Energy Sector Clean-Up and Land Reclamation Project

Independent Environmental Impact Assessment for the Remediation of a former Lignite Gasification Plant

Client: Kosovo Energy Corporation j.s.c.

Project No: P105870

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Final: 10 February 2010
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<table>
<thead>
<tr>
<th>Author</th>
<th>Draft v.1.0</th>
<th>Dr. Peter Bayer</th>
<th>20 November to 07 December 2009</th>
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<td>Dr. Norbert Molitor</td>
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<td>27 January to 10 February 2010</td>
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Executive Summary

The key objective of the Clean-up and Land Reclamation Project (CLRP) is to improve the overall environmental situation by mitigation of the environmental damages caused by inadequate overburden and ash dumping practice in the past five decades of lignite mining and lignite based power generation.

This includes collection and elimination of some 20,000 t of hazardous waste stored at the shut-down gasification plant adjacent to the Kosovo A power plant as a first step towards dismantling of the gasification plant and future land reclamation. The waste represents an environmental hazard due to potential deterioration of the storage facilities with the risk of spills and contamination of soil, groundwater and surface water.

An EIA Environmental Impact Assessment has been performed for the collection and elimination of the hazardous waste including the preparation of a concise EMP Environmental Management Plant. EIA and EMP have been prepared with regard to the respective Kosovo laws and regulations and World Bank guidelines. Mandatory public hearings have been held in November 2009 and January 2010.

Based on a detailed inventory and the physical and chemical properties of the waste two major fractions have been identified requiring specific measures. Alternative approaches have been assessed by the technical designer of the project. The approach as described below has been retained as the most feasible and commensurate approach with regard to the environmental, technical and financial aspects. Works are compliant with applicable regulations. Required permits have been identified and will be obtained prior to the operation.

About 5,500 t of waste consisting of liquids with high organic content, solvents and tar residues will be collected from the storage facility, transported to and eliminated in licensed disposal facilities (cement plants and hazardous waste incinerators) outside Kosovo as appropriate facilities are at present not available in Kosovo. Collection, transport and elimination are governed by the respective Kosovo laws, European regulations and regulations of other countries involved. The described approach corresponds to generally accepted and well established approaches in European countries.
About 14,700 t of liquids with low organic contents (LLOC) will be collected from the storage facilities and treated on-site with the elimination of the hazardous compounds. The treatment is an adaptation of a well-established industrial waste water treatment process comprising elimination of the organic compounds by oxidation with Fenton’s reagent. Fenton’s reagent employs hydrogen peroxide (H2O2) as an oxidant and iron sulphate (FeSO4) as catalyst. As the LLOC also contain metals a separate step is required for removal/precipitation of metals from the liquids. Local facilities will be used after technical upgrading for the treatment. The treatment is a batch process (batch volume 500 m³). Treated effluent concentrations comply with permissible levels Cat IV level of applicable Kosovo regulation. Effluent is discharged to the adjacent Sitnica River having no adverse effect on Sitnica River water quality. This also applies for sulphate freight in the effluent after introduction of additional treatments steps and mitigation measures. Solid residues from the treatment (dewatered sludge from metal precipitation, approximately 500 to 800 t) are deposited in an engineered cassette made of low permeable clay on the adjacent ash disposal facility of Kosovo A power plant. Deposition is according to the multi-barrier concept which is well established in European countries sustainable preventing mobilisation of metals.

The outlined technical measures are accompanied and complemented by a variety of organisational measures effectively preventing potential adverse effects including accident scenarios. In addition to the supervision and monitoring by competent authorities, activities will be controlled and monitored by an independent supervisor. Mitigation measures are described in detail in a concise EMP Environmental Management Plan.

Project implementation period is 8 Months (not including tendering and contract awarding procedure). Start of activities is scheduled for spring 2010. End of activities is scheduled for: the end of 2010.

A cost estimate for the independent supervisor and the accompanying monitoring programme has been provided.
Potential adverse impacts of the activities have been identified based on an analysis of the planned activities, transfer paths and potential receptors. Potential adverse effects have been assessed. Efficient technical and organisational mitigation measures are foreseen as to prevent or limit adverse effects to the extend possible and feasible. Remaining adverse affects are tolerable in terms of duration and intensity. Long term positive effects of the project by far outweigh tolerable adverse effects.

The project activities result in a significant and sustainable improvement of the environmental situation at the site. Overall projects goals thus are therefore achieved efficiently.
Abbreviations and Acronyms used (in alphabetical order)

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>ADR</td>
<td>Accord européen relatif au transport international des marchandises dangereuses par route - European Agreement concerning the International Carriage of Dangerous Goods by Road</td>
</tr>
<tr>
<td>App.</td>
<td>Approximately</td>
</tr>
<tr>
<td>asl</td>
<td>above sea level</td>
</tr>
<tr>
<td>BAT</td>
<td>Best Available Technology</td>
</tr>
<tr>
<td>CLRP</td>
<td>Clean-up and Land Reclamation Project</td>
</tr>
<tr>
<td>D</td>
<td>Document</td>
</tr>
<tr>
<td>DIN</td>
<td>Deutsches Institut für Normung (German Standardisation Institute)</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>EMP</td>
<td>Environmental Management Plan</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>EUR</td>
<td>Euro</td>
</tr>
<tr>
<td>EWC</td>
<td>European Waste Code</td>
</tr>
<tr>
<td>h</td>
<td>hour</td>
</tr>
<tr>
<td>ha</td>
<td>Hectare</td>
</tr>
<tr>
<td>KEK</td>
<td>Kosovo Energy Corporation j.s.c.</td>
</tr>
<tr>
<td>km</td>
<td>Kilometre</td>
</tr>
<tr>
<td>l</td>
<td>litre</td>
</tr>
<tr>
<td>LLOC</td>
<td>Liquids with Low Organic Contents</td>
</tr>
<tr>
<td>m</td>
<td>Metre</td>
</tr>
<tr>
<td>m²</td>
<td>Square metre</td>
</tr>
<tr>
<td>m³</td>
<td>Cubic metre</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>m³/s</td>
<td>Cubic metre per second</td>
</tr>
<tr>
<td>mg/l</td>
<td>Milligramme per litre</td>
</tr>
<tr>
<td>mg/kg</td>
<td>Milligramme per kilogramme</td>
</tr>
<tr>
<td>No</td>
<td>Number</td>
</tr>
<tr>
<td>PAH</td>
<td>Polycyclic Aromatic Hydrocarbons</td>
</tr>
<tr>
<td>PCDD/PCDF</td>
<td>Polychlorinated Dibenzodioxenes and -furanes</td>
</tr>
<tr>
<td>PCU</td>
<td>Project Control Unit</td>
</tr>
<tr>
<td>PMU</td>
<td>Project Management Unit</td>
</tr>
<tr>
<td>PE</td>
<td>Polyethylene</td>
</tr>
<tr>
<td>pH</td>
<td>pH-Value</td>
</tr>
<tr>
<td>RID</td>
<td>Règlement concernant le transport international ferroviaire de marchandises dangereuses - Regulations concerning the international carriage of dangerous goods by rail</td>
</tr>
<tr>
<td>s</td>
<td>Second</td>
</tr>
<tr>
<td>t</td>
<td>Ton (metric)</td>
</tr>
<tr>
<td>TTP</td>
<td>Thermal Power Plant</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
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</tbody>
</table>
Table of Contents

1 Introduction .................................................................................................................................10
  1.1 Background ..........................................................................................................................10
  1.2 Scope of the EIA ..................................................................................................................11
  1.3 Legal and administrative framework ..................................................................................11
  1.4 Documents used for preparation of the EIA ........................................................................11

2 Description of the project ..........................................................................................................13
  2.1 Purpose of the project .........................................................................................................13
  2.2 Site description .....................................................................................................................13
    2.2.1 General aspects .............................................................................................................13
    2.2.2 Hazardous waste/chemicals stored at the site .............................................................16
  2.3 Main characteristics of project activities .............................................................................17
    2.3.1 Elimination of hazardous waste/chemicals in licensed disposal facilities ..................18
    2.3.2 On-site treatment of liquids with low organic content and elimination of hazardous compounds ..................................................................................................................................................................................20
  2.4 Permits and requirements .....................................................................................................35
  2.5 Project management organisation .......................................................................................36
  2.6 Time schedule for implementation ......................................................................................38
  2.7 Costs/Investments ................................................................................................................38
  2.8 Alternatives assessment .......................................................................................................38
    2.8.1 Alternatives assessment: Elimination of hazardous waste/chemicals in licensed disposal facilities ..................................................................................................................................................................................39
    2.8.2 Alternatives assessment: On-site treatment of liquids with low organic content and elimination of hazardous compounds ..................................................................................................................................................................................40
  2.9 Justification of project activities ...........................................................................................43

3 Environmental Baseline Conditions .........................................................................................44
  3.1 General Aspects ....................................................................................................................44
    3.1.1 Geology ..........................................................................................................................44
    3.1.2 Hydrogeology ..................................................................................................................44
    3.1.3 Climate ............................................................................................................................45
    3.1.4 Social Aspects ................................................................................................................46
  3.2 Identification of environmental compartments potentially affected ....................................46
  3.3 Baseline conditions of environmental compartments potentially affected ..........................47
    3.3.1 Air (contamination) .......................................................................................................47
    3.4 Water (groundwater and surface water) ............................................................................48
4 Emissions and potential adverse effects caused by planned activities ........52
4.1 Air (contamination) .................................................................52
4.2 Water (groundwater/surface water) ........................................53
4.3 Soil/subsoil ...........................................................................54
4.4 Air (Noise) ............................................................................55
4.5 Settlements (Residential areas) .............................................55
4.6 Biosphere (Land Use) .............................................................55
4.7 Other potential adverse effects ..............................................56
4.8 Accident scenarios .................................................................56
5 Mitigation measures ................................................................58
6 Summary assessment .................................................................60
Annexes

A 1 Non-technical summary

A 2 List of EIA report authors

A 3 References and Bibliography
   A 3.1 Legal and administrative documents
   A 3.2 Technical documents used for the study

A 4 Tables with relevant data
   A 4.1 Inventory of storage facilities and hazardous waste/chemicals stored at the gasification plant site
   A 4.2 Sulphate freight assessment Sitnica River – Effluent discharge effects

A 5 Records of meetings
   A 5.1 Minutes first public consultation (held on 19 November 2009)
   A 5.2 Minutes second public consultation (held on 27 January 2010)

A 6 EMP Environmental management plan: Collection and disposal/on-site treatment of hazardous waste from lignite gasification process

A 7 Terms of Reference for the Assignment
1 Introduction

1.1 Background

The Government of Kosovo has received financing from the World Bank / International Development Agency and the Dutch Minister for Development Cooperation towards the cost of the Energy Sector Clean-up and Land Reclamation Project (CLRP).

The Clean-up project aims to support Kosovo Energy Corporation j.s.c. (KEK j.s.c.) and the Kosovo authorities to address environmental issues related to production/power generation processes in the past including open dumping of ashes on land. The clean-up project enables KEK j.s.c. to free land for community development purposes currently occupied by overburden material and to remediate the Kosovo A ash dump facility.

The clean-up project consists of the following main components:

- Preparation of Mirash Open Pit Mine for Ash Management;
- Remediation of Kosovo A Ash Dump;
- Adaptation of ash disposal system of Kosovo A Thermal Power Plant for direct discharge into Mirash Open Pit Mine;
- Reclamation of Overburden Dumps;
- Investigation and immediate measures for the lignite gasification plant site adjacent to Kosovo A Thermal Power Plant;
- Project Management

The objective of the Kosovo Energy Sector Clean-Up and Land Reclamation Project is to improve the overall environmental situation by mitigation of the environmental damages caused by inadequate overburden and ash dumping practice in the past five decades of lignite mining and lignite based power generation as well as the realisation of emergency measures related to the lignite gasification plant.

The funding of the CLRP has been increased to include the collection, removal and disposal of specified hazardous waste/chemicals) at KEK's shut down gasification plant site, such as phenol water, phenols, tar, oil, di-isopropylether and other typical residues and chemicals from the lignite gasification process.
The particular project, for which this EIA is prepared, comprises the collection of the hazardous waste/chemicals at the shut down gasification plant site and the elimination/disposal of the hazardous waste/chemicals.

1.2 Scope of the EIA

The scope of this EIA is to
- identify potential adverse effects of the project,
- identify and provide/propose mitigation measures,
- assess adverse effects/environmental impact,
- identify relevant monitoring actions and to
- outline institutional arrangements in charge with environmental management.

1.3 Legal and administrative framework

This EIA is prepared with regard to the respective Kosovo laws and regulations. European directives and regulations have also been taken into account (as far as not yet integrated into Kosovo laws and regulations).

World Bank guidelines on EIA preparation have also been taken into account.

A comprehensive list of legal and administrative documents is given in annex 3.1.

1.4 Documents used for preparation of the EIA

A comprehensive list of technical documents used for the preparation of this EIA is given in annex 3.2.

This independent EIA is based mainly on the report of Chiresa AG and Dr. Heinrich Jäckli AG (14 August 2009): Clean up of a gasification plant site. Final report. Turgi/Zurich, Switzerland. 103 pages, including annexes 11 Environmental Impact Assessment (EIA) and Hazard Impact Assessment (HIA) and 12 Environmental Management Plan – Action Plan,
Part I: Removal of the Chemicals/Wastes, On Site Chemical-Physical Treatment, Transport and Final Disposal (D 1 in annex 3.2).

Additional information has been provided by Chiresa after review of the above-mentioned report by the consultant (D 5 in annex 3.2.)

Additional data have been collected by the consultant during a site inspection performed on 18 November 2009.

Environmental baseline data, in addition to the data provided in D 1 have been extracted from an EIA report on the rehabilitation of the ash disposal facility and the overburden dump adjacent to the gasification plant site (D 8).

Comments provided by WB representatives on earlier versions of this EIA report (D 9, D 11) have been integrated into the present final version.
2 Description of the project

2.1 Purpose of the project

The purpose of the project is to:

- Collect hazardous waste/chemicals at the gasification plant site,
- Dispose of/eliminate hazardous waste/chemicals,
- Eliminate environmental hazards related to present storage of hazardous waste/chemicals,
- Prepare for demolition and disposal of derelict technical installations and to
- Prepare for site rehabilitation and land reclamation.

2.2 Site description

2.2.1 General aspects

The gasification plant is adjacent to the Kosovo A Thermal Power Plant complex operated by the Kosovo Energy Corporation j.s.c (KEK). The site is located in the municipality of Obilic approximately 10 km to the west from the city of Prishtina (Fig. 1). The gasification plant site covers an area of some 40 ha.

Since 1964 the thermal power plants Kosovo A and Kosovo B are the main electricity supplier for Kosovo with fuel provided by the Bardh and Mirash open cast lignite mines in the area). Plans are in hand for the development of a new mine and a new power plant ("New Kosovo") as to satisfy on-going energy demand.

The site is situated on an alluvial plain on the eastern bank of the Sitnica River (Fig. 2). Elevation is about 550 m asl. The alluvial plain is surrounded by hills and mountains. The climate of the area is continental with dry warm summers and cool wet winters.

To the North of the site is the Obilic village (about 500 m distant), to the East and directly adjacent is the Thermal Power Plant A (TPP A). The southern boundary is defined by conveyor belts transporting lignite from the adjacent open pit mine to the power plant. The Dardishte village is beyond these conveyors in about 400 m distance. The western limit of the gasification plant is defined by a railway line with low grasslands and fields between the
rail way line and the Sitnica River further to the West. The present Sitnica River bed is an artificial bed from diverting the river course prior to lignite open pit mining.

The plant was built in the second half of the 1960ies (some installations bear manufacturer’s plates indicating 1966 as construction year). It was decommissioned in 1988 with some components remaining in operation until today (compressor and water cooling unit) serving the adjacent power plant.

Figure 1 Map of Kosovo and location of the gasification plant site.
The quite aged technical installations are still in place and to a major extent are in bad repair. The production units consisted of the main gasification plant unit, a steam and power generation plant, an ammonia plant, an air separation plant and storage facilities including a variety of storage tanks. The various units are connected by a number of above-ground and underground pipelines.

The plant produced mainly fuel gas and hydrogen for use in ammonia synthesis from lignite (Lurgi coal gasification process). Various by-products were also produced like tar, oil, naphta and crude oil.

The conversion process consisted of feeding dried lignite into the Lurgi-type gasifiers where it was reacted with oxygen and steam at 25 atm pressure. The crude gas was cooled, cleaned and transported by pipeline to end users. During the cooling process, tars, oils and
naphta were condensed and removed in a phenolic water stream. Acid gases, like CO₂ and H₂S, were removed by sorption with cold methanol. Tars and oils were removed by decantation. The soluble organics (phenol) were removed by extraction with di-isopropylether. Other by-products were collected, extracted or directly released into the atmosphere.

The entire complex is fenced in with an access gate and access control. The site is supervised by KEK staff.

### 2.2.2 Hazardous waste/chemicals stored at the site

Residues from the production process are still stored at the site. A detailed inventory and technical description of the storage facilities and the chemicals stored is available. A summary is provided in annex 4.1.

Based on the inventory, physical properties and chemical analyses from representative samples the waste can be classified as following

<table>
<thead>
<tr>
<th>Pos.</th>
<th>Characterisation of hazardous waste/chemicals</th>
<th>EWC Code</th>
<th>Mass (metric tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Liquids (Low Organic Content) Mainly aqueous liquids with low phenol concentrations, heavy-metal containing</td>
<td>10 01 20</td>
<td>14,755</td>
</tr>
<tr>
<td>2</td>
<td>Liquids (High Organic Content) Mainly aqueous liquids with high phenol concentrations</td>
<td>16 10 03</td>
<td>1,091</td>
</tr>
<tr>
<td>3</td>
<td>Liquids (Solvents)</td>
<td>14 06 03</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>Liquids (Solvents/Di-isopropylether)</td>
<td>14 06 03</td>
<td>43</td>
</tr>
<tr>
<td>5</td>
<td>Tar sludge</td>
<td>05 06 03</td>
<td>1,903</td>
</tr>
<tr>
<td>6</td>
<td>Tar condensate</td>
<td>05 06 03</td>
<td>195</td>
</tr>
</tbody>
</table>
Table 1 Classification of hazardous waste stored at the site. The classification is based on a detailed inventory of the storage facilities, physical properties of the waste and chemical analyses from representative samples. EWC code refers to the respective European Waste Code.

Due to potential deterioration of the storage facilities with leakage and spills the hazardous chemicals represent an environmental hazard requiring remedial action in terms of removal and elimination of the hazardous waste/chemicals.

### 2.3 Main characteristics of project activities

The project comprises two major activities:

- **Elimination of hazardous waste/chemicals** (pos 2 to 8 in table 1) in licensed waste disposal facilities.

  These wastes represent about 27% of the hazardous chemicals with an estimated mass of about 5,486 t.

- **On-site treatment of liquids with low organic content** (pos 1 in table 1) and elimination of hazardous compounds.

  This waste fraction represents about 73% of the hazardous chemicals with an estimated mass of about 14,755 t.

The main characteristics of the respective activities are described below.
2.3.1 Elimination of hazardous waste/chemicals in licensed disposal facilities

The activities comprise the following technical measures:

- Preparation of temporary access roads (gravel) to tanks/sites (if present access roads are inexisten or unsuitable for lorries).
- Temporary upgrading of unsealed working/loading areas (impermeable PE-liner with protective gravel layer) as to prevent infiltration of eventual leakage into the subsoil/groundwater.
- Water filled tank compartments will be emptied prior to collection of hazardous waste/chemicals from tanks. Contaminated water will be treated together with liquids with low organic content (see section 2.3.2 below).
- Collection of hazardous waste/chemicals from tanks and transfer into tanker lorries or railway tank wagons. Transfer will be achieved by pumps (liquids, sludges) or manually (solids). Heating (portable steam heating devices or existing heating facilities) may be required for pasty fractions.
- Waste fractions will be separated (if different fractions/phases are present in one tank).
- Barrels and drums will be collected separately and loaded to lorries or rail cars.
- Tar from the tar deposit will be conditioned prior to excavation by in-situ/on-site blending with fly ash (addition of approximately 10 vol %) from the adjacent Kosovo A thermal power plant ash disposal site. Conditioned tar will be excavated and loaded to lorries/railway cars.
- Waste will be transported (either by road or rail) to licensed waste disposal facilities abroad (waste incinerator plants or cement plants licensed to re-use/recycle certain waste as substitute fuel).
- Hazardous waste is eliminated at licensed waste disposal facilities.
- Emptied tanks will be given a first interior cleaning if required using water jets. Cleaning water will be collected and treated together with liquids with low organic content (see section 2.3.2 below). Volume of contaminated cleaning water is supposed to be in the range of 100 to 200 m³.
  Note: Emptied tanks and pipes/conducts will be thoroughly cleaned prior to later demolition of the technical installations of the gasification plant.
- Temporary access roads (including upgraded loading areas) are removed (if not used for later demolition of gasification plant). Materials are either re-used (if not contaminated) or disposed of properly.
- Technical emission control measures are employed where appropriate and required (i.e. tank lorries/tank cars equipped with activated carbon to capture vaporous/gaseous emission, inert gas for flooding residual tank volumes).

The technical measures outlined above are accompanied by organisational measures as following:
- Detailed assessment of tank/storage area conditions prior to collection of hazardous waste/chemicals.
- Elaboration of detailed work concept by contractor prior to collection of hazardous waste/chemicals. The work concept will also consider emergency case scenarios (accidents, spills, fire) with respective counter measures.
- Employment of experienced staff, training of staff.
- Appropriate occupational health and safety measures.
- Chemical analyses (as required for identification of waste disposal facilities and permitting procedures).
- Implementation of mitigation measures
- Monitoring activities (air quality inside tanks, ambient air quality outside tanks/storage areas) during collection of hazardous waste/chemicals.
- Supervision (by contractor staff).
- Independent supervision and monitoring by contracting agency.
- Documentation
- Reporting to PCU/PMU and World Bank (on works progress and management)

As licensed waste disposal facilities at present are not available in Kosovo, cross border transport to disposal facilities abroad is required. Cross border shipment of wastes from Kosovo to disposal facilities in EC member states requires a notification procedure according to the “Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal” (council regulation 259/93/EEC on the supervision and control of shipments of waste within, into and out of the European Community). Respective permits will have to be applied for by KEK as “waste producer”. As Kosovo is not an EU member state and not recognised by some states UNMIK or another recognised entity may eventually substitute KEK as “waste producer” and “sender” in the notification procedure.

Waste transport from the gasification plant site to the disposal facilities will be according to ADR regulations (ADR Accord européen relatif au transport international des marchandises Dangereuses par Route - European Agreement concerning the International Carriage of Dangerous Goods by Road) especially when road transport is considered and applicable regulations for rail transport (RID Règlement concernant le transport international ferroviaire de marchandises Dangereuses - Regulations concerning the international carriage of dangerous goods by rail). Regulatory content of ADR is conform to Model Regulations of UN Recommendations on the Transport of Dangerous Goods.
Disposal/elimination of the hazardous waste/chemicals will be covered by the respective permits of the licensed disposal facilities and the competent authorities of the country where the facility is located.

The outlined technical, organisational and administrative measures comply with well-established European standard procedures for collection, transport and elimination of hazardous waste/chemicals. All permitting requirements are complied with.

Note: Disposal facilities have been tentatively identified in D 1 (see also annex 4.1, table 3). The disposal facilities are subject to modification as the contractor will identify licensed disposal facilities. However, the specific requirements as shown above will be outlined in the tender dossiers for contracting of collection and disposal/elimination of hazardous waste/chemicals and the general approach and standards will be the same.

2.3.2 On-site treatment of liquids with low organic content and elimination of hazardous compounds

On-site treatment is foreseen for the liquids with low organic contents (LLOC) comprising the bulk of the hazardous waste/chemicals stored at the site with some 14,755 t. The treatment is an adaptation of a well-established state of the art industrial waste water treatment process which is considered as one of the BAT.

The on-site treatment comprises elimination of the organic compounds by oxidation with Fenton’s reagent. Fenton’s reagent employs hydrogen peroxide (H₂O₂) as an oxidant and iron sulphate (FeSO₄) as catalyst. Feasibility of the reaction has been proven on laboratory scale using representative samples. As the LLOC also contain metals an additional step is required for precipitation of metals from the liquids (see process description below).

Fenton’s reagent is a solution of hydrogen peroxide and an iron catalyst that is used to oxidize contaminants or waste waters. Fenton’s reagent can be used to destroy organic compounds such as phenols. It was developed in the 1890s by Henry John Horstman Fenton.

Ferrous Iron(II) is oxidized by hydrogen peroxide to ferric iron(III), a hydroxyl radical and a hydroxyl anion. Iron(III) is then reduced back to iron(II), a peroxide radical and a proton by the same hydrogen peroxide (disproportionation).

\[
(1) \text{Fe}^{2+} + \text{H}_2\text{O}_2 \rightarrow \text{Fe}^{3+} + \text{OH}^- + \text{OH}^-
\]
(2) \( \text{Fe}^{3+} + \text{H}_2\text{O}_2 \rightarrow \text{Fe}^{2+} + \text{OOH}^- + \text{H}^+ \)

In the net reaction the presence of iron is truly catalytic and two molecules of hydrogen peroxide are converted into two hydroxyl radicals and water. The generated radicals then engage in secondary reactions. Iron(II) sulfate is a typical iron compound in Fenton's reagent.


Phenols will be effectively destroyed by the characterised process (oxidised), the resulting compounds being carbon dioxide (CO₂) and water (H₂O). Residual phenol concentrations in the effluent after treatment are below the respective permissible levels (see tables 3.1 and 3.2, below).

Locally available infrastructure from shut down facilities will be reactivated for the treatment process. Infrastructure consists of a set of 3 concrete basins suitably located in the southern portion of the site (see fig. 3 and 4). Dimensions of the basins are 50 m x 10 m x 2.5 m (L x W x D) with a volume of some 800 m³ each. The basis will require upgrading prior to on-site treatment (preparation of temporary access road/working area/chemical storage area, cleaning of the basins, and coating/PE-liner as to prevent eventual leakage).

![Basins for on-site treatment](image)

Figure 3 Location of basins for on-site treatment of liquids with low organic content (LLOC).
Liquids with low organic contents will be collected from the storage tanks (see annex 4.1, table 5) and pumped through hoses/temporary pipelines to the treatment basins. As the majority (about 84 %, corresponding to 12,459 t) of the total volume of the liquids are stored in just two tanks (B3A and B3B, see annex 4.1, table 5), pumps and hoses/pipelines will not have to change position frequently.

The on-site treatment is essentially a batch process with a batch volume of some 500 t requiring about 30 batches in total. At 2 batches per week, treatment of the entire volume of 14,755 t will take about 15 weeks (for duration of the entire project see also section 2.5 below).

Effluent from the on-site treatment is foreseen to be discharged to the Sitnica River either by using the existing storm water system or a temporary discharge pipeline constructed for this purpose.
Effluent water quality will comply with the maximum concentrations of category IV as set out in the respective Kosovo regulation (Administrative instruction No. 13/2008 for the limited values of the effluents that discharged on water bodies and on the system of public canalisation). An exception is the sulphate concentration in the effluent which will be significantly higher than the maximum concentration indicated for category IV (see also tables 3.1 and 3.2). Special consideration is therefore given to this issue in annex 4.2 and in section 6.

The on-site treatment with Fenton’s agent requires the following subsequent steps for each batch which are outlined below:

- Transfer of batch of some 500 m³ LLOC to the upgraded concrete process basin
- Oxidation of phenols and other organic compounds through Fenton’s reaction (see above):
  - Adjustment of pH-value to pH 3 – 5 through addition of 0.3 m³ concentrated sulphuric acid (H₂SO₄).
  - Addition of Fenton’s reaction catalyst: 10 m³ of 35 % ferrous sulphate (FeSO₄) solution.
  - Addition of Fenton’s reaction oxidant: 15 m³ of 30 % hydrogen peroxide (H₂O₂) solution.
- Optional: Addition of up to 0.250 t activated carbon for adsorption of non polar organic compounds (if phenol or DOC and COD concentrations do not yet comply with category IV target, this will be verified by chemical analyses).
- Addition of lime milk (10 weight % suspension): 1 m³ for precipitation of sulphate as gypsum (CaSO₄•2 H₂O).
- Precipitation of heavy metals (as far as not precipitated as hydroxides in the previous step):
  - Addition of 0.02 m³ flocculant¹.
  - Adjustment of pH-value to pH 8,5 through addition of 0.7 m³ of 40 % sodium hydroxide solution (NaOH).
  - Precipitation of metal sulphides through addition of 0.5 m³ of 10 % sodium sulphide solution (Na₂S).

¹ Name and manufacturer of the flocculant can not be specified yet as this would not comply with WB tendering guidelines and rules. However, it will be specified in the tender documents that only flocculants can be used which are employed in waste water treatment processes and which are having no adverse effects on the environment. Specific documentation and certificates will have to be submitted by the contractor prior to contract awarding. Flocculants do not have adverse effects on the environment if employed according to manufacturer’s specification and if applied according to commonly accepted procedures. This applies for effluent as well as for residual sludge.
Discharge of the treated water to the adjacent Sitnica River. Discharge rate is 100 to 150 m³/h resulting in 5 to 3.3 h time for discharge of an entire batch volume.

Transfer of residual sludge with suction pump to neighbouring upgraded concrete basin for temporary storage until dewatering (see below). Residual sludge consists of solid residues of LLOC, activated carbon, precipitated metal hydroxide(s), gypsum and metal sulphides. The amount of sludge is estimated at 35 – 55 t per batch (prior to dewatering).

Collection of sludge from temporary storage basin with suction pump, dewatering with filter press to 40 – 50 % water content.

Disposal of dewatered sludge on the adjacent Kosovo A thermal power plant fly ash disposal facility in an engineered cassette made of low permeable clay (see also Fig. 6)

Overall amount of sludge from on-site treatment of LLOC is estimated at 500 to 800 t (after dewatering).

The technical measures outlined above are accompanied by organisational measures as following:

- Elaboration of detailed work concept by contractor prior to treatment of LLOC, including temporary storage and handling of chemicals employed in the process (addition and blending of chemicals) and reaction control measures as to prevent excess of permissible concentrations of organic compounds and metals in effluent and organic compounds in ambient air (addressed by an emission control plan). Transport, temporary storage and handling of chemicals employed in the treatment process will be according to applicable Kosovo regulation and/or established European standards. The work concept will also consider emergency case scenarios (accidents, spills, fire) with respective countermeasures.

- Employment of experienced staff, training of staff.

- Appropriate occupational health and safety measures.

- Chemical analyses of effluent as to ensure compliance with target values for discharge to Sitnica River.

- Monitoring of ambient air quality immediately downwind of treatment areas.

- Supervision (by contractor staff).

- Independent supervision and monitoring by contracting agency.

- Documentation.

Figure 5 (following page) Schematic diagram for on-site treatment of liquids with low organic content (LLOC). Note: The treatment process has been modified by introduction of an additional sulphate precipitation step (addition of lime milk) as to reduce sulphate freight in the effluent.
Table 2 provides an overview of the chemicals used in the on-site treatment process including the masses of liquids with low organic content (LLOC) (input) and the masses of treated effluent and sludge (output). Mass and volume estimates are based on the inventory of hazardous waste/chemical stored at the site and laboratory scale feasibility test for on-site treatment. Chemicals consumption will be verified and masses/volumes adjusted during an upgrading pilot test under site conditions prior to treatment of the entire volumes of LLOC.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Mass/Volume (approximate)</th>
<th>Unit</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLOC Liquids with low organic content (hazardous waste from site)</td>
<td>14,755 t</td>
<td>t</td>
<td>on-site treatment</td>
<td></td>
</tr>
<tr>
<td>FeSO₄-Iron sulphate solution (35 %)</td>
<td>300 m³</td>
<td>m³</td>
<td>Fenton’s reagent (catalyst)</td>
<td></td>
</tr>
<tr>
<td>H₂O₂ Hydrogen peroxide (30 %)</td>
<td>450 m³</td>
<td>m³</td>
<td>Fenton’s reagent (oxidant)</td>
<td></td>
</tr>
<tr>
<td>H₂SO₄ Sulphuric acid (concentrated)</td>
<td>10 m³</td>
<td>m³</td>
<td>pH-adjustment for phenol elimination by Fenton’s reagent</td>
<td></td>
</tr>
<tr>
<td>Powdered activated carbon</td>
<td>7.5 t</td>
<td>t</td>
<td>Optional, for elimination of residual phenol, TOC and/or COD</td>
<td></td>
</tr>
<tr>
<td>Ca(OH)₂ 10 % suspension (lime milk)</td>
<td>30 m³</td>
<td>m³</td>
<td>Reduction of sulphate in effluent, precipitation as gypsum</td>
<td></td>
</tr>
<tr>
<td>NaOH Sodium hydroxide solution (40 %)</td>
<td>20 m³</td>
<td>m³</td>
<td>pH-adjustment for metal precipitation</td>
<td></td>
</tr>
<tr>
<td>Na₂S Sodium Sulphite solution (10 %)</td>
<td>15 m³</td>
<td>m³</td>
<td>Metal precipitation</td>
<td></td>
</tr>
<tr>
<td>Flocculant</td>
<td>0.5 m³</td>
<td>m³</td>
<td>Metal precipitation</td>
<td></td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effluent</td>
<td>15,000 m³</td>
<td>m³</td>
<td>Discharge to Sitnica river</td>
<td></td>
</tr>
<tr>
<td>Dewatered sludge</td>
<td>500 – 800 t (dewatered)</td>
<td>t</td>
<td>Disposal in specially constructed cassette on adjacent Kosovo A TPP fly ash disposal facility</td>
<td></td>
</tr>
</tbody>
</table>

Table 2   Overview input and output for the on-site treatment of liquids with low organic content (LLOC). Chemicals used in the process are indicated. Mass and volume
estimates are based on inventory on hazardous waste/chemical stored at the site and laboratory scale feasibility test for on-site treatment. Chemicals consumption will be verified and masses/volumes adjusted during an upgrading pilot test under site conditions prior to full scale on-site treatment.

Tables 3.1 and 3.2 (following pages) provide a comparison of initial concentrations in LLOC and effluent quality (relevant parameters) after treatment with respect to Cat IV concentrations according to applicable Kosovo regulation (Administrative instruction No. 13/2008 for the limited values of the effluents that are discharged on water bodies and on the system of public canalisation). Data are based on representative samples obtained from LLOC stored at the site and laboratory scale feasibility tests. Effluent concentrations (with the exception of sulphate) meet the requirements thus having no adverse effects on Sitnica River water quality.

Management of sulphate in effluent and mitigation measures: Sulphate concentration and freight in effluent has already been considerably reduced with respect to the original design by introduction of an additional treatment step as a mitigation measure (see above). Effects of sulphate concentration in effluent on the Sitnica River have been assessed for various Sitnica River flow rates and effluent discharge rates (see freight assessment in annex 4.2). In consequence, a second additional technical mitigation measure has been introduced with the reduction of effluent discharge rate for very low Sitnica River flow rates. Treatment will be monitored with chemical analyses of batches after treatment and prior to discharge. If required, treatment of a single batch can be repeated. Discharge of treated effluent is subject to approval by an independent supervisor and will be permitted only if resulting temporary sulphate freight increase in the Sitnica River is tolerable (for details see assessment in annex 4.2).

Further reduction of sulphate in effluent would require additional treatment steps, infrastructure and time and would result in considerable additional costs. Considering the results of the freight assessment in annex 4.2., the tolerable impact and the temporary nature of the tolerable impact and the overall positive long term effects of the project, further additional treatments steps would not be commensurate.
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>-</td>
<td>9.0</td>
<td>8.5</td>
<td>6 – 8.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Phenols</td>
<td>mg/l</td>
<td>500</td>
<td>&lt; 0.01</td>
<td>0.015</td>
<td>-</td>
<td>0.15</td>
</tr>
<tr>
<td>TOC</td>
<td>mg/l</td>
<td>1,454</td>
<td>(365)* 4.5²</td>
<td>30</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>COD</td>
<td>mg/l</td>
<td>3,900</td>
<td>(480)* 6.4²</td>
<td>20 – 30</td>
<td>125</td>
<td>200</td>
</tr>
<tr>
<td>Al</td>
<td>mg/l</td>
<td>264</td>
<td>0.72</td>
<td>3.5</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Cd</td>
<td>mg/l</td>
<td>6.8</td>
<td>0.06</td>
<td>0.1</td>
<td>0.05</td>
<td>0.2</td>
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<tr>
<td>Co</td>
<td>mg/l</td>
<td>1.9</td>
<td>0.02</td>
<td>1.25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cr</td>
<td>mg/l</td>
<td>6.6</td>
<td>0.07</td>
<td>1.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Cu</td>
<td>mg/l</td>
<td>1.0</td>
<td>0.04</td>
<td>0.4</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Hg</td>
<td>mg/l</td>
<td>0.6</td>
<td>&lt; 0.01</td>
<td>0.01</td>
<td>0.03</td>
<td>0.05</td>
</tr>
<tr>
<td>Mn</td>
<td>mg/l</td>
<td>4.3</td>
<td>0.29</td>
<td>2.5</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Ni</td>
<td>mg/l</td>
<td>1.4</td>
<td>0.33</td>
<td>1.0</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Zn</td>
<td>mg/l</td>
<td>0.6</td>
<td>1.19</td>
<td>1.5</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Pb</td>
<td>mg/l</td>
<td>0.7</td>
<td>&lt; 0.02</td>
<td>0.75</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Sulphate</td>
<td>mg/l</td>
<td>Not indicated</td>
<td>2,500**</td>
<td>250</td>
<td>-</td>
<td>2,000</td>
</tr>
</tbody>
</table>

2 Laboratory tests showed efficient elimination of phenols, TOC and COD. Figures in italics show TOC and COD concentrations after treatment step “oxidation with Fenton’s reagent”. Further reduction of TOC and COD for specific batches may require (to be verified with chemical analyses) an optional treatment step with powdered activated carbon (non-italic figures for TOC and COD, see text for explanation).
Table 3.1 (previous page) Comparison of initial concentrations in LLOC prior to treatment and effluent quality (relevant parameters) after treatment. Data are based on representative sample obtained from Tank B 3 B left. Apparent increase of Zn-concentration after treatment is due to impurities of technical grade chemicals used in laboratory test.

* Concentrations prior to optional treatment step with PAC pulvred activated carbon. Non-Italic figures show TOC and COD after additional treatment step with powdered activated carbon

** Data are from D 5 after introduction of an additional step for sulphate reduction

*** Applicable Kosovo regulation (see text) with maximum permissible concentrations.


***** For comparison: Maximum permissible concentrations from German Ministry of Environment (17 June 2004) Administrative order on discharge of waste water to surface water bodies (Abwasserverordnung - AbwV), Annex 27 Chemical and physical waste treatment and waste oil recycling facilities, Annex 33 Flue gas treatment of Waste incinerator facilities.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>-</td>
<td>8.5</td>
<td>8.5</td>
<td>6 – 8.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Phenols</td>
<td>mg/l</td>
<td>890</td>
<td>&lt; 0.01</td>
<td>0.015</td>
<td>-</td>
<td>0.15</td>
</tr>
<tr>
<td>TOC</td>
<td>mg/l</td>
<td>2,040</td>
<td>*(64)*6.2(^2)</td>
<td>30</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>COD</td>
<td>mg/l</td>
<td>5,386</td>
<td>*(91)*7.9(^3)</td>
<td>20 - 30</td>
<td>125</td>
<td>200</td>
</tr>
<tr>
<td>Al</td>
<td>mg/l</td>
<td>0.115</td>
<td>&lt; 0.02</td>
<td>3.5</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Cd</td>
<td>mg/l</td>
<td>&lt; 0.001</td>
<td>0.019</td>
<td>0.1</td>
<td>0.05</td>
<td>0.2</td>
</tr>
<tr>
<td>Co</td>
<td>mg/l</td>
<td>&lt; 0.002</td>
<td>0.008</td>
<td>1.25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cr</td>
<td>mg/l</td>
<td>0.008</td>
<td>&lt; 0.008</td>
<td>1.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Cu</td>
<td>mg/l</td>
<td>0.011</td>
<td>0.003</td>
<td>0.4</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Hg</td>
<td>mg/l</td>
<td>&lt; 0.001</td>
<td>&lt; 0.001</td>
<td>0.01</td>
<td>0.03</td>
<td>0.05</td>
</tr>
<tr>
<td>Mn</td>
<td>mg/l</td>
<td>0.380</td>
<td>0.956</td>
<td>2.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ni</td>
<td>mg/l</td>
<td>0.307</td>
<td>0.085</td>
<td>1.0</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Zn</td>
<td>mg/l</td>
<td>0.020</td>
<td>0.251</td>
<td>1.5</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Pb</td>
<td>mg/l</td>
<td>&lt; 0.113</td>
<td>&lt; 0.113</td>
<td>0.75</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Sulphate</td>
<td>mg/l</td>
<td>Not indicated</td>
<td>2,500(^**)</td>
<td>250</td>
<td>-</td>
<td>2,000</td>
</tr>
</tbody>
</table>

\(^3\) Laboratory tests showed efficient elimination of phenols, TOC and COD. Figures in italics show TOC and COD concentrations after treatment step “oxidation with Fenton’s reagent”. Further reduction of TOC and COD for specific batches may require (to be verified with chemical analyses) an optional treatment step with powdered activated carbon (non-italic figures for TOC and COD, see text for explanation).
Table 3.2 (previous page) Comparison of initial concentrations in LLOC prior to treatment and effluent quality (relevant parameters) after treatment. Cat IV refers to concentrations according to applicable Kosovo regulation. Data are based on blended representative sample obtained from Tanks B 1, B 3 A, B 3 B, A 2 and R 3. Effluent concentrations meet the requirements with the exception of sulphate. Special consideration is given this issue in annex 4.2. Apparent increase of Cd-, Co-, Mn- and Zn-concentration after treatment is due to impurities of technical grade chemicals used in laboratory test.

* Concentrations prior to optional treatment step with PAC powdered activated carbon. Non-Italic figures show TOC and COD after additional treatment step with powdered activated carbon.

** Figure is from D 5 with additional step for sulphate reduction.

*** Applicable Kosovo regulation (see text) with maximum permissible concentrations.


***** For comparison: Maximum permissible concentrations from German Ministry of Environment (17 June 2004) Administrative order on discharge of waste water to surface water bodies (Abwasserverordnung - AbwV), Annex 27 Chemical and physical waste treatment and waste oil recycling facilities, Annex 33 Flue gas treatment of Waste incinerator facilities.

Table 4 (following page) shows chemical analyses of residual sludge after on-site treatment. Data are from sludge from laboratory scale feasibility tests. For comparison data from fly ash analyses (metals as relevant parameters) from Kosovo A TPP ash disposal facility are given. Residual sludge from on-site treatment show very similar composition with respect to fly ash from Kosovo A TPP. This is understandable as metals originate from lignite as input material for both lignite gasification and power generation and are not destroyed in the processes but transferred either to LLOC or fly ash.
### Table 4
Comparison of metal concentrations in sludge from on-site treatment (samples from laboratory scale feasibility test) and Kosovo A TPP fly ash as deposited on fly ash disposal facility. Sludge and fly ash are of very similar composition.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Sludge from on-site treatment (dewatered)</th>
<th>Kosovo A TPP fly ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>-</td>
<td>8.5</td>
<td>Not indicated</td>
</tr>
<tr>
<td>Al</td>
<td>mg/kg</td>
<td>&lt; 0.01</td>
<td>2.16</td>
</tr>
<tr>
<td>Cd</td>
<td>mg/kg</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Co</td>
<td>mg/kg</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Cr</td>
<td>mg/kg</td>
<td>&lt; 0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Cu</td>
<td>mg/kg</td>
<td>&lt; 0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Fe</td>
<td>mg/kg</td>
<td>2.51</td>
<td>3.75</td>
</tr>
<tr>
<td>Hg</td>
<td>mg/kg</td>
<td>&lt; 0.01</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Mn</td>
<td>mg/kg</td>
<td>0.01</td>
<td>0.14</td>
</tr>
<tr>
<td>Ni</td>
<td>mg/kg</td>
<td>&lt; 0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>Zn</td>
<td>mg/kg</td>
<td>&lt; 0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Pb</td>
<td>mg/kg</td>
<td>&lt; 0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

The residual sludge contains metals mostly as sulphides. Table 5 (following page) provides data from leachate analyses (DIN 38414-S4) performed on residual sludge from on-site treatment. Data are from sludge from laboratory scale feasibility tests.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Leachate</th>
<th>Cat IV Level</th>
</tr>
</thead>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Administrative Instruction 13/2008</td>
</tr>
<tr>
<td>pH</td>
<td>-</td>
<td>7.8</td>
<td>6.5 – 8</td>
</tr>
<tr>
<td>Soluble matter</td>
<td>%</td>
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<tr>
<td>Ammonium</td>
<td>mg/l</td>
<td>1.2</td>
<td>2.5 - 8</td>
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<tr>
<td>Cyanide</td>
<td>mg/l</td>
<td>&lt; 0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Nitrite</td>
<td>mg/l</td>
<td>&lt; 0.1</td>
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<td>Sulphide</td>
<td>mg/l</td>
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<td>4.0</td>
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<tr>
<td>Cr VI</td>
<td>mg/l</td>
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<td>0.15</td>
</tr>
<tr>
<td>Cr total</td>
<td>mg/l</td>
<td>&lt; 0.1</td>
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<tr>
<td>Al</td>
<td>mg/l</td>
<td>0.4</td>
<td>3.5</td>
</tr>
<tr>
<td>Ba</td>
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<td>4.0</td>
</tr>
<tr>
<td>Cd</td>
<td>mg/l</td>
<td>&lt; 0.01</td>
<td>0.1</td>
</tr>
<tr>
<td>Cu</td>
<td>mg/l</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Ni</td>
<td>mg/l</td>
<td>0.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Pb</td>
<td>mg/l</td>
<td>&lt; 0.1</td>
<td>0.75</td>
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<tr>
<td>Zn</td>
<td>mg/l</td>
<td>0.3</td>
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<tr>
<td>Co</td>
<td>mg/l</td>
<td>&lt; 0.1</td>
<td>1.25</td>
</tr>
<tr>
<td>As</td>
<td>mg/l</td>
<td>&lt; 0.01</td>
<td>0.2</td>
</tr>
<tr>
<td>Hg</td>
<td>mg/l</td>
<td>&lt; 0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Table 5  Leachate analyses (DIN 38414-S4) performed on residual sludge from on-site treatment. Data are from sludge from laboratory scale feasibility tests. Cat IV refers to concentrations according to applicable Kosovo regulation. Leachate concentrations provide an indication of possible mobilisation of inventory through water, which comply with quality criteria defined for discharge of effluent from on-site treatment to the Sitnica River. It should be however noted that the disposal of residual sludge on Kosovo A TPP fly ash disposal facility with the technical measures foreseen mitigates mobilisation through water leachate.
The dewatered sludge from the on-site treatment will be deposited in a specially constructed compartment with separate base liner and cover layer made of low permeable clay. The cassette will be constructed on the Kosovo A TPP fly ash disposal facility well above the groundwater level and will be covered with a low permeable fly ash cover with sufficient field capacity as to effectively prevent eventual infiltration of rain water.

The proposed deposition of sludge corresponds to the state-of-the-art “multi-barrier approach” and commonly applied good practice in Europe. Several elements are combined as to mitigate mobilisation of source potential with subsequent transport into sensible receptors (i.e. groundwater or surface water).
Barriers/retaining elements from top to bottom are:

- Geometry (inclined surfaces fostering run-off of rain water and reducing infiltration of rainwater).
- Vegetation cover and recultivation substrate layer (reducing infiltration of rainwater by evapo-transpiration).
- Cover with low permeable fly ash acting as water management stratum (field capacity of fly ash reducing/preventing infiltration of rainwater).
- Low permeable clay cover (reducing/preventing infiltration of rainwater).
- Low leachability of metals in sludge (as relevant source potential).
- Low permeable clay base liner (reducing/mitigating downward seepage of pore fluids from sludge and providing additionally high absorption/resorption potential for contaminants).
- Fly ash (field capacity retains pore fluids, metal are adsorbed).

The above-mentioned barriers/elements affectively and sustainable prevent mobilisation of source potential and impact on sensitive receptors and the environment.

Additional measures, such as packaging the dewatered sludge using containers or bags prior to deposition have been assessed. They do not provide an additional level of security and compromise the multi-barrier approach described above (differential settlement of clay cover over containers/bags with the risk of formation of joints/ruptures). Therefore packaging the dewatered sludge using containers or bags prior to deposition is not appropriate.

2.4 Permitting requirements

The following activities are expected being of relevance with respect to permits (in addition to the EIA and the above-described notification procedure):

- Handling of hazardous waste/chemicals on the site (both collection from the tanks and on-site treatment of LLOC)
- Discharge of effluent from on-site treatment of LLOC to the Sitnica river
- Disposal of sludge from on-site treatment on Kosovo TPP ash dump
- Transport of waste inside Kosovo
The activities as described above, with the exception of transport, will be covered by the Environmental Consent (approval) issued by the Ministry of Environment and Spatial Planning. KEK will apply for the Environmental Consent through the EIA Report.

The transport of dangerous materials in Kosovo is regulated through an Administrative Instruction (see annex A 3.1). The permit will be issued by the Ministry of Environment and Spatial Planning. Documents required for the application/permit are the ones required in the notification procedure for cross border transport of waste.

Permit for waste transport will be applied for by KEK (with support from the contractor providing technical documents, as applicable).

2.5 Project management organisation

The project management organisation is depicted in figure 8 (following page). The following stakeholders have been identified (with indication of major tasks/responsibilities):

- KEK j.s.c: Responsible for site rehabilitation, project management.
- Works supervisor: Supervision/control/monitoring of waste collection, disposal and on-site treatment. Independent entity on behalf of KEK (contracted by KEK).
- Authorities (Kosovo and others): Permits, notification procedure, supervision/control/monitoring.
- Contractor: Collection and transport of waste, on-site treatment, internal project management/supervision/control and monitoring.
- Disposal facilities (licensed incinerator plants/cement plants, subcontracted by contractor): Elimination of hazardous waste/chemicals.
Environmental aspects of project management organisation are addressed in the “EMP Environmental management plan: Collection and disposal/on-site treatment of hazardous waste from lignite gasification process”, attached as annex A 6.
2.6 Time schedule for implementation

Time schedule for project implementation is as following (indicative, excluding tendering and contract awarding):

- Start of activities: Spring 2010
- Duration of activities: 8 Months overall including notification procedure (3 - 5 months)
- End of activities: End of 2010

Most of the activities will be performed either in parallel or with considerable overlap. A detailed time schedule will be provided by the contractor prior to contract awarding.

2.7 Costs/Investments

Overall costs (contractor’s works, excluding independent supervision of works) are estimated as following:

*(Section deleted)*

Note: Cost estimates have been prepared by the technical designer based on respective price information from licensed disposal facilities and estimates of transport costs. Cost estimates are subject to market variations.

The above-indicated costs include all technical and organisational mitigation measures including the contractor monitoring programme but excluding the costs for the independent supervisor and the independent monitoring programme (see Annex 6, EMP, section 10).

2.8 Alternatives assessment

Alternatives have been assessed in the design process prior to identification of the technical approach as described above. Alternatives assessment also included the “zero option” without intervention of any type.
### 2.8.1 Alternatives assessment: Elimination of hazardous waste/chemicals in licensed disposal facilities

The following table provides a summary of the alternatives assessment for the elimination of hazardous waste/chemicals in licensed disposal facilities as described in section 2.3.1.

<table>
<thead>
<tr>
<th>Approach</th>
<th>Not feasible Rejected</th>
<th>Feasible Retained</th>
<th>Justification</th>
<th>Possible adverse environmental impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>„Zero Option“</td>
<td>X</td>
<td></td>
<td>Further deterioration of storage tanks likely</td>
<td>Contamination of soil, groundwater and surface water</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leakage risk</td>
<td>Site is not available for reclamation</td>
</tr>
<tr>
<td>Upgrading of storage facilities, continue storage at site</td>
<td>X</td>
<td></td>
<td>Hazardous waste/chemicals are not eliminated</td>
<td>Contamination of soil, groundwater and surface water (if upgraded facilities are not maintained)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No suitable interim storage available (type, capacity) as to cover upgrading time</td>
<td>Site is not available for reclamation</td>
</tr>
<tr>
<td>Immobilisation of hazardous waste/chemicals Disposal in landfill</td>
<td>X</td>
<td></td>
<td>Hazardous waste/chemicals are not eliminated</td>
<td>Considerable impact of emission from transport (noise, air)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Licensed landfill not available in Kosovo</td>
<td>Additional disposal volume required</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Impacts of transport to landfill outside Kosovo</td>
<td></td>
</tr>
<tr>
<td>Disposal/Re-use on-site or in Kosovo</td>
<td>X</td>
<td></td>
<td>TPP A and B are not licensed for hazardous waste disposal/re-use</td>
<td>Emission of hazardous substances to air</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Technical appropriate facilities (power plants/cement plants) not available in Kosovo</td>
<td>(if disposed of in non-licensed or technical inappropriate facilities)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Technical upgrading and permitting of existing plants not possible in short time and expensive</td>
<td></td>
</tr>
</tbody>
</table>
### Table 6  Alternatives assessment for the elimination of hazardous waste/chemicals in licensed disposal facilities.

<table>
<thead>
<tr>
<th>Approach</th>
<th>Not feasible</th>
<th>Feasible</th>
<th>Justification</th>
<th>Possible adverse environmental impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposal/Re-use off-site and outside Kosovo</td>
<td>X</td>
<td></td>
<td>No disposal/re-use facilities in Kosovo</td>
<td>Tolerable</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sustainable elimination of hazardous waste/chemicals and environmental risks</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Licensed disposal/re-use facilities available abroad (incinerator, cement plant)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Established BAT, no significant adverse effects</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Site is available for land reclamation</td>
<td></td>
</tr>
</tbody>
</table>

**Conclusion:** The selected approach “elimination of hazardous waste/chemicals in licensed disposal facilities” is to be considered feasible and the most suitable approach with respect to the overall project goals (elimination of environmental risks and preparation of site for land reclamation.

### 2.8.2 Alternatives assessment: On-site treatment of liquids with low organic content and elimination of hazardous compounds

Table 7 (following page) provides a summary of the alternatives assessment for the on-site treatment of liquids with low organic content and elimination of hazardous compounds as described in section 2.3.2.
<table>
<thead>
<tr>
<th>Approach</th>
<th>Not feasible</th>
<th>Feasible Retained</th>
<th>Justification</th>
<th>Possible adverse environmental impact</th>
</tr>
</thead>
</table>
| „Zero Option“                                                           | X            |                   | Further deterioration of storage tanks likely  
Leakage risk                                                                                                                                                                                                   | Contamination of soil, groundwater and surface water  
Site is not available for reclamation                                                                                                                 |
| Upgrading of storage facilities, continue storage at site               | X            |                   | Hazardous waste/chemicals are not eliminated  
No suitable interim storage available (type, capacity) as to cover upgrading time                                                                                                                              | Contamination of soil, groundwater and surface water (if upgraded facilities are not maintained)  
Site is not available for reclamation                                                                                                           |
| Immobilisation of liquids with low organic content                      | X            |                   | Hazardous waste/chemicals are not eliminated  
Licensed landfill not available in Kosovo  
Considerable costs for transport to licensed landfill outside Kosovo                                                                               | Considerable impact of emission from transport (noise, air)  
Considerable increase of volume to be disposed of                                                                                                 |
| Disposal in landfill                                                   | X            |                   | No disposal facilities in Kosovo  
Considerable masses (15,000 t) to be transported to disposal facilities abroad  
High costs                                                                                                                                                                                                 | Considerable impact of emission from transport (noise, air)                                                                                              |
| Disposal off-site (without prior immobilisation)                       | X            |                   |                                                                                                                                                                                                             |                                                                                                                                                     |
| Treatment on-site (microbiological)                                    | X            |                   | Unsuitable conditions (variation in composition, presence of other chemicals, temperature variation)  
Microbiological treatment was intended for effluent from gasification plant during operation time but never worked properly  
Impact on Sitnica River (if effluent is discharged after improper treatment)                                                                   |                                                                                                                                                     |
<table>
<thead>
<tr>
<th>Approach</th>
<th>Not feasible</th>
<th>Feasible Retained</th>
<th>Justification</th>
<th>Possible adverse environmental impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment on-site (oxidation with Fenton's Reagent)</td>
<td>X</td>
<td></td>
<td>Established process in waste water treatment</td>
<td>Tolerable</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Can be realised using existing facilities</td>
<td>(tolerable temporary effect on Sitnica River water quality due to sulphate freight)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Acceptable costs</td>
<td></td>
</tr>
</tbody>
</table>

Table 7 Alternatives assessment for the on-site treatment of liquids with low organic content

**Conclusion:** The selected approach “on-site treatment of liquids with low organic content and elimination of hazardous compounds” is to be considered feasible and the most suitable approach with respect to the overall project goals (elimination of environmental risks and preparation of site for land reclamation.

Note: The retained option “Treatment on-site (oxidation with Fenton’s Reagent)” includes deposition of residual sludge in an engineered cassette made of low permeable clay on the adjacent ash disposal facility of Kosovo A power plant. Alternatives have been considered (i.e disposal on ash disposal facility without engineered cassette and transport to/disposal of in waste disposal facility abroad) and have been assessed as non-feasible (potential mobilisation and transport emission / non commensurate costs).
2.9 Justification of project activities

Project activities are justified by the following reasons:

- Present situation (storage of hazardous waste/chemicals is subject to deterioration) with significant risk of leakage/spill and considerable impact on sensible receptors/the environment.
- Project activities will result in the elimination of the hazardous waste/chemicals and the environmental risks associated with deterioration of storage facilities, thus improving environmental situation at the site.
- The proposed activities are performed according to internationally accepted methods, standards and practice.
- The temporary adverse environmental impacts related to proposed activities are minimised and small compared to the achieved environmental benefits.
- Project activities are a pre-requisite for subsequent dismantling and removal of the derelict technical installations at the site.
- Project activities will contribute to future land reclamation.
3 Environmental Baseline Conditions

3.1 General Aspects

3.1.1 Geology

The geology of the area (the Kosovo Basin) comprises the following series (from top to bottom):

- Fluvial/alluvial inhomogeneous sediments (sand, gravel rich layers, clay beds), thickness about 6 m
- Silt and clay sequence (overburden) of varying thickness with occasional intercalated sand horizons and frequent shell beds.
- Lignite sequence with intercalated calcareous mudstones. Thickness of the lignite sequences is some 70 m.
- Fine-grained sediments (clays and silts) of Pliocene age. Overall thickness is some 100 m.
- Older Mesozoic and pre-Mesozoic sedimentary and igneous rocks (basement).

3.1.2 Hydrogeology

Soils that favour the development of useful groundwater reserves are poorly developed in the Kosovo Basin. Groundwater may be associated with the more fissured parts of the Pliocene and Quaternary deposits. The hydrogeological situation of the area is defined by the following main hydrogeological units. They are described below, from top to bottom (for thickness of formations see previous section).

- Shallow fluvial/alluvial aquifer (interfingering sand, gravel-rich and clay layers), locally good permeability (for more details see below).
- Silt and clay sequence (overburden). Clay layers are of low permeability. Faults, fissures and cracks can reportedly reach depths of 10 to 15 m from the surface, forming potential pathways for groundwater migration.
- Lignite sequence. The lignite itself is described having poor permeability, with a secondary permeability existing due to fissures and cracks within the coal. Close to the open cast mines the lignite sequence is dewatering into the mines.
- Fine-grained sediments (clays and silts) of Pliocene age. Permeability is very low, the sequence is an aquiclude, i.e. a non water bearing horizon.
Groundwater utilisation in the vicinity of the gasification plant site is restricted to private wells with a depth of 10 to 15 m in the overburden sequence. Well yields are modest (in the range of 3 l/min to 11 l/min with a maximum of Q = 54 l/min). Inhabitants in the area describe the wells as unproductive but sufficient for private use.

It should be noted, that the original groundwater flow regime (about which very little is known) is modified by the open cast mining operations. The mines act as a large groundwater sink / sump, thus regionally flow directions will have adjusted towards the mines.

### 3.1.3 Climate

The climate of the area is continental and is characterized by warm summers and cool winters, with moderate quantities of precipitation.

Average long-term precipitation for the Kosovo Basin is 590 mm/a, with a minimum annual precipitation of 372 mm and a maximum of 1,028 mm in the period 1948 to 2006. On average, every month has moderate rainfall, the driest months being January to March with long term averages of 35 mm; and the wettest months being May and June with average precipitation over 70 mm. Monthly variations in precipitation are considerable with every month of the year showing variations in precipitation between almost 0 mm and more than 100 mm.

Temperature data indicate that the average temperature in the area is 10°C with the lowest temperatures occurring in January and the highest in July. The absolute minimum temperature recorded is -25°C. Average summer temperatures (July –August) are some 20°C.

Data on prevailing wind directions are inconclusive. Prevailing wind direction is either indicated as being westerly (D 1) or from the North/Northeast (D 8). Visual observation of smoke from house chimneys and the power plant’s stacks during the site inspection on 18/19 November 2009 showed that wind direction close to ground (from southerly directions) can be almost opposite to wind direction in several hundred meters height (from northern to north-easterly directions).
3.1.4 Social Aspects

Current economic activity in the Region is dominated by KEK activities, primarily those involving lignite mining and power generation. 3,703 are employed in all KEK mining activities and a further 1,597 at both Kosovo A and Kosovo B power plants (data from D 8). About 10% of the locally population are therefore employed by the lignite mining and power industry, with possibly up to 40 % of population dependant on these jobs. No exact statistics are available on the general economic activities of the area. However unemployment in the region is high and based on information available from the Statistical Office of Kosovo is approximately 39%.

Much of the area in and around the generation and mining activities/facilities is used for agriculture with a mixture of arable and livestock development apparent. The agricultural activity consists predominantly of small properties and carried out, due to lack of affordability of modern agricultural machinery and facilities, in a simple manner.

3.2 Identification of environmental compartments potentially affected

The project is of limited duration (8 months, see section 2.6). Significant construction measures prior to regular operations are not foreseen. A separate assessment for construction, operation and post-operation phase is not required therefore.

Based on the descriptions of the activities in the previous section the following environmental compartments have been identified as potentially affected (either by project activities or by emissions or other consequences due to the planned activities including accidental situations) by the project:

- Air (contamination)
- Water (groundwater/surface water)
- Soil (contamination)
- Air (noise)
- Settlements (residential area/residents)
- Biosphere (land use)
The EIA is focussed on potentially affected environmental compartments. The present situation (prior to project activities) with respect to the above-identified compartments is summarised in the following sections.

3.3 Baseline conditions of environmental compartments potentially affected

3.3.1 Air (contamination)

There are no quantitative monitoring results available of the current air quality at the shut down gasification plant site.

In a more qualitative and subjective way intensive odour of phenols and polycyclic aromatic hydrocarbons (PAHs) on the entire site and at the open tar deposit can be observed. Olfactory evidence of di-isopropylether as one of the substances stored in larger quantities also occurs in the proximity of to the corresponding tanks.

The manholes on the tanks roofs of the vertical tanks are reported as being open. As a consequence, gaseous and vaporous substances are released into the atmosphere. Data on concentrations and amounts are not available.

As a conclusion even in absence of quantitative data it can be retained that emissions from the shut down gasification plant occur, which are observable significantly in the direct proximity of the sources and which dissipates with increasing distance.

Beside the described current emissions from the sources remaining at the shut down gasification plant there are significant emissions from the adjacent operating lignite fired power plant and its emissions (dust, fly ash, SO₂ etc.) which can be observed at the site of the shut down gasification plant and can be considered as local background for the air quality.

In summary, there are some, though not quantifiable local emissions at present from the sources (wastes, chemicals, by-products) remaining at the shut down gasification plant.

There is a considerable dust emission and corresponding impact on air quality from the adjacent power plants, ash tipping and mining operation as well as SO₂ from the power plants smoke stacks.
3.4 Water (groundwater and surface water)

The uppermost aquifer at the site consists of inhomogeneous alluvial sediments with intercalated sand, gravel rich layers and less permeable clay beds. Thickness of this sequence is about 6 m. The groundwater table is between 1.35 to 2.6 m below surface. Groundwater flow direction is generally toward the west (Sitnica River) with a gradient of approximately 1 %. Hydraulic conductivity is between $5 \times 10^{-4}$ to $5 \times 10^{-5}$ m/s. Groundwater flow velocity is estimated at 0.4 to 4.0 m/day, considering an effective porosity of 10 %. The aquifer most likely discharges partially into the Sitnica river fluvial aquifer and the Sitnica River.

Below the shallow alluvial aquifer are the clayey sediments of the Kosovo Basin with embedded lignite layers (see sections 3.1.1. and 3.1.2.).

The shallow groundwater at the site locally shows elevated concentrations of organic compounds (PAH, Xylene) likely originating from the gasification process, which confirms evidence of impact on the groundwater. However, according to D 1 groundwater remediation is not required.

There are no surface water bodies at the gasification plant site. The nearest surface water body is the Sitnica River some 800 to 1,000 m to the West of the shut down gasification plant site. The present Sitnica river bed is artificial after relocation of the original course in the context of open cast lignite mining.

No data have been made available from government sources with respect to Sitnica River water quality. Limited data are available from a chemical laboratory contracted by KEK and have been considered in the sulphate freight assessment (see annex 4.2). According to oral information from KEK representatives, Sitnica River water quality is equivalent to cat IV of Kosovo regulation (Administrative instruction No. 13/2008 for the limited values of the effluents that are discharged on water bodies and on the system of public canalisation). This means that the Sitnica River is considerably influenced by domestic and industrial discharges.
Flow rates for the Sitnica River are as following (D 1 and D 6):

- Min: 0.5 – 1.5 m³/s
- Max: 50 – 120 m³/s
- Average: 5 – 10 m³/s

Data on annual variation of Sitnica river flow rates are not available but seasonal variations are to be assumed (e.g. snow melting in spring in near mountain ranges, dry summers).

The Sitnica flows into the Ibar River at Mitrovica some 30 km downriver. The Ibar River later discharges into the Danube via the Zapadna Morava River.

The storm water/sewer system from the shut down gasification plant site discharges into the Sitnica River without pre-treatment. With the exception of phenol concentrations (0.05 to 0.20 mg/l in the first half of 2008, D 1) reliable data are not available on discharge quality and rates from the sewer system of the shut down gasification plant.

### 3.5 Soil/Subsoil

The A-horizon (uppermost layer) consists of brown coloured fine-grained clayey material, well penetrated by grass and shrub roots. It is low in carbonates.

The B-horizon is of dark brown colour and consists of clayey low permeable sediments with some clayey-silty and sandy lenses. The B-horizon extends until about 2 m below surface.

Below the B-horizon the subsoil consists mainly of brown coloured clay and gravelly sand.

According to D 1 soil and subsoil do not show elevated concentrations of contaminants beyond natural background with respect to metals and PAH.
3.6 Air (Noise)

There are no data available of the current noise level at the shut down gasification plant site.

Noise is caused on the site by the compressor station situated within the perimeter of the gasification plant site and serving the power plant. The compressor plant presumably works 24 h a day. All other facilities are shut down, such that further noise from the shut down gasification plant is mainly limited to occasional incoming and leaving car traffic and occasional works executed at the site.

On the entire site there is a continuous, though not quantifiable, back ground noise level caused by the adjacent power plant and the conveyor belts transferring lignite from the open cast mine to the power plant.

3.7 Settlements (Residential Area/Residents)

The gasification plant is located in the Obilic municipality. The nearest settlements are:

- Obilic, approx. 500 m the North of the site, and
- Dardishte, located at a distance of approx. 500 m to the South

Obiliq has a population of some 31,000. There are no reliable data available with respect to number of households or number of inhabitants in the villages other than Obiliq. Overall number of inhabitants in the area is estimated at some 45,000.

The settlements are mostly one-story houses with gardens (partially with fruits or vegetables) and of limited extent (rough estimate below few thousand inhabitants). There is no evidence of specific areas with higher sensitivity like, for example, hospitals.
3.8 Biosphere (Land Use)

The project area is exclusively in the industrial area of the shut down gasification plant.

The land around the shut down gasification plant site includes extensively used agricultural areas and green fields. Forested areas are not present in closer distances.

Within the gasification plant perimeter the vegetation (natural succession of grass, shrubs and small trees) is naturally growing at many places. However, they are not considered ecosystems of particular relevance.

The Sitnica River represents the only aqueous ecosystem of relevance in the immediate vicinity of the plant site. As previously mentioned, Sitnica river water quality is heavily affected by domestic and industrial waste water.

Reliable plans, inventories or other data on specific land uses or biotopes, nature conservation areas and the like are not available.

3.9 Other aspects

Other aspects, like socio-economic conditions and social and cultural issues are not of relevance in the particular direct context of the project due to the short implementation period (8 months) and the nature of the project.

However it should be noted that the planned activities will have several positive effects such as:

- Employment to implement works (transitional)
- Improving living quality environment
- Contribution as step forward to anticipated long term revitalisation of the shut down gasification plant area.
4 Emissions and potential adverse effects caused by planned activities

In the following sections the potential adverse effects and emissions related to the planned project activities are described with respect to the relevant environmental compartments or receptors identified in the previous section.

A separate section covers accident scenarios.

4.1 Air (contamination)

Emissions from sources (wastes and by-product stocks handled during remedial actions):

Additional emissions may arise from the identified sources in the moment of their handling: Opening of the tanks, collection of the waste and chemicals from the tanks and pumping/loading to transport vehicles may cause emissions of gaseous and vaporous compounds into the atmosphere. These emissions will be of temporarily and locally limited character and depend very much on the actual environmental conditions (temperature, moisture, wind) and of the work sequence and work technologies: By minimising extent (in geometry and duration) of direct contact of potential sources of emissions with the atmosphere and avoiding too unfavourable weather conditions (hot, dry, windless) emissions will be correspondingly minimised. The highest impact will be at the direct places of work such that the leading motivation to respect such proceedings will be the health and safety provisions, which are part of the tender specifications for works. The respect of health and safety provisions will imply the sufficient mitigation of air emissions.

On-site treatment of the liquids with low organic contents may cause emissions of gaseous and vaporous compounds into the atmosphere. Mitigation measures are foreseen to prevent release of gaseous and vaporous compounds into the atmosphere already by the health and safety requirements to protect workers also limiting impact on the atmosphere (maximum permissible concentrations in ambient air).

Therefore, although the total impact of air contamination can not be quantified in advance, it can be concluded that

- the impact to atmosphere will be temporarily and locally limited to the time, duration and locations of specific works and
the mitigation measures foreseen to prevent exposure of workers to gaseous and vaporous compounds beyond tolerable level (maximum permissible concentrations in ambient air) will contribute to further (and more than sufficient) reduction of impacts to the atmosphere.

Emissions from transports:

In order to reduce transports to the reasonable extent the on site treatment and elimination of wastes is applied for the majority of the inventory to be treated (14,000-15,000 t). Only wastes (about 5,500 t) which can not be treated or eliminated on or near site are foreseen for transport to licensed disposal facilities outside Kosovo. Assuming road transport and lorry loading capacity of 24 t this corresponds to about 230-250 lorries in total, over a period of time of about 2-3 months. One can assume a typical circulation of up to 5 to 10 lorries per day over a limited period. Therefore, although emissions due to transport (e.g. diesel fuel consumption) can not be quantified as transport means and distance to disposal facilities are unknown at present, they can be considered as tolerable. Emissions due to transport are not concentrated to the gasification plant site but spread over the entire transport distance.

Long distance transport should be preferably done by rail as to reduce emissions from fuel consumption but will depend very much of the location of the disposal facility.

Emissions are also caused by the waste disposal facilities (incinerator plants/cement plants). As the disposal facilities are licensed, potential adverse effects are addressed in the respective operation/disposal permits and mitigation measures in place and are therefore considered to be acceptable.

4.2 Water (groundwater/surface water)

The collection of waste and chemicals from the tanks, pumping/loading to transport vehicles is made to prevent potential impacts on groundwater and surface water from the sources still existing on the site.

Most of critical activities are at the tank storages in retention basins or on specially prepared work areas (impermeable liner) such that in the event of unplanned spills liquids and other
materials will be retained. Therefore no additional adverse impacts are expected through these activities limited in extent and time.

The foreseen on-site treatment of the liquids with low organic content (LLOC) will be performed only for a limited amount and in waterproofed basins upgraded with a liner such that no additional adverse impact on groundwater is to be expected.

The treated effluent is discharged to the Sitnica River, so there will be an impact on the surface water body. Because the chosen process is a batch process there is no risk of throughput of contaminants such that even in the case of process failures during treatment the effluent can be retained and retreated until results will be obtained that comply with the set effluent criteria (cat IV requirements for discharge into surface waters) as outlined in section 2.3.2. The only parameter of relevance is sulphate where additional measures are foreseen to mitigate negative effects (see chapter 2.3.2):

- Additional sulphate precipitation
- Control and adaptation of discharge flow rate to limit impact to Sitnica river, especially in vulnerable low water situations

A detailed assessment of sulphate discharge to the Sitnica river and the corresponding impact is given in annex 4.2.

Temporary storage of residual sludge from on-site treatment of the liquids with low organic content (LLOC) prior to dewatering will have no adverse effects on groundwater and/or surface water.

Deposition of the dewatered sludge from on-site treatment of the liquids with low organic content (LLOC) in a engineered cassette on the ash disposal facility of Kosovo A power plant will have no adverse effects on groundwater and/or surface water.

4.3 Soil/subsoil

The planned project activities will have no adverse impact on soil and subsoil. Consequences of possible spills during activities are to be covered by a spill management plan.
4.4 Air (Noise)

The project activities will cause noise emissions mainly in a very limited extent and over a limited duration from the following sources:

- Pumps
- Generators
- Transport and other vehicles

They can be considered tolerable with regard to the industrial nature of the site, the general noise level at the site from the adjacent power plant and the conveyor belts, distance to next settlements (residential areas) and the limited duration of the activities.

With regard to noise due to road transport not only the number of lorries per day are small compared to normal traffic (in average up to 5 to 10 lorries per day) but will be also limited to normal working hours and working days. Where possible, transport routes bypassing residential areas and railway transport are to be given preference.

4.5 Settlements (Residential areas)

The project activities will cause no emissions having an adverse effect on settlements and residential areas.

The exception is noise from transport vehicles in residential areas outside the plant. The number of additional traffic compared to normal traffic will be negligible (in average up to 5 to 10 lorries per day) and appropriate mitigation measures are foreseen (see previous section).

4.6 Biosphere (Land Use)

The planned project activities will not use any land other the site itself or adjacent industrially used land. Further, the planned activities including appropriate mitigation measures do not result in emissions in terms of contaminants or noise having an adverse impact on the biosphere/land use in the neighbourhood.
4.7 Other potential adverse effects

Project activities have no adverse effects other than described above. Other adverse effects of project activities are prevented by the particular nature and design of the activities including supplementary technical and organisational measures, mitigation measures as well as occupational health and safety measures.

4.8 Accident scenarios

The following accidents scenarios could cause adverse effects (with environmental compartments/receptors likely affected):

- Spill/leakage during collection/loading of chemicals and on-site treatment (soil, groundwater, surface water)
- Fire during collection/loading of chemicals (air, biosphere, settlements)
- Spill/leakage during transport to disposal facility (soil, groundwater, surface water, others)
- Fire during transport to disposal facility (air, settlements, biosphere)

Fire accident probability and consequences are to be addressed by the health and safety plan and the emergency plan. For fire accident scenarios it can reasonably be assumed that the volume of inflammable substances involved is limited to about 20 m³ (volume of tank lorry/tank car, volume of largest storage tank on-site with inflammable substances) thus limiting the environmental damage. Formation of polychlorinated dioxines and furanes (PCDD/PCDF) in fire accident is not an issue as the hazardous substances stored at the site do not contain chlorinated organic compounds.

Management of spills and consequences are to be addressed by a spill management plan. For spill scenarios it can also reasonably be assumed that the maximum volume of hazardous substances involved is limited for similar reasons as outlined above. Further damage to soil and groundwater can be limited by excavating soil at the spill site, temporary storage in containers or on sealed storage areas (PE-layer or the like) and proper disposal.
Damage to surface water in spill scenarios can be limited by controlling/closing sewage system discharge.

Technical (health and safety provisions) and organisational measures (health and safety plan) will be foreseen as to reduce accident probability.

Technical (health and safety provisions, spill management provisions, emergency provisions) and organisational measures (health and safety plan, spill management plan, emergency plan) will be foreseen as to cope with and limit adverse consequences in accident scenarios (e.g. alert of fire fighting brigade, police and hospital; alert of technical equipment to cope with accident scenarios).
5 Mitigation measures

A variety of mitigation measures has been introduced into the project as to reduce eventual adverse effects to the possible extend and financially feasible. The measures are technical and organisational.

The technical measures are summarised as following:

- Technical emission control measures where appropriate and required (i.e. tank lorries/tank cars equipped with activated carbon filters to capture vaporous/gaseous emission, inert gas for flooding residual tank volumes).
- Construction of temporary access roads to tanks/storage areas and temporary upgrading of loading areas (impermeable liner) as to prevent infiltration into the subsoil in case of minor spills and leakages.
- Selection of an on-site treatment technology for treatment of the LLOC liquids with low organic contents resulting in an effluent quality complying with the respective cat IV requirements according to Kosovo regulations for discharge into the Sitnica River (with the exception of sulphate, see below).
- Introduction of an additional sulphate precipitation step into the on-site treatment of the LLOC liquids with low organic contents as to reduce short term effects of sulphate freight discharged into the Sitnica River to a tolerable level.
- Adaptation of batch discharge rate from on-site treatment of LLOC liquids with low organic contents to Sitnica River water flow regime as to limit short term effects of sulphate freight discharged to a tolerable level.
- Upgrading of the existing basins foreseen for on-site treatment and temporary storage of sludge prior to dewatering as to effectively prevent leakage into the subsoil.
- Technical scale on-site pilot test as to detail treatments parameters for on-site treatment of LLOC liquids with low organic content (chemicals consumption).
- Deposition of residual sludge from on-site treatment of LLOC liquids with low organic contents on Kosovo TTT A ash disposal facility according to multiple barrier concept.
- Chemical analyses (as required for identification of waste disposal facilities and permitting procedures)
- Monitoring (air quality inside tanks, ambient air quality outside tanks/storage areas) during collection of hazardous waste/chemicals
- Further provisions for health and safety, spill management, emergency situations (e.g. as specified in health and safety plan, spill management plan, emergency plan)
The technical measures as summarised above are accompanied by complementary **organisational measures** as following:

- Contract award only to contractor with proven track record demonstrating competence, experience with similar projects, availability of competent staff and identification of licensed disposal facilities including supporting documents.
- Detailed assessment of tank/storage area and other local conditions prior to collection of hazardous waste/chemicals and on-site treatment.
- Elaboration of detailed work and control/supervision/monitoring concept by contractor prior to collection of hazardous waste/chemicals and on-site treatment including health and safety plan addressing counter measures in case maximum permissible concentrations in ambient air are exceeded.
- Integration of emergency case scenarios (accidents, spills, fire) into the above-mentioned work concept through a spill management and an emergency plan addressing respective counter measures.
- Access control
- Training of contractor staff
- Appropriate occupational health and safety measures
- Supervision (by contractor staff)
- Independent supervision by contracting agency
- Documentation

The above-mentioned technical and organisational mitigations are embedded in a comprehensive environmental management plan (see annex 6).
6 Summary assessment

Table 8 (following page) summarises the situation at present (prior to implementation of the project), potential impact of planned project activities, mitigation measures in place, assessment of effects as well as the situation after project implementation.

The project follows established standard approaches for the collection and disposal of hazardous waste in licensed disposal facilities.

The on-site treatment of LLOC liquids with low organic content is an adaptation of a well established industrial waste water treatment technology.

Discharge of effluent from on-site treatment to the Sitnica River does not have adverse effects on the river. Short term increase of sulphate freight from effluent is tolerable and does not have adverse effects.

Deposition of dewatered sludge from on-site treatment on the Kosovo A ash disposal facility in an engineered follows an established multi-barrier approach and does not have adverse effects on the environment.

Efficient mitigation technical and organisational measures are foreseen as to prevent or limit adverse effects to the extend possible and feasible.

Remaining adverse affects are tolerable in terms of duration and intensity.

The project activities result in a significant and sustainable improvement of the environmental situation at the site with elimination of environmental hazards from storage of hazardous waste/chemicals at the site and elimination of the hazardous waste/chemicals. Project activities prepare the site for dismantling of technical installation and future land reclamation. Overall projects goals thus are efficiently achieved.

Long term positive effects of the project by far outweigh adverse effects.

Table 8 (Following page) Summary situation at present (prior to implementation of the project), potential impact of planned project activities, mitigation measures in place, assessment of adverse effects and situation after project implementation.
## Potential impact on environmental compartments/potential receptors

<table>
<thead>
<tr>
<th>Situation</th>
<th>Activities/scenarios</th>
<th>Potential impact on environmental compartments/potential receptors</th>
<th>Mitigation measures</th>
<th>Summary assessment adverse effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial condition prior to project activities</td>
<td>Yes (emission from contaminant sources on site)</td>
<td>Risk (leakage of tanks)</td>
<td>Tolerable</td>
<td>None</td>
</tr>
<tr>
<td>Project activities (with mitigation measures)</td>
<td>Transfer of hazardous waste/chemicals, to licensed facilities</td>
<td>None (collection)</td>
<td>Tolerable</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Yes (transport, disposal)</td>
<td>Risk (leakage of tanks)</td>
<td>Tolerable</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>On-site treatment of LLOC (including sludge disposal)</td>
<td>Tolerable (sulphate in effluent/impact on Sitnica River)</td>
<td>None</td>
<td>(See water)</td>
</tr>
<tr>
<td>Accident scenarios</td>
<td>(low probability, adverse effects limited)</td>
<td>(low probability, adverse effects limited)</td>
<td>None</td>
<td>Technical and organisational</td>
</tr>
<tr>
<td>After project implementation</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>