1958: UN Discrimination (Employment and Occupation) Convention, 1958, No.111	Ratified on 2 June 1993– Covers sexual harassment as a form of sex discrimination
2006: The UN Convention on the Rights of Persons with Disabilities	Ratified 12 March 2010 – To take all appropriate legislative, administrative, social, educational and other measures to protect persons with disabilities.

In addition, the IFC PSs require investees to address gender risks, promote non-discrimination and equal opportunity, and ensure the health and safety of communities (IFC, 2012). The EBRD's Environmental and Social Policy and PRs make explicit reference to preventing and addressing GBVH through PS2/PR2 on Labour and Working Conditions and PS4/PR4 on Community Health, Safety and Security (EBRD, 2019). More specifically, the EBRD requires that project-related GBHV risks have to be evaluated and where appropriate, specific measures to prevent and address these risks must be adopted (EBRD, 2019).

4.12.2.1 National Context

Different international organisations have assessed and ranked countries to create global indices in regards to their efforts in data collection, identification and management of gender-related issues such as gender inequality, discrimination and GBVH risks. The ranking of BiH within those indices can be seen in Table 4.12.2, presenting BiH in the mid-range of the indices.

Table 4.12.2: Global GBVH Rankings		
Index	**Description**	**Ranking/countries assessed**
The Women, Peace and Security (WPS) Index	Georgetown University draw on international data sources to prove a comprehensive measure of women's wellbeing and their empowerment.	56/167
The Annual Global Gender Gap Index	A framework for capturing the magnitude of gender-based disparities and tracking their progress over time.	69/149
The SDG Gender Index	Measure state of gender equality and includes 51 issues including health, GBV, decent work etc.	38/129
The Gender Social Norms Index	UNDP uses data on attitudes towards gender and their impact on social and political life.	75/189

At a national level, BiH is undergoing post-conflict transitional justice processes within its entities and this is specifically relevant for conflict-related sexual violence victims (UN OHCHR, 2021). Within a post-conflict baseline condition, potentially wider prevalence and exposure to GBVH risks must be analysed closely based on publicly available information.

According to a study conducted by the Council of Europe in 2019, official public bodies are tasked with GBVH data collection in both entities (the FBiH and the RS) and on the national level in BiH. However, there are reported difficulties with co-ordination and gaps in coverage, as well as with data analysis as both entities have a two-track system of data collection with different processes. (Council of Europe, 2019).

The most recent concluding observation by the Committee on the Elimination of Discrimination against Women in BiH identified positive amendments in the applicable legal framework (UN Committee on the Elimination of Discrimination against Women, 2019):

- Amended Law on the Prohibition of Discrimination which now includes a definition on sexual harassment, as well as the Law on the Provision of Free Legal Aid which facilitates access to justice for women (2016);
- Amended Law on Asylum and Law on Foreigners providing support for human trafficking victims (2015);
- Amendments to the Criminal Code, which now defines forms of sexual violence as a war crime with increased sentences;
- The adoption of a Gender Action Plan (2018-2022), a national action plan to counter trafficking (2016-2019) and a framework strategy for the implementation of the Convention on Preventing and Combating Violence against Women and Domestic Violence (Istanbul Convention) (2015–2018); and
- The ratification of the Istanbul Convention on November 7, 2013.

Remaining concerns were reported at a country-wide level, notwithstanding the above, on the continued prevalence of GBVH against women (UN Committee on the Elimination of Discrimination against Women, 2019), particularly concerning:

- Underreporting of GBVH cases due to social stigma;
- Lack of specialised knowledge on gender issues by public service, legal and health professionals and staff of the centres for social welfare who work with GBVH victims; and
- A low prosecution and conviction rate in cases of non-physical violence against women, including the lack of disaggregated data on all forms of GBVH.

4.12.2.2 Local Context

The Centre for Social Work in Vareš was available to participate in engagement activities for baseline data collection with the Adriatic Metals team during a site visit in January 2021. In comparison with the country-wide context of parallel processes between FBiH and RS, the director of the Centre for Social Work in Vareš was well aware and informed of GBVH risks and conditions in the Project area.

According to the director of the Centre, the FBiH Law on Domestic Violence sets the applicable legal framework for violence-related support services. Reportedly, a safe house located in the Zenica-Doboj Canton, called MEDICA, began its work immediately after the war in 1995 and operates as a shelter for female victims of violence. According to the interviewee, there is ongoing cooperation between the Vareš Health Centre, the Vareš Police Station and the Centre for Social Work, and in the case of reported violence, they have operational procedures to address the cases. In most cases, the victims of violence are women and children.

While global research has shown that the number of domestic violence cases has increased due to the COVID-19 pandemic, the director of the Centre of Social Work reported that this increase has not been reported in Vareš. The Centre has received seven cases of domestic violence in 2020, which has decreased compared to other municipalities in the same time period. Reportedly, this may be due to tensions within migratory families due to lack of local work. However, as noted in the national context, it may also be a sign of underreporting.

One of the challenges to maintain an accurate record of the number of reports of domestic violence was, according to the Centre, that reports logged in the police station were dropped. Three out of four applications received by the police were withdrawn by the victims in 2020. This may be due to, as reported by the Centre representatives, the position of vulnerability and dependency of the victims in terms of access to education, lack of economic opportunities to become independent, and lack of housing alternatives.

An interview undertaken with social services in Vareš in November 2019, for the purpose of baseline data collection, indicated, in contrast, that incidents of domestic violence are high across the municipality, with 13.35% of the population reporting cases and requiring help in this regard. It was stated that incidents of domestic violence are closely related to alcohol abuse, a problem that was more prevalent during the previous industrial period when expendable income was greater.

The president of the Women's Association for Rural Development, Sustainable Return, Reintegration and Resocialisation of Returnees "Zvijezda" ("Star") Vareš, was interviewed by the Adriatic Metals team in March 2021. The interviewee, also a member of the Public Liaison Committee, reported that Zvijezda Vareš works with unemployed women and conflict-related female victims of sexual violence to engage in the cultivation and processing of agricultural and dairy products. They reportedly hold creative activities during the winter seasons, and particularly during the COVID-19 pandemic. Some of their products are donated to the Public Kitchen in Vareš. The president of Zvijezda mentioned that their organisation had previously provided assistance to Syrian refugee women in the last couple of years.

In addition to Zvijezda Vareš, the following women's associations and groups were identified in the Vareš municipality.

- Originally Vareš
- Women Of Stupni Do
- Women's Association „Zvjezdangrad" Vareš
- Women's Forum Strica-Zaruđe
- Women's Forum Pogar
- Women's Association For Rural Development, Sustainable Return, Reintegration And Resocialization "Narcis Dabravine" Vareš

As part of the ongoing engagement activities comprised in the Stakeholder Engagement Plan, further focus groups will be undertaken with women in the Project area and the women associations listed previously to monitor and gain continued understanding of GBVH risks.

4.12.3 Community Health and Safety

4.12.3.1 National Context

The Bosnian war resulted in socioeconomic losses for the people of BiH, and in doing so created health linked concerns, particularly involving increased drug and alcohol use and post-traumatic stress disorder (PTSD). Smoking is rife throughout BiH, with more than 8,600 citizens dying of tobacco-caused diseases annually; more than 2,000 children (10-14 years) and 1.014 million adults (15+) use tobacco daily[3]. Smoking can cause premature death; projected premature deaths of smokers within the FBiH are presented in Table 4.12.3.

Table 4.12.3: Smoking Prevalence and Premature Deaths in the FBiH

Smoking Prevalence %		Projected premature deaths of current smokers	
Male	**Female**	**Male**	**Female**
56.3	31.6	164,678	92.430

[3] The Tobacco Atlas

Non-communicable diseases caused the most deaths in BiH from 2009 to 2019. Injuries and communicable, maternal, neonatal, and nutritional diseases were not in the top 10 causes of deaths. In 2019, the five greatest causes of death across BiH were Ischemic heart disease, stroke, lung cancer, diabetes, and colorectal cancer, which all show increased rates compared with the last decade. Deaths caused by heart disease showed the largest increase of 16.3%. Similar to the results of the HIA report (See Appendix 4.12.1 and Section 4.12.3.2), the latest official data from the Municipality of Vareš showed that the leading cause of mortality is cardiovascular disease, including among the working population and the elderly.

The BiH healthcare system provides free access to healthcare for the public. In the FBiH, health care is decentralised and as such organised at the Canton level. The RS has a centralised health care system. As with all cantons in the FBiH, Zenica-Doboj has an independent Minister of Health. Funding of healthcare is defined in Table 4.12.4.

Table 4.12.4: Public Health System Financial Contributors

Entity	% Contribution
Government of BiH	54%
Employers	30%
Employees	16%

Primary healthcare is provided through health centres and health stations (ambulantas). Health centres are owned by municipal Governments and are staffed with general practitioners and nurses.

The Laws on Health Insurance in the FBiH comprise of persons paying contributions to fall in the category of insured persons. Insured persons are further divided into several categories dependent on whose name is on the insurance and the level of coverage; insurance coverage in FBiH per canton can be seen in Table 4.12.5. Note that discrimination in terms of health care does exist through the exclusion of certain groups from the healthcare system, such as those whose years of service have not been “linked”, self employed people who have not paid health insurance contributions and the unemployed who have failed to extend registration[4].

Table 4.12.5: Percentage of Population of the FBiH with Health Insurance Coverage[4].			
Canton	**2010**	**2012**	**2015**
Una-Sana	72.98	73.78	72.16
Posavina	79.11	79.31	75.46
Tuzla	87.42	89.4	88.11
Zenica-Doboj	82.47	86.65	85.9
Bosnian-Pdrinje	77.62	79.2	78.6
Central Bosnia	84.23	86.82	85.79
Herzegovina-Neretva	84.36	85.07	86.61
West Herzegovina	89.65	91.79	96.5
Sarajevo	93.94	95.74	95.64
Canton 10	66.84	67.07	63.7
Total	84.55	86.52	85.96

The FBiH registered a continuous fall in vaccine coverage from the Mandatory Immunisation Programme in 2019 and for five years prior to that date. An immunisation coverage of 90-95% is recommended. In 2016 only the tuberculosis vaccine met this recommendation with coverage of 96.4%. For Hepatitis B the average vaccination of children in the FBiH was 71.1% and for diphtheria, tetanus, whooping cough and polio it was 71.3%.

4.12.3.2 Local Context

The JU Dom Zdravlja Vareš Health Centre, located at the southern end of the main town, has several services on offer:

- Occupational Medicine;
- Preschool children health protection
- School children and youth health protection;
- Gynaecology;
- Respiratory;
- Emergency services;
- Family/General medicine; and
- 11 ambulances located in Vareš and surrounding communities.

A travelling clinic is deployed to Borovica once per month providing general check-up services and distributing medicine, as required. If necessary, this service can be deployed on an ad-hoc basis, or a doctor can travel to the patient, outside of the normal clinic schedule. The clinic was previously deployed weekly, although this has decreased to a monthly basis as the population has diminished. The closest hospitals are located at Sarajevo, Zenica and Tuzla. Regular transportation is provided for patients who are receiving some treatments at these places, such as oncology.

[4] Martic and Dukic, Health Care Systems in BiH, 2017

4.12.3.1 Local Health Setting

Within the Zenica Doboj Canton the leading diseases are heart and blood vessel diseases (51%), followed by malignant diseases (22%) and respiratory diseases (6%). Cardiovascular diseases most often include heart failure, acute heart attack and stroke. Malignant diseases most often occur as lung malignancy, gastric malignancy, liver malignancy, and breast malignancy. Fibrosis and cirrhosis of the liver are the leading causes of death from diseases of the digestive system. Although Vareš has one of the highest numbers of malignant disease cases, it is in line with cases across the Zenica-Doboj Canton.

An interview was conducted with health centre personnel in Vareš for the purpose of social baseline data collection. It was stated that cases of STDs, HIV, water borne diseases and respiratory diseases are minimal, while health in elderly adults is deteriorating with chronic conditions being prominent, including impotency, heart disease, cancer and diabetes. Mental health problems are also increasing due to stress and the standard of living in the area. Generally, patients do not take preventative action and instead wait until they are ill to attend the health centre. Vareš municipality leading diseases, as reported in the HIA, are presented in Table 4.12.6.

The previously operational Veovaca pit and process plant is perceived across the municipality as exacerbating health deterioration and causing many premature deaths linked to oncology and respiratory conditions, both during and after its operation. The concern of the population has been considered and, as such, Adriatic Metals commissioned the previously mentioned HIA. According to that study, the local population is most concerned about pollution from previous mining activities related to soil pollution, watercourse pollution, air pollution (presence of dust and other particles) as well as noise from the pre-existing plant.

Health centre professionals stated that both cancer cases and chronic lung and respiratory conditions have been elevated in the past, possibly attributable to the iron foundry as well as previous mining operations. Health centre staff interviewed were not concerned about a recurrence of the incidence of these potentially occupational health related diseases moving forwards, presuming that EU and international standards for emissions and best practice will be adhered to across the operation.

Household Survey respondents were asked about key health conditions and concerns, with many reporting either conditions for themselves or other household members. Among the most common illnesses reported (Table 4.12.7), heart issues and high blood pressure were the most prevalent. Reports of back problems, gout, hernia, poor vision and arthritis were listed, amongst others.

Table 4.12.6: Leading diseases by Age Group for Vareš Municipality in 2018				
Disease	**0-6 years**	**School children and youth**	**Adults**	**65+**
Respiratory System	195	191	167	
Musculoskeletal system	13	23	178	750
Digestive system	6			
Skin and subcutaneous tissue		16		
Circulatory system			466	496
Endocrine system			154	150
Mental illness			71	73

Table 4.12.7: Reported Illness according to household survey	
Disease / Illness	**Reported Cases**
Heart and/or increased blood pressure	42
Respiratory	8
Physical Disability	5
Stroke	8
Mental Health, including PTSD	6
Diabetes	13
Cancer	6

4.12.3.2 Health Impact Assessment

A standalone Health Impact Assessment (HIA) was developed for the Vareš Project, including an initial risk assessment for human health in relation to the potential exposure of the community and workers to harmful substances, as well as baseline information on community health and safety conditions.

The report identified potential baseline factors that may affect community health:

- Increased risk of traffic accidents (i.e. traffic injuries), especially on the route for extraction of materials / waste in the northern part of Vareš, at crossings and on the main road;
- Environmental impacts on human health, from air pollution and the release of certain air particles, as well as the effects of noise; and
- Potentially elevated levels of thallium and mercury detected in sediments in groundwater and soils that could potentially contaminate watercourses during the Project implementation and operation.

The HIA is presented as appendices 4.12.1 and relevant data has been integrated into the sections below, as appropriate.

4.12.3.3 Thallium as a Human Health Risk

Occurrence and Monitoring

Elevated levels of thallium have been observed in the background geology at Rupice, though not directly within the ore material. Thallium has been included within the baseline monitoring programme since November 2020, and has been tested for within groundwater, spring, surface waters and soils (along the haul route). During processing thallium may be present in material associated with the ore, or processed along with the ore.

Thallium concentrations reported within baseline surface water, spring and groundwater samples collected from the Rupice mining concession have been seen to regularly exceed Bosnia Maximum Permissible Concentrations[5].

Health Risk associated with Thallium

Accumulation of thallium in the human body can cause adverse effects on the nervous system, organs such as the lungs, heart, and kidney, as well as causing temporary hair loss and vomiting. These effects are prominent if ingested in large quantities for short periods of time. Toxicity is associated with very low concentrations. Thallium can enter the body through ingestions, inhalation or skin contact.

Potential Pathways

Mining works may accelerate the release of thallium into the environment as a result of acid rock drainage, associated with sulphide rocks within the orebody. Infiltration and percolation of thallium enriched waters (associated with acid rock drainage) from waste rock dumps and ore stockpiles has the potential to contaminate local aquifer systems underlying the Rupice concession, including spring networks, including Donja Borovica (Residents Spring), Gornja Borovica (Spring Box), Vruci Potok Spring and Kings Spring, on which local communities rely for sanitary and consumptive water supply purposes. Furthermore, surface run-off of thallium enriched waters from waste rock dumps and ore stockpiles has the potential to contaminate local surface water courses, including the Borovicki, Bukovica River, Vruci Potak and the Tristionica River. Water is abstracted from the Sastacve pump station along the Borovicki for human usage.

Studies have also shown that when lead-zinc ores are processed via flotation, the total concentration of thallium increases within the process water[6]. Escapes, spills and accidental discharge of untreated, thallium enriched, process waste waters has the potential to contaminate the underlying groundwater as well as surface watercourses, including the Mala River. Waters within the Mala river may be abstracted and used for irrigation within agriculture, contaminating potential food crops, which may be ingested by humans.

[5] (Decree on Hazardous and Harmful Substances in Waters)
[6] Karbowska, B., et al., 2014. Translocation and mobility of thallium from zinc–lead ores. *Journal of Geochemical Exploration*, **143**, pp.127-135.

Health Impact Assessment

The human health risk associated with the release of thallium into the environmental is assessed within relevant sections of chapter 5 of the ESIA. The geochemistry, soils and hydrology/hydrogeology impact assessments highlight potential sources, pathways and receptors potentially at risk within the study area and determine existing linkages. Mitigation and management, as deemed necessary in the impact assessment, is to be integrated into environmental management plans.

4.12.4 Vulnerable Groups

Vulnerable individuals and groups are defined as those who may face a particular risk of being exposed to, and being disproportionately affected by, the Project activities and impacts. They may require differentiated measures for engagement activities in case of existing restrictions or limited abilities to participate in them. As marginalised rights-holders, they could be further disadvantaged[7] or excluded from society, facing additional risk of discrimination (UN Human Rights Office of the High Commissioner, 2012).

A mapping exercise of vulnerable groups in the Project area has been undertaken on the key identified communities (Table 4.12.8). The exercise is based on EBRD guidance on ESIA and project communication (2014) and has been used to inform both the impact assessment process and the Stakeholder Engagement Plan (SEP). Potential groups identified are presented below with recommendations for stakeholder engagement / community development activities.

Table 4.12.8: Vulnerable Group's Characteristics

Category	Location and Prevalence	Characteristics	Engagement Activities
Elderly (65+)	Percentage of Population: Brezik 83%, Tisovci 67%, Visnjici 50%, Donja Borovica 80%, Gornja Borovica 89%, Osredak 50%, Polozac 67%, Semizova Ponikva 78%.	Lack of Mobility. Potential difficulties with visibility and hearing. Those that are vulnerable within this group tend to fit to one of the other identified groups as well.	Door-to-door consultation, provision of newsletters
Disabled	A small number of individuals are located in key communities. These are known	Varies from person to person	Door-to-door consultation, ensuring full understanding of the grievance mechanism and project progression – possibly through carer as necessary.

[7] This disadvantaged or vulnerable status may stem from an individual's or group's race, colour, sex, language, religion, political or other opinion, national or social origin, property, birth, or other status (IFC, 2012).

Table 4.12.8: Vulnerable Group's Characteristics			
Category	**Location and Prevalence**	**Characteristics**	**Engagement Activities**
	by the Project team.		Future community development could aim to help this group further (e.g. improvement to health services).
Debilitating Illnesses		Likely to be people within the 65+ age bracket. Illnesses include heart disease, cancer and diabetes.	Door-to-door consultation, provision of newsletters. Future community development could aim to help this group further (e.g. improvement to health services).
Women (Widows, female headed households and those in special circumstances)	Approximately 50% of households in key communities.	Within closest communities there is a number of female headed households, many of whom are widows likely due to the impacts on the male population during the Bosnian War, combined with the slightly lower life expectancy of men.	Represented within the PLC, recurring women focus groups / gatherings allowing discussion in an informal yet safe setting.

Overlapping levels of marginalisation can affect already vulnerable people with additional exposure to impacts and risks. From this perspective, intersectional vulnerability can account for particularly disadvantaged people belonging to one or more of the groupings mentioned above.

Within the local context, the presence of intersectional vulnerability must be accompanied by specific management measures. The UN Committee's observations in BiH prioritised the following groups (UN Committee on the Elimination of Discrimination against Women, 2019):

- **Roma women and girls**, due to their long-lasting social exclusion and discrimination;
- **Women and girls with disabilities**, due to the absence of reasonable accommodation and inclusive services (particularly in the case of GBVH);
- **Migrant women and girls**, due to the lack of information on the coverage of social protection schemes;
- **Refugee and asylum-seeking women and girls**, due to their limited access to health care services, maternal care services and increased exposure to GBVH; and
- **LGBTQ+ groups**, due to ongoing stigmatisation and discrimination.

4.12.5 Social Receptors

Social receptors are groups which may interact with the Project activities or impacts and perceive a change to their life conditions or quality of life as compared to their baseline conditions. The following table lists the potential social receptors, including a sensitivity level which will be detailed in the impact assessment Chapter.

Table 4.12.9: Potential Social Receptors			
Receptor	**Description**	**Sensitivity**	**Sensitivity Analysis**
Project workforce	Approximately 320 workers are expected to work during the peak period of operations.	Low	Project workforce and supply chain staff will be hired through a work contract under GIIP in terms of labour rights. The workforce will have access to financial resources and organisational support from Adriatic Metals in case of occupational (OHS) incidents.
Local economically active population	The local economically active population (EAP) may interact with Project employment and training needs.	Low	The local EAP is predominantly active in the services sector, with adaptation capacities to meet potential economic opportunities in the area.
General local businesses, service providers and suppliers	Including local business owners and trades people (see business directory), service providers and related Project procurement supply chain businesses (see stakeholder mapping in Appendix 4.11.1 for details).	Negligible	Local businesses will have access to financial and human resources to adapt to Project-related supply needs.
Key communities (Direct)	Local communities or settlements in the direct area of influence, including the inhabitants of the key communities (see Chapter 4.11).	Medium	The local communities have (limited/ restricted) access to resources to adapt to the presence of local projects, including mining operations in the area.
Secondary communities (Indirect)	Local community residents in the indirect area of influence, including people who have visited the information centres.	Low	The local communities have (limited/ restricted) access to resources to adapt to the presence of local projects, including mining operations in the area.
Landowners	An initial six identified landowners at Rupice where acquisition is required, and an additional six within the vicinity of the TSF. Further land along the haul route may also be required, this aspect is being undertaken by the municipality. Land and property owners who currently do not permanently reside in the Project area.	Low	Programme of land acquisition has been carried out for the six parcels required for project development. This is carried out in accordance with national regulation as well as to standards of EBRD PR5.

Table 4.12.9: Potential Social Receptors

Receptor	Description	Sensitivity	Sensitivity Analysis
Haul road users	Existing and anticipated road users on the haul route and in Vareš town.	Medium	The haul route will be a multipurpose route for mine traffic, forestry traffic and public use. Public health and safety will be critical to the management of the route. Only one main route through Vareš town with limited parking available.
Local organisations	Organisations, societies, and associations within communities or among villages (see stakeholder mapping in Appendix 4.11.1 for details), including local religious organisations of the Islamic, Catholic and Orthodox communities in the Project area.	Medium	Local organisations have partial collaboration and cooperation with municipal public services but generally lack funds to conduct their activities with vulnerable people in the area.
Vulnerable groups	Groups with limited or restricted capacities to adapt to external changes, including children, women, elderly adults and people with disabilities.	High	Vulnerable groups in the Project area may include ethnic minorities in the Project workforce, informal migrant workers, children, women, elderly and people with disabilities.

4.13 Ecosystem Services

4.13.1 Introduction

This section identifies and prioritises the ecosystem services in the Vareš region in a social, economic and geographical context. The location and use of each service in relation to the planned Project is presented.

EBRD Performance Requirement 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources requires that ecosystem services are maintained throughout the life of the Project. Ecosystem services are defined as: "the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organized into four types: (i) provisioning services, which are the products people obtain from ecosystems; (ii) regulating services, which are the benefits people obtain from the regulation of ecosystem processes; (iii) cultural services, which are the non-material benefits people obtain from ecosystems; and (iv) supporting services, which are the natural processes that maintain the other services."[1]

4.13.2 Methodology

Ecosystem services have been identified through a number of ways including household surveys undertaken as part of the social baseline, land use mapping, stakeholder discussion and consultation and through biodiversity desk-based and field studies, as presented in Chapter 4.5. Specifically, consultations were undertaken with the following parties:

- Vareš Forestry Commission representatives;
- Vareš Sports Fishing Association;
- Vareš Hunting Society;
- Community leaders for Borovica, Przici, Tisovci, Pogar and Dastansko; and
- National Museum of BiH.

The ecosystem services have been identified and then prioritised based upon their ability to benefit stakeholders, whilst being important to the beneficiaries' well-being and whether the beneficiaries have a viable alternative. This prioritisation also takes the ecosystem services location and use in respect to Project activities into account.

4.13.3 Identified Services

Identified services are presented in Table 4.13.1. Broadly speaking those identified can be summarised as follows:

- Provisioning Services:

[1] EBRD Environmental and Social Policy, 2019

  - Food production for subsistence purposes including crop farming and keeping of livestock;
  - Fishing for personal consumption;
  - Foraging for food and medicinal herbs.
  - Use of forested areas for firewood and commercial timber production;
  - Fresh water from springs as a residential resource;

- Regulating:
  - Regulation of air quality and climate through forested land;
  - Water flows in rivers used to flush effluent away;
  - Erosion control on steep slopes;

- Cultural:
  - Outdoor activities – hiking, mountain biking undertaken by both local residents and tourists;
  - Fishing and Hunting for recreation;
  - Landscape and sense of place;

- Supporting:
  - Role of ecosystems in supplying habitat, both in forested areas and the Mala River for fish spawning;
  - Nutrient cycling;
  - Primary production;
  - Water cycle.

Table 4.13.1: Identification and Prioritisation of Ecosystem Services

Ecosystem Service	Identified activity	Location and Use of ES	Prioritisation
Provisioning			
Food	Subsistence farming of crops (potatoes, onions, carrots, cabbages, mainly).	40% household respondents partake in some form of subsistence farming, occurring across all key communities. No land parcels used for subsistence farming are present in or directly adjacent to planned mining activities.	**NOT PRIORITY** Whilst impact will be considered with the Air Quality assessment, areas used for subsistence are away from Project infrastructure and activities and will not be directly impacted.
	Commercial farming of crops	40% household survey respondents sell a proportion of their crops for income. The amount is small, and generally comprises of any excess that cannot be consumed. Some utilise orchards to make jams for sale. This activity is most prevalent in Pogar. No land parcels used for commercial farming are present in or directly adjacent to planned mining activities.	**NOT PRIORITY** As most of these activities occur away from Project infrastructure impact is not anticipated. Commercial farming is not widely practiced, and dependency is low.
	Keeping of livestock (chickens, goats, cows and pigs) for own consumption and small scale commercial purposes, and keeping of bees.	Poultry farm – Pržići Stockbreeding – Daštansko, Pogar. Pig breeding - Pogar Bee Keeping (own consumption) – 1 Pržići, 1 Donja Borovica	**NOT PRIORITY** Beneficiaries are minimal, and away from project activities.
	Foraging for mushrooms, wild berries and medicinal plants, for own consumption. Foraging of rosehip to make tea and jam, to sell in small quantities.	50% of household survey respondents partake in some form of foraging activities. Carried out adjacent to the existing Veovaca open pit, on banks of the Mala River (south of planned TSF), Zvijezda mountain, Mekuše forest and Dugiratat, Hrida, Bjelovače and around church in Gornja Borovica (Drawing 4.13.1).	**PRIORITY** Most foraging activities occur away from the Project affected area and dependency is low. However, some foraging for mushrooms occurs on the banks of the Mala River, south of the planned TSF, in an area identified as high quality spruce forest.
	Fishing for Personal Consumption	Vareš Sports Fishing Association has 50 active paying members (2021). To fish in any public waterway in Vareš membership to the association is required.	**PRIORITY**

Table 4.13.1: Identification and Prioritisation of Ecosystem Services			
Ecosystem Service	**Identified activity**	**Location and Use of ES**	**Prioritisation**
		Across municipality water ways there are several species: • first class species requiring clean, fast flowing water include brown trout (closed season October-March), grayling (close season February-June) and danube salmon (closed season January-June), the latter of which is rare in the region and not found in the direct project area. • second class species are chub, nase, barbel and minnow (used as bait) which are all present in most larger streams/rivers. The main fished species are barbel and nase, as well as trout and grayling where water quality and flows are better. 90% of all fishing activities are for personal consumption, with no commercial fishing allowed. Fishing takes place mainly in the Borovicki, Bukovica, Stavinja and Mala Rivers.	The Project has potential to impact key waterways in the region.
	Trout Farming	A trout farm, restaurant and hotel are present on the Bukovica river, adjacent to the planned pumping station for Project water supply.	**PRIORITY** The trout farm is a source of livelihood income and the impact from pumping is uncertain.
Use of Wood	Biomass Fuel: Tree logging for heating and cooking fuel, carried out by official contractors and managed by the Forestry administration. Some unregulated activity does occur by local community	Across the municipality of Vareš wood is used as the main source of fuel for heating and cooking. Gas connections in homes are not common. In total 266.40m^3 firewood from state owned land and 121.43m^3 from privately owned land will be felled for development of Rupice.	**NOT PRIORITY** Forestry commission manage land, whilst trees will be felled, it is likely that these will be able to fall into the product line and be processed for firewood. Construction of the haul route will provide better access for the public to forested areas

Table 4.13.1: Identification and Prioritisation of Ecosystem Services			
Ecosystem Service	**Identified activity**	**Location and Use of ES**	**Prioritisation**
	members. This is not done on large scale and is illegal.		not currently accessible. This may increase the amount of illegal logging for firewood purposes and foraging opportunities.
	Wood production not for firewood.	For carpentry, paper production and other wood products trees are felled across the region, as part of the work of the forestry commission. Within the area of Rupice the following will be felled for the Project: For cellulose: 11.9m^3 private and 470.05m^3 state. Other use: 767.79m^3 private and 3,767.31m^3 state.	**NOT PRIORITY** Forestry commission manage land, whilst trees will be felled, it's likely that these will be able to fall into the product line.
Freshwater	Springs and groundwater wells used as a potable water source.	Donja Borovica, Gornja Borovica, Osredak, Semizova Ponikva, Polozac and Pogar all have water supply tanks, sourced from a number of springs in the region and shared between multiple houses. King's Spring water bottling factory approx. 1km SW of Donja Borovica.	**PRIORITY** Main source of household water supply in Rupice area, as well as a commercial source at the King's Spring, with no current alternatives present, thus dependency is high. Impact from mine activities is uncertain though the dewatering of Rupice has potential to impact groundwater and hence spring levels.
	Rivers used for watering of livestock	Mala River utilised south of existing Veovaca open pit by a small number of local community members.	**NOT PRIORITY** Dependency is low and this is outside of the Project impact zone.
Regulating			
Regulating of Air Quality and Climate	Forestry land provides an air pollutant trap and carbon sink.	Rupice, along haul route and within the planned area for TSF development.	**NOT PRIORITY**

Table 4.13.1: Identification and Prioritisation of Ecosystem Services			
Ecosystem Service	**Identified activity**	**Location and Use of ES**	**Prioritisation**
Water flows and timing	Borovica River is used to flush sanitary effluent from adjacent communities.	Donja Borovica, Gornja Borovica, Osredak generally have no waste water management systems and rely on the watercourse to flush away black and grey waters.	**PRIORITY** Dependency in named villages is high, with no alternative at present. Impacts from the Project are currently uncertain though possibly adverse due to dewatering of Rupice.
Erosion Control	Forested areas on steep valleys at Rupice and Veovaca TSF area.	Vegetation cover provides stabilisation, particularly on steep valley sides in the vicinity of Rupice and the TSF area.	**PRIORITY** Felling of trees has potential to cause erosion. Mala River, situated downstream of the planned TSF is sensitive to suspended sediments due to the presence of white clawed crayfish.
Cultural			
Outdoor activities e.g. cycling, walking, hiking	Residents partake in walking and hiking. Tourism activities relating to outdoor activities.	Residents of Vareš partake in walking, largely due to lack of public transportation. Tourism industry has a focus on cycle and hiking trails, including Via Denarica trail (Figure 4.13.1)[2]. Two multi day hiking trails travel through Vareš and close to the Project area, including the winter trail from Vareš south to Javorje Mountain Hut (adjacent to planned haul route) and from Vareš east (day 122 of the main Via Dinarica trail). A day hiking route has been established east of Vareš and north of VPP.	**PRIORITY** Proximity of the hiking route to haul route makes this priority. The impact is uncertain, but community health and safety could be compromised.
Fishing	Recreational fishing.	Undertaken across the project area for recreational purposes (10% of all fishing). Sports fishing competition occurs annually in	**PRIORITY**

[2] https://trail.viadinarica.com/en/

Table 4.13.1: Identification and Prioritisation of Ecosystem Services			
Ecosystem Service	**Identified activity**	**Location and Use of ES**	**Prioritisation**
		the Stavinja River, downstream of the Project area between Vareš and Breza.	Potential downstream impacts in the Stavinja River will be assessed to determine Project impact.
Hunting	Recreational hunting of wild boar, rabbits, foxes, wolves (1 annually).	10 household survey respondents partake in hunting activities. Undertaken in the Zvijezda Mountain. 5-6 residents of Borovica, and about 40 people in total, partake in recreational hunting activities around the vicinity of the Rupice mine. Land in this region has not widely been used for hunting since the initiation of exploration activities by Adriatic Metals. Sufficient hunting land outside of this area is present.	**NOT PRIORITY** Hunting is done for recreational purposes rather than for subsistence, so dependency is low. These activities do not currently occur in the Project area thus impacts will be negligible.
Landscape and Sense of Place	Rural and natural landscape is appreciated for its value.	Residents across Vareš and visitors to Vareš, mainly holiday makers from Sarajevo and other cities who visit Vareš for the rural setting.	**PRIORITY** Change to the landscape should be determined as this can be detrimental to the character of the area. Tourism in Vareš is largely dependent on the rural setting and associated perceived “clean air” of the municipality in comparison to Sarajevo and other nearby cities.
Supporting			
Role of ecosystems in supplying habitat	Forestry land	Provision of food and shelter for different animals within the forestry habitat	**NOT PRIORITY** No protected areas or areas of habitat that will be completely removed (see Chapter 4.5 – Biodiversity)
	Fish Spawning	Eastern branch of Mala River used as fish spawning ground for the Danube Salmon, amongst others, on an annual basis.	**NOT PRIORITY**

Table 4.13.1: Identification and Prioritisation of Ecosystem Services			
Ecosystem Service	**Identified activity**	**Location and Use of ES**	**Prioritisation**
			Eastern branch of the Mala River is outside of the Project impact area.
Nutrient cycling	Beneficiaries from all other services		**NOT PRIORITY** Affected area is not critical to the levels of nutrient cycling in the region.
Primary production	Beneficiaries of those who keep livestock for milk, meat and animal products.	Residents across key communities who keep livestock.	**NOT PRIORITY** Dependency on this is low, with no respondents stating this is their only or main supply of these products.
Water cycle	Beneficiaries of water related services	Key communities around Rupice Site.	**NOT PRIORITY** As water is key resource in the region, this will be assessed as part of aforementioned assessment and future water studies.

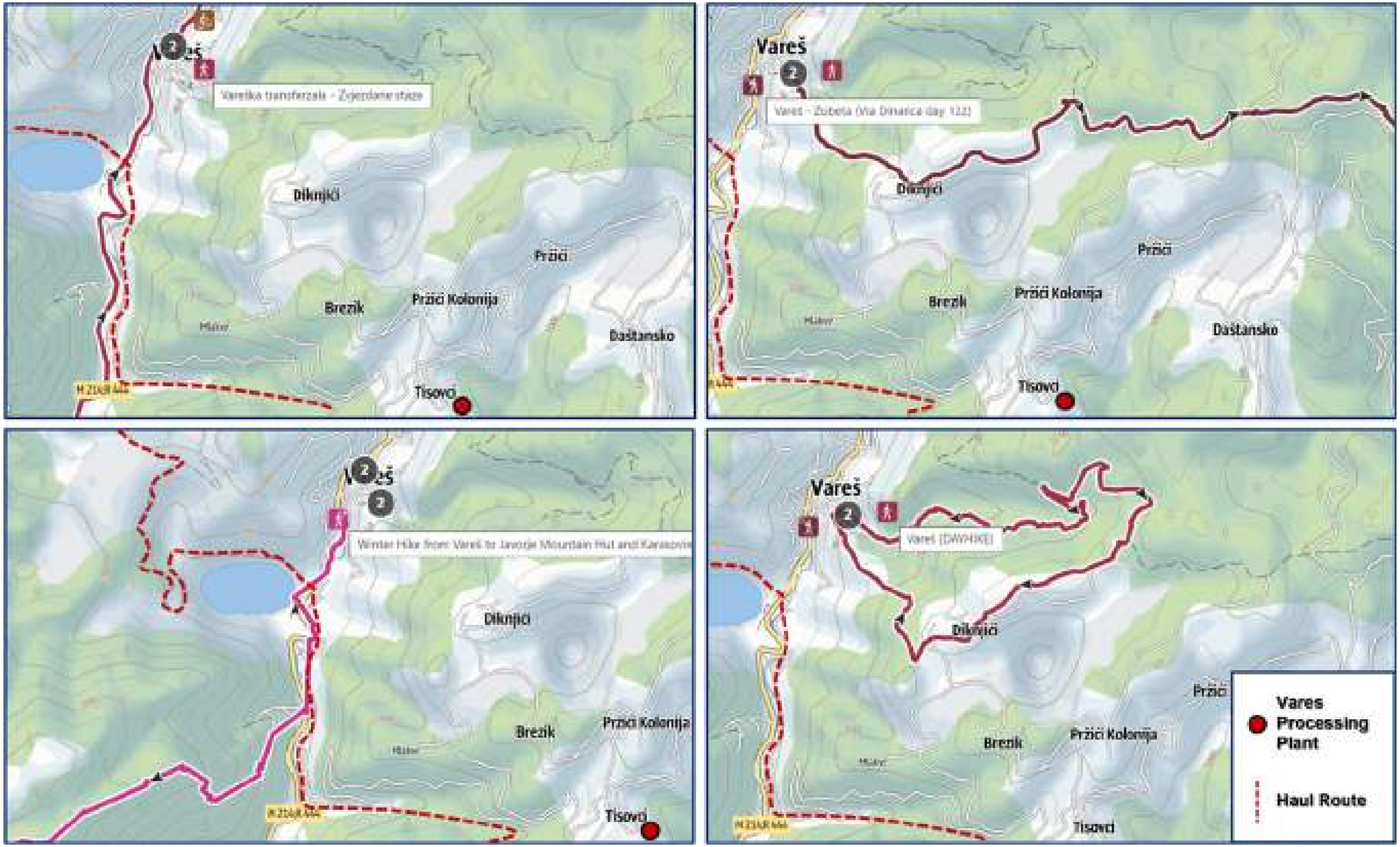
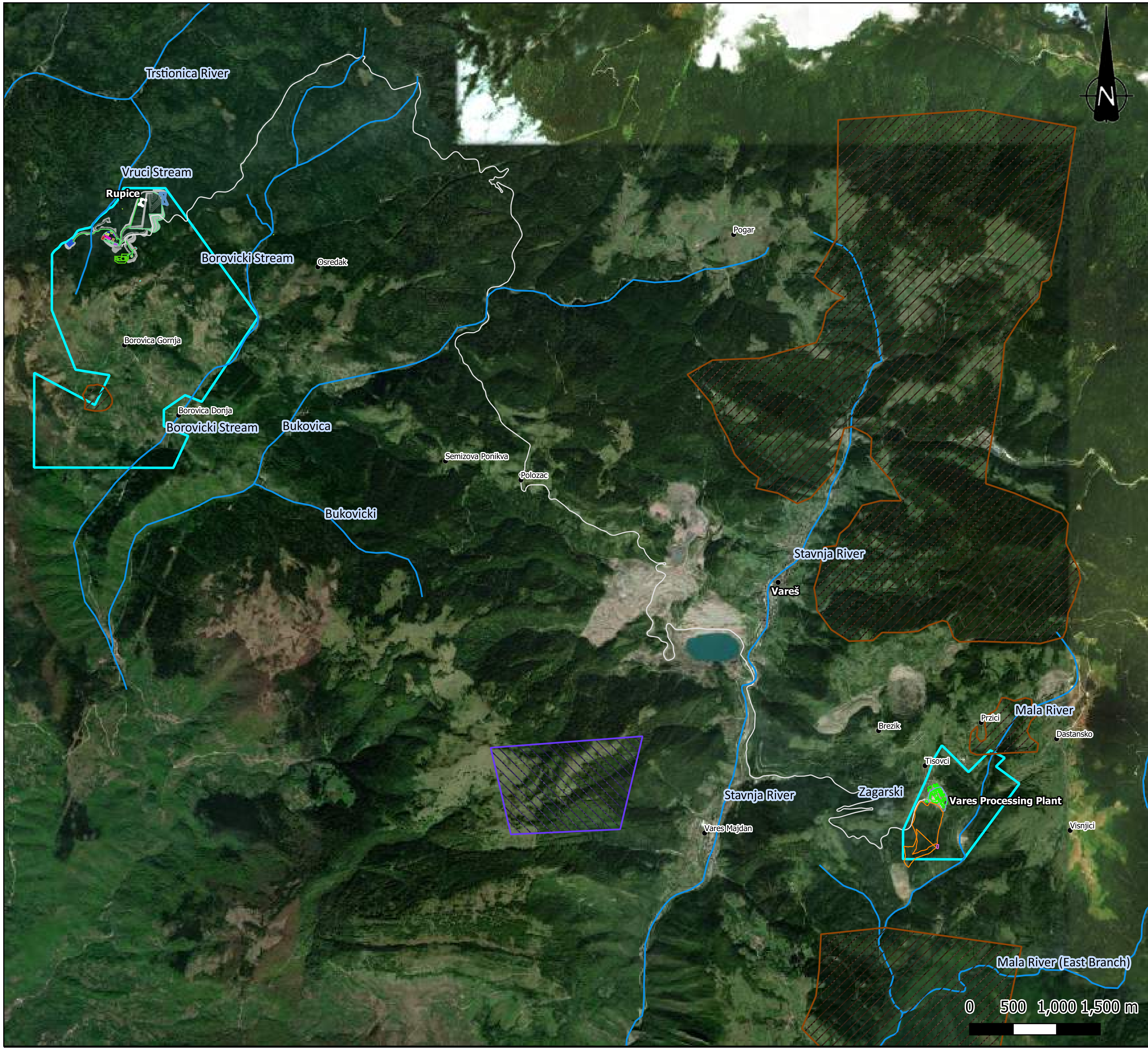


Figure 4.13.1: Via Dinarica Hiking Trails in Vicinity of Vares Processing Plant



DO NOT SCALE FROM THIS DRAWING

Key

- Mushrooms and Medicinal Plants Foraging Area
- Blueberry Foraging Area
- Haul Road
- Tailings Storage Facility
- Vares Processing Plant
- Concession Boundary
- Rivers

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT

Adriatic Metals PLC

PROJECT

Vares Project ESIA

DRAWING TITLE

Ecosystem Services Mapping

DRG No. ZT520182/4.13.1		REV A
DRG SIZE A3	SCALE 1:60000	DATE July 2021
DRAWN MBW	CHECKED BY AM	APPROVED BY AA

wardell armstrong

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4.14 Archaeology & Cultural Heritage

4.14.1 Approach

This study has been undertaken in accordance with the EBRD Performance Requirement 8: Cultural Heritage (see below).

The archaeological and cultural heritage baseline has been compiled predominantly through a desk study utilising the Archaeological Lexicon of Bosnia and Herzegovina and other published data. Field work has been undertaken by the National Museum of Bosnia. A site visit by WAI personnel in February 2020 included meetings with the Federal Archaeological institute in Sarajevo, as well as the National Museum, to discuss the potential for surviving archaeological remains in the area. Staff at the General Library in Vareš were consulted to determine what local archives are available for the region.

Household surveys were carried out with local residents to consider potential impacts on intangible cultural heritage assets.

4.14.2 Legislation and guidance

Cultural heritage policy in Bosnia and Herzegovina is defined in the General Framework Agreement for Peace (The Dayton Agreement). Annex 8, Article 6 of the Dayton agreement defines what is eligible to be designated as a national monument: movable or immovable property of great importance to a group of people with common cultural, historic, religious or ethnic heritage, such as monuments of architecture, art or history; archaeological sites; groups of buildings; as well as cemeteries[1].

There are several public institutions responsible for the protection of cultural heritage at state level; the primary one being Commission to Preserve National Monuments. Administering cultural heritage legislation within the project area, as defined by the FBiH, is the responsibility of the Institute for the Protection of Monuments, part of the ministry of Culture and Sport under the Ministry of Regional Planning.

FBiH heritage legislation, pertinent to the Project area, includes:

- Zenica Doboj Canton – Law on the Protection of the Cultural Heritage (Official Gazette of Zenica-Doboj Canton no. 2/00);
- The General Framework Agreement for Peace in Bosnia and Herzegovina (Dayton Peace Agreement), Annex 8 – Agreement on the Commission to Preserve National Monuments, 1995;
- The Decision of the Presidency of Bosnia and Herzegovina on the Commission to Preserve National Monuments, 2001;

[1] Council of Europe, Bosnia and Herzegovina, Cultural Heritage Policy

- The Rules on the Activities of the Commission to Preserve National Monuments with respect to International Co-operation, 2002;
- The Criteria for the Designation of Property as National Monuments, 2002/2003; and
- The Federation of Bosnia and Herzegovina Law on Regional Planning and Land Use.

Several international conventions relating to the protection of cultural heritage have been ratified in Bosnia and Herzegovina. These conventions come under both the Council of Europe and UNESCO.

EBRD Performance Requirement 8: Cultural Heritage, (EBRD PR 8) aims to protect cultural heritage and provides guidance for clients to avoid or mitigate adverse impacts on cultural heritage in the course of their business operations.

EBRD PR8 provides guidance for a two-stage approach to considering Cultural Heritage within the development of a project; Assessment process and Managing impacts on Cultural Heritage.

The Assessment process comprises:

- Screening for impacts on cultural heritage (Paragraph 8);
- Avoiding impacts (Paragraph 9); and
- Assessing impacts that cannot be avoided (Paragraphs 10 and 11).

Following the Assessment Process, the client will:

- develop appropriate measures for minimising and mitigating adverse impacts on the cultural heritage (Paragraph 12);
- develop a Chance finds procedure (Paragraph 14); and
- undertake Consultation with affected communities and other stakeholders.

4.14.3 General Background

Due to its location, the municipality of Vareš has strong ties with the Bosnian War (April 1992 – December 1995). Three forces were located nearby: the Croatian Defence Council (HVO), Army of Republic of Bosnia and Herzegovina (ARBiH) and the Army of Republika Srpska (VRS).

The territory was under the joint control of the HVO and the ARBiH, until the ARBiH attacked the HVO, leading to the HVO settling in Vareš. In November 1993, the ARBiH attacked the Vareš enclave, leading the HVO to flee to Daštansko where they remained until the Dayton Agreement was signed in November 1995.

The Bosnian War has had lasting effects on the people and communities, which are still visible today in the form of abandoned houses across the municipality. The population of Vareš municipality has steeply declined from 22,203, recorded in the 1991 census, to 9,556 in the 2013 census.

In 2013, 21 settlements were completely uninhabited, and 15 settlements had a population of fewer than 10 inhabitants. It is understood that even more settlements are uninhabited now. War memorials and cemeteries linked to the war are found throughout the region.

Mining has occurred in the area since the Bronze Age (9^{th}- 8^{th} century BC), and during the Roman era (AD 9-10 – 395) the town was famous for its miners and smiths. Mining continued during the medieval and Ottoman periods, when taxes were paid in the form of crafted metal (wrought iron) objects.

Development of the modern iron mining industry in Vareš coincided with the annexation of Bosnia into the Austro-Hungarian empire in 1878. Evidence of this mining activity is scattered across the landscape in the form of abandoned open pits, waste dumps and mine shafts.

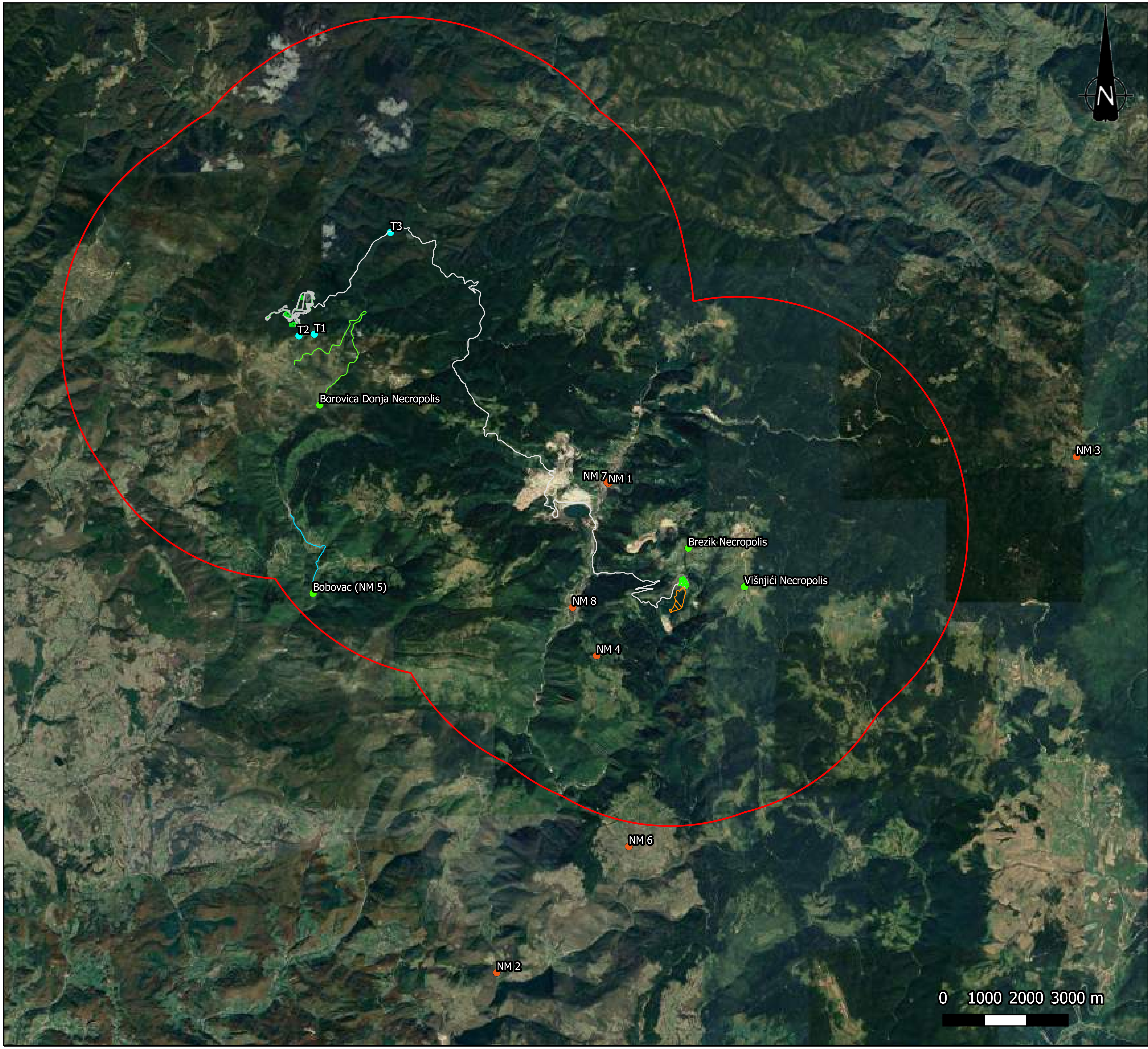
Vareš Municipality Day, August 16^{th}, which commemorates the opening the first blast furnace in Vareš in 1891, is still celebrated today. A large memorial (Photo 4.14.1) stands at the entrance to the town of Vareš, as well as the industry being marked on the municipality shield.

Photo 4.14.1: Mining Memorial Located at Entrance to Vareš Town

4.14.4 National Monuments

In the municipality of Vareš, eight cultural heritage assets are listed as protected under the Commission for Protection of National Monuments FBiH. None of these sites is located in close proximity to the proposed project; the assets are listed below and marked on Drawing 4.14.1:

- Church of the Holy Mother of God’s Mantle with movables [property of great importance] (historical monument), Vareš town (NM 1);
- Dabravine with remains of the Bronze Age and late Antique period (archaeological site) (NM 2);
- Historic blacksmith village of Oćevija (NM 3);
- Necropolis with Bosnian medieval headstones in Stupni Do (NM 4);
- Medieval royal castle of Bobovac (NM 5);
- Necropolis with stećak and old nišan tombstones in Budoželje (NM 6);
- Parish Church of St Michael, Vareš town (NM 8); and
- Workers’ settlement Majdan (historic buildings) (NM 8).



DO NOT SCALE FROM THIS DRAWING

Key

- Archaeological Lexicon sites
- National Monuments
- Archaeological field study sites
- The Way of the Cross Pilgrimage Route
- The Mass for the Homeland Pilgrimage
- 5km infrastructure and road buffer
- TSF
- Site Infrastructure
- Haul Road

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT
Adriatic Metals PLC

PROJECT
Vares Project ESIA

DRAWING TITLE
Archaeological and Cultural Heritage Features

DRG No. ZT520182/4.14.1		REV A
DRG SIZE A3	SCALE 1:125000	DATE September 2021
DRAWN MBW	CHECKED BY AM	APPROVED BY AA

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4.14.5 Archaeological Lexicon

Within the municipality of Vareš, 28 archaeological sites are recorded within the Archaeological Lexicon of FBiH (1988, volume 3). Four of those recorded sites are prehistoric, one of the sites is described as "ancient" and 23 sites date from the medieval period.

None of these sites lie within the proposed infrastructure for the Project; the closest recorded sites to the Project have been identified below, and their locations are shown on Drawing 4.14.1:

- Bobovac, Dragovići and Mijakovići village, Vareš, a prehistoric fortress, late antique castle, and medieval city;
- Medieval burial site at Brezik, Przici, comprising nine tombstones;
- Medieval burial site comprising four tombstones located in the cemetery of the Roman Catholic church, Borovica Donja; and
- Višnjići medieval burial site, comprising 18-25 tombstones.

A number of medieval burial sites and tombstones are present across the region. These are comparable to the Stećci Medieval Tombstones, located across the Balkans region, which are protected by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as a World Heritage Site. There are no UNESCO protected tombstones recorded within the municipality of Vareš.

4.14.5.1 Bobovac

The most prominent cultural heritage site in Vareš municipality is the fortified medieval city of Bobovac, which was recorded by archaeological excavation between 1959 and 1969. Bobovac is located approximately 6.5km from the Rupice mine and 4.8km from the haul route.

Bobovac was constructed during the reign of Bosnian Ban (ruler) Stjepan II Kotromanić as the medieval royal palace in the early 14th century. Bobovac was referred to in writing in 1350 as the capital of Bosnia. The town is known to have been the home of Queen Katarina, the last Queen of Bosnia, prior to the Ottoman invasion led by Sultan Mehmed the Conqueror, in 1463.

The remains of the medieval city consist of the prehistoric fortress and late antique castle, as well as ramparts with built-in towers, a royal court complex, sacral structures, church foundations, cemetery and a small square in front of the church. Four 15th century tombstones have been found in the vicinity of Bobovac, including the tombs of King Tvrtko II (1338 -1391) and the last King of Bosnia, Stjepan Tomaš (1412 - 1463).

Bobovac is recorded on the Archaeological Lexicon as a National Monument of FBiH. According to the tourism information centre in Vareš, approximately 10,000 people visit Bobovac annually, travelling from all over the world. Events and holidays are held every year at Bobovac, including the Bosnian Gastro Fest in June, a celebration of traditional Bosnian cooking; and the Prayer Day for Homeland

and Pilgrimage of the Armed and Military Forces of FBiH, on the 20th October. The latter is a Roman Catholic remembrance ceremony marking the day of Queen Katarina's death.

4.14.5.2 Borovica Donja Necropolis

A medieval cemetery is located within the settlement of Donja Borovica (at 44°10'41.97"N, 18°14'26.83"E). The cemetery is of Roman Catholic origin and consists of four tombstones in the shape of sarcophagi, oriented NE-SW, decorated with twisting bands. The archaeological lexicon states that "the site dates back to the Late Middle Ages" but no closer dating evidence is provided.

Consultation undertaken by the National Museum with community members revealed that additional tombstones were found in the hillside adjacent to the cemetery during the construction of nearby homes. The status of these "additional tombs" is unknown.

An ancient lime tree standing in the centre of the cemetery is protected as a natural monument as per the Official Gazette of FBiH No 4/65 (Photo 4.14.2).

Photo 4.14.2: Tombstones and Graveyard at Borovica Donja

4.14.5.3 Brezik Necropolis

Nine medieval tombstones are recorded adjacent to the Roman Catholic Church and cemetery at Brezik, Photo 4.14.3, in the village of Pržići. The tombstones, in the shape of plain coffins and sarcophagi decorated with twisted bands, spirals and rosettes are orientated E-W. The archaeological lexicon states that "the site dates back to the Late Middle Ages" but no closer dating evidence is provided.

The site of Brezik is located approximately 1km west of the Veovaca open pit and 0.75km from the processing plant.


Photo 4.14.3: Tombstones and Catholic Church at Brezik

4.14.5.4 Višnjići Necropolis

Located in the village of Višnjići, the medieval cemetery is found within a later Roman Catholic cemetery dating from 1905/06, Photo 4.14.4. The archaeological lexicon records 25 medieval tombstones in the shape of coffins and sarcophagi. However, recent studies recorded only 18 extant tombstones. It is assumed that expansion of the later cemetery led to medieval tombstones being moved or buried in layers. Only one of the surviving medieval tombstones is decorated with an anthropomorphic cross.

The Višnjići site is located approximately 2km south of the Veovaca open pit.

Photo 4.14.4: Tombstones at Višnjići

4.14.6 Field Studies

Following the desk top review, in accordance with EBRD PR8, field surveys were undertaken to assess potential impacts to buried archaeological remains. Three trial pits were excavated on land adjacent to existing known sites, including accessible land close to the medieval city of Bobovac, and along the proposed haul route. All trial pits (dimensions: 4x2m and one 2x2m) were sterile with no trace of surviving archaeological remains.

A Field Reconnaissance Survey was carried out along the new sections of the proposed haul route and community members were interviewed to determine the potential presence of archaeological sites.

4.14.7 Cultural Heritage

4.14.7.1 Cultural Community Sites

The people of Vareš municipality and the surrounding area have strong ties to the land and area within which they live, with many residents having been born in the region. The proximity and experiences of the Bosnian war have further enhanced people's ties to the region, and has played a significant role in the current status of the area.

Religion plays a key part in the day-to-day life of those in Vareš and communities can generally be classed according to their prominent religion, based on the presence of religious buildings in remote villages.

The following religious and culturally significant buildings are found close to the project areas:

Veovača:

- Tisovci Chapel and graveyard - c 560m northwest from the Veovača ore processing facilities;
- Pržići Church and graveyard - c. 700m north of the Veovača ore processing facilities;
- Catholic Church located in Vareš Majdan (Crkva Sv. Barbare) – c.0.85km south of haul route; and
- Mosque located in Daštansko – c.250m from storage area south of Veovaca Open Pit.

Rupice:

- Catholic Church located in the town of Borovica Gonja (Župa Preobraženja Gospodinova) – c.500m from closest point of haul road;
- Catholic Church located in Pogar (Crkva svetog Ante) – c.500m from current road utilised for site access;
- Church with medieval tombstones, graveyard and ancient lime tree in Borovica Donja – c.300m from proposed haul route;
- Catholic pilgrimage monuments / markers, located along the road leading to Borovica Donja – located on or adjacent to proposed haul route. The extent of use of these monuments will be confirmed with religious leaders and community leaders during the ongoing baseline work; and
- War memorial located in Borovica Donja – c.300m from proposed haul route.

4.14.7.2 Religious Events

The local population of Vareš has celebrations associated with religious festivals, cultural ties and past wars and conflicts throughout the year. A full event calendar can be seen in Appendix 4.15.1. Religious holidays celebrated are as follows:

- Orthodox Christmas and New year;
- Catholic Masquerade and Zuta Zaba;
- Easter;
- Ramadan;
- St. Mark the Evangelist;
- St. Joseph the Worker;
- Ramadan Bayram;
- The Ascension of Salvation;
- A Feast of Spirits;
- Holy Trinity;
- St. Anthony;
- Feast of the Sacred Heart;

- Our Lady of Mount Carmel;
- Dova Karici;
- Potocani meeting;
- St. James the Apostle;
- Eid al-Adha-Kurban Bayram;
- Feast of the Transfiguration; and
- St. Michael the Archangel.

4.14.7.3 Roman Catholic Feast Days in Vareš Municipality

Mass for The Homeland

The prayer procession to Bobovac was initiated by Cardinal Vinko Puljić in 2001 in memory of the day of the death of the last Queen of Bosnia, Katarina Kosača on 25th October 1478. The procession is held on the Saturday closest to October 25th; in 2021, the pilgrimage to Bobovac will be held on October 23rd.

Feast of the Assumption

The Assumption of the Blessed Virgin Mary is celebrated on August 15th, when believers make a pilgrimage to one of the many shrines of Mary. The Shrine in Olovo, located 50km northeast of Sarajevo, is one of the oldest Marian shrines in this area and is one of the most popular places of pilgrimage in the Balkans. There are two routes of pilgrimage to Olovo; one leads from Očevija towards Olovo, and the other route starts from Vareš, through the villages of Ravne, Crna Rijeka, Nišići to Olovo. A large number of pilgrims choose to go to Olovo on foot on August 14th, the day before the Assumption.

Patron Saints' Feast Days

The Patron Saint of the parish of Vareš is St. Michael Archangel, whose Feast Day is celebrated on September 29th, also known as "Miholj Summer" (unseasonably warm weather similar to Indian summer). Catholics also celebrate the Patron Saint of Vijaka, St. Ana, on July 26th and the Transfiguration of the Lord, on August 6th.

Way of the Cross aka Stations of the Cross

The Way of the Cross, also known as the Stations of the Cross, comprises 14 stations devoted to the memory of Jesus' passion, from the moment Jesus is sentenced to death to the laying of Jesus' body in the tomb. Pictorial depictions of each station of Jesus' passion, either paintings or statues, are placed in churches or public places.

The Way of the Cross takes place twice a year in Borovica, on Good Friday and on the Feast of the Transfiguration, August 6th.

4.14.7.4 Cultural Events

The Borovica International Art Colony is traditionally held in June within the medieval town of Bobovac. Artistic activities include art workshops, concerts, literature and poetry readings, exhibitions and visits to historical cultural sites. VaClaf Classical Music Festival features concerts in the oldest preserved Catholic Church in FBiH and the new church in Vareš, as well as lectures, presentations and interactive music workshops, held in Vareš Elementary School, aimed at children.

Prayer Day for Homeland and Pilgrimage of the Armed and Military Forces of FBiH, celebrated in October of every year in the village of Bobovac, combines the culture and history of Vareš.

Mining remains an integral part of the culture and history across much of the wider Vareš region, including Breza, Kakanj and Tuzla Vareš. Municipality Day, August 16^{th}, which commemorates the opening of the first blast furnace in Vareš in 1891, is still celebrated today.

4.15 Landscape and Visual

4.15.1 Landscape and Visual Methodology

This chapter establishes the baseline landscape and visual conditions relevant to the project, which is the initial step in any landscape and visual impact assessment (LVIA). This information will, in conjunction with the description of the project, form the basis for the identification and description of the changes that will result in the landscape and visual effects of the proposals. The LVIA will follow the recommendations contained in the UK's Landscape Institute and the Institute of Environmental Management and Assessment's guidelines[1] (GLVIA).

According to GLVIA, the landscape baseline should provide an understanding of the landscape in the area that may be affected. This may cover its constituent elements, character, spatial variation, geographical extent, history, condition, the value attached to it and its experiential characteristics. The visual baseline should establish the area over which the project may be visible and describe the different groups of people who may have views of the project, the places where they will be affected and the nature of the views and visual amenity. Landscape resources and character are considered to be of importance in their own right and are valued for their intrinsic qualities regardless of whether they are seen by people. Impacts on visual amenity as perceived by people are therefore clearly distinguished from, although closely linked to, impacts on landscape resources and character.

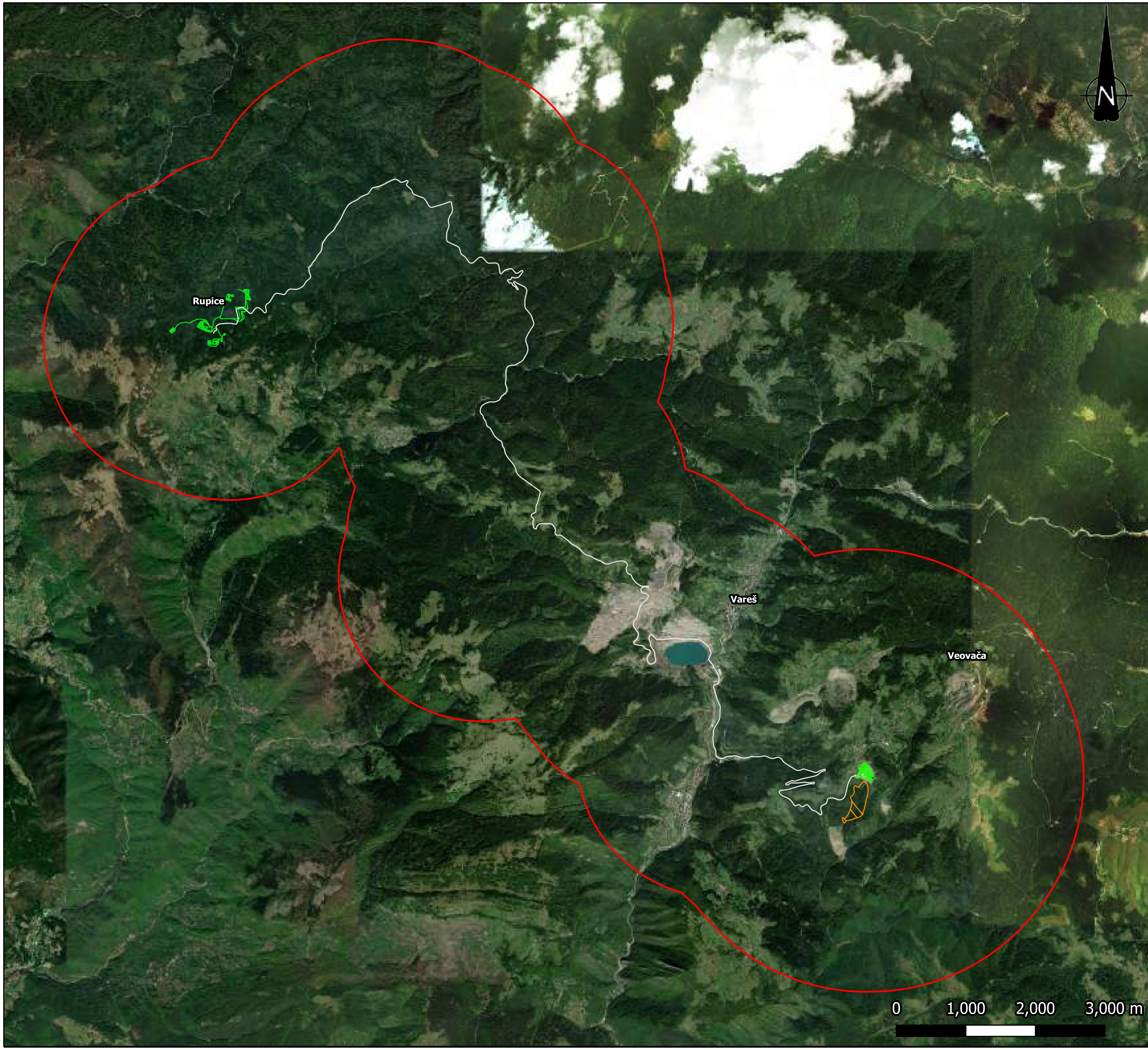
4.15.2 Study Area

A study area for the assessment of landscape and visual impacts has been defined based on professional experience and on the recommendations contained in the GLVIA and encompasses the project components together with the area of wider landscape around it which the project may influence in a significant manner, or from which the project will potentially be visible. The study area is shown on Drawing 4.15.1 and includes areas within a 5km offset from the Vares Processing Plant infrastructure together with areas within a 2km offset from the Rupice project infrastructure and the haul roads connecting the two project areas. Photographs included in this chapter were taken during fieldwork carried out in November 2019 and by Eastern Mining Staff at identified potential vantage points. Representative viewpoint photography was carried out in April 2021 by WAI.

4.15.3 Landscape Baseline

Landscape is primarily concerned with the relationship and interaction between people and place. Landscape is defined by GLVIA, as an area, which is perceived by people, the character of which is the result of natural and/or human factors. Different components of the environment, both natural (geology, soils, climate, flora, fauna) and cultural (historical, land use, settlement and other human intervention) combine to shape landscape character as perceived and related to by the people who experience it.

[1] Guidelines for Landscape and Visual Impact Assessment, Third Edition, by the Landscape Institute and Institute of Environmental Management and Assessment (2013)



DO NOT SCALE FROM THIS DRAWING

Key

LVIA Study Area
Infrastructure
TSF
Haul Road

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

CLIENT
Adriatic Metals PLC

PROJECT
Vares Project ESIA

DRAWING TITLE
LVIA - Study Area

DRG No. ZT520182/4.15.1		REV A
DRG SIZE A3	SCALE 1:75,000	DATE September 2021
DRAWN MBW	CHECKED BY AM	APPROVED BY AA

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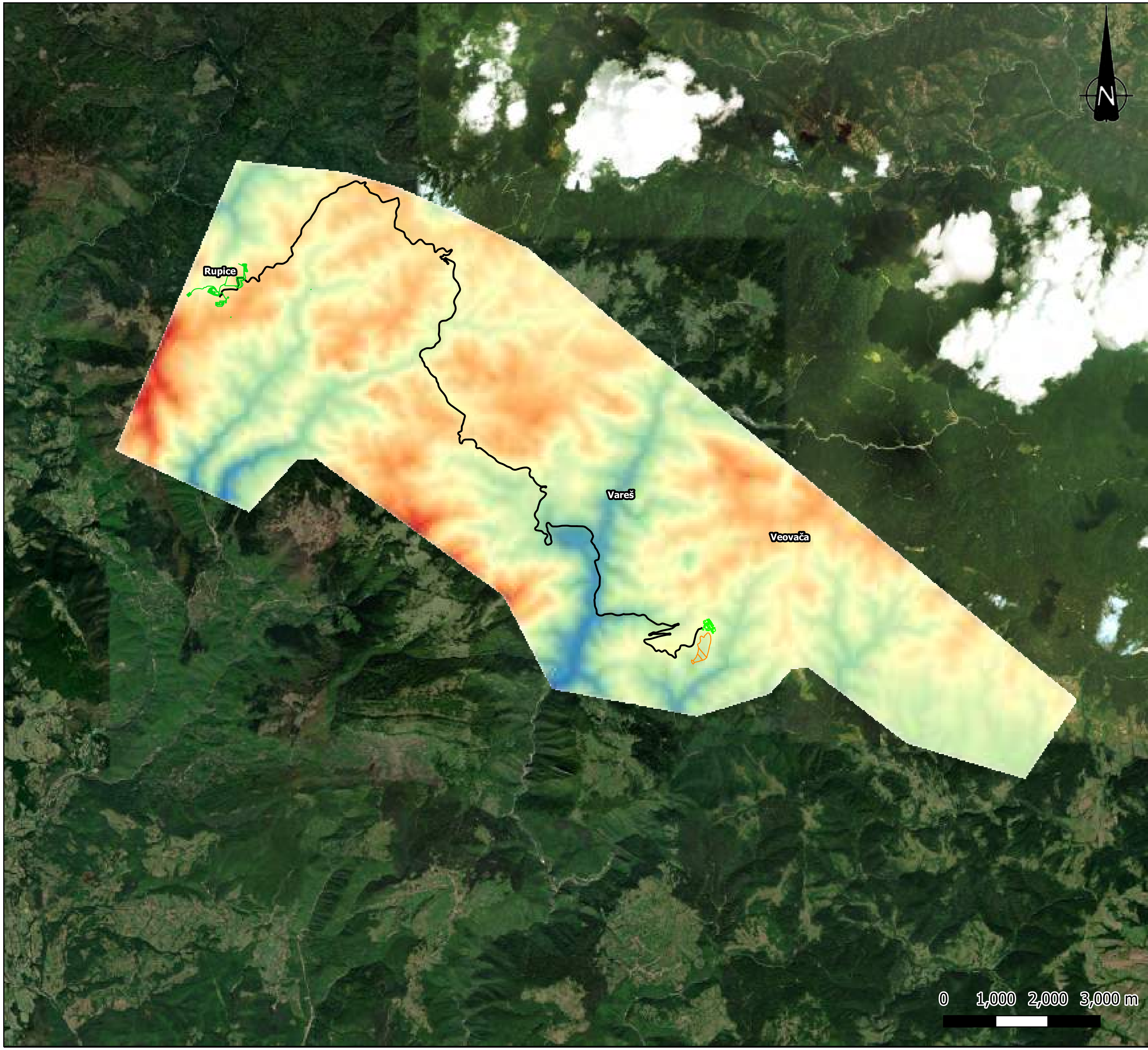
4.15.3.1 Landform and Drainage

Bosnia and Herzegovina (BIH) has a largely mountainous terrain, encompassing the central Dinaric Alps, with numerous ranges running through the country, and generally oriented in a north-west – south-east direction. The country's highest peak, Maglić, is located on the border with Montenegro at a height of 2,386m above sea level. In central Bosnia, including the Vareš region, the landscape forms a succession of ridges and peaks, high plateaux and deep valleys. The Rupice project area and surroundings are located within a largely forested environment on Zvijezda Mountain, at an altitude of approximately 900 – 1,280m above sea level. The Vares Processing Plant is located at an altitude of approximately 1,060m above sea level to the east of Vareš, on the southern edge of the village of Tisovci.

The hydrology is directly related to the terrain. Vareš is situated in the valley of the Stavnja River, which is a tributary of the Bosna River, the third longest river in Bosnia which flows north through the centre of Bosnia for some 282km before discharging to the Sava River. The hydrological network of the study area is well developed with mountainous catchments characterised by numerous streams feeding larger rivers. The closest watercourses to the project all form part of the Bosna River network, with the Borovički stream and Vrući stream located in close proximity to the Rupice project area, and the Mala River located southeast of the Vares Processing Plant and channelled beneath the historic tailings pond before discharging downstream (Photo 4.15.1). The topography of the study area is shown in Photo 4.15.2 and Drawing 4.15.2.

Photo 4.15.1: Historical Tailings Pond

Photo 4.15.2: View South over Vareš, showing the rugged, hilly topography typical of the area



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Key

Elevation (metres)
- 1433
- 1259
- 1086
- 912
- 738.5
- TSF
- Infrastructure
- Haul Road

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

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Adriatic Metals PLC

PROJECT
Vares Project ESIA

DRAWING TITLE
Site Topography

DRG No. ZT520182/4.15.2		REV A
DRG SIZE A3	SCALE 1:100,000	DATE September 2021
DRAWN MBW	CHECKED BY AM	APPROVED BY AA

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4.15.3.2 Landcover and Landuse

As stated previously, BiH is primarily a mountainous country: of its total surface area, 42% consists of mountains, 24% of hills, 29% of karst areas and 5% of lowlands. 80% of the land use is forestry and agriculture (including pasture and intensive crops). Although agricultural land accounts for nearly 50% of the total territory, BiH is not rich in high quality agricultural land.

Within the study area, the primary habitat is forest (including spruce and fir) interspersed with areas of pasture, arable farming, human settlements, together with former mining land and associated infrastructure. The Rupice project area is located within an area primarily covered in forest and the access road, mine and associated buildings will be constructed within this dense mountain forest. In addition, there are some small areas of rocky slopes and grassland also present, with several watercourses. The Vares project area is a mix of grasslands / pasture and other agricultural uses, scattered spruce forests, several watercourses and several brownfield sites (including the former open pit and associated infrastructure). A full land use baseline is presented in Chapter 4.6.

Photo 4.15.3: Typical Landscape of the Study Area showing Primarily Forest, but with Areas of Grassland

4.15.3.3 Transportation and Access

The Rupice and Vares Processing Plant project areas are located approximately 8.7km west north-west and 3.5km east respectively from Vareš which is the nearest town of any size having a population of about 5000. The closest commercial airport is in Sarajevo and the project can be reached from the capital city along 50km of sealed roads, via the coal mining town of Breza. The Vares Processing Plant project area is accessed from Vareš by a sealed road and Rupice by a mix of existing sealed and unsealed roads. Road infrastructure in the study area is generally poor, particularly around the Rupice project area. The quality of the roads is also poor (weathered asphalt, unsurfaced routes). There is a distinct lack of public transportation, particularly around rural communities. Industrial traffic in the study aera tends to be related to the logging and wood processing industries, with factories located to the north of Vareš on the road to Tuzla, as well as at Daštansko and Vareš Majdan.

Photo 4.15.4: Typical Unsealed Forest Track

4.15.3.4 Settlement and Infrastructure

As noted above, Vareš is the main town in the study area. Outside of Vareš, the population is spread across small rural villages, of which there are a large number. The Socio-Economic baseline assessment in Chapter 4.11 has identified 24 local community centres comprising of 81 settlements in the municipality of Vareš with key communities and places of interest in the villages of Veovaca, Rupice, and Daštansko.

Photo 4.15.5: Vernacular Architecture of Rural Villages

The Rupice project area is a greenfield site and no infrastructure currently exists at the proposed mining operations. In the Vares Processing Plant area and its surroundings, the following infrastructure remains from historical mining operations in the 1980s: Veovaca open pit, processing plant site foundations, tailings storage facility, waste rock dumps, and access roads. Existing infrastructure from previous operations at the Vares Processing Plant site has been demolished, re-used or stored as necessary to accommodate the proposed site layout.

Photo 4.15.6: Remains of the former Vares Processing Plant (Pre-demolition)

4.15.3.5 Character

The project is notable for the relative contrast in character between the two areas. The greenfield Rupice project area consists of mountains with limestone outcrops and dense forests. There is minimal industry in the area, with the exception of a small water bottling factory. There are currently no scars or marks on the landscape, therefore impacts are likely to relate to the extent to which this remote area is affected by the introduction of new roads and mining infrastructure.

At the Vares Processing Plant site, in addition to the remains former plant, the character of the surrounding area is heavily influenced by the presence of historical mine sites including open pits, tailings storage and rock dumps. Forest cover has largely been removed as settlements are more closely spaced. In this case, the proposed project will not give rise to any new land uses but will lead to redevelopment of the derelict brownfield site of the former plant. The area around the processing plant has a comparatively larger population compared to Rupice therefore there will be a greater concentration of visual receptors. It is also less forested than Rupice with greater intervisibility between the site and surrounding area.

Photo 4.15.7: View South over Veovaca Open Pit with Daštansko Mosque Visible to the Left and the Vares Processing Plant Site Visible in the Distance

4.15.4 Visual Baseline

Establishing the visual baseline for the assessment of visual impacts involves three stages:

- Identifying the area in which the project may be visible;
- Identifying different groups of people (visual receptors) who may experience views of the project; and,
- Identifying the viewpoints where they will be affected and the nature of the view at those points and using this information to establish a number of representative viewpoints to be used in the assessment of visual impacts.

4.15.4.1 Extent of Visibility

There are two main approaches to mapping visibility: manual and digital, a combination of the two has been used for the development of the baseline. A manual approach has been adopted along the haul route using a combination of map interpretation, cross sections through various project components in relation to their surroundings, and visual envelope mapping on site during fieldwork visits. A digital zone of theoretical visibility (ZTV) has been developed for the Vares Processing Plant.

This utilises elevation data to create a digital terrain model of the study area and calculate intervisibility between points or along lines radiating out from the plant site. As shown in Drawing 4.15.3, the ZTV illustrates the area of the landscape from which a viewer can theoretically see the tallest building (Workshop at 18m) of the Vares processing plant.

The ZTV shows that the process plant is visible in multiple directions from several communities and receptors. There is significant visibility in the villages of Tisovci and Pržići directly adjacent to the plant site, as well as in Višnjići. Views are visible on the hillside west of Vareš Majdan, however there are minimal receptors in this region.

4.15.4.2 Visual Receptors

At Rupice, no sensitive receptors to landscape change have been identified. The deep valley, lack of nearby residents and predominantly underground operation combined with the dense surrounding forest suggests that visual impacts would be minimal. Overlooking the proposed road link between the two project areas are a number of villages which may have views of construction and mine traffic.

The Vares Processing Plant area has remained in the same state since its closure in the early 1990s, though the demolition of buildings has taken place since the closure of the mine. The exposed plateau is visible from multiple villages namely Daštansko, Višnjići and Pržići while some houses in Tisovci directly overlook the plant site and access road.

4.15.4.3 Representative Viewpoints

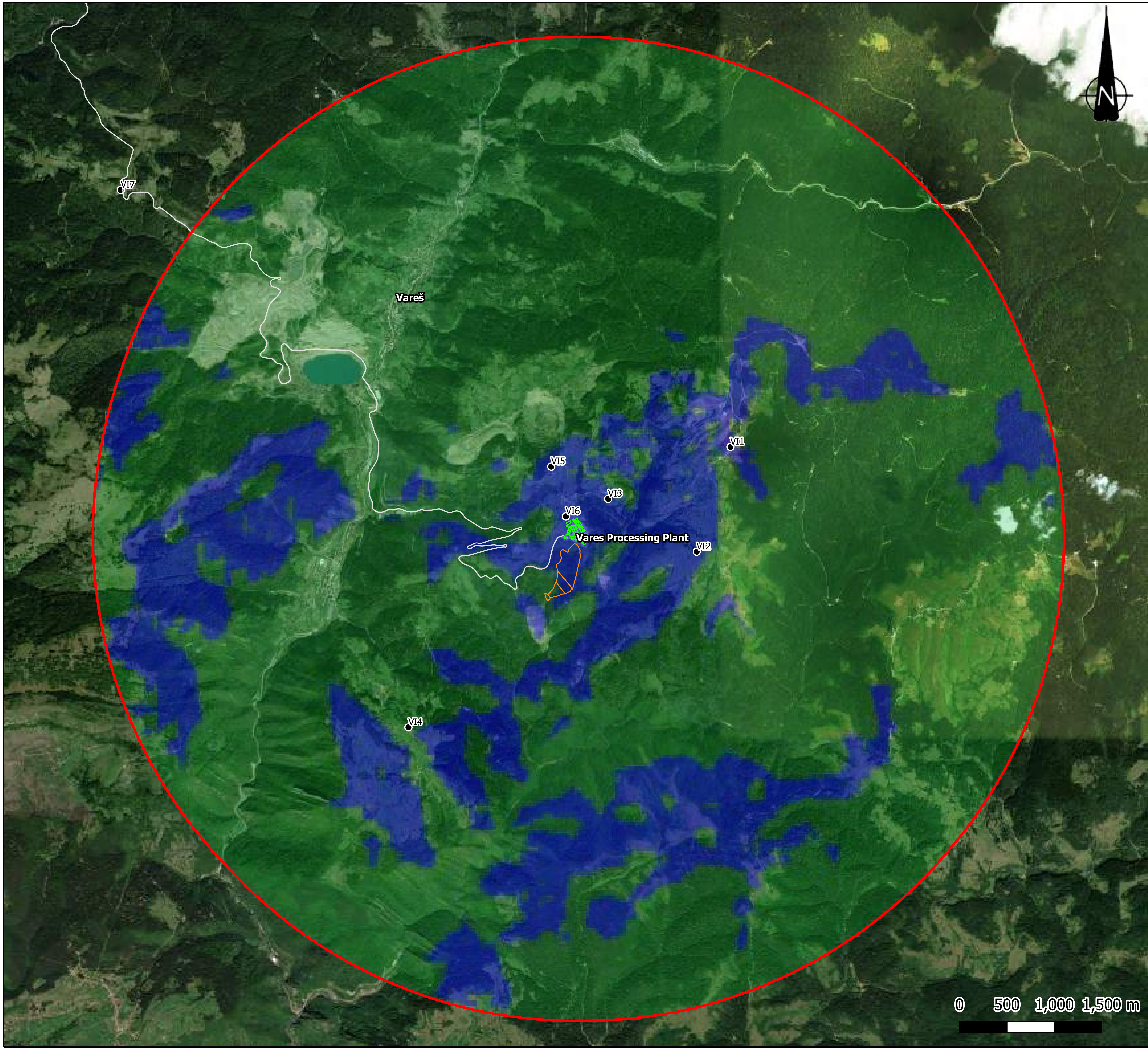
A number of potential representative viewpoint locations were identified during fieldwork. The final representative viewpoints used for the assessment of visual impacts were chosen according to the following criteria:

- Being publicly accessible;
- Having a reasonably high potential number of receptors or being of particular importance to the viewers affected;
- Providing a representative range of viewing distances, directions and elevations (short, medium and longer distance views);
- Representing a range of viewing experiences (static views, views from settlements and sequential points along routes);
- Representing a range of view types, (panoramas, vistas, glimpses); and
- Representing views with different parts of the project potentially being visible.

Seven representative viewpoints have been chosen for the assessment as follows:

Table 4.15.1 Location of Representative Viewpoints			
ID of point	**Latitude**	**Longitude**	**Name**
VI1	44.148236	18.370000	Daštansko Central
VI2	44.138333	18.365556	Višnjići
VI3	44.146944	18.356389	Pržići North
VI4	44.143333	18.353889	Pržići South
VI5	44.146389	18.346389	Tisovci North
VI6	44.141667	18.348333	Tisovci
VI7	44.172500°	18.289722°	Položac

The location of these viewpoints is shown on 4.15.3, in relation to the Zone of Theoretical Visibility for the Vares Processing Plant. Effects on views from areas such as upstairs windows are assessed, however the views from upstairs windows are typically accorded a lower visual sensitivity.



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Key

- Viewpoint Locations
- TSF
- Infrastructure
- Haul Road

5km ZTV of 18m Infrastructure

- Infrastructure is not visible at 2m
- Infrastructure is visible at 2m

REVISION	DETAILS	DATE	DR'N	CHK'D	APP'D

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PROJECT
Vares Project ESIA

DRAWING TITLE
ZTV of Vares Proccesing Plant & Viewpoint Locations

DRG No. ZT520182/4.15.3		REV A
DRG SIZE A3	SCALE 1:55000	DATE September 2021
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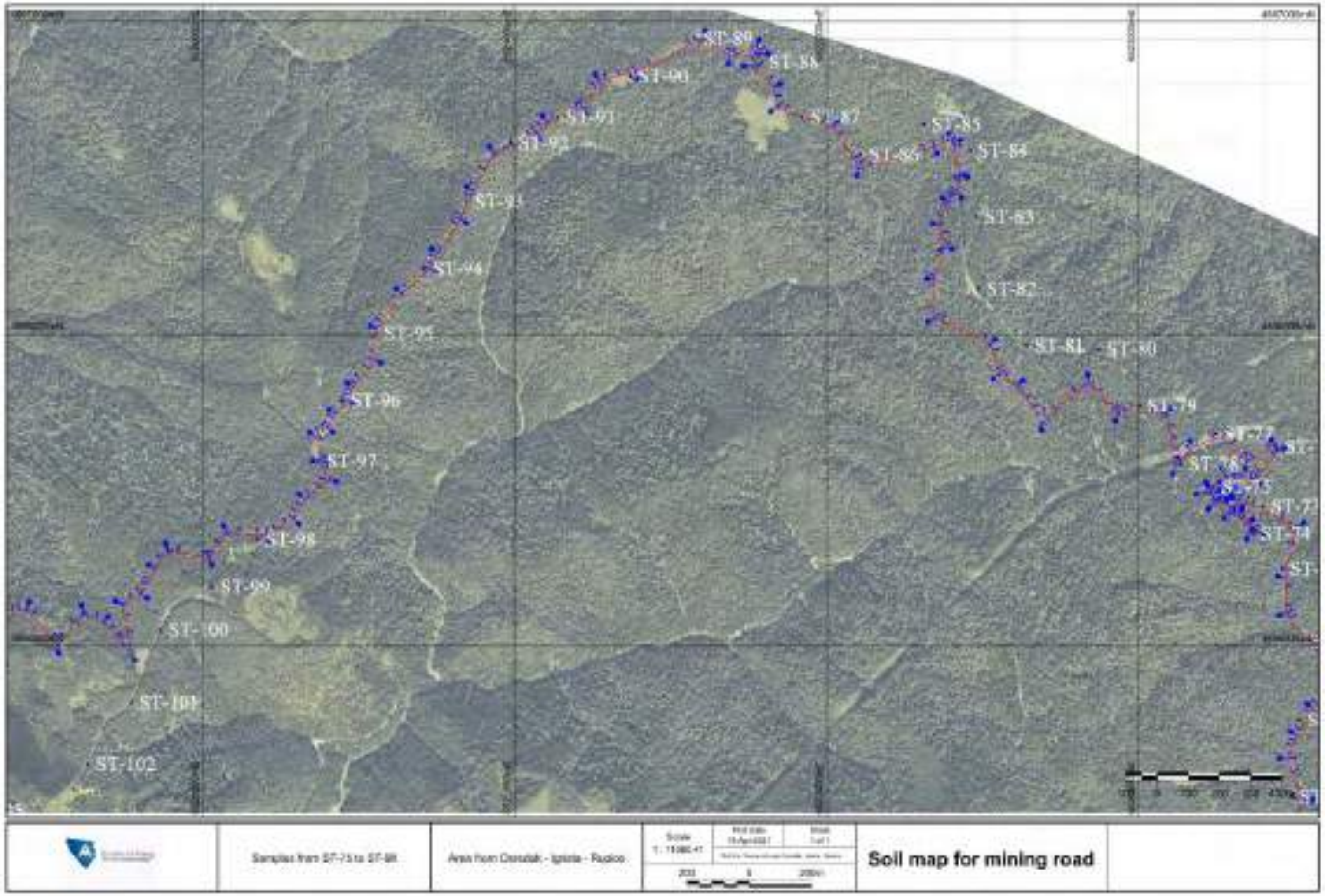
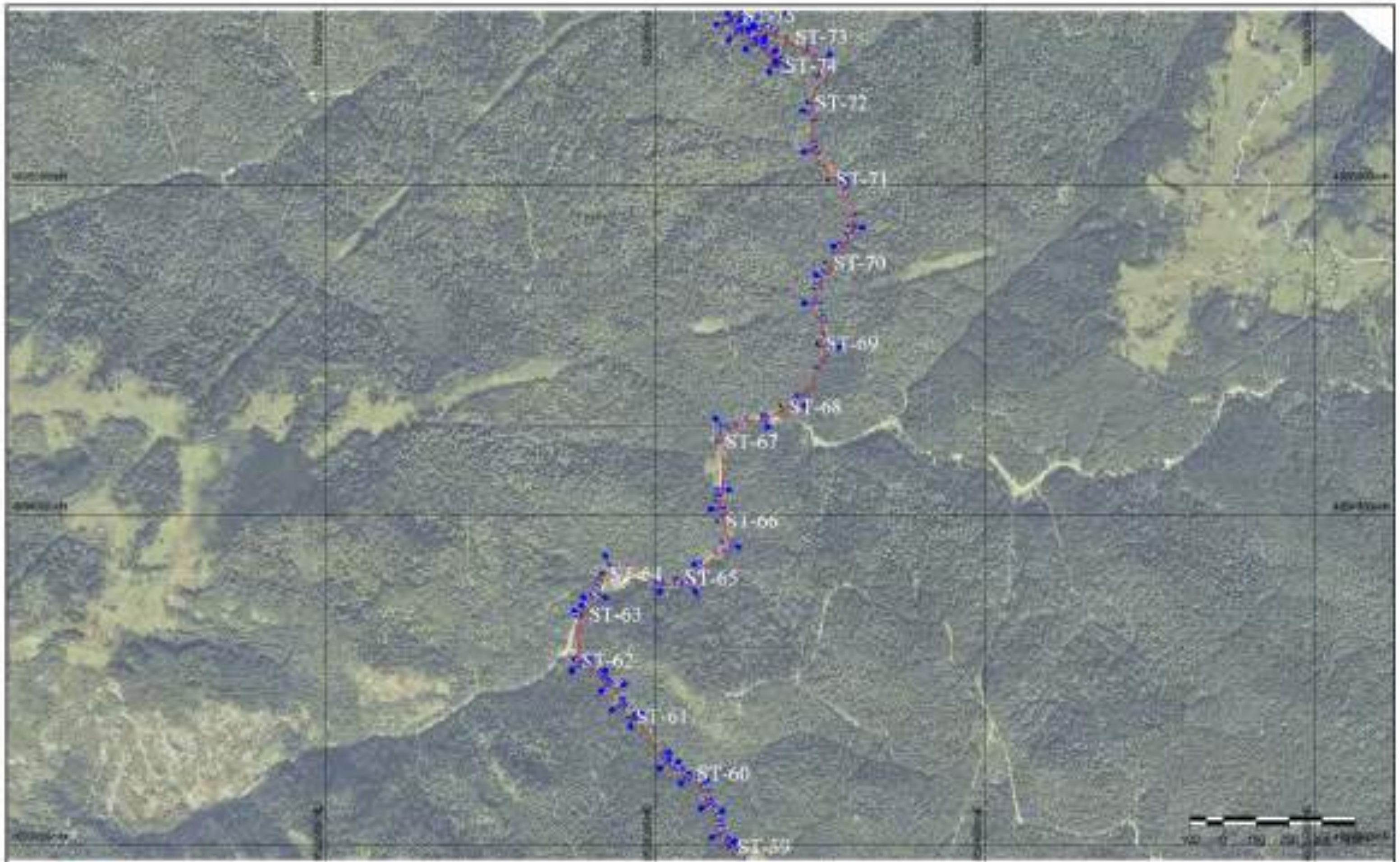
APPENDIX 4.4.1: Soil Sampling Along Haul Route

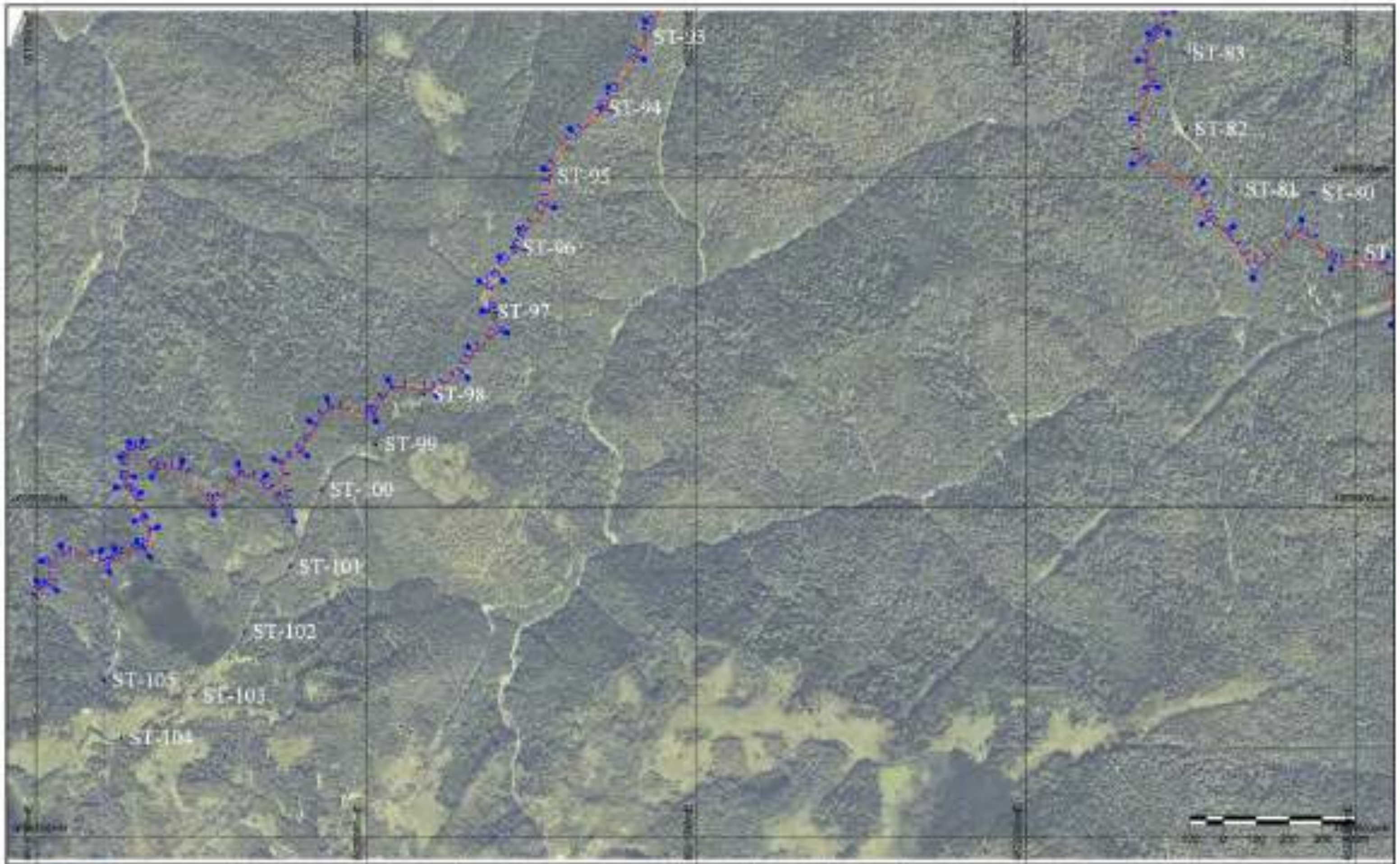
Appendix 4.4.1: Soil Sampling Locations along Haul Route



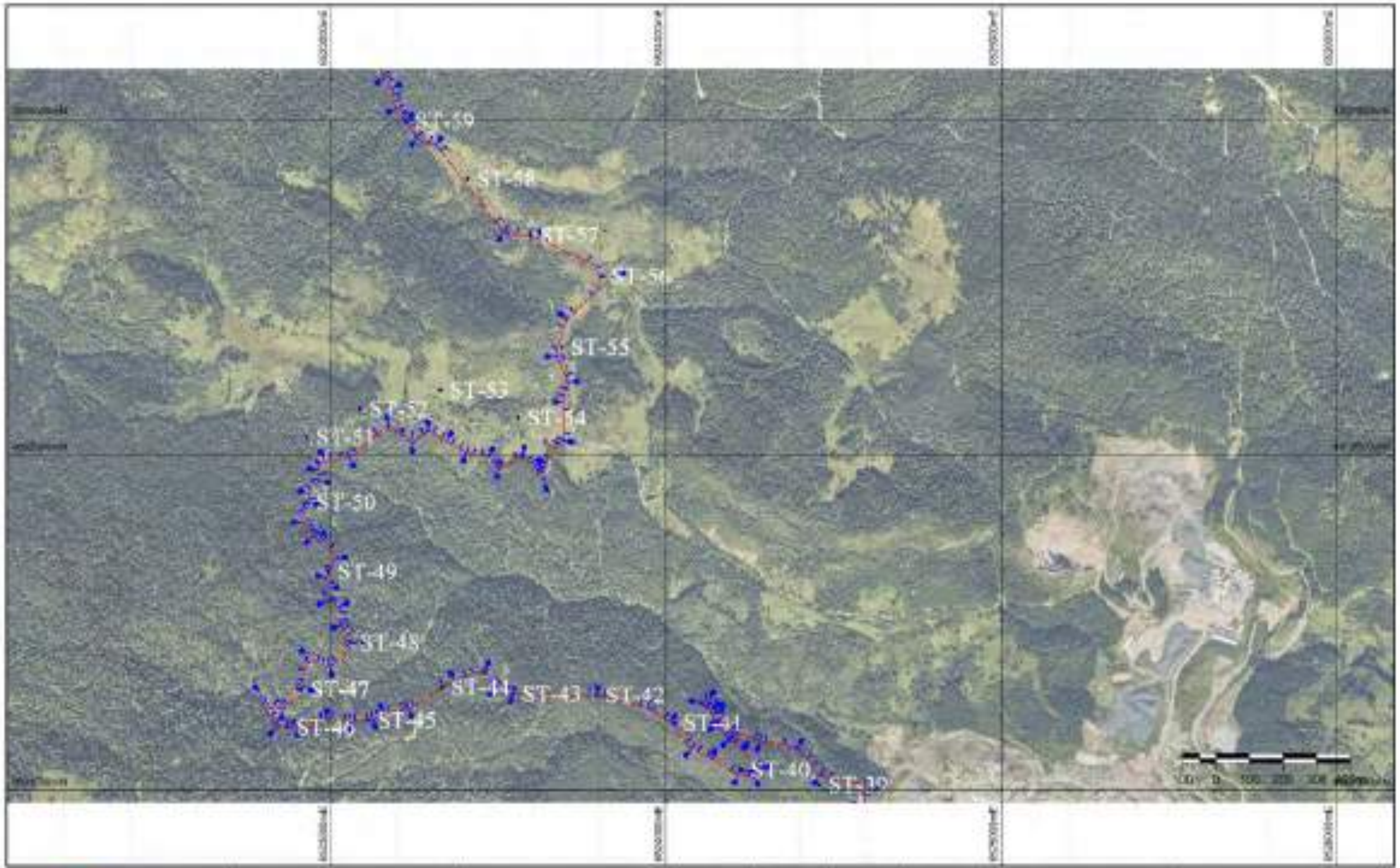


Samples from ST-59 to ST-74

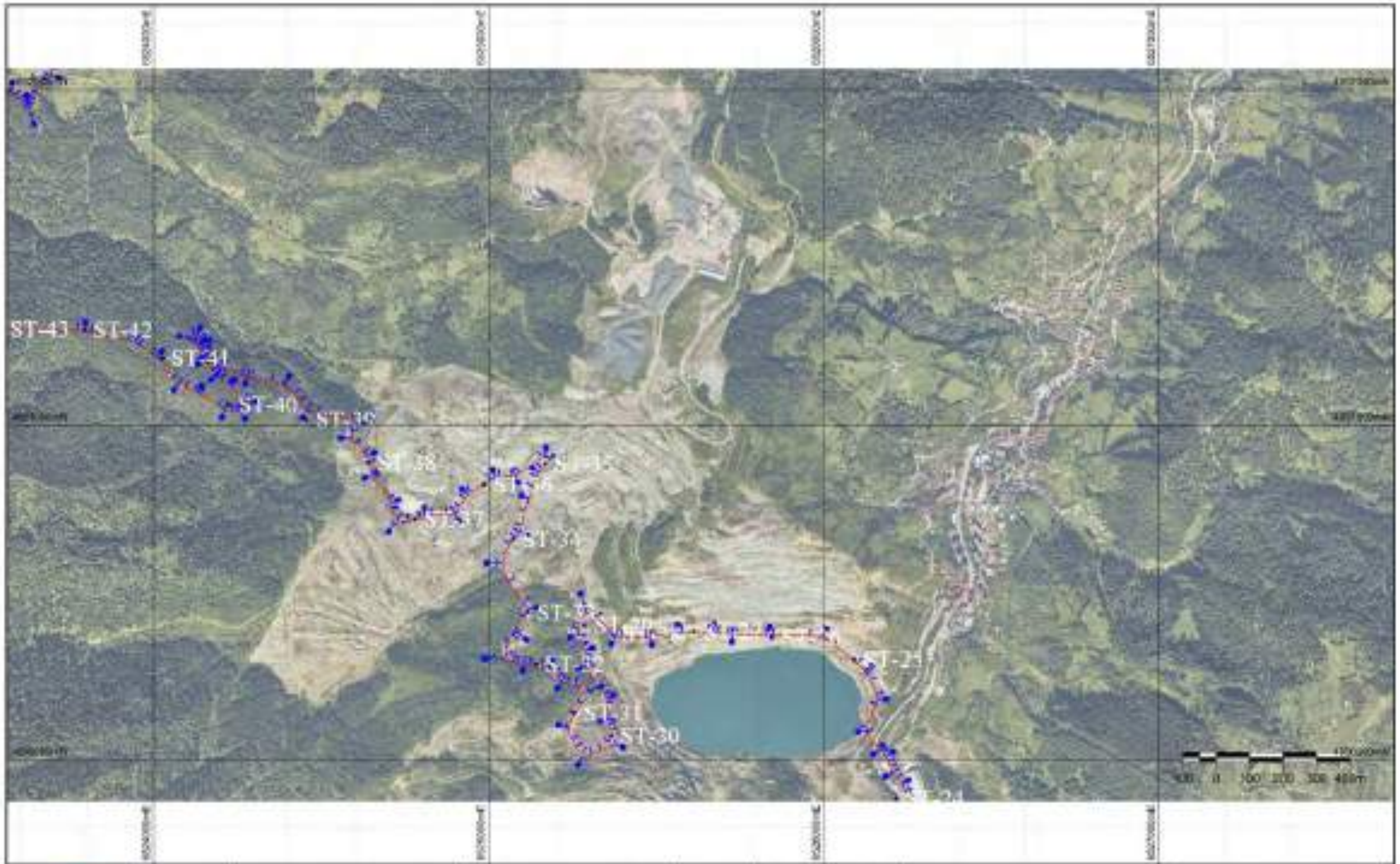
Soil map for mining road



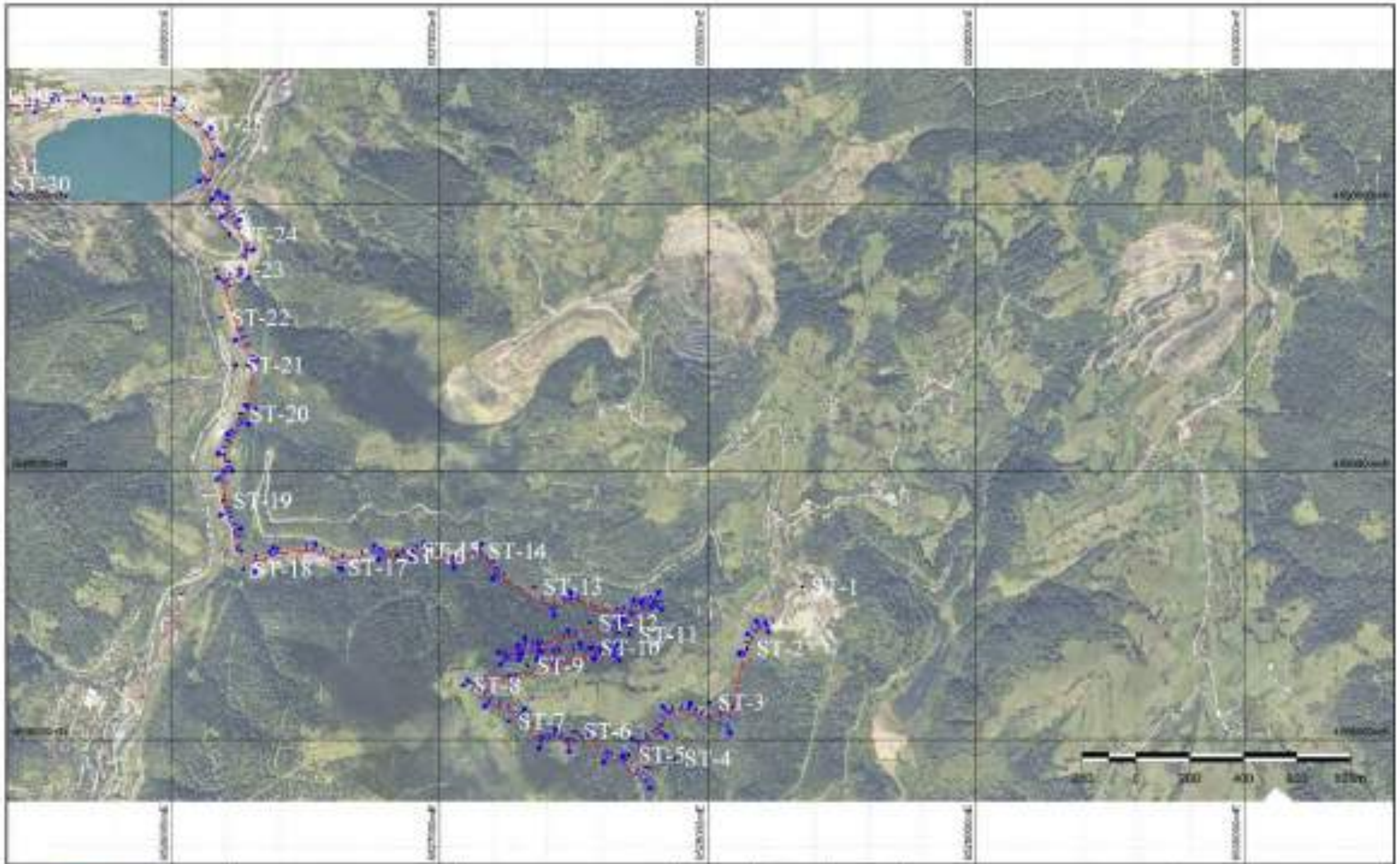
	Samples from ST-88 to ST-105	Area at Rupsa	Scale 1 : 11880.41	**Soil map for mining road**



Sample from ST-43 to ST-59	Area at Semizovo	Scale 1 : 10913.00	Sheet 1 of 1	**Soil map for mining road**



Sample from ST-29 to ST-43	Area from Smrekar lake to Semizova ponikva	Scale 1 : 10910.00	**Soil map for mining road**	



	Samples from ST-1 TO ST-28	Area from Tisovo to Smolsko lake	Scale 1 : 13837.57	**Soil map for mining road**

APPENDIX 4.4.2: Results of Physical and Chemical Analysis for Rupice and Vares Areas v2

APPENDIX 4.4.2

Table 1: Physical and chemical analyses of soil samples at Vares and Rupice.

Sample ID	Land Use	Depth	pH in H2O	Electrical Conductivity	Total Organic Matter	Total Nitrogen	Accessible Phosphorous - P2O5	Accessible Potassium - K2O	Phosphate	Cyclohexame	Phenols	Cyanide	Nitrate	PAH	Potassium	Total Petroleum Hydrocarbons	Chloride
		cm		(µS/cm)	(%)	(%)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Natural Soils																	
RS-01	Rupice, Forestry	50	5.22	60.38	11.48	0.26	0.7	14.53									
RS-10		50	5.34	86.69	24.93	0.54	9.98	34.88									
VS-01	Vares surrounding area, Forestry	50	5.37	90.08	9.11	0.19	1.23	14.91									
VS-06		50	7.55	247.5	13.7	0.33	1.29	35.36									
VS-07		50	8.43	210.6	5.76	0.11	1.07	42.82									
VS-08		50	7.66	554.6	19.73	0.63	0.78	17.8									
VS-09		50	7.09	147.6	13.92	0.46	0.67	35.6									
VS-10		50	7.12	142.1	12.64	0.31	0.51	22.71									
Locations with history of industrial activities																	
C-VS-01	Veovaca Open Pit	40	8.03			0.08	147	153.3	147	81.6	7.46	<0.50	5.2	0.2	153.3	5.74	36.9
C-VS-02		45	7.34			0.13	8.38	161	8.38	111	7.25	<0.50	9.45	0.23	161	7.22	63.8
C-VS-03		50	6.07			0.14	2.38	307.5	2.38	103	5.56	<0.50	5.49	0.23	307.5	1.43	49.6
C-VS-04		50	7.18			0.17	8.99	155.9	8.99	55.4	5.3	1.05	4.4	0.36	155.9	4.3	36.9
C-VS-05		45	8			0.23	5.39	172.2	5.39	56.8	7.42	4.1	10.16	0.55	172.2	11.67	36.9
C-VP-01	Vares Processing Plant	40	7.22			0.15	0.89	176.5	0.89	91.3	5.47	<0.50	5.48	0.58	176.5	5.05	105
C-VP-02		30	7.95			0.07	0.9	168.2	0.9	76.1	0.25	<0.50	2.9	0.8	168.2	5.73	24.1
C-VP-03		70	8.37			0.1	0.87	181.9	0.87	105	1.05	1.02	5.28	0.62	181.9	10.14	105
C-VP-05		50	7.68			0.06	14.3	49.48	14.3	293	0.3	5.19	2.02	0.86	49.48	21.75	24.1
C-VP-06		50	8.1			0.11	174	163.1	174	38.7	5.65	2.08	4.38	0.72	163.1	4.4	24.1
C-VP-07		30	7.43			0.09	94.5	54.15	94.5	364	7.25	5.21	1.81	2.1	54.15	66.11	9.9
C-VP-08		50	7.56			0.07	1.25	52.2	1.25	195	5.4	4.16	1.98	1.05	52.2	6.87	63.8
C-VP-09		40	8.19			0.04	15.8	140.8	15.8	3.8	7.17	5.25	0.93	0.37	140.8	3.02	9.9
C-VP-10		60	7.28			0.24	9.87	190.1	9.87	108	0.27	2.1	8.85	0.68	190.1	10.21	78
C-VP-11		30	7.35			0.04	1.1	26.98	1.1	197	1.12	<0.50	2.08	0.84	26.98	8.07	24.1

APPENDIX 4.4.3: Results of Physical and Chemical Analysis for Haul Route v2

Appendix 4.4.3

Table 1: Physical analysis of soil samples from the haul route.

Type	SAMPLE ID	Location	Land Use	Depth (cm)	soil horizon	Texture	Consistence (kg/cm2)	Structure (Median sand- µm)	Percentage of stones greater than 2.0 cm (%)	Presence of organic material	Any evidence of contamination	Other relevant observations	Hue	Value	Chroma	Colour-Munsell system	pH - Current acidity (H2O)	pH - Substitution acidity (1M KCl)	Conductivity (µS/cm)
Soil	ST-01	Tisovci to Smreka lake	Forestry	50	End of A horizon	Crumb	4.2	Sand (2000 µm -extreme coarse)	0	Grass			10YR	5	4	10YR 5/4 YELLOWISH BROWN	4.83	4.72	49.50
Soil	ST-02	Tisovci to Smreka lake	Forestry	75	C	Crumb	4.5	Sand (710 µm - extreme coarse)	0.2				10YR	4	4	10YR 4/4 DARK YELLOWISH	6.73	5.81	127.20
Soil	ST-03	Tisovci to Smreka lake	Forestry	50	B	Crumb	1.3	Sand (1000 µm -extreme coarse)	0.8				10YR	4	1	10RY 4/1 DARK GRAY	5.97	6.47	78.80
Soil	ST-04	Tisovci to Smreka lake	Forestry	75	C	Crumb	3.2	Sand (1000 µm -extreme coarse)	5				7.5YR	4	1	7.5Y 4/1 DARK GRAY	7.75	5.99	94.80
Soil	ST-05	Tisovci to Smreka lake	Forestry	55	B	Granular	1.6	Sand (500 µm - extreme coarse)	0.1	Plants roots			5YR	4	1	5Y 4/1 DARK GRAY	7.60	6.72	98.10
Soil	ST-06	Tisovci to Smreka lake	Forestry	45	From A to B	Crumb	4.2	Sand (710 µm - extreme coarse)	0	Plants roots			2.5Y	6	1	2.5Y 6/1 GRAY	5.28	4.23	133.70
Soil	ST-07	Tisovci to Smreka lake	Forestry	60	B	Crumb	5.3	Sand (500 µm - extreme coarse)	0	Grass			7.5R	2.5	2	7.5R 2.5/2 VERY DUSKY RED	6.67	6.23	97.00
Soil	ST-08	Tisovci to Smreka lake	Forestry	64	B	Crumb	2.1	Sand (1400 µm -extreme coarse)	0				10YR	6	1	10YR 5/4 BROWN	5.52	4.54	64.10
Soil	ST-09	Tisovci to Smreka lake	Forestry	80	C	A little granular	3.7	Sand (2000 µm -extreme coarse)	0.5		Plastic bottle		2.5Y	5	2	2.5Y 4/3 GRAYISH BROWN	7.10	6.98	120.20
Soil	ST-10	Tisovci to Smreka lake	Forestry	52	A	Crumb	5.2	Sand (1000 µm -extreme coarse)	0	Remnans of trees, leaves and grass			2.5Y	5	4	2.5Y 5/4 LIGHT OLIVE BROWN	5.31	4.40	97.70
Soil	ST-11	Tisovci to Smreka lake	Forestry	55	Entrance to B	Crumb	5.7	Sand (400 µm - very coarse)	0	Small plants roots			10YR	5	4	10YR 3/3 YELLOWISH BROWN	6.70	5.40	75.20
Soil	ST-12	Tisovci to Smreka lake	Forestry	65	B	Crumb	5.8	Sand (1400 µm - extreme coarse)	0	Wood and roots		Through the forest	10YR	5	2	10YR 5/2 GRAYISH BROWN	7.30	5.80	79.00
Soil	ST-13	Tisovci to Smreka lake	Forestry	64	B	Granular	4.4	Sand (2000 µm - extreme coarse)	10			Through the forest	10YR	5	1	10YR 5/1 GRAY	7.20	6.10	78.50
Soil	ST-14	Tisovci to Smreka lake	Forestry	85	C	Single granular	2.3	Sand (1400 µm - extreme coarse)	5			Through the forest	7.5YR	3	2	7.5YR 3/2 DARK BROWN	7.40	6.00	79.50
Soil	ST-15	Tisovci to Smreka lake	Forestry	55	End of A	Crumb	3.2	Sand (2000 µm - extreme coarse)	5	Leaves		Through the forest	10YR	6	3	10YR 6/3 PALE BROWN	7.80	6.20	77.60
Soil	ST-16	Tisovci to Smreka lake	Forestry	85	C	Single granular	2.9	Sand (1400 µm - extreme coarse)	25			Through the forest	10YR	7	3	10YR 7/3 VERY PALE BROWN	7.70	6.50	78.30
Soil	ST-17	Tisovci to Smreka lake	Forestry	90	C	Single granular	2.1	Sand (1000 µm - extreme coarse)	5			On the main road	10YR	5	1	5YR 5/1 GRAY	8.30	7.40	76.20

Soil	ST-18	Tisovci to Smreka lake	Residential	95	C	Crumb	4.5	Sand (710 µm - extreme coarse)	20	Very small woods		On the main road	2.5Y	5	1	2.5Y 5/1 GRAY	8.50	7.80	78.40
Soil	ST-19	Tisovci to Smreka lake	Residential	60	B	Crumb	4.5	Sand (1400 µm - extreme coarse)	0.2	Plants roots	Plastic bottles	Near the main road	10YR	5	2	10YR 5/2 GRAYISH BROWN	8.30	7.40	74.20
Soil	ST-20	Tisovci to Smreka lake	Residential	98	C	Granular	3.3	Sand (1000 µm - extreme coarse)	40		Covered road with bulk material	Exsisting road	10YR	6	3	10YR 6/3 PALE BROWN	8.20	7.60	106.20
Soil	ST-21	Tisovci to Smreka lake	Residential	60	B	Granular	3.1	Sand (500 µm - extreme coarse)	0	Contains grass, roots and humus	Covered road with bulk material	Exsisting road	7.5YR	4	4	7.5YR 4/4 BROWN	8.50	7.10	99.10
Soil	ST-22	Tisovci to Smreka lake	Residential	100	C	Granular	4.3	Sand (14000 µm - extreme coarse)	15		Covered road with bulk material Plastic bootle and paper	Exsisting road	7.5YR	2.5	3	7.5YR 2.5/3 VERY DARK BROWN	8.40	7.50	159.50
Soil	ST-23	Tisovci to Smreka lake	Residential	68	B	Crumb	4.1	Sand (2000 µm - extreme coarse)	0	Woods		Exsisting road	5YR	5	2	5YR 5/2 DARK YELLOWISH BROWN	8.50	7.70	127.70
Soil	ST-24	Tisovci to Smreka lake	Industrial	66	B	Crumb	5.2	Sand (1000 µm - extreme coarse)	0	Plants roots	Covered road with bulk material	Exsisting road	2.5YR	4	1	2.5YR 4/1 DARK REDDISH GRAY	8.40	7.20	102.50
Soil	ST-25	Tisovci to Smreka lake	Industrial	65	B	Granular	3.2	Sand (1400 µm - extreme coarse)	0		Paper	Existing road Near the lake Smreka	5YR	1	3	5YR 6/1 GRAY	8.40	8.20	192.10
Soil	ST-26	Tisovci to Smreka lake	Industrial	70	End of B	Granular	2.1	Sand (710 µm - extreme coarse)	0				2.5Y	7	4	2.5Y 7/4 PALE BROWN	8.50	8.10	153.10
Soil	ST-27	Tisovci to Smreka lake	Industrial	65	B	Granular	2.9	Sand (1400 µm - extreme coarse)	0		Covered road with bulk material	Existing road,near the lake Smreka	2.5Y	7	1	2.5Y 7/1 LIGHT GRAY	8.50	7.90	143.80
Soil	ST-28	Tisovci to Smreka lake	Industrial	60	B	Granular	2.4	Sand (1000 µm - extreme coarse)	0		Covered road wit bulk material	Above the lake Smreka, Existing road	2.5YR	4	3	2.5YR 4/3 REDDISH BROWN	8.70	8.60	189.60
Soil	ST-29	Smreka lake to Semizova Ponikva	Industrial	63	B	Crumb	3.5	Sand (2000 µm - extreme coarse)	0		Plastic	Above the lake Smreka	7.5Y	1	3	7.5Y 5/1 GRAY	8.80	8.10	177.30
Soil	ST-30	Smreka lake to Semizova Ponikva	Industrial	60	B	Crumb	3.1	Sand (1400 µm - extreme coarse)	0			Above the lake Smreka	7.5YR	5	1	7.5YR 5/1 GRAY	8.70	7.90	126.40
Soil	ST-31	Smreka lake to Semizova Ponikva	Industrial	80	C	Crumb and a little granular	2.6	Sand (2000 µm - extreme coarse)	30			Above the lake Smreka, existing road Smreka	7.5R	3	4	7.5R 3/4 DUSKY RED	8.60	8.00	129.60
Soil	ST-32	Smreka lake to Semizova Ponikva	Industrial	90	C	A little platy	2.1	Sand (1400 µm - extreme coarse)	20			Above the lake Smreka, existing road Smreka	10YR	3	3	10YR 3/3 DARK BROWN	8.60	8.00	129.60
Soil	ST-33	Smreka lake to Semizova Ponikva	Industrial	63	B	Crumb	2.5	Sand (1000 µm - extreme coarse)	0			Above the lake Smreka, existing road Smreka	10YR	6	4	10YR 6/4 LIGHT YELLOWISH BROWN	8.20	7.20	68.80
Soil	ST-34	Smreka lake to Semizova Ponikva	Industrial	85	C	Crumb	4.4	Sand (2000 µm - extreme coarse)	40			Above the lake Smreka	10YR	8	2	10YR 8/2 VERY PALE BROWN	8.80	8.40	160.50

Soil	ST-35	Smreka lake to Semizova Ponikva	Industrial	67	B	Crumb	2.9	Sand (710 µm - extreme coarse)	2.5		Covered road with bulk material	Above the lake Smreka, existing road Smreka	7.5YR	5	3	7.5YR 5/3 BROWN	8.40	7.50	149.10
Soil	ST-36	Smreka lake to Semizova Ponikva	Industrial	60	B	Crumb	3.9	Sand (1000 µm - extreme coarse)	7	A little woods and grass		Above the lake Smreka, existing road Smreka	10YR	4	2	10YR 4/2 DARK GRAYISH BROWN	8.60	8.30	169.80
Soil	ST-37	Smreka lake to Semizova Ponikva	Industrial	65	B	Crumb	4	Sand (1400 µm - extreme coarse)	0	Roots		According to Semizova Ponikva	10YR	6	1	10YR 6/1 GRAY	8.10	7.40	121.50
Soil	ST-38	Smreka lake to Semizova Ponikva	Industrial	67	B	Crumb	3.4	Sand (1000 µm - extreme coarse)	0	Roots plants		According to Semizova Ponikva	2.5Y	6	2	2.5Y 6/2 LIGHT BROWNIS H GRAY	8.00	7.20	128.50
Soil	ST-39	Smreka lake to Semizova Ponikva	Forestry	55	A	Crumb	3.5	Sand (2000 µm - extreme coarse)	0	Humus			2.5Y	7	2	2.5Y 7/2 LIGHT GRAY	7.40	6.60	91.10
Soil	ST-40	Smreka lake to Semizova Ponikva	Forestry	65	B	Crumb	3.3	Sand (2000 µm - extreme coarse)	0	Humus		According to Semizova Ponikva	7.5YR	6	3	7.5YR 6/3 LIGHT BROWN	5.70	3.90	90.70
Soil	ST-41	Smreka lake to Semizova Ponikva	Forestry	60	B	Crumb	3	Sand (2000 µm - extreme coarse)	0	Humus		According to Semizova Ponikva	5YR	6	3	5YR 6/3 LIGHT REDDISH BROWN	6.00	3.80	72.10
Soil	ST-42	Smreka lake to Semizova Ponikva	Forestry	65	B	Single granular	2	Sand (1400 µm - extreme coarse)	0	Roots plants		According to Semizova Ponikva	5YR	6	4	5YR 6/4 LIGHT REDDISH BROWN	5.70	3.90	57.10
Soil	ST-43	Semizova Ponikva	Forestry	62	B	Crumb	2.7	Sand (1400 µm - extreme coarse)	0			According to Semizova Ponikva	7.5YR	6	6	7.5YR 6/6 REDDISH YELLOW	6.00	3.80	80.10
Soil	ST-44	Semizova Ponikva	Forestry	85	C	Single granular	2.8	Sand (1000 µm - extreme coarse)	0			According to Semizova Ponikva	5YR	6	1	5YR 6/1 GRAY	5.50	5.30	86.80
Soil	ST-45	Semizova Ponikva	Forestry	68	B	Crumb	2.5	Sand (1400 µm - extreme coarse)	0			According to Semizova Ponikva	10YR	7	3	10YR 7/3 VERY PALE BROWN	6.40	5.40	212.00
Soil	ST-46	Semizova Ponikva	Forestry	55	B	Columnar	2.3	Sand (1400 µm - extreme coarse)	0	Contains clay		Existing road	10YR	7	2	10YR 7/2 LIGHT GRAY	7.60	5.90	152.20
Soil	ST-47	Semizova Ponikva	Forestry	60	B	Crumb	4	Sand (1400 µm - extreme coarse)	0.2			Existing road	5YR	5	1	5YR 5/1 GRAY	7.80	5.60	97.40
Soil	ST-48	Semizova Ponikva	Forestry	50	A	Crumb	3.4	Sand (1000 µm - extreme coarse)	0	Grass		Existing road	7.5YR	6	3	7.5YR 6/3 LIGHT BROWN	7.30	6.60	106.10
Soil	ST-49	Semizova Ponikva	Forestry	55	B	Crumb	3.3	Sand (1000 µm - extreme coarse)	0	Roots plants		Existing road	10YR	6	4	10YR 6/4 LIGHT YELLOWIS H BROWN	7.90	6.70	94.40
Soil	ST-50	Semizova Ponikva	Forestry	65	B	Granular	1.3	Sand (1000 µm - extreme coarse)	0	Moss		Existing road	2.5YR	5	3	2.5YR 5/3 REDDISH BROWN	8.00	7.10	97.00
Soil	ST-51	Semizova Ponikva	Forestry	60	B	Plate	3	Sand (710 µm - extreme coarse)	0			Existing road	7.5YR	5	4	7.5YR 5/4 BROWN	7.50	4.20	71.10
Soil	ST-52	Semizova Ponikva	Forestry	60	B	Crumb	2.3	Sand (1400 µm - extreme coarse)	0	Humus		Existing road	7.5YR	3	4	7.5YR 3/4 DARK BROWN	7.30	5.90	80.20
Soil	ST-53	Semizova Ponikva	Residential	65	B	Crumb	3.4	Sand (1000 µm - extreme coarse)	0	Moss, roots and leaves		Existing road in poor condition	7.5YR	5	2	7.5YR 5/2 BROWN	6.10	4.60	76.50

Soil	ST-54	Semizova Ponikva	Residential	64	B	Crumb	2.7	Sand (500 µm - extreme coarse)	0	Grass		Existing road in poor condition	7.5YR	5	4	7.5YR 5/4 BROWN	6.20	4.10	79.90
Soil	ST-55	Semizova Ponikva	Residential	70	B	Crumb	2.9	Sand (1000 µm - extreme coarse)	0	Plants roots		Existing road in poor condition	7.5YR	5	4	7.5YR 5/4 BROWN	7.50	5.70	90.50
Soil	ST-56	Semizova Ponikva	Residential	63	B	Crumb	2.2	Sand (1400 µm - extreme coarse	0	Plants roots and leaves		Existing road	7.5YR	3	3	7.5YR 3/3 REDDISH YELLOW	7.20	6.00	87.90
Soil	ST-57	Semizova Ponikva	Residential	75	B	Plate	3.1	Sand (1000 µm - extreme coarse)	0				5YR	4	4	5YR 4/34 REDDISH BROWN	7.50	6.00	83.80
Soil	ST-58	Semizova Ponikva	Residential	66	B	Crumb	3.7	Sand (710 µm - extreme coarse)	0	Leaves and roots			7.5YR	4	4	7.5YR 4/34 BROWN	7.90	5.90	81.10
Soil	ST-59	Osredak	Forestry	57	B	Crumb	3.7	Sand (1000 µm - extreme coarse)	0	Plants roots			2.5YR	4	3	2.5YR 4/3 REDDISH BROWN	7.70	6.40	73.30
Soil	ST-60	Osredak	Forestry	70	B	Crumb	3.7	Sand (355 µm - very coarse)	0	Clay			10R	4	3	10R 4/3 WEAK RED	7.50	5.70	96.70
Soil	ST-61	Osredak	Forestry	72	B	Granular	2.5	Sand (710 µm - extreme coarse)	0	Humus, woods			10R	3	3	10R 3/3 DUSKY RED	7.90	6.50	86.30
Soil	ST-62	Osredak	Forestry	61	B	Granular	2.7	Sand (1000 µm - extreme coarse)	0	Grass and roots			5YR	4	4	5YR 4/4 REDDISH BROWN	7.70	6.10	71.90
Soil	ST-63	Osredak	Forestry	80	C	Granular	3	Sand (1000 µm - extreme coarse)	5	Plants roots			10YR	3	3	10YR 3/3 DARK BROWN	7.80	6.00	74.50
Soil	ST-64	Osredak	Forestry	75	C	Granular	2.8	Sand (1400 µm - extreme coarse)	0.5				10YR	7	2	10YR 7/2 LIGHT GRAY	7.90	6.00	78.30
Soil	ST-65	Osredak	Forestry	67	B	Crumb	3.8	Sand (2000 µm - extreme coarse)	0.3				5YR	4	6	5YR 4/6 YELLOWISH RED	7.80	6.30	92.30
Soil	ST-66	Osredak	Forestry	66	B	Crumb	3.3	Sand (1000 µm - extreme coarse)	0				2.5YR	6	1	2.5YR 4/3 REDDISH GRAY	8.00	5.00	50.40
Soil	ST-67	Osredak	Forestry	60	A	Crumb	2.9	Sand (1000 µm - extreme coarse)	0	Roots and leaves			10YR	4	3	10YR 4/3 BROWN	6.60	4.70	81.40
Soil	ST-68	Osredak	Forestry	62	A	Crumb	2.6	Sand (710 µm - extreme coarse)	0	Humus and roots			2.5Y	2.5	1	2.5Y 2.5/1 BLACK	7.10	4.60	59.10
Soil	ST-69	Osredak	Forestry	67	B	Granular	3.3	Sand (500 µm - extreme coarse)	0	Roots			2.5Y	5	3	2.5Y 5/3 LIGHT OLIVE BROWN	5.50	4.60	57.40
Soil	ST-70	Osredak	Forestry	61	B	Granular	3.3	Sand (1400 µm - extreme coarse)	0	Roots			2.5Y	6	4	2.5Y 6/4 LIGHT YELLOWISH BROWN	6.40	5.30	44.50
Soil	ST-71	Osredak	Forestry	55	A	Crumb	4	Sand (2000 µm - extreme coarse)	0	Humus			10YR	4	1	10YR 4/1 DARK GRAY	7.40	6.40	69.20
Soil	ST-72	Osredak	Forestry	53	A	Crumb	4.3	Sand (1000 µm - extreme coarse)	0	Humus and roots plants			10YR	5	2	10YR 5/2 GRAYISH BROWN	8.30	6.20	81.80
Soil	ST-73	Osredak	Forestry	57	B	Crumb	4.6	Sand (1000 µm - extreme coarse)	0	Roots plants			10YR	7	3	10YR 7/3 VERY PALE BROWN	8.10	4.90	72.10

Soil	ST-74	Osredak	Forestry	55	A	Granular	3.2	Sand (1400 µm - extreme coarse)	0	Moss			2.5Y	7	4	2.5YR 7/4 PALE BROWN	6.90	4.70	74.30
Soil	ST-75	Osredak - Igrišta - Rupice	Forestry	62	B	Granular	2.3	Sand (1400 µm - extreme coarse)	0	Moss and very small humus			2.5Y	6	6	2.5YR 6/6 OLIVE YELLOW	6.80	4.40	70.00
Soil	ST-76	Osredak - Igrišta - Rupice	Forestry	65	B	Crumb	3.6	Sand (1400 µm - extreme coarse)	0.2	Very small humus			2.5Y	6	8	2.5YR 6/8 OLIVE YELLOW	6.30	4.30	125.60
Soil	ST-77	Osredak - Igrišta - Rupice	Forestry	66	B	Granular	2.9	Sand (1000 µm - extreme coarse)	0	Roots plants			2.5Y	6	4	2.5YR 6/4 LIGHT YELLOWISH BROWN	5.30	5.70	78.00
Soil	ST-78	Osredak - Igrišta - Rupice	Forestry	60	B	Granular	2.9	Sand (1000 µm - extreme coarse)	0	Roots plants and woods			2.5Y	6	4	2.5YR 6/4 LIGHT YELLOWISH BROWN	7.00	5.60	75.70
Soil	ST-79	Osredak - Igrišta - Rupice	Forestry	65	B	A little Granular and crumb	2.9	Sand (1000 µm - extreme coarse)	0	Roots plants and woods			2.5Y	6	6	2.5YR 6/6 OLIVE YELLOW	7.50	6.00	98.90
Soil	ST-80	Osredak - Igrišta - Rupice	Forestry	67	B	Granular	2.5	Sand (710 µm - extreme coarse)	0	Roots plants and woods			2.5Y	5	3	2.5YR 5/3 LIGHT OLIVE BROWN	7.40	5.60	72.90
Soil	ST-81	Osredak - Igrišta - Rupice	Forestry	55	A	55	4.6	Sand (1000 µm - extreme coarse)	0	Roots plants, woods, and humus			5Y	2.5	1	5Y 2.5/1 BLACK	7.70	6.30	90.70
Soil	ST-82	Osredak - Igrišta - Rupice	Forestry	60	B	Crumb	4.3	Sand (710 µm - extreme coarse)	0	Roots plants and woods			2.5Y	6	4	2.5Y 6/4 LIGHT YELLOWISH BROWN	7.40	6.50	98.30
Soil	ST-83	Osredak - Igrišta - Rupice	Forestry	55	A	A little plate	4.7	Sand (710 µm - extreme coarse)	0	Roots plants, woods and moss			10YR	4	4	2.5Y 3/2 DARK YELLOWISH BROWN	6.70	6.10	66.90
Soil	ST-84	Osredak - Igrišta - Rupice	Forestry	85	C	Granular	3.1	Sand (1000 µm - extreme coarse)	0				2.5Y	6	1	2.5Y 6/1 GRAY	7.10	6.80	98.30
Soil	ST-85	Osredak - Igrišta - Rupice	Forestry	55	A	Granular	2.9	Sand (1000 µm - extreme coarse)	0	Humus an leaves			10YR	2	1	10YR 2/1 BLACK	6.60	5.10	38.80
Soil	ST-86	Osredak - Igrišta - Rupice	Forestry	65	B	Crumb	3.2	Sand (2000 µm - extreme coarse)	0	Humus			2.5Y	6	4	2.5Y 6/4 LIGHT YELLOWISH BROWN	6.80	4.50	49.00
Soil	ST-87	Osredak - Igrišta - Rupice	Forestry	58	A	Crumb	3	Sand (1400 µm - extreme coarse)	0	Leaves			2.5Y	5	3	2.5Y 5/3 LIGHT OLIVE BROWN	6.30	5.90	61.80
Soil	ST-88	Osredak - Igrišta - Rupice	Forestry	58	A	Crumb	2.9	Sand (1000 µm - extreme coarse)	0	Roots plants, woods and humus			10YR	4	4	10YR 4/6 DARK YELLOWISH BROWN	6.30	6.00	65.60
Soil	ST-89	Osredak - Igrišta - Rupice	Forestry	62	A	Granular	2.7	Sand (1000 µm - extreme coarse)	0	Roots plants, woods, leves and humus			2.5Y	4	2	2.5Y 3/3 DARK GRAYISH BROWN	6.30	5.90	77.40
Soil	ST-90	Osredak - Igrišta - Rupice	Forestry	68	B	Granular	3.4	Sand (1400 µm - extreme coarse)	0	Roots plants, woods, and leves			2.5Y	6	3	2.5Y 6/3 LIGHT YELLOWISH BROWN	6.60	5.00	82.00
Soil	ST-91	Osredak - Igrišta - Rupice	Forestry	69	B	Granular	3.2	Sand (740 µm - extreme coarse)	0	Roots plants, woods			2.5Y	5	3	2.5Y 5/3 LIGHT OLIVE BROWN	6.20	4.90	68.80

Soil	ST-92	Osredak - Igrišta - Rupice	Forestry	66	B	Crumb	4.3	Sand (2000 µm - extreme coarse)	0	Roots plants, woods			2.5Y	7	6	2.5Y 7/6 YELLOW	4.80	4.50	52.20
Soil	ST-93	Osredak - Igrišta - Rupice	Forestry	68	B	Crumb	3	Sand (1000 µm - extreme coarse)	0	Roots plants, woods and humus			2.5Y	6	6	2.5Y 6/6 OLIVE YELLOW	4.50	4.00	45.00
Soil	ST-94	Osredak - Igrišta - Rupice	Forestry	60	B	Crumb	3	Sand (1000 µm - extreme coarse)	0	Roots plants, woods and humus			2.5Y	5	4	2.5Y 5/4 LIGHT OLIVE BROWN	4.10	3.80	56.50
Soil	ST-95	Osredak - Igrišta - Rupice	Forestry	56	A	Crumb	3.2	Sand (1400 µm - extreme coarse)	0	Woods			2.5Y	7	4	2.5Y 7/4 PALE BROWN	5.70	5.10	74.70
Soil	ST-96	Osredak - Igrišta - Rupice	Forestry	68	B	Granular	2.9	Sand (1000 µm - extreme coarse)	0				10YR	4	2	10YR 4/2 DARK GRAYISH BROWN	4.80	4.20	70.70
Soil	ST-97	Osredak - Igrišta - Rupice	Forestry	70	B	Granular	3	Sand (1400 µm - extreme coarse)	0				2.5Y	6	4	2.5Y 6/4 LIGHT YELLOWISH BROWN	5.10	5.00	67.50
Soil	ST-98	Osredak - Igrišta - Rupice	Forestry	57	A	Granular	3.5	Sand (1400 µm - extreme coarse)	0	Roots plants and woods			10YR	4	1	10YR 4/1 DARK GRAY	3.70	3.50	48.00
Soil	ST-99	Rupice	Forestry	55	A	Granular	2.8	Sand (2000 µm - extreme coarse)	0	Roots plants, humus and woods			10YR	4	1	10YR 4/1 DARK GRAY	3.60	3.40	48.50
Soil	ST-100	Rupice	Forestry	98	C	Granular	3.3	Sand (2000 µm - extreme coarse)	10				2.5Y	5	6	2.5Y 5/6 LIGHT OLIVE BROWN	4.30	4.10	71.50
Soil	ST-101	Rupice	Forestry	80	B	Granular	2.4	Sand (500 µm - extreme coarse)	10	A little roots			2.5Y	7	4	2.5Y 7/4 PALE BROWN	4.50	4.30	48.10
Soil	ST-102	Rupice	Forestry	55	A	Crumb	2.7	Sand (1000 µm - extreme coarse)	0	Humus			2.5Y	8	4	2.5Y 8/4 PALE BROWN	5.30	5.10	66.40
Soil	ST-103	Rupice	Residential	65	B	Crumb	4.6	Sand (1000 µm - extreme coarse)	0	Roots plants and moss			2.5Y	3	1	2.5Y 3/1 VERY DARK GRAY	6.00	5.00	47.50
Soil	ST-104	Rupice	Residential	68	B	Crumb	4.6	Sand (1400 µm - extreme coarse)	0				2.5Y	5	2	2.5Y 5/2 GRAYISH BROWN	5.70	5.30	86.40
Soil	ST-105	Rupice	Forestry	100	C	Granular	4	Sand (1400 µm - extreme coarse)	0.9				2.5Y	5	1	2.5Y 5/1 GRAY	6.10	5.20	95.00

APPENDIX 4.4.4: XRF Chemical Analysis for Haul Route Soil v2

Appendix 4.4.4

Table 1: XRF chemical (metals) analysis of soil samples from the haul route, with comparison to BiH limits (for loamy soils) where soils are more natural and CCME limits (for industrial soils) where soils have a history of industrial activity. with exceedances highlighted in red, values below zero have been assumed as below detectable limits and notes as NULL. Residential includes Urban and Rural locations. Where there is an existing road samples were taken at the roadside, where there is no ecisting road, samples were taken at the proposed location.

SAMPLE ID	Land Use	Units	Pb	Zn	Cu	Ba	Ag	Hg	Ti	Cr	Mn	Fe	Co	Ni	As	Se	Rb	Sr	Zr	Pb	Cd	Sn	Sb	W	Au
Natural Soils																									
BiH (loamy soils)			80	150	65	100		1		80			45	40	15					80	1				
ST-01	Forestry	ppm	74.52	107.43	NULL	1449.03	60.68	NULL	3631.74	362.79	686.06	27515.64	106.94	142.22	29.37	10.72	90.47	16.01	136.95	8.73	124.37	110.3	87.28	12.42	37.43
ST-02	Forestry	ppm	240.44	139.58	94.09	1964.53	27.14	1.67	2699.03	345.76	2097.91	48664.16	84.86	80.69	17.96	2.7	67.74	20.74	145.68	3.43	28.45	47.83	46.18	3.58	4.9
ST-03	Forestry	ppm	88.46	103.79	NULL	1181.43	32.93	1	3277.75	347.28	773.26	31225.74	42.38	130.31	NULL	NULL	65.69	37.99	188.53	12.92	47.93	59.45	47	3.77	NULL
ST-04	Forestry	ppm	22.62	71.5	NULL	1225.58	74.53	19.07	3193.14	309.78	926.08	21999.82	NULL	272.25	20.14	NULL	47.9	41.61	126.82	21.81	130.54	136.9	99.55	NULL	NULL
ST-05	Forestry	ppm	960.94	379.16	240.47	8242.45	27.32	NULL	6239.66	555.8	7521.01	163932.61	185.85	46.15	59.18	NULL	52.44	NULL	137.23	1.93	30.54	41.69	108.9	NULL	NULL
ST-06	Forestry	ppm	35	71.28	NULL	481.43	31.58	NULL	3541.69	199.59	347.66	28800.2	44.71	86.06	6.55	NULL	64.9	35.63	169.98	0.5	26.8	37.12	36.31	NULL	NULL
ST-07	Forestry	ppm	1246.15	398.93	393.13	8498.72	34.6	9.49	4072.42	411	7540.34	138954.34	NULL	32.19	47.11	4.99	46.58	NULL	122.85	3.87	42.08	41.65	116.64	NULL	NULL
ST-08	Forestry	ppm	52.84	122.62	11.7	765.38	29.99	NULL	3246.83	383.98	1114.7	35357.28	77.04	134.33	12.38	1.41	82.99	16.87	153.7	9.14	39.43	61.49	45.11	NULL	7.26
ST-09	Forestry	ppm	364.51	286.73	18.53	1616.48	56.09	6.98	3413.62	174.61	1086.26	27725.33	96.83	132.5	16.76	NULL	71.9	49.29	156.6	20.06	73.85	81.47	70.61	NULL	23.77
ST-10	Forestry	ppm	50.51	74.08	NULL	825.1	38.04	NULL	3832.8	410.53	850.02	29197.86	NULL	121.18	12.81	10.53	78.94	20.86	175.83	16.13	66.41	47.87	47.9	31.03	NULL
ST-11	Forestry	ppm	51.61	91.16	NULL	725.75	29.91	NULL	3194.36	153.7	966.71	30545.83	77.93	57.7	9.04	4	84.2	45.72	150.78	3.83	54.09	52.7	39.5	NULL	NULL
ST-12	Forestry	ppm	57.73	92.87	35.68	783.53	49.32	13.73	3204.02	35.2	951.09	30665.13	60.24	104.54	NULL	2.47	80.51	40.89	173.76	8.44	55.91	97.72	62.05	NULL	8.03
ST-13	Forestry	ppm	114.17	194.35	53.12	713.6	49.46	9.95	2876.36	373.19	1188.85	30903.45	30.34	121.42	19.21	1	93.2	46.31	147.8	8.86	77.89	87.89	55.57	55.36	7.12
ST-14	Forestry	ppm	50.29	30.83	43.32	NULL	NULL	9.85	NULL	NULL	87.7	4904.76	1.06	NULL	NULL	1.48	7.56	13.85	NULL	NULL	NULL	NULL	NULL	13	NULL
ST-15	Forestry	ppm	15.49	31.74	20.32	NULL	NULL	0.3	NULL	NULL	603.09	3795.17	NULL	NULL	1.83	NULL	4.68	18.22	NULL	NULL	NULL	NULL	NULL	2.61	NULL
ST-16	Forestry	ppm	79.57	90.55	77.36	NULL	NULL	0.34	1035.99	NULL	2503.53	16217.04	NULL	NULL	5.87	2.02	23.65	37.43	25.65	NULL	NULL	NULL	NULL	44.02	NULL
ST-17	Forestry	ppm	46.29	43.16	40.67	NULL	NULL	4.02	NULL	NULL	118.95	6546.39	NULL	NULL	3.97	1.5	6.89	12.21	NULL	NULL	NULL	NULL	NULL	19.82	NULL
ST-39	Forestry	ppm	27.15	29.88	110.95	120.93	2.83	3.78	2696.16	20.2	343.39	14362.67	32.72	14.59	0.34	2.53	160.54	31.17	373.16	NULL	NULL	NULL	NULL	NULL	NULL
ST-40	Forestry	ppm	26.76	24.43	3.69	264.56	2.05	4.68	3831.65	91.51	151.8	17247.01	18.08	22.48	8.46	1.06	114.71	18.32	462.08	1.09	NULL	13.64	3.82	NULL	NULL
ST-41	Forestry	ppm	9620.59	3034.68	1549.21	9575.39	67.91	NULL	8938.29	431.77	34404.01	301525.97	NULL	116.73	644.45	6.27	102.73	381.28	48.64	NULL	15.22	21.68	273.15	NULL	3.98
ST-42	Forestry	ppm	2198.27	804.54	304.41	2282.42	21.31	3.22	3767.34	96.32	6695.48	80187.15	0.03	13.25	92.45	1.19	121.29	403.58	111.96	NULL	NULL	NULL	49.64	NULL	9.23
ST-43	Forestry	ppm	34	99.42	2.44	112.1	NULL	NULL	4192.93	60.19	944.99	28015.27	30.44	21.6	10.12	0.37	138.34	82.31	294.39	NULL	NULL	NULL	NULL	5.97	NULL
ST-44	Forestry	ppm	43.25	45.31	NULL	89.46	NULL	0.54	3233.88	45.65	810.59	16285.5	5.92	9.64	6.93	0.97	107.6	77.81	345.35	2.34	NULL	NULL	NULL	NULL	NULL
ST-45	Forestry	ppm	30.08	85.41	2.96	64.37	5.07	1.41	3422.83	69.11	512.01	28113.44	21.12	24.52	5.41	0.09	143.41	733.22	129.01	1.54	NULL	NULL	NULL	NULL	5.25
ST-46	Forestry	ppm	47.81	67.82	NULL	1298.28	84.83	2.59	3659.91	177.29	306.32	18897	77.44	95.06	10.46	7.2	114	473.74	172.73	17.29	121.8	151.29	100.11	127.14	13.61
ST-47	Forestry	ppm	36.39	94.86	6.17	NULL	NULL	3.68	3498.24	49.38	604.14	26540.12	49.39	17.71	10.11	0.5	157.53	651.88	153.7	NULL	NULL	NULL	NULL	NULL	NULL
ST-48	Forestry	ppm	36.91	101.86	3.7	99.47	NULL	3.61	3789.45	71.14	928.33	32794.18	70.56	9.25	11.9	NULL	163.37	244.28	195.5	1.18	NULL	NULL	NULL	NULL	NULL
ST-49	Forestry	ppm	103.32	95.48	NULL	289.14	1.05	NULL	2617.59	73.37	1055.75	13578.99	NULL	19.68	10.72	NULL	144.34	42.57	286.68	1.75	0.72	NULL	3.59	NULL	2.65
ST-50	Forestry	ppm	33.77	56.13	NULL	23.89	NULL	1.58	2982.37	61.2	937.2	22721.26	31.23	0.49	17.39	NULL	162.51	38.71	207.27	NULL	NULL	NULL	NULL	NULL	NULL
ST-51	Forestry	ppm	47.8	35.04	93.64	41.91	NULL	2.55	643.7	16.9	223.92	9415.49	1.14	20.06	8.21	6.42	71.21	71.59	89.85	NULL	NULL	NULL	NULL	58.53	NULL
ST-52	Forestry	ppm	44.26	98.26	NULL	1005.26	69.11	6.79	2735.09	125.05	482.45	18418.67	0.18	135.14	4.63	2.31	97.11	63.75	232.27	17.91	116.06	118.71	97.46	NULL	NULL
ST-59	Forestry	ppm	95.3	144.51	NULL	695	51.35	6.84	2195.94	NULL	796.15	15675.71	31.93	129.39	12.55	7.92	41.32		97.94	1.45	88	90.75	52.25	10.29	2.38
ST-60	Forestry	ppm	123.4	106.09	NULL	1038.4	61.99	NULL	2881.09	50.07	1687.72	23396.05	90.71	113.6	0.25	5.19	54.7	31.07	186.33	10.07	109.63	105.52	86.52	88.39	1.97
ST-61	Forestry	ppm	183.77	214.73	NULL	715.38	49.26	10.52	2957.12	169.56	2133.78	22463.85	25.08	82.62	8.37	11.36	54.6	20.36	135.24	9.9	103.53	106.58	85.09	NULL	NULL
ST-62	Forestry	ppm	88.72	182.18	NULL	272.54	51.22	4.11	944.87	NULL	917.99	14122.52	24.08	112.72	25.12	1.36	32.86	9.68	72.13	NULL	87.28	49.38	44.87	NULL	NULL
ST-63	Forestry	ppm	24.72	54.47	NULL			3.36	572.71	NULL	408.34	8860.51	7.32	44.04	16.92	2.83	26.49	18.58	84.3	NULL	3.55	NULL	0.32	NULL	NULL
ST-64	Forestry	ppm	81.02	130.26	NULL	636.2	70.54	6.35	2110.29	14.24	844.08	15127.82	NULL	65.59	23.68	6.05	49.92	18.3	129.94	7.8	109.22	114.94	69.24	13.86	5.31
ST-65	Forestry	ppm	96.77	95.56	41.12	488.37	31.82	NULL	1189.8	111.82	324.48	7908.82	32.88	25.6	18.69	NULL	40.57	22.99	92.69	4	37.3	40.17	42.07	19.35	4.5
ST-66	Forestry	ppm	157.06	217.82	2.66	536.8	35.88	15.54	2858.81	45.12	2257.05	20126.05	81.12	61.83	45.61	NULL	60.71	32.87	128.8	6.63	42.36	55.83	40.42	NULL	3.23
ST-67	Forestry	ppm	66.29	122.94	NULL	651.8	41.92	3.73	3159.3	215.42	1406.68	24057.14	NULL	41.7	16.57	1.49	96.79	43.45	191.53	7.47	42.86	64.81	52.06	NULL	NULL
ST-68	Forestry	ppm	83.31	101.86	NULL	467.25	41.78	8.3	1673.4	NULL	1711.58	16619.12	13.16	99.66	11.77	5.63	68.61	33.32	126.57	0.78	42.46	40.66	40.22	NULL	NULL
ST-69	Forestry	ppm	53.21	90.36	NULL	393.45	37.29	8.67	1757.52	28.9	1680.56	16402.11	NULL	40.08	17.35	3.38	65.2	32.46	113.51	0.65	38.01	40.24	33.52	NULL	NULL
ST-70	Forestry	ppm	75.25	132.18	7.8	326.22	23.17	5.14	1950.74	NULL	1387.42	17137.38	7.06	NULL	16.84	2.5	54.67	31.01	108.34	4.69	20.92	30.97	30.12	NULL	NULL
ST-71	Forestry	ppm	143.48	173.21	NULL	534.35	36.98	7.76	1955.51	54.16	2197.16	17951.73	0.31	30.34	20.96	4.3	58.98	52.57	132.19	1.16	52.31	45.64	44.6	NULL	NULL
ST-72	Forestry	ppm	70.66	142.76	NULL	938.12	56.79	3.91	2497.31	NULL	1993.68	18923.03	17.68	173.59	3.41	0.27	64.44	38.71	163.37	6.72	100.85	146.72	76.68	NULL	15.14
ST-73	Forestry	ppm	73.84	130.54	NULL	393.13	34.61	6.93	2476.1	NULL	1455.56	21913.22	7.39	51.51	16.91	2.24	76.69	49.52	172.06	2.94	29.11	35.62	31.97	NULL	4.34
ST-74	Forestry	ppm	26.94	72.26	NULL	383.43	25.29	5.25	2568.31	NULL	797.19	20644.63	5.57	14.27	24.21	2.57	80.04	55.99	161.77	9.14	37.73	40.45	32.29	NULL	13.29
ST-75	Forestry	ppm	44.23	69.74	NULL	802.93	68.09	1.62	1906.53	44.88	1096.87	18511.69	66.05	69.07	29.45	5.61	69.17	31.76	154.51	21.53	71.69	99.97	74.25	57.98	15.02
ST-76	Forestry	ppm	136.95	58.71	NULL	425.21	28.76	0.48	2971.96	28.84	276.62	34113.75	50.62	5.63	15.21	2.75	109.44	36.27	194.12	3.56	23.84	26.41	24.15	NULL	NULL
ST-77	Forestry	ppm	42.6	73.43	NULL	513.86	23.59	7.11	2755.36	96.15	196.69	23939.75	23.31	32.12	11.89	NULL	93.29	44.17	212.19	5.25	31.5	50.48	29.6	NULL	3.88
ST-78	Forestry	ppm	68.73	67.6	NULL	272.69	16.59	3.31	3608.66	64.53	732.73	28627.73	16.9	NULL	22	1.55	89.2	50.83	223.13	NULL	9.08	21.83	19.19	NULL	9.18
ST-79	Forestry	ppm	17.58	76.77	NULL	338.03	17.02	6.41	3638.17	54.94	182.5	19175.06	44.97	4.31	11.1	2.02	80.02	61.78	255.2	4.22	14.79	28.49	25.22	NULL	NULL
ST-80	Forestry	ppm	21.81	74.06	NULL	625.23	33.77	9.98	4266.24	82.32	452.28	33628.34	134.48	15.98	15.88	1.47	104.03	37.95	228.02	8.81	34.5	48.13	34.55	NULL	NULL
ST-81	Forestry	ppm	96.48	108.43	NULL	584.6	30.22	14.7	3172.07	119	831.35	23054.31	39.7	33.4	9.53	3.91	67.91	33.54	215.4	6.45	43.45	62.03	41.64	NULL	9.37
ST-82	Forestry	ppm	41.65	75.04	NULL	695.36	38.3	13.48	2398.9	16	1155.51	17401.87	NULL	105.29	10.05	3.63	53	24.51	166.1	1.14	54.48	87.16	67.41	NULL	2.14
ST-83	Forestry	ppm	194.01	183	3.16	659.21	26.49	3.35	3491.62	91.56	1169.04	32168.57	48.92	37.17	9.7	3.48	66.67	44.38	127.7	5.19	31.46	46.55	37.08	35.42	0.08
ST-84	Forestry	ppm	266.38	354.38	NULL	1831.23	26.86	NULL	1996.92	91.69	933.02	18511.61	10.9	18.55	8.89	2.07	49.96	67.91	135.08	7.49	53.87	74.08	53.64	18.93	10.12
ST-85	Forestry	ppm	38.25	86.46	NULL	533.65	37.45	5.04	2393.43	62.08	1098.34	22605.75	65.49	8.93	9.28	3.14	45.18	33.63	137.57	4.98	43.16	44.02	36.25	NULL	NULL
ST-86	Forestry	ppm	19.76	69.42	4.56	466.34	30.52	6.38	3091.62	158.98	597.88	26042.92	4.47	33.17	7.52	1.34	72.48	31.02	209.84	4.26	38	38.83	37.17	NULL	2.83
ST-87	Forestry	ppm	168.74	253.05	9.15	657.22	19.52	7.68	3417.58	65.33	1458.49	29744.57	15.36	29.77	19.83	2.4	68.71	79.09	182.57	9.11	25.87	26.86	26.73	NULL	3.87
ST-88	Forestry	ppm	39.67	95.34	NULL	590.52	29.26	7.83	3528.37	135.62	1511.95	29036.02	NULL	64.53	16.51	4.14	46.6	52.92	145.13	NULL	46.04	47.65	38.47	NULL	0.89
ST-89	Forestry	ppm	97.42	189.74	NULL	6446.74	37.25	23.44	1547.02	11.42	2781.18	20694.98	9.64	53.39	7.23	8.25	48.63	40.77	163.72	12.77	75.45	70.34	55.74	NULL	NULL
ST-90	Forestry	ppm	64.6	92.41	NULL	563.12	19.68	5.48	2533.45	180.21	905.12	32171.3	91.98	58.24	7.12	2.78	41.55	62.51	159.84	4.61	30.11	29.3	27.38	NULL	5.56
ST-91	Forestry	ppm	31.97	85.2	4.2	314.93	10.96	7.36	3825.98	206.08	1160.95	40303.05	64.01	3.31	7.14	1.7	46.94	56.02	144.41	NULL	19.08	15.43	16.5	NULL	3.72
ST-92	Forestry	ppm	152.61	234.67	NULL	891.15	20.59	8.03	4437.05	218.51	877.38	35238.72	51.03	37.04	10.54	1.11	56.66	44.84	179.21	0.83	31.5	44.28	28.41	NULL	4.85
ST-93	Forestry	ppm	33.94	25.09	4.55	NULL	NULL	4.1	788.05	NULL	213	10777.1	36.9	NULL	5.89	6.01	23.87	17.22	79.21	NULL	NULL	NULL	NULL	NULL	NULL
ST-94	Forestry	ppm	29.94	50.79	22.57	394.67	22.53	10.3	3048.95	37.97	574.93	24724.56	21.67	23.09	6.58	1.3	50.86	23.77	181.05	6.36	35.64	38.5	29.99	NULL	NULL
ST-95	Forestry	ppm	27.51	39.27	40.39	NULL	NULL	NULL	1470.02	NULL	775.92	18883.51	51.19	NULL	4.95	0.94	31.08	37.18	91.52	NULL	NULL	NULL	NULL	NULL	NULL
ST-96	Forestry	ppm	36.47	67.94	NULL	395.13	25.29	5.59	3011.24	163.27	1074.51	24980.84	2.27	11.88	15.58	0.07	73.94	35.16	172.48	NULL	19.68	39.51	23.69	NULL	NULL
ST-97	Forestry	ppm	18.95	54.95	NULL	326.26	25.2	4.66	2731.59	96.27	1100.57	21364.12	NULL	23.97	7.78	0.47	48.31	40.18	184.12	NULL	24.43	18.7	25.62	NULL	0.65
ST-98	Forestry	ppm	44.57	80.05	NULL	415.97	13.53	NULL	3370.29	90.29	832.74	20849	41.22	8.05	9.05	NULL	100.78	56.81	232.27	NULL	15.81	32.16	25.71	16.09	NULL
ST-99	Forestry	ppm	49.42	52.93	NULL	616.09	23.72	NULL	3339.34	48.15	338.37	15488.98	NULL	27.04	1.73	3.94	78.22	31.11	200.67	1.91	55.2	59.47	44.16	96.98	NULL
ST-100	Forestry	ppm	31.64	46.16	NULL	473.36	38.33	1.43	2282.78	54.81	34.74	14603.26	5.99	18.29	4.42	3.43	54.53	26.14	268.31	5.17	27.19	36.24	34.65	NULL	NULL
ST-101	Forestry	ppm	35.8	81.97	15.73	434.48	23.53	NULL	3690.69	125.81	422.45	27344.62	74.54	NULL	16.76	6.12	125.37	67.58	222.62	0.35	18.25	25.29	24.37	2	1.67
ST-102	Forestry	ppm	23.02	88.4	NULL	439.65	27.88	3.7	4192.94	74.05	1134.43	28516.95	54.56	23.77	9.05	NULL	86.48	40.92	213.08	0.14	30.91	34.62	24.13	NULL	6.89
ST-105	Forestry	ppm	294.43	173.22	NULL	626.36	32.12	NULL	2393.62	123.62	666.85	25144.96	97.24	6.71	23.95	1.53	109.86	40.7	147.89	3.03	32.78	33.17	35.56	NULL	3.41
ST-18	Residential	ppm	237.04	356.74	117.21	3504.72	49.59	20.79	6933.13	215.22	8383.72	395829.81	337.44	NULL	32.42	12.65	71.52	NULL	102.28	NULL	36.83	105.58	69.63	NULL	13.15
ST-19	Residential	ppm	94.35	122.9	35.56	635.33	36.6	6.67	3180.5	473.08	695.94	27877.44	36.94	99.01	5.9	1.11	59.77	45.7	197.52	11.32	45.12	48.71	34.42	26.98	2.32
ST-20	Residential	ppm	326.87	683.18	162.36	2009.79	48.06	7.38	7444.38	491.75	8256.69	391467.22	243.69	113.69	112.52	7.86	83.76	38.02	112.28	40.53	50.25	103.81	67.98	16.11	NULL
ST-21	Residential	ppm	5379.89	1135.13	344.2	8497.35	61.93	16.12	7044.63	788.11	15123.32	167288.92	NULL	107.65	55.53	13.21	45.68	77.82	111.16	18.44	76.64	88.07	115.98	NULL	NULL
ST-22	Residential	ppm	356.89	544.39	524.05	1159.16	20.07	13.44	3755.73	294.4	4046.17	136884.81	248.09	96	10.18	4.61	35.22	72.21	102.11	3.5	25.64	84.73	49.12	NULL	6.77
ST-23	Residential	ppm	243.41	266.6	449.12	469.57	NULL	2.77	1299.27	87.23	1833.8	69682.11	173.44	94.02	19.32	7.56	25.98	40.55	55.76	NULL	39.65	17.33	4.84	265.69	NULL
ST-53	Residential	ppm	69.37	149.43	NULL	1107.61	68.73	5.87	2657.78	153.9	715.08	19847	NULL	127.73	17.87	21.96	86.44	37.82	212.54	22.06	148.47	144.84	100.57	72.83	NULL
ST-54	Residential	ppm	38.76	59.73	NULL	1171.93	79.06	39.55	3090.3	210.48	407.48	21364.23	NULL	155.44	18.07	7.74	97.93	47.59	193.43	15.99	120.94	132.35	113.29	16.03	4.8
ST-55	Residential	ppm	24.26	52.33	NULL	1024.56	58.49	0.47	2677.79	155.07	215.46	11299.71	NULL	111.61	6.57	7.2	64.57	31.03	391.28	27.12	85.45	96.25	86.96	30.48	NULL
ST-56	Residential	ppm	52.12	79.95	NULL	1056.06	90.72	7.44	3818.23	NULL	626.31	25081.26	95.67	263.52	20.31	1.63	40.44	24	134.17	26.6	111.72	145.4	99.44	NULL	27.13
ST-57	Residential	ppm	75.54	139.3	NULL	999.37	29.47	14.65	3451.82	100.23	431.21	22798.24	NULL	95.45	45.3	13.98	89.85	39.66	292.98	13.8	81.72	91.24	64.09	NULL	NULL
ST-58	Residential	ppm	193.22	242.6	NULL	1216.13	54.25	17.62	3871.04	333.34	2965.54	28411.11	131.48	120.91	NULL	8.1	67.13	12.51	164.11	23.06	86.48	146.2	115.64	NULL	NULL
ST-103	Residential	ppm	41.8	68.55	33.21	589.99	29.01	6.1	3603	109.51	3041.77	32345.86	63.75	26.39	7.33	3.14	79.62	36.75	145.52	9.48	35.36	49.04	36.67	NULL	4.29
ST-104	Residential	ppm	179.33	177.05	NULL	895.89	50.11	6.82	2898.98	NULL	1375.08	18800.6	33.1	63.82	15.33	NULL	60.75	21.51	147.59	15.83	63.87	93	68.6	NULL	NULL
SAMPLE ID	Land Use	Units	Pb	Zn	Cu	Ba	Ag	Hg	Ti	Cr	Mn	Fe	Co	Ni	As	Se	Rb	Sr	Zr	Pb	Cd	Sn	Sb	W	Au
Locations with history of industrial activities																									
CCME (Industrial soils)			600	410	91			50		87			300	89	12					600	22				
ST-24	Industrial	ppm	1324.63	1646.82	313.06	3583.81	16.23	6.56	5075.58	236.9	8462.6	93725.39	NULL	55.29	178.58	NULL	111.99	167.8	99.14	NULL	3.87	NULL	49.22	NULL	6.27
ST-25	Industrial	ppm	178.18	362.39	15.67	529.58	0	NULL	3650.18	139.44	1155.86	26153.54	43.73	37.31	31.81	NULL	144.15	124.88	92.8	5.26	5.46	18.84	14.87	NULL	9.45
ST-26	Industrial	ppm	27.28	136.89	3.9	460	NULL	3.98	2386.77	108.35	353.85	18102.45	26.83	20.88	14.98	1.42	99.77	242.03	80.89	4.16	5.15	8.63	7.34	NULL	5.27
ST-27	Industrial	ppm	58.22	132.86	17.49	320.04	6.41	1.61	1795.83	63.96	471.81	16989.45	27.73	41.91	10.19	2.19	80.48	157.95	65.46	1.67	4.57	10.44	10.15	NULL	8.42
ST-28	Industrial	ppm	1870.45	1103.88	274.43	3129.06	19.84	2.6	3465.59	137.17	7599.01	80781.18	NULL	46.16	109.72	NULL	109.18	266.44	85.84	2.53	7.71	19.08	82.93	0.13	NULL
ST-29	Industrial	ppm	444.28	329.1	43.63	474.66	NULL	2.37	3727.55	NULL	2239.9	35994.65	17.22	5.73	32.14	0.06	124.74	257.65	285.31	NULL	NULL	NULL	NULL	NULL	NULL
ST-30	Industrial	ppm	2771.31	2344.26	442.83	2383.45	3.61	9.24	6545.01	266.51	26551.03	283884.19	NULL	84.29	358.63	2.59	122.83	204.16	95.45	0.43	4.05	12.65	111.47	NULL	NULL
ST-31	Industrial	ppm	1404.43	2000.52	195.41	943.51	4.9	6.47	4462.38	143.27	15433.31	89122.2	NULL	67.93	152.58	NULL	139.2	84.32	130.91	NULL	0.01	10.15	42.07	NULL	3.08
ST-32	Industrial	ppm	732.56	462.11	122.85	2388.57	13.78	4.28	2933.17	78.48	3483.46	51442.66	NULL	26.36	37.95	NULL	133.36	258.45	110.28	9.28	1.11	19.05	33.44	NULL	9.11
ST-33	Industrial	ppm	97.8	294.18	1.39	401.67	1.04	2.1	2054.17	45.77	716.07	15243.89	23.97	33.14	20.31	0.6	78.41	89.15	90.5	3.83	10.34	20.68	9.63	NULL	NULL
ST-34	Industrial	ppm	457.32	400.43	67.87	1424.15	8.32	3.7	3409.07	173.09	5476.8	50486.24	NULL	55.7	44.89	0.94	72.35	233.78	65.7	4.5	10.62	19.98	27.46	NULL	NULL
ST-35	Industrial	ppm	9110.72	2698.08	1404.41	7532.36	58.45	NULL	7677.74	390.29	31330.19	295811.81	NULL	155.45	769.58	NULL	94.56	354.4	46.49	4.52	3.99	19.73	235.25	NULL	NULL
ST-36	Industrial	ppm	2200.32	810.46	322.7	2397.11	19.66	NULL	4448.01	99.21	7085.95	84215.19	NULL	30.29	100.12	NULL	120.82	337.63	116.9	1.02	NULL	NULL	50.24	1.01	11.64
ST-37	Industrial	ppm	271.72	222.14	36.82	922.87	3.11	2.22	3580.85	65.99	1987.01	36236.37	24.4	29.4	32.88	1.22	115.46	182.01	185.81	NULL	4.69	11.2	14.98	1.05	NULL
ST-38	Industrial	ppm	267.83	213.28	16.67	535.25	3.47	2.72	1935.42	62.09	935.05	22292.55	39.32	15.47	28.42	2.38	85.2	117.94	53.89	NULL	NULL	3.49	12.02	NULL	NULL

APPENDIX 4.4.5: Analysis Results for Contaminated Land v2

Appendix 4.4.5

Table 1: Vares Processin gPlant and surrounding locations, contaminated land results (heavy metals, PAH's and pH) with comparison to BiH (for agricultural loamy soils) and CCME (for Industrial soils), with exceedances highlighted in red.

Sample Location	Land Use	Depth	As	B	Cd	Cr	Co	Cu	Pb	Hg	Ni	Zn	Total Petroleum Hydrocarbons	Sulphide	Cyanide (total)	Total Phenols	PAH	Nitrate (water-soluble)	pH
		cm	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Locations with history of industrial activities																			
CCME (Industrial soils)			**12**		**22**	**87**	**300**	**91**	**600**	**50**	**89**	**410**			**8**	**3.8**			
C-VP-01		40	61.52	27.42	3.28	61.47	22.2	216.9	1268	9.12	60	1241.7	5.05	2.58	<0.50	5.47	0.58	5.48	7.22
C-VP-02		30	392.2	38.4	9.64	63.1	26.63	412.7	7053.3	8.99	60.9	6006.7	5.73	3.22	<0.50	0.25	0.8	2.9	7.95
C-VP-03		70	102.8	28.25	3.55	109.4	40.1	121.8	1364.7	9.41	191.9	1641.7	10.14	2.67	1.02	1.05	0.62	5.28	8.37
C-VP-05		50	641.5	12.72	50.62	44.9	16.33	897.8	22313.3	0.14	40.87	22983.3	21.75	5.23	5.19	0.3	0.86	2.02	7.68
C-VP-06	Industrial: Vares Processing Plant	50	167.9	44.9	3.24	94.57	34.27	126.9	1257.7	3.32	157.3	1476.7	4.4	3.18	2.08	5.65	0.72	4.38	8.1
C-VP-07		30	212.6	17.19	29.79	38.43	16.77	716.7	13936.7	2.63	48.5	13916.7	66.11	41.5	5.21	7.25	2.1	1.81	7.43
C-VP-08		50	380	5.14	32.54	71.1	18.53	1422.8	32336.7	0.16	85.43	21916.7	6.87	3.38	4.16	5.4	1.05	1.98	7.56
C-VP-09		40	277.9	30.7	13.16	34	16.53	332	6413.3	1.97	35.37	5513.3	3.02	2.3	5.25	7.17	0.37	0.93	8.19
C-VP-10		60	132.3	65	1.86	84.3	29.07	635.7	1312	2.75	95.27	908	10.21	3.3	2.1	0.27	0.68	8.85	7.28
C-VP-11		30	118.8	42.6	21.31	72.77	26.77	1381.7	6375.8	3.17	63.83	6460	8.07	3.53	<0.50	1.12	0.84	2.08	7.35
C-VS-01		40	34.57	34	0.54	103.5	22.87	43.4	422.3	0.45	171.8	212.3	5.74	2.94	<0.50	7.46	0.2	5.2	8.03
C-VS-02	Industrial: Veovaca Open Pit	45	18.19	37.8	0.27	323.7	36.27	40.83	37.8	0.34	408.2	104.7	7.22	2.35	<0.50	7.25	0.23	9.45	7.34
C-VS-03		50	2.24	33.09	0.22	476.5	51.93	52.33	33.1	0.19	584.8	83.33	1.43	3.17	<0.50	5.56	0.23	5.49	6.07
C-VS-04		50	1.7	27.18	0.28	130.8	32.07	69.43	76.67	0.54	183.3	164.7	4.3	2.64	1.05	5.3	0.36	4.4	7.18
C-VS-05		45	11.55	64.48	0.57	113.8	20.13	68.93	256.2	1.92	127.4	322.2	11.67	4351	4.1	7.42	0.55	10.16	8
Natural Soils																			
BiH (agricultural loamy soil)			**15**	**40**	**1**	**80**	**45**	**65**	**80**	**1**	**40**	**150**					**2**		
C-VS-06	Residential	30	161	23.31	7.65	33.53	17.07	126.3	2591	7.03	33.1	3643.3	2.38	2.89	3.12	5.8	0.48	2.94	6.97
C-VS-07	Residential	50	7.24	23.71	0.23	43.6	18.8	55.57	76.33	0.2	28.87	127.2	1.03	3.05	<0.50	3.29	0.2	4.71	6.89
C-VS-08	Forestry	40	13.16	24.13	0.26	42.3	18.1	28.77	133.5	0.25	29.73	83.33	2.62	3.39	<0.50	7.38	0.28	6.79	5.7
C-VS-09	Forestry	50	6.79	22.21	0.21	38.13	12.97	13	59.03	0.21	14.17	73.5	6.22	2.34	1.04	9.72	0.46	6.44	6.11

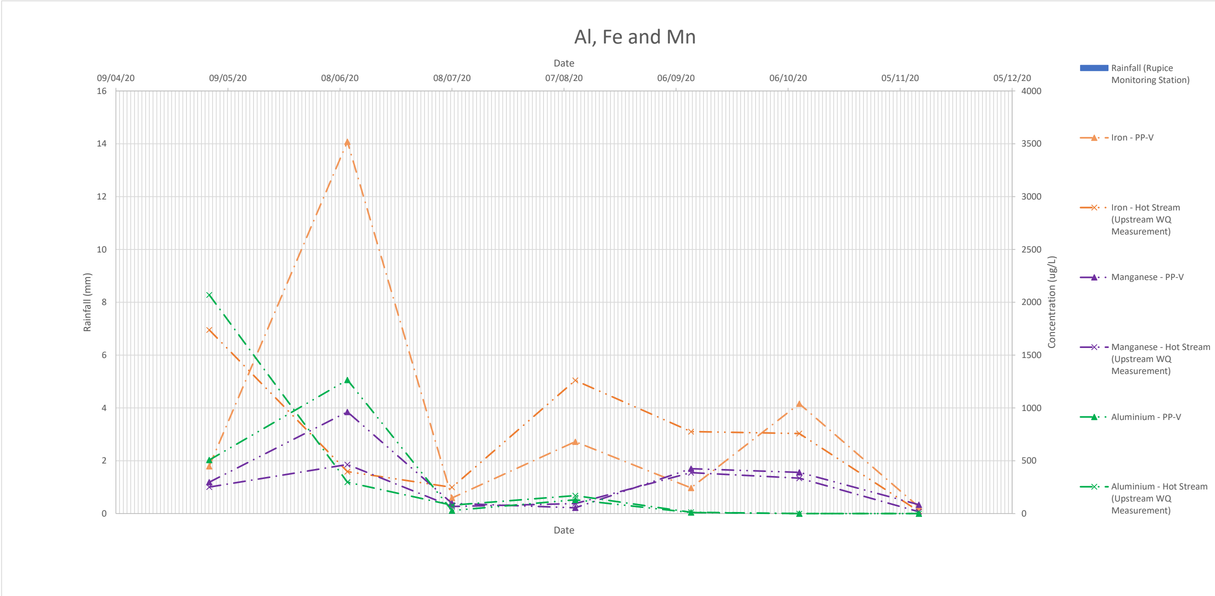
Table 2: Chemical analysis of selected haul route soil samples (nutrient availiability and heavy metals) with comparison to BiH (for agricultural loamy soils) and to CCME (for Industrial soils) with exceedances highlighted in red.

Sample Location	Land Use	Depth	As	B	Cd	Cr	Co	Cu	Pb	Hg	Ni	Zn	Fe	Tl	Availiable Mg	CEC	Exchangable Na
		cm	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg
Locations with history of industrial activities																	
CCME (Industrial soils)			**12**		**22**	**87**	**300**	**91**	**600**	**50**	**89**	**410**					
ST-25	Industrial	65	< 1	1.1	< 1	27	8.4	17.8	95.7	1.5	31	308	20777	4.2	2.21	21.35	0.07
ST-37	Industrial	65	< 1	1.9	< 1	20.3	8.5	30.7	107	27.4	26.3	169	30190	0.3	1.94	17.42	0.09
Natural Soils																	
BiH (agricultural loamy soil)			**15**	**40**	**1**	**80**	**45**	**65**	**80**	**1**	**40**	**150**					
ST-01	Forestry	50	< 1	6.5	< 1	112	24	46.5	52.9	2.1	159	194	44762	5.7	2.66	20.72	0.1
ST-12	Forestry	65	< 1	3.5	< 1	182	31.2	38.4	37	0.5	280	426	43190	3.4	2.85	23.7	0.09
ST-49	Forestry	55	< 1	1.9	< 1	19	< 2	< 2	12.2	0.8	10.4	12	18356	6.1	1.04	17.16	0.19
ST-61	Forestry	72	< 1	1.5	1.7	52.9	12.1	44.1	162	1.8	80.5	826	42654	< 0.1	1.43	44.26	0.15
ST-73	Forestry	57	< 1	1.3	< 1	34.1	12.6	40.4	47.1	5	51.5	112	22212	7.3	1.13	17.9	0.09
ST-85	Forestry	55	< 1	1.5	1.2	58.2	10.7	19.1	12.6	0.3	43.6	72.6	24370	7.6	1.51	32.49	0.14
ST-97	Forestry	70	< 1	1.2	< 1	53.8	5.7	16.3	5.6	2.1	42.3	48.6	25011	4	1.77	17.32	0.09

APPENDIX 4.5.1: Biodiversity Study Vares 19-06-21

To Be Sent Separately

APPENDIX 4.9.1: Rupice Flushing Results


Al, Fe and Mn
Date
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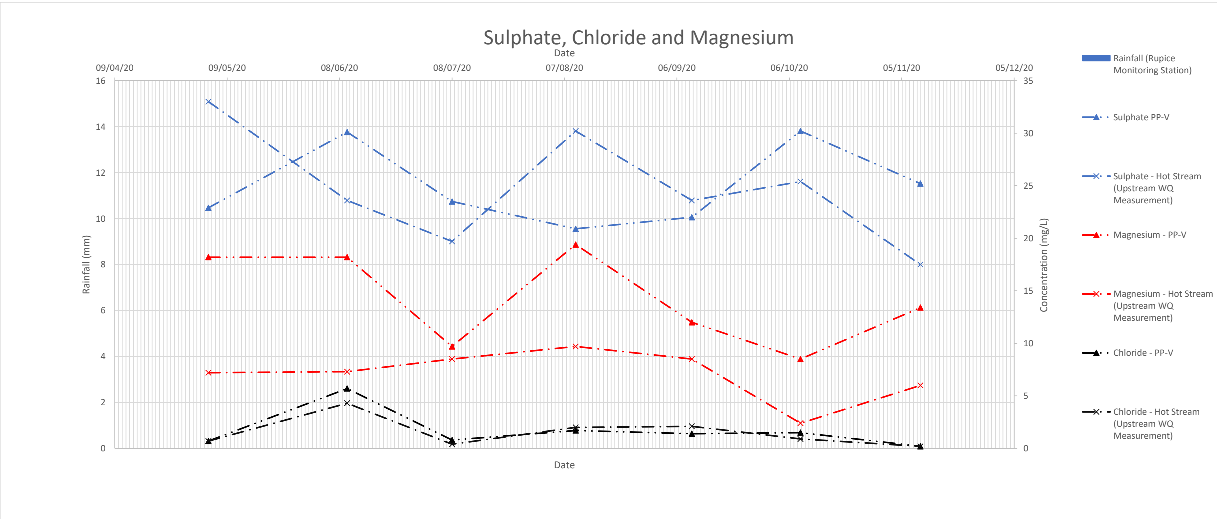
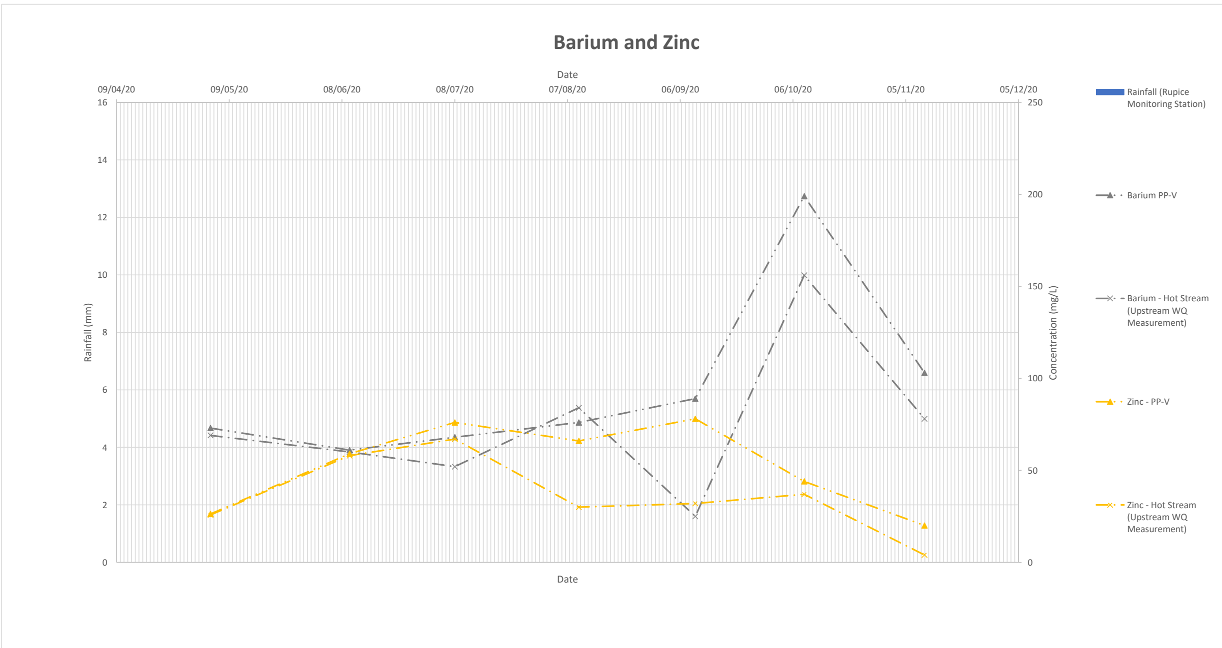
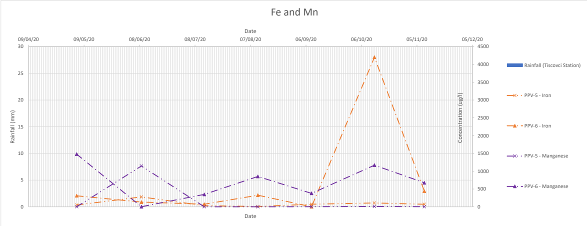
09/05/20
08/06/20
08/07/20
07/08/20
06/09/20
06/10/20
05/11/20
05/12/20
Rainfall (mm)
Concentration (ug/L)
Date
Rainfall (Rupice Monitoring Station)
Iron - PP-V
Iron - Hot Stream (Upstream WQ Measurement)
Manganese - PP-V
Manganese - Hot Stream (Upstream WQ Measurement)
Aluminium - PP-V
Aluminium - Hot Stream (Upstream WQ Measurement)

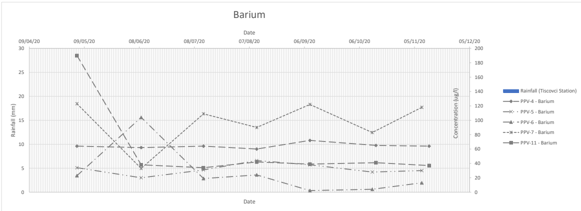

Sulphate, Chloride and Magnesium
Date
09/04/20
09/05/20
08/06/20
08/07/20
07/08/20
06/09/20
06/10/20
05/11/20
05/12/20
Rainfall (mm)
Concentration (mg/L)
Date
Rainfall (Rupice Monitoring Station)
Sulphate PP-V
Sulphate - Hot Stream (Upstream WQ Measurement)
Magnesium - PP-V
Magnesium - Hot Stream (Upstream WQ Measurement)
Chloride - PP-V
Chloride - Hot Stream (Upstream WQ Measurement)

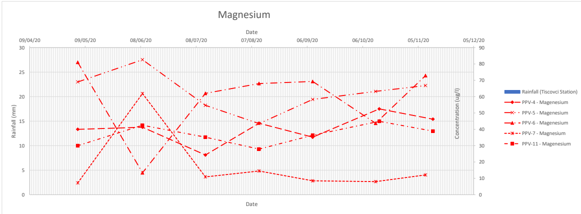

Barium and Zinc
Date
09/04/20
09/05/20
08/06/20
08/07/20
07/08/20
06/09/20
06/10/20
05/11/20
05/12/20
Rainfall (mm)
Concentration (mg/L)
Date
Rainfall (Rupice Monitoring Station)
Barium PP-V
Barium - Hot Stream (Upstream WQ Measurement)
Zinc - PP-V
Zinc - Hot Stream (Upstream WQ Measurement)

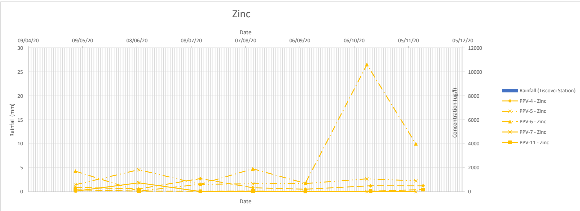
APPENDIX 4.9.2: VPP Flushing Results


Fe and Mn
Date
Rainfall (mm)
Concentration (ug/l)
Rainfall (Tiscovci Station)
PPV-5 - Iron
PPV-6 - Iron
PPV-5 - Manganese
PPV-6 - Manganese

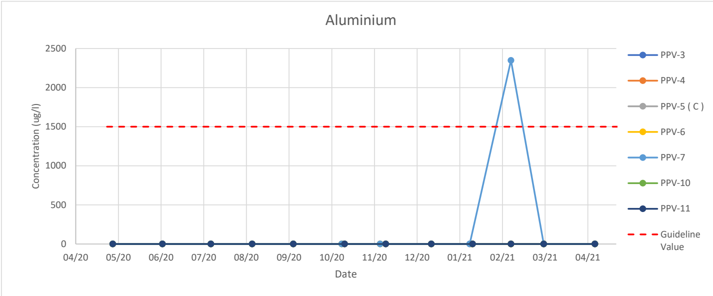
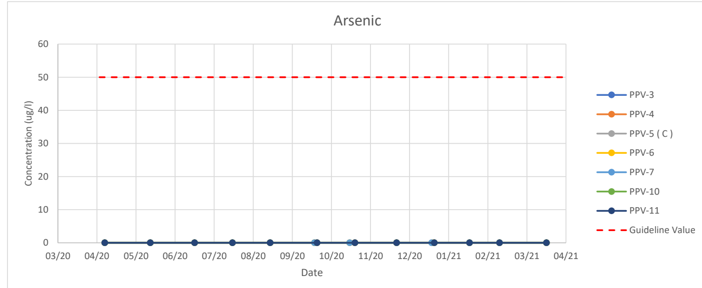
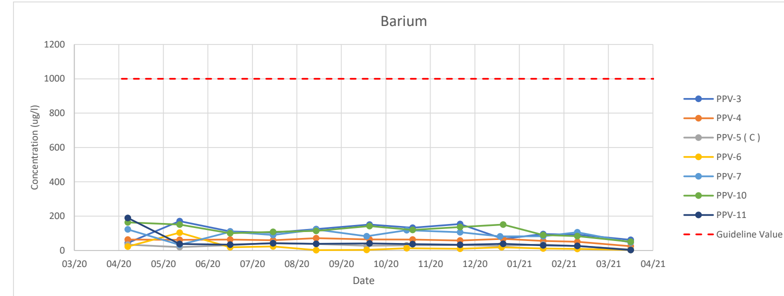
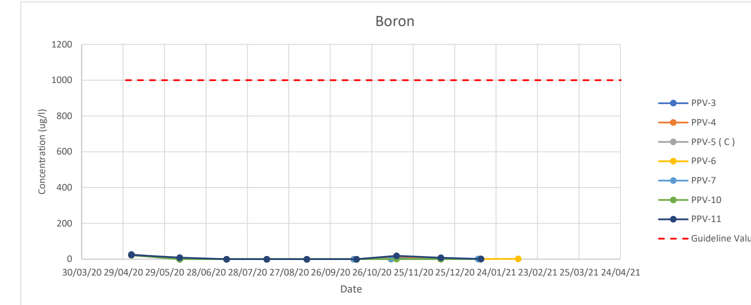
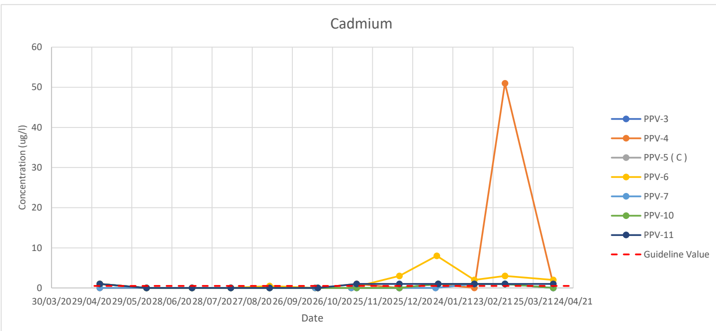
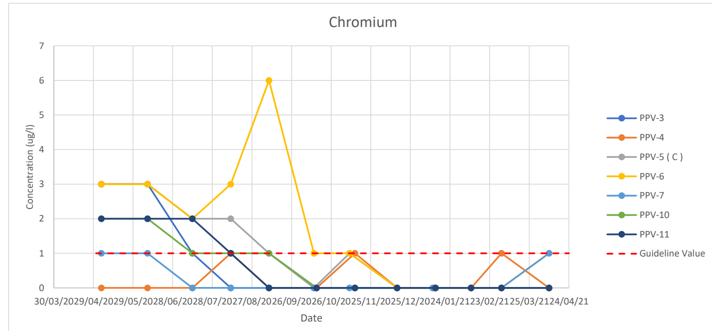
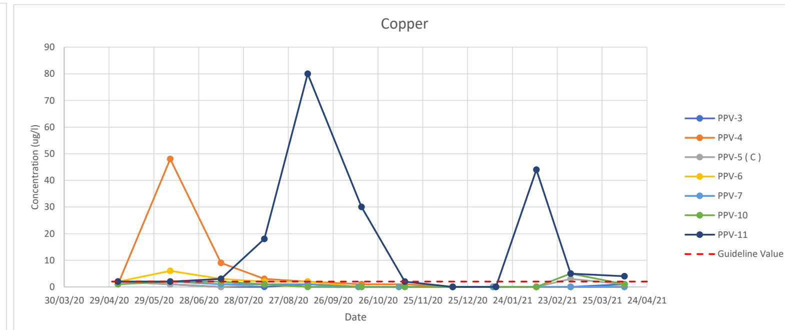
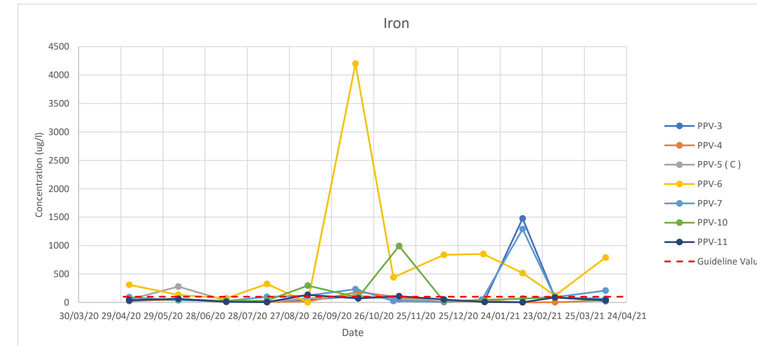
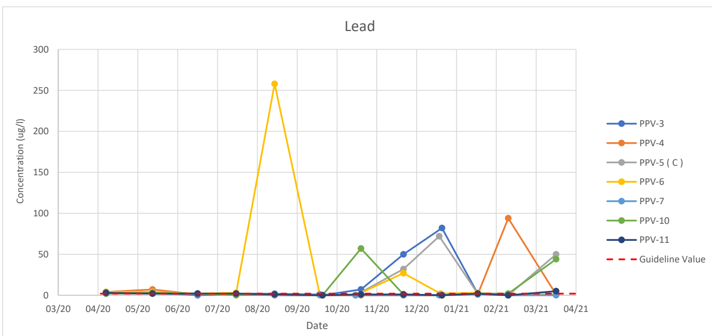
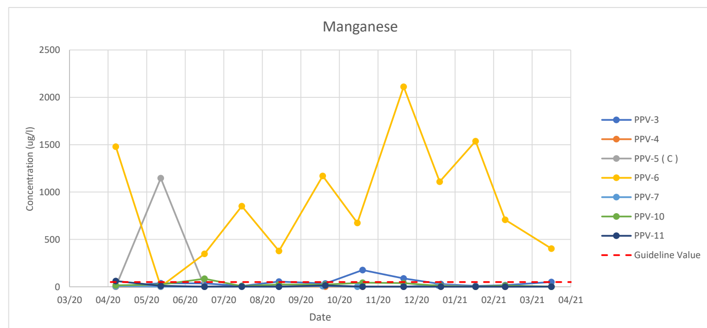
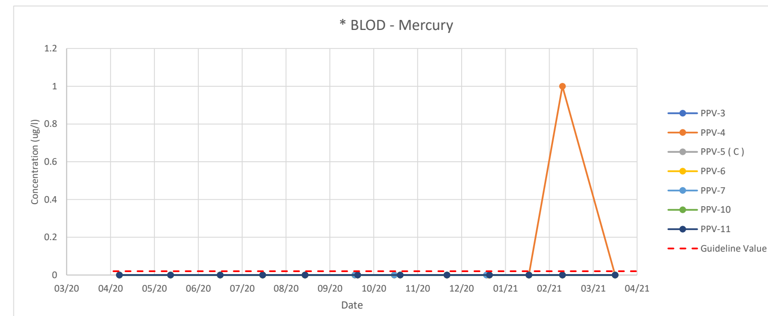
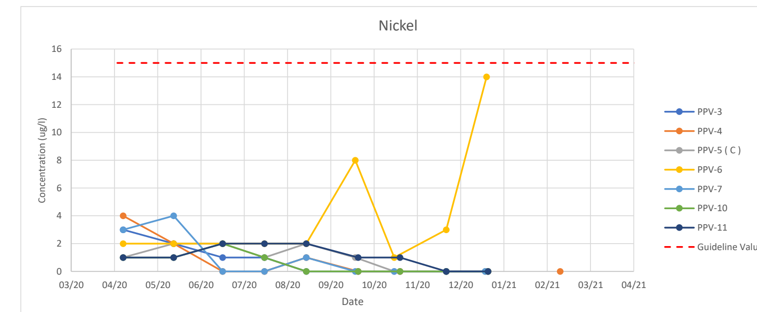
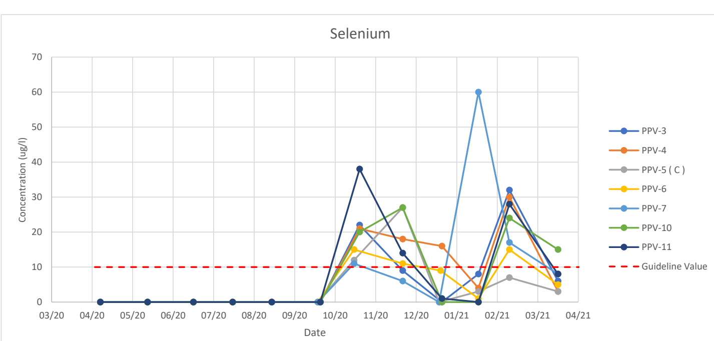
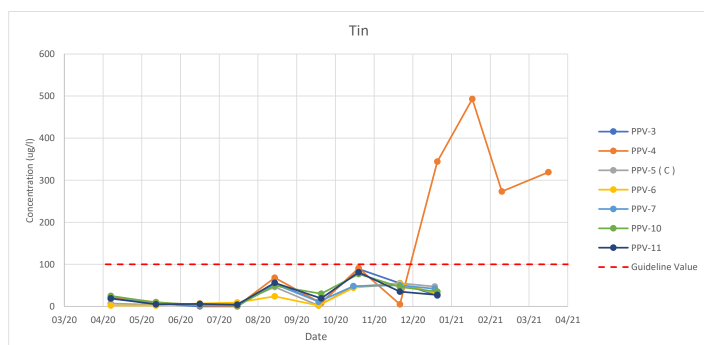
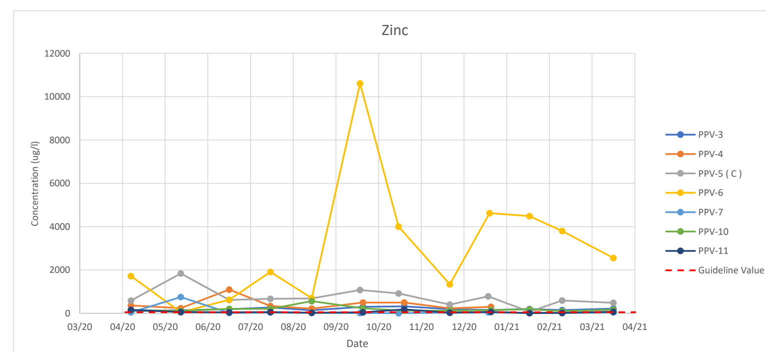
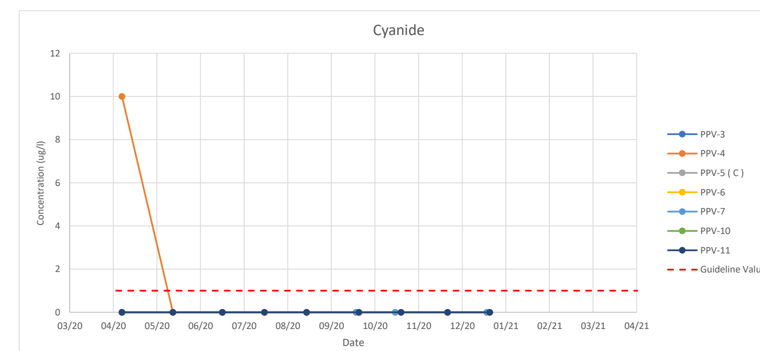
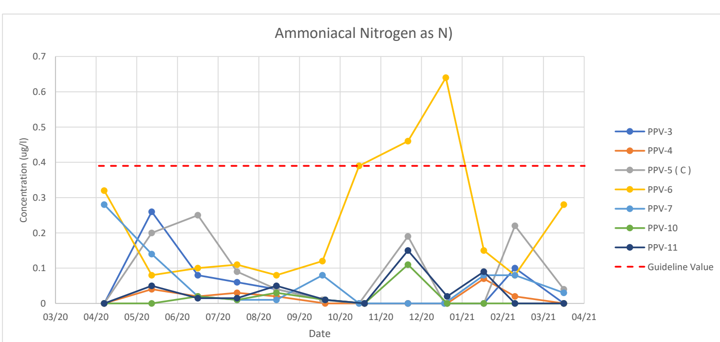
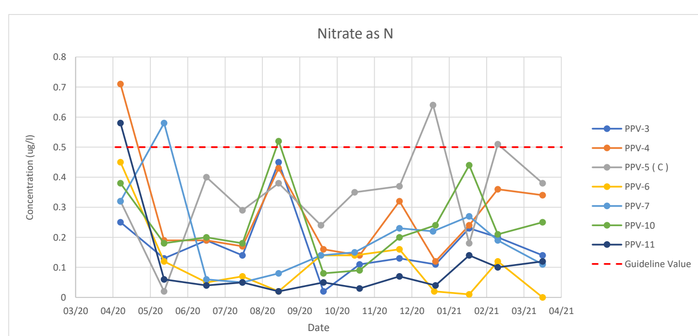

Chloride
Date
Rainfall (mm)
Concentration (ug/l)
Rainfall (Tiscovci Station)
PPV-4 - Chloride
PPV-5 - Chloride
PPV-6 - Chloride
PPV-7 - Chloride
PPV-11 - Chloride


Barium
Date
Rainfall (mm)
Concentration (ug/l)
Rainfall (Tiscovci Station)
PPV-4 - Barium
PPV-5 - Barium
PPV-6 - Barium
PPV-7 - Barium
PPV-11 - Barium

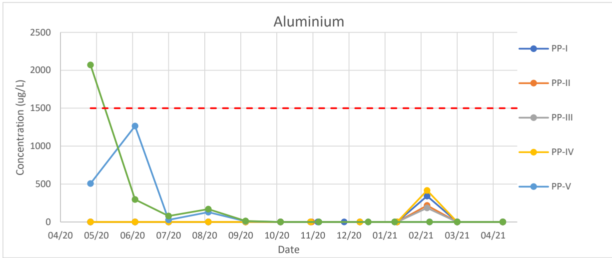

Magnesium
Date
Rainfall (mm)
Concentration (ug/l)
Rainfall (Tiscovci Station)
PPV-4 - Magenesium
PPV-5 - Magenesium
PPV-6 - Magenesium
PPV-7 - Magnesium
PPV-11 - Magenesium

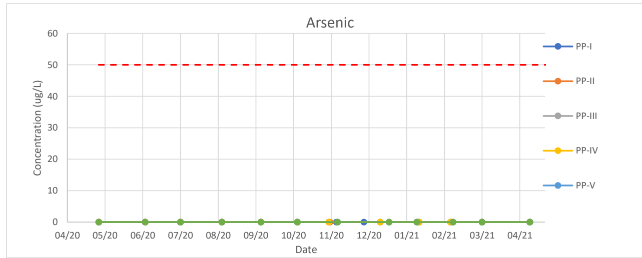

Zinc
Date
Rainfall (mm)
Concentration (ug/l)
Rainfall (Tiscovci Station)
PPV-4 - Zinc
PPV-5 - Zinc
PPV-6 - Zinc
PPV-7 - Zinc
PPV-11 - Zinc

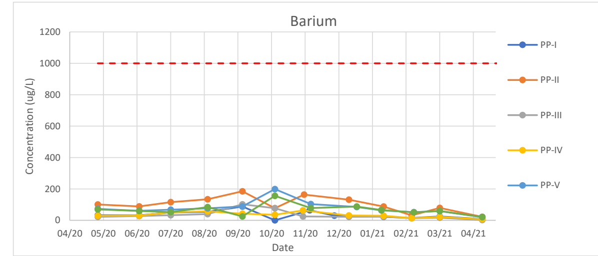
APPENDIX 4.9.3: Graphical Surface Water Quality Analytical Results for VPP

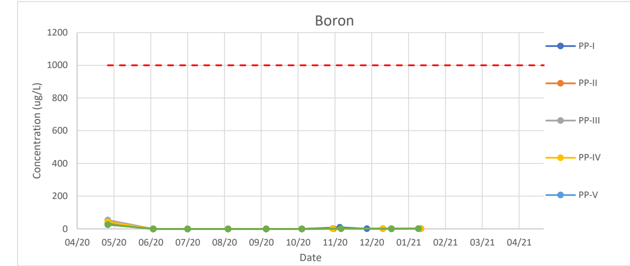

Aluminium
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Arsenic
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Barium
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Boron
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Cadmium
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Chromium
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Copper
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Iron
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Lead
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Manganese
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

* BLOD - Mercury
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Nickel
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Selenium
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Tin
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Zinc
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Cyanide
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Ammoniacal Nitrogen as N)
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

Nitrate as N
Concentration (ug/l)
Date
PPV-3
PPV-4
PPV-5 (C)
PPV-6
PPV-7
PPV-10
PPV-11
Guideline Value

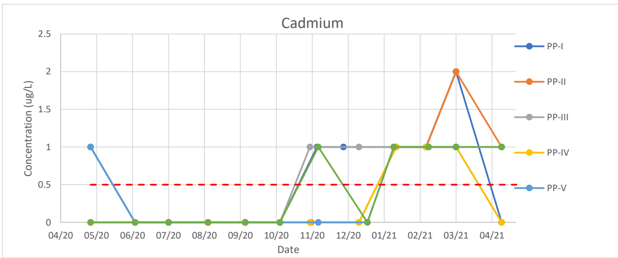
APPENDIX 4.9.4: Graphical Surface Water Quality Analytical Results for Rupice

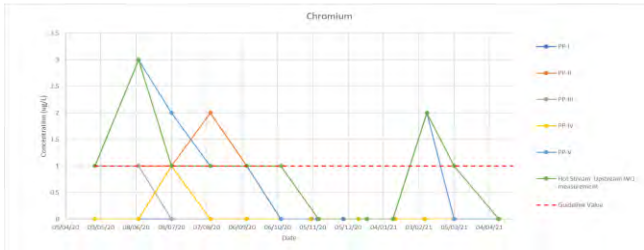

Aluminium
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV
PP-V

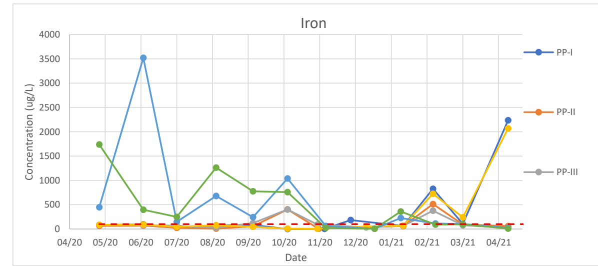

Arsenic
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV
PP-V

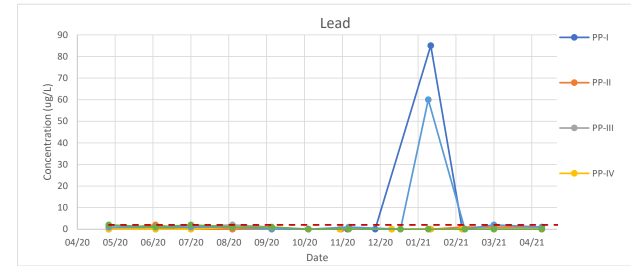

Barium
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV
PP-V

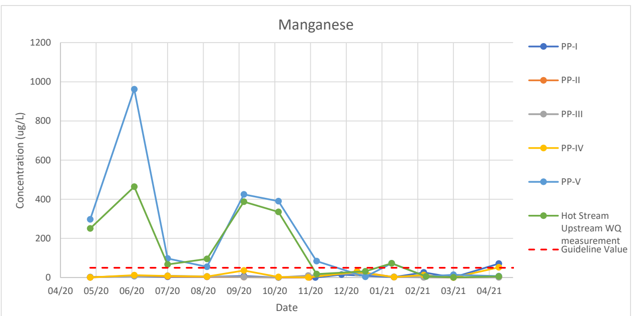

Boron
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV
PP-V

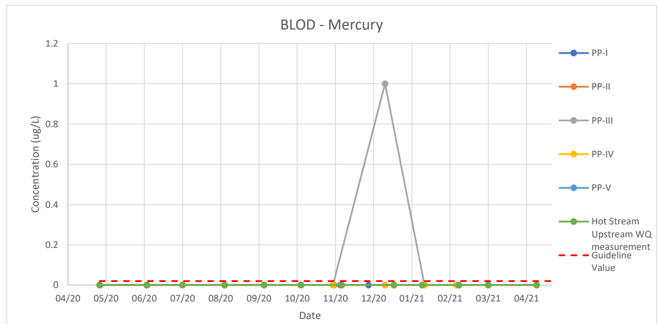

Cadmium
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV
PP-V

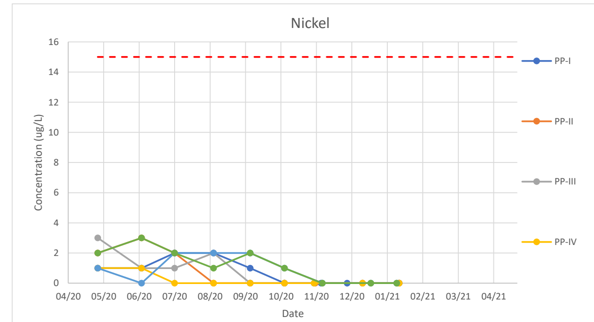

Chromium

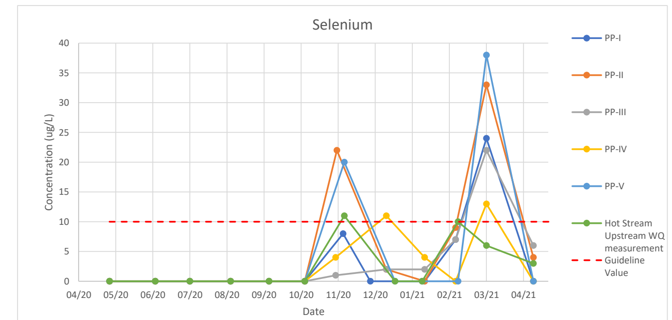

Iron
Concentration (ug/L)
Date
PP-I
PP-II
PP-III

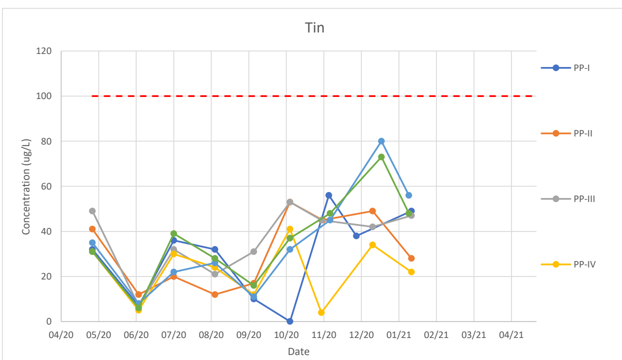

Lead
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV

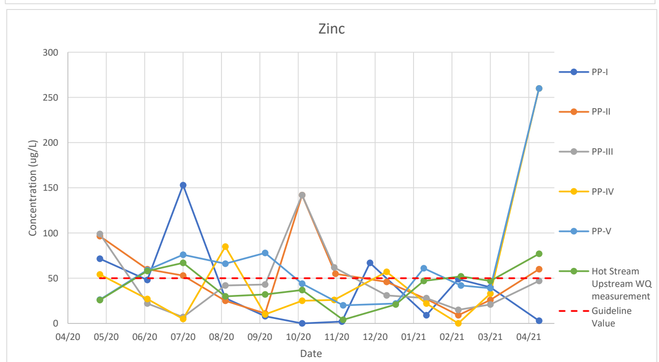

Manganese
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV
PP-V
Hot Stream Upstream WQ measurement
Guideline Value

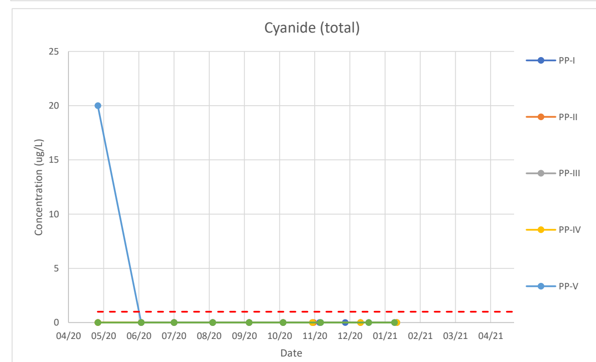

BLOD - Mercury
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV
PP-V
Hot Stream Upstream WQ measurement
Guideline Value

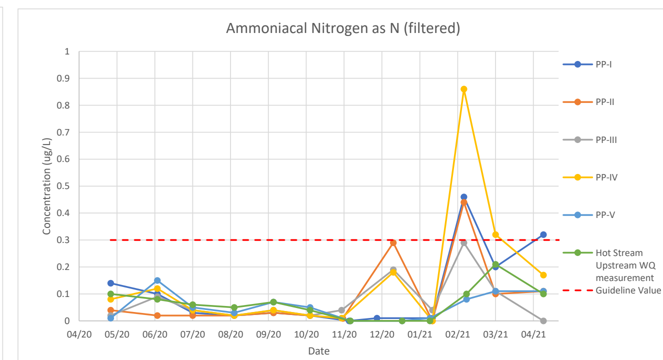

Nickel
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV

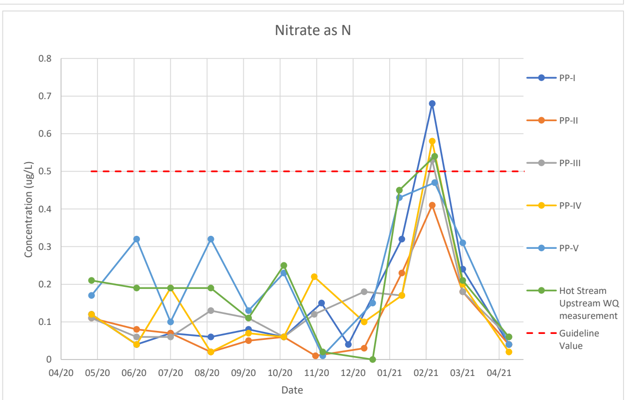

Selenium
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV
PP-V
Hot Stream Upstream WQ measurement
Guideline Value


Tin
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV

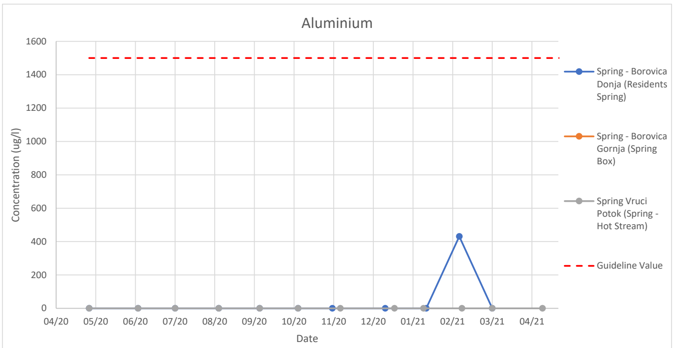
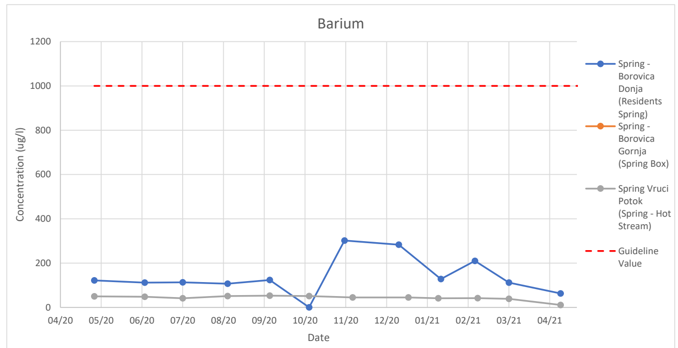
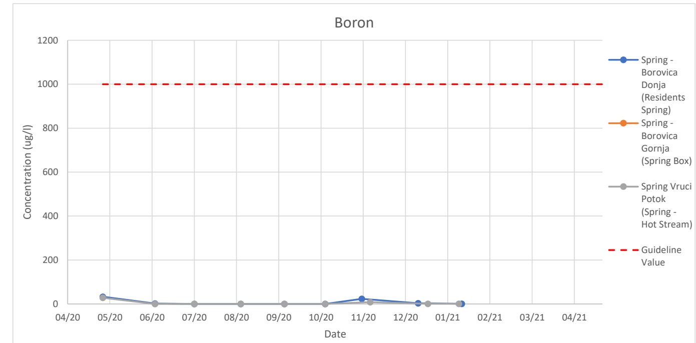
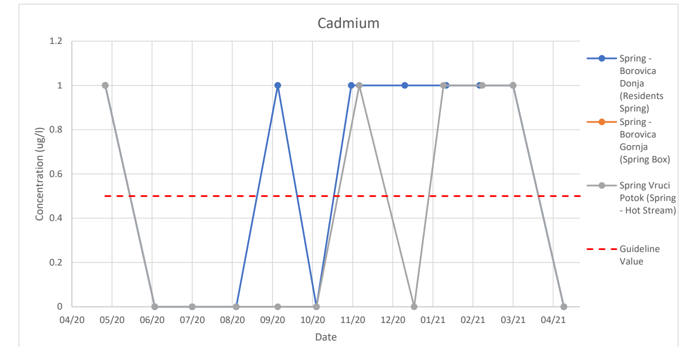
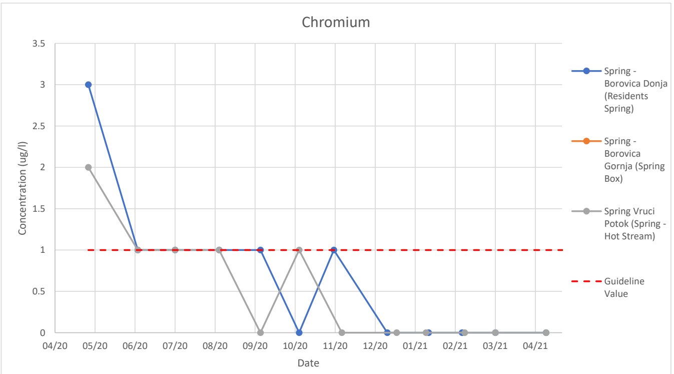
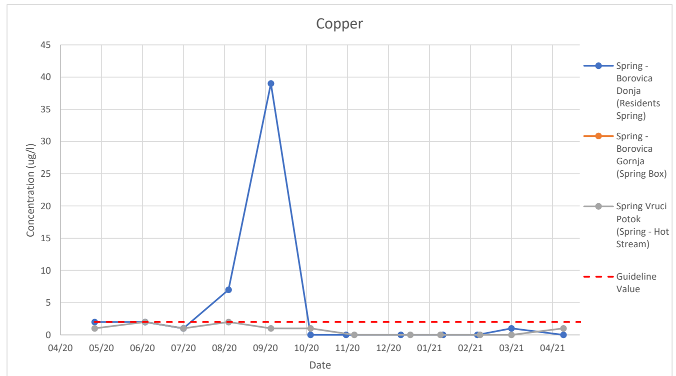
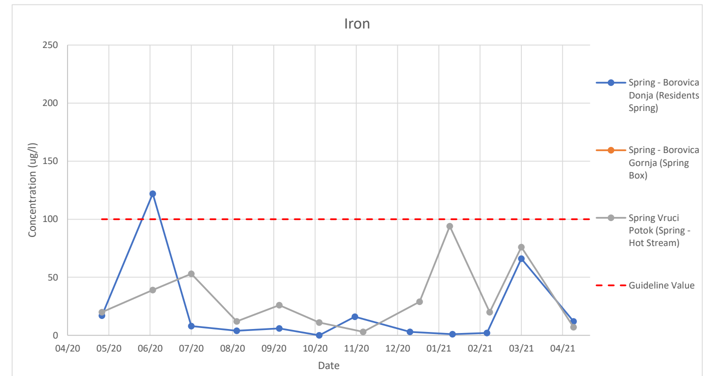
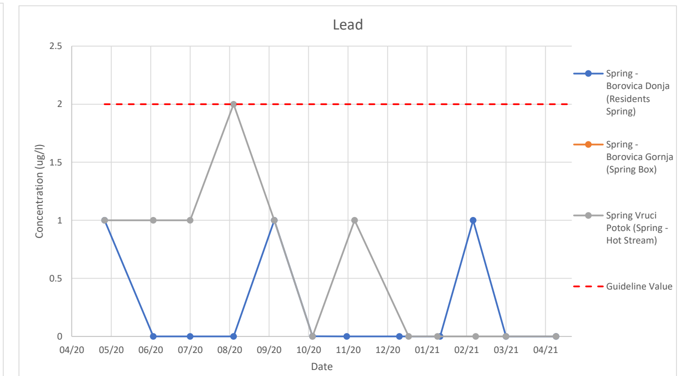
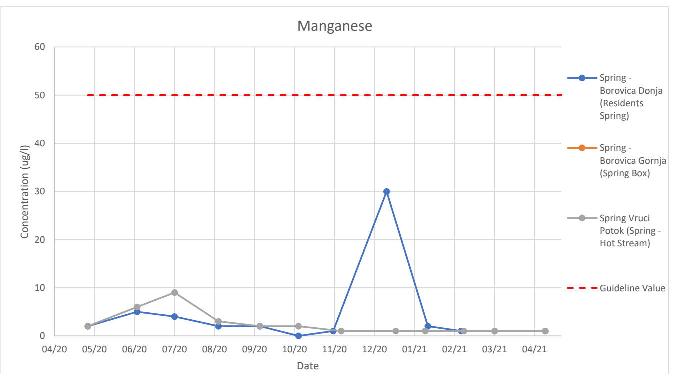
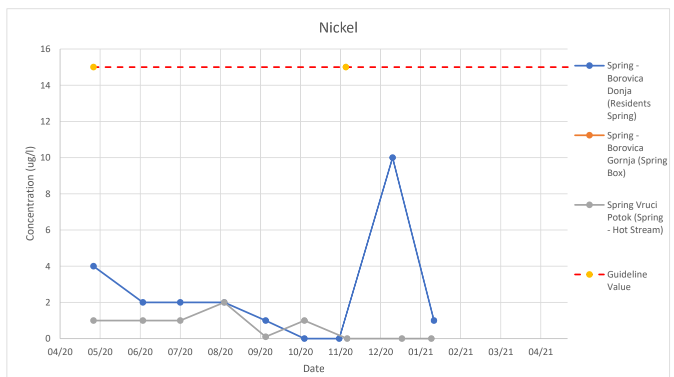
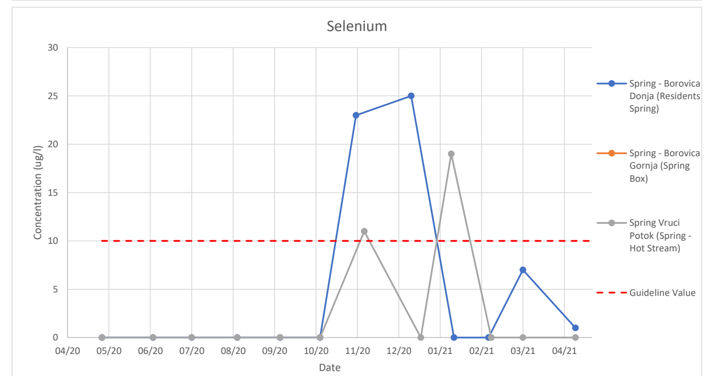
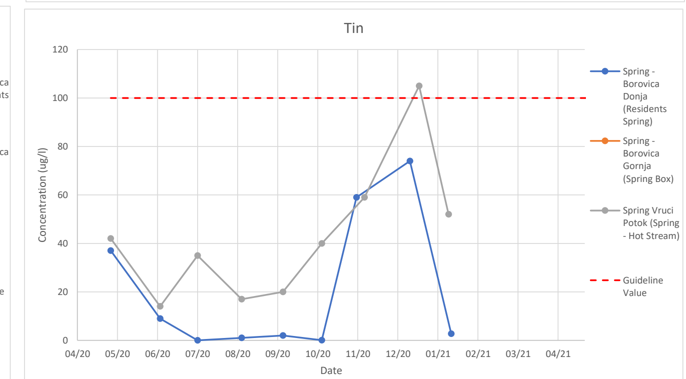
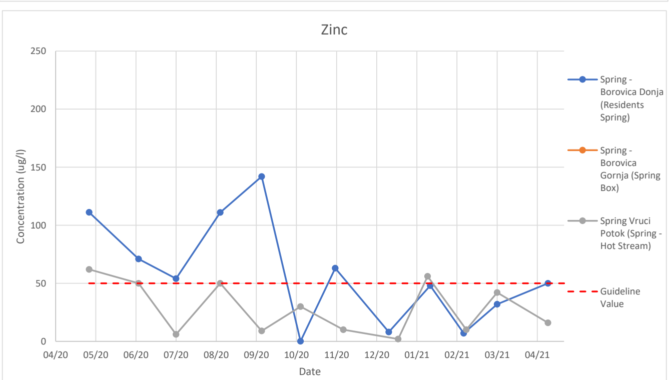
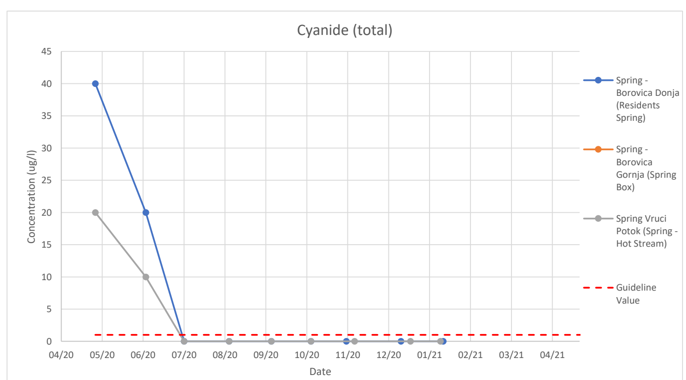
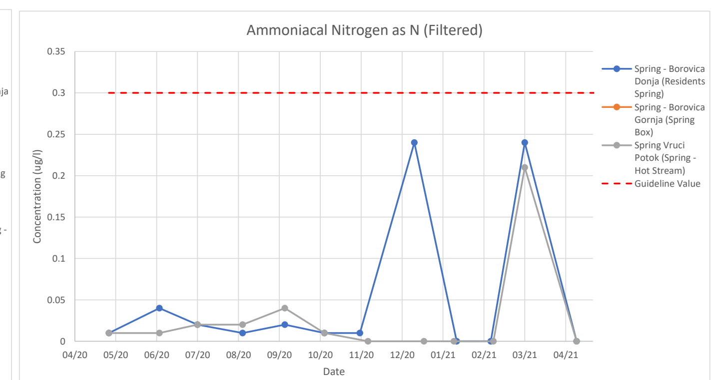
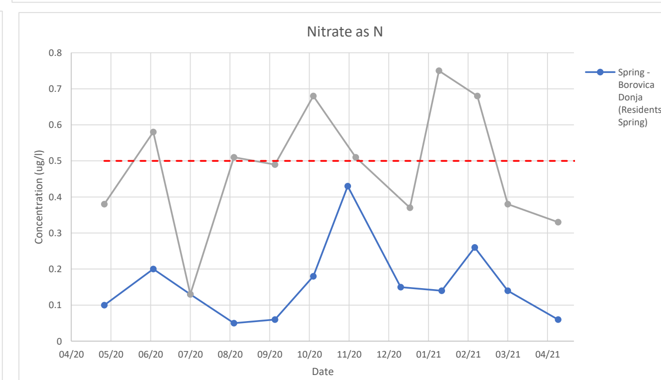

Zinc
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV
PP-V
Hot Stream Upstream WQ measurement
Guideline Value


Cyanide (total)
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV
PP-V


Ammoniacal Nitrogen as N (filtered)
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV
PP-V
Hot Stream Upstream WQ measurement
Guideline Value


Nitrate as N
Concentration (ug/L)
Date
PP-I
PP-II
PP-III
PP-IV
PP-V
Hot Stream Upstream WQ measurement
Guideline Value

APPENDIX 4.9.5: Graphical Spring Water Quality Analytical Results for Rupice


Aluminium
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Barium
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Boron
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Cadmium
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Chromium
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Copper
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Iron
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Lead
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Manganese
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Nickel
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Selenium
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Tin
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Zinc
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Cyanide (total)
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Ammoniacal Nitrogen as N (Filtered)
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)
Spring - Borovica Gornja (Spring Box)
Spring Vruci Potok (Spring - Hot Stream)
Guideline Value

Nitrate as N
Concentration (ug/l)
Date
Spring - Borovica Donja (Residents Spring)

APPENDIX 4.9.6: Conditionally Formatted Surface Water Quality Analytical Results for VPP Catchment.

Results	Units	Detection Limit	Hazardous	Guideline Value: EQS	Guideline Value: UKDWS	Bosnia Maximum Permissible Concentrations (Decree on Hazardous and Harmful Substances in Waters): I - II Class Surface Water	Bosnia Maximum Permissible Concentrations (Decree on Hazardous and Harmful Substances in Waters): III - IV Class Surface Water
Major Ions							
Ionic Balance	%	/			-	-	-
Carbonates	mg/l	/			-	-	-
Alkalinity (total as bica	mg/l	/			-	-	-
Calcium	mg/l	/		-	250	-	-
Magnesium	mg/l	/		-	50	-	-
Sodium	mg/l	0.2			200	-	-
Potasium	mg/l	0.2		-	12	-	-
Chloride	mg/l	/		250	250	-	-
Sulphate	mg/l	/		400	250	-	-
Fluoride	mg/l	0.002		-	1.5	300	1500
Phosphate	mg/l	0.001			-	-	-
Physio-Chemical Parameters							
Electrical Conductivity	µS/cm	/			2500	-	-
Total Dissolved Solids	ug/l	/			-	-	-
pH	-	/		-	-	-	-
Total Suspended Solids	ug/l	0.05			-	-	-
Nutrients							
Ammoniacal Nitrogen	mg/l	0.02		0.3	-	-	-
Ammoniacal nitrogen	mg/l	0.02		0.39	-	-	-
Nitrate as N	mg/l	0.005			50	0.5	1.5
Biochemical Oxygen De	mgO2/l	0.5			-	-	-
Minor Ions							
Aluminium	µg/l	1		-	200	1500	1500
Arsenic	µg/l	1		50	10	50	50
Barium	µg/l	10		-	1000	1000	4000
Boron	µg/l	20		-	1000	-	-
Cadmium	µg/l	0.5		0.25		0.5	5
Chromium	µg/l	6		3.4	50	1	6
Copper	µg/l	3		1	2000	2	10
Iron	µg/l	6		1000	200	100	1000
Lead	µg/l	10		1.2	10	2	80
Manganese	µg/l	2		123	50	50	1000
Mercury*	µg/l	1		0.07	1	0.02	0.1
Nickel	µg/l	3		4	20	15	30
Selenium	µg/l	1		-	10	10	10
Thallium							
Tin	µg/l	2		-	-	100	500
Zinc	µg/l	1		10.9	5000	50	80
Cyanide (total)	µg/l	/		1	50	1	100
Sulphide	µg/l	/		-	-	2	5
Total TPH	ug/l	20		-	10	-	-
Total PAH	ug/l	0.1			0.1	0.2	1

PPV-3

Results	05/05/20	09/06/20	13/07/20	11/08/20	09/09/20	15/10/20	13/11/20	15/12/20	13/01/21	09/02/21	04/03/2021	09/04/2021	06/05/2021
Major Ions													
Ionic Balance	-2.307	-4.78	-1.57	-4.55	0.70	0.82	2.82	2.47	-0.63	-3.5	-4.7	-2.56	
Carbonates	12	24	36	18	18.0	6.0	6	30	29	18	6	15	
Alkalinity (total as bica	262	195	195	165	219	236	232	195	165	238	274	213	
Calcium	102	84.1	92.1	96.1	100.0	106	114	102	86	90.2	94.1	88.1	
Magnesium	42	29.1	29.1	29.2	30.4	36.4	32.8	37.7	29.1	29.2	27.9	24.9	
Sodium	2.152	3.506	3.383	3.460	4.160	3.588	4.167	3.058	1.445	1.713	2.12	2.802	
Potasium	2.004	1.252	1.427	2.042	1.772	2.070	2.245	1.534	2.293	1.799	1.413	1.459	
Chloride	2.8	2.8	2.85	3.9	3.5	2.1	0.7	2.1	2.1	0.7	4.2	2.8	
Sulphate	207	162	140	160	158	203	198	178	152	144	151	138	
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0	
Phosphate	0.006	0	0.005	0.009	0.003	0.001	0.002	0	0.008	0	0.003	0.002	
Physio-Chemical Parameters													
Electrical Conductivity	728	670	665	764	740	715	735	699	598	601	630	573	
Total Dissolved Solids	589	477	482	469	502	518	556	508	486	436	480	421	
pH	8.34	8.38	8.39	8.42	8.37	8.36	8.37	8.39	8.35	8.34	8.33	8.35	
Total Suspended Solids	1.1	0.5	0.35	0.40	0.30	0.80	0.4	0.5	3.5	16	0.6	0.8	
Nutrients													
Ammoniacal Nitrogen	0	0.22	0.04	0.04	0.04	0.010	0	0	0	0	0.08	0	
Ammoniacal nitrogen	0	0.26	0.08	0.06	0.04	0.010	0	0	0	0	0.1	0	
Nitrate as N	0.25	0.13	0.19	0.14	0.45	0.020	0.11	0.13	0.11	0.23	0.2	0.14	
Biochemical Oxygen De	5.02	1.24	1.85	1.70	1.90	1.70	1.5	1.6	1.7				
Minor Ions													
Aluminium	0	0	0	0	0	0	0	0	0	0	0	0	
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0	
Barium	44	171	111	104	125	151	133	154	68	96	93	62	
Boron	27	0	0	0	0	0	6	1	1				
Cadmium	1	0	0	0	0	0	0	0	1	1	1	0	
Chromium	3	3	1	0	0	0	0	0	0	0	0	0	
Copper	2	1	0	0	1	0	0	0	0	0	0	1	
Iron	24	56	22	8	47	113	58	9	35	1478	88	61	
Lead	2	3	0	1	0	0	7	50	82	2	0	1	
Manganese	2	38	36	9	55	35	177	88	29	9	18	51	
Mercury*	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Nickel	3	2	1	1	0	0	0	0	0				
Selenium	0	0	0	0	0	0	22	9	0	8	32	6	
Thallium													
Tin	19	6	0	0	55	9	89	55	26				
Zinc	99.8	142	192	270	137	299	320	190	153	200	144	217	
Cyanide (total)	0	0	0	0	0	0	0	0	0				
Sulphide	0	0	0	0	0	0	0	0	0				
Total TPH	<20	<20		<20			<20						
Total PAH	<0,10	<0,10		<0,10			<0,10						

PPV-4

Results	05/05/20	09/06/20	13/07/20	11/08/20	09/09/20	15/10/20	13/11/20	15/12/20	13/01/21	09/02/21	04/03/2021	09/04/2021
Major Ions												
Ionic Balance	-4.35	3.26	-0.8	4.74	-0.19	1.79	4.04	3.57	3.66	3	1.2	-0.194
Carbonates	36	36	30	6	12.0	12.0	6	18	35	18	18	12
Alkalinity (total as bica	226	183	220	250	256	238	250	238	177	189	207	238
Calcium	120	98.2	122	100	118	120	121	112	102	101	99.2	94
Magnesium	40	41.3	24.3	43.7	35.2	52.5	46.2	53.5	37.6	36.4	38.3	35.2
Sodium	2.79	3.4	1.995	2.461	3.201	3.119	2.149	1.989	1.615	1.318	1.691	2.016
Potasium	1.548	1.304	1.295	2.147	1.761	2.073	1.905	1.604	2.367	1.891	1.172	1.676
Chloride	2.8	4.6	2.8	3.2	3.9	3.2	1.7	3.9	2.8	0.6	3.5	2.7
Sulphate	253	173	175	172	205	275	233	231	172	189	187	174
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0
Phosphate	0.004	0	0.006	0.011	0.008	0.001	0.007	0.002	0.007	0	0.004	0.002
Physio-Chemical Parameters												
Electrical Conductivity	786	773	736	680	778	770	845	815	724	689	706	663
Total Dissolved Solids	648	605	569	572	580	658	525	630	628	542	592	556
pH	8.37	8.41	8.37	8.33	8.35	8.34	8.33	8.36	8.37	8.36	8.35	8.34
Total Suspended Solids	0.9	0.65	0.2	0.25	0.30	0.50	0.4	0.7	2.8	14.5	0.4	1
Nutrients												
Ammoniacal Nitrogen	0	0.03	0.02	0.02	0.01	0.00	0	0	0	0.07	0.02	0
Ammoniacal nitrogen	0	0.04	0.02	0.03	0.02	0.00	0	0	0	0.07	0.02	0
Nitrate as N	0.71	0.19	0.19	0.17	0.43	0.16	0.14	0.32	0.12	0.24	0.36	0.34
Biochemical Oxygen De	5.49	0.88	1.8	1.65	1.80	1.65	1.55	1.4	1.5			
Minor Ions												
Aluminium	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0
Barium	64	62	64	60	72	65	64	58	68	56	51	25
Boron	25	5	0	0	0	0	16	1	1			
Cadmium	0	0	0	0	0	0	1	0	1	0	51	1
Chromium	0	0	0	1	0	0	1	0	0	0	1	0
Copper	1	48	9	3	2	1	1	0	0	0	0	0
Iron	41	40	15	6	17	183	93	8	29	2	2	36
Lead	4	7	1	1	1	0	0	0	0	1	94	1
Manganese	2	2	1	2	3	2	1	1	1	1	0	1
Mercury*	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1
Nickel	4	2	0	0	1	0	0	0	0	0	<1	
Selenium	0	0	0	0	0	0	21	18	16	4	30	3
Thallium												
Tin	23	10	2	1	68	8	91	5	344	493	273	319
Zinc	365	234	1095	337	215	498	495	227	297			
Cyanide (total)	10	0	0	0	0	0	0	0	0			
Sulphide	0	0	0	0	0	0	0	0	0			
Total TPH	<20	<20		<20			<20					
Total PAH	<0,10	<0,10		<0,10			<0,10					

PPV-5 (C)

Results	05/05/20	09/06/20	13/07/20	11/08/20	09/09/20	13/10/20	09/11/20	15/12/20	11/01/21	09/02/21	04/03/2021	09/04/2021
Major Ions												
Ionic Balance	-1.013	-2.69	-3.87	-2.39	0.34	0.39	-0.19	-0.71	4.79	0.31	-2.35	-1.4
Carbonates	24	6	30	0	0.00	0.00	18	0	0	0	0	9
Alkalinity (total as bica	232	201	226	293	280	220	244	311	285	274	287	232
Calcium	146	140	130	128	140	114	156	140	135	116	130	120
Magnesium	69	82.6	54.7	43.5	58.3	63.2	66.8	36.4	41	55.9	55.9	55.3
Sodium	2.643	1.46	1.438	1.585	2.171	2.453	1.962	1.342	1.584	1.173	1.174	1.601
Potasium	1.501	2.346	1.266	1.803	1.637	1.808	2.013	1.635	2.157	1.778	1.194	1.429
Chloride	2.8	4.5	2.9	2.5	2.1	4.6	0.5	2.5	2.4	1.6	4.9	4.2
Sulphate	417	531	344	273	344	346	425	243	219	282	328	322
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0
Phosphate	0	0.008	0.008	0.005	0.002	0.001	0	0.008	0	0	0.025	0.003
Physio-Chemical Parameters												
Electrical Conductivity	1033	1120	975	940	1030	872	1060	1054	994	873	947	891
Total Dissolved Solids	880	940	784	732	810	740	1040	873	865	717	840	805
pH	8.41	8.35	8.33	8.10	8.17	8.20	8.37	8.11	8.09	7.87	8.08	8.33
Total Suspended Solids	1.4	6.3	0.5	0.70	0.50	0.60	0.3	0.6	0.4	12	0.1	0.9
Nutrients												
Ammoniacal Nitrogen	0	0.15	0.02	0.05	0.03	0.01	0	0.17	0	0	0.2	0.04
Ammoniacal nitrogen	0	0.2	0.25	0.09	0.04	0.01	0	0.19	0	0	0.22	0.04
Nitrate as N	0.32	0.02	0.4	0.29	0.38	0.24	0.35	0.37	0.64	0.18	0.51	0.38
Biochemical Oxygen De	4.98	0.95	1.3	1.40	1.55	1.70	1.9	1.85	1.5			
Minor Ions												
Aluminium	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0
Barium	34	20	31	44	38	28	30	32	27	35	25	6
Boron	22	0	0	0	0	0	1	1	1			
Cadmium	1	0	0	0	0	0	0	0	0	1	1	0
Chromium	3	3	2	2	1	0	1	0	0	0	0	0
Copper	2	1	0	1	0	0	0	0	0	0	3	1
Iron	51	278	32	9	73	108	72	4	49	62	98	17
Lead	4	4	2	1	0	0	0	32	72	2	0	50
Manganese	2	1147	2	1	3	10	3	2	20	1	1	1
Mercury*	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	1	2	2	1	2	1	0	0	0			
Selenium	0	0	0	0	0	0	12	27	0	3	7	3
Thallium												
Tin	7	4	5	7	46	2	47	55	47			
Zinc	586	1838	620	667	686	1075	914	400	781	70	594	484
Cyanide (total)	0	0	0	0	0	0	0	0	0			
Sulphide	0	0	0	0	0	0	0	0	0			
Total TPH	<20	<20		<20			<20					
Total PAH	<0,10	<0,10		<0,10			<0,10					

PPV-6

Results	05/05/20	09/06/20	13/07/20	11/08/20	09/09/20	13/10/20	09/11/20	15/12/20	12/01/21	09/02/21	04/03/2021	09/04/2021
Major Ions												
Ionic Balance	-2.308	3.66	-4.64	-4.55	2.02	-1.95	0.12	4.73	1.65	0.07	-3.83	2.75
Carbonates	24	24	36	0	36.0	0.00	0	0	0	0	0	0
Alkalinity (total as bica	165	156	219	256	122	116	238	254	226	152	305	225
Calcium	150	54.1	125	120	121	110	140	150	134	122	142	122
Magnesium	81	13.4	62	68.0	69.3	43.7	72.9	87	82.6	85	83.8	74.1
Sodium	2.294	2.55	0.909	0.589	1.411	0.645	0.932	0.72	0.798	0.744	0.764	1.06
Potasium	2.583	0.481	2.014	2.712	2.496	2.197	2.522	1.462	2.605	2.216	1.831	2.158
Chloride	1.7	3.6	2.5	2.8	1.2	1.1	0.3	2.1	1	0.8	2.8	4
Sulphate	548	17	369	409	392	376	439	440	452	511	485	376
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0
Phosphate	0	0	0.002	0.009	0.003	0.007	0.006	0.005	0.002	0	0.006	0.002
Physio-Chemical Parameters												
Electrical Conductivity	1140	298	990	1146	1040	890	1030	1253	1120	1030	1131	958
Total Dissolved Solids	962	208	806	841	730	710	1020	1118	1007	998	1109	899
pH	8.33	8.37	8.42	8.06	8.43	6.83	7.88	7.64	7.56	7.29	7.87	7.83
Total Suspended Solids	3.85	1.7	2.65	35.6	25.4	20.3	17	51	35	12.5	0.8	12.5
Nutrients												
Ammoniacal Nitrogen	0.25	0.05	0.06	0.07	0.06	0.08	0.25	0.34	0.52	0.19	0.05	0.3
Ammoniacal nitrogen	0.32	0.08	0.1	0.11	0.08	0.12	0.39	0.46	0.64	0.15	0.08	0.28
Nitrate as N	0.45	0.12	0.05	0.07	0.02	0.14	0.14	0.16	0.02	0.01	0.12	0
Biochemical Oxygen De	5.66	1.1	1.25	1.30	1.80	2.00	1.9	2.1	1.75			
Minor Ions												
Aluminium	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0
Barium	23	104	19	24	2	4	13	10	19	12	9	4
Boron	22	0	0	0	0	0	1	1	1	2		
Cadmium	1	0	0	0	1	0	0	3	8	2	3	2
Chromium	3	3	2	3	6	1	1	0	0	0	0	1
Copper	2	6	3	2	2	0	0	0	0	0	0	0
Iron	310	133	73	325	1	4200	440	837	853	515	122	790
Lead	4	4	2	3	258	1	0	27	2	3	0	1
Manganese	1480	3	348	852	378	1170	675	2112	1110	1538	708	403
Mercury*	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	2	2	2	2	2	8	1	3	14			
Selenium	0	0	0	0	0	0	15	11	9	1	15	5
Thallium										12	13	21
Tin	2	2	7	9	24	2	44	54	31			
Zinc	1719	50	625	1911	701	10610	4003	1336	4622	4486	3795	2548
Cyanide (total)	0	0	0	0	0	0	0	0	0			
Sulphide	0	0	0	0	0	0	0	0	0			
Total TPH	<20	<20		<20			<20					
Total PAH	<0,10	<0,10		<0,10			<0,10					

PPV-7

Results	05/05/20	09/06/20	13/07/20	11/08/20	09/09/20	13/10/20	09/11/20	15/12/20	11/01/21	09/02/21	04/03/2021	09/04/2021
Major Ions												
Ionic Balance	-4.97	-0.359	-4.82	-1.74	-4.95	-2.81	3.85	4.62	2.76	-0.08	-4.70	-2.74
Carbonates	18	12	36	18	12.0	6.00	18	36.0	0.00	0.00	0.00	0.00
Alkalinity (total as bica	171	250	158	201	232	146	165	115	165	122	221	161
Calcium	60	132	60	56.0	70.1	44.1	68.1	58.0	50.0	34.0	58.2	42.0
Magnesium	7.2	61.9	10.9	14.5	8.50	8.00	12.1	12.9	8.5	7.3	9.7	9.7
Sodium	1.378	2.39	1.664	2.188	2.763	1.417	1.285	1.631	1.359	0.928	1.165	1.374
Potasium	0.6328	1.214	0.505	0.883	0.682	0.853	0.706	0.487	1.023	1.326	0.647	0.506
Chloride	2.1	4.9	2.1	2.8	2.1	1.4	0.2	2.0	0.35	0.10	2.1	2.1
Sulphate	26.9	347	25.3	13.2	25.0	22.6	33	26.0	18.7	17.0	21.5	20.6
Fluoride	0	0	0	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0.00
Phosphate	0.005	0.008	0.005	0.010	0.007	0.009	0.002	0.017	0.004	0.010	0.009	0.010
Physio-Chemical Parameters												
Electrical Conductivity	305	1010	355	322	380	251	373	361	289	202	327	264
Total Dissolved Solids	240	807	281	221	244	210	307	212	255	186	240	244
pH	8.35	8.34	8.36	8.41	8.44	8.36	8.41	8.39	8.16	7.78	8.21	8.12
Total Suspended Solids	1.1	0.4	1.1	0.50	0.60	0.60	0.3	0.5	6.5	112	1	20.2
Nutrients												
Ammoniacal Nitrogen	0.22	0.1	0.02	0.01	0.01	0.04	0	0	0	0.12	0.06	0.04
Ammoniacal nitrogen	0.28	0.14	0.02	0.01	0.01	0.08	0	0	0	0.08	0.08	0.03
Nitrate as N	0.32	0.58	0.06	0.05	0.08	0.14	0.15	0.23	0.22	0.27	0.19	0.11
Biochemical Oxygen De	5.05	0.9	1.45	1.55	1.30	1.60	1.7	1.45	1.6			
Minor Ions												
Aluminium	0	0	0	0	0	0	0	0	0	2349	0	0
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0
Barium	123	33	109	90	122	83	118	106	82	83	106	47
Boron	23	0	0	0	0	0	1	1	1			
Cadmium	0	0	0	0	0	0	0	0	0	1	1	0
Chromium	1	1	0	0	0	0	0	0	0	0	0	1
Copper	2	2	1	1	1	0	0	0	0	0	0	0
Iron	91	37	27	97	121	232	24	9	47	1290	92	209
Lead	2	2	1	2	2	1	0	0	0	1	0	0
Manganese	6	2	1	2	2	7	1	1	13	1	1	1
Mercury*	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	3	4	0	0	1	0	0	0	0			
Selenium	0	0	0	0	0	0	11	6	0	60	17	8
Thallium												
Tin	18	7	3	4	53	11	48	50	42			
Zinc	47.1	749	20	36	17	10	9	33	49	19	10	47
Cyanide (total)	0	0	0	0	0	0	0	0	0			
Sulphide	0	0	0	0	0	0	0	0	0			
Total TPH	<20	<20		<20			<20					
Total PAH	<0,10	<0,10		<0,10			<0,10					

PPV-10

Results	05/05/20	09/06/20	13/07/20	11/08/20	09/09/20	15/10/20	13/11/20	15/12/20	13/01/21	09/02/21	########	########
Major Ions												
Ionic Balance	-2.46	0.621	-4.04	-1.58	0.67	-0.95	2.61	4.88	2.09	-1.92	-1.52	-2.5
Carbonates	36	30	48	15	30.0	6.00	12	24	42	12	12	12
Alkalinity (total as bica	171	171	159	177	189	239	214	175	146	231	220	214
Calcium	100	84.1	90.1	99.0	102.0	100	104	98.2	76	88.1	90.2	84.1
Magnesium	24	29.1	21.8	17.0	25.5	32.8	29.1	35.2	27.9	25.5	24.3	21.8
Sodium	3.008	3.612	3.366	3.462	4.979	3.412	3.473	2.993	2.325	1.755	2.324	1.374
Potasium	1.346	1.142	1.318	1.941	1.716	1.840	2.085	1.445	2.05	1.465	1.475	1.287
Chloride	2.4	3.9	3.9	3.9	2.5	2.2	0.8	3.5	3.2	1	2.7	2
Sulphate	163	133	129	155	151	185	166	166	101	126	132	116
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0
Phosphate	0	0	0	0.007	0.002	0.007	0.007	0.006	0.002	0.01	0.006	0.001
Physio-Chemical Parameters												
Electrical Conductivity	598	655	605	700	672	640	681	655	559	574	577	540
Total Dissolved Solids	484	403	437	461	491	545	562	472	499	485	456	464
pH	8.39	8.38	8.4	8.46	8.45	8.39	8.41	8.38	8.38	8.33	8.37	8.33
Total Suspended Solids	1.3	0.8	0.2	0.15	0.85	1.30	0.3	17.6	5.1	0.2	0.5	1.7
Nutrients												
Ammoniacal Nitrogen	0	0	0.02	0.01	0.03	0.01	0	0.09	0	0	0	0
Ammoniacal nitrogen	0	0	0.02	0.01	0.03	0.01	0	0.11	0	0	0	0
Nitrate as N	0.38	0.18	0.2	0.18	0.52	0.08	0.09	0.2	0.24	0.44	0.21	0.25
Biochemical Oxygen De	5.16	1.18	1.4	1.30	1.60	1.55	1.5	1.65	1.45			
Minor Ions												
Aluminium	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0
Barium	164	151	101	109	114	142	120	137	151	90	84	51
Boron	24	0	0	0	0	0	1	1	1			
Cadmium	1	0	0	0	0	0	0	0	1	1	1	0
Chromium	2	2	1	1	1	0	0	0	0	0	0	0
Copper	1	2	2	1	0	0	0	0	0	0	5	1
Iron	45	58	25	31	295	89	993	17	40	67	87	26
Lead	2	3	2	0	1	0	57	1	0	2	2	44
Manganese	16	23	85	7	25	23	43	39	9	2	13	2
Mercury*	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	1	1	2	1	0	0	0	0	0			
Selenium	0	0	0	0	0	0	20	27	0	0	24	15
Thallium												
Tin	25	9	4	2	49	30	77	46	35			
Zinc	149	107	202	204	562	231	121	119	144	185	100	164
Cyanide (total)	0	0	0	0	0	0	0	0	0			
Sulphide	0	0	0	0	0	0	0	0	0			
Total TPH	<20	<20		<20			<20					
Total PAH	<0,10	<0,10		<0,10			<0,10					

PPV-11

Results	05/05/20	09/06/20	13/07/20	11/08/20	09/09/20	15/10/20	13/11/20	15/12/20	13/01/21	09/02/21	########	########
Major Ions												
Ionic Balance	-2.808	-1.18	-4.8	-3.10	0.25	2.92	3.74	4.76	3.51	-4.35	0.04	0.02
Carbonates	30	24	54	9	12.0	5.0	18	0	41	12	0	0
Alkalinity (total as bica	195	244	194	128	256	244	231	293	146	219	256	238
Calcium	101	90.2	92	52.0	106.0	88.1	112	100	80.2	74	84.1	76
Magnesium	30	42.5	35.2	27.9	36.4	44.9	38.9	52.5	37.6	29.1	34.6	32.8
Sodium	3.011	8.512	3.008	3.853	3.617	2.761	2.139	2.223	1.557	1.798	1.751	2.488
Potasium	1.692	1.485	1.588	2.243	2.105	2.130	2.419	1.598	2.206	1.682	1.422	1.556
Chloride	2.1	3.5	3.5	3.8	4.6	0.9	0.7	2.1	2	1.7	3.4	2.2
Sulphate	184	178	161	141	179	173.0	187	179	140	131	137	128
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0
Phosphate	0.005	0	0	0.002	0.001	0.001	0.001	0.003	0.002	0.05	0.009	0.001
Physio-Chemical Parameters												
Electrical Conductivity	641	735	693	580	620	660	761	779	645	543	621	580
Total Dissolved Solids	535	560	531	575	591	550	651	582	530	494	497	446
pH	8.54	8.35	8.34	8.39	8.33	8.34	8.37	8.15	8.36	8.34	8.03	8.12
Total Suspended Solids	0.8	0.5	0.25	0.20	0.40	1.70	0.4	0.6	2	0.2	0.4	1.1
Nutrients												
Ammoniacal Nitrogen	0	0.03	0.02	0.02	0.04	0.01	0	0.15	0.02	0.09	0	0
Ammoniacal nitrogen	0	0.05	0.015	0.02	0.05	0.01	0	0.15	0.02	0.09	0	0
Nitrate as N	0.58	0.06	0.04	0.05	0.02	0.05	0.03	0.07	0.04	0.14	0.1	0.12
Biochemical Oxygen De	4.91	1.2	1.35	1.40	1.75	1.50	1.65	1.6	1.4			
Minor Ions												
Aluminium	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0
Barium	190	38	34	42	39	41	37	33	39	30	27	3
Boron	24	9	0	0	0	0	19	8	1			
Cadmium	1	0	0	0	0	0	1	1	1	1	1	1
Chromium	2	2	2	1	0	0	0	0	0	0	0	0
Copper	2	2	3	18	80	30	2	0	0	44	5	4
Iron	41	64	10	5	133	71	109	50	6	2	86	36
Lead	3	2	2	2	1	0	1	1	0	2	0	5
Manganese	61	10	2	3	2	14	2	1	1	1	2	2
Mercury*	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	1	1	2	2	2	1	1	0	0			
Selenium	0	0	0	0	0	0	38	14	1	0	28	8
Thallium												
Tin	19	5	6	4	56	19	81	35	27			
Zinc	162	55	46	57	25	47	182	23	66	9	20	68
Cyanide (total)	0	0	0	0	0	0	0	0	0			
Sulphide	0	0	0	0	0	0	0	0	0			
Total TPH	<20	<20		<20			<20					
Total PAH	<0,10	<0,10		<0,10			<0,10					

APPENDIX 4.9.7: Conditionally Formatted Surface Water Quality Analytical Results for Rupice Catchment

Results	Units	Detection Limit	Hazardous	Guideline Value		Bosnia Maximum		PP-I											
				EQS	UKDWS	I - II Class Surface Water	III - IV Class Surface Water	04/05/20	10/06/20	08/07/20	10/08/20	10/09/20	09/10/20	09/11/20	01/12/20	14/01/21	08/02/21	05/03/21	12/04/21
Major Ions																			
Ionic Balance	%	/			-	-	-	-4.93	-4.6	-3.32	-2.69	-3.64	-4.26	-1.67	4.06	-1.46	-2.06	-3.67	-2.96
Carbonates	mg/l	/			-	-	-	0	0	0	0	0.00	0.00	0	0	0	0	0	0
Alkalinity (total as bicarbonate)	mg/l	/			-	-	-	79	92	116	117	175	146	128	78	72	42.7	78	69
Calcium	mg/l	/		-	250	-	-	20	26	36	28.0	46.1	40.1	39.6	28	24	12	24	22
Magnesium	mg/l	/		-	50	-	-	4.8	2.4	2.4	6.00	6.10	4.60	2.4	2.4	0.8	2.4	3.6	1.2
Sodium	mg/l	0.2			200	-	-	1.478	2.403	1.317	2.327	2.328	1.530	1.535	1.169	1.407	0.977	1.043	1.571
Potasium	mg/l	0.2		-	12	-	-	0.329	0.287	0.471	0.724	0.418	0.614	0.479	0.4173	0.719	0.795	0.408	1.684
Chloride	mg/l	/		250	250	-	-	0.3	3.6	0.2	2.1	1.0	1.0	0.3	0.4	0.7	0.35	1.4	0.9
Sulphate	mg/l	/		400	250	-	-	14.7	7.2	14.1	6.79	11.2	12.3	10.2	11.4	8.8	6.6	16	11
Fluoride	mg/l	0.002		-	1.5	300	1500	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0
Phosphate	mg/l	0.001			-	-	-	0.001	0.008	0.042	0.004	0.001	0.002	0.006	0.011	0.006	0.04	0.008	0.01
Physio-Chemical Parameters																			
Electrical Conductivity	µS/cm	/			2500	-	-	131	150	193	205	235	207	204	136	118	70.3	136	111
Total Dissolved Solids	mg/l	/			-	-	-	104	121	156	133	181	179	136	121	116	102	116	97
pH	–	/				-	-	8.09	8.08	8.03	8.17	8.15	7.92	8.08	7.67	7.65	7.24	7.34	7.76
Total Suspended Solids	mg/l	0.05			-	-	-	1	0.55	0.3	0.20	0.80	1.20	0.5	0.65	0.9	91.5	0.2	154
Nutrients																			
Ammoniacal Nitrogen as N (filtered)	mg/l	0.02		0.3	-	-	-	0.14	0.1	0.03	0.02	0.03	0.02	0	0.01	0.01	0.46	0.2	0.32
Ammoniacal nitrogen as N	mg/l	0.02			0.39	-	-	0.14	0.14	0.04	0.02	0.07	0.02	0	0.01	0.01	0.39	0.22	0.26
Nitrate as N	mg/l	0.005			50	0.5	1.5	0.12	0.04	0.07	0.06	0.08	0.06	0.15	0.04	0.32	0.68	0.24	0.04
Biochemical Oxygen Demand (5 day incubation time)	mgO2/l	0.5			-	-	-	1.26	1.18	1.45	1.65	1.80	1.70	1.35	1.2	1.25			
Minor Ions																			
Aluminium	µg/l	1		-	200	1500	1500	0	0	0	0	0	0	0	0	0	342	0	0
Arsenic	µg/l	1		50	10	50	50	0	0	0	0	0	0	0	0	0	0	0	0
Barium	µg/l	10		-	1000	1000	4000	33	32	50	54	88	0	64	30	22	15	25	8
Boron	µg/l	20		-	1000	-	-	37	0	0	0	0	0	10	1	1			
Cadmium	µg/l	0.5		0.25	5	0.5	5	1	0	0	0	0	0	1	1	1	1	2	0
Chromium	µg/l	6		3.4	50	1	6	0	0	0	0	0	0	0	0	0	0	0	0
Copper	µg/l	3		1	2000	2	10	1	0	2	1	0	0	0	0	0	0	0	0
Iron	µg/l	6		1000	200	100	1000	82	97	27	73	82	0	2	184	63	826	104	2235
Lead	µg/l	10		1.2	10	2	80	0	0	1	0	0	0	0	0	85	0	0	0
Manganese	µg/l	2		123	50	50	1000	2	7	4	4	8	0	0	15	2	26	1	71
Mercury	µg/l	1		0.07	1	0.02	0.1	<1	<1	<1	<1	<1	<1	<1	<0.001	<1	<1	<1	<1
Nickel	µg/l	3		4	20	15	30	1	1	2	2	1	0	0	0	0			
Selenium	µg/l	1		-	10	10	10	0	0	0	0	0	0	8	0	0	7	24	0
Thallium																			
Tin	µg/l	2		-	-	100	500	32	7	36	32	10	0	56	38	49			
Zinc	µg/l	1		10.9	5000	50	80	71.6	48	153	28	8	0	2	67	9	49	40	3
Cyanide (total)	µg/l	/		1	50	1	100	0	0	0	0	0	0	0	0	0			
Sulphide	µg/l	/		-	-	2	5	0	0	0	0	0	0	0	0	0			
Total TPH	µg/l	20		-	10	-	-	<20	<20		<20			<20					
Total PAH	µg/l	0.1			0.1	0.2	1	<0,10	<0,10		<0,10			<0,10					

Results	PP-II											
	04/05/20	10/06/20	08/07/20	10/08/20	10/09/20	09/10/20	04/11/20	14/12/20	14/01/21	08/02/21	05/03/21	12/04/21
Major Ions												
Ionic Balance	-2.48	-2.7	-2.48	4.10	2.97	-4.23	1.15	0.87	-0.76	-2.5	-4.56	3.71
Carbonates	0	12	30	20	0.0	0.00	0	0	0	0	0	0
Alkalinity (total as bicarbonate)	144	122	134	114	180	128	171	146	152	61	156	116
Calcium	42	40.1	52.1	50.1	60.1	36.1	59.4	44	42	20.5	44	36
Magnesium	6	6	10.9	7.3	12.1	4.40	6	8.5	7.2	4.8	7.3	4.8
Sodium	1.162	2.104	1.078	1.631	1.907	1.968	1.4861	0.9983	1.182	0.879	0.905	1.349
Potasium	0.5023	0.368	0.692	1.007	0.781	0.552	0.931	0.5488	1.023	0.832	0.758	0.647
Chloride	0.3	2.5	0.7	0.70	1.70	1.0	0.3	0.4	1	0.15	2.1	1.6
Sulphate	19.8	12.7	25.1	18.7	41.3	16.0	31.4	23.9	13.9	25	24	7.4
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0
Phosphate	0	0.004	0.008	0.003	0.001	0.008	0.007	0.008	0.01	0.066	0.016	0.01
Physio-Chemical Parameters												
Electrical Conductivity	216	227	352	266	353	198	318	233	237	117	247	209
Total Dissolved Solids	179	145	176	164	258	165	223	168	186	127	185	170
pH	8.22	8.34	8.33	8.33	8.18	7.85	8.23	7.89	7.93	7.52	7.88	7.86
Total Suspended Solids	0.9	1.2	0.5	0.65	0.50	5.10	0.5	0.3	1.1	85	0.8	13
Nutrients												
Ammoniacal Nitrogen as N (filtered)	0.04	0.02	0.02	0.02	0.03	0.02	0.009	0.29	0	0.44	0.1	0.11
Ammoniacal nitrogen as N	0.04	0.02	0.02	0.02	0.04	0.02	0.01	0.36	0	0.4	0.14	0.14
Nitrate as N	0.11	0.08	0.07	0.02	0.05	0.06	0.01	0.03	0.23	0.41	0.18	0.04
Biochemical Oxygen Demand (5 day incubation time)	1.08	1.3	1.3	1.45	1.50	1.65	1.5	1.35	1.45			
Minor Ions												
Aluminium	0	0	0	0	0	0	0	0	0	218	0	0
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0
Barium	101	89	116	134	185	77	164	131	88	32	79	22
Boron	30	0	0	0	0	0	1	1	1			
Cadmium	0	0	0	0	0	0	0	0	1	1	2	1
Chromium	1	1	1	2	1	0	0	0	0	0	0	0
Copper	1	1	2	2	1	1	0	0	0	2	0	0
Iron	64	70	25	9	56	402	5	46	58.5	513	94	59
Lead	0	2	0	0	0	0	0	0	0	1	1	1
Manganese	1	10	6	4	2	1	1	31	2	2	0	2
Mercury	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	2	3	2	0	0	0	0	0	0			
Selenium	0	0	0	0	0	0	22	2	0	9	33	4
Thallium											14	12
Tin	41	12	20	12	17	53	45	49	28			
Zinc	96.6	60	53	25	11	142	55	46	27	9	26	60
Cyanide (total)	0	0	0	0	0	0	0	0	0			
Sulphide	0	0	0	0	0	0	0	0	0			
Total TPH	<20	<20		<20			<20					
Total PAH	<0,10	<0,10		<0,10			<0,10					

Results	PP-III											
	04/05/20	10/06/20	08/07/20	10/08/20	10/09/20	09/10/20	03/11/20	14/12/20	14/01/21	08/02/21	05/03/21	12/04/21
Major Ions												
Ionic Balance	-4.92	-4.82	-4.73	-3.28	-0.54	-4.23	-0.54	0.54	-3.72	-4.28	-4.49	-4.2
Carbonates	0	0	0	0	0.00	0.00	0	0	0	0	0	0
Alkalinity (total as bicarbonate)	79	91	134	134	165	128	158	91.5	85.4	46	87	48
Calcium	22	24	40	34.0	44.0	36.1	42	24	22	14	28.1	17
Magnesium	2.4	3.6	2.4	4.80	7.30	4.40	6.1	7.3	2.4	2.5	1.2	1.8
Sodium	2.985	2.28	1.05	2.124	2.787	1.968	1.328	1.01	1.445	0.835	0.887	1.421
Potasium	0.339	0.36	0.529	0.715	0.388	0.552	0.444	0.327	0.747	0.744	0.4	0.409
Chloride	0.7	4.3	0.35	2.1	0.8	1.0	0.6	0.3	0.7	0.15	1	2.4
Sulphate	12.5	7.1	12.8	4.21	10.8	16.0	18.9	15.5	3.1	12	11	14.6
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0
Phosphate	0.007	0.004	0.021	0.005	0.002	0.008	0.02	0.015	0.007	0.017	0.005	0.007
Physio-Chemical Parameters												
Electrical Conductivity	132	149	215	199	220	198	230	142	123	81	146	103
Total Dissolved Solids	110	119	155	127	147	165	155	117	98	114	101	118
pH	8.09	8.03	7.91	8.07	8.05	7.85	8.04	7.8	7.75	7.41	7.76	7.65
Total Suspended Solids	0.5	0.3	0.1	0.10	22.0	5.10	1	0.75	0.7	52	0	0.4
Nutrients												
Ammoniacal Nitrogen as N (filtered)	0.02	0.09	0.04	0.02	0.04	0.02	0.04	0.19	0.04	0.29	0.11	0
Ammoniacal nitrogen as N	0.02	0.2	0.06	0.02	0.06	0.02	0.04	0.23	0.06	0.25	0.11	0
Nitrate as N	0.11	0.06	0.06	0.13	0.11	0.06	0.12	0.18	0.17	0.53	0.18	0.06
Biochemical Oxygen Demand (5 day incubation time)	1.59	0.9	1.75	1.60	1.80	1.65	1.6	1.45	1.4			
Minor Ions												
Aluminium	0	0	0	0	0	0	0	0	0	185	0	0
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0
Barium	22	27	33	40	102	77	25	22	23	13	17	2
Boron	54	0	0	0	0	0	2	1	1			
Cadmium	0	0	0	0	0	0	1	1	1	1	1	0
Chromium	1	1	0	0	0	0	0	0	0	0	0	0
Copper	1	1	0	4	2	1	0	0	0	0	0	0
Iron	79	80	67	26	121	402	90	35	66	376	77	26
Lead	0	1	1	2	1	0	0	0	0	0	0	0
Manganese	1	8	9	6	2	1	10	22	4	1	1	1
Mercury	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1
Nickel	3	1	1	2	0	0	0	0	0			
Selenium	0	0	0	0	0	0	1	2	2	7	22	6
Thallium												
Tin	49	7	32	21	31	53	45	42	47			
Zinc	99	22	7	42	43	142	62	31	28	15	21	47
Cyanide (total)	0	0	0	0	0	0	0	0	0			
Sulphide	0	0	0	0	0	0	0	0	0			
Total TPH	<20	<20		<20			<20	0				
Total PAH	<0.1	<0,10		<0,10			<0,10	0				

Results	PP-IV											
	04/05/20	10/06/20	08/07/20	10/08/20	10/09/20	09/10/20	03/11/20	14/12/20	14/01/21	08/02/21	05/03/21	12/04/21
Major Ions												
Ionic Balance	-4.77	-4.76	-2.13	-4.35	-0.33	-1.28	-4.23	-0.9	-3.36	-3.6	-4.57	-3.4
Carbonates	0	0	0	0	0.00	0.00	0	0	0	0	0	0.0011
Alkalinity (total as bicarbonate)	66	79	116	119	152	140	134	97.6	61	36.6	70	61
Calcium	19	22	32	34.0	42.0	46.1	34	20	18	12	20	16
Magnesium	3	2.4	4.8	2.40	7.20	2.20	7.3	9.7	2.2	1.3	3.5	3.6
Sodium	1.302	2.51	1.678	2.643	2.075	1.278	1.873	1.273	1.521	1.101	1.245	1.737
Potasium	0.3111	0.254	0.481	0.714	0.467	0.536	0.43	0.382	0.889	0.879	0.625	1.676
Chloride	0.3	3.5	0.7	1.7	1.8	1.7	0.6	0.3	1.4	0.35	1.4	1.7
Sulphate	13.8	7.5	11.2	10.2	12.6	17.5	17.9	13.8	10.1	8.8	13.7	12
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0
Phosphate	0.002	0.005	0.008	0.004	0.002	0.013	0.016	0.014	0.008	0.076	0.019	0.014
Physio-Chemical Parameters												
Electrical Conductivity	123	144	169	182	219	211	200	150	131	63	131	107
Total Dissolved Solids	97.5	105	140	116	171	188	154	139	128	95	114	117
pH	8.01	8.03	8.02	8.18	8.07	7.86	8.05	7.79	7.68	7.25	7.75	7.75
Total Suspended Solids	0.8	0.7	0.2	0.20	0.25	0.80	0.6	0.4	1.8	134	1.1	127
Nutrients												
Ammoniacal Nitrogen as N (filtered)	0.08	0.12	0.04	0.02	0.04	0.02	0.01	0.18	0	0.86	0.32	0.17
Ammoniacal nitrogen as N	0.08	0.16	0.06	0.02	0.08	0.03	0.01	0.2	0	0.7	0.4	0.09
Nitrate as N	0.12	0.04	0.19	0.02	0.07	0.06	0.22	0.1	0.17	0.58	0.2	0.02
Biochemical Oxygen Demand (5 day incubation time)	1.5	1.2	1.8	1.60	1.45	1.60	1.7	1.55	1.5			
Minor Ions												
Aluminium	0	0	0	0	0	0	0	0	0	416	0	0
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0
Barium	29	30	51	57	42	35	63	31	29	14	22	7
Boron	43	0	0	0	0	0	1	1	1			
Cadmium	0	0	0	0	0	0	0	0	1	1	1	0
Chromium	0	0	1	0	0	0	0	0	0	0	0	0
Copper	1	1	2	1	1	0	0	0	0	0	0	1
Iron	86	94	46	76	46	8	6	52	68	723	240	2070
Lead	0	0	0	1	0	0	0	0	0	0	0	0
Manganese	1	12	8	5	36	3	1	29	2	13	0	52
Mercury	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	1	1	0	0	0	0	0	0	0			
Selenium	0	0	0	0	0	0	4	11	4	0	13	0
Thallium												
Tin	31	5	30	24	12	41	4	34	22			
Zinc	54.2	27	5	85	10	25	26	57	22	0.024	33	260
Cyanide (total)	0	0	0	0	0	0	0	0	0			
Sulphide	0	0	0	0	0	0	0	0	0			
Total TPH	<20	<20		<20			<20					
Total PAH	<0,10	<0,10		<0,10		2.0	<0,10					

Results	PP-V											
	04/05/20	10/06/20	08/07/20	10/08/20	10/09/20	09/10/20	10/11/20	21/12/20	12/01/21	10/02/21	05/03/21	12/04/21
Major Ions												
Ionic Balance	4.08	-3.91	-0.88	4.86	-4.94	-2.81	3.49	4.3	4.08	0.92	-2.87	-0.62
Carbonates	60	0	24	24	42.0	12.0	18	15	12	0	0	0
Alkalinity (total as bicarbonate)	86	220	152	155	170	189	171	195	175	164	189	183
Calcium	54	50	58.1	52.0	64.0	64.1	60.2	62.2	60	54.2	56.1	58.1
Magnesium	18.2	18.2	9.7	19.4	12.0	8.50	13.4	17	10.9	4.8	7.9	4.8
Sodium	0.9309	1.141	0.581	0.545	1.243	0.824	2.098	0.879	0.798	0.573	0.494	0.826
Potasium	0.7341	1.589	0.529	0.958	0.601	0.854	0.778	0.96	0.835	0.502	0.533	0.547
Chloride	0.7	5.7	0.8	1.7	1.4	1.5	0.2	1.4	1	0.1	1.3	0.7
Sulphate	22.9	30.1	23.5	20.9	22.0	30.2	25.2	21.8	16.4	17.1	25.7	17.5
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0
Phosphate	0.003	0.09	0.017	0.016	0.006	0.004	0.019	0.01	0.007	0.007	0.006	0.01
Physio-Chemical Parameters												
Electrical Conductivity	275	360	305	290	339	324	327	331	322	278	304	305
Total Dissolved Solids	221	288	147	161	182	246	166	238	283	243	243	216
pH	8.35	7.96	8.34	8.49	8.36	8.34	8.35	8.34	8.33	8.21	8.01	8.1
Total Suspended Solids	35	10100	43.4	42.6	35.5	110	10.9	5.5	4.2	16	0.3	0.6
Nutrients												
Ammoniacal Nitrogen as N (filtered)	0.01	0.15	0.05	0.03	0.07	0.05	0	0	0.01	0.08	0.11	0.11
Ammoniacal nitrogen as N	0.01	0.35	0.08	0.06	0.11	0.09	0	0	0.01	0.07	0.14	0.11
Nitrate as N	0.17	0.32	0.1	0.32	0.13	0.23	0.01	0.15	0.43	0.47	0.31	0.04
Biochemical Oxygen Demand (5 day incubation time)	2.01	9	1.55	1.45	1.90	2.05	1.7	1.65	1.5			
Minor Ions												
Aluminium	507	1265	28	130	10	0	0	0	0	0	0	0
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0
Barium	73	61	68	76	89	199	103	85	63	52	59	20
Boron	26	0	0	0	0	0	1	1	1			
Cadmium	1	0	0	0	0	0	0	0	1	1	1	1
Chromium	1	3	2	1	1	0	0	0	0	2	0	0
Copper	2	3	2	1	0	0	1	3	0	0	0	0
Iron	448	3520	148	680	243	1040	63	6	226	113	101	26
Lead	1	1	1	1	0	0	1	0	60	0	2	1
Manganese	297	962	97	55	425	390	84	4	73	6	14	7
Mercury	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	1	0	2	2	2	1	0	0	0			
Selenium	0	0	0	0	0	0	20	0	0	0	38	0
Thallium										13	13	12
Tin	35	8	22	26	11	32	45	80	56			
Zinc	26.3	59	76	66	78	44	20	22	61	42	39	260
Cyanide (total)	20	0	0	0	0	0	0	0	0			
Sulphide	0	0	0	0	0	0	0	0	0			
Total TPH	<20	<20		<20			<20					
Total PAH	<0,10	<0,10		<0,10			<0,10					

Results	Hot Stream Upstream WQ measurement											
	04/05/20	10/06/20	08/07/20	10/08/20	10/09/20	09/10/20	10/11/20	21/12/20	12/01/21	10/02/21	05/03/21	12/04/21
Major Ions												
Ionic Balance	-3.54	-4.43	-4.35	-4.57	-2.29	-2.51	3.49	4.9	-3.55	0.97	-4.71	-4.56
Carbonates	0	0	24	12	30.0	18.0	12	12.2	6.5	0	0	0
Alkalinity (total as bicarbonate)	220	220	159	177	152	170	165	182	207	164	192	190
Calcium	68	64.2	56	56.1	62.1	70.1	64	69	62	52.1	56	58
Magnesium	7.2	7.3	8.5	9.70	8.50	2.40	6	8.5	6.1	4.9	6.1	4.8
Sodium	0.493	1.04	0.283	0.590	1.177	0.846	1.972	0.9272	0.702	0.577	0.497	0.822
Potasium	0.9331	0.885	0.535	1.027	0.704	0.850	0.351	1.3069	0.813	0.568	0.396	0.471
Chloride	0.7	4.3	0.4	2.0	2.1	0.9	0.2	1.4	1	0.8	2.1	0.7
Sulphate	33	23.6	19.7	30.2	23.6	25.4	17.5	18.4	13.4	11.3	21	24.9
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0
Phosphate	0.006	0.02	0.018	0.015	0.002	0.003	0.016	0.015	0.012	0.008	0.016	0.011
Physio-Chemical Parameters												
Electrical Conductivity	335	325	295	312	340	351	312	331	319	279	305	304
Total Dissolved Solids	277	269	146	170	179	254	175	190	288	249	245	223
pH	8.17	8.02	8.36	8.46	8.37	8.36	8.34	8.36	8.35	8.24	8.05	8.12
Total Suspended Solids	134	3145	22	226	133	72	7.9	5	8.5	11	0.4	8.8
Nutrients												
Ammoniacal Nitrogen as N (filtered)	0.1	0.08	0.06	0.05	0.07	0.04	0	0	0	0.1	0.21	0.1
Ammoniacal nitrogen as N	0.2	0.2	0.1	0.08	0.13	0.09	0	0	0	0.08	0.29	0.1
Nitrate as N	0.21	0.19	0.19	0.19	0.11	0.25	0.02	0	0.45	0.54	0.21	0.06
Biochemical Oxygen Demand (5 day incubation time)	2.48	2.3	1.4	1.50	1.95	2.00	1.8	1.65	1.55			
Minor Ions												
Aluminium	2070	297	79	170	13	0	0	0	0	0	0	0
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0
Barium	69	60	52	84	25	156	78	88	66	51	60	21
Boron	26	0	0	0	0	0	1	0	1			
Cadmium	0	0	0	0	0	0	1	0	1	1	1	1
Chromium	1	3	1	1	1	1	0	0	0	2	1	0
Copper	1	2	2	1	2	1	0	0	0	0	0	0
Iron	1738	397	249	1261	776	758	23	5	359	90	97	9
Lead	2	1	2	1	1	0	0	0	0	0	0	0
Manganese	251	464	67	95	387	335	18	32	73	6	1	6
Mercury	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	2	3	2	1	2	1	0	0	0			
Selenium	0	0	0	0	0	0	11	0	0	10	6	3
Thallium												
Tin	31	6	39	28	16	37	48	73	48			
Zinc	25.8	58	67	30	32	37	4	21	47	52	47	77
Cyanide (total)	0	0	0	0	0	0	0	0	0			
Sulphide	0	0	0	0	0	0	0	0	0			
Total TPH	<20	<20		<20			<20					
Total PAH	<0,10	<0,10		<0,10			<0,10					

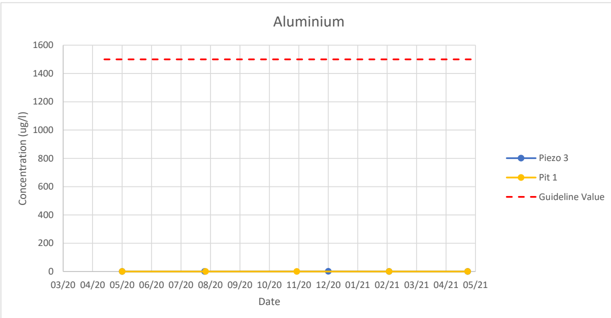
APPENDIX 4.9.8: Conditionally Formatted Spring Water Quality Analytical Results for Rupice Catchment

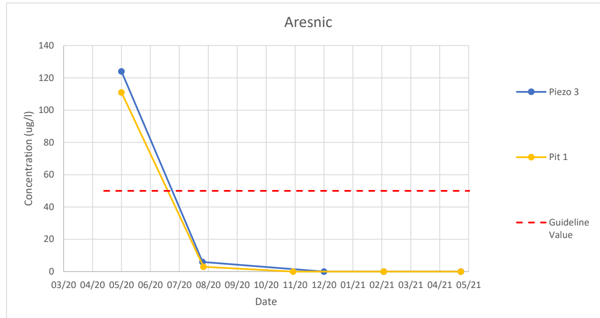
Results	Units	Detection Limit	Hazardous	Guideline Value		Bosnia Maximum Permissible Concentrations (Decree on Hazardous and Harmful Substances in Waters)		Spring - Borovica Donja (Residents Spring)												
				EQS	UKDWS	I - II Class Surface Water	III - IV Class Surface Water	04/05/20	10/06/20	08/07/20	10/08/20	10/09/20	09/10/20	04/11/20	14/12/20	14/01/21	08/02/21	05/03/21	12/04/21	07/05/21
Major Ions																				
Ionic Balance	%	/			-	-	-	-0.518	-2.57	-4.73	0.39	-1.7	-4.26	-0.21	1.31	-0.35	-3.28	-4.77	-4.05	
Carbonates	mg/l	/			-	-	-	0	0	0	0	0.00	0.00	0	0	0	0	0	0	
Alkalinity (total as bicarbonate)	mg/l	/			-	-	-	237	238	254	232	244	262	264	256	238	238	240	244	
Calcium	mg/l	/		-	250	-	-	63	74	72.1	58.1	72.1	82.1	78.1	76.1	62.1	68.1	66.1	66.1	
Magnesium	mg/l	/		-	50	-	-	10.9	3.6	4.9	12.1	4.8	4.90	13.4	18.2	10.9	7	7.4	7.3	
Sodium	mg/l	0.2			200	-	-	1.869	1.547	1.286	2.232	1.243	1.191	1.923	1.829	1.502	1.358	1.105	1.668	
Potasium	mg/l	0.2		-	12	-	-	0.5197	0.386	0.542	0.751	0.581	3.278	3.423	3.793	1.033	0.788	0.54	0.575	
Chloride	mg/l	/		250	250	-	-	1.4	2.8	1.7	1.0	1.2	1.6	0.4	0.5	2.2	0.5	2.5	1.7	
Sulphate	mg/l	/		400	250	-	-	11.9	13.8	12.3	7.00	8.00	33.5	39.6	53.8	7.4	19	17	13.1	
Fluoride	mg/l	0.002		-	1.5	300	1500	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0	
Phosphate	mg/l	0.001			-	-	-	0.004	0.002	0.001	0.003	0.010	0.002	0.011	0.015	0.009	0.002	0.001	0.006	
Physio-Chemical Parameters																				
Electrical Conductivity	µS/cm	/			2500	-	-	331	374	361	332	339	420	460	471	362	355	353	358	
Total Dissolved Solids	mg/l	/			-	-	-	275	282	271	179	188	346	385	374	263	312	257	220	
pH	–	/				-	-	7.93	7.61	7.87	7.89	7.64	7.58	7.68	7.61	7.65	7.57	7.62	7.54	
Total Suspended Solids	mg/l	0.05			-	-	-	0.9	0.3	0.1	0.20	0.30	0.50	0.65	0.5	0.1	0.4	0	0.8	
Nutrients																				
Ammoniacal Nitrogen as N (filtered)	mg/l	0.02		0.3	-	-	-	0.01	0.04	0.02	0.01	0.02	0.01	0.01	0.24	0	0	0.24	0	
Ammoniacal nitrogen as N	mg/l	0.02			0.39	-	-	0.01	0.04	0.02	0.01	0.02	0.01	0.01	0.28	0	0	0.24	0	
Nitrate as N	mg/l	0.005			50	0.5	1.5	0.1	0.2	0.13	0.05	0.06	0.18	0.43	0.15	0.14	0.26	0.14	0.06	
Biochemical Oxygen Demand (5 day incubation time)	mgO2/l	0.5			-	-	-	1.22	1.44	1.1	1.10	1.30	1.55	1.75	1.9	1.65				
Minor Ions																				
Aluminium	µg/l	1		-	200	1500	1500	0	0	0	0	0	0	0	0	0	431	0	0	
Arsenic	µg/l	1		50	10	50	50	0	0	0	0	0	0	0	0	0	0	0	0	
Barium	µg/l	10		-	1000	1000	4000	122	112	113	107	124	0	302	283	128	210	112	63	
Boron	µg/l	20		-	1000	-	-	33	2	0	0	0	0	23	3	1				
Cadmium	µg/l	0.5		0.25	5	0.5	5	1	0	0	0	1	0	1	1	1	1	1	0	
Chromium	µg/l	6		3.4	50	1	6	3	1	1	1	1	0	1	0	0	0	0	0	
Copper	µg/l	3		1	2000	2	10	2	2	1	7	39	0	0	0	0	0	1	0	
Iron	µg/l	6		1000	200	100	1000	17	122	8	4	6	0	16	3	1	2	66	12	
Lead	µg/l	10		1.2	10	2	80	1	0	0	0	1	0	0	0	0	1	0	0	
Manganese	µg/l	2		123	50	50	1000	2	5	4	2	2	0	1	30	2	1	1	1	
Mercury	µg/l	1		0.07	1	0.02	0.1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Nickel	µg/l	3		4	20	15	30	4	2	2	2	1	0	0	10	1				
Selenium	µg/l	1		-	10	10	10	0	0	0	0	0	0	23	25	0	0	7	1	
Tin	µg/l	2		-	-	100	500	37	9	0	1	2	0	59	74	2.7				
Zinc	µg/l	1		10.9	5000	50	80	111.2	71	54	111	142	0	63	8	48	7	32	50	
Thallium						3	30							17	54	31				
Cyanide (total)	µg/l	/		1	50	1	100	40	20	0	0	0	0	0	0	0				
Sulphide	µg/l	/		-	-	2	5	0	0	0	0	0	0	0	0	0				
Total TPH	µg/l	20		-	10	-	-	<20	<20		<20			<20						
Total PAH	µg/l	0.1			0.1	0.2	1	<0,10	<0,10		<0,10			<0,10						

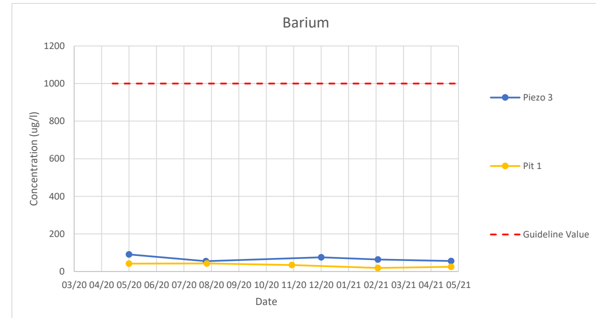
Results	Spring - Borovica Gornja (Spring Box)												
	04/05/20	10/06/20	08/07/20	10/08/20	10/09/20	09/10/20	03/11/20	14/12/20	14/01/2021	8.2.2021.	5.3.2021.	12/04/2021	07/05/21
Major Ions													
Ionic Balance	-1.89	-2.56	-4.73	-3.02	-2.28	-3.83	-2.6	-0.6	-4.28	-3.64	-2.66	-4.12	
Carbonates	0	0	0	0	0.00	0.00	0	0	0	0	0	0	
Alkalinity (total as bicarbonate)	226	244	256	268	274	262	250	262	250	166	232	240	
Calcium	46	56.1	51.5	48.0	58.1	58.6	58	54	52.8	36	51.2	50.1	
Magnesium	17	15.8	18.2	21.8	19.4	18.2	17	21.8	15.8	10.9	17.6	17	
Sodium	3.82	0.607	0.329	0.453	0.946	0.461	0.526	0.447	0.533	0.499	0.443	0.735	
Potasium	0.758	0.673	0.946	1.390	1.005	0.953	0.988	0.704	1.5	1.849	1.014	1.222	
Chloride	1	4.3	1.77	2.5	3.2	1.4	0.7	0.6	2.8	0.1	3.9	0.8	
Sulphate	13.9	10.7	12	1.64	8.95	22.9	21	13	7.8	21.2	16.8	16.6	
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0	
Phosphate	0	0.004	0.009	0.001	0.001	0.003	0.012	0.011	0.008	0.01	0.011	0.008	
Physio-Chemical Parameters													
Electrical Conductivity	325	369	422	351	355	367	369	371	373	253	354	352	
Total Dissolved Solids	263	218	244	228	253	296	261	303	277	211	221	262	
pH	8.03	7.69	7.59	7.61	7.64	7.47	7.57	7.54	7.51	7.23	7.51	7.43	
Total Suspended Solids	0.75	0.1	0.2	0.10	6.0	0.20	0.4	0.6	0.1	7.5	0.1	0.7	
Nutrients													
Ammoniacal Nitrogen as N (filtered)	0.02	0.02	0.02	0.01	0.03	0.01	0.04	0	0	0.23	0.13	0.05	
Ammoniacal nitrogen as N	0.02	0.02	0.03	0.01	0.04	0.01	0.04	0	0	0.23	0.13	0.05	
Nitrate as N	0.12	0.26	0.26	0.18	0.13	0.18	0.28	0.05	0.25	0.27	0.11	0.03	
Biochemical Oxygen Demand (5 day incubation time)	1.35	0.9	1.9	1.75	1.55	1.40	1.6	1.3	1.45				
Minor Ions													
Aluminium	0	0	0	0	0	0	0	0	0	408	0	0	
Arsenic	8	0	0	0	0	0	0	0	0	0	250	0	
Barium	257	238	249	263	235	232	237	241	268	208	1	156	
Boron	90	0	0	0	0	0	1	7	1				
Cadmium	1	0	0	0	0	0	0	0	1	1	1	1	
Chromium	2	1	0	0	0	0	0	0	0	0	0	0	
Copper	1	2	1	0	0	0	0	0	0	24	0	1	
Iron	34	28	19	7	47	7	5	6	4	233	86	67	
Lead	1	2	0	0	0	0	0	0	0	1	0	0	
Manganese	1	10	12	40	5	2	2	37	3	2	1	1	
Mercury	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Nickel	4	2	0	0	0	0	0	0	0				
Selenium	0	0	0	0	0	0	3	25	16	6	19	0	
Tin	96	10	40	29	34	65	61	75	32				
Zinc	183	108	107	139	128	103	237	135	140	107	115	186	
Thallium							20	28	32				
Cyanide (total)	0	0	0	0	0	0	0	0	0				
Sulphide	0	0	0	0	0	0	0	0	0				
Total TPH	<20	<20		<20			<20						
Total PAH	<0.1	<0,10		<0,10			<0,10						

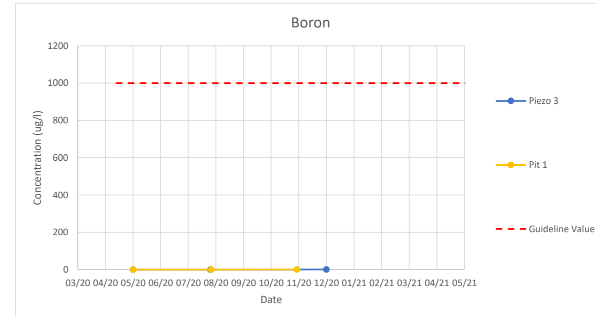
Results	Spring Vruci Potok (Spring - Hot Stream)												
	04/05/20	10/06/20	08/07/20	10/08/20	10/09/20	09/10/20	10/11/20	21/12/20	12/01/21	10/02/21	05/03/21	12/04/21	07/05/21
Major Ions													
Ionic Balance	-2.08	0.14	4.82	-3.66	-4.78	0.027	2.75	1.29	-4.23	-2.7	-4.89	-4.86	
Carbonates	0	0	0	0	0.00	0.0	0	0	0	0	0	0	
Alkalinity (total as bicarbonate)	232	238	246	262	256	232	213	236	251	238	253	251	
Calcium	70.1	80.1	74.1	76.0	78.0	80.1	78.1	70.2	76.1	78.2	77.6	76.1	
Magnesium	6	2.5	13.3	6.1	3.4	0.90	2.4	9.7	3.6	0.7	2.4	2.41	
Sodium	0.587	0.659	0.383	0.439	0.869	0.392	0.435	0.486	0.551	0.54	0.473	0.763	
Potasium	0.3827	0.291	0.404	0.515	0.155	0.428	0.114	0.789	0.837	0.63	0.446	0.653	
Chloride	2.1	6.7	4.2	4.3	3.2	1.8	0.1	2.8	3.1	1.5	3.2	0.7	
Sulphate	14.9	4.6	10.4	9.87	15.2	9.40	17.6	13.7	14.6	11.1	14.2	14.5	
Fluoride	0	0	0	0.00	0.00	0.00	0	0	0	0	0	0	
Phosphate	0	0.003	0.021	0.019	0.003	0.004	0	0.012	0.001	0.004	0.015	0.007	
Physio-Chemical Parameters													
Electrical Conductivity	337	366	379	366	377	364	341	346	366	363	367	363	
Total Dissolved Solids	272	193	195	245	290	308	295	266	331	286	305	274	
pH	8.13	7.76	7.65	7.66	7.68	7.97	8.03	7.88	7.95	7.5	7.54	7.49	
Total Suspended Solids	0.65	0.1	0.35	0.45	0.30	0.7	0.5	0.8	0.35	0.15	0	0.5	
Nutrients													
Ammoniacal Nitrogen as N (filtered)	0.01	0.01	0.02	0.02	0.04	0.01	0	0	0	0	0.21	0	
Ammoniacal nitrogen as N	0.01	0.02	0.02	0.03	0.06	0.01	0	0	0	0	0.21	0	
Nitrate as N	0.38	0.58	0.13	0.51	0.49	0.68	0.51	0.37	0.75	0.68	0.38	0.33	
Biochemical Oxygen Demand (5 day incubation time)	1.39	1	1.7	1.80	1.60	1.75	1.5	1.65	1.5				
Minor Ions													
Aluminium	0	0	0	0	0	0	0	0	0	0	0	0	
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0	
Barium	50	48	41	51	53	51	45	45	41	42	39	11	
Boron	28	0	0	0	0	0	8	1	1				
Cadmium	1	0	0	0	0	0	1	0	1	1	1	0	
Chromium	2	1	1	1	0	1	0	0	0	0	0	0	
Copper	1	2	1	2	1	1	0	0	0	0	0	1	
Iron	20	39	53	12	26	11	3	29	94	20	76	7	
Lead	1	1	1	2	1	0	1	0	0	0	0	0	
Manganese	2	6	9	3	2	2	1	1	1	1	1	1	
Mercury	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
Nickel	1	1	1	2	0	1	0	0	0				
Selenium	0	0	0	0	0	0	11	0	19	0	0	0	
Tin	42	14	35	17	20	40	59	105	52				
Zinc	62	50	6	50	9	30	10	2	56	10	42	16	
Thallium							7	41	44				
Cyanide (total)	20	10	0	0	0	0	0	0	0				
Sulphide	0	0	0	0	0	0	0	0	0				
Total TPH	<20	<20		<20			<20						
Total PAH	<0,10	<0,10		<0,10			<0,10						

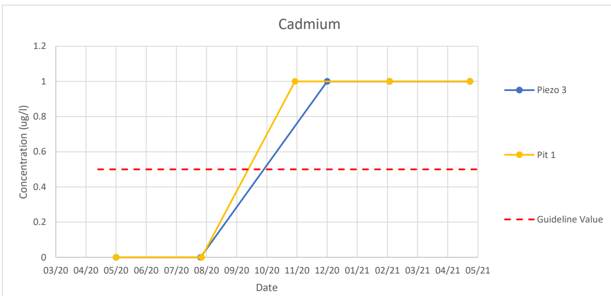
APPENDIX 4.9.9: Graphical Groundwater Quality Analytical for VPP

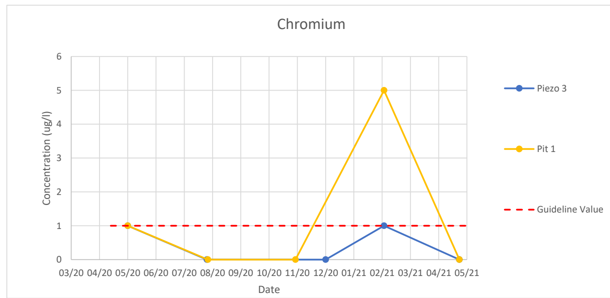

Aluminium
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

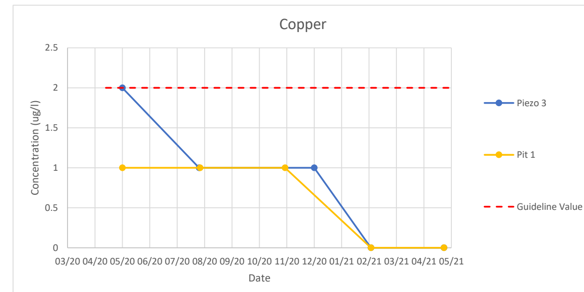

Aresnic
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

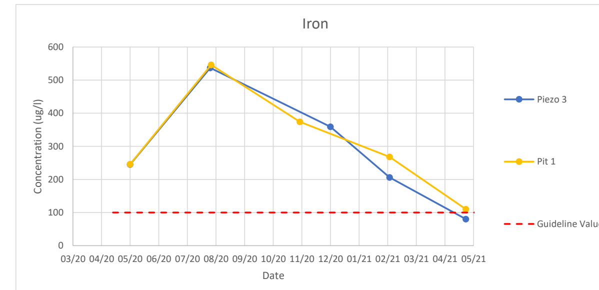

Barium
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

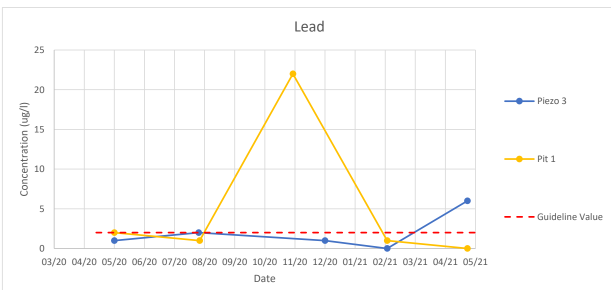

Boron
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

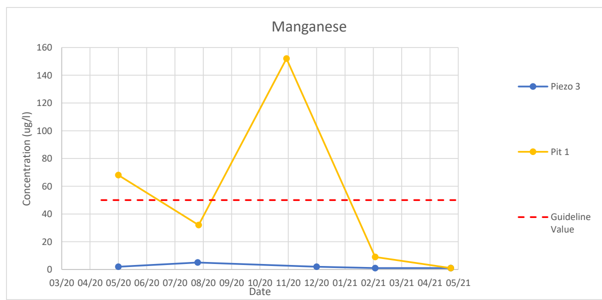

Cadmium
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

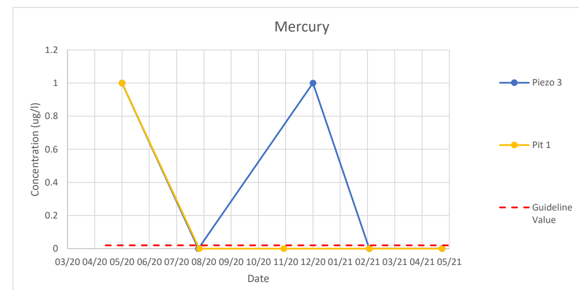

Chromium
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

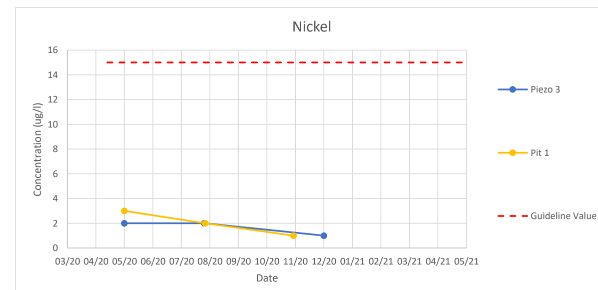

Copper
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

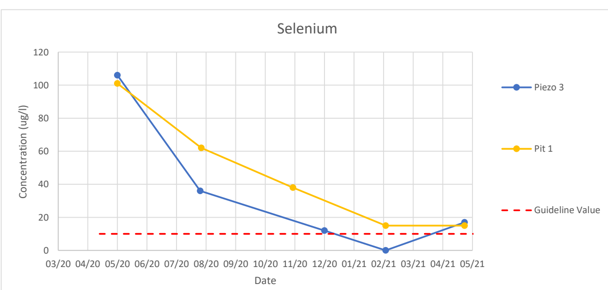

Iron
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

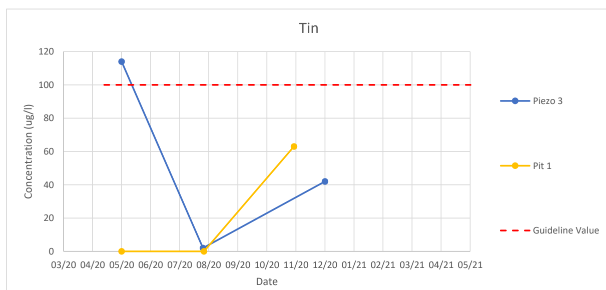

Lead
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

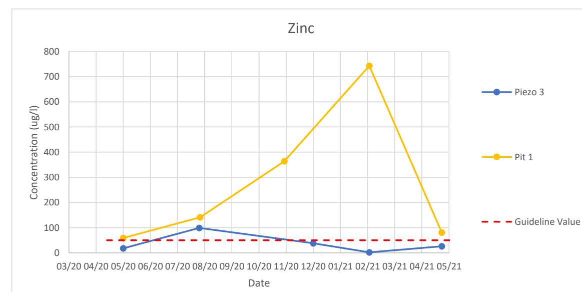

Manganese
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

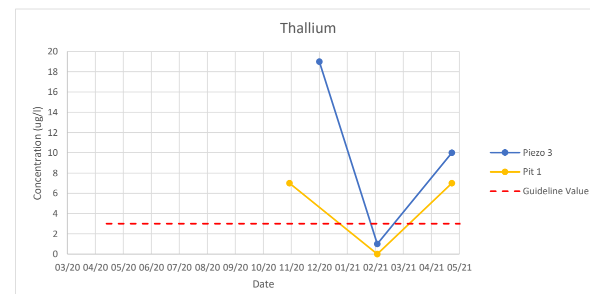

Mercury
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

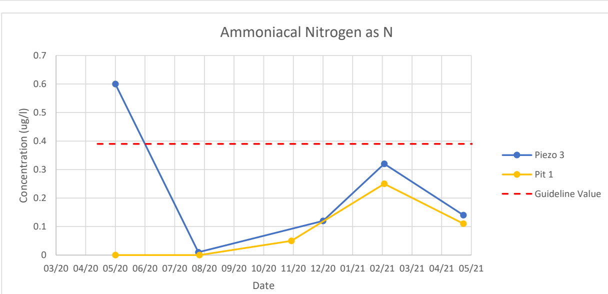

Nickel
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

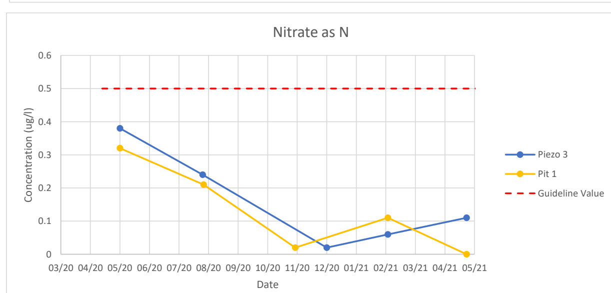

Selenium
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value


Tin
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

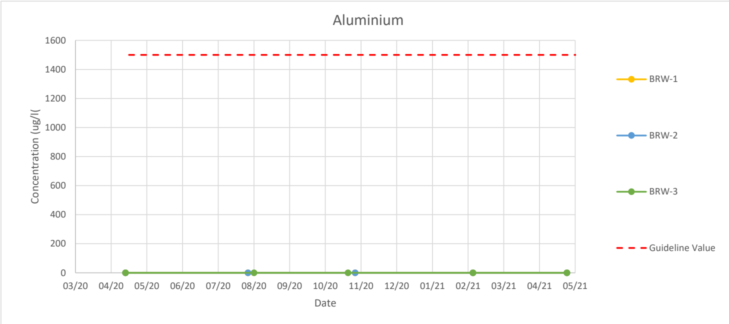

Zinc
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

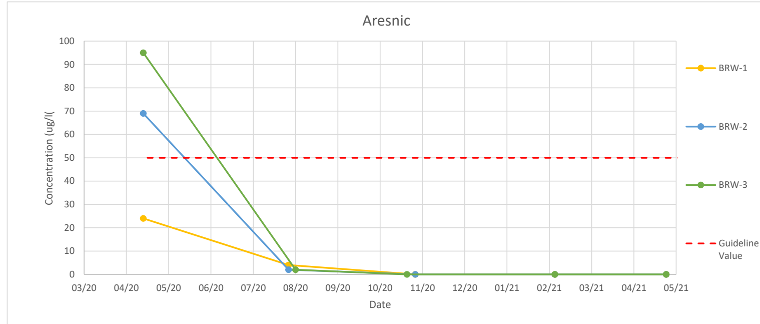

Thallium
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

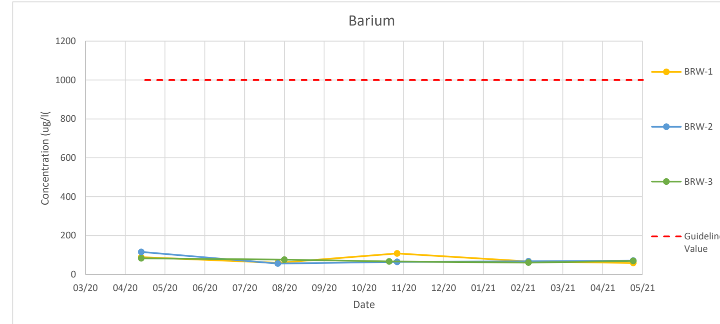

Ammoniacal Nitrogen as N
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

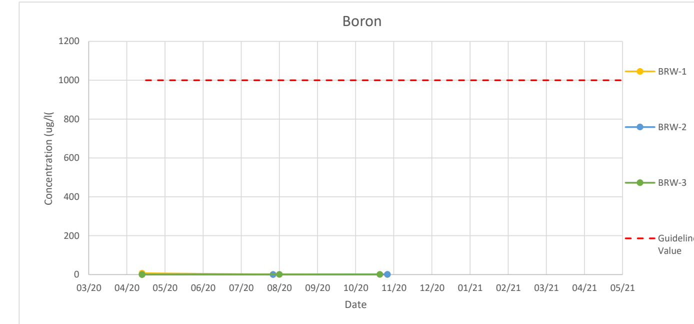

Nitrate as N
Concentration (ug/l)
Date
Piezo 3
Pit 1
Guideline Value

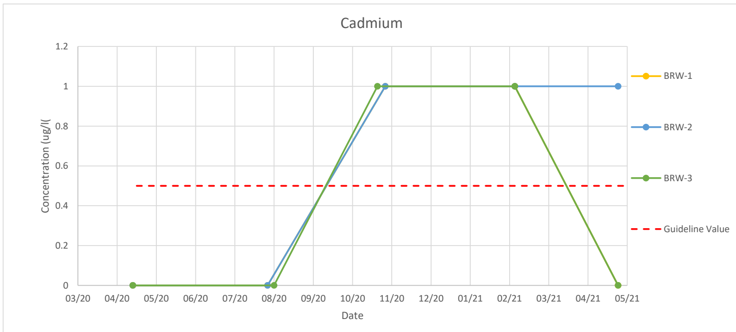
APPENDIX 4.9.10: Graphical Groundwater Quality Analytical for Rupice

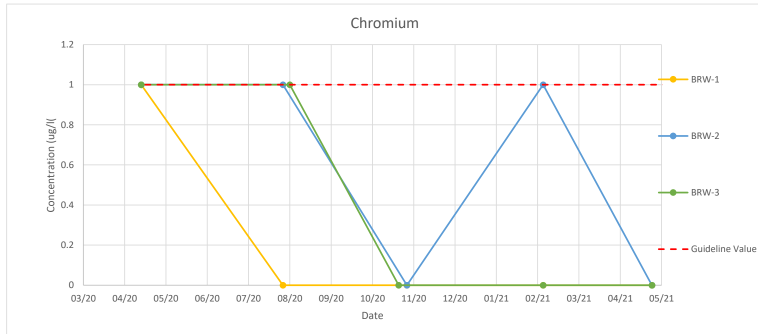

Aluminium
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value

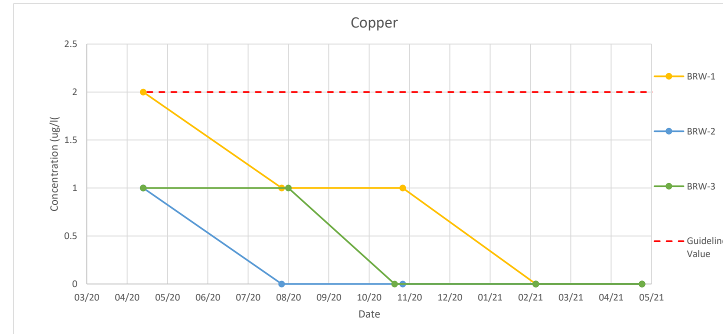

Aresnic
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value

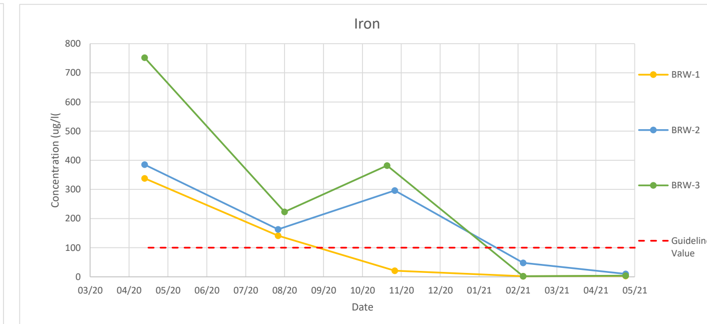

Barium
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value

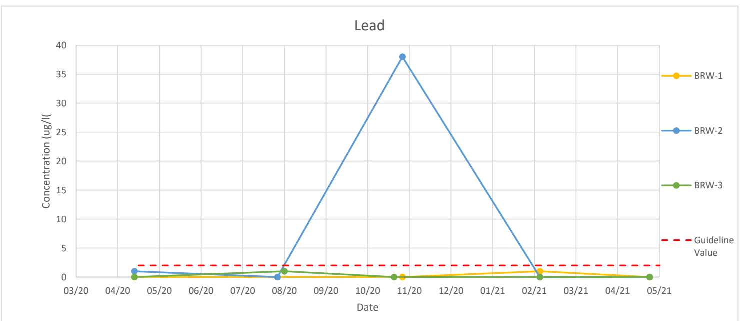

Boron
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value

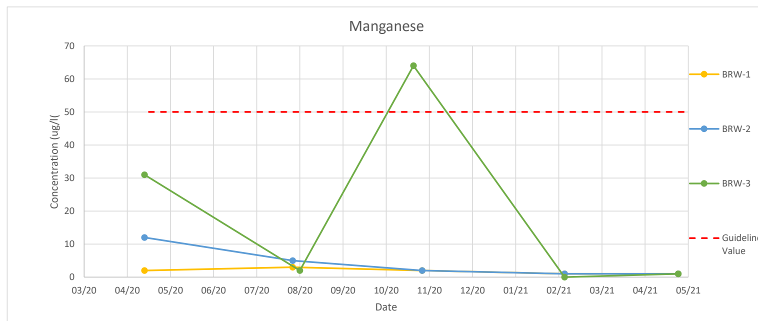

Cadmium
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value

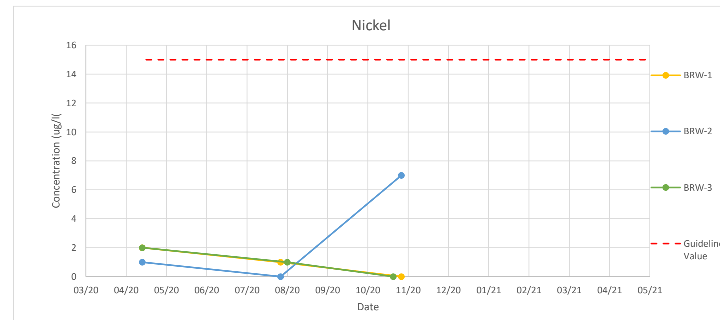

Chromium
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value

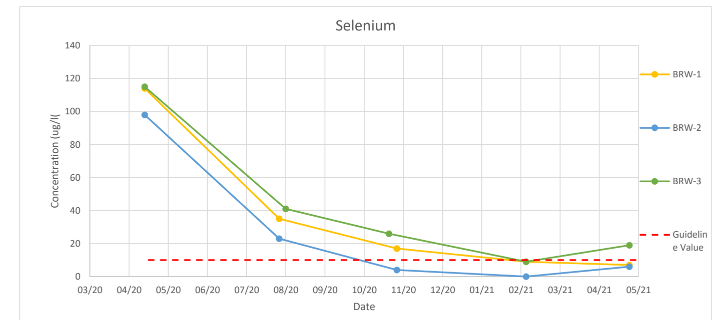

Copper
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value

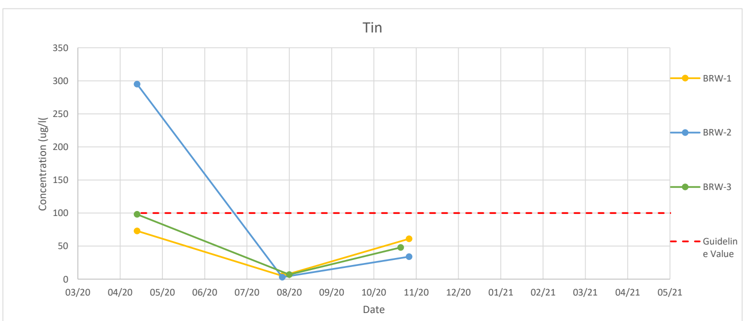

Iron
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value

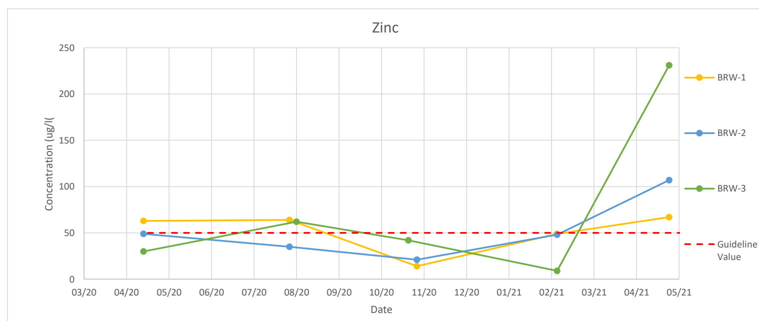

Lead
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value

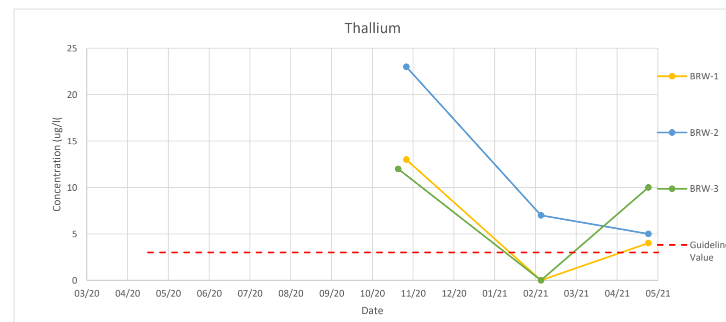

Manganese
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value

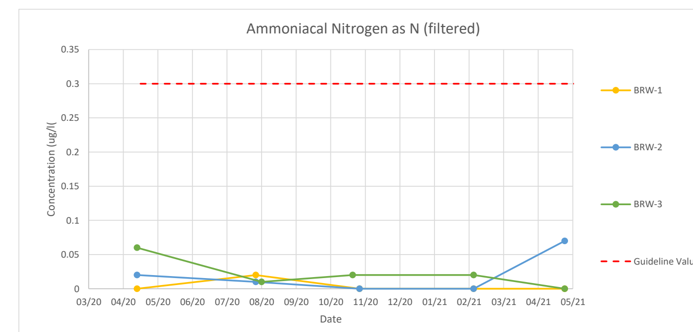

Nickel
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value

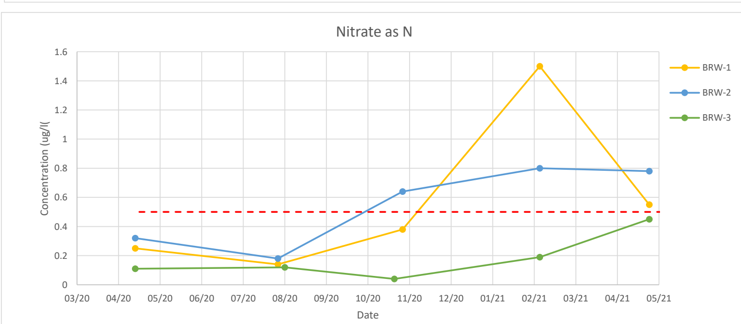

Selenium
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value


Tin
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value


Zinc
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value


Thallium
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value


Ammoniacal Nitrogen as N (filtered)
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3
Guideline Value


Nitrate as N
Concentration (ug/l)
Date
BRW-1
BRW-2
BRW-3

APPENDIX 4.9.11: Conditionally Formatted Groundwater Quality Analytical VPP

Results	Sampling Method	Units	Detection limit	Hazardous	Guideline Value				Piezo 3					Pit 1				
					EQS	UKDWS	Bosnia Maximum Permissible Concentrations (Decree on Hazardous and Harmful Substances in Waters)		19/05/20	11/08/20	15/12/20	15/02/21	06/05/21	19/05/20	12/08/20	13/11/20	15/02/21	06/05/21
Major Ions																		
Ionic Balance	Groundwater sampling device	%	/			-	-	-	-3.59	3.98	3.9	-4.32	-2.74	-0.62	-4.29	-0.55	-1.3	-0.68
Carbonates	Groundwater sampling device	mg/l	/			-	-	-	0	0	0	0	0	0	0	0	0	0
Alkalinity (total as bicarbonate)	Groundwater sampling device	mg/l	/			-	-	-	180	161	195	159	185	268	292	268	177	274
Calcium	Groundwater sampling device	mg/l	/		-	250	-	-	52.1	50.1	48	51	52.1	94.1	76	102	110	86
Magnesium	Groundwater sampling device	mg/l	/		-	50	-	-	7.3	13	19.4	6.1	8.5	52.3	68	51	52.2	54.7
Sodium	Groundwater sampling device	mg/l	0.2			200	-	-	2.25	2.161	1.15	0.765	1.071	3.31	4.656	1.348	0.461	1.121
Potasium	Groundwater sampling device	mg/l	0.2		-	12	-	-	0.872	1.353	1.368	1.024	1.404	1.257	2.326	1.67	1.292	1.18
Chloride	Groundwater sampling device	mg/l	/		250	250	-	-	1.4	2.8	1.4	0.4	2.8	2.1	5.6	0.7	0.2	3.2
Sulphate	Groundwater sampling device	mg/l	/		400	250	-	-	26.5	32.7	26.6	36.8	21.8	232	267	244	345	212.2
Fluoride	Groundwater sampling device	mg/l	0.002		-	1.5	300	1500	0	0	0	0	0	0	0	0	0	0
Phosphate	Groundwater sampling device	mg/l	0.001			-	-	-	0	0.001	0.025	0.001	0	0	0.08	0.02	0.022	0
Physio-Chemical Parameters																		
Electrical Conductivity		µS/cm	/			2500	-	-	345	370	320	301	287	825	860	801	857	724.8
Total Dissolved Solids		mg/l	/			-	-	-	204	182	176	197	193	649	710	687	705	507
pH		/	/		-	-	-	-	7.76	7.67	8.04	7.82	7.91	7.52	7.9	7.64	7.69	7.7
Total Suspended Solids		mg/l	0.05			-	-	-	36.3	41.6	38	8.7	22	58.2	135	52.2	12.1	70
Nutrients																		
Ammoniacal Nitrogen as N (filtered)		mg/l	0.02		0.3	-	-	-	0.6	0.01	0.08	0.3	0.12	0	0	0.07	0.21	0.09
Ammoniacal nitrogen as N		mg/l	0.02		0.39	-	-	-	0.6	0.01	0.12	0.32	0.14	0	0	0.05	0.25	0.11
Nitrate as N		mg/l	0.005			50	0.5	1.5	0.38	0.24	0.02	0.06	0.11	0.32	0.21	0.02	0.11	0
Biochemical Oxygen Demand (5 day incubation time)		mgO2/l	0.5			-	-	-	1.7	1.9	1.75			5.1	6	4.9		
Minor Ions																		
Aluminium		µg/l	1		-	200	1500	1500	0	0	1	0	0	0	0	0	0	0
Arsenic		µg/l	1		50	10	50	50	124	6	0	0	0	111	3	0	0	0
Barium		µg/l	10		-	1000	1000	4000	91	55	76	64	56	42	43	35	19	25
Boron		µg/l	20		-	1000	-	-	0	0	1			0	0	1		
Cadmium		µg/l	0.5		0.25	5	0.5	5	0	0	1	1	1	0	0	1	1	1
Chromium		µg/l	6		3.4	50	1	6	1	0	0	1	0	1	0	0	5	0
Copper		µg/l	3		1	2000	2	10	2	1	1	0	0	1	1	1	0	0
Iron		µg/l	6		1000	200	100	1000	245	537	359	206	80	246	546	374	268	110
Lead		µg/l	10		1.2	10	2	80	1	2	1	0	6	2	1	22	1	0
Manganese		µg/l	2		123	50	50	1000	2	5	2	1	1	68	32	152	9	1
Mercury		µg/l	1		0.07	1	0.02	0.1	1	<1	1	<1	<1	1	<1	<1	<1	<1
Nickel		µg/l	3		4	20	15	30	2	2	1			3	2	1		
Selenium		µg/l	1		-	10	10	10	106	36	12	0	17	101	62	38	15	15
Tin		µg/l	2		-	-	100	500	114	2	42			0	0	63		
Zinc		µg/l	1		10.9	5000	50	80	18	99	38	2	26	59	141	364	743	81
Thallium							3	30			19	1	10			7	0	7
Cyanide (total)		µg/l	/		1	50	1	100	0	0	0			0	0	0		
Sulphide		µg/l	/		-	-	2	5	0	0	0			0	0	0		

APPENDIX 4.9.12: Conditionally Formatted Groundwater Quality Analytical Results for Rupice

Results	Sampling Method	Units	Detection Limit	Hazardous	Guideline Value EQS	Guideline Value UKDWS	Guideline Value Bosnia Maximum		BRW-1 01/05/20	BRW-1 12/08/20	BRW-1 10/11/20	BRW-1 17/02/21	BRW-1 01/03/21	BRW-1 01/04/21	BRW-1 07/05/21	BRW-1 01/06/21
Major Ions																
Ionic Balance	Groundwater sampling devic	%	/			-	-	-	-2.26	-3.76	2.23	-4.46			-4.59	
Carbonates	Groundwater sampling devic	mg/l	/			-	-	-	0	0	0	0			0	
Alkalinity (total as bicarbonate)	Groundwater sampling devic	mg/l	/			-	-	-	165	171	177	164			165	
Calcium	Groundwater sampling devic	mg/l	/		-	250	-	-	56.1	52	52.1	60.1			52	
Magnesium	Groundwater sampling devic	mg/l	/		-	50	-	-	1.2	4.8	13.4	2.4			4.8	
Sodium	Groundwater sampling devic	mg/l	0.2			200	-	-	3.36	3.706	1.96	1.708			1.021	
Potasium	Groundwater sampling devic	mg/l	0.2		-	12	-	-	0.581	0.994	0.958	0.476			0.859	
Chloride	Groundwater sampling devic	mg/l	/		250	250	-	-	5.4	5.7	2.8	5.9			3.89	
Sulphate	Groundwater sampling devic	mg/l	/		400	250	-	-	16.6	21.7	30.7	30.2			23.1	
Fluoride	Groundwater sampling devic	mg/l	0.002		-	1.5	300	1500	0	0	0	0			0	
Phosphate	Groundwater sampling devic	mg/l	0.001			-	-	-	0.006	0.002	0.012	0.007			0.013	
Physio-Chemical Parameters																
Electrical Conductivity		µS/cm	/			2500	-	-	288	330	291	314			288.9	
Total Dissolved Solids		mg/l	/			-	-	-	163	192	217	221			194	
pH		–	/				-	-	8.2	7.82	7.83	7.78			7.75	
Total Suspended Solids		mg/l	0.05			-	-	-	13.2	4.2	6.8	1.7			1.3	
Nutrients																
Ammoniacal Nitrogen as N (filtered)		mg/l	0.02		0.3	-	-	-	0	0.02	0	0			0	
Ammoniacal nitrogen as N		mg/l	0.02			0.39	-	-	0	0.02	0	0			0	
Nitrate as N		mg/l	0.005			50	0.5	1.5	0.25	0.14	0.38	1.5			0.55	
Biochemical Oxygen Demand (5 day incubation time)		mgO2/l	0.5			-	-	-	3.4	2.9	3.05					
Minor Ions																
Aluminium		µg/l	1		-	200	1500	1500	0	0	0	0			0	
Arsenic		µg/l	1		50	10	50	50	24	4	0	0			0	
Barium		µg/l	10		-	1000	1000	4000	89	60	108	67			59	
Boron		µg/l	20		-	1000	-	-	7	1	1					
Cadmium		µg/l	0.5		0.25	5	0.5	5	0	0	1	1			0	
Chromium		µg/l	6		3.4	50	1	6	1	0	0	0			0	
Copper		µg/l	3		1	2000	2	10	2	1	1	0			0	
Iron		µg/l	6		1000	200	100	1000	338	141	21	2			3	
Lead		µg/l	10		1.2	10	2	80	0	0	0	1			0	
Manganese		µg/l	2		123	50	50	1000	2	3	2	1			1	
Mercury		µg/l	1		0.07	1	0.02	0.1	<1	<1	<1	<1			<1	
Nickel		µg/l	3		4	20	15	30	2	1	0					
Selenium		µg/l	1		-	10	10	10	114	35	17	9			7	
Tin		µg/l	2		-	-	100	500	73	5	61					
Zinc		µg/l	1		10.9	5000	50	80	63	64	14	49			67	
Thallium											13	0			4	
Cyanide (total)		µg/l	/		1	50	1	100	0	0	0					
Sulphide		µg/l	/		-	-	2	5	0	0	0					
Total TPH		µg/l	20		-	10	-	-	< 20	<20	<20					
Total PAH		µg/l	0.1			0.1	0.2	1	< 10	<0,10	<0,10					

Results	BRW-2 01/05/20	BRW-2 12/08/20	BRW-2 10/11/20	BRW-2 17/02/21	BRW-2 01/03/21	BRW-2 01/04/21	BRW-2 07/05/21	BRW-2 01/06/21	BRW-3 01/05/20	BRW-3 17/08/20	BRW-3 04/11/20	BRW-3 17/02/21	BRW-3 01/03/21	BRW-3 01/04/21	BRW-3 07/05/21	BRW-3 01/05/21
Major Ions																
Ionic Balance	-2.2	-2.04	0.37	3.53			-4.39		-2.5	-4.66	-2.41	-3.68			-4.86	
Carbonates	0	0	0	0			0		0	0	0	0			0	
Alkalinity (total as bicarbonate)	195	199	152	140			137		189	212	207	195			188	
Calcium	42	45	53.5	54			48		58.1	61	70.1	60			58.5	
Magnesium	13.3	10.3	1.8	1.2			1.2		3.6	3.7	0.9	4.8			3.7	
Sodium	3.8	5.729	2.24	1.847			1.676		3.89	3.255	1.918	3.977			1.965	
Potasium	0.951	0.665	0.389	0.441			0.642		0.356	0.562	0.511	0.696			0.8	
Chloride	3.9	4.2	0.6	1			2.12		4.4	1.7	0.5	2.1			2.7	
Sulphate	10.8	12	16.8	14.8			21.1		17.3	15	21.3	28.1			23.1	
Fluoride	0	0	0	0			0		0	0	0	0			0	
Phosphate	0.008	0.003	0	0.005			0.005		0.002	0.01	0.005	0.002			0.0063	
Physio-Chemical Parameters																
Electrical Conductivity	341	330	265	249			252.8		307	320	315	334			326.6	
Total Dissolved Solids	192	227	182	159			176		188	219	229	226			235	
pH	8.18	7.92	7.84	7.94			7.82		8.06	7.93	7.68	7.8			7.75	
Total Suspended Solids	15.9	5.9	3.8	0.25			0.5		11.2	2.4	1.6	32.5			1.4	
Nutrients																
Ammoniacal Nitrogen as N (filtered)	0.02	0.01	0	0			0.07		0.06	0.01	0.02	0.02			0	
Ammoniacal nitrogen as N	0.02	0.02	0	0			0.066		0.06	0.01	0.02	0.02			0	
Nitrate as N	0.32	0.18	0.64	0.8			0.78		0.11	0.12	0.04	0.19			0.45	
Biochemical Oxygen Demand (5 day incubation time)	2.8	2.55	2.4						5.4	4.9	3.6					
Minor Ions																
Aluminium	0	0	0	0			0		0	0	0	0			0	
Arsenic	69	2	0	0			0		95	2	0	0			0	
Barium	116	56	65	68			71		83	76	67	61			70	
Boron	0	0	1						0	1	1					
Cadmium	0	0	1	1			1		0	0	1	1			0	
Chromium	1	1	0	1			0		1	1	0	0			0	
Copper	1	0	0	0			0		1	1	0	0			0	
Iron	385	163	296	48			10		752	223	382	2			4	
Lead	1	0	38	0			0		0	1	0	0			0	
Manganese	12	5	2	1			1		31	2	64	0			1	
Mercury	<1	<1	<1	<1			<1		<1	<1	<1	<1			<1	
Nickel	1	0	7						2	1	0					
Selenium	98	23	4	0			6		115	41	26	9			19	
Tin	295	3	34						98	7	48					
Zinc	49	35	21	48			107		30	62	42	9			231	
Thallium			23	7			5				12	0			10	
Cyanide (total)	0	0	0						0	0	0					
Sulphide	0	0	0						0	0	0					
Total TPH	< 20	<20	<20						< 20	<20	<20					
Total PAH	< 0,10	<0,10	<0,10						< 0,1	<0,10	<0,10					

Results	Rupice ESIA Well (REW) 1 (BRW-7) 14/12/20	REW 1 16/02/21	REW 1 07/05/21	REW 2 (BRW-5) 09/11/20	REW 2 16/02/21	REW 2 07/05/21	REW3 (BRW-4) 18/08/20	REW3 03/11/20	REW3 17/02/21	REW3 10/05/21	REW 4 (BRW-6) 29/10/20	REW 4 17/02/21	REW 4 07/05/21
Major Ions													
Ionic Balance	0.57	-3.91	4.36	-0.83	-2.82	-4.16	-3.17	-1.91	-0.35	-4.63	0.36	-0.92	-4.86
Carbonates	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0
Alkalinity (total as bicarbonate)	201	104	189	189	329	354	220	214	219	216	262	256	251
Calcium	40	24	38	56	100	104	50.1	56.2	53	54.1	56.1	58	56.1
Magnesium	18.2	10.9	10.9	13.4	8.5	9.7	13.4	10.9	15.8	10.9	21.8	21.5	18.2
Sodium	12.87	11.93	11.9	7.511	2.894	2.458	9.496	2.19	2.107	1.886	12.7	2.415	1.899
Potasium	1.587	2.483	2.12	1.415	1.874	1.09	2.546	1.137	1.099	1.063	2.221	2.366	1.16
Chloride	0.5	3.1	3.9	0.4	3.8	5.67	10.6	8.1	9.2	9.2	3.9	2.4	3.4
Sulphate	35.5	53	47.54	58.2	29.4	27.1	21.6	10.9	11.1	12.8	36	32.3	30.5
Fluoride	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0
Phosphate	0.028	0.006	0.007	0.02	0.003	0.0076	0.001	0.13	0.006	0.003	0.05	0.002	0.0076
Physio-Chemical Parameters													
Electrical Conductivity	346	359	344.7	362	526	549	352	342	352	349	405	415	393.8
Total Dissolved Solids	280	225	258.6	283	309	358	242	233	230	230	288	260	250
pH	8.17	8.1	7.67	7.89	7.49	7.24	7.48	7.83	7.75	7.63	7.97	7.74	7.75
Total Suspended Solids	1.1	0.3	14.4	2.7	26.5	0.8	0.70	2	0.75	0.65	65.5	9.5	13.8
Nutrients													
Ammoniacal Nitrogen as N (filtered)	0.41	0.16	0.01	0.495	0.03	0	0.01	0	0	0.00	0.12	0.1	0.01
Ammoniacal nitrogen as N	0.43	0.16	0.01	0.47	0.04	0	0.01	0	0	0.00	0.14	0.1	0.009
Nitrate as N	0	0.00	0.03	0.16	1.3	1.82	0.12	0.17	0.2	0.03	0.17	0.13	0.22
Biochemical Oxygen Demand (5 day incubation time)	1.6			4.1			1.85	1.95			2.85		
Minor Ions													
Aluminium	1	0	0	1366	0	0	0	0	0	0	0	0	0
Arsenic	0	0	0	0	0	0	0	0	0	0	0	0	0
Barium	81	36	40	61	67	59	87	181	212	195	108	114	98
Boron	1			3			1	0			1		
Cadmium	1	1	1	1	1	1	1	0	1	1	1	1	1
Chromium	0	12	5	0	0	0	0	0	0	0	0	0	0
Copper	0	0	0	1	4	0	1	0	0	0	1	0	0
Iron	171	448	69	978	66	2	251	8	1	2	105	2	2
Lead	1	2	0	0	1	0	0	0	0	0	0	2	0
Manganese	55	11	2	11	10	2	24	2	0.011	1	166	152	1
Mercury	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	0			0			2	1			10		
Selenium	3	7	1	6	9	7	39	6	12	15	6		
Tin	34			44			47	39			37	0	0
Zinc	1	36	194	39	14	97	80	55	52	61	43		
Thallium	7	0	10	20	15	6	0	16	2	5	17	5.9	9
Cyanide (total)	0			0			0	0			0	3	10
Sulphide	0			0			0	0			0		
Total TPH	<20			<20			<20	<20			<20		
Total PAH	<0,10			<0,10			<0,10	<0,10			<0,10		

APPENDIX 4.11.1: Stakeholder Mapping

Appendix 4.11.1: Stakeholder Mapping for the Vareš Project

Category	Stakeholder
Government (National)	***Tripartite Presidency*** Šefik Džaferović Željko Komšić Milorad Dodik ***Ministries*** Ministry of Foreign Affairs Ministry of Security Ministry of Defence Ministry of Finance and Treasury Ministry of Justice Ministry of Foreign Trade and Economic Relations Ministry of Communications and Transport Ministry of Human Rights and Refugees Ministry of Civil Affairs Chairman of Council of Ministers Prof. Denis Zvizdić, Ph.D. Economic Committee Internal Policy Committee Directorate for European Integration
Government (Federation of Bosnia and Herzegovina)	***Prime Minister*** Fadil Novalić Deputy PM – Finance, Jelka Miličević Deputy PM – Work and Social Welfare, Vesko Drljača ***Ministers*** Minister Energy, Mining and Industry Minister Agriculture, Aquaculture and Forestry Minister Traffic and Communication Minister Planning Minister Trade Minister Internal Affairs Minister Development, Entrepreneurship and Craft Minister Justice Minister Healthcare Minister Veterans Minister Displaced Persons and Refugees Minister Environment and Tourism Minister Education and Science Minister Culture and Sports ***Jurisdiction over healthcare, education, agriculture, culture, veteran issues, labour, policing and internal affairs.***
Government (Canton – Zenica-Doboj)	***Canton Prime Minister*** Mirza Ganić ***Cantonal Ministries***

<table>
<tr><td></td><td colspan="2">Ministry of Finance
Ministry of Economy
Ministry of Justice and Administration
Ministry of Agriculture, Forestry and Water Management
Ministry of the Interior
Ministry of Education, Science, Culture and Sports
Ministry of Physical Planning, Transport and Communications and Environmental Protection
Ministry of Health
Ministry of Veteran Affairs
Ministry of Labor, Social Policy and Refugees

Governing Bodies
Cantonal Inspection Authority
Cantonal Civil Protection Administration
Cantonal Forestry Administration
Joint Affairs Service
Legislation Secretariat
Professional Development and International Projects Service
Cantonal Directorate of Commodity Reserves
Cantonal Roads Directorate
Cantonal Legal Aid Office
Cantonal Institute for Urbanism and Physical Planning
Veterinary Institute
Pedagogical Institute</td></tr>
<tr><td>Government (Municipality)</td><td colspan="2">Elected Mayor
Zdravko Marošević

Community Leaders for the 23 Community Centres (below)

Commissions
Statutory Issues and Regulation Commission
Commission for the Protection of Human Rights and Freedoms, Petitions, Complaints, Proposals and Gender Equality
Youth Affairs Commission
Ethics Committee
Commission for Economy, Finance, Budget
Commission for Reconstruction and Capital Investments
Administrative Commission

https://www.vares.info/</td></tr>
<tr><td>Vareš Community Centres</td><td>Borovica
Brgule
Budoželje
Dabravine
Javornik
Kadarici
Kokoscici
Ligatići</td><td>Pržići
Ravne
Strica-Zaruđe
Striježevo
Stupni Do
Vijaka
Daštansko
Vareš</td></tr>
</table>

	Mir Neprivaj Oćevija Pogar	Vareš Majdan Bastašići Vukanovići
Key Communities	For the Vares Processing Plant: Tisovci Pržići Brezik Daštansko Višnjići	For Haul route and Rupice: Gornja Borovica Donja Borovica Osredak Semizova Ponikva Polozac Pogar Vareš Majdan
Secondary Communities	Vares Municipality: Vareš Mlakve Ljepovići Sjenokos Javornik Osoje Diknjići Stupni Do Bijelo Borje	Kakanj Municipality: Bastašići; Lipnica; Nažbilj; Halinovići; Slagoščići; Zlokuće; and Vukanovići.
Regionally important communities	Sarajevo Vogošća Ilijaš Podlugovi Breza Slivno Dabravine Budoželje Striježevo Radonjići Poljani Kakanj Tičići Janjići Zenica Arnauti	Dragovići Bobovac Tuzla Omazići Banovići Rijeka Ligatići Mižnovići Naseoci Oćevija Donja Oćevija Gornja Zvijezda Strica-Zaruđe Brgule
Landowners	Six private landowners identified across the haul route and Rupice concession. Land and property owners who currently do not permanently reside in the Project area.	
Non-Government Organisations (National and International)	Regional Environmental Centre (BiH) (http://www.rec.org/office.php?id=5)	

	Friends of the Earth Europe, Regional Environmental Centre for Central and Eastern Europe (REC), Centre for environmentally Sustainable development (https://www.foeeurope.org/bosnia-herzegovina) Forestry and Environmental Action (https://www.feasee.org/) Bankwatch Network (https://bankwatch.org/about) Via Dinarica Trail (https://viadinarica.com/index.php/en/) Centre for Environment BiH Save the Blue Heart of Europe (https://www.balkanrivers.net/) University of Zenica, University of Sarajevo and University of Tuzla. Transboundary River Systems: Sava River Watershed Agency, Agency for the Maintenance of the Danube River
Non-governmental organisations (local and regional)	German humanitarian organization HELP-Hilfe – working locally (http://www.help.org.ba/en/) BiH Federation of Mines Workers Union Eko-Forum Zenica (http://d564271.u30.com.ba/onama.php) Association "Visit Vares" Scout Association "Zvijezda" Reconstruction and Development Foundation Vares
Businesses, organisations and Service Providers	***Service Providers*** Police Vares, Health Centre Vares, High School, Primary school, nursery, unemployment centre, social services, bus and transportation companies, Vareš library, Vareš Tourist Information Centre ***Businesses (See Business Directory)*** Local business owners and trades people in Vareš (café, shops, mechanics etc.), Market vendors, Kraljeuska Water Bottling Factory, Alma Ras doo (Lingerie factory / company), Logging factory Daštansko, Mrestilište Trout farm / Hotel, Alma-mas doo Olovo (Underwear manufacturer), Amia-Promet doo (Sawmill), Igrišpa Hunting Lodge, Visit Vareš, Mekuše Mountain Lodge, Karlovaćko local bar in Pogar. ***Religious*** *Islamic Community* – mosque located in Dastansko and Vares.

	Catholic Community – church in Borovica Gornja, church in Przici, church is Tisovci, church in Vareš *Orthodox Community* – church in Vareš ***Organisations*** Zvijezda Hunting Society Vareš, Association of Sports Fishermen, history enthusiasts, Diving Club Bosnia, Originally Vares, Women Associations of multiple villages, Bosniak Culture Community, Red Cross Vares, Eco Tourist Vijaka, Our Home Borovica, Retiree Association of Vares, Mother Theresa Association, Employer Association Vares, The Royal Town of Bobovac Association, Hiking and Skiing Society, Fishing Sports Association, Beekeeper Association.
Media (International)	Bosnia and Herzegovina's Public Service Broadcasting System (BHRT) – member of European Broadcasting Union
Media (National)	***Newspapers*** Dnevi Avaz (Bosniak) Blic Glas Srpske Večernje novosti Večernji list (Bosnian Croat) Nezavisne novine (Bosnian Serb) Oslobođenje ***Radio*** Bosnia and Herzegovina's Public Service Broadcasting System (BHRT) – BH Radio 1 (State), Radio FBiH (Federal), Radio 202 (Federal), Radio Republika Srpska (Republic) Radio BN Radio Big 1 ***Television*** Federalna TV (Federation TV) Radio Televizija Republike Srpske (RTRS) BHRT Sarajevo – Al-Jazeera Balkans TV (News network broadcasting in Bosnian, Serbian and Croatian) N1 – 24 hour news ***News Agencies*** FBiH's Federal News Agency (FENA) – publicly owned RS' News Agency od Republika Srpska (SRNA) – publicly owned ONASA – privately owned The Roman Catholic Conference of Bishops of BiH Islamic Community of Bosnia and Herzegovina Anadolu Agency – Turkish Government owned
Media (Local and Regional)	***Radio*** Hrvatski Radio Bobovac (Vareš)

	Narodni Radio (Zenica) Nazavisni TNT Radio (Tuzla) Radio Kakanj (Kakanj) Radio Breza (Breza) Radio Slon (Tuzla) Radio Zenit (Zenica) Radio Zenica (Zenica) – public Radio Tuzlanskog kantona (Tuzla) - public Radio Tuzla (Tuzla) – public ***Newspapers*** Magazine Bobovac (Vareš) Naša riječ (Zenica) BH Dani (Sarajevo) Start BiH (Sarajevo) Hrvatski glasnik (Tuzla)

APPENDIX 4.11.2: Turning Counts

Turning Counts

TS1 - Borovica Gornja

23rd July

22
0

→ **A** Gornja Borovica

Donja Borovica **B** ←

18
0

25th July

18
0

→ **A** Gornja Borovica

Donja Borovica **B** ←

16
0

22nd Oct

7
0

→ **A** Gornja Borovica

Donja Borovica **B** ←

3
0

24th Oct

7
0

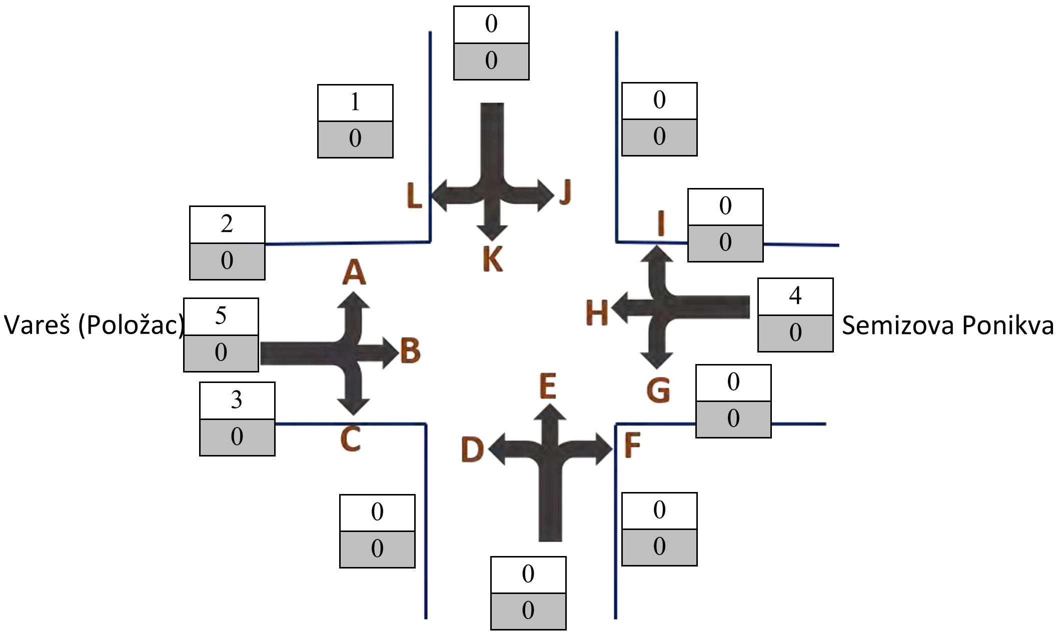
→ **A** Gornja Borovica

Donja Borovica **B** ←

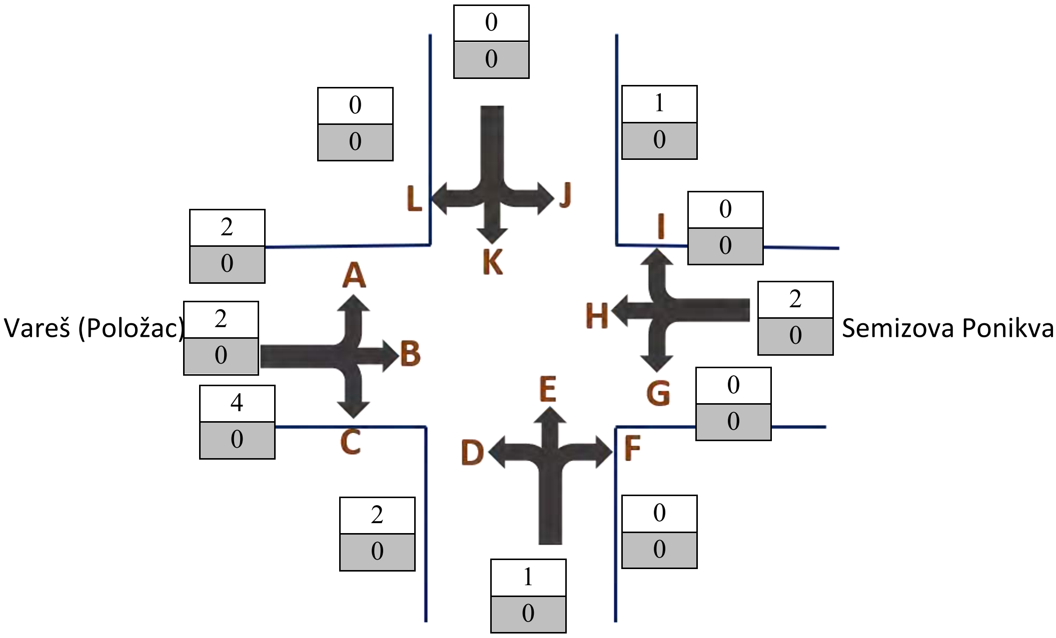
2
0

TS2 – Semizova Ponikva

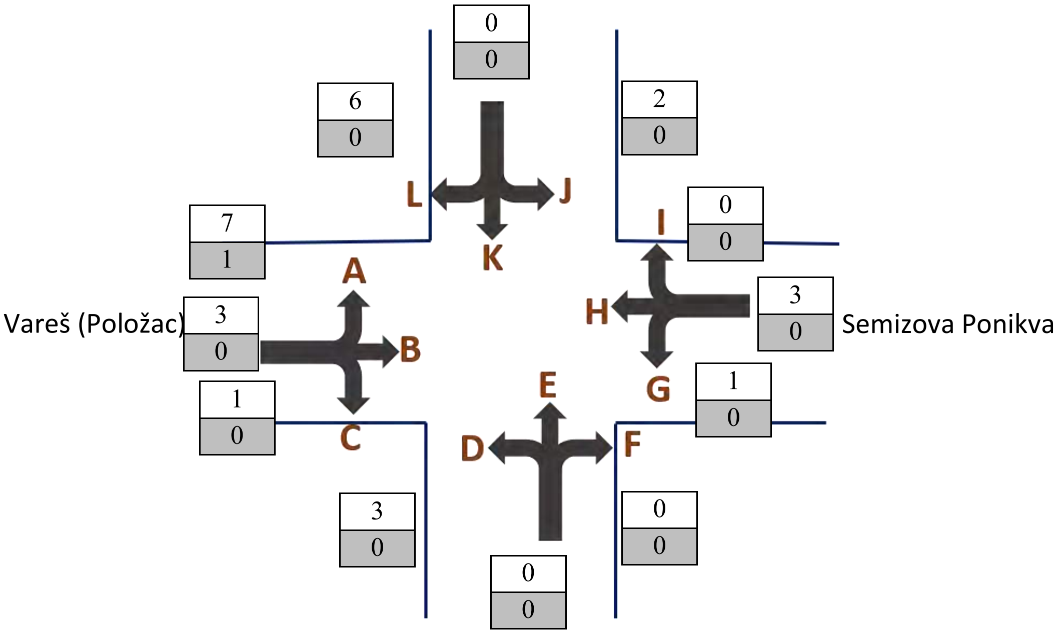
23rd July



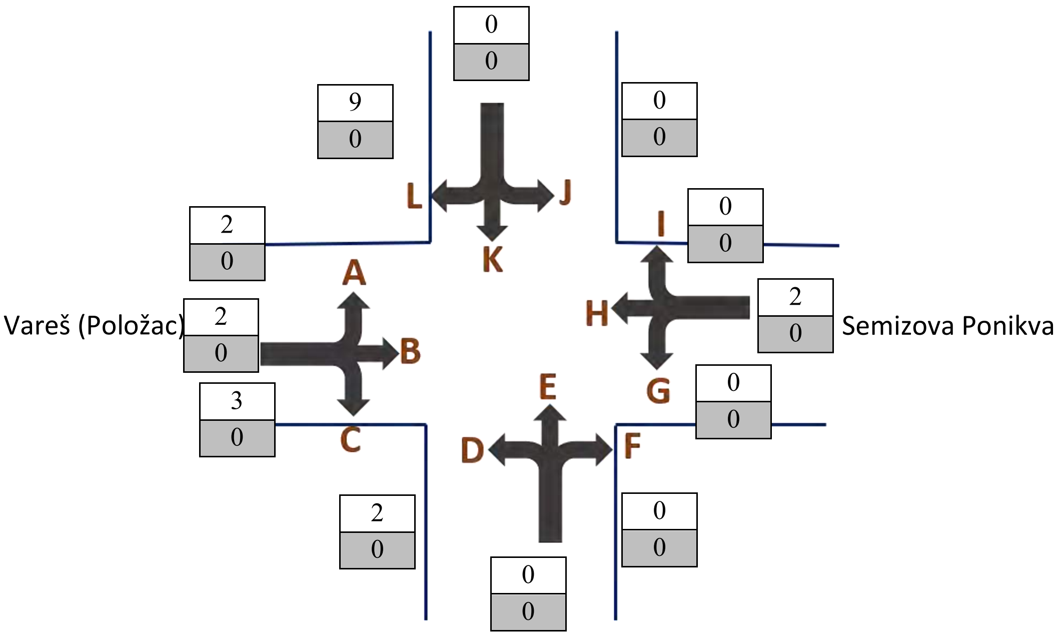
25th July



22nd Oct

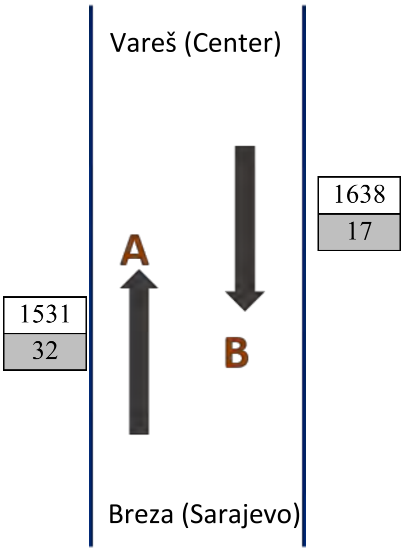


24th Oct

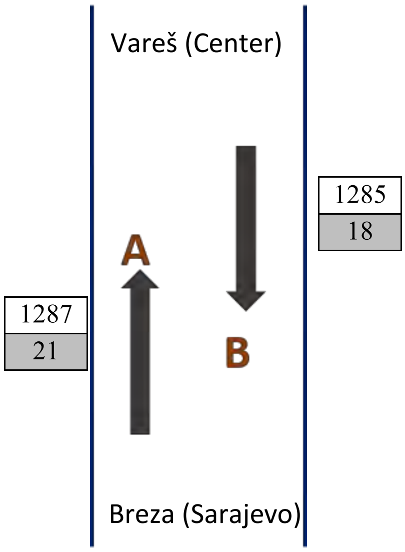


TS3 Vareš

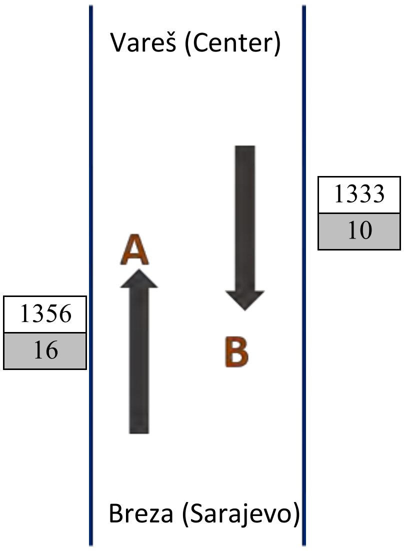
30th July



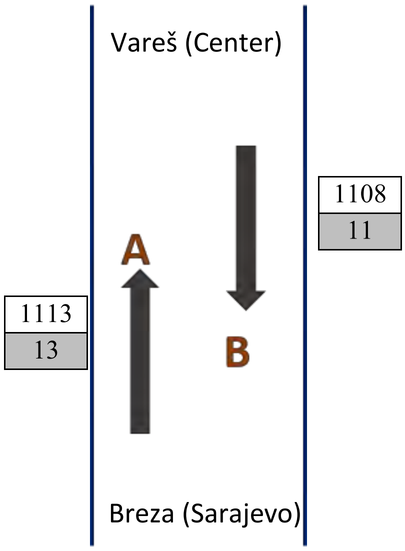
22nd Oct



1st August

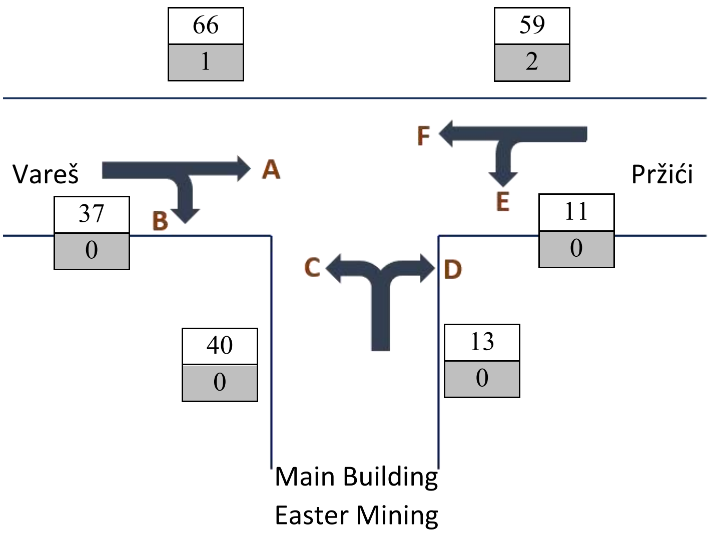


24th Oct



TS4 Tisovci

23rd July



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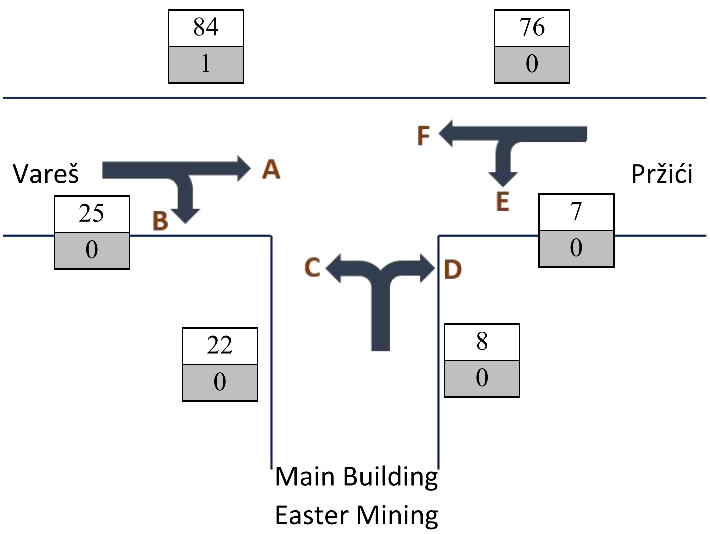
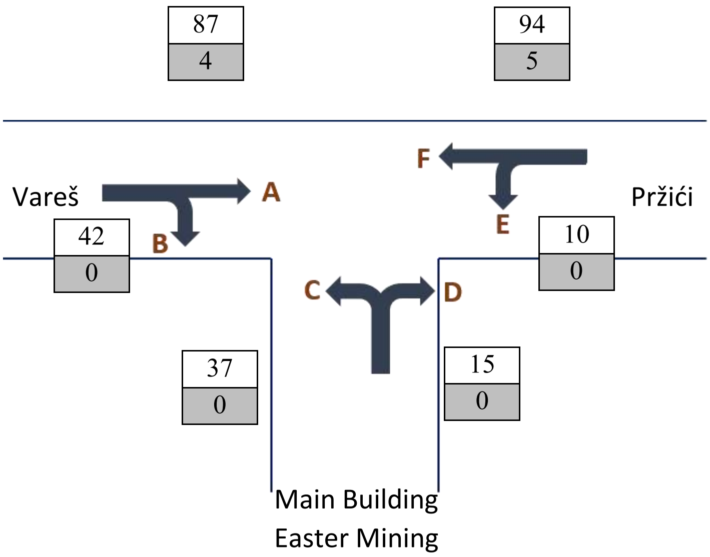
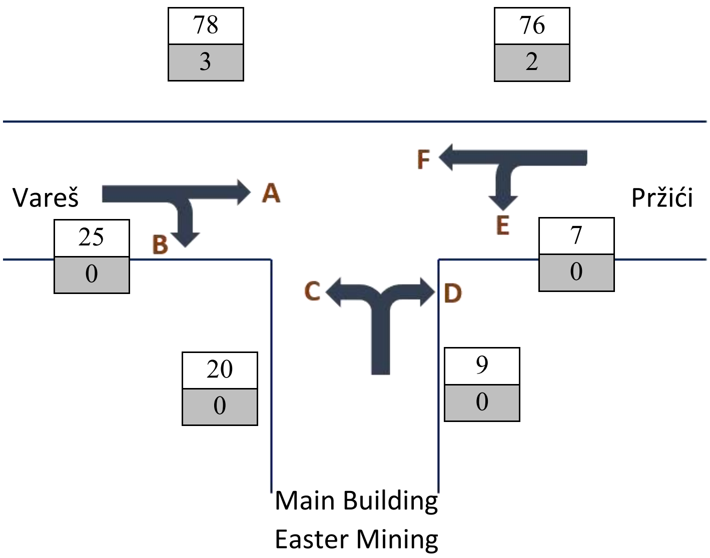


22nd Oct



24th October



APPENDIX 4.12.1: HIA-Vares – ENG vrs 18-04-2021

Health Impact Assessment & HHRA
Desktop study
PROJECT „VAREŠ“
LOCATION RUPICE & VEOVAČA

General data:

Company	*Z-Stem d.o.o.* *Maršala Tita 17,* *7200 Zenica* *e-mail: info@z-stem.org*
Prof dr sc Suad Sivić	*Social medicine specialist*
Doc dr sc Mirza Oruč	*Health promotion and disease prevention, Health management*
Doc dr sc Adnan Mujezinović	*Health promotion and disease prevention,*
Kenan Galijašević, MA	*Health promotion and disease prevention,*

General information about client:

Client	*Eastern Mining d.o.o. podružnica Vareš*
Adress	*Tisovci, bb 71330 Vareš*
Contact person	*VildanaMahmutović*

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LIST OF ACRONYMS

ZDK – Zenica- doboj Canton
FBIH – Federation of Bosnia and Herzegovina
BIH – Bosnia and Herzegovina

DDD – disinfection, disinsection, deratization (rodent control)

K – Company
ZU – Health facility
LZ – Local Community
MH – Ministry of health
NGO – Non–governmental organisation

1. INTRODUCTION

The municipality of Vareš is geographically located in the area of Zenica – doboj Canton as and administrative unit within the administrative and political system of Bosnia and Herzegovina, ie within the entities of the Federation of Bosnia and Herzegovina.

As one of the twelve municipalities / cities within the Zenica-Doboj Canton, the entire administrative and technical center is connected to the City of Zenica as the Capitol of the Zenica-Doboj Canton, such as:

- Health insurance.
- Secondary and tertiary level of health care.
- Environmental issues, etc.

Taking into account the impact of a project such as this, it is necessary to look at the broader picture of the entire regional position of the Municipality of Vareš as part of Zenica - Doboj Canton whose geographical location affects certain characteristics of the health but also the overall organization of health care at local and microregional level.

Geographical location and connections with road traffic The Municipality of Vareš is approximately 75 km away from the center of the Canton, which are connected by road..

According to the available data that we have, which are referent and related to the municipality of Vareš, we state the following:

Table 1. Presentation of population age strucutre Municipality of Vareš [1]

Municipality	Total	Age group (%)		
		0-14	15 – 64	65+
Vareš	8.026	811 (10%)	5.352 (67%)	1.863 (23%)
	8892 (2013)	945 (10,6)	5529 (62%)	1843 (20,7)

Given the number and percentages of the specific population in this region, it is extremely necessary during the launch of a large project such as this to conduct a study of the impact on the health of the local population as well as the impact on health and safety of micro and macro regions. The age structure in the Municipality of Vareš, which has not changed drastically in the last two years, ie since the official report of the Federal Bureau of Statistics of the FBIH and the official Information on the health status of the population from 2018, puts the Municipality of Vareš in the leading position with the most unfavorable situation (progressively – regressive). thus requiring a specific type of health care organization and health care organization. This age structure of the population together with other factors that affect the health of the population may show a specific structure of the disease.

[1] Izvor: Informacije o zdravstvenom stanju stanovništva ZDK 2018, Popis 2013 www.statistika.ba

Birth rate – mortality ration in the Municipality of Vares is negative, and the municipality of Vareš has a leading role in this negative trend shows another factor that significantly affects the design and organization of health care.

According to: Information on the health status of the population and the organization of health care in the Zenica-Doboj Canton in 2018, the leading diseases due to death are heart and blood vessel diseases with 51% share, followed by malignant diseases 22% and respiratory diseases 6%. Cardiovascular diseases most often include heart failure, acute heart attack and stroke. Malignant diseases most often occurred in lung malignancy, gastric malignancy, liver malignancy, and breast malignancy. Fibrosis and cirrhosis of the liver are the leading causes of death from the group of diseases of the digestive system. Although Vareš has one of the largest numbers of malignant neoplasms, it fits into the Presentation structure of the disease in the Zenica-Doboj Canton.

It is necessary to assess the initial risk to human health as well as to identify potential exposure of the environment, employees and other persons to harmful substances that can be identified during the establishment of the project.

The leading diseases in the Municipality of Vareš during 2018 were:

- - Diseases of the respiratory system.
- - Diseases of the circulatory system.
- - Endocrine and metabolic diseases.
- - Diseases of the musculoskeletal system.

Table 2. Presentation of strucutre of leading diseases by age groups in the Municipality of Vareš

Disease/age	0-6 years	School children and youth	Adults	Older than 65
Respiratory system	195	191	167	
Musculoskeletal system	13	23	178	750
Digestive system	6			
Skin and subcutaneous tissue		16		
Circulatory system			466	496
Endocrine system			154	150
Mental illness			71	73

The movement of the organization of health care in the Municipality of Vareš also has an impact and a direct connection with the project "Vareš" it is necessary to present data on health care and its potential::

Table 3. Presentation of potential and structure of health care sector in period 1991 – 2018. in the Municipality of Vareš .

	1991	1998	2006	2007	2008	2009.	2010.	2011.	2012.	2014.	2015.	2016	2017	2018.
Number of hospital beds	*Using resources of Cantonal Hospital in Zenica*													
Number of primary medicine practice	23	12	11	11	14	11	13	14	11	14	11	10	10	10
Number of specialist consultative practice	6	6	9	9	8	8	7	7	7	8	6	6	7	7
Number of dentist practice	6	3	3	3	3	3	3	3	2	2	2	2	2	2
Number of pharmacies	2	1	0	0	0	0	0	0	0	0	.-	-	-	-
Number of doctors	26	9	9	7	7	7	6	10	10	9	9	9	9	10
General medicine doctors	15	5	2	2	2	3	2	4	7	5	4	2	4	5
Doctors with specializations	11	4	7	5	5	4	4	6	3	4	5	7	5	5
Number of dentists	8	3	3	3	3	2	2	3	2	2	0	0	0	3
Number of pharmacists	3	1	0	0	0	0	0	0	0	0	0	0	0	0
Number of nurses	74	37	36	35	35	36	36	35	34	33	32	32	35	35
Nurses with University diploma	13	2	3	3	3	3	3	2	3	3	3	3	3	3
Number of supporting staff	44	29	22	19	20	21	21	21	21	21	21	20	21	21
% of supporting staff	28,4	36,7	43,1	29,7	30,7	46,6	44,3	31	29	29	32,8	31,7	30,8	30,4

During 2018, in the area of the Municipality of Vareš, there is 1 specialist clinic, 1 optician's activity and 1 pharmacy in private ownership, while the JU Dom Zdravlja Vareš (Public Health Center) is a public health institution.

Table 4. Presentation of services within the JU Dom Zdravlja Vareš

Medical service	No of teams	No. of interventions	Job description
Occupational medicine	1	108	Systematic examination, preventive examination, counseling
Preschool children health protection	1	359 (210 preventive examination)	Systematic examination, medical control
School children and youth health protcetion	1	73 (6 preventive examination)	Systematic examination, medical control
OBG	1	1338 visits	Women health protection
Pneumophthisiology	1	750 visits (100 preventive examination)	Protection, follow up and prevention of respiratory diseases
Emergency medicine	1	3179 visits (518 house visits)	Emergency conditions
Patronage service	1	415 partonage visits	Patronage service

In order to have a clearer picture of the situation in the micro-region (area of Zenica-Doboj Canton) demographic Presentation by municipalities / cities:

Figure 1. Presentation of Zenica-doboj canton

Općina	Površina, km²	Procjena broja stanovnika
Breza	72,9	13.726
Doboj-Jug	10,2	4.053
Kakanj	377,0	37.155
Maglaj	290,0	22.875
Olovo	407,8	9.609
Tešanj	155,9	43.456
Usora	49,8	6.483
Vareš	390,1	8.158
Visoko	230,8	39.501
Zavidovići	590,3	35.419
Zenica	558,5	109.679
Žepče	210,0	29.979
UKUPNO KANTON:	3.343,3	360.093
Broj stanovnika/km²	119,0	

* procjena broja stanovnika na dan 30.06.2017. godine

Tabela 2: Preliminarni pokazatelji vitalne statistike za 2016 i 2017. godinu

	2016.	2017.
Natalitet	9,5	10,0
Mortalitet	9,5	9,8
Smrtnost dojenčadi	4,9	8,1
Prirodni priraštaj	-0,1	0,1

1.1

Project Background

The Vareš project is the first mining project since 1980 to be approved in Bosnia and Herzegovina. Adriatic Metal proposed this project through its sister company Eastern Mining doo, which has the right to a concession for excavations at the locations of Rupica and Veovace, which is located within the Municipality of Vareš, which is located in central Bosnia (northern part of the central part) within Zeničko -Doboj Canton as an administrative administration within the entities of the Federation of Bosnia and Herzegovina on an area of 390 km2 and an altitude of 829 m with a population of approximately 8892 persons, of which approximately 2917 in the urban environment. The location of Vareš puts it on close communication (below 100 km) by road with three major centers such as Zenica, Sarajevo and Tuzla.

Initial scoping studies were performed during 2020 by the Wardell Armstrong company, and various measurements by the Metallurgical Institute "Kemal Kapetanović" Zenica.

During the preparation of this desktop study in accordance with the needs of the study, the following documents were used:

- Wardell Armstrong development and social scoping study - Vareš Project
- Report No. 33/20 EKO on measuring the amount of determining the composition of the total sediment at the sites of the surface mine "Veovača" and the mine "Rupice" at sensitive receptors in the Municipality of Vareš company "Eastern Mining" d.o.o. Sarajevo.
- Report No. 04/21-EKO on measuring the amount and determining the composition of the total sediment at the sites of the surface mine "Veovača" and the mine "Rupice" tan and sensitive receptors in the Municipality of Vareš company "Eastern Mining" d.o.o. Sarajevo.
- Report on the health status of the population and the organization of health care in the area of Zenica - Doboj Canton period 2010 - 2017
- Information on the health status of the population and the organization of health care in the area of Zenica - Doboj Canton for 2018.
- Health status of the population and health care in the Federation of Bosnia and Herzegovina period 2010 - 2017 of the Public Health Institute of the Federation of Bosnia and Herzegovina.

1.2

Objectives and Scope

The objective and goal of this desktop study include the following:

- Desktop studies of the assessment of risk factors and their effects on human health
- Initial risk assessment for human health as part of the study, with reference to potential exposure of the community and workers (employees) to harmful substances.
- Assessment of the development and timeline of a complete human health impact study with EBRD performance included with community and public health conditions.

During the development of the baseline study, factors that may affect community health (public health) and safety were identified:

- Increased risk of traffic accidents, ie traffic injuries, especially on the route for extraction of materials / waste in the northern part of Vareš, at crossings and uses of the main road.
- Environmental impacts on human health, from the aspect of air pollution and the release of certain particles into the air, as well as the effects of noise that will be the result of work activities.
- Potentially high thallium levels in basic tests and causes that could potentially contaminate watercourses during the project implementation operation.

Although the above-mentioned factors have been identified as a potential danger to the health of the local population and employees, by reviewing the project documentation it can be concluded that Adriatic metals, ie Eastern Mining d.o.o. develop appropriate plans for monitoring and monitoring these factors in accordance with the legal framework in Bosnia and Herzegovina and best practices and in accordance with the recommendations of the EBRD in cooperation and consultation with local stakeholders.

Reports available during the baseline study indicate that the local population is most concerned about pollution from previous mining activities related to soil pollution, watercourse pollution, air pollution (presence of dust and other particles) as well as noise from the plant.

According to the results of initial studies and initial surveys, the impact of substances that can affect pollution were taken into account during the construction of the mine design plant at both locations Veovača and Rupica, the best techniques for urban and construction planning were presented. There are certain researches, initial, which indicate the existence of mercury and thallium in the deposited particles and waters near the mine location, it is necessary to point out the importance of these substances and take into account their concentrations and make a plan for wastewater and matter management. According to available data, there are no data on diseases caused by these elements.

Each of these issues is specifically addressed in the thematic areas of this study.

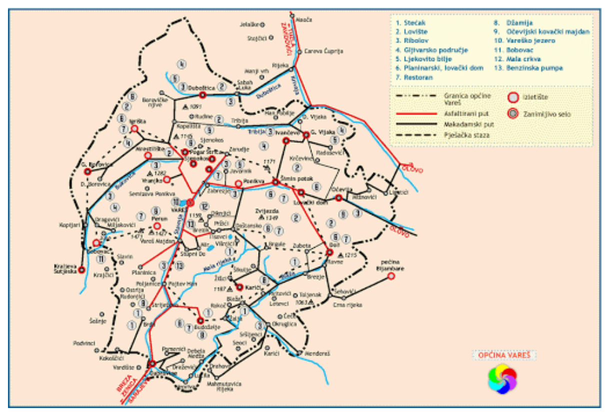
2.0

PROJECT DESCRIPTION

2.1
Location

The location of the project implementation is the Municipality of Vareš, Federation of Bosnia and Herzegovina, Bosnia and Herzegovina. Administrative location in the area of Zenica-Doboj Canton located in central Bosnia and Herzegovina with twelve municipalities with a total area of 3,343.3 km2 with an estimated population of over 360,000 inhabitants. The municipality of Vareš covers 390.1 km2 with an estimated population of over 8,000. The geographical location of the Municipality of Vareš includes road transport that connects it with three major centers within Bosnia and Herzegovina within 100 km, namely Sarajevo, Tuzla and Zenica.

Figure 2. Presentation of Municipality of Vareš geolocation in area of Bosnia and Herzegovina. (left), Presentation of Municipality of Vareš with municipality borders and municipality infrastructure (right). Presentation of Municipality of Vašer geolocation in context of Cantonal capitol and BiH capitol (below)



2.2

Key Operational Aspects of the Proposed Project

The current project of starting a mine in the area of "Veovača" and "Rupica" is located in the rural part of the Municipality of Vareš, in a rural area with an altitude of up to 1250 m covered with forest and low vegetation. Both areas of the excavation project of Veovača and Rupica are connected with the urban part by road infrastructure which is largely asphalted and maintained, Veovača is 2.5 km away from the urban part of Vareš while Rupice is connected with Veovača with 15 km of road infrastructure.

Vareš has a long history of the mining industry and the metal mining and processing industry.
In the period from 1960 to 1980, the domestic company, more precisely Energoinvest, carried out research activities and preparations for the preparation of ore mining in the area of Veovača (surface mine) and the area of Rupica (pit mine).

The political and economic situation in the former state during the 1980s led to the closure of these mines and thus prevented future development. The war actions during the 1990s led to the complete closure and disruption of the mine structure.

According to the forecasts and plans, the construction of the plant is planned for the second half of 2021.

2.2.1

Site Access

The Vareš project area is accessible by road infrastructure using road infrastructure: highway corridor V C, main, regional and local roads for communication and transport.

Available communication with the capital of BiH and the nearest airport is Sarajevo at a distance of 49.3 km.

Figure 3. Presentation of road infrastrucutre and road distance of Municipality of Vareš from BiH Capitol city, Sarajevo.

Extremely important communication with the administrative center and all administrative important structures is the center of Zenica-Doboj Canton on the route Vareš - Zenica total distance in one direction of 75.2 km.

Figure 4. Presentation of road distance of Municipality of Vareš from City of Zenica

Figure 5. Road distance from urban area of Municipality of Vareša from projec location Veovača 9,9 km

In addition to road traffic, there is also rail traffic that allows the use of railways and the type of transport that can be used in the future of the project.

Given the availability of data from a study conducted by Wardell Armstrong, an increase in road infrastructure is evident leading to an increase in traffic and traffic frequency.

Table 5. Presentation of identified risks in the field of traffic

Identified human health risks	Indicators	Prevention and follow up measures
Increased number of traffic accidents. Increased number of traumas caused by traffic accidents. Increasing the total number of waste particles that affect human health (dust, CO, tar, etc ..). Increasing noise in the area of excavated material transport. Increased risk of pollution of watercourses (both drinking water sources and local watercourses).	Number of traffic accidents, Increased number of traumas, changes in results of analyzes of water sources, in the results of noise measurements and measurement of the presence of deposited particles in the air in the area of Veovača and Rupica.	Develop a continuous plan for measuring airborne particles in the project area Develop a continuous plan for measuring the presence of brushes that are dangerous to human health and are directly related to increased traffic Make contact with the competent medical institutions that monitor the number of diseases that occur with increased pollution (eg respiratory diseases) Analyze the impact of other pollutants on the micro and macro region.

:

2.2.2

Operational Support

The review of the existing project documentation did not determine the risk of bringing employees from third countries or other countries. The workforce and human resources are based on local employees.
Considering the increased scope of work and the number of new employees that will increase with the process of excavation and starting the entire operation, and given the specifics of the profession, it is evident that micro migration will occur in the Zenica-Doboj Canton.

Table 6. Presentation of identfied potential risks in operational support

Identified human health risks	Indicators	Prevention and follow up measures
Given the lack of arrival of staff from "third" countries and changes in cultural and ethnological terms, a high risk of introduction of foreign and non-specific diseases cannot be identified. The number of foreign experts to be involved in the process has not been identified as a threat to human health. Given the increase in the number of employees and the working age population in the field of project actions, and the nature of the industry itself, a greater number of traumas can be expected, as well as an increase in non-specific diseases, to an increase in occupational diseases.	Number of occupational diseases, Number of occupational injuries, Number of registered incidents at work that resulted in injury,	Development of an employee health care plan in cooperation with subcontractors who take care of the health of the working population with a specific emphasis on the protection of employees in this area of industry Development of an action plan in emergencies and conditions caused by accidents at work. Development of a plan in action in accordance with the occurrence of epidemics and pandemics such as Covid-19, other viral diseases, zoonoses, etc.… Connecting with key stakeholders involved in preserving the health of workers. Forming a team (independently or in collaboration) to respond to an accident in the industry. Continuous monitoring of the occurrence of specific diseases in cooperation with the competent institutions.

2.2.3

Project Timing/Schedule:

Area of Vareš Project especially Rupice i Veovača are located on natural high ground 1250 m above sea level it is important due the climate that very low temperature can make impact on people involved in project Rupice and Veovaca location.

Table 7. Presentation of identified potential risks

Identified human health risks	Indicators	Prevention and follow up measures
Increased number of frostbites and other traumas caused by low temperatures. An increased number of other types of injuries are directly related to low temperatures and climatic conditions.	Number of injuries caused by low temperatures. Number of seasonal diseases associated with low temperatures.	Plan for education and prevention of injuries caused by low temperatures and climatic conditions. Develop a plan for the care of injuries and traumas during the occurrence of possible accidents due to complex climatic conditions.

3.0 LEGAL, ADMINISTRATIVE, AND LEGISLATIVE FRAMEWORK:

Given that in the preparatory phase of the project, all the necessary regulations and legal regulations were sewn, respecting the elements of application of best practice, the legislation clearly prescribes compliance with the elements that affect human health and community health. Given the political and administrative order of Bosnia and Herzegovina, certain legal elements are transferred from the jurisdiction of the entities to the jurisdiction of the cantons and are applied with the same rights.

Laws that directly affect people's health are:

- Law on Health protection in Federation BiH (Official gazette FBIH 46/10 and 75/13)
- Law on population protection from Infectious disease (Official gazette FBIH no. 29/05).
- Law on radiation and nuclear safety in BIH (Official Gazette of BIH, no 88/07).
- Law on disposal management (Official Gazette of FBIH 33/03).
- Law on environment protection (Official Gazette of FBIH 33/03 and 38/09).
- Law on environment protection of Zenica – Doboj Canton (Official Gazzette of FBiH no 1, Year V. 2000.)
- Law on environment protection (Official Gazzette of FBIH no 15/2021)
- Law on noise protection of Zenica-Doboj Canton (Official Gazette 1/14)

These legal acts directly affect the regulations concerning human health and community health, along with the accompanying acts which prescribe the legislation in more detail.
Legal elements that indirectly affect the preservation of human health but have a role in project preparation are:

- Law on Nature Protection ("Official Gazette of the FBiH," No. 66/13);
- Law on Water ("Official Gazette of the FBiH," No. 70/06);
- Law on Spatial Planning and Land Utilization at the FBiH level ("Official Gazette of the FBiH," No. 02/06, 72/07, 32/08, 04/10, 13/10, 45/10);
- Regulation on Determination of Works and Buildings for Which the Federal Ministry of Spatial Planning Issues the Urban Permit and/or Location Information ("Official Gazette of the FBiH," No. 32/14);
- Regulation on Plants and Facilities for Which the Environmental Impact Assessment Must Be Carried Out and Plants and Facilities Which Can Be Constructed Only with the Environmental Permit ("Official Gazette of the FBiH," No. 19/04);
- Regulation on Content, Order of Preparation, Constituent Parts and Method of Developing Mining Projects ("Official Gazette of the FBiH," No. 53/12);
- Decision on Conversion of Forest Land to Construction Land ("Official Gazette of the FBiH," No. 108/12); and
- Law on Forests ("Official Gazette of ZDC," No. 8/13 and 1/15).

Insight into the project documentation and initial measurements shows that best practices are applied and legal regulations are respected.

4.0

HIA FRAMEWORK AND METHODOLOGY

4.1

HIA within the Proposed Project

The existence of a scoping study done by the Werdell Armstrong company that points to a number of risks identified has led to the need to produce a human health impact study, i.e.:

- Increased risk of increased traffic accidents, especially in the area of transport trucks;
- Environmental impact on health-related factors, air pollution and increased deposition and presence of dangerous particles in the air, the impact of noise during operations;
- Results of basic tests that show elevated levels of thallium, which could increase during operations.

The existence of studies and measurements of the value of elements that affect the health of the population and related to environmental and social factors, the inevitability of the existence of the HIA study is stated as the need to complete the documentation in the project.

4.1.1

Scope of the HIA

The objective and goal of this desktop study include the following:

- Desktop scoping study of the existence and identification of risk factors for the health of the population.
- Initial risk assessment for human health as part of the study, with reference to potential exposure of the community and workers (employees) to harmful substances.
- Development and timeline of a full human health impact study with EBRD performance included with community and public health conditions.

Given that the development of desktop studies of the impact on human health is planned, the current part involves the identification of all potential factors and risks of the impact on health as well as indicators that can be monitored by this process. the aim of this study.

4.2

Impacts Categorization

The system of monitoring the impact on the health of the local population and the environment cannot be monitored in one way, but it is necessary to develop several monitoring systems depending on the results and parameters of other measurements.

The categorization of impacts needs to be carried out at several levels as follows:

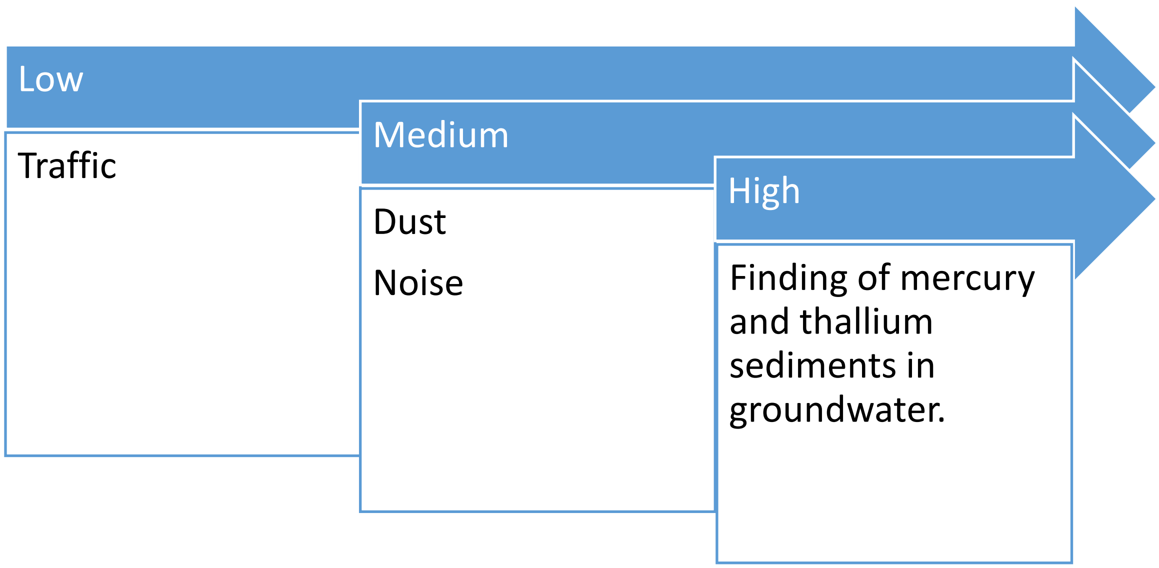
Table 8. Imapct categorization

Level	Action	Indicators
I	Screening	Identification of key factors as potential causes of human health.
II	Scoping	In case level I is satisfied. Identification of key factors necessary for this phase in cooperation with local stakeholders: - Health care - Quality of life - Recreation - MNB - Nutrition - Geolocation - Employment - - Crime
III	Assesment	Only if level II is satisfied. Identify the following key factors: - Epidemiological measurements - Which population is affected - Who has the most influence - Key stakeholder - Key measurements - Interventions - Strategies - Procedures - Politics
IV	Reporting	Conclusions Data display Recommendations Defining implementation dates

Given these elements mentioned above, we must keep in mind the degree of impact on health and the local community. The impact identification system must be defined from very small to very high.

Identified elements recorded by the baseline study such as dust, noise, increased traffic, and the discovery of mercury and thallium in the country must be analyzed.

Graph 1. Presentation of degree of potential risk influence/impact



4.2.1

Direct versus Indirect Effects

During the preparation of the study of the impact on the health of the population, it is extremely important to note that the geographical position greatly influences all the factors and risks that have been identified in this process.

The region to which the Municipality of Vareš belongs, ie Zenica-Doboj Canton, and the surrounding municipalities have a significant impact of cumulative effects that affect health because there are large industrial factors that affect all the above factors such as:

- Air pollutants:

1. Kakanj Thermal Power Plant
2. Cement factory Kakanj
3. Natron Maglaj (which is not in the immediate vicinity but due to the unfavorable influence of winds, the possibility of particles reaching the specified area).
4. ArcelorMittal Zenica (which is not in the immediate vicinity but due to the unfavorable influence of winds, the possibility of particles reaching the specified area).
5. Prevent Leather
6. Home fireplaces
7. Cars (close to highways, other regional, main and local roads)

Potential water pollutants:

1. KTK Visoko, Prevent Visoko

2. Coal mines near the geographical location
3. More meat industries in the Canton area and near the location along with certain food processing industry.
4. More illegal landfills in the area and near the location.
5. A series of sewage systems from rural and urban settlements
6. Potential factors that cannot be determined now but as new investors who can launch new “projects” that can be within water protection zones.

These potential risk factors contribute to the development of indirect effects on the health of the micro community.

Direct factors can still be clearly identified but, it is certainly necessary to pay attention to pollution and factors that may affect from the immediate environment and play an indirect role.

4.2.2

Cumulative Effects

According to statistical indicators, the leading cause of mortality in this region is cardiovascular disease. These are also the leading causes of illness in the working population and the elderly. A significant number of these patients have reduced working capacity, economic, emotional and other disorders. The onset of most of these diseases can be prevented by a healthier attitude towards certain habits (lifestyles), and complications can already be prevented in those who are already ill and the risk of premature death. The main risks for the appearance of these diseases are therefore unfavorable habits and unfavorable environment such as stressful situations, inadequate diet, smoking.
Early detection and early treatment prevents the occurrence of fatal complications and irreparable damage to the organism, as well as the return of the patient to his normal work tasks.
The five leading chronic diseases of the cardiovascular system participate with 93.9% in the total morbidity of chronic CVD diseases.

Since the largest number of mass chronic non-communicable diseases occurs due to the cumulative factor, it is necessary to monitor diseases that occur due to the cumulative effect, such as malignant neoplasms, cardiovascular diseases, endocrine diseases, etc.

According to the latest official data from the competent institutions, the Municipality of Vareš had 36 reported cases of malignant neoplasms, if we take into account the structure of the population, morbidity puts this municipality in second place in Zenica-Doboj Canton. The most common malignant neoplasm in men in Zenica-Doboj Canton was at the localization of the trachea, bronchi and lungs (27%) and it should be monitored in cooperation with relevant institutions, while in women the most common malignant neoplasm was localized in the breast 21%). Considering all the indicators concerning the microenvironment (Zenica - Doboj Canton), the occurrence, morbidity and mortality in the Municipality of Vareš do not show any certain deviations in relation to other Municipalities / Cities that are part of the canton.

Since most mass chronic non-communicable diseases are caused by cumulative effects, it is necessary to pay attention to neuropathic diseases that occur in the canton, but also musculoskeletal diseases that are a significant public health problem. Given the type of industry that will be implemented in the Municipality of Vareš, it is necessary to develop a plan to improve the protection and prevention of musculoskeletal diseases in cooperation with the local community. The most common diseases that occur in this group are diseases of the spine with diseases of the joints.

4.2.3

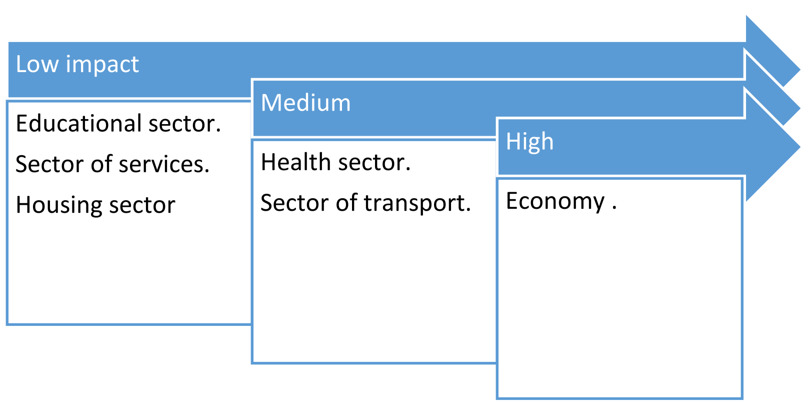
Specific Mini-HIA Methodology: Sectoral approach

The Vareš project (Rupice and Veovača) will certainly have an impact on various sectors in the Municipality of Vareš micro-region. Given that all elements of society and social welfare will be included, the increase of employees from 246 employees in total at the peak of work will not have a large direct impact on the population of Vareš, which is an increase of approximately 0.02% in total population. Considering the reports of the competent institutions that show a negative natural increase in this municipality, and the regressive progression of the age of the population, we must certainly consider.

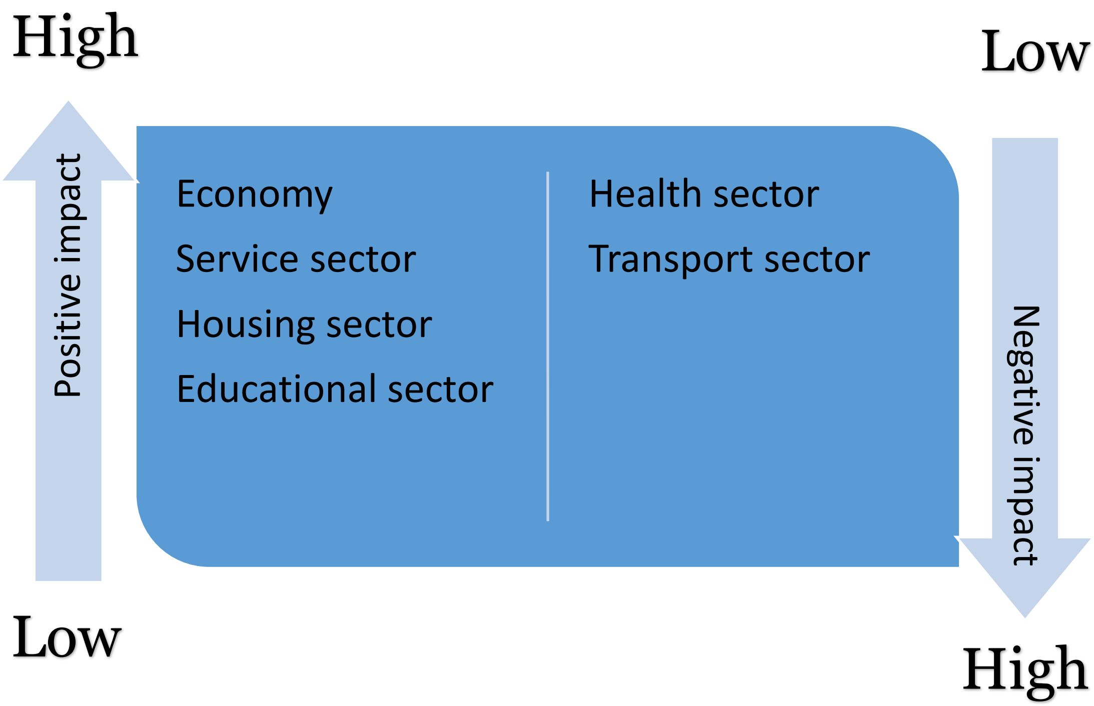
An indirect factor that will monitor all sectors of the micro region will be the monitoring of migration, ie the arrival of people who have qualifications to work on this project, given the previous migrations of the working population, which implies that the number of family members who will come with them is likely to grow exponentially. accompanied..

The cross-sectoral impact does not always have to have a negative implication but also a positive one, so the level of health care, the level of education, the level of service activities provided, housing capacities, road infrastructure capacities, etc. must be taken into account.

Graph 2. Presentation of itnersectoral impact in the area of Municipality of Vareš



Graph 3. Presentation level of intersectoral impact of project „Vareš“



4.2.3.1

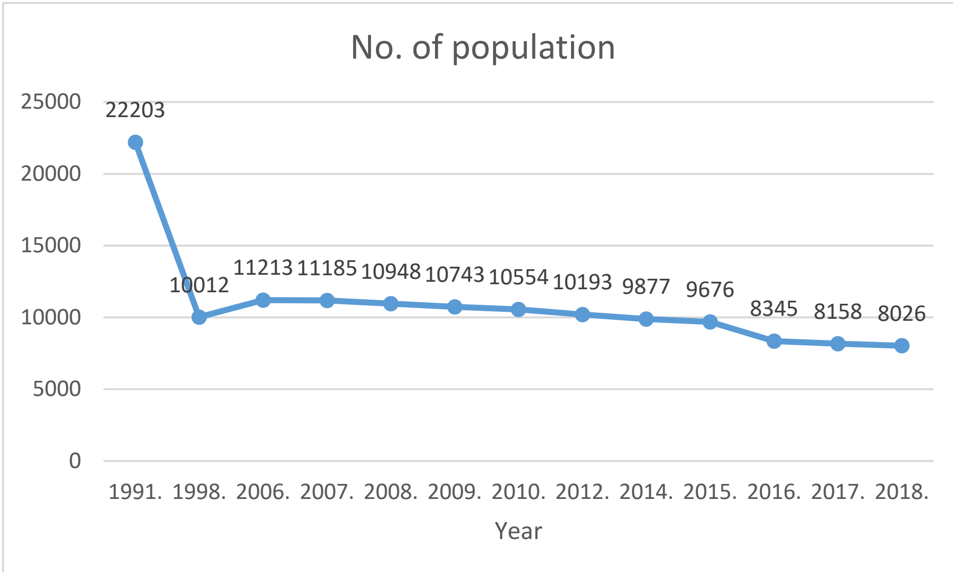
Housing

Insight into the demographic structure of population movement in the Municipality of Vareš we can see that the population is declining and there is a negative natural increase, and increased negative regressive aspect of population (old population) the existing infrastructure in the Municipality of Vareš will provide accommodation for all new employees Rupice 118 and Veovača 128 represents fluctuations in 3% of the total population and as such does not affect the need to develop a special camp or accommodation for new employees.

Table 9. Presentation of population movement in the Municipality of Vareš

Year	No. Population
1991.	22203
1998.	10012
2006.	11213
2007.	11185
2008.	10948
2009.	10743
2010.	10554
2012.	10193
2014.	9877
2015.	9676
2016.	8345
2017.	8158
2018.	8026

Graph 4. Presentation of population movement in the area of Municipality of Vareš.



4.2.3.2

Water supply, Sanitation and Food

Given the existing data from studies such as Wardell Armstrong, there will be no changes in water supply, given the proven elements and the factual state of the project as well as previous elements of the Review of project documentation in both Rupica and Veovača. By applying high standards in this area of industry and respecting the relevant legal regulations, it is possible to predict the safety of water supply when we talk about drinking water..

Since the project documentation will not build a new camp or settlement for employees and staff who will work on the site of Rupica and Veovača and will use existing residential buildings, the use of communal infrastructure will be enabled and facilitate compliance with all regulations and reduce risk.

No specific elements related to direct dietary risk were recorded. Since the existing project did not envisage a camp for workers / employees nor the existence of a space / facility for food preparation, there is no direct risk and impact on human health. In the event of the existence or need to organize such a plant / department, the applicable laws and regulations have a high standard of quality assurance in this process.

However, based on the published results in the Information on population health in the Zenica-Doboj Canton from 2018, published by the Institute for Health and Food Safety, key sanitary and hygienic problems in the Zenica-Doboj Canton have been identified but which can be reflected in each individual municipality in the canton.

Those factors are:[2]

1. Lack of public health control of drinking water.
2. Poor sanitary and technical condition of local water facilities.
3. Insufficient supervision over the health safety of water from local water bodies.
4. High percentage of microbiologically defective drinking water samples from local water bodies.
5. High percentage of microbiologically defective samples of drinking water from school water facilities.
6. Incomplete and sanitary-technically defective city sewerage network.
7. Insufficient supervision of public baths.
8. Deficiencies in resolving the issue of maintenance of common parts of privatized and non-privatized residential and commercial buildings, which results in difficulties in resolving current and incidental environmental problems
9. Lack of system for treatment of municipal and industrial wastewater.
10. Non-existence or sanitary-technical malfunction of local facilities for removal of liquid waste materials.
11. Insufficient technical equipment of utility companies, with an insufficient number of workers employed in the immediate maintenance of the cleanliness of the settlement.
12. Unsatisfactory general hygienic condition of the settlement.
13. Irregular garbage collection from settlements and unresolved issue of garbage collection and final disposal of garbage from most rural settlements.
14. Unacceptably poor sanitary and technical condition and location of most solid waste landfills in the area of Zenica-Doboj Canton.

In the group of diseases that develop under the influence of these factors, intestinal early diseases that are directly related to contaminated food, water and contact most often occur and may have the characteristics of an epidemic in large groups. Although according to available data the highest incidence rate in Zenica-Doboj Canton was in cities with the largest population such as Zenica and Visoko and the lowest in the municipalities of Maglaj, Vares, Doboj South and Usora, which is directly related to population size and development, we can conclude that Hygienic - epidemiological factors of water, rescue waste and sewage play a key role in this process.

Existence of data on the increased amount of deposited thallium at the research sites of the Vareš project, and where there is a real possibility of it reaching the water supply system, it is necessary to pay attention to the amount of thallium and its value in this area.

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[2] Source: Informacije o zdravstvenom stanju stanovništva i zdravstva na području ZDK 2018. Institu za zdravlje i sigurnost hrane ZDK

Table 10. Presentation of identified risk
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Identified human health risks	Indicators	Prevention and follow up measures
Occurrence of pollution in the process of watering the local area. Condition of the sewerage system in the peaceful area of Veovača and Rupica. The process of nutrition and the way of establishing and preserving the quality of nutrition. Occurrence of diseases associated with poor hygienic-epidemiological situation that directly affect human health. Occurrence of the disease due to increased concentration of naturally deposited thallium in the area of Veovača and Rupica. Outbreaks of infectious diseases transmitted by contaminated water, food or vectors due to poor hygienic epidemiological diseases (different types of zoonoses).	Number of infectious diseases of the intestinal tract caused by poor hygienic and epidemiological situation. Increased number of zoonosis. Increased number of non-specific diseases associated with natural thallium deposition. Increased number of defective analyzed drinking water samples. Absence or damage to the sewer network. Risky handling of food and groceries. Increased number of defective or contaminated food causes being analyzed.	Monitoring of communal hygiene and hygiene in common facilities. Activity on improving the health safety of food and drinking water, hygiene in the production and serving of food, while raising the hygienic habits of employees / population. In cooperation with local stakeholders, improve the control over the health safety of drinking water from local water bodies and undertake the rehabilitation of local water bodies. If necessary, disinfect water in local water facilities, especially rural and local water supply systems. Training of staff for the water disinfection process. Monitorin) on health safety parameters (chemical safety of toxic metals, organochlorine and organophosphorus pesticides, polychlorinated biphenols, mycotoxins, additives, and microbiological and radiological safety). Monitoring and detection of pollutants in air and soil. Measures of forest devastation and land degradation, especially in the catchment areas of the main springs. Make a reforestation plan

		Regular cleaning of watercourses from sediments that are suitable habitats for harmful rodents and can be a source of dangerous infectious diseases for humans and animals. Rehabilitate sewerage networks. Monitor supervision in cooperation with the competent services for health ecology. Continuous implementation of targeted research in order to collect accurate data on the harmful effects of certain environmental risk factors on human health. Information and education plan in schools, as well as children and their parents, on the importance and manner of reducing the impact of harmful environmental factors on health in cooperation with stakeholders. Strengthening own capacities for water health testing or cooperation with competent laboratories.

4.2.3.3

Transportation

There is a certain road infrastructure at the project site that is already in use. The Vareš project includes the construction of new access roads that will intersect with local roads and road infrastructure.

The municipality is well connected by road, from the aspect of health needs the local population is 49.1 km away from the nearest hospital, while the location of the surface mine Veovača is 9.4

km away from the nearest health institution JU Dom zdravlja Vareš, while the location of the mine Rupice is approx. 21 km from the first medical institution JU Dom zdravlja Vareš.

Figure 6. Presentation of road distance of project location Veovače to the JU Dom zdravlja Vareš

Table 11. Presentation of identified potential risk factors

Identified human health risks	Indicators	Prevention and follow up measures
Increased number of traffic accidents. Increased number of injuries due to traffic accidents. Increased noise level due to transport. Increased dust levels during transport and transportation. Lack of public transport and impossibility of equal access to health care.	Number of traffic accidents. Number of injuries. Noise values. Dust (particles) values.	A plan to promote education on traffic culture and increase the transport of the local population, which will be directly exposed to this process. Building internal safety policies during transport.

4.2.3.4

Communications, Information Distribution

In the area of Zenica - Doboj Canton, of which Vareš is a part, the distribution and transfer of information from the aspect of health is being implemented very well. The competent body that collects information and distributes it to the competent authorities but also to the citizens is at a very high level. Data are collected by a hierarchical method in accordance with established practice prescribed by law.

Eastern mining d.o.o. The company also opened an info center within the urban zone of the Municipality of Vareš, thus enabling citizens to disseminate information and provide timely information on all topics, including health.

The entire area of the "Vareš" project is covered by the reception of mobile telephony of local operators.

There are no identified risks in this area.

4.2.4

Environmental Health Areas (EHAs):

Table 12. Presentation of potential elements that could have impact on population health, so attention should be paid

Area	Potential human health impact	Mitigation strategy
Infectious diseases associated with overcrowding and poor hygienic and epidemiological conditions - acute respiratory infections (bacterial and viral), pneumonia, tuberculosis, the impact of hygienic - epidemiological conditions on respiratory diseases, immunization coverage.	The existence of the "Vareš" project will not lead to major changes in population density. Hygienic and epidemiological measures will not be changed and the same incidence of respiratory infections and TB is expected, which is likely to remain at the current average. NOTE: due to pandemics or large epidemics such as Covid-19, N1H1 and the like, there may be a risk of developing these infections due to the nature of the job itself.	Visually, public health supervision is well organized, the existing health institutions provide periodic preventive examinations of employees within the occupational medicine service, it is necessary to make contact and make a plan of cooperation and periodic mandatory examination of employees. Due to the outbreak of the epidemic and the spread of respiratory diseases, it is necessary to follow the protocols of the competent legislative structures in these processes.
Vector transmitted diseases - malaria, dengue, tick-	The type of work that will be done by itself carries an	In cooperation with the local competent

borne diseases, and other zoonosis	increased risk of developing these diseases. Since micro location has no recorded diseases such as malaria or different types of hemorrhagic fevers, the risk of developing the same is small. The risk of tick-borne diseases can be considered very low. The occurrence of leptospirosis is at a moderate risk level. The project will not develop any direct or indirect impacts with disease transmission.	authorities in charge of maintaining hygienic and sanitary measures, make a maintenance plan and periodization of its implementation. Follow the reports of institutions dealing with the monitoring of these diseases and react accordingly. Intensify DDD activities in accordance with prescribed standards.
Diseases related to soil, water and general sanitation	According to the available data and the initiation of operations at the Veovača and Rupica sites, changes in soil and water quality may occur. However, taken into consideration the information presented in the original project and the presentation of activities this risk is low moderate. The occurrence of the disease due to poor sanitary and hygienic conditions is a very low risk given the application of best practices and standards in construction. Since the project itself will use certain amounts of water in its process by applying high standards the risks will be eliminated. Given that there is not a large number of workers and the development of camps / settlements for	Although a plan already exists, it is necessary to continuously monitor the occurrence of various elements that can lead to the occurrence of diseases caused by these factors. Although there are no written traces or information about specific patients caused by high amounts of mercury or thallium in the soil, it is necessary to develop a plan for monitoring the value of these elements during the process of implementing activities in this project.

	the same project has no impact on diseases that can occur due to poor sanitation of the local community. The eventual development of a camp / settlement for workers will be accompanied by high standards of sanitary ware construction, which would reduce the pollution of soil and surrounding waters to a minimum.	
Sexually transmitted diseases - HIV / AIDS, syphilis, gonorrhea, hepatitis B	iven that there will be no high population growth in the Municipality of Vareš or large migration of staff, the risk of sexually transmitted diseases is very low, ie negligible and the project has no impact on the increased number of these diseases.	Develop a plan and cooperation with local health stakeholders that will enable periodic examinations and employee education.
Food and nutrition related diseases - eg anemia, avitaminosis, food poisoning, etc....	The nutrition of the employees in the project itself is not clearly presented as it represents the next phase of the project. The sector of providing services in the process of food production and marketing, both individually and within large collectives, is extremely well resolved by sanitary-inspection-legislative regulations. However, there is a low moderate risk of occurrence and occurrence of these diseases that are not directly caused by the project or project activities. The project will	The key plan and strategy is to comply with local community legislation in this process.

	not use arable land currently used for food production and will not have any impact on the development of these diseases.	
Non-communicable chronic diseases - hypertension, diabetes, CVI, CVD disorders	Chronic non-communicable diseases are extremely important and regardless of the nature of the project, they always represent a low moderate risk of impact on the local community, because with the development of the project, the income of the local community increases and thus the practice of unhealthy lifestyle.	The goal of mitigating this risk is to cooperate with the local community in order to create policies to prevent the occurrence of these diseases, as well as to detect possible risk factors. Potential risk factors associated with the project will be dust and noise. Focusing on the project itself, to achieve cooperation with local stakeholders who have the opportunity to periodically monitor and prevent the occurrence of these diseases, such as the service for occupational medicine JU DZ Vareš.
Injuries - traffic trauma and other injuries and trauma	The Vareš project envisages the construction of new roads and at the same time the intersection with permanent local and regional roads, and as such represents a moderate risk for the occurrence of these injuries. Given that this is a transport not only in the local community but also at the wider community level, this risk needs to be considered.	The strategy of prevention of this factor and reduction of its impact can be achieved by applying the best practices and the highest standards in this area, respecting the necessary technical conditions of vehicle correctness and compliance with the rules during transport. Establish cooperation with local stakeholders who deal with the maintenance and technical correctness of roads as well as their signalization, and part of the roads that are not

		under the jurisdiction of the company itself.
Veterinary diseases and other zoonosis	According to the available data in the Municipality of Vareš, no such diseases were reported during 2018, so this risk can be considered a very low risk factor for the impact on the health of the population.	Follow the recommendations of the relevant stakeholders and respect preventive measures in accordance with legal acts.
Environmental factors	Considering the location of the project, the local population is at an appropriate distance from noise and vibration. The harmful effects of noise and vibration should not affect populated areas. The effect of thallium and mercury accumulation in the project area in groundwater samples may pose a potential risk. There is a possibility of dust as a factor influencing human health together with other pollutants.	Continuous monitoring and measurement of noise and vibration levels as well as air quality. Development of effective communication procedures to transparently present measurement results. By monitoring the results of certain diseases, the factors influencing human health have not been determined. Develop an appropriate system for monitoring the concentration of suspected elements. Continuous monitoring of their concentrations. Air quality monitoring together with a program for assessing possible risks to human health as well as prevention of disease development. In case of detection of environmental potentially harmful substances (mercury, thallium) in concentrations that are higher than allowed, it is necessary to have an action plan for remediation and

		reduction of their concentration.
Social factors	The municipality of Vareš is one of the least developed municipalities in ZDK, as such social styles have a high risk to the health of individuals from the municipality, as such social styles have a high risk to the health of individuals from this municipality. According to the projected and available data, this project does not have a negative impact on the social factors of the environment, on the contrary, it should have a positive impact with raising welfare and strengthening lifestyles.	Cooperation with the environment, stakeholders and other NGO sector that can have an impact on this process. Development and support of lifestyle improvement programs.
Traditional medicine	Data on the existence of traditional treatment are mostly related to the collection of medicinal herbs in the process of traditional treatment for the preparation of teas, beverages and other types of medicines. Given that the geographical location is suitable for the collection of medicinal plants and comes into close contact with the locations of the project, there is a possibility of influencing this process.	No information is available on the official connection with the official bodies. According to the data of the population survey from the area of Veovača and Rupica, the local population of both localities pays special attention to picking and consuming medicinal herbs in their habits. In cooperation with relevant stakeholders, create the promotion of these activities.
Health care system infrastructure	The municipality of Vareš has a very poor infrastructure of the health system. Given the fragmentation of housing infrastructure, a rather large problem and a	In cooperation with the local community, strengthen the health infrastructure, lobby higher levels of government to improve health care.

	particularly poor organization of the health system can be seen in local communities / villages that have functional clinics, but due to poor organization of the primary level of health care, health workers come occasionally (monthly / not at all). As is the case with the surveyed residents of Borovica. This is a moderate risk, but there is still good communication with other developed municipalities / cities that have developed infrastructure.	Within the company and the protection of workers, signing contracts with other companies that deal with health care. Development of disease prevention programs in cooperation with the local community.

4.2.5

Potentially Affected Communities (PACs):

The geographical location of the "Vareš" project, ie the micro-locations of Rupica and Veovača, will have an impact on the entire Municipality of Vareš, both urban and rural, as well as local communities that are closely related to the location of Rupica and Veovača.

Potentially affected communities are at the following locations:

- Veovača:
  - Tisovci
  - Pržići
  - Brezik
  - Daštansko
  - Višnjići
- Rupice:
  - Gornja Borovica
  - Donja Borovica
  - Osredak
  - Semizova Ponikva
  - Položac
  - Pogar
  - Vareš Majdan

5.0 BASELINE ANALYSIS

Since this is a "desktop" study for the purpose of assessing the impact on the health of the population and the local community in the field of project implementation, the data of previous studies and measurements were used to prepare the project location:
- Wardell study
- Measurements of the Institute "Kemal Kapetanović" of the University of Zenica
- Reports of competent institutions in the field of monitoring the health status of the population.

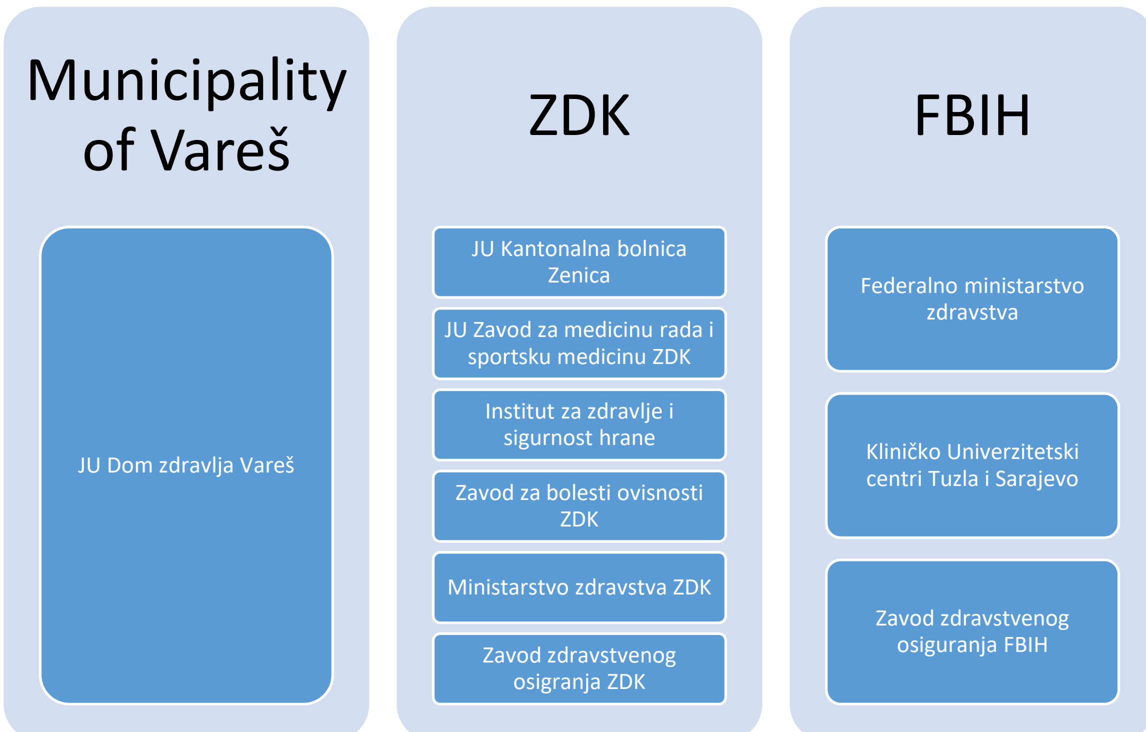
Adequate data sources are those that can be obtained in accordance with legal regulations that require monitoring the health of the population in the area of ZDK. However, there is some data lost during the 1992-1995 war, but over a period of 15 years there is an extremely high quality system of access and availability of data on health status and health care at both the cantonal and federal levels.

6.0 STAKEHOLDER ANALYSIS

The complex political-administrative system of Bosnia and Herzegovina has a direct impact on the connection of key stakeholders in the field of health and stakeholders in the field of social and environmental issues.

Key stockholders for the field of health care in the field of project implementation can be seen as follows:

Graph 5. Presentation of key stakeholders in field of health care



In addition to the above-mentioned key stakeholders in the field of health, it is necessary to mention that the administrative and political organization of Bosnia and Herzegovina transfers competencies in the field of environmental protection at the cantonal and federal level.
At the cantonal level, these are the following ministries:
- Ministry of Space Planning, Transport and Communications and Environmental Protection
- Ministry of Agriculture, Forestry and Water Management
- Ministry of Labor, Social Policy and Refugees

At the federal level, key stakeholders are:
- Federal Ministry of Health
- Federal Ministry of Labor and Social Policy
- Federal Ministry of Space Planning
- Federal Ministry of Environment and Tourism

The key elements that must be mentioned when talking about the connection of stakeholders from different competencies, but also health care itself is the extremely complicated administrative bureaucratic procedure and the complexity of exercising the process and rights in the field of health care.

7.0

RISK ANALYSIS

7.1

Analysis

Table 13. Assessment and rancing of potential health risk factors.

Area	Influx	Relocation	Water management	Linear features	Hazardous materials control and disposal	Changes in income and consumption	Infrastructure: facilities
Vector diseases							
Respiratory disease							
Veterinary medicine							
STD							
Soil, water & sanitation							
Food and nutrition							
Injuries and trauma							
Hazardous material exposure							
Cultural health practices							
Health service infrastructure							
Noncommunicable							

Visoki rizik	Umjereni rizik	Niski rizik

7.2

Overall Summary Analysis

The existence of the "Vareš" project will not lead to major changes in the structure and demography of the population in the Municipality of Vareš. The identification of potential risks to human health is a significant procedure in the implementation of the entire project.
They analyze all the elements in the process of identifying factors for human health, both in the local community and employees, potential factors that can lead to a certain level of impact on human health are identified, such as:

- Noise (during the process of construction works and during the exploitation process in the area of the Veovača site, as well as noise due to the transport of materials).
- Dust (during the project implementation process, establishment of the Veovac surface mine and during the transport of materials)
- Potential factors of local groundwater pollution, with traces found in basic research (occurrence of thallium and mercury) that must be monitored at the regular annual prescribed level.
- Postojanje drugih umjereno rizičnih faktora kao što su:
- - Unhealthy lifestyles due to the appearance of larger inflows of funds into the local community, and employees are causally and consequently connected to each other. This factor can be eliminated by conducting educational and promotional activities in dealing with the local community.
- - Morbidity of chronic non-communicable diseases, but which is not directly related to the existence of the "Vareš" project. Morbidity and mortality of chronic non-communicable diseases is causally related to the demographic / age structure of the population in the observed area, with the infrastructure of the health system and access to health services of remote rural areas (such as areas around mine sites) and other sources of air, water and soil pollution. on the micro and macro regions of the observed space.

Factors that may occur but will not have a significant impact on the local population but must be taken into consideration are:

- Occurrence of an increased number of traffic accidents due to increased traffic frequency.
- Occurrence of certain vector diseases that come with an increased number of staff in the area where the vectors of these diseases live
- Occurrence of pandemic / epidemic cases such as COVID - 19.
- These factors may arise but are addressed in accordance with the legal regulatory framework at the ZDK level; FBIH and BIH:

The project "Vareš" which will be implemented, ie already implemented by the company Eastern Mining d.o.o. the project is an example of cooperation with the local community, because by taking preventive actions and procedures it reduces the occurrence of risks to the health of the population to a minimum.
In the project documentation, and research conducted to study sites such as biodiversity, environmental impact, measurement of pollution of accumulated particles in soil and air, as well as groundwater testing indicate the seriousness of the approach to the project and show that use best practice practices for implementation.

8.0

MITIGATION

The general strategy of prevention (mitigation) will be based on two key elements:

- Disease prevention
- Health promotion and education

Since both strategies have many points of implementation, both are crucial for this process at the same time.

Implement the disease prevention development strategy in cooperation with key stakeholders with regard to the prevention of diagnostic diseases..

Table 14. Mitigation strategy based on three key levels

Primary	Secondary	Tertiary
Education and programs on prevention of infectious and non-infectious diseases. Involvement in the process of promotion of healthy lifestyles with the aspect of prevention of diseases of the cardiovascular system, malignant neoplasms, mental health and oral health. Screening program promotion.	Promotion and cooperation in the field of vaccination both in regular conditions and in conditions of epidemics and pandemics (extraordinary conditions).	Cooperation with key stakeholders with the aim of treating diseases or injuries caused by direct or indirect action of project.
At the project level, internal programs to ensure the closest standards and practices within the machine-building sense.	Prevention and monitoring of contaminated soil, waste disposal, polluted air.	
Education on zoonoses	Disinfection, deratisation (rodent control) and disinsection programs.	

Primary	Secondary	Tertiary
Cooperation with: Local government Health institutions Local NGO	Cooperation with: Local Government Cantonal government Health institutions at the cantonal level Local / cantonal NGO	Cooperation with government levels at local and cantonal level. Cooperation with medical institutions at all levels and specialties.

Social health factors that lead to the development of chronic non-communicable diseases such as tobacco consumption, poor eating habits, reduced physical activity are the leading risk factors not only in the local area but also in the Federation of BiH. All population groups are affected by these factors, which with other identified risk factors can be a very serious combination and problem.

In cooperation with key stakeholders, work on improving the promotion of mandatory vaccination of the youngest population in order to reach the desired levels of 95% of vaccines and in accordance with "According to the Law on Protection of the Population from Infectious Diseases (Official Gazette of FBiH
no. 29/05), the Rulebook on the implementation of mandatory vaccination, immunoprophylaxis and chemoprophylaxis, and persons subject to this obligation (Official Gazette of FBiH No. 22/7), but also the Law on Rights, Obligations and Responsibilities of Patients (Official Gazette of FBiH No. .40 / 10).

It is necessary to develop strategies and plans, or to join the existing ones related to the reduction of risk factors in all age groups..

Table 15. Overview of mitigation strategies

Action plan	Timeframe	Action plan		Responsible	Potential partners	Indicators	Surveillance method
Community focused mitigation measures external to the project		C&C	PACs				
Infectious diseases associated with overcrowding and poor hygienic and epidemiological conditions - acute respiratory infections (bacterial and viral), pneumonia, tuberculosis, the impact of hygienic - epidemiological conditions on respiratory diseases, immunization coverage							
Annual systematic preventive medical examination	1x year	K + ZU		K	JZU DZ JZU ZMRISM		Medical records of employee
Epidemic prevention	By need	K+ZU	LZ	K+LZ+ZU+MH	ZU+MH		Authorities input
Vector transmitted disease							
Disinfection Disinsection Deratiosation (rodent control)	By plan	K	LZ	K	ZU or private company		Legal framework
Personal hygiene		K	K	K	ZU		Education plan
Communal hygiene	By need	K+LZ	LZ	K+LZ	LZ		Samples
Diseases connected with water, soil and general fanitation							
Control of drinkable sources of water	Legal framework	K+LZ	K+LZ	K+LZ	LZ +Institut		Reports
Control of level of thallium and mercury in underground waters	Legal framework	K	K	K	K+Institut		Reports
STD	By need	K	K+LZ+NGO	LZ+K	K+NGO+Z		Education

Food and nutrition							
Food safety	Legal framework	K	K+LZ+ZU	LZ	K+ZU		Reports
Non-Communicable disease							
Prevention programs	By need	K+LZ	K+LZ+ZU	K+LZ+ZU	K+NGO		Programs
Injuries and trauma							
Prevention programs and standards	By need and legal framework	K	K	LZ	K		Reports
Environmental factors							
Prevention programs	By need	K	K+LZ+NGO	LZ+K	NGO+LZ		Report on activates
Health care system infrastructure							
Service availability	By need	K	LZ+ZVU	ZVU	LV		Activities, plan
Infrastructure	By need	K+LZ	LZ	ZVU	LZ+ZVU		Activites

9.0

MONITORING AND EVALUATION (M E)

Competence to monitor the elements of health status of the population and health in the Zenica-Doboj Canton in the competence of the secondary level of health care, ie data collection and processing is carried out by the Institute for Health and Food Safety which publishes annual reports / information on health of the population. / city member of the canton and in accordance with the competent legal acts related to data collection and disease reporting.

Monitoring and evaluation of the impact of factors such as noise, dust and the occurrence of metal particles in groundwater are analyzed in accordance with the annual measurement plan by certified houses and institutions whose results can be used for analysis.

Given that there are key stakeholders for disease monitoring and surveillance who have defined key parameters and indicators for monitoring the health status of the population, it is recommended to communicate and cooperate with these institutions and conduct assessments on a monthly, semi-annual and annual basis depending on the type of indicator, cumulative factor and degree. the impact of factors on health.

Demographic Indicators that show a very low birth rate, ie the lowest in the municipality of Vareš during 2018, indicate a regressive flow of the population, which is directly related to the specific health needs of the population. These factors have a direct impact on indicators such as incidence, morbidity, mortality of chronic mass non-communicable diseases, certain infectious diseases, increased need to use health care institutions, etc.

According to available data and considering the geostrategic position and identified risk factors, respiratory diseases were the leading in the area of Zenica-Doboj Canton, it is necessary to make a set of indicators that will monitor the increase / decrease, occurrence of respiratory diseases and monitoring the presence of dust particles. air.

10.0

SUMMARY

The Vareš project of Easter Mining is an extremely complex and valuable driver of local community development such as Vareš, which includes the process of engaging different levels of government but also creates and develops an impact that is positive on the local community.

However, with such large projects, it is necessary to pay attention to the possible risks that develop with the implementation of the project and may have a direct or indirect impact on human health.

The preparation of a study assessing the impact of risk factors on human health is extremely important and as such shows the seriousness of Easter Mining in its approach to project implementation.
The risk factors identified in this study as direct impacts from the project and project activities (noise, vibration, dust, increased traffic, occurrence of metals in groundwater) should not be considered as independent factors but as part of environmental factors consisting of numerous demographic, social and economic factors that existed in this area before the initiation of the implementation of this project.

11.0

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CONTENT

APPENDIX 4.15.1: Calendar of Events in Vares

Event Calendar – Municipality of Vareš 2020

January			
DATE	NAME	LOCATION	WORKING / NON-WORKING DAY
1.	New Year		Non-Working
07.	Orthodox Christmas (religious holiday)		Non-Working
14.	Orthodox New Year (religious holiday)		Non-Working

February			
DATE	NAME	LOCATION	WORKING / NON-WORKING DAY
03.	Masquerade (Catholic holiday)	Pržići	Working
10.	Masquerade (Catholic holiday)	Pogar	Working
11.	Masquerade (Catholic holiday)	Zarudje	Working
12.	Masquerade (Catholic holiday)	Oćevija	Working
13.	„Žuta žaba" (Catholic holiday)	Vijaka	Working

March			
DATE	NAME	LOCATION	WORKING / NON-WORKING DAY
01.	BiH Independence Day		Non-Working

April			
DATE	NAME	LOCATION	WORKING / NON-WORKING DAY
12.	Easter (Catholic holiday)		Non-Working
19.	Easter (Orthodox holiday)		Non-Working
24.	Ramadan- Day 1 (Islamic holiday)		Working
25.	St. Mark the Evangelist (Catholic holiday)	Javornik	Working

May			
DATE	NAME	LOCATION	WORKING / NON-WORKING DAY
01. i 02.	International Workers' day		Non-Working
01.	St. Joseph the Worker (Catholic Holiday)v	Semizova Ponikva	Working
24.	Ramadan Bayram (Islamic holiday)		Working
24.	The Ascension of Salvation (Catholic holiday)	Mir	Working
24.	The Ascension of Salvation (Catholic holiday)	Strica	Working
31.	A feast of spirits (Catholic holiday)	Pržići	Working

June			
DATE	NAME	LOCATION	WORKING / NON-WORKING DAY
01. - 04.	Borovica Painting Colony	Borovica	Working
07.	Holy Trinity (Catholic holiday)	Višnjići	Working
07.	Holy Trinity (Catholic holiday)	Diknjići	Working
13.	St. Anthony (Catholic holiday)	Donja Borovica	Working
13.	St. Anthony (Catholic holiday)	Pogar	Working
19.	Feast of the Sacred Heart (Catholic Holiday)	Diknjići	Working
19 .- 21.	"Bosnian Gastro Fest" (Local Holiday)	Bobovac	Working

July			
DATE	NAME	LOCATION	WORKING / NON-WORKING DAY
16.	Our Lady of Mount Carmel (Catholic holiday)	Zvijezda	Working
24.	„Potočani“ Meeting (Catholic Feast)	Vrankovci	Working
25. - 26.	„Dova Karići“ (Islamic holiday)	Karići	Working
25.	Saint James the Apostle (Catholic holiday)	Tisovci	Working
26.	Feast of St. Anne (Catholic holiday)	Vijaka	Working
27.	Accordion Festival (local holiday)	Pržići	Working
31.	Eid al-Adha - Kurban Bayram (Islamic holiday)		Non-Working

August			
DATE	NAME	LOCATION	WORKING / NON-WORKING DAY
03. - 17.	Vareš Artists' Salon	Vareš	Working
04.	Meeting at „Obla Glava“	Zarudje	Working
06.	Feast of the Transfiguration (Catholic holiday)	Borovica	Working
10. -11.	„Pekijada“ Culinary Competition (Local Holiday)	Oćevija	Working
16.	Vareš Municipality Day	Vareš	Working

September			
DATE	NAME	LOCATION	WORKING / NON-WORKING DAY
15. - 16.	Quad expedition „Željezna dolina“	Vareš	Working
15. - 16.	Scouts' Friendship Meeting	Vareš	Working
15. - 25.	„VaClaf“ Classical Music Festival	Vareš	Working
29.	St. Michael the Archangel (Catholic holiday)	Vareš-Majdan	Working

October			
DATE	NAME	LOCATION	WORKING / NON-WORKING DAY
20.	Prayer Day for Homeland and Pilgrimage of the Armed and Military Forces of BiH	Bobovac	Working

November			
DATE	NAME	LOCATION	WORKING / NON-WORKING DAY
01.	All Saints Day (Catholic Holiday)	Vareš-Stogić	Working
14.	Saint Nicholas Tavelic (Catholic holiday)	Bijelo borje	Working
25.	BiH National Day		Non-Working
25.	Celebrating National Day	Bobovac	Non-Working

December			
DATE	NAME	LOCATION	WORKING / NON-WORKING DAY
04.	St. Barbara the Protector of Miners (Catholic Holiday)	Vareš Majdan	Working
22 - 23	Holiday Market	Green Market Vareš	Working
25.	Catholic Christmas (Catholic holiday)		Non-Working
30.	Mountaineering hike „Bijelom Zvijezdom“	Mountain „Zvijezda“	Working
31.	New Year's Eve	Playground at Primary School	Non-Working