Executive Summary

In August 2014, Cinkarna Metalurško- kemična industrija Celje d.d. (the Company) commissioned execution of a Phase II Environmental Site Assessment and preparation of a Phase II Environmental Report in order to verify the status of soil and groundwater contamination at the land which is operated by Cinkarna Metalurško- kemična industrija Celje d.d. Phase II Environmental Site Assessment was performed by ENVIRON Poland Sp. z o.o. This is an executive summary which presents the key findings and recommendations from the performed assessment. For further details, please contact the management board of Cinkarna Metalurško- kemična industrija d.d..

I. Field works of the Phase II Environmental Site Assessment took place between August 19 and September 3, 2014. The following scope of works was performed:

- Drilling of 70 boreholes for the purpose of soil sampling (52 boreholes at Cinkarna Celje production facility, 3 boreholes at the gypsum pipeline, 3 boreholes at the Cinkarna Mozirje facility, 3 boreholes at Za Travnikom red gypsum landfill, 3 boreholes at Bukovžlak red gypsum landfill, 3 boreholes at Bukovžlak non-hazardous solid wastes landfill and 3 boreholes at the farming land located adjacent to the landfills);

- Installation of 28 temporary monitoring wells, collection and analysis of 28 groundwater samples (22 temporary monitoring wells at Cinkarna Celje production facility, 3 temporary monitoring wells at the gypsum pipeline, 3 temporary monitoring wells at the Cinkarna Mozirje facility);

- Collection of groundwater samples from 14 permanent monitoring wells installed at the landfills (4 permanent monitoring wells at Za Travnikom red gypsum landfill, 4 permanent monitoring wells at Bukovžlak red gypsum landfill, 6 permanent monitoring wells at Bukovžlak non-hazardous solid wastes landfill);

- Analysis of 142 soil samples (109 soil samples collected at Cinkarna Celje production facility, 6 soil samples collected at the gypsum pipeline, 6 soil samples collected at the Cinkarna Mozirje facility, 6 soil samples collected at Za Travnikom red gypsum landfill, 6 soil samples collected at Bukovžlak red gypsum landfill, 6 soil samples collected at Bukovžlak non-hazardous solid wastes landfill and 3 soil samples collected at the farming land located adjacent to the landfills) and one sample of currently produced gypsum (sample GYP-1);

- As a QA/QC measure, two Trip Blank soil samples and one Trip Blank groundwater samples were transported to the investigated sites and were analysed following delivery of the samples to the laboratory.

II. Laboratory analysis of collected soil and groundwater samples has revealed the following:

1. At the **Cinkarna Celje** production site, sixteen areas (zones of suspected pollutant concentrations) were designed and in each area at least one borehole was drilled and soil and groundwater samples were collected and analysed. Laboratory analysis of collected samples revealed high concentrations of heavy metals in collected soil samples, for such metals as Zinc, Antimony, Arsenic, Barium, Cadmium, Copper, Cobalt, Lead and Nickel. In numerous samples, both the Slovenian Critical Values and Dutch List Intervention Values were exceeded.

The highest concentrations were observed for:

- Zinc (concentrations up to 180000 mg/kg, which is 250 times higher than Dutch List Intervention Value of 720 mg/kg),
- Antimony (concentrations up to 530 mg/kg, which is 24 times higher than Dutch List Intervention Value of 22 mg/kg),
- Arsenic (concentrations up to 10000 mg/kg, which is 131 times higher than Dutch List Intervention Value of 76 mg/kg),
- Barium (concentrations up to 3200 mg/kg, which is 3.5 times higher than Dutch List Intervention Value of 920 mg/kg),
- Cadmium (concentrations up to 660 mg/kg, which is 50 times higher than Dutch List Intervention Value of 13 mg/kg),
- Copper (concentrations up to 160000 mg/kg, which is 842 times higher than Dutch List Intervention Value of 190 mg/kg),
- Cobalt (concentrations up to 770 mg/kg, which is 4 times higher than Dutch List Intervention Value of 190 mg/kg),
- Lead (concentrations up to 45000 mg/kg, which is 84 times higher than Dutch List Intervention Value of 530 mg/kg) and
- Nickel (concentrations up to 670 mg/kg, which is 6.7 times higher than Dutch List Intervention Value of 100 mg/kg).

The highest concentrations of heavy metals were associated with presence of man-made fills, mainly in the layers of gravel-size metallurgical waste. Man-made fills were observed in all executed boreholes. The layer of man-made fills reaches a thickness of 1.4-3.6 m-bgl in Area 1, 1.2-4.7 m-bgl in Area 2, 2.1-3.7 m-bgl in Area 3, 3.5 m-bgl in Area 4, 2.2 m-bgl in Area 5, 0.5-1.4 m-bgl in Area 6, 1.2-1.6 m-bgl in Area 7, 0.6-3.8 in Area 8, 1.1-2.0 m-bgl in Area 9, 0.9-1.4 m-bgl in Area 10, 1.7 m-bgl in Area 11, 0.5-4.4 m-bgl in Area 12, 0.5-3.5 m-bgl in Area 13, 0.9 m-bgl in Area 14, 3.0-4.5 m-bgl in Area 15 and 1.2 m-bgl in Area 16. The results of analysis of groundwater samples collected from 25 temporary

monitoring wells installed at Cinkarna Celje site indicated that groundwater is impacted with heavy metals, in particular Zinc, which was observed in all collected groundwater samples. In some groundwater samples, concentrations of Zinc were significantly high and exceeded Dutch List Intervention Values for groundwater (800 µg/l) in groundwater samples collected from temporary monitoring wells No. 2-1 (25000 µg/l), 2-5 (34000 µg/l), 3-1 (120000 µg/l), 4-1 (1700 µg/l), 5-1 (7700 µg/l), 7-1 (1600 µg/l), 8-5 (18000 µg/l), 8-6 (2000 µg/l), 8-7 (1700 µg/l), 11-1 (1000 µg/l), 12-3 (8400 µg/l), 12-11 (1600 µg/l) and 12-13 (2400 µg/l). Elevated concentrations of Arsenic, Cadmium, Cobalt, Copper, Lead, Mercury and Nickel were also observed.

2. At the **Cinkarna Mozirje** production site, three areas (zones of suspected pollutant concentrations) were designed and in each area one borehole was drilled and soil and groundwater samples were collected and analysed. Laboratory analysis of collected soil samples revealed natural, background concentrations of heavy metals, except for concentration of Zinc in one soil sample (concentration of Zinc of 850 mg/kg in the soil sample MO-1 at 2.2 m-bgl, which exceeded a Dutch List Intervention Value of 720 mg/kg). Presence of organic compounds was detected in two soil samples collected from a layer of man-made fills (MO-1 at 2.2 m-bgl and MO-2 at 0.5 m-bgl). In both samples compounds from the group of Polycyclic Aromatic Hydrocarbons (the sum of PAHs in the first sample was 4.46 mg/kg and was 18.8 mg/kg in the second one), as well as mineral oil (TPH fraction C12-C35 in the first sample was 19 mg/kg and 100 mg/kg in the second one) were detected (both the Slovenian Critical Values and Dutch List Intervention Values were not exceeded). Analysis of groundwater samples collected from three temporary monitoring wells installed at Cinkarna Mozirje site did not reveal significant impacts both of heavy metals and organic compounds. In particular, no presence of Polycyclic Aromatic Hydrocarbons or Volatile Organic Compounds was observed.

3. At the **Bukovžlak landfill for red gypsum**, three boreholes were drilled for the purpose of collection of soil samples and four groundwater samples were collected from existing, permanent monitoring wells.

   Laboratory analysis of collected soil samples revealed natural, background concentrations of heavy metals in all soil samples, except for one soil sample, collected from the borehole BG-2 at a depth of 4.2 m-bgl (sample collected from a layer of silty, red-colored fine industrial waste material (“pyrite waste”)). Laboratory analysis of this sample revealed high concentrations (exceeding Dutch List Intervention Values) of Arsenic (2000 mg/kg), Copper (1800 mg/kg), Lead (910 mg/kg) and Zinc (2400 mg/kg).

   Analysis of groundwater samples collected from four permanent monitoring wells installed in the vicinity of the Bukovžlak landfill for red gypsum, indicated low concentrations of heavy metals, typical for natural, not impacted groundwater, in the groundwater sample BUK-1, collected from a monitoring well located up-gradient of the landfill and in the groundwater sample BUK-2, collected from a monitoring well located down-gradient of the landfill.

Elevated concentrations of heavy metals were detected in two groundwater samples collected from monitoring wells located down-gradient of the landfill: in the groundwater sample K-10 (Arsenic concentration of 1550 µg/l and Zinc concentration of 990 µg/l) and in the groundwater sample K-11 (Cadmium concentration of 43 µg/l, Cobalt concentration of 210 µg/l, Nickel concentration of 140 µg/l and Zinc concentration of 8400 µg/l). Presence of elevated concentrations of heavy metals in K-10 and K-11 groundwater samples is not an influence of red gypsum. Both permanent wells (K-10 and K-11) are located in the area built of "pyrite waste" (silty, red-colored fine industrial waste material), which was incorporated in the air side of the dam Bukovžlak. Increased concentrations of heavy metals in groundwater sample collected from a monitoring wells K-10 and K-11 result from leaching of heavy metals from the "pyrite waste". The "pyrite waste" is known to contain elevated concentrations of leachable heavy metals such as Arsenic, Cadmium, Cobalt, Copper, Lead, Nickel and Zinc.

4. At the **Bukovžlak landfill for non-hazardous solid wastes**, three boreholes were drilled for the purpose of collection of soil samples and six groundwater samples were collected from existing, permanent monitoring wells.

   Laboratory analysis of collected soil samples revealed natural, background concentrations of heavy metals in all soil samples, except for one soil sample, collected from the borehole BS-2 at a depth of 1.0 m-bgl (sample collected from a layer of silty, red-colored fine industrial waste material ("pyrite waste")). Laboratory analysis of this sample revealed high concentrations (exceeding Dutch List Intervention Values) of Antimony (48 mg/kg), Arsenic (1200 mg/kg), Cadmium (15 mg/kg), Copper (3200 mg/kg) and Zinc (4100 mg/kg).

   Analysis of groundwater samples collected from six permanent monitoring wells installed in the vicinity of the Bukovžlak landfill for solid wastes, indicated low concentrations of heavy metals, typical for natural, not impacted groundwater, in groundwater samples BUK-3 and N-3, collected from a monitoring wells located up-gradient of the landfill and in the groundwater samples A-1 and A-2, collected from monitoring wells located down-gradient of the landfill. Elevated concentrations of heavy metals were observed in one groundwater sample collected from a monitoring well located down-gradient of the Bukovžlak landfill for solid wastes: in groundwater sample A-3 (Cobalt concentration of 220 µg/l, Nickel concentration of 140 µg/l and Zinc concentration of 9200 µg/l), all of them exceeding Dutch List Intervention Values.

   Elevated concentrations of heavy metals were observed in one groundwater sample located up-gradient of the the Bukovžlak landfill for solid wastes: in groundwater sample P-4 (Cadmium concentration of 9.9 µg/l, Copper concentration of 110 µg/l, and Zinc concentration of 4700 µg/l - all of them exceeding Dutch List Intervention Values). This monitoring well (P-4) is located up-gradient of Bukovžlak landfill for solid wastes but down-gradient of the Bukovžlak landfill for red gypsum (10 meters north of the landfill's embankment). P-4 monitoring well is located in the area built of "pyrite waste" (silty, red-colored fine industrial waste material), which was incorporated in the air side of the Bukovžlak landfill dam and disposed of in the location of solid waste landfill Bukovžlak.

Increased concentrations of heavy metals in groundwater sample collected from a monitoring well P-4 result from leaching of heavy metals from the “pyrite waste”. The “pyrite waste” is known to contain elevated concentrations of leachable heavy metals such as Arsenic, Cadmium, Cobalt, Copper, Lead, Nickel and Zinc.

5. At the **Za Travnikom landfill for red gypsum landfill,** three boreholes were drilled for the purpose of collection of soil samples and four groundwater samples were collected from existing, permanent monitoring wells.

   No elevated concentrations of heavy metals and organic compounds were observed in any of the collected soil samples. The observed concentrations of heavy metals and organic compounds indicated natural, background concentrations.

   Analysis of groundwater samples collected from four permanent monitoring wells installed in the vicinity of the Za Travnikom landfill for red gypsum, indicated low concentrations of heavy metals, typical for natural, not impacted groundwater, in a groundwater sample Z-1A, collected from a monitoring well located up-gradient of the landfill and in two samples collected down-gradient of the landfill (ZT-1A and ZT-2A). In groundwater sample TV-1A collected from a monitoring well located down-gradient of the landfill, elevated concentrations of heavy metals were observed for Cobalt (concentration of 1700 µg/l), Nickel (concentration of 430 µg/l) and Zinc (concentration of 9000 µg/l). Presence of elevated concentrations of heavy metals in TV-1A groundwater sample is not an influence of red gypsum. According to the information of Cinkarna’s representatives, on this location “pyrite waste” was incorporated in the air side of the dam Za Travnikom. Increased concentrations of heavy metals in groundwater sample collected from a monitoring well TV-1A result from leaching of heavy metals from the “pyrite waste”. The “pyrite waste” is known to contain elevated concentrations of leachable heavy metals such as Arsenic, Cadmium, Cobalt, Copper, Lead, Nickel and Zinc.

6. At the **farming land located north of Bukovžlak landfill,** no significant soil contamination with respect to both heavy metals and organic compounds was observed in any of collected three soil samples. The observed concentrations of heavy metals and organic compounds indicated natural, background concentrations.

7. Other parameters, including inorganic parameters (Cyanides, Sulphates, Chlorides and Ammonium,) and metals such as Berylium, Boron, Iron, Managanese, Phosphorus, Selenium, Thallium, Tin, Titanium and Vanadium were tested both in soil and groundwater samples. However, these parameters were not evaluated against Dutch List Intervention Values (DLIV) and Slovenian Critical Values (SCV) for soil and against Dutch List Intervention Values (DLIV) and Slovenian Treshold Values for groundwater because these reference documents do not contain screening values for given parameters.

III. Based on the conducted investigations, the most significant contamination which needs improvement actions was identified at Cinkarna Celje site.

Despite observed environmental impacts (i.e. elevated concentrations of heavy metals in some of soil and groundwater samples collected at Bukovžlak and Za Travnikom landfills, which are clearly the result of impact of pyrite waste and not of deferred red gypsum), it is understood that the already implemented mitigation measures and control at the landfills, including a yearly monitoring of groundwater, collection of leachates from Bukovžlak landfill for solid wastes, capping of the landfills' surface with waters (landfills for red gypsum) and vegetation (Bukovžlak landfill for solid wastes) are oriented on minimization of environmental impacts. Additionally the company has prepared a project of installation of a capping system equipped with a system of drainage and collection of rain water in the frame of closing Bukovžlak solid waste landfill. At the landfill Za Travnik a project of dewatering of the landfill's surface is already under completion and the same solution could be carried out on the landfill of red gypsum Bukovžlak.

IV. Concentrations of heavy metals in soil and groundwater samples collected at Cinkarna Mozirje site, do not indicate a need to undertake improvement (remediation type) measures.

V. It is recommended to perform improvement activities at the Cinkarna Celje site. The Recommended Improvement Action Plan is based on the following assumptions:

1. Contamination is spread under the ground surface in irregular way at the majority of the Cinkarna Celje area and it is of historical origin. According to available information, industrial operations in the current location of Cinkarna Celje were initiated in 1949. In the initial period, the location of the current Cinkarna Celje site was used for different types of chemical and metallurgical production including mechanical workshop. The most eastern part was used as a landfill of metallurgical and other waste from the previous location of Cinkarna. It was also reported that in the eastern part of the site, open storage for pyrite and residues originating from roasting of pyrite was historically present. The man-made fills observed across the site area are considered to comprise remains of historically deposited industrial wastes.

2. The Cinkarna Celje site occupies an area of approximately 45.81 hectares (ha), whereof app. 11.55 ha is built up area and app. 13.56 ha represent paved outdoor areas around the buildings used as traffic and parking areas. The remaining parts (i.e. 20.7 hectares) of the site are covered with vegetation (i.e. trees, lawns).

3. The improvement activities are to be conducted with limited influence on the local environment and the production processes performed at the site. While performing any type of remediation actions at Cinkarna Celje site, it is necessary to ensure appropriate Health and Safety measures at the same time with continuous, undisturbed and safe operation of the production plant.

VI. The most reasonable scenario:

- In order to ensure that heavy metals are not migrating out of the areas of their current presence, the areas which are not hardened or covered by buildings should be covered by permanent vegetal cover.

- Quality of groundwater at Cinkarna Celje should be monitored on permanent basis; it is recommended to install a network of permanent monitoring wells. According to land surveying measurements performed in August 2014 (within investigations conducted by ENVIRON), the groundwater flow direction is towards the north-west. It is recommended to install permanent groundwater monitoring wells downgradient and upgradient of the potential groundwater flow. The potential cost of permanent monitoring system installation at the site is approximately 50,000-80,000€. The hydrogeological monitoring should be based on measurements of groundwater table depth at least one time per month. Groundwater sampling and testing should be conducted every three months; in the future, based on obtained monitoring results, the frequency of sampling and testing can be modified accordingly.

- In order to observe the quality of groundwater, it is recommended to install a network of permanent monitoring wells. According to land surveying measurements performed in August 2014 (within investigations conducted by ENVIRON), the groundwater flow direction is towards the north-west. It is recommended to install permanent groundwater monitoring wells in the following areas:
    - inflow of groundwater (south-eastern part of the site): in location of temporary monitoring wells 10-3, 16-1 and on a lawn in the vicinity of the fire-station),
    - Area 12 (with observed groundwater contamination with Arsenic, Chromium, Nickel, Cadmium and Zinc): in location of temporary monitoring wells 12-3, 12-11 and 12-13,
    - central part of the site: in location of temporary monitoring wells 3-1, 5-1, 7-1, 8-5, 8-6, 8-7,
    - outflow of groundwater: in location of temporary monitoring wells 2-1, 2-5, 6-3 and one additional monitoring well on a lawn in the vicinity of Hudinja river (north-western border of the site).

- The on-site groundwater monitoring system via on-site monitoring wells, should be supplemented by monitoring of quality of surface water in both rivers located in the site's vicinity. According to the site management, monitoring of water, sediment and biotope of Hudinja river has been performed by the company since 2005, but the scope of monitoring is limited to parameters which are associated with actual production of TiO_2.

- With the aim to determine the possible impact on the environment and human health (ZVO-1) it is recommended to prepare a comprehensive monitoring program on rivers Hudinja and Vzhodna Ložnica. The scope of the monitoring program should cover at least all the pollutants that exceed Dutch List Intervention Values and/or Slovenian

Critical Values. The frequency and duration of monitoring should be determined by the competent authority.

VII. If future groundwater monitoring results indicate a significant impact of the contaminated fill material present at the site, in order to avoid further propagation (migration) of contaminants through groundwater into adjacent water bodies (Hudinja and Vzhodna Ložnica rivers), it is proposed to consider implementation of further mitigation measures.

VIII. In cases where due to construction needs it will be necessary to excavate soil at Cinkarna Celje site, the excavated soil should be remediated and all dusting preventive measures during the work should be undertaken. It is also recommended to implement appropriate Health and Safety measures for workers that may come into contact with impacted soils.

IX. All improvement works should be discussed, with participation of a legal advisor, with a competent environmental authority. Prior to initiation of improvement works, it is recommended to obtain a confirmation (a formal document/decision/certificate) from a competent environmental authority that the proposed scope of works will result in: (1) acceptable limitation of impacts on humans and environment, and (2) that the current/future owners/occupants of the site will not be held liable for a historical contamination. After completion of the works, it is recommended to obtain a formal confirmation from competent authorities that agreed activities have been completed in line with agreed scope and conditions.